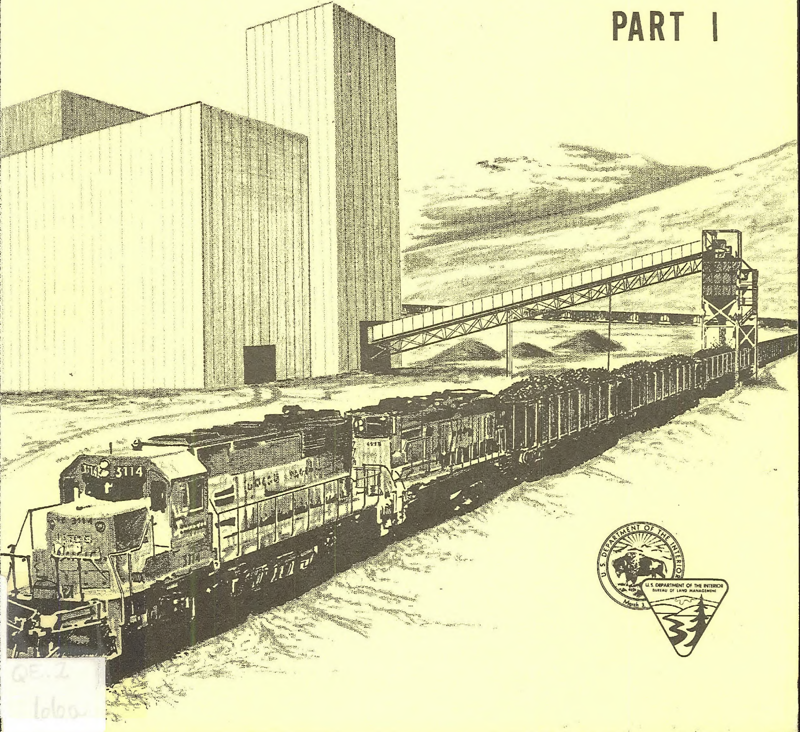
GREEN RIVER-HAMS FORK

DRAFT ENVIRONMENTAL IMPACT STATEMENT

COAL

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

PART I



IN REPLY REFER TO

United States Department of the Interior

BUREAU OF LAND MANAGEMENT

COLORADO STATE OFFICE
ROOM 700, COLORADO STATE BANK BUILDING
1600 BROADWAY
DENVER, COLORADO 80202

1792 (922)

NOTICE

Enclosed is the Draft Green River-Hams Fork Regional Coal Environmental Impact Statement. Your review and comments regarding this Draft Environmental Impact Statement (DEIS) are invited. Please direct your written comments to the EIS Team Leader, Bureau of Land Management, Craig District Office, P.O. Box 248, 455 Emerson Street, Craig, Colorado 81625.

Public hearings will be held in Colorado and Wyoming according to the following schedule:

June 23, 1980
Auditorium
Denver Public Library
1357 Broadway
Denver, Colorado
1:00 p.m. and 7:30 p.m.

June 24, 1980
Auditorium
Moffat County Courthouse
W. Victory Way
Craig, Colorado
7:30 p.m.

June 25, 1980
West Room
Jeffery Center
3rd and Spruce
Rawlins, Wyoming
7:30 p.m.

June 26, 1980
Little America
West of Cheyenne
Cheyenne, Wyoming
7:30 p.m.

Written requests to testify should be submitted to the EIS Team Leader at the above address prior to the close of business on June 18, 1980.

Written comments received by July 8, 1980, and testimony presented at the public hearings will be fully considered and evaluated in preparation of the Final Environmental Impact Statement (FEIS). Those comments that pertain to the adequacy of the impact assessment or present new data, will be addressed in the FEIS.

Please retain your copy of the DEIS. Portions of this document will probably not be reprinted if changes in response to comments on that particular section are minor.

Charles W. Luscher
Acting State Director

DRAFT

GREEN RIVER - HAMS FORK REGIONAL COAL

ENVIRONMENTAL IMPACT STATEMENT

Prepared by:

BUREAU OF LAND MANAGEMENT

DEPARTMENT OF THE INTERIOR

Charles W. Luscher

ACTING STATE DIRECTOR

COLORADO STATE OFFICE

GREEN RIVER/HAMS FORK REGIONAL COAL
ENVIRONMENTAL IMPACT STATEMENT

Draft (X)   Final ( )

The United States Department of the Interior, Bureau of Land Management

1. Type of Action: Administrative (X)   Legislative ( )

2. Abstract: Under regulations of the Federal Coal Management Program (43 CFR 3400), the Bureau of Land Management proposes to offer for lease 13 tracts of coal in Northwest Colorado and Southcentral Wyoming to meet the nation's future energy needs. Coal production from these tracts is expected to meet a 1987 annual shortfall of new production of 18.5 million tons and to allow existing mines to continue operation. The environmental impacts of four leasing alternatives, including the Preferred Alternative, are analyzed in this EIS, as well as a No Action Alternative. The Preferred Alternative would foster the production of 789.5 million tons of coal, increase employment in the region by 3,150 by 1995, increase population by 6,827 by 1995, and result in the cumulative disturbance of 33,433 acres of land. The impact analysis shows that generally most impacts gain their significance by adding to greater impacts brought on by other developments in the area.

3. Comments have been requested from the following:

   See attached list.

4. For further information, contact:

Dan Martin, Team Leader
Bureau of Land Management
Craig District Office
P. O. Box 248
Craig, Colorado 81625
Telephone: (303) 824-8186

5. Comments on the draft statement must be received no later than:

   July 8, 1980

DISTRIBUTION LIST

FEDERAL AGENCIES

Department of Agriculture
- Farmers Home Administration
- Forest Service
- Soil Conservation Service

Department of the Army, Corps of Engineers
Department of Commerce
Department of Defense
- Environmental Control Office

Department of Energy
Department of Health, Education and Welfare
Department of Housing and Urban Development

Department of the Interior
- Federal Energy Regulatory Commission
- Fish and Wildlife Service
- Geological Service
- Heritage Conservation and Recreation Service
- National Park Service
- Office of Surface Mining

Department of Justice
Department of Labor, Mine Safety and Health Administration
Department of Transportation
Environmental Protection Agency
Interstate Commerce Commission
Nuclear Regulatory Commission
Office of Economic Development Admin.

STATE AGENCIES

Colorado State Clearinghouse
Wyoming State Clearinghouse

LOCAL AGENCIES

County Government, Councils & Commissions
- Carbon
- Moffat
- Rio Blanco
- Routt
- Summit
- Sweetwater
- Uinta

Carbon County Council of Governments
Colorado West Area Council of Governments
Public Lands Council
Water Resources Council

MAJOR SPECIAL INTEREST GROUPS

Colorado Cattlemen's Association
Colorado Mining Association
Colorado Open Space Council
Colorado Wilderness Society
Colorado Wool Growers Association
Environmental Defense Fund
Friends of the Earth
National Coal Association
National Resources Defense Council
National Wildlife Federation
Public Lands Institute
Rocky Mountain Coal Association
Sierra Club
Western Interstate Energy Board

OTHER ORGANIZATIONS AND INDIVIDUALS

Numerous organizations and individuals expressing interest in the proposed action have been sent copies of this statement and have been invited to comment.

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CONTENTS

SUCCESSFUL STRIP MINE RECLAMATION IN COLORADO

Photo: David Bray 1979

STRIP MINE IN COLORADO

Photo: Bureau of Land Management 1975

SUMMARY

This Environmental Impact Statement (EIS) is intended to be apart of the decision-making process, providing information to the Secretary of the Interior and the public concerning the use of national resources. It has been prepared to comply with regulations of the Council on Environmental Quality (CEQ) issued November 29, 1978 (43 FR 55978-56007), which emphasize concentration on significant issues and impacts. This emphasis sharply defines the options and provides a clear basis for choice by the decision-maker and the public.

PART I

Section 1, Purpose and Need for Action, identifies the need for new Federal leasing in the Green River/Hams Fork region to meet national energy goals and provides background information, which puts this need in perspective. It outlines the methods used to select and combine coal mining tracts into alternatives for meeting production goals. This section also details the concerns raised by government agencies and the public. Those concerns which this EIS assess are: secondary as well as primary impacts; the wishes of adjacent landowners; reclamation; air quality; water quality; water storage, depletion and use; cultural resources; municipal funding; community facilities such as sewers, water, schools, etc.; boom town effects like mental health, crime, etc.; and the overall energy efficiency of mining coal.

Section 2 Alternatives Including the Proposed Action, presents five alternatives for environmental analysis: Maximum, High, Medium, Low, and No Action, corresponding to the levels of coal production the alternatives would provide. The Regional Coal Team, an inter-governmental committee charged with supervision of this EIS effort, has selected the High Alternative as the Preferred Alternative, which would best meet the needs for coal. The No Action Alternative is a forecast of anticipated impacts without new Federal coal leasing against which the magnitude of the impacts of the other alternatives can be measured. The Secretary of the Interior may select any of these alternatives or some other alternative determined from the information provided in this document.

Section 3, Affected Environment, identifies the study area for each affected resource and describes the environment as it exists at this writing and forecasts its condition without new Federal coal leasing through the next 15 years.

Section 4, Environmental Impacts, is a resource by resource analysis of the impacts of new Federal coal leasing. Here the reader can find the detailed explanations for the impacts presented in Section 2. Thus if a reader wants to understand the impacts on raptors caused by the various alternatives, he may turn to the Wildlife portion of this section for an explanation.

PART II

Each of the alternatives analyzed in the EIS is composed of a combination of mining tracts. These tracts were analyzed individually in documents called Site-Specific Analyses, which have been summarized in this document as Site-Specific Matrices. These matrices are supplied as a reference and show the basis of the EIS analysis. They should be used with caution since new data has become available during the preparation of the EIS. In addition, the alternative analysis is often more complex than a simple addition of the impacts noted in the matrices.

In those cases where methodology was too long or too complex to be easily presented in the body of the EIS, it has been placed in an appendix, which appears in Part II following the Site-Specific Matrices.

HIGHLIGHTS AND CONCLUSIONS

GENERAL CONCLUSIONS

This EIS generally shows that the No Action Alternative will have impacts considerably greater than any of the proposed alternatives. Most impacts, which can be attributed to new Federal leasing, gain their significance by adding to an already taxed situation.

The alternatives do not differ from one another by the nature of their impacts, they differ only in their magnitude. The alternatives will produce impacts generally in proportion to the coal produced.

The magnitude of these impacts tend to be diminished when measured across the entire Green River/Hams Fork region, but are compounded when measured locally. Most of the impacts will occur in two relatively small areas in Colorado and Wyoming. There are five coal mining tracts in Wyoming, which are included in all of the proposed alternatives, so the impact analysis for Wyoming is identical for each alternative.

All of the alternatives, including the No Action, would further commit the region to a single economic base--coal. Therefore, the stability of the region's economy will be linked to the cycles of the nation's coal industry. However, this impact may be offset by increased income opportunities.

GEOLOGY AND MINERAL RESOURCES

Large quantities of valuable minerals which could be economically exploited exist in the study area. Coal production would not generally interfere with extraction of other minerals and would not destroy especially valuable paleontologic resources.

SOILS

Soils in the area are often shallow and difficult to reclaim because of low productivity and steep slopes, but regulations enforced by the Office of Surface Mining would assure satisfactory reestablishment of equivalent soils.

WATER RESOURCES

All impacts caused by new Federal leasing would be very small and become significant only when they compound affects of the No Action Alternative. An example is the salinity predictions. The adopted limits or threshold for salinity at Imperial Dam is 879 mg/L while the trended environment, shown in the No Action Alternative, would increase this to 1,046 mg/L. New Federal leasing would increase this figure by at most .2 mg/L. Impacts to the water supply tend to be small because the disturbances are centered away from the high mountains, which are the prime water producing regions. Consumption of water will not appreciably increase but the consumer will change from agriculture to industry and human population.

Increased sewage resulting from all of the alternatives, including the No Action, could combine with low stream flows during drought and seriously affect aquatic biology. No data models are available to predict the magnitude of this impact, but it should be given serious consideration, especially for low flow conditions in the Yampa River below Craig, Colorado.

VEGETATION

Present technology may not allow the reestablishment of disturbed native vegetation. Loss of native plant communities and replacement with introduced communities could mean the loss of productivity, vegetative diversity, resiliance, and soil stability. This would result in a reduction of livestock grazing capacity and wildlife habitat. It would interfere with wildlife migration and reduce or alter elk calving areas. It would alter the appearance of the landscape for a quarter century or longer.

WILDLIFE

Simultaneously leasing all five proposed coal tracts in Wyoming would have major affects on local populations of wildlife but minor affects on regional populations. Full commitment to mitigation, such as staggered development of the tracts, would considerably reduce these impacts, but other actions occurring without new Federal leasing may produce impacts as great or greater than those caused by Federal leasing.

Colorado deer and elk populations can be expected to decline because of the loss of important winter range. New Federal leasing would remove portions of habitat, which have become crucial because of the lack of suitable feeding ground elsewhere.

Fish kills could occur in the lower Yampa River as a result of any of the alternatives, including the No Action. Increased sewage effluent resulting from population growth could combine with low stream flow caused by drought and seriously affect aquatic biology.

CULTURAL RESOURCES

Regulations largely protect these resources. One archaeological site in Wyoming, the Union Pacific Mammoth, is of major importance but it can be protected. Historic and architectural resources not on Federal lands may not be protected unless steps are taken by local governments and private citizens.

RECREATION

It is significant that funds needed by communities to provide additional urban recreational facilities would be increased by 10 to 16 percent as a result of new Federal leasing. Dispersed recreational opportunities, such as camping and fishing, are ample throughout the region, but the quality of these experiences may be diminished because of the increased population expected to enter the area under the No Action Alternative. New Federal leasing would not appreciably affect dispersed recreation.

Most of the mining considered in this EIS would severely disfigure the landscape, which would not be fully restored for 20 to 50 years after the end of mine life. These lands are not given a high Visual Resource classification and in most cases are infrequently seen by persons not involved in mining, so the degradation of visual quality would not be unacceptably obvious. Some mining would occur adjacent to major highways and in those places visual quality would be dramatically diminished.

Vast areas of wilderness exist in the region. These areas can absorb the additional use anticipated by population growth but some individuals may believe their wilderness experience has been diminished.

SOCIOECONOMIC ENVIRONMENT

Continuous increases in population are expected, with or without new Federal coal leasing, which would significantly change the social structure of the area and impose a heavy financial burden on most communities and individuals.

More than half of the communities will have to obtain funds from outside the region to meet population demands; in some cases the needs will be double their capacity to provide. Such public services as schools, sewers, fire fighting and police would all have to be expanded. Even if funding is obtained, these services would be insufficient from time to time because of rapid or unexpected growth. Housing would be expensive and in short supply.

The impact of the inadequacy of essential services is compounded by social-structural and social-psychological disruption caused by rapid population growth. Tension between established residents and newcomers can be expected and alcoholism, mental disorders, and crime would increase.

Income and employment opportunities would increase, which would stimulate the local economy and support otherwise economically prohibitive but personally rewarding life styles such as hobby ranching. On the other hand, this increased income will generate local inflation and create serious hardships for lower paid workers and those on fixed income. Some labor intensive industries, like agriculture, which are unable to pay high wages would find it difficult to compete for labor. Some small businesses would be phased out, thus placing the region's economic stability in the cyclic patterns of the coal industry.

These socioeconomic effects will only be marginally increased by new Federal coal leasing, but this increase will often be upon an already taxed situation. Most of these impacts can be adequately mitigated but only through strong community commitment and assistance from both Federal and state government.

TRANSPORTATION

Wyoming has adequate transportation capacity to handle the needs generated by any of the alternatives. Colorado systems would become congested as a result of the implementation of some of these alternatives. U. S. Highway 40 in Colorado between Craig and Steamboat Springs would experience congestion during peak traffic hours if the Medium, High or Maximum alternatives were implemented. The D&RGW railroad would exceed 85 percent of its capacity hauling coal under the High Alternative and reach 95 percent of capacity under the Maximum Alternative. This would interfere with the railroad's ability to haul other types of freight in and out of northwest Colorado.

Hauling coal by truck could increase road maintenance costs by 1.4 cents per ton of coal hauled each mile. A million tons of coal hauled 10 miles could result in $140,000 road maintenance cost beyond what can be collected through regular fees. Most of the coal would be handled by rail, but some coal trucking is expected under each of these alternatives.

LAND USE

Lands within this region are administered and controlled by a variety of governmental jurisdictions, each of which exercises a different level of land use planning, development and resource use control. All of the affected jurisdictions have sufficient authority to impose effective land and resource control and they have policies to accomodate anticipated growth. All affected communities are familiar with land use problems associated with rapid growth.

Land use patterns are expected to shift from agriculture toward mining and urbanization without new Federal coal leasing and the proposed alternatives will augment this change very little. Thirty-eight ranches could be affected, but only two would suffer long-term significant impacts. These two are almost totally dependent on Federal grazing privileges, which would be lost in the event of mining. Other ranches in the area rely on a mix of Federal and private lands. Even these ranches would be substantially reduced, but their losses should be compensated somewhat by royalties or fees paid by the mines for the use of private land.

CLIMATE AND AIR QUALITY

No substantial changes in the climate of the region are expected from any of the proposed alternatives. Air pollution from mining and indirect development would be local and not significantly affect air quality except in the vicinity of the coal lease tracts. Population and transportation growth which will accompany mining will have a greater effect on regional air quality than the mining itself. The greatest local impact centers around Craig, Colorado. Craig is presently classified by the Colorado Air Pollution Control Division and the Environmental Protection Agency as an "unclassified" TSP area; though both Federal and state standards are being violated by what are probably non-manmade sources. The impacts from the Maximum Alternative would only add approximately one percent over the No Action Alternative levels.

SECTION 1

PURPOSE AND NEED FOR ACTION

PURPOSE AND NEED FOR LEASING

In June of 1979, the Secretary of the Interior adopted a new program for management of coal resources on Federal lands. This program uses information from the Department of Energy and the coal mining and consuming industries to estimate the demand for new Federal coal leasing. Land use plans, industry data, environmental analysis, and the concerns of the public and Federal, state and local officials are used to identify coal lease tracts to supply that need. The nation's coal reserves can be naturally divided into twelve regions scattered throughout the Continental United States. The Green River/Hams Fork is but one of these regions which the Bureau of Land Management (BLM) is using to administer the coal program. This impact statement addresses the environmental consequences of five leasing alternatives in the Green River/Hams Fork Region encompassing northwest Colorado and southwest and southcentral Wyoming. This statement with other relevant material will be used by the Department of the Interior and its operating agencies to plan actions and make decisions with respect to Federal coal leasing in the region.

The program is fully described in the *Final Environmental Statement: Federal Coal Management Program*, in *Federal Coal Management Regulations* at 43 CFR 3400, in *Federal Coal Management Program - A Narrative Description*, and in *Secretarial Issue Document-Federal Coal Management Program.* These documents are available from the Bureau of Land Management, Office of Coal Management, 18th and C Sts. NW, Washington D. C., 20240 (telephone 202-343-4537).

THE NEED FOR LEASING IN THE REGION

At the same time the Secretary adopted the new Federal coal management program in June of 1979, he tentatively selected a target of 531 million tons of in-place Federal coal to be leased in the Green River/Hams Fork region. This leasing target was based on the difference between the Department of Energy's 1987 medium production goal for the region and DOI's assessment of planned production not dependent on new Federal leasing, taking into consideration mine life, mining recovery, and Federal coal ownership in the region. While our assessment of the amount of coal needed to meet the target level has changed since June, 1979, the basic logic behind its derivation has not; all targets discussed below are the result of a forecasted shortfall of annual coal production in comparison to DOE's coal production goals for the region.

The Secretary directed that public comment be sought on the tentative target prior to adoption of a final target. During the preparation of a Federal Register notice seeking this public input, the BLM discovered new information on expected production from mines not dependent on new leasing which led to a revision of the target to 321 million tons. Comments received in response to the Federal Register notice led the Regional Coal Team to recommend a target of 416 million tons to the Secretary; this amount was reaffirmed by the team after a second consideration. The Secretary, on January 23, 1980, adopted a final leasing target of 416 million tons of in-place Federal coal to satisfy a forecasted 1987 shortfall of 18.5 million tons. Further, the Secretary increased the in-place tonnage target by 25 percent to 520 million tons to account for the likelihood that not all coal offered for lease will be mined, to promote competition and reasonable coal prices, and to provide greater assurance that DOE production goals are satisfied. Finally, the Secretary directed that sufficient coal be leased to allow existing mines to maintain existing production. Documentation of the development of the final leasing target is available for review from the Office of Coal Leasing, Planning, and Coordination, Land and Water Resources, Department of the Interior, l8th and C Sts., NW, Washington, D.C., 20240 (Telephone: 202-343-4191).

The Federal coal leasing action addressed in this impact statement is needed to satisfy the forecasted 1987 shortfall of 18.5 million tons of coal production. Leasing 520 million tons and additional amounts for production maintenance from those tracts listed in Section 2 under the High Alternative will most easily satisfy this need. It should be noted that, unless the projected demand actually occurs, the production will not increase to the assumed level.

REVIEW OF PROGRAM IMPLEMENTATION TO DATE

The following summary of the program implementation of the Federal Coal Program in the region presents the events leading to the publication of this EIS.

The BLM developed supplements to land use plans in Wyoming and Colorado which identified lands acceptable for further consideration for leasing. Coal-bearing lands of high and moderate development potential were examined to determine their acceptability. Multiple use trade-offs were analyzed, the preferences of the potentially affected ranchers and farmers were considered and unsuitability criteria were applied as specified by Section 522 of the *Surface Mining Control and Reclamation Act of 1977.* The tracts analyzed in this EIS were delineated from areas not found unsuitable for surface mining where multiple use trade-offs favored coal developments, and where a significant number of ranchers and farmers have not stated a preference against coal leasing. Documentation of this land use planning process is on file at BLM's District Offices in Craig, Colorado and Rawlins, Wyoming.

Consultation requirements set forth in several of the unsuitability criteria were completed by the BLM during the unsuitability criteria application process. Due to time constraints consultation in Colorado under criterion seven, with the Advisory Council on Historic Preservation and the State Historic Preservation Office (SHPO), was not completed. The draft unsuitability criteria application was presented to the various staffs of the Governor of Colorado in April, 1979. Formal consultation with the Fish and Wildlife Service and formal consultation with SHPO has been concurrent with this EIS process.

In Wyoming, the category of "acceptable pending further study" was sometimes used because sufficient data was not available to determine specific stipulations or mitigating measures that could prevent conflicts with the criteria. Further study is under way on these areas, a final determination as to the unsuitability criteria will be made before publication of the final environmental impact statement. Details of the application of the unsuitability criteria are presented in the Site-Specific matrices.

Surface owner consultation was completed for areas of split estate ownership. The response of the surface owners was not considered binding or contractual. The results of this process were used as a general guide concerning the preferences of surface owners in the study area. Industry will be responsible for acquiring formal surface owner consent on areas of split estate ownership prior to lease sale. The BLM Craig District Office is presently inquiring of all qualified surface owners whether they plan on submitting written statements of refusal to consent to aid with the coal activity planning process. Documentation of this land use planning process is on file at BLM's District Offices in Craig, Colorado, and Rawlins, Wyoming.

After the completion of land use planning, the BLM issued a call for industry expressions of interest in coal leasing those areas found acceptable for further consideration. Expressions of interest were received during the five-week period of the call which began July 20, 1979. Information provided by industry in response to the call is on file with the BLM State Offices in Denver, Colorado, and Cheyenne, Wyoming.

The steps of the leasing process following the call are under the purview of the Green River/Hams Fork Regional Coal Team (RCT). The team was organized on August 14, 1979, under the chairmanship of the BLM State Director from Utah. Other members are the BLM State Directors from Colorado and Wyoming and representatives of the governors of Colorado and Wyoming. Ultimately the Regional Coal Team will recommend a course of leasing action to the Director of the BLM who will in turn forward a recommendation to the Secretary. The team has held eight public meetings to consider the various phases of the process which have led to the publication of this document. Records of the meetings and correspondence to and from the team are available for review at the Bureau of Land Management, Utah State Office, 136 E. South Temple, Salt Lake City, Utah 64111.

The expressions of industry interest and other geologic and mining information were used to delineate 17 tracts for potential leasing. Of these, 16 tracts were selected by the Regional Coal Team for further consideration and analysis. One tract, the Horse Gulch Tract, was dropped by the Regional Coal Team for insufficient data. Maps of the tracts are presented in Section 2 of this document. The tract delineation reports and other related material are on file with the U. S. Geological Survey, Conservation Division, in the Denver Federal Center in Denver, Colorado.

The tract delineation reports indicate the annual production potential of each tract, the expected type of mining, employment required to develop and operate the tract, acreage disturbance, the method of transportation of mined coal, and other salient data. This information was used to develop a site-specific environmental analysis for each tract. This was an analysis of environmental, social and economic factors pertinent to or affected by development of each tract. Documentation of these analyses are available for review at the Craig District

Office of the BLM. Significant factors from the tract delineation reports and the site specific analyses were summarized in a tract profile, in the form of a matrix, for each tract. These were provided to each member of the Regional Coal Team, along with previously supplied maps, expressions of interest, etc., to be used in the tract ranking process.

Pursuant to regulations of 43 CFR 3420.4-4, the 16 tracts were ranked high, medium, and low on the basis of coal economics, environmental impacts and social and economic impacts. Subfactors of these three categories were determined by the Regional Coal Team. For the first ranking in the Green River/Hams Fork region, the subfactors in the Site-Specific Analyses were used. These included: coal volume per acre, coal quality, transportation requirements, communities likely to receive impacts from incoming workers, wildlife habitat, surface ownership, air emissions per million tons annual production, work force per million tons annual production, reclamation potential, and potential for future bypass or emergency lease situations.

All 16 tracts were ranked at the Regional Coal team meeting December 13, 1979. The minutes of this meeting contain the results of this ranking process and are available for review at the Bureau of Land Management, Utah State Office. The team also made a preliminary selection or grouping of tracts into four production alternatives, in addition to a no leasing alternative: Maximum, High, Medium and Low. These alternatives and the tracts they include are shown in table 2-1 in Section 2. A reflection of the relative rank of the tracts is portrayed in the range of alternatives. The lower production alternatives contain the most desirable tracts, and the successively higher production alternatives add the less desirable tracts in decreasing order of their ranking.

Following a review of the subsequent preliminary and final cumulative analysis documents, the Regional Coal Team, at its meeting on March 21, 1980, reviewed and confirmed its previous decisions concerning ranking and alternative composition. They made no changes in alternative rank or composition and they identified the High Alternative as the Preferred Alternative. This environmental impact statement was prepared around these selections.

When the Federal Coal Management Program was adopted, it was envisioned that any tract selected by the Secretary for sale could be offered over a four-year period. As a general startup consideration, however, sales schedules are being planned for periods shorter than four years. At this time the department anticipates, should the preferred alternative be adopted by the Secretary, tracts would be offered for sale over a three- to nine-month period beginning in January, 1981. This schedule is preferred over a longer schedule, because the lead time between leasing and anticipated production short-falls approximate the time it takes to bring a new mine into production. Comments on sales scheduling are encouraged during the comment period on this EIS, especially as different schedules may affect impacts. Upon the close of the comment period on this EIS, the Regional Coal Team will analyze the comments and make any revisions in ranking, selection, and scheduling they feel are necessary.

The Secretary of the Interior's decision on a course of action is not limited solely to the alternatives presented in this EIS. He may, through the use of his discretionary authority develop additional alternatives that are intermediate in magnitude to those analyzed in the EIS.

These intermediate alternatives can be developed through changes in the proposed level of leasing, changes in tract boundaries, changes in the tract combinations, and changes in the lease sale schedule. These would be based upon any of several factors: the views of the Governors of Wyoming and Colorado as determined by formal consultation, the results of the EIS, the recommendations of the Green River/Hams Fork Regional Coal Team, the results of coordination with other Federal Agencies, and other pertinent data.

ISSUES AND AREAS OF CONCERN

To insure that all concerns of individuals are considered in this analysis, four scoping hearings were held in the region. The public was offered the opportunity to express concerns on matters that ought to be studied. Records of these hearings are available from the Utah State Director at the address indicated above.

Several issues and values were identified through the scoping process. The issues that have been determined to be significant and within the scope of the EIS are presented first below. Other comments were received that were concerned with the basic assumptions of the team, and the level and methodologies of analysis. These baseline assumptions have been identified in the EIS, but are not considered significant issues to be addressed in detail. Still other issues were identified that are either beyond the scope of the study, were covered by prior environmental reviews, or are not considered to have a significant effect on the human environment within the area of study. These issues and the reasons they have not been addressed are presented in the second section below.

SIGNIFICANT ISSUES ADDRESSED

(1) There is a need to examine the cumulative impacts of the proposed action for each alternative. This should include impacts from non-mining activities such as transportation and utility construction for the mines, as well as the impacts from increased development generated by the expansion of the coal mining industry in the region.

(2) The concerns of private landowners whose land is adjacent to or within the delineated tracts must be considered. This is especially true of the private surface and subsurface owners located within the tracts in the checkerboard land-ownership pattern area of Wyoming.

(3) Problems associated with western mined land rehabilitation should be examined. This should include a description of problems anticipated in restoring the original ground cover, topography and plant species capable of sustaining the former native animals. The success or failure of reclamation practices shall determine the nature and extent of residual and long-term impacts on the mined lands and should therefore be analyzed.

(4)The impacts on air quality in the region should be examined. This should include an analysis of the fugitive dust and particulates generated in the mining process and on unimproved mine roads, as well as gaseous pollutants associated with increased population and development.

(5) The impacts on water quality in the region should be analyzed, especially increased sediment loads from construction and mining, increased salinity, and overall water quality deterioration associated with increased population and development.

(6) Surface and underground water storage impacts must be assessed, including aquifer restructuring following of surface mining.

(7) The allocation and availability of water in the region should be examined. The impacts from coal mining on water quantity and allotment in the region, particularly those relating to the agricultural sector, must be assessed.

(8) There is a need to examine cultural resource properties in the region as required under the National Historic Preservation Act.

(9) There is a need to consider the municipal funding capacities of the communities that will be impacted by the proposed action. While this concern is not under the purview of NEPA, it is addressed because of the high public interest shown.

(10) The impacts due to increased demand on community facilities should be assessed, including demands on sewer, water, transportation, housing and school systems.

(11) There is a need to examine the effects of "boom town" characteristics on the population of the impacted communities including mental health, transiency, alcoholism, crime, etc.

(12) The energy efficiency of mining different tracts should be assessed, as well as the comparative energy demands from existing utilities. While not under the purview of NEPA, this concern is addressed due to the high level of public interest.

ISSUES NOT ADDRESSED

(1) It was suggested that this EIS compare the impacts of mining coal for electricity generation versus the impacts of obtaining other energy sources, rather than only comparing the impacts of mining or not mining coal. This issue was previously addressed in the *Final Environmental Statement: Federal Coal Management Program.*. The decision to increase the utilization of coal to meet National energy demands has already been made.

(2) It was recommended that the EIS identify potential projects in the region that would exacerbate the impacts

from coal mining such as the Moon Lake power plant, oil shale developments and proposed synfuels projects. The Moon Lake project is being addressed in a Site-Specific EIS being prepared by the Utah State Office of BLM. Other projected developments such as oil shale, have been included in the baseline data.

(3) It was recommended that the EIS not identify impacts that are already limited by existing laws, and that mitigation measures only be considered when impacts exceed compliance with existing laws. This EIS assumes that existing OSM surface mining regulations will be enforced to at least the degree that they are presently being enforced. Under that assumption, the only additional impacts that will occur will be those that are either residual from the regulations or beyond the regulations. These are the impacts which the EIS will address.

(4) It was recommended that a coal market analysis and coal transportation analysis be prepared prior to leasing. Another analysis would be unnecessary duplication. The need for leasing addressed in this EIS is based on production goals from DOE; these goals are the result of a process which is essentially a market analysis. DOE goals include consideration of transportation cost and capabilities. Further, this EIS includes an assessment of impacts on transportation systems within the region.

(5) It was suggested that the EIS consider the use of public lands for locating new towns or other public uses to mitigate socioeconomic impacts of new coal development. This is not a significant issue. If problems with land requirement for individual communities arise, mechanisms already exist for the transfer or sale of public lands for expanding public facilities.

(6) There is a need to enforce controls of fugitive dust production at the mines and on adjacent roads since air quality would be severely impacted by a failure to apply existing control technology. This issue is beyond the scope of the EIS since the enforcement of controls will be addressed at the mine plan stage according to the requirements of SMCRA. Due to the decision of the U.S. Court of Appeals (D.C. Cir. 1979) in the Alabama Power Company, et al. vs. Costle (606F.2d 1068), it is unclear the extent to which the mines will be required to control fugitive dust emissions under EPA's PSO review process. Control measures might be required by the State Air Pollution Control Agencies or by the Office of Surface Mining during their permit review processes.

(7) It was suggested that the EIS address the problems of communities not receiving enough of the energy impact assistance funds controlled by the states. Discretionary funding sources are examined as uncommited mitigation in the EIS.

(8) It was recommended that the EIS consider measures to reduce cumulative impacts, increase efficiency and reduce energy demand, such as common loadout facilities, rail spur locations and cooperatively maintained road facilities. These measures are discussed as uncommitted mitigation in the EIS.

(9) The need to provide energy-efficient transportation to and from the mines and the need to determine the financial responsibility for doing so, was identified. This is discussed only as uncommitted mitigation.

(10) It was suggested that non-coal mineral leasing, especially oil and gas, be addressed by the EIS, particularly where it would conflict with the proposed coal leasing. Existing non-coal leasing is addressed in the land use section of the EIS; however, trade-offs between coal and non-coal leasing potential are beyond the scope of this EIS, and are addressed through BLM's land use planning process.

RESOURCE AND LEASING ASSUMPTION MODIFICATIONS

The impact analyses for each of the alternatives addressed in this impact statement assume that mine development begins in 1987 and full production is reached in 1990. (This is inconsistent with the manner in which the leasing target is calculated: the target assumes that full production will be achieved by 1987.) A more likely scenario than either of these two assumptions is that full production from the mining units of which the tracts are a part will be achieved over a span of time; for example, some mining units may be in production by 1985 with others coming on line over the period to 1991. The Department believes that production can be achieved from the tracts by 1987 and will take reasonable effort to insure the policies under its purview do not create undue impediments to production should leases be issued. Other constraints beyond the control of the Department, e.g., equipment shortages, lack of financing, or marketing problems, may cause delays in production startups. In any event, any leases issued must, by law, achieve diligent development within ten years of lease issuance. Assuming that the tracts discussed under the various alternatives would be issued in 1981, production would begin no later than 1991. To this end, reviewers should note that the impacts discussed in the following chapters may begin to occur up to three years earlier than indicated in the narrative and in tabular presentations; however, accumulations of impacts over time would remain the same, as would annual impacts beyond 1991.

In theory, the level of regional coal production in the No Action Alternative should be equivalent to the amount of coal production not dependent on new Federal leasing that was used to calculate the leasing target; however, the level assumed in the No Action Alternative is about 19 million tons higher in 1990 than that used to calculate the target. A preliminary assessment of this difference indicates a more realistic effect of production not dependent upon new leasing falls somewhere between the two extremes. Prediction of future events can and do change almost on a daily basis. Therefore, this difference in production level is just the difference between two "snapshots" of production forecasts. At this time, however, it appears the impacts associated with the No Action Alternative are likely higher than what might occur, both annually and cumulatively over time.

Additional coal resource data has been and are continually being developed by the USGS. This may change the estimate of annual production capacity of mining units of which these tracts are a part. It appears that annual production potential from the Danforth Hills #2 and #3 and the Iles Mountain tracts may be somewhat lower than originally thought. Therefore, impacts of alternatives which include these tracts would likely be somewhat lower.

The cumulative effects of these inconsistencies are being studied by the BLM. Should this study show significant differences in expected impacts of any alternative, the appropriate changes will be made in the final version of this EIS. Readers should note, however, that these matters are largely indicative of the degree of uncertainty involved with making leasing decisions now based on estimates of events five and ten years in the future. No amount of study will forecast the future with certainty; in any event there is a strong indication of need for new Federal coal leasing in the region. The range of alternatives contained herein are expected to bracket future events.

Readers should note further that the DOE is expected to provide new regional production goals prior to the Secretary's October, 1980, final decision on which tracts might be leased. Shortly before that decision, the entire matter of the leasing target will be reviewed in light of the new production goals and the impacts surfaced in this analysis. The Secretary's decision will be based on the best available information on coal demand, production potential of existing and future mines, and impacts of various levels of development.

PRLA's

There are 26 preference right lease applications (PRLA) in the region. They contain an estimated 297.5 million tons of coal and involve 66,008 acres. The holders of these applications are entitled to Federal coal leases if they meet certain requirements. The Department is in the process of reviewing these applications and is committed to completing this process by 1984.

It is possible, but unlikely, that some of the PRLA's within the region will mature to leases prior to final decision on leasing the tracts addressed in this EIS. Should any leases be issued in response to any PRLA within this time frame, they may be counted against the leasing target.

Competitive leasing decisions under the Federal coal management program are an iterative process; leasing will be reevaluated every two years. It is likely that at the second round of consideration in the Green River/Hams Fork Region, much better information on potential production from PRLA's will be available. For instance, three PRLA's in the western part of Moffat County associated with the proposed Moonlake Electric power project are being studied in a separate environmental impact statement under the lead of the BLM Utah State Office. It is possible that by the second round of consideration of leasing, production potential of these PRLA's will be known and production could be counted against the target calculated at that time. However, at this point no production from PRLA's is considered in this impact statement, either as part of any baseline figures or as part of new leasing to meet the current target.

SECTION 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

INTRODUCTION

The following chapter provides a summary of each of the five Federal coal leasing alternatives and the significant environmental impacts or issues inherent to the alternatives. The Green River/Hams Fork EIS Coal Region is shown on Map 2-1 along with the locations of the proposed coal lease tracts. The impacted areas within the region are depicted by Maps 2-2 and 2-3. These maps are further subdivided to show the location and size of the specific coal lease tracts proposed for Colorado (Maps C-1 through C-4) and Wyoming (Maps W-1 through W-4). The collections of tracts which comprise the various alternatives are shown graphically in Figure 2-1. The location of mines presently under production in the region is shown on Map 2-4.

Each alternative is described by identifying the tracts in the alternative, coal reserves and annual production, and expected acres to be disturbed from direct mining, ancillary facilities, and related population growth.

Environmental impacts are summarized in a two-fold manner. First, Table 2-1 is a summary matrix that compares the magnitude and significance of the major cumulative environmental impacts of each alternative that are presented at length in Section 4. Secondly, a narrative impact assessment focuses on those significant impacts or issues that clearly define a comparison between alternatives, or which are of special interest.

The issues contained in this section have been defined by the results of the environmental consequences analysis (Section 4), and the scoping process (40 CFR 1501.7). Section 4 describes in detail all environmental impacts, both beneficial and adverse, that result from implementing any of the alternatives. This analysis indicates that in many instances, environmental impacts are either insignificant for all alternatives or indistinguishable between alternatives. This is shown quantitatively in Table 2-1. Those impacts that do not sharply define a comparison between alternatives are not analyzed in this section, unless identified in the scoping process. Those environmental impacts that are significant and which provide a clear basis for choice by the decision-maker and the public are presented.

Results of the scoping process (described in detail in Section 1) revealed issues or environmental concerns that are of special interest to the public and Federal, state, and local agencies. These issues are included in this section whether or not they were found significant in the analysis contained in Section 4.

REQUIRED AUTHORIZATIONS

The development of Federal coal resources is controlled by numerous laws and regulations imposed by Federal, state and local agencies and authorities. Federal laws of paramount importance include the *Federal Coal Leasing Amendments Act of 1976* (FCLAA), the *Federal Lands Policy and Management Act of 1976* (FLPMA) and the *Surface Mining Control and Reclamation Act of 1977* (SMCRA).

The purpose of the FCLAA is to provide a more orderly procedure for the leasing and development of federally-owned coal than was set forth in its parent document, the *Mineral Leasing Act of 1920*. The Act sets forth major requirements including strictly competitive bidding, the abolishment of preference right leasing, the concept of Logical Mining Units (the term Logical Mining Units in this EIS is used in the context of probable Logical Mining Units), Diligent Development requirements, Maximum Economic Recovery (MER) and lease acreage restrictions.

FLPMA provides the BLM with a statutory framework for land use planning on public lands and requires that BLM use the principles of multiple use and sustained yield, give priority to the protection of areas of critical environmental concern, consider present as well as future uses of public lands, and coordinate planning activities with those of Federal, state and local agencies.

SMCRA establishes uniform minimum Federal standards for regulating surface mining and reclamation on Federal, state and private lands, and for assuring adequate protection from environmental impacts of surface mining. The Act also sets forth provisions regarding environmental protection performance standards and designation of areas unsuitable for surface coal mining. The act established the Office of Surface Mining (OSM) in the Interior Department to enforce the performance standards.

Each lease operator is required to submit a mining and reclamation plan that complies with OSM Regulations and USGS Rules and which demonstrates that non-coal resources will be protected. This plan must be approved by the Assistant Secretary, Energy and Minerals, prior to beginning mining operations.

State regulations and environmental standards are in many cases more stringent than or in addition to the corresponding Federal standards. State regulations deal with such aspects as water and air pollution, land use, cultural and historic preservation, reclamation, wildlife and aquatic resources, and mine safety practices. The state responsibility for enforcement of these regulations and standards is considerable. This responsibility is derived either from state legislation or through Federally authorized transfers of enforcement responsibility as provided by applicable Federal law.

Additional information about the aforementioned laws, as well as other applicable Federal and state regulations, and interagency relationships can be found in the *Final Environmental Statement, Federal Coal Management Program*, (Bureau of Land Management, April 1979), pp. 1-15 to 1-56.

Local level regulations are generally imposed at the county level and involve special use permits, zoning variances, or construction permits where applicable. Local regulations vary between states, and the reader is referred to the *Environmental Statement, Development of Coal Resources in Southcentral Wyoming*, Volume 1, p. R1 - 8, and the *Northwest Colorado Coal Supplemental Report*, (Bureau of Land Management, March 1978) p. 1-7 for a more detailed analysis of local requirements.

NO ACTION ALTERNATIVE

The No Action Alternative would not offer for competitive leasing any of the 16 tracts delineated in the GR/HF region. No new annual production would be generated, and there would be no disturbances from new Federal coal leasing and subsequent mining.

Without a leasing action, activities would occur, however, as a result of coal and non-coal actions, natural population growth, and continuation of some existing operations. Table 2-2 shows projected coal production from the study area by time frame. Study area is defined as Moffat, Routt and Rio Blanco Counties in Colorado, and Carbon and Sweetwater Counties in Wyoming. Additional specific information related to the individual operators can be found for Wyoming, in the *Southcentral Wyoming Regional Coal EIS* and the *Carbon Basin Final Environmental Statement* (Bureau of Land Management, May 1979). For Colorado, information can be found in the *Northwest Colorado Coal Supplemental Report*. Table 2-3 shows projected cumulative surface acres to be disturbed from coal and non-coal-related activities for Wyoming and Colorado portions of the study area.

WATER RESOURCES

The impacts that will occur from projected growth and disturbance without new Federal coal leasing (No Action Alternative) are far greater in magnitude than those attributable to any of the coal-leasing alternatives.

GROUND WATER

DISTURBANCE TO AQUIFERS. Projected development in the region will result in the unavoidable removal of certain aquifers in disturbed areas. Resulting impacts will occur to existing wells and springs and on future ground-water development in the affected areas.

A total of 37.3 sq mi of aquifers (0.52 percent of the watershed) will be removed in the North Platte watershed by 1995 and 29.0 sq mi (0.76 percent of the watershed) will be removed in the Yampa subbasin without new Federal coal leasing. The fact that less than one percent of the watersheds will be disturbed indicates that all impacts to ground-water systems will be very local.

Aquifers removed by mining will be replaced by spoils aquifers with recharge and permeability characteristics equal to or greater than the original aquifers. Therefore, impacts to ground-water systems will be limited primarily to the period of active mining.

SURFACE WATER

INCREASED SALINITY OF RECEIVING WATERS DOWNSTREAM. Projected development without leasing new Federal coal can be expected to increase the salinity of receiving waters downstream in the North Platte watershed, the Yampa subbasin, and the lower Colorado River at Imperial Dam.

Salinity in the North Platte River would increase about 75 percent from an inferred pristine level of about 154.8 mg/L (Table 3-2) to a maximum of about 270.98 mg/L over the long-term. Water containing 270.98 mg/L is suitable for all current downstream uses and no problems are anticipated. At low flow, dissolved solids concentrations would increase to no more than 500 mg/L, which should present no significant impact to aquatic biology.

Salinity in the Yampa River will increase about 64 percent from an inferred pristine level of about 111.6 mg/L to a maximum of about 182.5 mg/L over the long-term. This water will be suitable for all current uses and will have no impact on aquatic biology. Significant impacts to aquatic biology, however, could occur during periods of low flow when dissolved solids concentrations could exceed 1,000 mg/L. During these periods, which can be expected to occur on an average of once every 10 years, the impact on aquatic biology may be significant. Any impact, however, will be minor compared to the effect of toxic constituents introduced in sewage effluent as discussed below.

The states of the Colorado River basin have adopted salinity standards for locations on the Colorado River as required by the *Federal Water Pollution Control Act Amendments of 1972*. The standard at Imperial Dam is 879 mg/L. Despite ongoing salinity control programs, the salinity at Imperial Dam is expected to increase to about 1,046 mg/L through the time frames addressed in this analysis. This is 167 mg/L or 19 percent above the adopted standard.

POLLUTION BY SEWAGE EFFLUENT. Sewage effluent discharged into the North Platte River and the Yampa River by municipal sources will have the greatest effect on aquatic biology during periods of low flow when effluent dilution is minimal. The lowest flow on record in the North Platte River downstream from Sugar Creek was 70 cfs. Dilution of sewage effluent at this flow will be more than adequate to prevent any significant impact to the aquatic biology downstream.

Minimum discharge in the Yampa River was 4.0 cfs at Steamboat Springs and 2.0 cfs downstream near Maybell during 1934. Contaminants in sewage effluent entering the river during these low flow periods present a great hazard to aquatic biology.

Results of a study on the wastewater assimilative capacity of the Yampa River between Steamboat Springs and Hayden during September, 1975, (Bauer, Steel and Anderson, 1978) indicate that of the pollutants studied that could impact aquatic biology, only the proposed acceptable concentration for nonionized ammonia nitrogen of 0.02 mg/L will be equaled or exceeded with existing treatment facilities. Construction of a regional wastewater treatment plant as proposed in the Steamboat Springs area (U.S. Environmental Protection Agency, 1977) and implementation of proposed 1985 standards for effluent would eliminate this potential impact.

The possible degradation of water quality in the river downstream from Craig is unquantifiable, but the impacts on aquatic biology are expected to be severe with or without implementation of a Federal coal leasing program.

Should a repeat of the 1934 drought occur, the flow downstream from Steamboat Springs would be as much as 50 percent sewage effluent and the flow below Craig would be as much as 65 percent sewage effluent. The consequent impacts on aquatic biology could be disastrous, without new Federal coal leasing.

WILDLIFE

Major adverse impacts to big game winter ranges and riparian zones will occur by 1987 without additional Federal coal leasing. Estimated declines in deer and elk populations in Colorado (Game Management Units 11, 12, 13 and 131) would be 5.9 and 6.7 percent, respectively, in 1987 and 8.4 and 9.5 percent in 1995 of 1979 post-hunt numbers. An estimated 1,281 acres of riparian wildlife habitat will be out of production. Within the region, riparian zones comprise only 1.5 percent of all types. Any loss will be significant.

Locally, losses of aquatic habitats (ponds and streams) could be significant in Wyoming. The Yampa River, in Colorado, downstream from Craig, could suffer fish kills at low flow due to pollution from sewage effluents.

Sage grouse and antelope populations will decline, locally, in Wyoming. These losses will not be significant, regionally. Sensitive raptors (burrowing owl, ferruginous hawk and golden eagle) will be displaced and experience local reproductive declines.

Threatened or endangered species are protected by Federal and state law. Population declines which would jeoparidze the continued existence of the species will not be allowed. Some habitats will become uninhabitable due to mining and human harrassment.

Development in riparian zones and prairie dog towns will limit use by bald eagles, greater sandhill cranes, and black-footed ferrets. Sewage effluent could cause degradation of the Yampa River which could affect Colorado squawfish, razorback sucker, bonytail chub, and humpback chub. Final assessment is awaiting U.S. Fish and Wildlife Service reply to Section 7 consultation request as required by the *Endangered Species Act*.

Major adverse impacts to wildlife as shown in Table 2-1 will occur by 1987 without additional Federal coal leasing. Additional coal leasing would be additive, and most significant due to increases in number of acres of big game winter range out of production. These additional acres would not be large, but in view of regional development the cumulative losses could lead to deer and elk declines in Colorado (Game Management Units 11, 12, 13 and 131).

CULTURAL RESOURCES

Energy related actions not associated with Federal leasing proposals will disturb 80,552 acres. Where a different Federal undertaking (36 CFR 800.2(c)) is involved, inventory, evaluation, avoidance and mitigation steps will be followed. On the basis of estimates developed in Table 3-17 Section 3, it is expected that 356 cultural resources will be identified. Of these, up to 57 are likely to be eligible to the National Register.

Where no Federal undertaking is involved, cultural resource inventory is not a committed mitigation and such values may be destroyed.

SOCIOECONOMIC

Under the No Action Alternative, a population growth of 68 percent is expected to occur in the impacted area between 1978 and 1995 as a result of mining and recreation developments already underway or planned.

Mining's present dominance in the impacted area's economic base will increase. Mining employment in 1995 will be 21 percent of total employment. In terms of income, the importance of mining will be 34 percent by 1995. Construction employment and income will be 9.1 percent and 10.9 percent, respectively, in 1987, down somewhat from 1978 levels but still important.

By 1995, it is likely that 10 of the 18 communities will require improvements in community facilities (such as water and sewer systems) greater than they can finance from local resources. In the worst cases, requirements may be as much as 10 times the legal bonding capacity of the community.

Meeker is the community in most danger of social-structural breakdown over the next dozen years. A 14 percent growth rate is expected through 1987, which will exceed the threshold (10 percent annual population growth) with or without new Federal coal development. Of the other Colorado communities, Steamboat Springs and Hayden will probably receive some strong negative social-structural and social-psychological impacts, although they will probably not become unmanageable. In Craig, the threshold will not be exceeded, but it will represent a continuation of a high growth rate begun earlier and will have the problem of "slope decline" in the social structure without much opportunity for catch-up adjustments.

Several Wyoming communities (notably Rawlins) included in the study region had already experienced considerable energy development impact by 1978, as had Craig. Therefore, further growth without new Federal coal leasing will probably be sufficient to cause some social-structural strains. For the smallest communities, there may be some shift toward formalizing services and controls; for Rawlins a continued increase particularly in migrant newcomers will cause further strains in existing community structures but will not cause serious breakdowns.

TRANSPORTATION

Under the No Action Alternative, the road systems should be adequate enough to meet projected demands for the next 20 years in average daily traffic. During peak traffic hours, Colorado road segment C (U. S. 40 between Hayden and Steamboat Springs) and road segment B (U. S. 40 between Craig and Hayden) will be at capacity by 1995. As a result, these road segments will experience a decrease in the service level, with resulting congestion, during peak hours. Most of the other road segments in Wyoming and Colorado will be at less than 50 percent of capacity during peak traffic hours.

The projected daily train traffic for the Denver Rio Grande and Western (DRGW) railroad between Craig and Bond is 30 trains by 1987, 31 trains by 1990, and 33 trains by 1995. The maximum use of the line's capacity would be 69 percent by 1995. The projected daily train traffic on the Union Pacific line is 69 trains per day by 1987, 73 trains by 1990 and 79 trains per day by 1995. The maximum use of the line's capacity would be 99 percent by 1995. However, upgrades on the line are presently taking place, which will increase the line's capacity.

LAND USE

Baseline increases in population and the conversion of existing agricultural and rural land uses without the proposed action would result in recognizable land use impacts in the study region. A total of some 51,000 animal unit months (AUM's) will be lost by 1995 even if the new leasing does not take place. These AUM's will be irretrievably lost and, depending on the type of use that is replacing the grazing lands (i.e., urban or mineral extraction), production will not resume on the converted lands.

Some 4,500 additional acres of land will be required for urban expansion of existing communities by 1995. This will primarily occur in Craig, Hayden, Steamboat Springs and Meeker in Colorado, and Rawlins and eastern Sweetwater County in Wyoming. This growth will be due primarily to private coal and other energy-related growth in the region that will occur without new Federal leasing.

AIR QUALITY

The Town of Craig is presently classified by the Colorado Air Pollution Control Division (CAPCD) and the Environmental Protection Agency as an unclassified Total Suspended Particulate area; although NAAQS and CAAQS (Federal and state standards) are violated (recent years' levels are between 90 to 100 $\mu g/m^3$), the source has been shown probably to be due to non-manmade resources. The projected development associated with the No Action Alternative will exacerbate these violations by approximately 20 percent.

The CAPCD may reassess the present unclassified status of Craig and require an implementation plan to bring Craig into compliance with TSP standards. The implementation plans could take many forms and may limit the level of energy development in the region.

LOW ALTERNATIVE

The Low Alternative includes five tracts in Wyoming and five tracts in Colorado. The same five Wyoming tracts are included in all alternatives. Federal in-place reserves that would be leased total 420.75 million tons, which would result in an annual production of 10.76 million tons per year. Five of the tracts (two in Wyoming, three in Colorado) are assumed to be logical extensions of existing adjacent operations. Table 2-4 shows the tracts and coal reserves in this Alternative.

Table 2-5 shows transportation and employment requirements for the Low Alternative. Coal would be transported over 6.5 miles of road and 32 miles of railroad. A total of 260 employees would be required for mine construction (1987 to 1989), and 794 employees would be used for mine development (1989 to end of mine life).

Acres disturbed by mining and related facilities would reach 8,675 acres by 1995. Population increases would cause 343.1 acres to be disturbed for housing and infrastructure through 1995. Table 2-6 shows acres disturbed from the Low Alternative by time frame.

WATER RESOURCES

GROUND WATER

DISTURBANCE TO AQUIFERS. A cumulative total of 43.0 sq mi of aquifers (0.59 percent of the watershed) would be removed in the North Platte watershed by 1995 and 31.6 sq mi (0.83 percent of the watershed) would be removed in the Yampa subbasin. Of these totals, 13 percent of the aquifers removed in the North Platte basin and 8 percent of those removed in the Yampa subbasin would be attributable to the Federal action. Aquifers removed by surface mining would be replaced by spoils aquifers or rubble zones that should have a recharge capacity and permeability equal to or greater than the original aquifers. Coupled with the fact that an insignificant percentage of the principal watersheds would be disturbed, all impacts to ground-water systems would be very local and limited primarily to the period of active mining.

Eight wells and one spring in Wyoming and three wells and two springs in Colorado would be severely impacted. In all cases, however, new wells could be completed on the postmining surface, but their depth and pumping lift would be several hundred feet greater than the present wells. Most impacted springs would be permanently impaired, but in most cases new, possibly larger, springs would develop following resaturation of spoils aquifers. Thus, impacts to ground-water supplies should be very local, largely short-term, and principally a matter of increased drilling and pumping costs.

CHANGES IN GROUND-WATER QUALITY. Leaching of spoil materials would increase dissolved solids concentrations in postmining areas to two to three times premining levels. Water containing as much as 3,000 mg/L dissolved solids (maximum expected in Yampa River basin and Red Rim and China Butte areas) would be unsuitable for domestic use, but would be suitable for livestock and wildlife. Higher concentrations of dissolved solids of as much as 7,000 mg/L are expected in the Hanna area of Wyoming. This water would be marginal for livestock and wildlife use, and could require drilling to deeper aquifers for postmining water supplies.

These impacts would be largely local in extent, but could contribute to salinity problems downstream when a mine area is adjacent to a perennial stream. For this alternative, two tracts (Danforth Hills #1 and Danforth Hills #3) are adjacent to Good Spring Creek and the Grassy Creek tract is adjacent to Grassy Creek. Salinity problems downstream are addressed in the salinity subsection of this section.

Mixing of aquifer waters resulting from shear induced ruptures from underground mining (Empire and Bell Rock tracts) could slightly degrade water quality in deeper aquifers within and immediately adjacent to these tracts. No existing water supplies should be impacted. As these tracts are in all alternatives, the impacts would be the same.

SURFACE WATER

INCREASED SALINITY OF RECEIVING WATERS DOWNSTREAM. No significant increase in salinity is expected in Good Spring Creek during the period of active mining. On completion of mining, groundwater discharge would resume once the spoils have resaturated to a higher level than the stream. On a "worst case" basis, i.e., during low flow conditions, dissolved solids concentrations in Good Spring Creek would increase from about 1,050 mg/L before mining to about 1,550 mg/L after mining. Grassy Creek would increase from 620 mg/L before mining to about 825 mg/L after mining. These increases, although appreciable, would have no significant impact on current uses of the water or on aquatic biology downstream.

Increased dissolved solids concentration in both the North Platte watershed and Yampa subbasin would have no significant impacts on aquatic biology or on use of water downstream during periods of average or peak flow conditions. There would be no significant impacts during low flow in the North Platte watershed; however, significant impacts would occur to aquatic biology in the Yampa subbasin during low flow conditions.

Salinity in the Yampa River during extreme periods of low flow could exceed 1,000 mg/L without implementing this Alternative. During these periods, which can be expected to occur on an average of once every 10 years, the impact on aquatic biology could be significant. This impact, however, would be minor compared to the effect of toxic constituents introduced in sewage effluent. These impacts are discussed in the next section. The leasing of coal under this Alternative would not significantly magnify the impacts on aquatic biology from the increased salinity that will occur without Federal action.

The cumulative salinity of the Colorado River at Imperial Dam would be 1,046.07 mg/L from 1987 through 1995. Over the long-term, it would increase to 1,046.10 mg/L. The increase attributable to the Federal action would be only 0.02 mg/L from 1987 through 1995 and 0.05 mg/L over the long-term. This constitutes a maximum 0.002 percent increase from 1987 through 1995 from mining new Federal coal. The consequent increase in cost to downstream users would be $20,000 per year over the long-term. This small increase in salinity in the lower Colorado River is significant only because projected salinity levels for the time frames addressed are expected to exceed adopted standards in spite of ongoing salinity control projects. It should be realized that the adopted salinity standard at Imperial Dam will be exceeded by about 19 percent without new Federal coal actions. This is discussed under the No Action Alternative.

POLLUTION BY SEWAGE EFFLUENT. Sewage effluent discharged into the North Platte River and the Yampa River by municipal sources would have the greatest effect on aquatic biology during periods of low flow when effluent dilution is minimal. The lowest flow on record in the North Platte River downstream from Sugar Creek was 70 cfs. As sewage effluent discharged by Rawlins at low level cumulative development in 1995 would be about 2 cfs, dilution even at lowest flow on record would be at least 35 to 1, which is more than adequate to prevent any significant impact to the aquatic biology downstream.

Minimum discharge in the Yampa River was recorded at 4.0 cfs at Steamboat Springs and 2.0 cfs downstream near Maybell during 1934. Contaminants in sewage effluent entering the river during these low-flow periods present a great hazard to aquatic biology.

The cumulative population of Steamboat Springs at low-level development of new Federal coal, would exceed the proposed standards for nonionized ammonia nitrogen by less than 0.003 mg/L by 1995, which could pose a potential threat to aquatic biology. Construction of a regional waste water treatment plant as proposed in the Steamboat Springs area (U. S. Environmental Protection Agency, 1977) and implementation of proposed 1985 standards for effluent would eliminate this potential impact.

The possible degradation of water quality in the river downstream from Craig is unquantifiable, but the impacts on aquatic biology are expected to be severe with or without implementation of this Alternative. Assuming that the increase in pollutants is proportional to population increase, the low-level development of Federal coal would increase pollutant levels by about 5 percent by 1995.

Should a repeat of the 1934 drought occur, the flow downstream from Steamboat Springs would be as much as 50 percent sewage effluent and the flow below Craig would be as much as 65 percent sewage effluent. The consequent impacts on aquatic biology could be as disastrous with or without implementing any of the coal leasing alternatives.

EROSION AND SEDIMENTATION. Maximum changes in annual sediment yield at the Low Development Alternative for the North Platte River and the Yampa subbasin would be 855 tons (+0.86 percent) and 519 tons (+0.17 percent), respectively, in 1987, during the period of active construction. Thereafter, the sediment yield would decrease progressively, and an overall small decrease in cumulative sediment yield is expected by 1995 (-6,441 tons, -2.02 percent for North Platte River; -352 tons, -0.12 percent for Yampa subbasin).

These inferred changes in annual sediment yield are insignificant compared to annual and seasonal fluctuations in sediment yield in both rivers. There would be no measurable effects on aquatic biology and any impacts from increased erosion and sediment yield over the period of mining should be very local and short lived.

WILDLIFE

Implementation of the Low Alternative would result in the cumulative loss of 96,329 acres of big game winter range by 1995. Of this, 12,213 acres (12.7 percent) would be attributable to the Federal action. As a result of habitat loss, 3,163 deer and 968 elk would be lost in Colorado. These losses would be significant enough to bring about a downward trend in regional population over the long term. Of these losses, 188 deer (5.9 percent) and 58 elk (6.0 percent) would be attributable to the Federal action.

Losses to habitat and animals in Wyoming for all alternatives would be minor, in that significant animal losses would occur, but numbers would still maintain the current stable or increasing regional trend over the long term. The development of the five Wyoming tracts (as would occur in all alternatives) would, however, result in locally significant declines in antelope, and deer herds (DAU's), and sage grouse through habitat destruction and restriction of movements by mining roads and fences. Regionally, declines would not be highly significant in the long-term, if adjacent suitable habitats are available and reclamation is successful. The numbers of animals lost would be a relatively small proportion of regional populations. The partial loss of winter ranges would have a significant, short-term impact on the Red Rim/China Butte area.

An estimated 1,393 acres of riparian habitat would be out of production by 1995. One-hundred-twelve acres (eight percent) would be attributable to the Federal action within the region. Riparian zones comprise only 1.5 percent of all types, so any loss would be significant.

The major portion of the impacts is attributable to projected growth and development without implementation of this Alternative.

Federal leasing would be additive to these impacts, but would not significantly increase the magnitude of these impacts through 1995.

For this Alternative (and for all alternatives) the Danforth Hills #1 and #3 Tracts would be included in the tracts leased. This would cause significant local removal of big game winter range and disruption of movement patterns. Vehicle collisions with deer and elk would increase. Local deer population declines would be significant, if continued private development removes critical winter ranges offsite. Slow reestablishment of disturbed mountain shrub communities and conversion of adjacent area vegetation to agriculture would compound declines and may increase crop damage by deer and elk.

CULTURAL RESOURCES

Mitigation of cultural resources is required by Section 13 of the standard coal lease stipulations. In addition, all cultural resources will be evaluated according to the Criteria of Eligibility (36 CFR 60.6). All sites eligible to the National Register of Historic Places would be avoided or impacts would be mitigated. Cultural sites which do not meet the Criteria of Eligibility, would in all probability be destroyed. The loss of these sites would not significantly affect the cultural resource, or reduce the knowledge that could be gained of the prehistory of the area.

Under the Low Alternative, 87 existing cultural resources have been identified. Of these, two have been identified as potentially eligible to the National Register. It is expected that 525 to 699 cultural sites could be encountered, of which 169 to 343 would be on the proposed lease tracts. 79 to 109 of these sites are expected to be eligible to the National Register (22 to 52 would be encountered on the tracts). The Union Pacific Mammoth, a paleontological specimen dated 11,280 $\pm$ 350 years ago (Clovis time period) is included in this alternative, located on the China Butte Tract and will require special consideration if disturbed.

SOCIOECONOMIC

Considerable economic impact would occur under the Low Alternative. There would be moderately significant impacts in four communities and two school districts. Highly significant impacts would occur in eleven communities. Most of the highly significant impacts would be caused by fiscal demands on the communities for additional facilities, and in several cases the significance would result from depletion of local capital resources due to growth already occurring under the No Action Alternative.

Based upon estimates of population growth and the overloading of community facilities, social-structural and social-psychological impacts would be significant for Craig and Creston Junction because of this Alternative, and highly significant for Meeker. All other communities would be insignificantly impacted.

TRANSPORTATION

The Low Alternative would increase Average Daily Traffic (ADT) in Wyoming by 7 percent and in Colorado by 12 percent. However, enough excess capacity exists on the Colorado and Wyoming roads so that no drop in service level would occur. The increase in ADT would result in an increase in traffic accidents of 7 percent in Wyoming and 12 percent in Colorado.

This Alternative would increase rail traffic on the Union Pacific (UP) railroad by four trains per day and on the Denver Rio Grande Western (DRGW) railroad by two trains per day. No significant impact on the DRGW's track capacity would occur. The cumulative traffic increase would use 75 percent of the line's capacity. Because of projected line upgrades to the UP, the addition of four trains per day would not be a significant impact. If, however, the UP does not continue to upgrade its mainline, the line would be over capacity by 1995. This would result in delays in getting products to market.

LAND USE

As a result of leasing the ten proposed tracts for this alternative, some existing onsite improvements such as oil and gas leases, transportation and communication lines, and water facilities would be displaced, although the net impact would be insignificant and temporary. Sixty oil and gas leases would be affected, resulting in a delay in exploration and development of these leases. None of the affected leases overlie known geologic structures with proven oil and gas deposits.

Nearly 150,000 total AUM's would be lost by 1995 under this Alternative, comprising 9.6 percent of fourteen Section 3 allotments, and 23 percent of four Section 15 allotments removed from production as a result of the Federal action. This translates into a cumulative total of some $8.7 million lost in primary and secondary gross income to ranch and related industries by 1995 in the region. Urban expansion would occupy an additional 500 acres beyond the No Action Alternative. This additional growth would primarily occur in the Carbon County and eastern Sweetwater County communities in Wyoming, and in Craig and Meeker in Colorado. Local jurisdictions must use their planning and zoning authority to direct this growth onto non-agricultural or less desirable lands adjacent to their communities. As in the other alternatives, consultation with the adjacent private landowners within the Wyoming checkerboard land-ownership pattern must be close. Through this consultation, surface owners within the delineated tracts would decide if compensation for their lands is adequate.

AIR QUALITY

The Town of Craig is presently classified by the Colorado Air Pollution Control Division (CAPCD) and EPA as an unclassified TSP area; though NAAQS and CAAQS (Federal and state standards) are violated (recent years' levels are between 90 to 100 $\mu g/m^3$) the source has been shown to probably be due to non-manmade sources. Impacts from the Low Action Alternative will add approximately one percent to the No Action Alternative levels.

The CAPCD may reassess the present unclassified status of Craig and require an implementation plan to bring Craig into compliance with TSP standards. The implementation plan could take many forms and may limit the level of energy development in the region.

MEDIUM ALTERNATIVE

The Medium Alternative would offer for lease five tracts in Wyoming and six tracts in Colorado. Federal in-place reserves, that would be leased, total 518.05 million tons, which would result in an annual production of 13.52 million tons. Five of the tracts (two in Wyoming, three in Colorado) are assumed to be logical extensions of existing adjacent operations. Table 2-7 shows the tracts and coal reserves in this Alternative.

Table 2-8 shows transportation and employment requirements. Coal would be transported over 6.5 miles of road and 42 miles of railroad. Three hundred twenty employees would be required for mine construction (1987 to 1989) and 1,006 employees would be used for mine development (1989 to end of mine life).

Acres disturbed by mining and related facilities would reach 10,030 by 1995. Population increases would cause 444.4 acres to be disturbed for housing and infrastructure through 1995. Table 2-9 shows acres disturbed from the Medium Alternative by time frames.

WATER RESOURCES

GROUND WATER

DISTURBANCE TO AQUIFERS. A cumulative total of 43.0 sq mi of aquifers (0.59 percent of the watershed) would be removed in the North Platte watershed by 1995 and 32.4 sq mi (0.85 percent of the watershed) would be removed in the Yampa subbasin. Of these totals, 13 percent of the aquifers removed in the North Platte basin and 10 percent of those removed in the Yampa subbasin would be attributable to the Federal action. All impacts to ground-water systems from this disturbance would be very local and limited primarily to the period of active mining.

Mixing of aquifer waters resulting from shear-induced ruptures from underground mining (Empire and Bell Rock tracts) could slightly degrade water quality in deeper aquifers within and immediately adjacent to these tracts. No existing water supplies should be impacted. As these tracts are in all alternatives, the impacts would be the same.

Eight wells and one spring in Wyoming and five wells and two springs in Colorado (same as Low Alternative) would be severely impacted. These impacts to ground-water supplies should be very local, largely short-term, and principally a matter of increased drilling and pumping costs.

SURFACE WATER

INCREASED SALINITY OF RECEIVING WATERS DOWNSTREAM. No significant increase in salinity is expected in Good Spring Creek or Grassy Creek during the period of active mining. On a "worst-case" basis during low flow conditions, dissolved solids concentrations in Good Spring Creek would increase from about 1,050 mg/L before mining to about 1,550 mg/L after mining. Grassy Creek would increase from 620 mg/L before mining to about 825 mg/L after mining (same as Low Alternative). These increases would have no significant impact on current uses of the water or on aquatic biology downstream. There would be no significant impacts during low flow in the North Platte watershed; however, significant impacts could occur to aquatic biology in the Yampa subbasin during low flow conditions.

The leasing of coal under this Alternative would not significantly magnify the impacts on aquatic biology from the increased salinity that will occur without Federal action. The cumulative salinity of the Colorado River at Imperial Dam would be 1,046.08 mg/L in 1987, and 1,046.09 mg/L from 1990 through 1995. Over the long-term, it would increase to 1,046.11 mg/L. The increase attributable to the Federal action would be only 0.03 mg/L in 1987, 0.04 mg/L from 1990 through 1995 and 0.06 mg/L over the long-term. This constitutes a maximum of 0.004 percent increase from 1987 through 1995 from mining new Federal coal. The consequent increase in cost to downstream users would be $24,000 per year over the long-term. This small increase in salinity in the lower Colorado River is significant only because projected salinity levels for the time frames addressed are expected to exceed adopted standards in spite of ongoing salinity control projects. It should be realized that the adopted salinity standard at Imperial Dam will be exceeded by about 19 percent without new Federal coal actions. This is discussed under the No Action Alternative.

POLLUTION BY SEWAGE EFFLUENT. Sewage effluent discharged into the North Platte River and the Yampa River by municipal sources would have the greatest effect on aquatic biology during periods of low flow when effluent dilution is minimal. Dilution of sewage effluent, even at lowest flow on record in the North Platte River, would be more than adequate to prevent any significant impact to the aquatic biology downstream.

The impacts on aquatic biology in the Yampa River downstream from Craig are expected to be severe with or without implementation of this Alternative during periods of low flow. Assuming that the increase in pollutants is proportional to population increase, the medium-level development of Federal coal would increase pollutant levels by about seven percent by 1995. Should a repeat of the 1934 drought occur, the consequent impacts from sewage effluent on aquatic biology could be disastrous with or without implementing any of the coal leasing alternatives.

The cumulative population of Steamboat Springs at medium level development of new Federal coal would exceed the proposed standard for nonionized ammonia nitrogen by less than 0.003 mg/L by 1995, which could pose a potential threat to aquatic biology. Construction of a regional waste water treatment plant as proposed in the Steamboat Springs area (U. S. Environmental Protection Agency, 1977) and implementation of proposed 1985 standards for effluent would eliminate this potential impact.

EROSION AND SEDIMENTATION. Maximum increase in annual sediment yield at the Medium Alternative for the North Platte River and the Yampa subbasin would be 855 tons (+0.86 percent) and 571 tons (+0.19 percent), respectively, in 1987, during the period of active construction. Thereafter, the sediment yield would decrease progressively, and an overall small decrease in cumulative sediment yield is expected by 1995 (-6,441 tons, -2.02 percent for North Platte River; -629 tons, -0.21 percent for Yampa subbasin). These changes would cause no measurable effects on aquatic biology and any impacts from increased erosion and sediment yield over the period of mining should be very local and short lived.

WILDLIFE

Implementation of the Medium Alternative would result in the cumulative loss of 98,299 acres of big game winter range by 1995. Of this, 14,188 acres (14.4 percent) would be attributable to the Federal action. As a result of habitat loss, 3,310 deer and 1,012 elk would be lost in Colorado. These losses would be significant enough to bring about a downward trend in regional populations over the long-term. Of these losses, 338 deer (10.1 percent) and 102 elk (10.1 percent) would be attributable to the Federal action.

Losses of habitat and animals in Wyoming for all alternatives would be minor in that significant animal losses would occur, but numbers would still maintain the current stable or increasing regional trend over the long-term. The development of the five Wyoming tracts (as would occur in all alternatives) would, however, result in locally significant declines in antelope and deer herds (DAU's) and sage grouse.

An estimated 1,434 acres of riparian habitat would be out of production by 1995. One-hundred-fifty-three acres (10.7 percent) would be attributable to the Federal action. Within the region, riparian zones comprise only 1.5 percent of all types, so any loss would be significant.

The major portion of the impacts is attributable to projected growth and development without implementation of this Alternative. Federal leasing would be additive to these impacts, but would not significantly increase the magnitude of these impacts through 1995.

For this Alternative (and for all alternatives) the Danforth Hills #1 and #3 tracts would be included in the tracts leased. Significant local removal of big game winter range and disruption of movement patterns would occur. Local deer population declines would be significant, if continued private development removes critical winter ranges offsite.

Inclusion of the Hayden Gulch Tract in this Alternative would cause the loss of winter range and disruption of deer and elk movements, but would not be highly significant, unless other widespread losses of habitat occur in the area.

CULTURAL RESOURCES

Under the Medium Alternative, 87 existing cultural resources have been identified. Of these, two have been identified as potentially eligible to the National Register. It is expected that 547 to 755 cultural sites could be encountered, of which 191 to 399 would be on the proposed lease tracts. Of these, 82 to 118 sites are expected to be eligible to the National Register (25 to 61 would be encountered on the tracts). The 189 to 281 sites not eligible would be lost, but would not significantly affect the knowledge that could be gained of the prehistory of the area. The Union Pacific Mammoth, a paleontological specimen dated 11,280 ± 350 years ago (Clovis time period) is included in this alternative, located on the China Butte Tract.

SOCIOECONOMIC

The Medium Alternative, involving the addition of a single tract (Hayden Gulch), would cause relatively little impact. The only significant impacts would be sharp increases in population and fiscal demands on the town of Hayden. Craig and Creston Junction would continue to receive significant impacts and Meeker would continue to receive highly significant impacts on its social structure and on the social-psychological well-being of its citizens. In addition, impacts upon Hayden and Steamboat Springs become significant at this level. All other communities would continue to be insignificantly impacted.

TRANSPORTATION

The Medium Alternative would increase Average Daily Traffic (ADT) in Wyoming by 7 percent and in Colorado by l8 percent. Colorado road segments B and C (U.S. 40 between Craig and Steamboat Springs) would experience a decrease in the service level with congestion during peak traffic hours as a result of the increased project traffic. The increased ADT would also result in an increase in traffic accidents of 7 percent in Wyoming and l8 percent in Colorado.

This Alternative would increase rail traffic on the UP and the D&RGW by four trains per day for each railroad. This increase would not have a significant impact on the capacity of either rail line. Cumulative traffic increase would use 79 percent of the lines' capacity. An average increase of two percent and five percent in the exposure factor for at-grade crossings in Wyoming and Colorado would occur. The time lost at grade crossings waiting for the increased train traffic would increase 12 minutes in Wyoming and Colorado.

LAND USE

The addition of one more proposed tract would marginally increase impacts in the study region. Sixty-nine oil and gas leases would be affected, resulting in a delay in their exploration and development, although none of these overlie proven oil and gas deposits.

Some 163,000 total AUM's would be lost by 1995. This includes 9.6 percent of fourteen Section 3 allotments, and 20 percent of seven Section 15 allotments removed from production as a result of the proposed action. This translates to a cumulative total of $9.8 million in gross income lost to ranching and related industries by 1995.

Urban expansion would occupy an additional 600 acres beyond the No Action Alternative. This growth would occur primarily in the Wyoming communities, and in Craig, Meeker, and Hayden in Colorado. In order to limit the conversion of rural agricultural lands to urban uses, existing planning and zoning tools should be used to direct this expansion to less desirable lands.

As in the other alternatives, consultation with landowners adjacent to and within the proposed tracts must be close, particularly in the checkerboard land-ownership pattern in Wyoming where privately-owned surface and mineral lands alternate with BLM lands within the delineated tracts.

AIR QUALITY

Impacts from the Medium Alternative would add approximately one percent to the No Action Alternative levels of TCP which are between 90 to 100 $\mu g/m^3$.

The CAPCD may reassess the present unclassified status of Craig and require an implementation plan to bring Craig into compliance with TSP standards. The implementation plan could take many forms and may limit the level of energy development in the region.

PREFERRED OR HIGH ALTERNATIVE

This Alternative has been identified by the Regional Coal Team as the Preferred Alternative. The High Alternative is comprised of five Wyoming tracts and eight Colorado tracts. Federal in-place reserves from the 13 tracts are 753.65 million tons, which would result in 20.52 million tons of new annual production per year. As with the previous alternatives, five of the tracts are assumed to be logical extensions of existing adjacent operations. Table 2-10 shows the tracts and coal reserves in this Alternative.

Table 2-11 shows transportation and employment requirements. Coal would be transported over 6.5 miles of road and 70.5 miles of railroad. A total of 450 employees would be needed for mine construction (1987 to 1989) and 1,464 employees would be used for mine development (1989 to end of mine life).

Acres disturbed by mining and ancillary facilities would reach 13,714 acres by 1995. Population increases would cause 676.5 acres to be disturbed for housing and infrastructure through 1995. Table 2-12 shows acres disturbed from the Preferred or High Alternative by time frame.

WATER RESOURCES

GROUND WATER

DISTURBANCE TO AQUIFERS. A cumulative total of 43.0 sq mi of aquifers (0.59 percent of the watershed) would be removed in the North Platte watershed by 1995 (same area for all alternatives, as the same five Wyoming tracts are included in all alternatives). A cumulative total of 34.6 sq mi (0.91 percent of the watershed) would be removed in the Yampa subbasin. Of these totals, l3 percent of the aquifers removed in the North Platte Basin and about 10 percent of those removed in the Yampa subbasin would be attributable to the Federal action. All impacts to ground-water systems from this disturbance would be very local and limited primarily to the period of active mining.

Mixing of aquifer waters resulting from shear-induced ruptures from underground mining (Empire and Bell Rock tracts) could slightly degrade water quality in deeper aquifers within and immediately adjacent to these tracts. No existing water supplies should be impacted. As these tracts are in all alternatives, the impacts would be the same.

Eight wells and one spring in Wyoming and five wells and two springs in Colorado would be severely impacted. Impacts to ground-water supplies should be very local, largely short-term, and principally a matter of increased drilling and pumping costs.

Leaching of spoil materials would increase dissolved solids concentrations in post-mining areas to two to three times premining levels. Water containing as much as 3,000 mg/L dissolved solids (maximum expected in Yampa River subbasin and Red Rim and China Butte areas) would be suitable for livestock and wildlife. Higher concentrations of dissolved solids of as much as 7,000 mg/L are expected in the Hanna area of Wyoming. This water would be marginal for livestock and wildlife use, and could require drilling to deeper aquifers for postmining water supplies.

SURFACE WATER

INCREASED SALINITY OF RECEIVING WATERS DOWNSTREAM. For this Alternative, two tracts (Danforth Hills #l and Danforth Hills #3) are adjacent to Good Spring Creek. Danforth Hills #3 is adjacent to Wilson Creek and the Grassy Creek Tract is adjacent to Grassy Creek. No significant increase in salinity is expected in Good Spring Creek, Wilson Creek or Grassy Creek during the period of active mining. On completion of mining, ground-water discharge would resume once the spoils have resaturated to a higher level than the stream. On a "worst case" basis during low flow conditions, dissolved solids concentrations in Good Spring Creek would increase from about l,050 mg/L before mining to about l,550 mg/L after mining. Wilson Creek would increase from about l,550 mg/L before mining to about 2,080 mg/L after mining. Grassy Creek would increase from about 620 mg/L before mining to about 825 mg/L after mining. These increases, although appreciable, would have no significant impact on current uses of the water or on aquatic biology downstream.

There would be no significant impacts during low flow in the North Platte watershed; however, significant impacts would occur to aquatic biology in the Yampa subbasin during low flow conditions. The leasing of coal under this Alternative would not significantly magnify the impacts on aquatic biology from the increased salinity that will occur without Federal action.

The cumulative salinity of the Colorado River at Imperial Dam would be l,046.l0 mg/L in l987, and l,046.l2 mg/L from 1990 to 1995. Over the long-term, it would increase to 1,046.16 mg/L. The increase attributable to the Federal action would be only 0.05 mg/L in 1987, 0.07 mg/L from 1990 to 1995 and 0.ll mg/L over the long-term. This constitutes a 0.007 percent increase from 1987 through 1995 from mining new Federal coal. The consequent increase in cost to downstream users would be $43,000 per year over the long-term. This small increase in salinity in the lower Colorado River is significant only because projected salinity levels for the time frames addressed are expected to exceed adopted standards in spite of ongoing salinity control projects. This is discussed under the No Action Alternative.

POLLUTION BY SEWAGE EFFLUENT. Sewage effluents discharged into the North Platte River and the Yampa River by municipal sources would have the greatest effect on aquatic biology during periods of low flow when effluent dilution is minimal. Dilution of sewage effluent, even at lowest recorded flow, in the North Platte river would be more than adequate to prevent any significant impact to the aquatic biology downstream. The impacts on aquatic biology in the Yampa River downstream from Craig are expected to be severe with or without implementation of this Alternative during periods of low flow. Assuming that the increase in pollutants is proportional to population increase, the high-level development of Federal coal would increase pollutant levels by about 16 percent by 1995. Should a repeat of the 1934 drought occur, the consequent impacts from sewage effluent on aquatic biology could be disastrous with or without implementing any of the coal leasing alternatives.

Minimum discharge in the Yampa River was recorded at 4.0 cfs at Steamboat Springs and 2.0 cfs downstream near Maybell during 1934. Contaminants in sewage effluent entering the river during these low-flow periods present a great hazard to aquatic biology.

The cumulative population of Steamboat Springs at high level development of new Federal coal would exceed the proposed standard for nonionized ammonia nitrogen by less than 0.003 mg/L by 1995, which could pose a potential threat to aquatic biology. Construction of a regional waste water treatment plant as proposed in the Steamboat Springs area (U.S. Environmental Protection Agency, 1977) and implementation of proposed 1985 standards for effluent would eliminate this potential impact.

EROSION AND SEDIMENTATION. Maximum increases in annual sediment yield at the Preferred or High Alternative for the North Platte River and the Yampa subbasin would be 855 tons (+0.86 percent) and 337 tons (+0.11 percent), respectively, in 1987, during the period of active construction. Thereafter, the sediment yield would decrease progressively, and an overall small decrease in cumulative sediment yield is expected by 1995 (-6,441 tons, -2.02 percent for North Platte River; -3,751 tons, -1.25 percent for Yampa subbasin).

These changes would cause no measurable effects on aquatic biology and any impacts from increased erosion and sediment yield over the period of mining should be very local and short lived.

WILDLIFE

Implementation of the Preferred or High Alternative would result in the cumulative loss of 103,953 acres of big game winter range by 1995. Of this, 19,842 acres (19.1 percent) would be attributable to the Federal action. As a result of habitat loss, 3,703 deer and 1,133 elk would be lost in Colorado. These losses would be significant enough to bring about a downward trend in regional populations over the long-term. Of these losses, 728 deer (19.7 percent) and 324 elk (19 percent) would be attributable to the Federal action.

Losses to habitat and animals in Wyoming for all alternatives would be minor in that significant animal losses would occur, but numbers would still maintain the current stable or increasing regional trend over the long-term. The development of the five Wyoming tracts (as would occur in all alternatives) would, however, result in locally significant declines in antelope and deer herds (DAU's), and sage grouse.

An estimated 1,659 acres of riparian habitat would be out of production by 1995. Three-hundred-seventy-eight acres (22.8 percent) would be attributable to the Federal action. Within the region, riparian zones comprise only 1.5 percent of all types, so any loss would be significant.

The major portion of the impacts is attributable to projected growth and development without implementation of this Alternative. Federal leasing would be additive to these impacts, but would not significantly increase the magnitude of these impacts through 1995. Under the Preferred or High Alternative, the addition of the Danforth Hills #2 Tract in combination with the Danforth Hills #1 and #3, would cause a serious loss of winter ranges, disruption of animal movements, and increased roadkill. This action would reduce deer numbers significantly.

CULTURAL RESOURCES

Under the Preferred or High Alternative, 96 existing cultural resources have been identified. Of these, two have been identified as potentially eligible to the National Register. It is expected that 629 to 942 cultural sites could be encountered, of which 273 to 586 would be on the proposed lease tracts. Of these, 94 to 147 sites are expected to be eligible to the National Register (37 to 90 would be encountered on the tracts). The 179 to 439 sites not eligible would be lost, but would not significantly affect the knowledge that could be gained of the prehistory of the area. The Union Pacific Mammoth, a paleontological specimen dated 11,280 ± 350 years ago (Clovis time period) is included in this alternative, located on the China Butte Tract.

SOCIOECONOMIC

The Preferred or High Alternative would significantly impact the communities of Craig and Meeker and their school districts in terms of population growth and fiscal requirements. Capital facilities requirements for Craig would rise from 17 to 38 percent above the No Action Alternative level. On the positive side, personal income in Moffat County would grow from 8 to 18 percent above the No Action Alternative level.

The Preferred or High Alternative would have significant impact upon the social structure and social-psychological well-being of the citizens of Hayden, Steamboat Springs, and Creston Junction; the impact upon Meeker would continue highly significant, and upon Craig would become so with this Alternative. In all these cases, except Creston Junction, the degree of seriousness would be somewhat greater than for the medium level, even though the communities do not change categories. All other communities would continue to be insignificantly impacted.

TRANSPORTATION

The Preferred or High Alternative would increase Average Daily Traffic (ADT) in Wyoming by 7 percent and in Colorado by 40 percent. Colorado road segments B and C (U.S. 40 between Craig and Steamboat Springs) would experience a decrease in the service level with the resulting congestion during peak traffic hours as a result of the increased project traffic. The increased ADT will also result in an increase in traffic accidents of 7 percent in Wyoming and 40 percent in Colorado.

This Alternative would increase rail traffic on the UP by four trains per day and on the D&RGW by nine trains per day. No significant impact on the D&RGW's track capacity would occur. The cumulative traffic increase would use 86 percent of the line's capacity. Because of projected line upgrades to the UP, the addition of four trains per day would not be a significant impact. An average increase of 5 percent and 23 percent in the exposure factor for at-grade crossings in Wyoming and Colorado, respectively, would occur. The time lost at grade crossings waiting for the increased train traffic would increase 12 minutes in Wyoming and 27 minutes in Colorado.

LAND USE

The 13 tracts leased under this alternative would further increase the land use impacts in the region. A total of 114 oil and gas leases would be delayed in their exploration and development, none of which overlie proven oil and gas deposits. Some additional impacts on other onsite improvements would also be felt, but their loss would be insignificant and temporary.

More than 176,000 AUM's would be lost through 1995. This figure includes 9.8 percent of fifteen Section 3 allotments, and 17.7 percent of fourteen Section 15 allotments that would be removed from production due to the Federal action. A cumulative total of more than $11 million in primary and secondary income would be lost in the region by 1995.

Over 800 acres of rural lands would be converted to urban uses region-wide as a result of the Federal action. In addition to the Wyoming communities that would be equally impacted by all alternatives, the communities of Craig, Hayden, and Meeker would be most affected by urban expansion in this alternative.

As in the other alternatives, local jurisdictions must use their planning and zoning authority to direct urban expansion onto non-agricultural or less desirable lands adjacent to their communities. Consultation with landowners adjacent to the proposed tracts must be close, particularly in the checkerboard land-ownership pattern in Wyoming where privately-owned surface and mineral lands alternate with BLM lands within the delineated tracts.

AIR QUALITY

Impacts from the Preferred or High Action Alternative would add approximately one percent to the No Action Alternative levels of TSP which are expected to be between $\mu g/m^3$.

The CAPCD may reassess the present unclassified status of Craig and require an implementation plan to bring Craig into compliance with TSP standards. The implementation plan could take many forms and may limit the level of energy development in the region.

MAXIMUM ALTERNATIVE

The Maximum Alternative includes five tracts in Wyoming and 11 tracts in Colorado. This Alternative includes all tracts delineated in the GR/HF region. Federal in-place reserves from the 16 tracts are 844.65 million tons which would yield 23.72 million tons of new annual production. Six of the tracts (two in Wyoming and four in Colorado) are assumed to be logical extensions of existing adjacent operations. Table 2-13 shows the tracts and coal reserves for this Alternative.

Table 2-14 shows the transportation and employment requirements. Coal would be transported over 19.5 miles of road and 70.5 miles of railroad. A total of 550 employees would be needed for mine construction (1987 to 1989) and 1,704 employees would be used for mine development (1989 to end of mine life).

Acres disturbed by mining and ancillary facilities would reach 16,313 acres by 1995. Population increases would cause 793.2 acres to be disturbed for housing and infrastructure through 1995. Table 2-15 shows acres disturbed from the Maximum Alternative by time frame.

WATER RESOURCES

GROUND WATER

DISTURBANCE TO AQUIFERS. A cumulative total of 43.0 sq mi of aquifers (0.59 percent of the watershed) would be removed in the North Platte watershed by 1995 (same area for all alternatives, as the same five Wyoming tracts are included in all alternatives) and 36.2 sq mi (0.95 percent of the watershed) would be removed in the Yampa subbasin. Of these totals, 13 percent of the aquifers removed in the North Platte basin and about 20 percent of those removed in the Yampa subbasin would be attributable to the Federal action. All impacts to ground-water systems from this disturbance would be very local and limited primarily to the period of active mining.

Mixing of aquifer waters resulting from shear-induced ruptures from underground mining (Empire and Bell Rock tracts) could slightly degrade water quality in deeper aquifers within and immediately adjacent to these tracts. No existing water supplies should be impacted. As these tracts are in all alternatives, the impacts would be the same.

Eight wells and one spring in Wyoming and six wells and eight springs in Colorado would be severely impacted. Impacts to ground-water supplies should be very local, largely short-term, and principally a matter of increased drilling and pumping costs.

SURFACE WATER

INCREASED SALINITY OF RECEIVING WATERS DOWNSTREAM. For this Alternative, five tracts are adjacent to perennial streams. Danforth Hills #1 and #3 are adjacent to Wilson Creek, Grassy Creek Tract is adjacent to Grassy Creek and Pinnacle Tract is adjacent to Fish Creek. No significant increase in salinity is expected in any of the perennial streams adjacent to tracts during the period of active mining. On a "worst case" basis during low flow conditions, dissolved solids concentrations in Good Spring Creek would increase from about 1,050 mg/L before mining to about 1,550 mg/L after mining. Wilson Creek would increase from about 1,550 mg/L before mining to about 2,080 mg/L after mining. Grassy Creek would increase from about 620 mg/L before mining to about 825 mg/L after mining. These increases, although appreciable, would have no significant impact on current uses of the water or on aquatic biology downstream. Fish Creek would increase from about 570 mg/L before mining to about 635 mg/L after mining, which is an insignificant increase.

There would be no significant impacts during low flow in the North Platte watershed; however, significant impacts would occur to aquatic biology in the Yampa subbasin during low flow conditions. The leasing of coal under this Alternative would not significantly magnify the impacts on aquatic biology from the increased salinity that will occur without Federal action.

The cumulative salinity of the Colorado River at Imperial Dam would be 1,046.11 mg/L in 1987, 1,046.15 mg/L from 1990 to 1995 and 1,046.25 mg/L over the long-term. The increase attributable to the Federal action would be only 0.06 mg/L in 1987, 0.10 mg/L from 1990 to 1995 and 0.20 mg/L over the long-term. This constitutes a 0.010 percent increase from 1987 through 1995 from mining new Federal coal. The consequent increase in cost to downstream users would be $79,000 per year over the long term. This small increase in salinity in the lower Colorado River is significant only because projected salinity levels for the time frames addressed are expected to exceed adopted standards in spite of ongoing salinity control projects. This is discussed under the No Action Alternative.

POLLUTION BY SEWAGE EFFLUENT. Sewage effluent discharged into the North Platte River and the Yampa River by municipal sources would have the greatest effect on aquatic biology during periods of low flow when effluent dilution is minimal. Dilution of sewage effluent in the North Platte River, even at lowest flow on record, would be more than adequate to prevent any significant impact to the aquatic biology downstream. The impacts on aquatic biology in the Yampa River downstream from Craig are expected to be severe with or without implementation of this Alternative during periods of low flow. Assuming that the increase in pollutants is proportional to population increase, the maximum-level development of Federal coal would increase pollutant levels by about 20 percent by 1995. Should a repeat of the 1934 drought occur, the consequent impacts on aquatic biology could be disastrous with or without implementing any of the coal leasing alternatives.

The cumulative population of Steamboat Springs at maximum level development of new Federal coal, would exceed the proposed standard for nonionized ammonia nitrogen by less than 0.003 mg/L by 1995, which could pose a potential threat to aquatic biology. Construction of a regional waste water treatment plant as proposed in the Steamboat Springs area (U.S. Environmental Protection Agency, 1977) and implementation of proposed 1985 standards for effluent would eliminate this potential impact.

EROSION AND SEDIMENTATION. Maximum increases in annual sediment yield at the Maximum Alternative for the North Platte River and the Yampa subbasin would be 855 tons (+0.86 percent) and 97 tons (+0.03 percent), respectively, in 1987, during the period of active construction. Thereafter, the sediment yield would decrease progressively, and an overall small decrease in cumulative sediment yield is expected by 1995 (-6,441 tons, -2.02 percent for North Platte River; -4,775 tons, -1.59 percent for Yampa subbasin). These changes would cause no measurable effect on aquatic biology and any impacts from increased erosion and sediment yield over the period of mining should be very local and short lived.

WILDLIFE

Implementation of the Maximum Alternative would result in the cumulative loss of 102,414 acres of big game winter range by 1995. Of this, 23,303 acres (21.7 percent) would be attributable to the Federal action. As a result of habitat loss, 3,976 deer and 1,216 elk would be lost in Colorado. These losses would be significant enough to bring about a downward trend in regional populations over the long-term. Of these losses, 1,001 deer (25 percent) and 306 elk (25 percent) would be attributable to the Federal action.

Losses to habitat and animals in Wyoming for all alternatives would be minor in that significant animal losses would occur, but numbers would still maintain the current stable or increasing regional trend over the long-term. The development of the five Wyoming tracts (as would occur in all alternatives) would, however, result in locally significant declines in antelope and deer herds (DAUs), and sage grouse.

An estimated 1,701 acres of riparian habitat would be out of production by 1995. Four hundred twenty acres (24.7 percent) would be attributable to the Federal action. Within the region, riparian zones comprise only 1.5 percent of all types, so any loss would be significant.

The major portion of the impacts is attributable to projected growth and development without implementation of this Alternative. Federal leasing would be additive to these impacts, but would not significantly increase the magnitude of these impacts through 1995.

The addition of the Danforth Hills #2 Tract, in combination with the Danforth Hills #1 and #3 tracts would cause a serious loss of winter ranges, disruption of animal movements, and increased roadkill. This would cause a significant reduction in deer numbers.

Adding Williams Fork Mountains and Iles Mountain tracts would remove large areas of essential winter range and production (fawning and calving) areas. A major migration corridor for deer and elk would be impacted. This widespread leasing would have highly significant adverse impacts on deer and elk populations in Government Maintenance Units 11,12,13 and 131.

CULTURAL RESOURCES

Under the Maximum Alternative, 96 existing cultural resources have been identified. Of these, two have been identified as potentially Eligible to the National Register. It is expected that 685 to l,088 cultural sites could be encountered, of which 329 to 732 would be on the proposed lease tracts. Of these, 102 to 169 sites are expected to be eligible to the National Register (45 to 112 would be encountered on the tracts). the 227 to 563 sites not eligible would be lost, but would not significantly affect the knowledge that could be gained of the pehistory of the area. The Union Pacific Mammoth, a paleontological specimen dated 11,280 ± 350 years ago (Clovis time period) is included in this alternative, located on the China Butte Tract.

SOCIOECONOMIC

In terms of population growth, Craig would experience a further rise from 16 percent to 22 percent above the baseline, compounding an already difficult fiscal situation. Conversely, total personal income in Moffat County would grow from l8 percent to 24 percent above the baseline, perhaps alleviating some, but by no means all, of Craig's fiscal plight.

At the Maximum Alternative, there are no significant category changes in structural or social-psychological impacts, but as for the Preferred or High Alternative, the individual community impacts have gradually increased.

TRANSPORTATION

The Maximum Alternative would increase Average Daily Traffic (ADT) in Wyoming by 7 percent and in Colorado by 45 percent. Colorado road segments B + C (U.S. 40 between Craig and Steamboat Springs) would experience a decrease in the service level with congestion during peak traffic hours as a result of the increased project traffic. The increased ADT would also result in an increase in traffic accidents of 7 percent in Wyoming and 45 percent in Colorado.

This Alternative would increase rail traffic on the UP by four trains per day and on the D&RGW by l2 trains per day. The cumulative traffic increase would use 96 percent of the line's capacity and would limit growth (after 1995) in product transportation via the D&RGW. Because of projected line upgrades on the UP, the addition of four trains per day would not be a significant impact. An average increase of 5 percent and 22 percent in the exposure factor for at-grade crossings in Wyoming and Colorado, respectively, would occur. The time lost at grade crossings waiting for the increased train traffic would increase l2 minutes in Wyoming and 36 minutes in Colorado.

LAND USE

With all tracts leased, impacts on land use in the region would be greatest with this alternative. One-hundred-thirty-four oil and gas leases would be delayed in their exploration and development and additional impacts on onsite improvements would increase; however, their loss, displacement or delay would be insignificant and temporary.

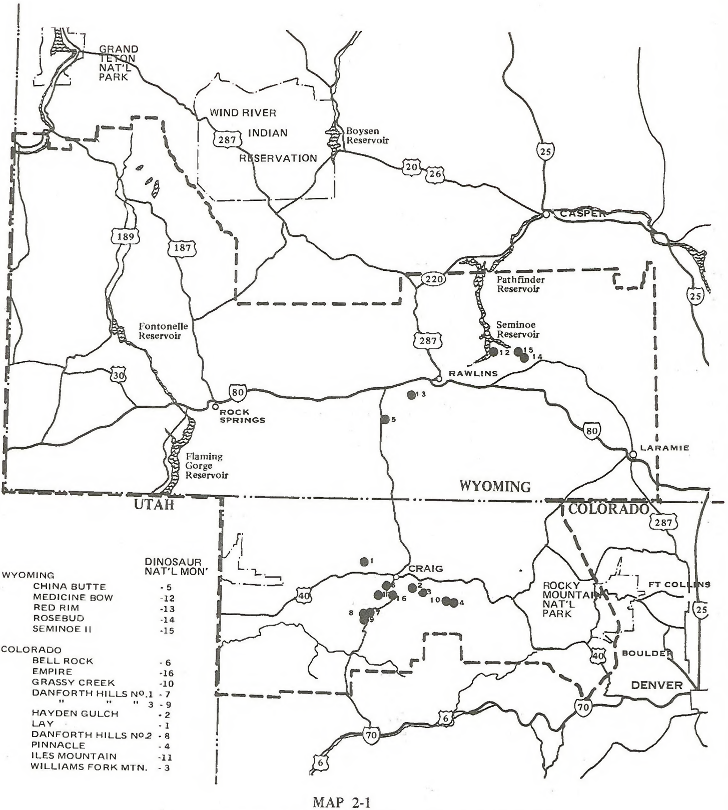
Nearly 195,000 total AUM's would be removed from production by 1995, representing 10 percent of sixteen Section 3 allotments, and 20.6 percent of twenty-one Section 15 allotments. This would result in a cumulative gross income loss of $12.6 million dollars to ranchers and related business in the region by 1995.

Communities would have to expand by 950 acres into rural lands by 1995 to accommodate population increases resulting from the Federal action. Hayden, along with Craig and Meeker, would feel most of the additional growth in Colorado. In order to limit the conversion of rural agricultural lands to urban uses, existing planning and zoning tools should be used to direct this expansion to less desirable agricultural lands.

Consultation with landowners adjacent to the proposed tracts must also be close, particularly in the checkerboard land-ownership pattern of Wyoming where privately-owned surface and mineral lands alternate with BLM lands within the delineated tracts.

AIR QUALITY

Impacts from the Maximum Action Alternative would add approximately one percent to the No Action Alternative levels of TSP which are expected to be between 90 to 100 $\mu g/m^3$. The CAPCD may reassess the present unclassified status of Craig and require an implementation plan to bring Craig into compliance with TSP standards. The implementation plan could take many forms and may limit the level of energy development in the region.



MAP 2-1

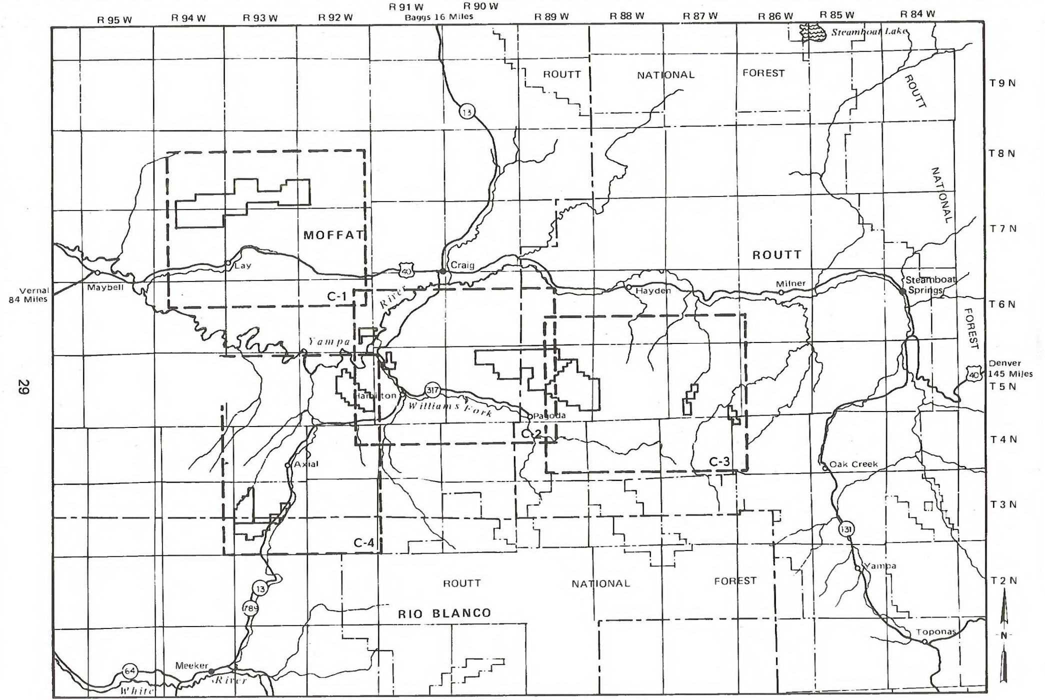
GREEN RIVER - HAMS FORK EIS COAL REGION

— — — Boundary

● Locations of Lease Study Tracts

-N-

0 50 MILES



C-1 LAY

C-2 BELL ROCK / EMPIRE / WILLIAMS FORK

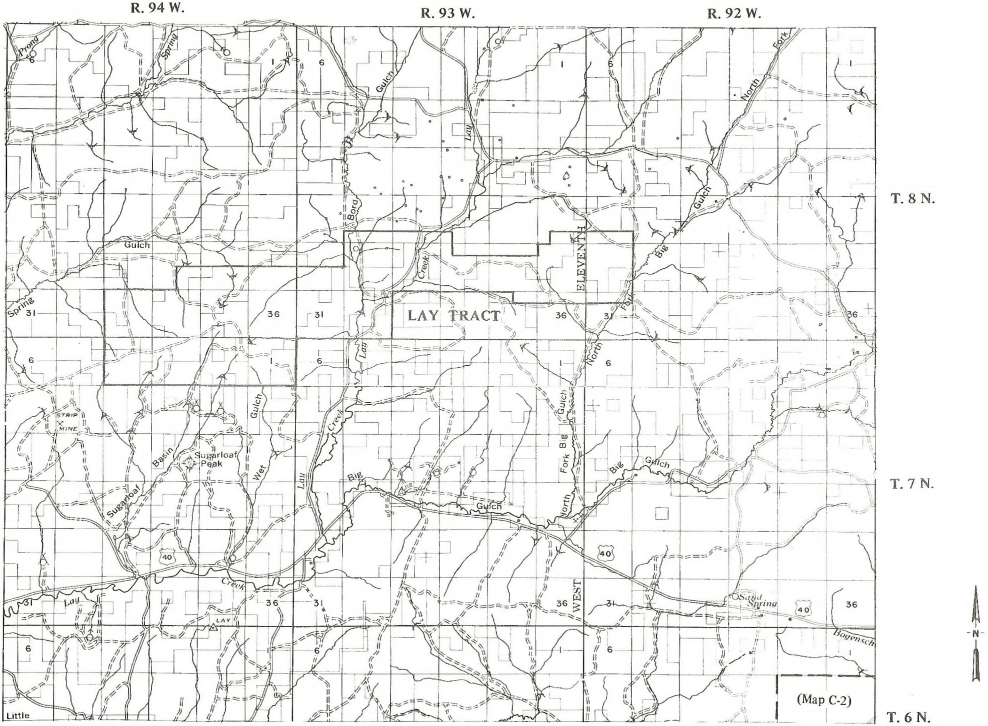
C-3 HAYDEN GULCH / GRASSY CREEK / PINNACLE

C-4 DANFORTH HILLS / ILES MOUNTAIN

Map 2-2
PROPOSED COLORADO COAL LEASE TRACTS

0 5 10 miles

Local Map Boundaries

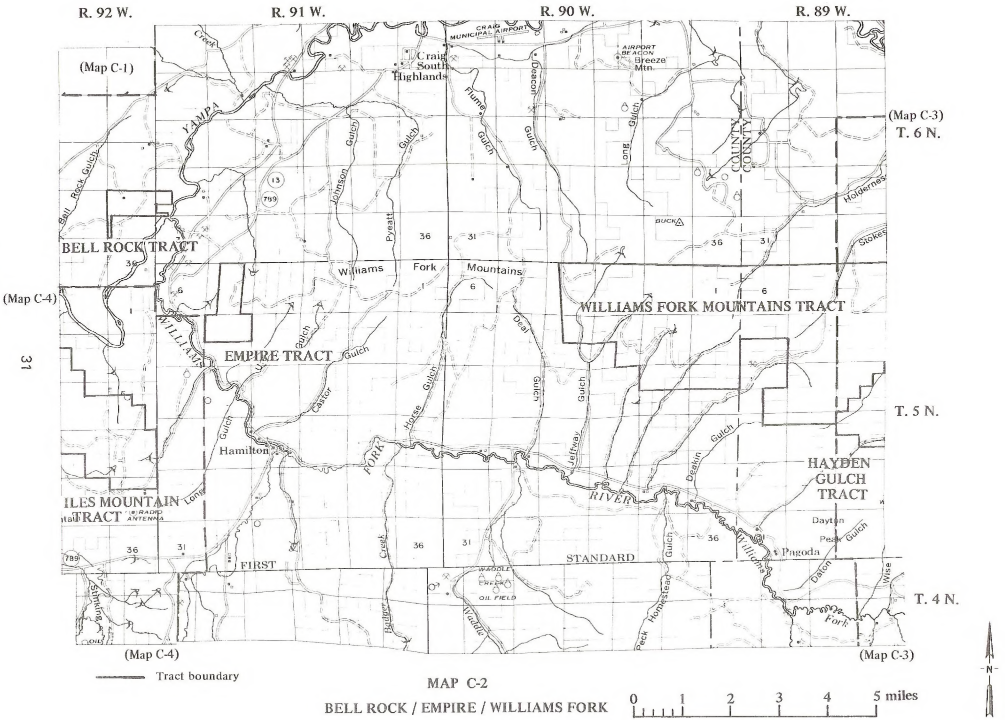


Tract boundary

0 1 2 3 4 5 miles

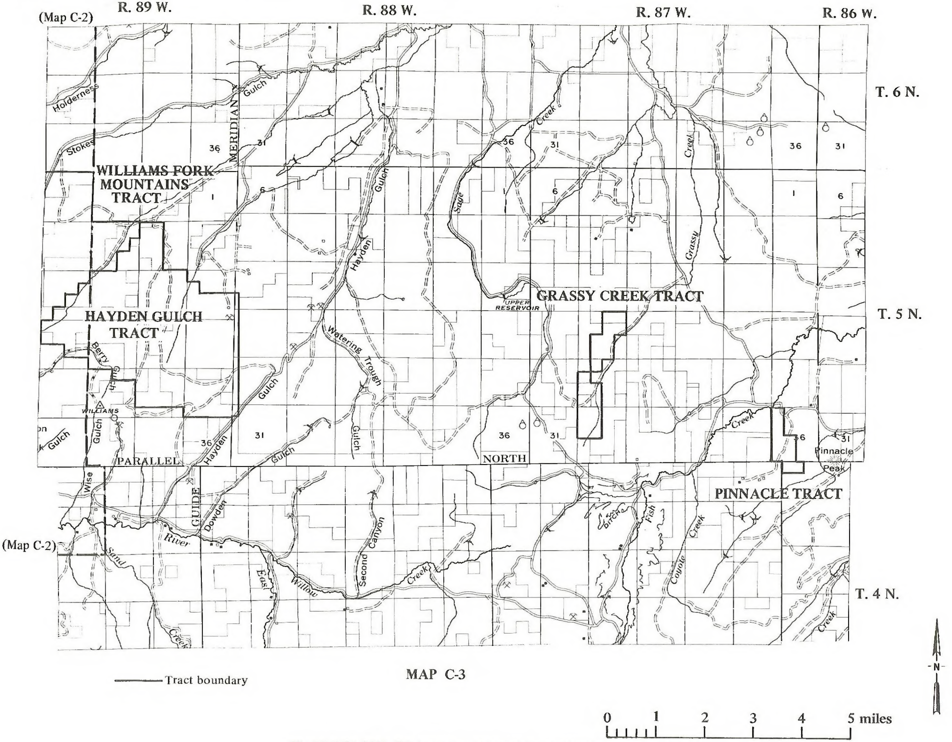
MAP C–1

LAY



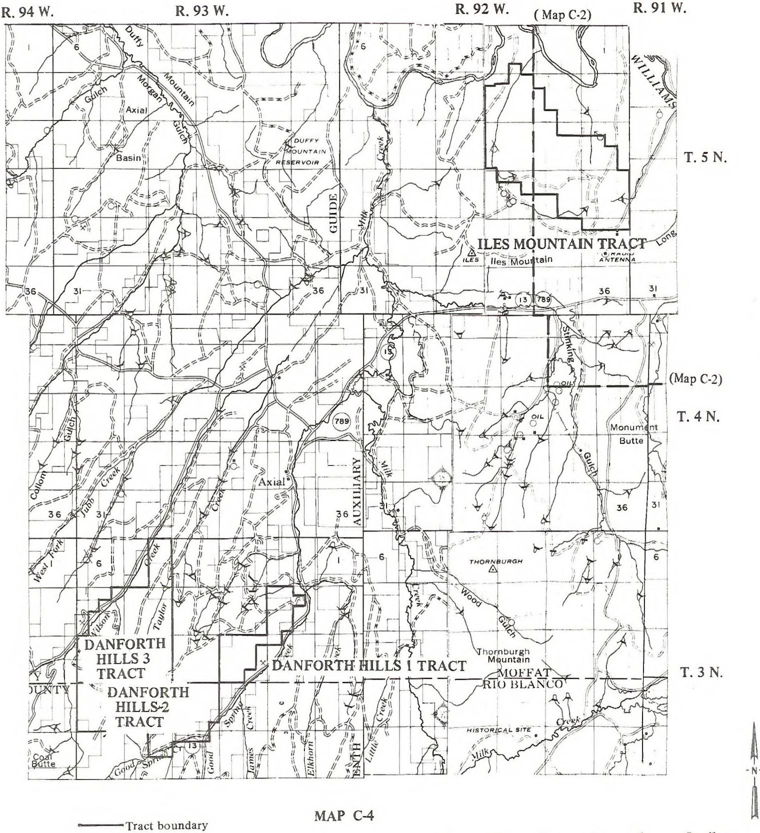
MAP C-2

BELL ROCK / EMPIRE / WILLIAMS FORK



MAP C-3

HAYDEN GULCH / GRASSEY CREEK / PINNACLE

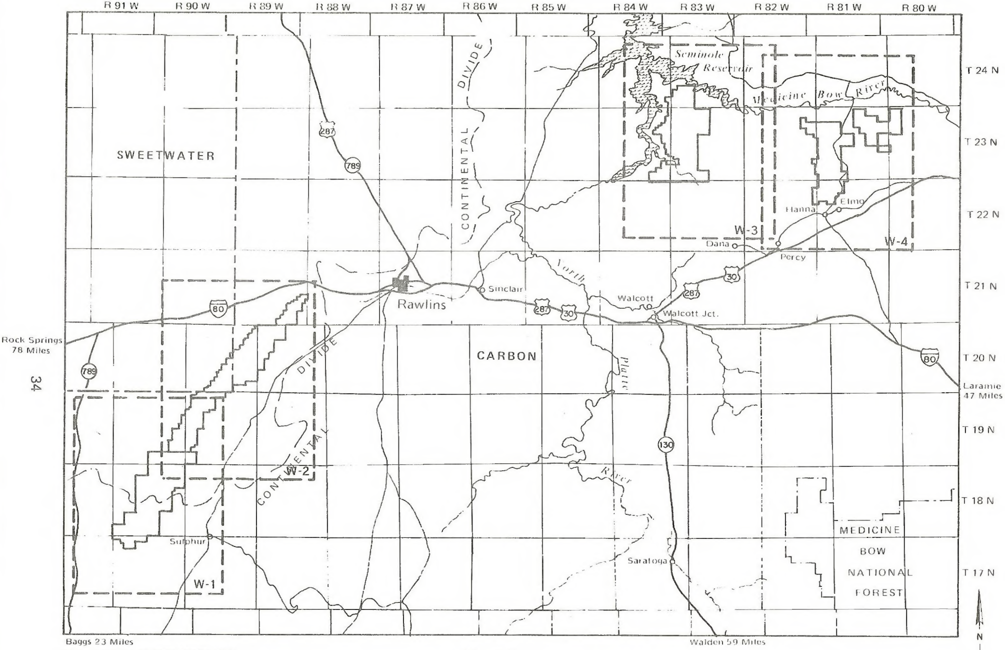


Tract boundary

MAP C-4

0 1 2 3 4 5 miles

DANFORTH HILLS / ILES MOUNTAIN

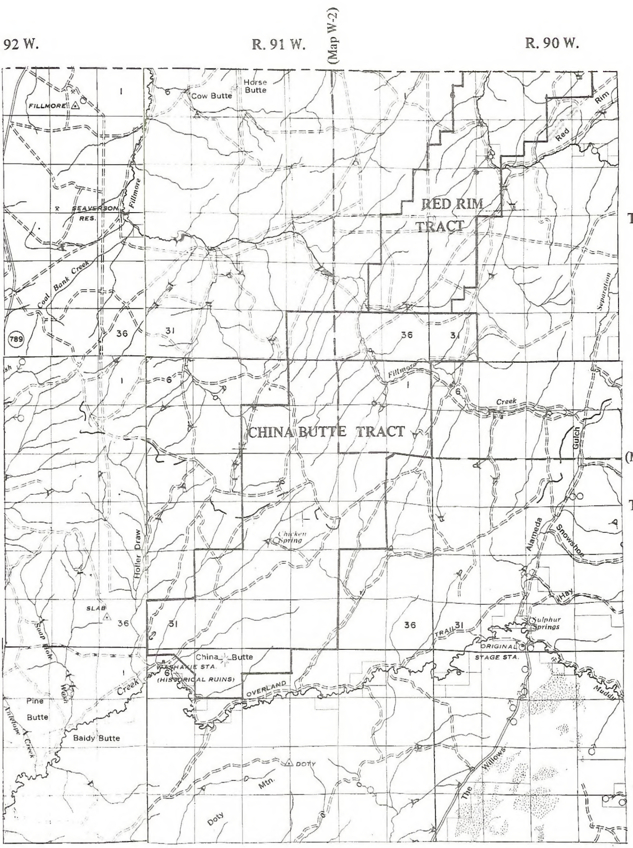


W-1 CHINA BUTTE/RED RIM
W-2 RED RIM/CHINA BUTTE
W-3 MEDICINE BOW
W-4 SEMINOE II/ROSEBUD

Map 2-3
PROPOSED WYOMING COAL LEASE TRACTS

0 5 10 miles

Local Map Boundaries



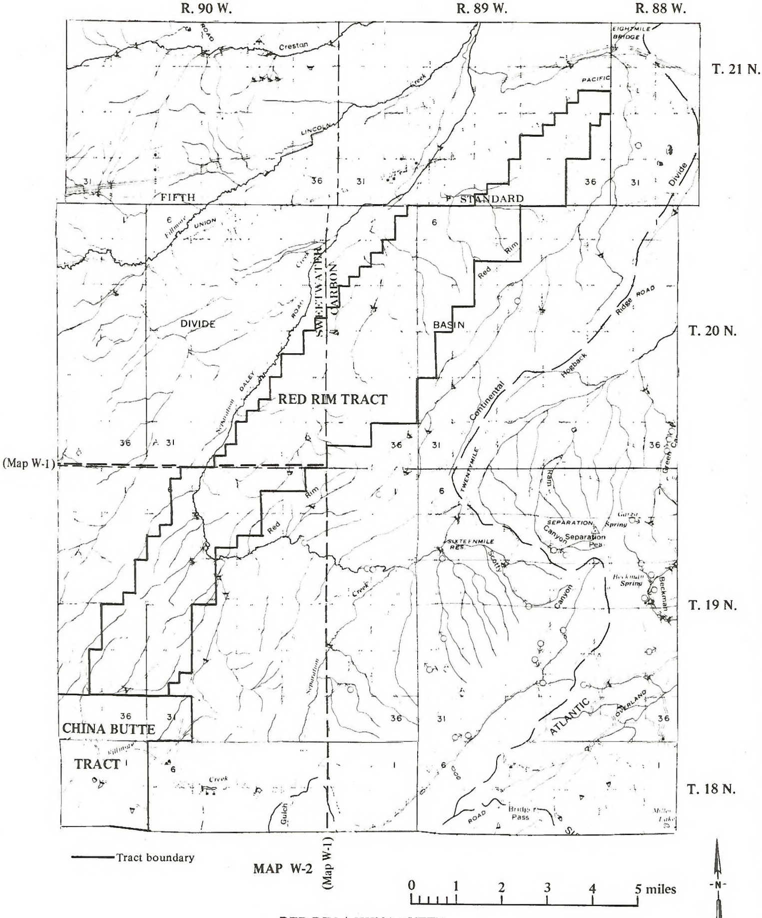
Tract boundary

MAP W-1

0 1 2 3 4 5 miles

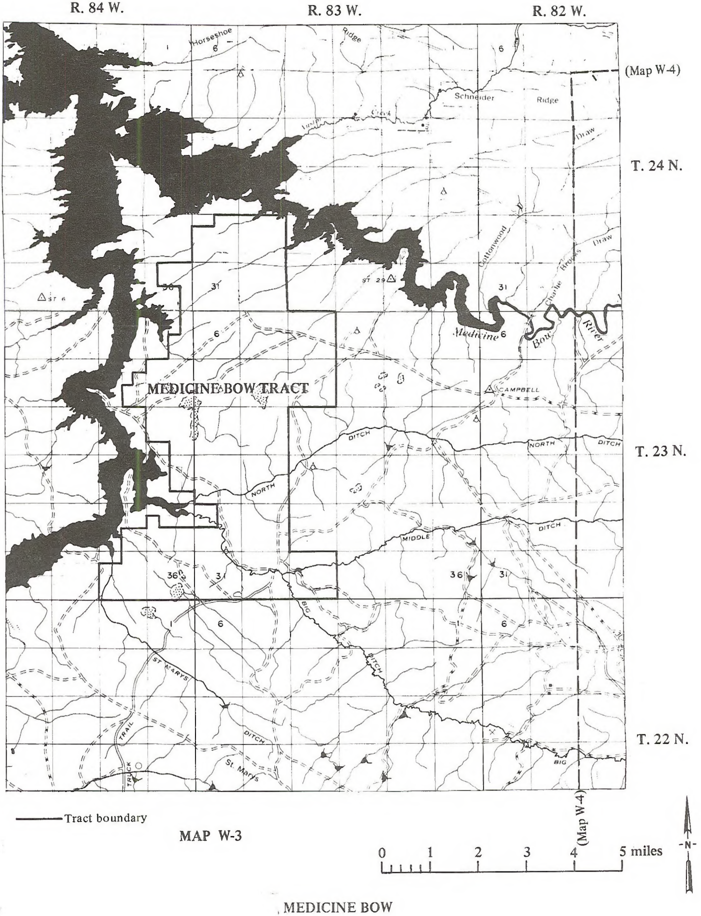
N

CHINA BUTTE / RED RIM

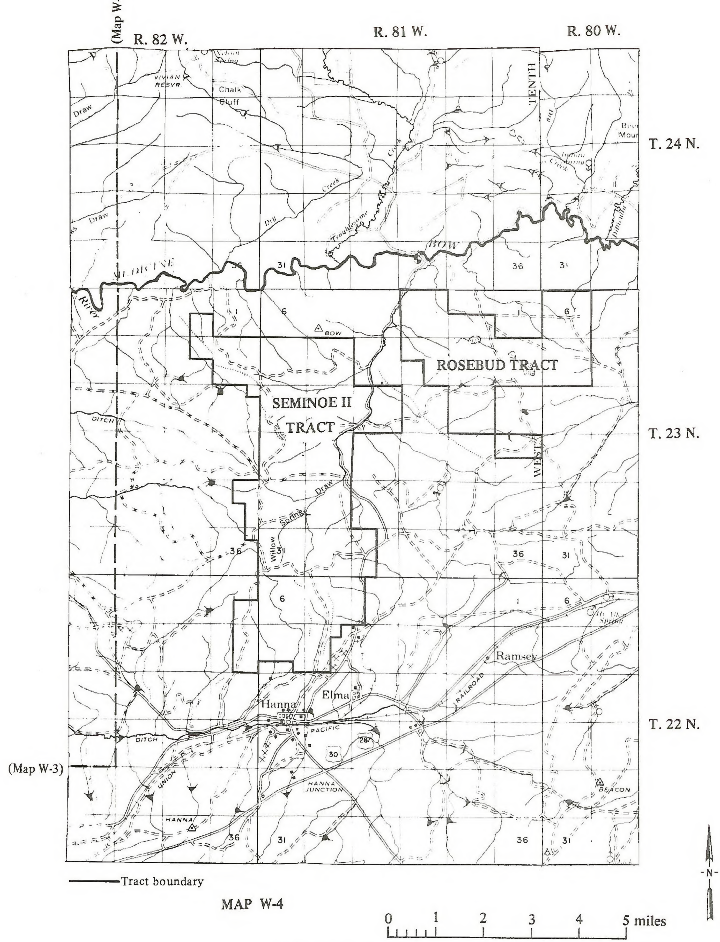


MAP W-2

RED RIM / CHINA BUTTE

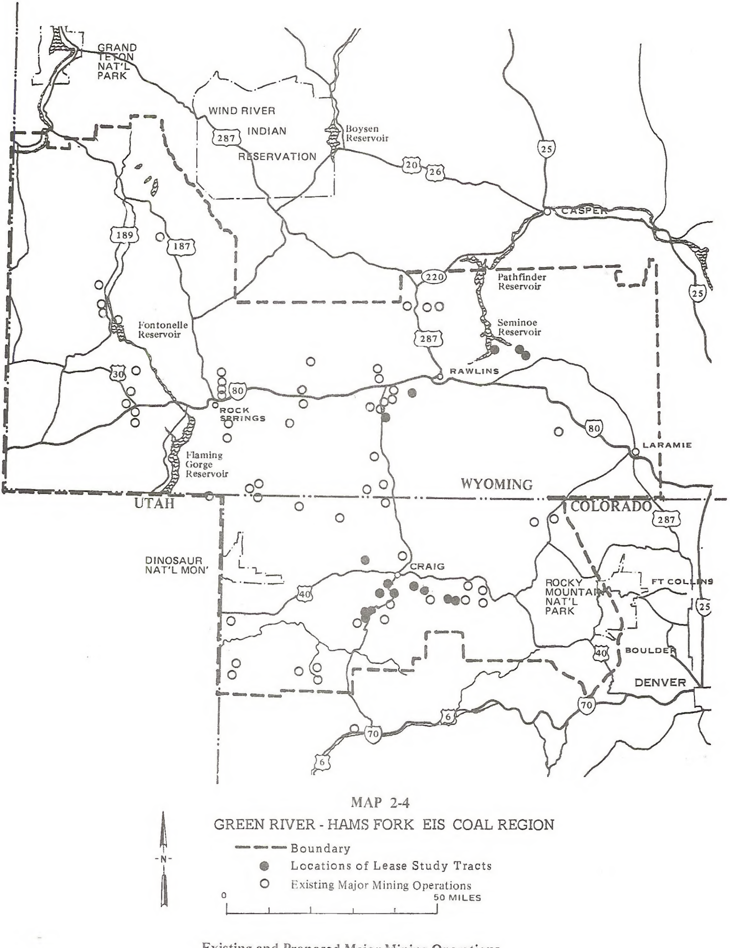

R. 84 W.
R. 83 W.
R. 82 W.
(Map W-4)
T. 24 N.
T. 23 N.
T. 22 N.
Horseshoe
Ridge
Schneider
Ridge
Creek
Draw
Cottonwood
Charlie Brooks Draw
ST 29
ST 6
Medicine Bow River
MEDICINE BOW TRACT
CAMPBELL
NORTH DITCH
MIDDLE DITCH
BIG DITCH
ST MARYS DITCH
St. Marys
TRUCK TRAIL
(Map W-4)
Tract boundary
0 1 2 3 4 5 miles
N

MAP W-3



MAP W-4

SEMINOE II / ROSEBUD



Existing and Proposed Major Mining Operations

FIGURE 2-1

GREEN RIVER/HAMS FORK REGIONAL EIS DRAFT ALTERNATIVE LIST

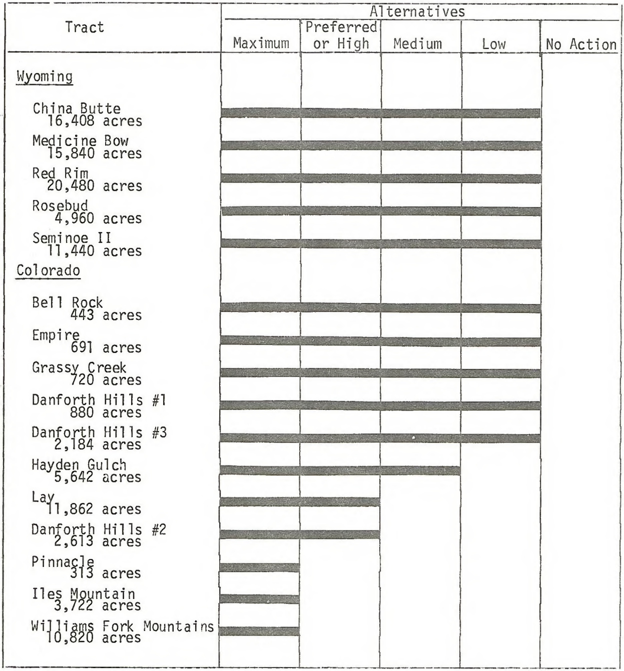


TABLE 2-1, Part 1

ALTERNATIVE MATRIX

Notes:

1/ These soils do not have adequate topsoil because of highly significant problems resulting from shallow, stony, droughty soils and/or very steep slopes.
2/ Significant problems with these soils will result from steep slopes, high erodibility, and/or low permeability.
3/ Loss of sagebrush and mountain communities is significant to wildlife in relationship to big game critical winter range, sage grouse habitat and livestock grazing (see Wildlife for more detail).
4/ Loss of aspen communities is significant to wildlife for elk calving areas, livestock and wildlife grazing and VRM in highly scenic areas.
5/ Any loss of riparian habitat is very significant to wildlife, aquatic communities, livestock grazing and VRM due to the high utilization and limited amount of habitat (1.5 percent of total region).
6/ Includes acres unuseable due to human activity.
7/ Psychological value judgement.
8/ The direct land use is existing roads, railroads, powerlines, etc. and these will not be significantly impacted.
9/ The loss of Section 3 grazing allotments will impact two local ranchers very significantly and loss of several thousand AUMs will significantly impact livestock production and economics to the local agricultural communities.
10/ The indirect land use is changed from existing land use to urbanization from population increases from new coal development.
11/ The significant impacts in the high and maximum alternatives are from problems associated with the Human Settlement Policy and the Lay tract's effect on the town of Maybell.
12/ These income impacts are beneficial.

ELEMENT	No Action	Low Alternative	Medium Alternative	Preferred or High Alternative	Maximum Alternative
MINERALS					
New Federal Coal Production (MM tons/yr)	0	10.76	13.52	20.52	23.72
SOILS					
T Reclamation Problems 1/ (Acres Disturbed)	10,400 H	17,500 H	17,900 H	20,800 H	22,200 H
T Reclamation Problems 2/ (Acres Disturbed)	10,400 S	17,700 S	18,900 S	23,600 S	26,400 S
WATER RESOURCES					
T Aquifers Removed					
North Platte River (% of watershed disturbed)	0.52 I	0.59 I	---------->	---------->	---------->
Yampa Subbasin (% of watershed disturbed)	0.76 I	0.83 I	0.85 I	0.91 I	0.95 I
T Ground-water Quality	* I	---------->	---------->	---------->	---------->
Reservoirs Removed #	0 I	26 I	31 I	36 I	47 I
Annual Consumptive Use of Water					
North Platte River (ac-ft)	316,400 S	316,847 S	---------->	---------->	---------->

I--Insiginificant Impact; S--Significant Impact; H--Highly Significant Impact
T--Identified in scoping process.
*--Quantification or significance not determinable.

TABLE 2-1, Part 2

ALTERNATIVE MATRIX

Element	No Action	Low Alternative	Medium Alternative	Preferred or High Alternative	Maximum Alternative
WATER RESOURCES (cont.)					
Yampa Subbasin (ac-ft)	S 134,900	S 135,056	S 135,198	S 135,513	S 135,612
T Salinity (Lower Colorado River) (mg/L)	S 1,046.05	S 1,046.10	S 1,046.11	S 1,046.16	S 1,046.25
T Sewage Effluent	HS *	---------->	---------->	---------->	---------->
S Annual Sediment Yield					
North Platte (tons)	I 100,000	I 100,855	---------->	---------->	---------->
Yampa Subbasin (tons)	I 300,000	I 300,519	I 300,571	I 300,337	I 300,097
VEGETATION					
Sagebrush 3/ (Acres lost)	S 31,743	S 37,604	S 38,107	S 40,063	S 40,928
Mountain Shrub 3/ (Acres lost)	S 8,057	S 8,896	S 9,424	S 10,349	S 11,272
Aspen 4/ (Acres lost)	S 3,887	S 4,147	S 4,237	S 4,470	S 4,570
Riparian 5/ (Acres lost)	H 821	H 893	H 919	H 1,063	H 1,090
Threatened and Endangered	Threatened and Endangered plants and animals cannot be evaluated at this time. A biological opinion has been requested from the Fish and Wildlife Service and results of this opinion will be supplied for the final.				
WILDLIFE					
T Habitat Losses 6/					
Big Game Winter Range	H 84,111	H 96,324	H 98,299	H 103,953	H 107,414
Riparian	H 1,281	H 1,393	H 1,434	H 2,392	H 2,452
T Animal Losses (Numbers)					
Big Game	H 5,924	H 6,621	H 6,797	H 7,390	H 7,785
Sage Grouse	S 766	S 932	---------->	---------->	---------->

I--Insiginificant Impact; S--Significant Impact; H--Highly Significant Impact
T--Identified in scoping process.
*--Quantification or significance not determinable.

TABLE 2-1, Part 3

ALTERNATIVE MATRIX

Element	No Action	Low Alternative	Medium Alternative	Preferred or High Alternative	Maximum Alternative
WILDLIFE (cont.)					
Sensitive Raptors	S *	-->			
Threatened or Endangered 6/	Threatened and Endangered plants and animals can not be evaluated at this time. A biological opinion has been requested from the Fish and Wildlife Service and results of this opinion will be supplied for the final.				
T CULTURAL RESOURCES					
Expected Cultural Resources	I 356	I 525-699	I 547-755	I 629-942	I 685-1,088
Expected Eligible	I 57	I 79-109	I 82-118	I 94-147	I 102-169
Union Pacific Mammoth	S 1	S 1	S 1	S 1	S 1
RECREATION					
Urban ($000)	H 3,394	S 3,757	S 3,828	S 4,014	S 4,055
Dispersed 8/ (loss of quality)	S *	-->			
Visual Resources (acres disturbed	H 70,020	H 76,527	H 77,622	H 79,715	H 81,879
Wilderness	I	-->			
T SOCIAL-ECONOMIC					
Number of Counties with 10% or More Income Increase 13/	H 4	-->			
Number of Towns and School Districts with >10% Capital Fiscal Impact	H 0	H 9	H 10	H 12	---------->
Number of Communities With Social-Structural Problems	S 4	S 5	-->		
Number of Communities With Social-Psychological Problems For Individuals	S 4	S 5	-->		
T TRANSPORTATION					
Increased ADT (Colo.) (percent)	S 155	S 167	S 173	H 195	H 200
Increased ADT (Wyo.) (percent)	S 180	S 187	-->		
Traffic Congestion	I No	---------->	S Yes	------------------------>	

I--Insiginificant Impact; S--Significant Impact; H--Highly Significant Impact
T--Identified in scoping process.
*--Quantification or significance not determinable.

TABLE 2-1, Part 4

ALTERNATIVE MATRIX

Element	No Action	Low Alternative	Medium Alternative	Preferred or High Alternative	Maximum Alternative
S TRANSPORTATION (cont.)					
Increased Accidents (Colo.) (percent)	* 155	* 167	* 173	* 195	* 200
Increased Accidents (Wyo.) (percent)	* 180	* 187	------------	------------	------------>
Increased Rail Traffic (Colo.) (number of trains)	I 16	I 18	I 20	I 25	I 28
Increased Rail Traffic (Wyo.) (number of trains)	I 27	I 31	I 4	------------	------------>
Increased At Grade Hazard Ratings (Colo.) (percent)	* 260	* 262	* 264	* 266	* 264
Increased Waiting Time (Colo.) (minutes)	I 48	I 54	I 60	I 75	I 84
Increased Waiting Time (Wyo.) (minutes)	I 81	I 93	------------	------------	------------>
NET ENERGY ANALYSIS					
Energy Produced / Energy Consumed	* *	* 12.3/1	* 12.3/1	* 12.4/1	* 12.3/1
LAND USE					
Direct Land Use 8/	I *	------------	------------	------------	------------>
Agricultural Economic Loss 9/	S 0	S $ 3,578,000	S $ 4,054,000	S $ 4,534,000	S $ 5,201,000
Indirect Land Use 10/	I	------------	------------	------------	------------>
Policies and Plans 11/	I *	------------	------------	------------	------------>
Air Quality					
TSP					
Wyoming	I <60 g/m3	------------	------------	------------	------------>
Colorado	H 115-125 g/m3	H 116-126 g/m3	------------	------------>	H 119-129 g/m3

I - Insignificant Impact; S - Significant Impact; H - Highly Significant Impact
T--Identified in scoping process.
* - Quantification or significance not determinable

TABLE 2-2

PROJECTED COAL PRODUCTION FROM THE STUDY REGION WITHOUT NEW FEDERAL LEASING

State - Company	Production (million tons) 1987	1990	1995
Wyoming			
Medicine Bow	2.5	2.5	2.5
Seminoe I	2.3	0	0
Seminoe II	3.5	3.5	3.5
Energy Development	1.3	0	0
Carbon County Coal	2.2	2.5	2.5
Hanna South	0.6	0.6	0
Carbon Basin	1.5	5.0	5.0
Cherokee	5.0	6.0	6.0
Subtotal	18.9	20.1	19.5
Colorado			
AMCA	.25	.25	.25
Coal Fuels Company	2.0	2.0	2.0
Colowyo Coal Company	3.0	3.0	3.0
Empire Energy	2.4	2.4	2.4
Energy Fuels Corporation	4.0	4.0	4.0
Energy West, Inc.	4.5	5.7	5.7
Milner Coal Corporation	.5	0	0
Northern Minerals Company	1.2	1.2	1.2
Peabody Coal Company	2.0	2.0	2.0
Pittsburg & Midway	2.2	2.5	2.5
Rockcastle Company	.25	.25	.25
Ruby Construction	.20	.20	.20
Sheridan Enterprises	.28	.28	.28
Sun Coal Company	.20	.20	.20
Sunland Coal Company	.10	.10	.10
Utah International, Inc.	3.36	3.36	3.36
W. R. Grace & Company	1.0	1.0	1.0
Subtotal	27.34	28.24	28.24
Total	46.34	48.34	47.74

TABLE 2-3

CUMULATIVE REGIONAL SURFACE ACRES TO BE DISTURBED
WITHOUT NEW FEDERAL LEASING

	1987	1990	1995
COLORADO			
COAL-RELATED			
Mine Area disturbed	10,590	17,920	17,920
Mine Facilities and Related R/W 1/ 3/	2,970	2,970	2,970
Powerlines	1,880	1,880	1,880
Powerplants 3/	380	380	380
Railroads 3/	990	1,090	1,090
Acres Reclaimed 2/	5,360	12,670	12,670
Total Disturbed	16,810	24,240	24,240
Total Permanently Removed 4/	1,475	1,575	1,575
NON COAL-RELATED			
Oil Shale			
Superior (project)	438	447	463
Superior (housing)	990	990	990
ca	1,517	1,970	2,725
cb	935	992	1,087
Oil and Gas	6,645	8,606	13,242
Uranium	623	623	623
Population (total)	4,074.4	4,282.4	4,317.7
WYOMING			
COAL-RELATED			
Mine Area Disturbed	13,300	20,500	23,850
Mine Facilities and Related R/W 1/	850	900	900
Ancilliary Facilities 5/	1,050	1,100	1,100
Facility Relocation 6/	600	700	800
Acres Reclaimed	11,700	16,500	19,500
Total Disturbed	15,800	23,200	26,650
Total Permanently Removed	1,650	1,800	1,900
NON COAL-RELATED			
Total 7/	1,900	2,400	3,300
Population	2,766.3	2,805.6	2,913.5

1/ Includes haul roads, access roads, and coal exploration trails.
2/ Includes acres reclaimed for mine areas and powerlines.
3/ This acreage considered removed from production for time frames indicated.
4/ This acreage considered permanently removed from production over long term (includes acreage for access roads).
5/ Includes access roads, rail spurs, and powerlines.
6/ Includes powerline, telephone line, and Highway 789 relocation.
7/ Includes acres disturbed by oil and gas production, uranium, sand and gravel, prison construction, etc.

TABLE 2-4

LOW ALTERNATIVE

MINERAL RESOURCE VALUES

Tract	Coal Reserves (million tons) In-Place Federal	In-Place Non Federal	In-Place Total	Recoverable Federal	Recoverable Non Federal	Recoverable Total	New Annual Production (million tons)
WYOMING							
China Butte	69.90	69.90	139.8	59.4	59.0	118.4	4.0
Medicine Bow 1/	30.1	88.60	118.7	25.6	69.3	94.9	0
Red Rim	42.20	16.20	58.4	35.9	13.8	49.7	1.7
Rosebud	18.50	11.90	30.4	15.7	10.1	25.8	1.0
Seminoe II 1/	25.45	25.46	50.91	21.6	21.7	43.3	0
Sub-Total	186.15	212.06	398.21	158.2	173.9	332.1	6.7
COLORADO							
Bell Rock 1/	46.6	0	46.6	11.9	0	11.9	0
Empire	34.5	0	34.5	13.8	0	13.8	0.50
Grassy Creek 1/	1.6	1.1	2.7	1.4	0.9	2.3	0
Danforth Hills #1 1/	40.3	0	40.3	34.2	0	34.2	0
Danforth Hills #3	111.6	13.9	125.5	94.9	11.8	106.7	3.56
Sub-Total	234.6	15	249.6	156.2	12.7	168.9	4.06
Total	420.75	227.06	647.81	314.4	186.6	500.9	10.76

1/ Assumes extension of existing adjacent operator.

TABLE 2-5

LOW ALTERNATIVE

TRANSPORTATION AND EMPLOYMENT

	Transportation 1/ (miles) Truck	Transportation 1/ (miles) Rail	Employment Construc.	Employment Mining
WYOMING				
China Butte	5.5	20	63	437
Medicine Bow 2/	--	--	0	- 33
Red Rim	--	8	55	186
Rosebud	--	1.5	55	109
Seminoe II 2/	--	--	0	11
Sub-Total	5.5	29.5	218	710
COLORADO				
Bell Rock 2/	--	--	0	0
Empire	1	--	15	43
Grassy Creek 2/	--	--	0	0
Danforth Hills #1 2/	--	--	0	0
Danforth Hills #3	--	2.5	72	250
Sub-Total	1	2.5	87	295
Total	6.5	32	305	1,003

1/ No new transportation facilities needed for mine extension.
2/ Assumes extension of existing adjacent operator.

TABLE 2-6

LOW ALTERNATIVE

ACRES DISTURBED

Tract	Mining Operations				Onsite Facilities 2/				Offsite Facilities 3/				Housing & Infrastructure (Total) 4/			
	1987	1990	1995	EOML	1987	1990	1995	EOML	1987	1990	1995	EOML	1987	1990	1995	EOML
WYOMING																
China Butte	0	270	945	4050	140	402	554	796	288	288	288	288	--	--	--	--
Medicine Bow 5/	0	234	819	3510	0	49	129	327	0	0	0	0	--	--	--	--
Red Rim	0	268	938	4020	75	375	500	1052	533	765	765	765	--	--	--	--
Rosebud	0	88	308	792	190	349	419	540	343	343	343	343	--	--	--	--
Seminoe II 5/	0	182	637	1274	88	175	300	356	0	0	0	0	--	--	--	--
Sub-Total	0	1042	3647	13646	493	1350	1902	3071	1164	1396	1396	1396	6/ 205.6	6/ 195.6	6/ 199.4	6/ 199.4
COLORADO																
Bell Rock 5/	0	0	0	0	0	0	0	0	0	0	0	0	--	--	--	--
Empire	0	0	0	0	20	20	20	20	40	40	40	40	--	--	--	--
Grassy Creek 5/	0	34	119	170	0	0	0	0	0	0	0	0	--	--	--	--
Danforth Hills #1 5/	0	54	189	810	0	0	0	0	0	0	0	0	--	--	--	--
Danforth Hills #3	0	140	630	2100	0	0	0	0	732	732	732	732	--	--	--	--
Sub-Total	0	228	938	3080	20	20	20	20	772	772	772	722	112.6	143.7	143.7	143.7
Total	0	1270	4585	16726	513	1370	1922	3091	1936	2168	2168	2168	318.2	339.3	343.1	343.1

1/ Includes only that area to be actually mined.
2/ Includes all structures, haul roads, topsoil and overburden storage.
3/ Includes rail and access roads, power and telephone lines.
4/ Acreage based on assumption of 100 acres disturbed per 1000 population increase.
5/ Assumes extension of existing adjacent operator.
6/ Does not include secondary population impacts that could occur in Casper, Laramie, Rock Springs, and Sinclair.

TABLE 2-7

MEDIUM ALTERNATIVE

MINERAL RESOURCE VALUES

Tract	Coal Reserves (million tons) In-Place Federal	In-Place Non Federal	In-Place Total	Recoverable Federal	Recoverable Non Federal	Recoverable Total	New Annual Production (million tons)
WYOMING							
China Butte	69.90	69.90	139.8	59.4	59.0	118.4	4.0
Medicine Bow 1/	30.1	88.60	118.7	25.6	69.3	94.9	0
Red Rim	42.20	16.20	58.4	35.9	13.8	49.7	1.7
Rosebud	18.50	11.90	30.4	15.7	10.1	25.8	1.0
Seminoe II 1/	25.45	25.46	50.91	21.6	21.7	43.3	0
Sub-Total	186.15	212.06	398.21	158.2	173.9	332.1	6.7
COLORADO							
Bell Rock 1/	46.6	0	46.6	11.9	0	11.9	0
Empire	34.5	0	34.5	13.8	0	13.8	0.50
Grassy Creek 1/	1.6	1.1	2.7	1.4	0.9	2.3	0
Danforth Hills #1 1/	40.3	0	40.3	34.2	0	34.2	0
Danforth Hills #3	111.6	13.9	125.5	94.9	11.8	106.7	3.56
Hayden Gulch	97.3	0	97.3	82.7	0	82.7	2.76
Sub-Total	331.9	15	346.9	238.9	12.7	251.6	6.82
Total	518.05	227.06	745.11	397.1	186.6	583.7	13.52

1/ Assumes extension of existing adjacent operator.

TABLE 2-8

MEDIUM ALTERNATIVE

TRANSPORTATION AND EMPLOYMENT

	Transportation 1/ (miles) Truck	Transportation 1/ (miles) Rail	Employment Construc.	Employment Mining
WYOMING				
China Butte	5.5	20	63	437
Medicine Bow 2/	--	--	0	- 33
Red Rim	--	8	55	186
Rosebud	--	1.5	100	109
Seminoe II 2/	--	--	0	0
Sub-Total	5.5	29.5	218	710
COLORADO				
Bell Rock 2/	--	--	0	0
Empire	1	--	15	43
Grassy Creek 2/	--	--	0	0
Danforth Hills #1 2/	--	--	0	0
Danforth Hills #3	--	2.5	72	250
Hayden Gulch	--	10	38	212
Sub-Total	1	12.5	125	505
Total	6.5	42.0	343	1215

1/ No new transportation facilities needed for mine extension.
2/ Assumes extension of existing adjacent operator.

TABLE 2-9

MEDIUM ALTERNATIVE

ACRES DISTURBED

Tract	Mining Operations				Onsite Facilities 2/				Offsite Facilities 3/				Housing & Infrastructure (Total) 4/			
	1987	1990	1995	EOML	1987	1990	1995	EOML	1987	1990	1995	EOML	1987	1990	1995	EOML
WYOMING																
China Butte	0	270	945	4050	140	402	554	796	288	288	288	288	--	--	--	--
Medicine Bow 5/	0	234	819	3510	0	49	129	327	0	0	0	0	--	--	--	--
Red Rim	0	268	938	4020	75	375	500	1052	533	765	765	765	--	--	--	--
Rosebud	0	88	308	792	190	349	419	540	343	343	343	343	--	--	--	--
Seminoe II 5/	0	182	637	1274	88	175	300	356	0	0	0	0	--	--	--	--
Sub-Total	0	1042	3647	13646	493	1350	1902	3071	1164	1396	1396	1396	6/ 205.6	6/ 195.6	6/ 199.4	6/ 199.4
COLORADO																
Bell Rock 5/	0	0	0	0	0	0	0	0	0	0	0	0	--	--	--	--
Empire	0	0	0	0	20	20	20	20	40	40	40	40	--	--	--	--
Grassy Creek 5/	0	34	119	170	0	0	0	0	0	0	0	0	--	--	--	--
Danforth Hills #1 5/	0	54	189	810	0	0	0	0	0	0	0	0	--	--	--	--
Danforth Hills #3	0	140	630	2100	0	0	0	0	732	732	732	732	--	--	--	--
Hayden Gulch	0	220	495	1650	600	600	600	600	260	260	260	260	--	--	--	--
Sub-Total	0	448	1433	4730	620	620	620	620	1032	1032	1032	1032	161.8	245.0	245.0	245.0
Total	0	1490	5080	18376	1113	1970	2522	3691	2196	2428	2428	2428	367.4	440.6	444.4	444.4

1/ Includes only that area to be actually mined.
2/ Includes all structures, haul roads, topsoil and overburden storage.
3/ Includes rail and access roads, power and telephone lines.
4/ Acreage based on assumption of 100 acres disturbed per 1000 population increase.
5/ Assumes extension of existing adjacent operator.
6/ Does not include secondary impacts that could occur in Casper, Laramie, Rock Springs, and Sinclair.

TABLE 2-10

PREFERREO OR HIGH ALTERNATIVE

MINERAL RESOURCE VALUES

Tract	Coal Reserves (million tons) In-Place Federal	In-Place Non Federal	In-Place Total	Recoverable Federal	Recoverable Non Federal	Recoverable Total	New Annual Production (million tons)
WYOMING							
China 8utte	69.90	69.90	139.8	59.4	59.0	118.4	4.0
Medicine 8ow 1/	30.1	88.60	118.7	25.6	69.3	94.9	0
Red Rim	42.20	16.20	58.4	35.9	13.8	49.7	1.7
Rosebud	18.50	11.90	30.4	15.7	10.1	25.8	1.0
Seminoe II 1/	25.45	25.46	50.91	21.6	21.7	43.3	0
Sub-Total	186.15	212.06	398.21	158.2	173.9	332.1	6.7
COLORAOO							
Bell Rock 1/	46.6	0	46.6	11.9	0	11.9	0
Empire	34.5	0	34.5	13.8	0	13.8	0.50
Grassy Creek 1/	1.6	1.1	2.7	1.4	0.9	2.3	0
Oanforth Hills #1 1/	40.3	0	40.3	34.2	0	34.2	0
Danforth Hills #3	111.6	13.9	125.5	94.9	11.8	106.7	3.56
Hayden Gulch	97.3	0	97.3	82.7	0	82.7	2.76
Lay	83.9	6.6	90.5	71.3	5.6	76.9	2.7
Danforth Hills #2	151.7	0	151.7	129.0	0	129.0	4.3
Sub-Total	567.5	21.6	589.1	439.2	18.3	457.5	13.82
Total	753.65	233.66	987.31	597.4	192.2	789.5	20.52

1/ Assumes extension of existing adjacent operator.

TABLE 2-11

PREFERRED OR HIGH ALTERNATIVE

TRANSPORTATION AND EMPLOYMENT

	Transportation 1/ (miles) Truck	Rail	Employment Construc.	Mining
WYOMING				
China 8utte	5.5	20	63	437
Medicine Bow 2/	--	--	0	- 33
Red Rim	--	8	55	186
Rosebud	--	1.5	100	109
Seminoe II 2/	--	--	0	11
Sub-Total	5.5	29.5	218	710
COLORAOO				
Bell Rock 2/	--	--	0	0
Empire	1	--	15	43
Grassy Creek 2/	--	--	0	0
Danforth Hills #1 2/	--	--	0	0
Danforth Hills #3	--	2.5	72	250
Hayden Gulch	--	10	38	212
Lay	--	25	50	208
Danforth Hills #2	--	3.5	71	250
Sub-Total	1	41.0	246	963
Total	6.5	70.5	464	1,673

1/ No new transportation facilities needed for mine extension.
2/ Assumes extension of existing adjacent operator.

TABLE 2-12

PREFERRED OR HIGH ALTERNATIVE

ACRES DISTURBED

Tract	Mining Operations 1/				Onsite Facilities 2/				Offsite Facilities 3/				Housing & Infrastructure 4/ (Total)			
	1987	1990	1995	EOML	1987	1990	1995	EOML	1987	1990	1995	EOML	1987	1990	1995	EOML
WYOMING																
China Butte	0	270	945	4050	140	402	554	796	288	288	288	288	--	--	--	--
Medicine Bow 5/	0	234	819	3510	0	49	129	327	0	0	0	0	--	--	--	--
Red Rim	0	268	938	4020	75	375	500	1052	533	765	765	765	--	--	--	--
Rosebud	0	88	308	792	190	349	419	540	343	343	343	343	--	--	--	--
Seminoe II 5/	0	182	637	1274	88	175	300	356	0	0	0	0	--	--	--	--
Sub-Total	0	1042	3647	13646	493	1350	1902	3071	1164	1396	1396	1396	205.6 6/	195.6 6/	199.4 6/	199.4 6/
COLORADO																
Bell Rock 5/	0	0	0	0	0	0	0	0	0	0	0	0	--	--	--	--
Empire	0	0	0	0	20	20	20	20	40	40	40	40	--	--	--	--
Grassy Creek 5/	0	34	119	170	0	0	0	0	0	0	0	0	--	--	--	--
Danforth Hills #1 5/	0	54	189	810	0	0	0	0	0	0	0	0	--	--	--	--
Danforth Hills #3	0	140	630	2100	0	0	0	0	732	732	732	732	--	--	--	--
Hayden Gulch	0	220	495	1650	600	600	600	600	260	260	260	260	--	--	--	--
Lay	0	228	798	3420	700	700	700	700	835	835	835	835	--	--	--	--
Danforth Hills #2	0	170	595	2550	0	0	0	0	756	756	756	756	--	--	--	--
Sub-Total	0	846	2826	10700	1320	1320	1320	1320	2623	2623	2623	2623	320.1	477.1	477.1	477.1
Total	0	1888	6473	24346	1813	2670	3222	4391	3787	4019	4019	4019	525.7	672.7	676.5	676.5

1/ Includes only that area to be actually mined.
2/ Includes all structures, haul roads, topsoil and overburden storage.
3/ Includes rail and access roads, power and telephone lines.
4/ Acreage based on assumption of 100 acres disturbed per 1000 population increase.
5/ Assumes extension of existing adjacent operator.
6/ Does not include secondary population impacts that could occur in Casper, Laramie, Rock Springs, and Sinclair.

TABLE 2-13

MAXIMUM ALTERNATIVE

MINERAL RESOURCE VALUES

Tract	Coal Reserves (million tons) In-Place Federal	In-Place Non Federal	In-Place Total	Recoverable Federal	Recoverable Non Federal	Recoverable Total	New Annual Production (million tons)
WYOMING							
China Butte	69.90	69.90	139.8	59.4	59.0	118.4	4.0
Medicine Bow 1/	30.1	88.60	118.7	25.6	69.3	94.9	0
Red Rim	42.20	16.20	58.4	35.9	13.8	49.7	1.7
Rosebud	18.50	11.90	30.4	15.7	10.1	25.8	1.0
Seminoe II 1/	25.45	25.46	50.91	21.6	21.7	43.3	0
Sub-Total	186.15	212.06	398.21	158.2	173.9	332.1	6.7
COLORADO							
Bell Rock 1/	46.6	0	46.6	11.9	0	11.9	0
Empire	34.5	0	34.5	13.8	0	13.8	0.50
Grassy Creek 1/	1.6	1.1	2.7	1.4	0.9	2.3	0
Danforth Hills #1 1/	40.3	0	40.3	34.2	0	34.2	0
Danforth Hills #3	111.6	13.9	125.5	94.9	11.8	106.7	3.56
Hayden Gulch	97.3	0	97.3	82.7	0	82.7	2.76
Lay	83.9	6.6	90.5	71.3	5.6	76.9	2.7
Danforth Hills #2	151.7	0	151.7	129.0	0	129.0	4.3
Pinnacle 1/	1.1	0	1.1	0.9	0	0.9	
Iles Mountain	45.1	0	45.1	38.3	0	38.3	1.9
Williams Fork Mtns.	44.8	1.6	46.4	38.1	1.4	39.5	1.3
Sub-Total	658.5	23.4	681.7	516.5	19.7	536.2	17.02
Total	844.65	235.46	1079.40	674.7	194.0	868.2	23.72

1/ Assumes extension of existing adjacent operator.

TABLE 2-14

MAXIMUM ALTERNATIVE

TRANSPORTATION AND EMPLOYMENT

	Transportation 1/ (miles) Truck	Rail	Employment Construc.	Mining
WYOMING				
China Butte	5.5	20	63	437
Medicine Bow 2/	--	--	0	- 33
Red Rim	--	8	55	186
Rosebud	--	1.5	100	109
Seminoe II 2/	--	--	0	11
Sub-Total	5.5	29.5	218	710
COLORADO				
Bell Rock 2/	--	--	0	0
Empire	1	--	15	43
Grassy Creek 2/	--	--	0	0
Danforth Hills #1 2/	--	--	0	0
Danforth Hills #3	--	2.5	72	250
Hayden Gulch	--	10	38	212
Lay	--	25	50	208
Danforth Hills #2	--	3.5	71	250
Pinnacle 2/	--	--	0	0
Iles Mountain	3	--	21	140
Williams Fork Mountains	10	- -	14	100
Sub-Total	14	41.0	281	1203
Total	19.5	70.5	499	1913

1/ No new transportation facilities needed for mine extension.
2/ Assumes extension of existing adjacent operator.

TABLE 2-15

MAXIMUM ALTERNATIVE

ACRES DISTURBED

Tract	Mining Operations 1/ 1987	1990	1995	EOML	Onsite Facilities 2/ 1987	1990	1995	EOML	Offsite Facilities 3/ 1987	1990	1995	EOML	Housing & Infrastructure (Total) 4/ 1987	1990	1995	EOML
WYOMING																
China Butte	0	270	945	4050	140	402	554	796	288	288	288	288	--	--	--	--
Medicine Bow 5/	0	234	819	3510	0	49	129	327	0	0	0	0	--	--	--	--
Red Rim	0	268	938	4020	75	375	500	1052	533	765	765	765	--	--	--	--
Rosebud	0	88	308	792	190	349	419	540	343	343	343	343	--	--	--	--
Seminoe II 5/	0	182	637	1274	88	175	300	356	0	0	0	0	--	--	--	--
Sub-Total	0	1042	3647	13646	493	1350	1902	3071	1164	1396	1396	1396	205.6	195.6 6/	199.4 6/	199.4 6/
COLORADO																
Bell Rock 5/	0	0	0	0	0	0	0	0	0	0	0	0	--	--	--	--
Empire	0	0	0	0	20	20	20	20	40	40	40	40	--	--	--	--
Grassy Creek 5/	0	34	119	170	0	0	0	0	0	0	0	0	--	--	--	--
Danforth Hills #1 5/	0	54	189	810	0	0	0	0	0	0	0	0	--	--	--	--
Danforth Hills #3	0	140	630	2100	0	0	0	0	732	732	732	732	--	--	--	--
Hayden Gulch	0	220	495	1650	600	600	600	600	260	260	260	260	--	--	--	--
Lay	0	228	798	3420	700	700	700	700	835	835	835	835	--	--	--	--
Danforth Hills #2	0	170	595	2550	0	0	0	0	756	756	756	756	--	--	--	--
Pinnacle 5/	0	24	84	120	0	0	0	0	0	0	0	0	--	--	--	--
Iles Mountain	0	120	420	1800	600	600	600	600	80	80	80	80	--	--	--	--
Williams Fork Mtns.	0	160	560	2400	500	500	500	500	355	355	355	355	--	--	--	--
Sub-Total	0	1150	3890	15020	2420	2420	2420	2420	3058	3058	3058	3058	364.7	593.8	593.8	593.8
Total	0	2192	7537	28666	2913	3770	4322	5491	4222	4454	4454	4454	570.3	789.4	793.2	793.2

1/ Includes only that area to be actually mined.
2/ Includes all structures, haul roads, topsoil and overburden storage.
3/ Includes rail and access roads, power and telephone lines.
4/ Acreage based on assumption of 100 acres disturbed per 1000 population increase.
5/ Assumes extension of existing adjacent operator.
6/ Does not include secondary population impacts that could occur in Casper, Laramie, Rock Springs, and Sinclair.

SECTION 3

DESCRIPTION OF THE ENVIRONMENT

LOCATION AND GENERAL DESCRIPTION

The Green River/Hams Fork Coal Region encompasses approximately 37,000 square miles in five Colorado and 12 Wyoming counties. The region is part of the Middle Rocky Mountain province, characterized by complex mountains with many intermountain basins and plains. Map 2-1 in Section 2 shows the Green River/Hams Fork Coal Region. The region includes several separate geologic structural units. The Green River and Great Divide Basins in the south are separated by the large Rock Springs anticline, and the highly complex Wyoming overthrust belt is evident to the west and north. The coal-bearing rocks include the Rock Springs, Lance, Fort Union, Wasatch, Iles, Williams Fork, Medicine Bow, Ferris, Hanna, Bear River, Frontier, Adaville, and Evanston Formations. Coal beds range in thickness from a few inches to over 100 feet and coal quality varies from sub-bituminous C to high volatile bituminous A.

Principal fossiliferous formations in the region are the North Park, Bridger, Green River, Hanna, Ferris, Fort Chiron, Lance, Lewis, Almond, Rock Springs, and Morrison. Of major geological interest in the region are the Como Bluff Fossil Area in Carbon County (National Natural Landmark and a property on the National Register of Historic Places), and the Petrified Fish cut in Lincoln County. Dinosaur National Monument is located in Moffat County.

The most common soils throughout the region have a sandy loam, loam, or silty surface and a calcium carbonate accumulation at depths greater than four feet. Permeability is moderate to low and, due to climatic conditions, these soils seldom retain moisture for three consecutive months. Shallow, poorly developed soils consisting mainly of rock fragments occur along the mountains in the region. Dominant soil limitations of the region are shallowness, erosion, stoniness, and salinity.

Major drainage basins in the region are the Green, North Platte, and Yampa Rivers. Average annual runoff ranges from less than one inch on the basin floors to over 20 inches in some of the high mountains. Most streams heading in the higher mountainous areas are perennial, whereas the smaller tributaries originating in the lower areas are generally intermittent or ephemeral.

The quality of surface waters in the region ranges from good in the higher elevations to poor in the lower elevations. During low-flow periods many tributary streams contain more than a thousand milligrams per liter dissolved solids. The suspended-sediment content of surface waters is generally high, and during high flows exceeds 30,000 parts per million in many tributaries.

Ground water occurs in alluvial and bedrock aquifers. Alluvial deposits are good aquifers and are capable of yielding moderate amounts of groundwater. Pumping from alluvial aquifers, however, is generally restricted because of adverse effects on appropriated water rights or on nearby streams. Water in the alluvial aquifers is generally suitable for most uses, but is highly mineralized in some areas.

Yields of most sandstone aquifers are low to moderate, while the highly variable limestone aquifers may yield up to a thousand gallons per minute to wells. In general, where aquifers are highly permeable, good quality water can be obtained at depths of a thousand feet or more. However, where aquifers have low permeability, moderately mineralized water occurs even at shallow depths. Water quality throughout the region has not been fully explored.

The Green River/Hams Fork Coal Region is part of the cold desert biome, and is comprised primarily of sagebrush or mountain shrub dominated communities. Other communities of local importance include saltbush, greasewood, conifer, aspen, pinyon-juniper and barren areas. The sagebrush community is composed of a mixture of low-growing shrubs dominated by sagebrush with a variable understory of perennial grasses and forbs. Understory vegetation includes bluebunch wheatgrass, thick wheatgrass, Indian ricegrass, prairie junegrass, cheatgrass, brome, lupines, rabbitbrush, broom snakeweed, and goldenweeds.

Shrub communities of the higher elevations are dominated by serviceberry- snowberry-mountain mahogany associations with understories that include thickspike wheatgrass, prairie junegrass, bluegrasses, western yarrow, asters, and milkvetch. On well drained, poorly developed, shallow, gravelly soils, shrub woodlands are dominated by rocky mountain juniper. Associated species include big sagebrush, low sagebrush, rabbitbrush, mountain mahogany, prickly pear, and a variety of grasses, phloxes, and goldenweeds.

Depending upon slope, aspect, and elevation, forested mountain areas may contain associations of pinyon-juniper, spruce-Douglas fir, ponderosa pine-lodgepole, or a mixture of evergreen-aspen. Understory species include snowberries, blueberries, mountain mahogany, pine readgrass, lupines, mountain brome, and various grasses. Broadleaf forests, consisting principally of willow and cottonwood with grass understories, are limited primarily to floodplains along perennial streams. Barren areas associated with rock outcrops have a limited vegetation cover provided by mountain mahogany, serviceberry, wild buckwheats, big sagebrush, saltbushes, and prairie junegrasses.

Primary productivity estimates for the major vegetative communities of the region range from about 1.8 tons per acre per year for sagebrush to approximately 5.4 tons per year for forested areas. Four listed endangered plants may exist within the area.

The region has 53 species of mammals including big game such as black bear, elk, mule deer, pronghorn antelope, moose, and Rocky Mountain bighorn sheep; and small game and non-game species such as cottontail rabbit, white-tailed jackrabbit, red squirrel, white-tailed prairie dog, long-tailed weasel, badger, coyote, and red fox. Twenty percent of the world's pronghorn antelope population and a major portion of the world's sage grouse population may be found within the sagebrush-grassland areas of this region. These areas also provide critical winter habitat for elk and mule deer. In addition to these mammals, the sagebrush biome is a winter concentration area for golden and bald eagles.

Species found in the conifer-aspen forest include the Canada lynx, beaver, snowshoe hare, red squirrel, porcupine, and the great horned owl. The Shiras moose occurs in the conifer-aspen forest and along the willow-dominated river bottoms. Rocky Mountain bighorn sheep prefer higher elevations where the coniferous forests are broken by alpine openings.

In the woodland-bushland communities, mule deer, mountain lion, and coyote commonly occur in the woodlands during the fall, winter, and spring and range into adjacent habitats during summer. Rocky hillsides and cliffs within the woodland-bushland community provide habitat for the bobcat, rock squirrel, cliff chipmunk, desert and bushy-tailed woodrats, and pinyon mouse. Common birds of the woodland area include pinyon and scrub jays and band-tailed pigeon. Rattlesnakes, lizards, and horned toads may invade from adjacent desert areas, but are not particularly characteristic of woodland communities.

A number of game and non-game fish species are typical of the region's waterways. Principal game fish native to the region include mountain whitefish and cutthroat trout. Fish introduced into the region include brook, rainbow and brown trout, largemouth bass, smallmouth bass, crappie, bluegill, yellow perch, channel catfish and northern pike. Nongame species found in the region include speckled dace, mountain sucker, redsided shiner, and longnose dace. Pond-marsh biotic communities are limited in extent, but have local significance. The most widespread type of aquatic or semi-aquatic situation is provided by beaver ponds which are numerous on small mountain streams throughout the region. Also found in the pond marsh communities are mallards, pintails, teal, Barrow's golden eye, Great Basin Canada goose, marsh hawk, bald eagle, and osprey.

In the region two species of fish (the Colorado squawfish and humpback chub), three species of birds (the peregrine falcon, bald eagle, and whooping crane), and three species of mammals (the black-footed ferret, Rocky Mountain wolf, and grizzly bear) are presently officially listed as endangered or threatened species by the U. S. Fish and Wildlife Service. In addition to these federally listed species, the state of Colorado lists three fish species, one bird species, and three mammal species as endangered or threatened.

The region has been occupied by humans for at least 11,200 years. The earliest well defined occupation was by the Big Game Hunters of the late Pleistocene. When the Big Game became extinct, the region's inhabitants utilized more diversified animal and vegetable resources. In the southern parts of the region, cultivated corn, beans and squash became a notable resource for a few hundred years. People whose heritage was from Western Europe passed through the region from A. D. 1776 on, but actual settlement by EuroAmericans did not take place until the late 1800's. Improved transportation, especially the transcontinental railroad, made agriculture, ranching and mineral extraction feasible throughout the region.

There are 72 listings from this region on the National Register of Historic Places, including stage line stations, army forts, Oregon Trail sites, and a variety of buildings and historic districts.

This region has an array of recreational resources. Parts of Rocky Mountain National Park, the Flat Tops, Mt. Zirkel, Savage Run and Rawah Wilderness areas, and the Denver and Rio Preservation Areas within Routt and Roosevelt National Forests, are located within the region. Six National Wildlife Refuges (National Elk Refuge, Seedskadee, Browns Park, Pamforth, Hutton Lake, and Arapahoe) with a combined area of approximately 42,000 acres, are also located here. The Fossil Butte National Monument in Wyoming and Dinosaur National Monument in Colorado are in the area. The Mormon, Oregon, and Continental Divide Trails are under consideration for the national System of Trails. Three state recreational areas, three state parks, and 12 state historical sites are in the region. These facilities have a total area of over 76,200 acres and have an annual attendance of more than 693,000. Two nationally known floatboating rivers, the Yampa and Green, provide high quality white water rafting in the region. Camping, fishing, and hunting are the most popular recreational activities.

The region is typically western with a low population using vast areas of public lands and large ranches. Agriculture has been the area's historic economic base, but it has been supplanted by mining during the last two decades. The construction industry accounts for 5 percent of the employment. Agricultural employment in the region is 10 percent, and mining and mineral industry in the region is 12 percent of the employment. Federal, state and local governments employ 23 percent of the work force.

Coal is presently produced in several counties in the region, but is the leading mineral commodity in only three of these counties. Other important commodities include oil, gas, phosphate, rock, stone cement, vanadium, and trona. Sweetwater County, Wyoming is the nation's principal source of trona.

While agriculture is not large in terms of the number of people employed or the total income, it is the most visible activity throughout the region. Some farming and widespread grazing of domestic livestock persist throughout the region. Farming is limited by rainfall and temperature. Cattle and sheep ranching are the leading agricultural activities.

Counties in the region are characterized by sparse population with densities of about 2.6 persons per square mile. The total population is approximately 126,900. The decade of the 1960's recorded high rates of out-migration ranging from 8 to 34 percent. This trend reversed, however, between 1970 and 1976 when over 33,000 persons migrated to the region.

Major transportation in the Colorado section of the region is provided by the east-west Denver and Rio Grande Western railroad and U. S. 40. The southern Wyoming region is served by Interstate 80 and by the Union Pacific railroad. There are many other paved highways and unpaved roads existing throughout the region which provide access into the major areas of economic development.

Many smaller communities within the region such as Craig, Colorado, are experiencing housing problems. The number of mobile homes and mobile home parks has increased in many communities. Increased population in many communities has also produced increased school enrollments, resulting in overcrowded classrooms and understaffed schools.

Health care facilities are generally adequate for the region, although some areas are experiencing a shortage of physicians and ambulance service. Mental health care facilities, where they exist within the region, are receiving a disproportionate number of cases resulting from energy related rapid growth. Fire protection service is generally provided by the volunteer departments, and only Rawlins, Sinclair, Rock Springs, and Green River, Wyoming, have fire insurance ratings which are considered adequate. Expansion of water and sewer systems is of highest priority for most local officials. Nearly all water systems are publicly owned. Telephone, electricity, and natural gas systems are generally adequate for the region, with some exceptions where local shortages may occur.

The communities of the region are characterized by considerable social structural strain, particularly Craig, Hayden, Meeker and Rawlins, and some of the smaller Wyoming communities. High levels of transiency combined with marginal social status has made life socially uncomfortable for substantial numbers of newcomers, while the original population of oldtimers has had difficulty adjusting to the structurally and psychologically threatening changes occurring because of this rapid influx of new persons having culturally different views and requirements than their own. These stresses have given rise to sometimes disruptive levels of personal deviance such as crime, delinquency, mental health and family problems, and of structural change such as social power turnover, community conflict, and the replacement of informal with formal social control mechanisms.

Most of the land is Federally-owned and administered by the Bureau of Land Management and the Forest Service. Within the Federal land area, some state and private lands occur. Of significant interest in the southern portion of Wyoming is the checkerboard pattern of alternating private and Federal lands interspersed with some state-owned sections.

The region has a primarily continental climate. Fronts generally originate in the Pacific and deposit moisture in the mountains as wind currents pass over increased elevations. Average annual precipitation is more evenly distributed in the mountains than in the basin areas. The average annual temperatures range from 37 to 46 degrees Fahrenheit, with variations due mostly to differences in elevation and exposure. Growing seasons range from 28 days at Steamboat Springs, Colorado, to 130 days at Rawlins, Wyoming.

Prevailing winds for most of the area are out of the southwest. Most of the harsh winter storms are out of the northwest. The winter winds typically bring cold dry air with velocities sometimes exceeding 40 mph. The region has surface-based inversions on 85 percent of the mornings during both summer and winter. They tend to be intense, but not particularly deep.

Overall regional air quality is very good. Areas not meeting the national standard for particulates are Craig, Colorado, and the trona industrial area of Sweetwater County, Wyoming. The entire region is better than average for sulfur dioxide air quality.

DESCRIPTION OF AFFECTED ENVIRONMENTS

Each of the resource components in this chapter keys in on a specific affected environment which may vary between resources. In the same way that impacts vary between resources, so does the area affected. The affected environment defined for each resource is the area that most accurately and rationally defines the environmental impacts for that resource.

GEOLOGY AND MINERALS

PHYSIOGRAPHY

COLORADO IMPACTED AREA

Routt, Moffat, and northern Rio Blanco counties are almost surrounded on the east, south, and west by the Southern Rocky Mountains, the White River Plateau, and the eastern Uinta Mountains, respectively. Mountains to the east are mostly 8,000 to 10,000 feet high, with some peaks rising to almost 12,000 feet. Westward drainage is to the Yampa River. Mountains to the north range from about 7,500 to more than 11,000 feet. The Flat Tops area of the White River Plateau to the south is between 8,500 and 11,000 feet high, and the mesas descend to the lower elevations of Williams Fork Mountains and Danforth Hills in the coal-bearing region. Drainage is to the White and Yampa Rivers. The Uinta Mountains to the northwest reach altitudes of nearly 10,000 feet.

The area surrounded by these highlands, in general, is characterized by rolling hills, broad river valleys, and low mountain ranges. Most altitudes are between 6,000 and 8,000 feet. Most of the region between these mountainous areas is underlain by somewhat less resistant strata of late Mesozoic and Tertiary age, so more subdued landforms are present.

To the southwest, in areas drained by the White River, the land is characterized by broad, open plains with low relief, interrupted by long and wide-to-narrow ridges, and some moderately hilly land and mesas. Altitudes range from about 5,200 to 7,700 feet.

WYOMING IMPACTED AREA

The physiography of the China Butte-Red Rim area is characterized by sagebrush-covered low rolling hills, low northeasterly trending cuestas, and broad shallow valleys containing intermittent streams that flow principally in response to spring snowmelt. High tablelands occur along the Continental Divide, which crosses the southwestern end of the area and separates the Great Divide Basin from the more southerly Washakie Basin. Elevations range from about 6,700 feet in the northeastern part of the area to about 7,400 feet along the Continental Divide.

The Hanna Basin is characterized by sagebrush-covered high plains topography broken around the margin by low ridges composed of resistant sandstones. The highest of these ridges reaches approximately 7,900 feet above sea level. Maximum relief in the area is about 1,600 feet. The high plains are in various stages of erosion; cut by terraces formed by streams that flow at higher levels than now and by alluvial flats as much as a half mile wide (Dobbin, Bowen, and Hoots, 1929, p. 6-7).

GEOLOGY

There are approximately 50 named stratigraphic formations or groups in the Colorado portion of the study region. Distribution of most of these formations is shown on various regional maps, particularly those compiled by Burbank and others (1967), Miller (1975), and Tweto (1975, 1976). The two maps by Tweto were used to compile the geologic map for the Regional Environmental Statement, Northwest Colorado. A summary of various characteristics of these formations is presented in Appendix D of this same report. Coal beds of economic interest are present only in strata of Late Cretaceous and Tertiary age. These will be more fully described in the following part of this report.

The Red Rim-China Butte area is on the southeastern margin of the Great Divide (structural) Basin. It is also on the western flank of the narrow, northerly trending anticlinal Sierra Madre Uplift, and on the northern flanks of a westerly to northwesterly plunging anticline, which, with the Wamsutter Arch, forms the structural divide between the Great Divide Basin and the Washakie Basin. The Sierra Madre Uplift and the more northerly Rawlins Uplift separate the Washakie and Great Divide Basins from the Saratoga Valley and the Hanna Basin to the east.

The rocks exposed on the southeastern margin of the Great Divide Basin range in age from Cambrian to Miocene. The distribution of the various formations in this part of the basin is shown on geologic maps by Welder and McGreevy (1966), and in Appendix A of the *Draft Environmental Statement for Southcentral Wyoming*. The stratigraphy of the formations is discussed in reports by Vine and Prichard (1959), Bradley (1964), Pipiringos (1968), and Gill, Merewether, and Cobban (1970), and their information was used extensively in the preparation of this report.

The Hanna Basin is one of the smallest of a series of structural basins scattered across southcentral Wyoming but is the deepest. It measures approximately 24 miles wide, north to south, by 42 miles long, east to west. The basin is at least 35,000 feet deep of structural relief. The downwarp lies between the Rawlins uplift on the west, the Ferris, Seminoe, Shirley, and Freezout uplifts on the north, and the Medicine Bow uplift on the south. The Eastern margin of the basin is not bounded by an uplift; it is a more severely warped northwestward extension of the Laramie Basin (Dobbin, Bowen, and Hoots, p. 1-2). This structural trough is divided into two separate basins by the large northeast-trending Saddleback Hills anticline. The Hanna and Carbon Basins lie northwest and southeast, respectively, of the anticline.

Rocks exposed in the Hanna Basin range in age from Cambrian to Miocene. The geologic map by Lowry, et al (1973) and Map #4 in Appendix A of the *Draft Environmental Statement for Southcentral Wyoming* , shows the distribution of formations. Dobbin, Bowen, and Hoots (1929), Harshman (1972), Pipiringos (1968), and Gill, Merewether and Cobban (1970), discuss the stratigraphy of the formations.

PALEONTOLOGY

Paleontology has been studied in several parts of the Colorado region through the years. The Powell and Hayden surveys traversed the area and completed the first inventory of the region's fossils. More recently, parts of the area have been geologically mapped and some paleontological studies have been completed, although no comprehensive regional and paleontological study has been done. Fossils are found in most sedimentary rocks and are particularly common in shales and limestone. The majority of fossils represent marine invertebrates, as conditions for preservation are usually better in aquatic than in terrestrial environments. In many cases, terrestrial animals and plants are preserved in water-laid sediments such as lakes, swamps, or rivers. Trace fossils (footprints, imprints, burrows) are recognized throughout the region. Figure 3-1 cites references to paleontological studies done in the region and shows common fossil occurrence by formation.

Invertebrates, vertebrates and plant fossils have been found in both the Ferris and Hanna Formations. Plant fossils are the most common. Vertebrates occur mainly in the lower 1,000 feet of the Ferris Formation and represent remains of turtles, fishes and dinosaurs. Vertebrate fossils are very scarce in the Hanna Formation and consist of fish scales, turtle shell fragments and part of a mammalian jaw (Dobbin, et al, 1929). Fossil localities have been identified on maps by Blanchard and Comstock (1980) and Blanchard and Jones (in preparation).

Both the Fort Union and Lance Formations are known to be fossiliferous over the entire area of their occurrence in the Central Rocky Mountain and Central and Northern High Plains outcrop areas. Mollusks (snails and clams) are common in the lower part of the Lance. North of Baggs in the Washakie Basin, fragments of dinosaur bones have been found in the upper part of the Lance. The Fort Union contains fossils of fresh-water mollusks, turtles, and other reptiles, and early mammals. Both formations contain fossil leaves, wood, and pollen. Fossil localities on the east side of the Washakie and Great Divide Basins are identified on maps in reports by Swain (1957), Sanders (1974, 1975), Rigby (1976), and Edson (1979).

MINERALS

COAL

Coal beds of economic interest in Colorado occur in the Iles and Williams Fork Formations of the Mesaverde Group, and the Lance Formation, all of Late Cretaceous age, and the Fort Union Formation of Paleocene age.

The coal tracts delineated in northwest Colorado are in the Danforth Hills and Yampa Coal Fields. There are a total of 11 tracts in the region with three tracts located in the Danforth Hills Coal Field and eight tracts located throughout the Yampa Coal Field.

The Yampa field occupies the southern and eastern part of the Green River region and is the principal area of minable coal. The coal ranges in rank from subbituminous to anthracite. Most of the coal is of high-volatile C bituminous rank; coal in the extreme east edge of the field is of higher rank, locally anthracitic. A total of about 23,607 million tons of coal (76 percent bituminous, 24 percent subbituminous), are estimated to have been originally present in an area of 828 square miles. An additional area of 852 square miles may contain 21,300 tons of coal within 3,000 feet of the surface (Hornbaker, 1976).

The Danforth Hills field comprises the coal deposits on the northeast flank of the Piceance Creek basin. The geology and coal resources of the field have been reported by Gale (1907 and 1910), Hancock (1925), and Hancock and Eby (1929). A total of about 7,854 million tons of bituminous coal is estimated to have been originally present in 252 square miles of the field. An additional area of 18 square miles may contain minable reserves of coal with less than 3,000 feet of overburden.

The China Butte-Red Rim area is in the northern part of the Rawlins (Little Snake River) Known Recoverable Coal Resource Area (KRCRA) which extends along the east side of the Great Divide and Washakie Basins from near Rawlins to Baggs, Wyoming.

Several of the Upper Cretaceous-Paleocene formations underlying the KRCRA contain coal deposits potentially valuable at the present time. They are the Upper Cretaceous Allen Ridge, Almond, Lewis, Fox Hills, and Lance Formations, and the Paleocene Fort Union Formation. In the China Butte-Red Rim area only the coals of the lower part of the Fort Union are exposed. Coals of the other formations are at depths of about 4,000 feet and more.

The reserve base for Federal coal in the lower Fort Union (in beds with a minimum thickness of five feet and a maximum depth of 3,000 feet), in a total area of about 336 square miles, in the KRCRA, is about 1,501,410,000 short tons, of which about 222,070,000 short tons are within 200 feet of the surface (Dames and Moore, 1978, 1978, and 1980).

The Rosebud, Seminoe II, and Medicine Bow tracts are in the Hanna and Carbon Basins Known Recoverable Coal Resource Area (KRCRA) which covers most of the Hanna Basin. The Allen Ridge, Pine Ridge, Almond, Medicine Bow, Ferris and Hanna Formations contain coal and underlie the KRCRA.

There are approximately 274 million tons of strippable reserves in the Hanna coal field. Present production is about 10.9 million tons per year. Nearly all of the coal is shipped to the Midwest for power generation (Bureau of Land Management, 1979 c., p. R2-83 and R2-85.)

OIL AND GAS

Many formations in the Colorado study area contain oil and gas. Principal among these are the Weber, Chinle, Entrada, Morrison, Dakota, and Niobrara below the coal-bearing rocks, and the Mesaverde, Lewis, Fort Union, and Wasatch among the coal-bearing formations.

Map Foldout No. 1 in Appendix B (Bureau of Land Management, 1976) shows the oil and gas fields. Most of the fields in the southern half of the study region, except those west of a line from Meeker to Cross Mountain, are developed at the crest of anticlines, whereas coal development in the same area is mostly on the flanks of these structures. Areas for exploration, however, are shifting from anticlinal traps to fault and sedimentary traps. Potential for resource conflicts with coal is therefore greater, even though resources normally can be recovered sequentially from the same place.

Because of the thick stack of sedimentary formations, including formations which produce oil and/or gas in nearby areas, the Red Rim area has potential for oil and/or gas production. Nearby gasfields are the Creston Southeast field which is in the northwest part of T. 19 N., R. 90 W., and east of the northern end of the Red Rim area and which produces from Upper Cretaceous Mesaverde Group rocks; the Sugar Creek gasfield, which is in the southeast part of T. 19 N., R. 90 W., and east of the southern end of the Red Rim area and which produces from the Pennsylvanian Tensleep Formation and the Upper Cretaceous Muddy and Frontier Formations; the Fillmore field which is in the southwest part of T. 19 N., R. 91 W. and west of the Red Rim area and which produces from the Upper Cretaceous Lewis and Ericson Formations; and the Creston field which is in the eastern part of T. 18 N., R. 92 W., and the southeastern part of T. 19 N., R. 92 W. and west of the China Butte area, and which produces from the Upper Cretaceous Ericson and Almond Formations.

There are a few small oil and gas fields along the margins of the Hanna Basin. However, owing to the tremendously thick (20,000 feet) stack of Upper Cretaceous and Tertiary nonmarine rocks, and the expense of deep drilling, there is little potential for production in the interior of the basin, especially within the three tracts, from marine units that produce along the margins of the basin.

URANIUM

Uranium has been produced from the Browns Park Formation near Lay and Maybell, west of Craig, Colorado. Minor deposits with no production occur in Precambrian rocks of the Park Range near Steamboat Springs, Colorado, and in the Dakota Sandstone east of Meeker, Colorado. Mineralization is believed to occur down dip from Fort Union outcrops in the Red Rim area. Mining claims for uranium are present on the Red Rim Tract. In nearby areas the Fort Union (Paleocene), Wasatch (Eocene), and Browns Park (Miocene) Formations continue to be prime targets for exploration that began in the 1950's. There is no known uranium mineralization in the Hanna Basin. The nearest uranium deposits and production is in the Shirley Basin, about 12 miles northeast of the Hanna Basin. Harshman (1972) discusses that area in detail.

BITUMINOUS SANDSTONE

Oil-impregnated sandstone and conglomerate outcrop near the contact between the Fort Union and Wasatch Formations south of the China Butte-Red Rim area in T. 17 N., R. 92 W.

SODIUM SALTS

Sodium salts occur in many of the small playa-lake basins that are common in the Wyoming area. Reserves, quality or economic potential of dissolved or precipitated salts in basins are not known.

SCORIA

Small scoria deposits formed by the *in-situ* burning of coal beds occur in the area. Reserves and suitability for use as aggregate in railroad spur and road construction are not known.

SAND AND GRAVEL

Thin (generally less than five feet thick) gravel deposits occur in the major drainages and on some high terraces along the Continental Divide. Reserves and suitability for use as concrete aggregate are not known. Extensive deposits of terrace gravels occur along the North Platte River, west of the Medicine Bow tract. Reserves or suitability for use as concrete aggregate are not known. Windblown sand deposits occur primarily on the west side of the North Platte River (Seminoe Reservoir). Reserves or suitability are also not known.

ZEOLITES

Roehler (1973) describes the use of the zeolite mineral clinoptilolite, and the occurrence of large tonnages in the Sand Wash Basin. Clinoptilolite has been reported to occur in the Browns Park Formation in the Lay area.

SOILS

Soil data and descriptions of the Colorado tracts were obtained from SCS Soil Surveys for Moffat and Routt Counties. From these surveys soil maps were prepared of the proposed final mining contour. These maps are contained within the site-specific analyses.

The soils of the Colorado tracts are located on rather broad ridge-tops, on steeply sloping canyon sides, and within the many draws or gulches which intersect the ridges. The tracts are quite similar in their soil characteristics with the exception of the Lay Tract. More than half of the Lay soils belong to the Aridisol order. This means that for three months, when the soil is warm enough for plant growth, there is a soil moisture deficit. The texture of the Lay soils is generally coarser with sandy loam topsoils and loam subsoils being more common. The Lay soils tend to be droughtier than the rest and lower in organic matter.

The soils of the Colorado tracts are mostly Mollisols which have moderate amounts of organic matter due to more favorable moisture regime. Saturation of soil profiles commonly occurs in the spring. Parent material is mostly shale and sandstones containing clay. Most soils developed residually, but eolian deposition is evident where soils developed under brushy vegetation. Generally, the soils are naturally calcareous with soil reactions being slightly to moderately alkaline, increasing with depth. Soil depths range from shallow to deep, although bedrock outcroppings are common, especially on steep canyon side slopes.

Topsoils are mostly loam and subsoils mostly clay loam in texture. Available water-holding capacities are generally high and permeability is slow. Percent sodium saturation is usually less than one percent. Entisols are predominant where parent material is more resistant or slopes are steep. These soils show little evidence of horizon development due to their youthfulness or high rate of erosion.

When examining the reclamation potential of strip-mined areas, it is relatively unrealistic to emphasize structure, undisturbed permeability, and other developmental characteristics of soils when, in all probability they will be destroyed or obliterated by mining operations. Significant soil characteristics to be considered when soils will be removed, stockpiled, and used for backfill would be such factors as organic matter content, moisture transmission, chemical status, and texture. The analysis of underlying overburden materials is often as important as the soil analysis since this overburden is very likely to be utilized as surface backfill material (Bureau of Land Management, 1975).

Reclamation success might be expected to be proportional to several factors, two of which are depth of quality topsoil and steepness of the soil surface. Suitable surface material as expressed in table 3-1 was considered to be topsoil and subsoil loamy in texture and deep enough for removal and stockpiling (six inches or more). Unsuitable material for surface reclamation included loamy topsoils less than six inches deep underlain by clayey subsoils. Also deemed unsuitable were areas having shallow, rocky soils with occasional bedrock outcroppings, usually located on steep terrain.

The average depth of suitable material varies from approximately one foot on tracts with subsoils mainly clayey in nature to about two feet where loamy subsoils are more common.

Initial stabilization of reclaimed surface is critical for successful reclamation. Steepness of reclaimed surface in all probability will be the greatest impediment to initial soil stabilization on the Colorado tracts where soils are fertile and moisture is usually available to plants during a significant part of the growing season. The approximate area of slopes exceeding 25 percent in grade were estimated from SCS soil descriptions for the soils directly disturbed by mining (table 3-1). These slopes often exceed 33 percent on canyon side slopes where bedrock outcroppings are present. This bedrock in its consolidated form lends stability to side slopes.

Data pertaining to suitability of overburden material for surface backfill on the Colorado tracts are contained in Bureau of Land Management 1976a and Bureau of Land Management 1976b. Indications are that practically no toxic materials are present. The existence of adequate amounts of suitable material was found from examination of deep core samples. The most suitable materials are the more weatherable sandstone preferably containing ample amounts of fines. Also preferred are sandy shales. Adequate material, circumneutral in reaction and low in salinity and sodium concentration, should be available. Greenhouse data demonstrate that productivity of the most suitable strata is considerably less than the overlying soils.

General topography of the Wyoming tracts varies from gently sloping to steeply sloping with the breaks into the draws tributary to the streams being very steeply sloping and having many rough-broken eroded areas. Some of the highly eroded drainageways and breaks from the upland appear almost as badlands. Soils belong to the Aridisol and Entisol orders. The Hanna Basin Study Site (Bureau of Land Management, 1975) provided data on the Medicine Bow Tract. The site-specific analyses contained within the *Southcentral Wyoming EIS* describe tracts near Seminoe II and Rosebud tracts from which inferences were made about the soils of these tracts. The Red Rim Study Area (Bureau of Land Management, 1976c) describes part of the Red Rim Tract, which is contiguous with the China Butte Tract.

Soil productivity is severely limited on the Wyoming tracts by lack of available soil moisture during the growing season when evaporation exceeds precipitation. Soils are poorly developed, low in organic matter, and quite frequently shallow to bedrock (less than 20 inches). Parent materials consist mainly of sandstones, shales, and eolian sands and silts.

Topsoil is less than four inches deep and usually sandy loam in texture. Subsoils may be sandy loam, loam, or sandy clay loam. Available water-holding capacity is low where soils are shallow to bedrock or very coarse textured. Permeability is moderate to rapid.

Soil reaction ranges from slightly alkaline to strongly alkaline. Calcium accumulations commonly occur below a depth of one foot in some of the deeper soils (two to four feet deep); however, many of these soils are only moderately alkaline at depths greater than two feet. On some tracts shallow, cobbly, strongly alkaline soils occur extensively. The Medicine Bow Tract contains the highest percentage of this kind of soil.

Table 3-2 indicates the suitability of soils for reclamation on the Wyoming tracts based upon soil depth and texture, chemical properties critical to soil fertility, and slope of the terrain which influences moisture regime and stability of the soil surface.

Limiting factors considered in determining suitability of soils for surface backfill material were shallow depth and coarse texture, alkalinity, and sodium concentration. Unsuitability is mainly due to shallowness and coarse texture and the presence of bedrock outcroppings. Also unsuitable are soils strongly alkaline at depths of less than one foot. The only tract having rather extensive areas of sodic soil which would be unsuitable is the Medicine Bow Tract. The soils deemed suitable are usually two to four feet deep and are slightly to moderately alkaline at depths which vary from one foot to three feet or more. The average depth of this suitable material is probably about two feet.

Steep slopes will be more of a problem on some tracts than others. The soils on steep slopes are usually shallow and rocky and bedrock outcroppings are very common. These slopes are presently quite stable in their undisturbed state owing to the rockiness of the surface.

The foremost problem which will be faced in reclaiming these tracts will be the establishment of a heavy cover of protective, stabilizing vegetation, the primary impediments being lack of precipitation, strong dry winds, and soils with bad physical and chemical properties adversely affecting moisture regimes.

Core samples of overburden taken in the Red Rim and Hanna Basin Study Areas (Bureau of Land Management, 1976c., and Bureau of Land Management, 1975) consist of sandstones and shales, some quite thickly bedded, while others are complexly interbedded. The major deficiencies of the core material in relation to use as a planting media are salinity and dense unweatherable sandstones. Most of the harmful concentrations of salinity occur in the shales. The bedrock is mainly neutral to alkaline in reaction. Greenhouse studies of the productivities of these materials demonstrated the existence of strata which produce favorable plant growth relative to that of the soils above them. The most favorable material for surface backfill was considered to be the more weatherable sandstone having fine materials within it. It should also be neutral to slightly alkaline in reaction and low in salt content.

WATER RESOURCES

The Green River/Hams Fork Region lies astride the Continental Divide and, as such, includes the upper reaches of seven river basins and a northcentral lowland area characterized by internal drainage (map 3-1). Most of the larger river basins are divided into subbasins. The North Platte River lies east of the Continental Divide and is tributary to the Mississippi. The Yampa, Green, White, Colorado, and Snake Rivers drain to the Pacific. The Bear River drains to Great Salt Lake, and the Great Divide basin contains a number of small closed depressions, the largest of which is Separation Lake.

The topography, stratigraphy, and geologic structure within the region is such that ground-water divides coincide very closely with surface-water divides, and therefore, each river basin or subbasin functions as a separate hydrologic unit. No exchange of water occurs between units except for accretion of water in the downstream direction where one basin or subbasin joins another or as a result of man's diversion of water from one basin to another.

The proposed leasing and development of new Federal coal would impact the water resources significantly only in the North Platte River basin in Wyoming and in the Yampa River subbasin in Colorado. The small reduction in flow to Separation Lake in the Great Divide basin as a result of mining on the Red Rim and China Butte tracts in Wyoming would present no significant impacts because all inflow to Separation Lake is lost to evapotranspiration. Also, the ground-water resources downstream from both tracts is moderately to highly saline and currently is unsuitable for virtually all uses. The discussion of water resources, therefore, has been limited to the North Platte and Yampa River basins and to the effect of mining new Federal coal in the Yampa River basin on the salinity of the lower Colorado River.

The regional significance of any given impact tends to decrease progressively with increasing size of the area over which the impact is distributed. Thus, the effect of any given mining operation or the cumulative effects of several operations on the environment tends to decrease with increasing distance downstream. Accordingly, the size of the two watersheds included in this analysis was limited to the smallest hydrologic unit where suitable U.S. Geological Survey (USGS) gaging stations records were available that included all prospective lease tracts in that basin. The North Platte River basin described in this analysis includes an area of 7,230 square miles upstream from Seminoe Dam. The Yampa River subbasin includes an area of 3,801 square miles upstream from the mouth of the Little Snake River.

General discussions of the water resources in the North Platte and the Yampa River watersheds are presented in Chapters 2, respectively, of the South-central Wyoming Coal Environmental Statement (SCWCES) and the Northwestern Colorado Coal Regional Environmental Statement (NWCCRES) (Bureau of Land Management 1979c and 1976). These discussions, however, generally treat each watershed as a hydrologic unit and do not emphasize the great differences between the quantity and quality of the water yielded by the mountain areas compared to that yielded by those coal areas that would be disturbed by the proposed leasing and development. Accordingly, the following description of the existing environment focuses primarily on the occurrence of water in the affected coal areas and stresses their much lower water yield compared to the higher mountain areas.

GROUND WATER

The proposed lease tracts in both Wyoming and Colorado typically occur in areas where structural deformation and differential erosion have exposed coal-bearing formations at or near the surface. The result is generally inclined strata on the flanks of anticlinal folds that have been eroded to form elongate strike valleys separated by broad dipslope surfaces. The valleys are cut in the softer rocks such as shale and coal, whereas the dipslopes are underlain by the more resistant sandstone beds. Ground-water recharge to these upturned beds occurs primarily on the high interstream areas during infrequent periods of excessive precipitation and saturated soil-moisture conditions. Movement is initially downward to the first relatively impermeable shale layer, which greatly retards any further downward movement and deflects the "perched" water downdip or laterally towards any incised valleys that break the continuity of the beds.

Characteristically steep hydraulic gradients in the downdip direction that range from 50 to 500 feet per mile (ft/mi), coupled with an obviously low rate of recharge in most of the coal tracts, indicate that most ground-water movement in the coal areas is not downdip, but along the direction of strike towards the nearest valley in which the "perching" layer is exposed in the valley side slopes. This discharge commonly is evidenced by elongate patches of giant wild rye or verdant bands of other plant types that parallel rock outcrops. The additional moisture provided by ground-water discharge in these areas stimulates plant growth, but generally is not sufficient to saturate the soil veneer and appear at the surface as springs. The absence of any springs on any of the tracts in the North Platte watershed in Wyoming and the paucity of springs on or adjacent to most tracts in Colorado attest to the low rate of ground-water discharge from the coal areas.

The top of the zone of saturation in the coal areas is typically graded to the level of the nearest perennial stream or to the level of perennial underflow in alluvium underlying intermittent or ephemeral streams. Above this level, perched ground water generally can be found within 200 feet of the surface. These perched zones commonly overlie unsaturated rocks so that test holes often show vertical drainage downward from shallow aquifers into underlying unsaturated coal and sandstone beds. Wells tapping perched aquifers seldom yield more than 10 gallons per minute (gal/min). The water is generally a calcium magnesium sulfate or a magnesium calcium sulfate type that is marginal or unsuitable for domestic use, but is suitable for use by livestock and wildlife. Perching is most prevalent in those tracts in Colorado where annual precipitation exceeds 15 inches and much less common in the Wyoming tracts where annual precipitation is less than 12 inches. Dissolved solids concentrations in water obtained from perched aquifers in Colorado generally range from 750 to 1,500 milligrams per liter (mg/L). Values in Wyoming, where the lower annual precipitation results in less flushing of perched aquifers, range from 2,000 to 6,500 mg/L.

Below the top of the zone of saturation, ground water typically occurs under confined conditions. Wells drilled more than 200 feet deep on the valley floors in the Yampa River subbasin commonly flow at the land surface although yields seldom exceed 10 gal/min. The water generally contains 500 to 1,000 mg/L dissolved solids and is typically a sodium bicarbonate type with lesser amounts of calcium, magnesium, and sulfate. This water is generally suitable for most domestic and ranch uses. In contrast, no flowing wells occur on or adjacent to any of the lease tracts in the North Platte River basin in Wyoming, undoubtedly reflecting the dryer climate and lesser recharge in that part of the region. Most bedrock wells yield less than 10 gal/min of water containing 2,000 to 4,000 mg/L dissolved solids. This water is generally a sodium sulfate, bicarbonate type that is suitable for use by livestock and wildlife, but unsuitable for domestic use.

The importance of coal beds as aquifers in the vicinity of the lease tracts in both Wyoming and Colorado is uncertain, but available data indicate that most wells in the coal areas obtain water from sandstone beds and not from coal. The reason is tentatively attributed more to the preponderance of sandstone in rocks underlying these areas rather than to any quantity or quality of water considerations although water obtained from coal beds sometimes has an unpleasant hydrogen sulfide odor. Coal beds may not be water bearing above the top of the saturated zone, but below that level, they must be regarded as potential aquifers.

Removal of coal and overburden aquifers by mining and replacement of the mined interval with reclaimed spoils materials that have different hydraulic characteristics than the undisturbed rocks introduces local changes in water availability and quality as described in Section 4, Water Resources. The projected cumulative area of aquifers removed by mining without new Federal leasing of coal for the time frames addressed in this analysis is given in table 3-3.

The relative significance of ground water discharged from the lease tracts in relation to the total water yield from the respective watersheds can be approximated from the base flow (low flow) of streams draining the coal areas. Gaging station records (see Surface Water) show that most of these streams are dry many days out of the year and, therefore, any ground-water discharge is limited primarily to the underflow percolating through the alluvium underlying the dry stream beds. It is estimated from the site-specific analyses that annual ground-water discharge from the lease tracts probably averages no more than 2 acre-feet per square mile (ac-ft/sq mi) in Wyoming and 5 ac-ft/sq mi in Colorado. On that basis, assuming no evapotranspiration losses enroute to the principal rivers, total ground-water contribution from all lease tracts would be about 100 ac-ft/yr in the North Platte watershed and about 310 ac-ft/yr in the Yampa watershed. This is about 0.01 percent and 0.03 percent of the annual water yield of the North Platte and Yampa watersheds, respectively. Actually, significant evapotranspiration losses are probably occurring enroute. The above figures, therefore, should be on the high side and, thus, further emphasize the insignificant effect of ground-water contribution from the lease tracts on the total water budget of the two basins.

SURFACE WATER

Surface runoff from the coal areas ranges widely in quantity from one part of the region to another. Annual runoff is highest in the eastern part of the Yampa River subbasin where annual precipitation exceeds 15 inches and is lowest in the western part of the Yampa River subbasin and in the North Platte River basin where annual precipitation is less than 12 inches. Differences in runoff from the various lease tracts, however, are dwarfed in comparison to differences between the coal areas and the mountain areas. Table 3-4 shows that the annual runoff from the coal areas averages only about 0.2 inch in the North Platte basin and about 0.7 inch in the Yampa subbasin, whereas annual runoff from the respective mountain areas (table 3-5) averages more than 15 times that amount. Based on table 3-4, annual runoff from all lease tracts in the North Platte basin averages about 540 ac-ft, which is only about 0.06 percent of the annual water yield from the watershed. Runoff from all lease tracts in the Yampa River subbasin averages about 2,300 ac-ft/yr, which is only about 0.2 percent of the annual yield from the watershed. Because of evapotranspiration losses enroute downstream from the lease tracts, actual water yield from the tracts to the rivers is probably even less than the amounts shown above.

Table 3-4 shows that measured peak discharges per unit area from the gaged coal areas are unusually small for watersheds containing less than 35 square miles. Small watersheds characteristically have much higher unit peak discharges, often exceeding 100 ac-ft/sq mi, than large watersheds such as those shown in table 3-5 for the mountain areas. This apparent anomaly is tentatively attributed largely to the short period of record of 2 to 4 years for streams draining the coal areas. Apparently no large runoff events have occurred during this period. Field observations, however, also indicate that most streams draining coal tracts show little or no indications of high peak discharges. Apparently, the sandy soils in most coal areas tend to absorb most of the rainfall, thereby minimizing runoff. Unit peak discharges listed in table 3-4, therefore, are probably low for streams draining coal areas, but excessive flooding appears to be uncommon in these areas.

Data on water quality presented in tables 3-6 and 3-7 show significant differences between streams draining the mountains and streams draining the coal areas. Snowmelt runoff from the mountains is typically a calcium bicarbonate water that contains less than 250 mg/L dissolved solids during the spring period. As snow-melt contribution to these streams decreases during the summer and fall and flow is increasingly derived from ground-water discharge, dissolved solids concentrations increase two to four fold. Concentrations of sodium and sulfate ions generally increase, but not sufficiently to change the water type.

In contrast, runoff from the coal areas commonly contains more than 1,000 mg/L dissolved solids in the spring and fall, about two to three times the corresponding values for mountain areas. Although no single water type characterizes the coal areas, analyses show significant amounts of magnesium, sodium, and sulfate ions in addition to the calcium and bicarbonate ions that characterize the mountain areas.

All streams in the region, with the exception of the Encampment River above Hog Park Creek, which is very low in dissolved solids concentration, have a pH in excess of 7.0 (tables 3-6 and 3-7).

Present and projected consumptive annual use of water and dissolved solids concentrations in the North Platte and Yampa River watersheds and in the Colorado River at Imperial Dam for the time frames addressed in this analysis are presented in tables 3-8 and 3-9. Baseline conditions in both watersheds were approximated by working backwards from known consumptive uses of water and changes in salt load as a result of man's activities to estimate undepleted water supply, use of water by riparian vegetation, and natural sources of salt. As this approach is subject to considerable error, the baseline conditions shown in tables 3-8 and 3-9 should be regarded only as indicative of inferred pristine conditions.

A comparison of suspended sediment loads yielded by the coal areas with that yielded by the respective watersheds is probably not warranted by the meager data in tables 3-4 and 3-5. It is interesting to note, however, that the annual unit suspended sediment yields from the coal areas are less than half the unit yields of the overall North Platte and Yampa watersheds. Normally, sediment yield per unit area of watershed decreases with increasing size of contributing area because of deposition of a part of the load as flows move downstream (Hadley and Schumm 1961). The low sediment yields from the coal areas may reflect greater erosional stability in these areas or an absence of high-intensity storms during the short period of record for streams draining these areas.

Premining sediment yields from the lease tracts were estimated using the Pacific Southwest Inter-Agency Committee (PSIAC 1968) method. A summary of this method is presented in Appendix B. Those estimates indicate a range in annual sediment yield from less than 0.1 ac-ft/sq mi in the more stable lease areas to as much as 3 ac-ft/sq mi in eroding areas on the more arid tracts. As a whole, however, the lease tracts appear to be moderately stable. The estimated premining average annual sediment yield for all Wyoming tracts is 0.5 ac-ft/sq mi (1.2 tons/acre). The average annual yield for all Colorado tracts is 0.25 ac-ft/sq mi (0.6 tons/acre).

ALLUVIAL VALLEY FLOORS.

Preservation of the hydrologic function of alluvial valley floors, which are those unconsolidated stream-laid deposits holding streams where water availability is sufficient for subirrigation or flood irrigation agricultural activities, is required by the Surface Mining Control and Reclamation Act (SMCRA) of 1977. Regulations pursuant to that act (30 CFR 822.11) require that all coal mining and reclamation operations be conducted so as to preserve the essential hydrologic functions of alluvial valley floors outside the affected areas and to reestablish the essential hydrologic functions of alluvial valley floors within affected areas. It is the responsibility of the Office of Surface Mining to identify all alluvial valley floors within and adjacent to the proposed lease tracts and to assure that their essential hydrologic functions are preserved or reestablished. Alluvial valley floors are also included in the unsuitability criteria as criterion 19. Although a preliminary determination of the presence of alluvial valley floors was made during site specific analysis, it is the Department's policy that this criteria will be applied at the time of mine plan submission. Presumably, therefore, no significant impacts would occur to any alluvial valley floors as a result of leasing and development of new Federal coal. Accordingly, no further discussion of alluvial valley floors is included in this analysis.

VEGETATION

The region analyzed consists of 5,466,500 acres in Wyoming and 1,495,603 acres in Colorado. The environments are the areas within the *Southcentral Wyoming Coal Environmental Statement* which covers part of Sweetwater County and Carbon County, and the area within the Williams Fork Planning Unit which is part of the BLM Craig, Colorado District (Map 3-2).

The region consists of 11 vegetative types with sagebrush being the dominant type in Colorado (48.4 percent) and Wyoming (53.0 percent). The acreage and percentage by type is depicted in table 3-10. Type designations and numbers are those used by the BLM as described in BLM Manuals 9160-9162.

The vegetation of this region is a complex mosaic where soils, climate, aspect, altitude, grazing, and general land use history are the controlling factors in vegetative distribution. Moisture is most often the general limiting factor for the distribution of vegetation.

The grasslands occur on sites that range from deep soil and wet mountain meadows, to dry, rocky hillsides. Grassland types of the region are much deteriorated, and have become increasingly less important to the biological systems of the area. Some areas that were formerly grassland types have been converted to sagebrush by historic cattle over-grazing. Progressing toward the drier lower end of the scale, it is evident that on deep well-drained soils, sagebrush communities dominate all locations where moisture limits other vegetative types.

At lower elevations (5,000 to 7,000 feet) the mountain shrub type develops where snow collects and lies late, or where moisture is adequate throughout spring and early summer. Soils associated with this type are deep and well-drained, but not as deep as those under aspen type. On sites where moisture is somewhat limiting, scrub oaks of the mountain shrub type lose their dominance in the community and the stands become dominated by serviceberry. Brown (1958) points out that the absence of coniferous species on many north-facing slopes is strong evidence supporting the premise of ecological stability of mountain shrub communities.

Pinyon-juniper type, often referred to as pigmy forest, is located in areas where precipitation is similar to sagebrush type, but soils are very shallow or nearly non-existent. Physiologically, these coniferous species are unable to tolerate accumulation of fine soil particles around the roots, so they occur where bedrock is close to the surface or outcrops.

Woodbury (1947) demonstrated that sagebrush is adapted to fine deep soils, and juniper to coarse porous soils; these vegetation types are segregated on that basis. In much of northwestern Colorado the occurrence of pinyon is limited in this vegetation type, either due to the fact that this area is near the northern limit of the species, or due to historic disturbances, such as fire or disease. Juniper is often found to recover from disturbance more readily than pinyon (Woodbury, 1947).

Northwest Colorado is also the approximate southern limit of the sagebrush type in the Rocky Mountain region. Therefore, the slopes around the basins of northwest Colorado are a tension zone between two distinct semi-desert vegetation types, sagebrush and pinyon-juniper.

Saltbush and greasewood types are found in the areas of the region with lowest precipitation and elevation. They occur where the soils are saline-alkaline, poorly drained, and often underdeveloped. Greasewood type dominates where soils are the most saline-alkaline, and are poorest drained.

Aspen type occurs in areas where soils are well-developed and soil moisture conditions are good; it is often a transition zone between the mountain shrub and conifer types.

Barren areas are primarily rock outcrops, areas of bentonite clay, and other areas where very little soil has developed because annual precipitation is very low.

Conifer type is marginal in the study area and usually occurs in areas of highest elevation, coolest soils, and highest annual precipitation, and often in areas of the most snow accumulation. In some areas this type is confined to north slopes where aspect creates microclimatic conditions suitable for a coniferous forest.

VEGETATIVE TYPES

GRASSLAND, TYPE 1

Native grassland vegetation consists primarily of scattered small native grass meadows, and numerous small patches on windswept ridge tops and uppermost south slopes. This type is usually found on shallow soil of exposed ridges, in deep mesa soils, on gentle sloping foothill terraces, and on alluvial fans in the valley bottoms.

Grassland areas created by vegetative manipulation and/or wildfires are also considered in this type, if they are unirrigated. Some of the deep soils in the valley bottoms have been successfully converted to perennial grass pasture. Several areas of pinyon-juniper type have also been successfully converted to grassland type.

Grasslands of the study region are composed mostly of perennial bunch-grasses intermixed with forbs, half shrubs, occasional shrub species, and, in a deteriorated condition, annual grasses. The native grasslands of the eastern part of the region are dominated by: needle-and-thread grass (*Stipa comata*), Columbia needlegrass (*Stipa columbiana*), green needlegrass (*Stipa viridula*), brome grasses (*Bromus* spp.), and timothy grass (*Phleum pratense*).

The dominant species of the central and western grassland types are: western wheatgrass (*Agropyron smithii*), needle-and-thread grass, June grass (*Koleria cristata*), bluegrass (*Poa* spp.), sedge (*Carex* spp.), and Indian ricegrass (*Oryzopsis hymenoides*).

Seeded areas of the grassland type are mostly introduced wheat grasses, in the western part of the study region, and bromes and timothy in the eastern part.

SAGEBRUSH, TYPE 4

The sagebrush type is the most extensive vegetative type in the EIS region. Table 3-10 depicts the dominance of this vegetative type. Wyoming big sagebrush (*Artemisia tridentata* wyomingensus) and basin big sagebrush (*Artemisia tridentata* tridentata) are the most common species present. Other sagebrush species that populate this type are: black sagebrush (*Artemisia nova*), silver sagebrush (*Artemisia cana*), birdfoot sagebrush (*Artemisia pedatifida*), bud sagebrush (*Artemisia spinescens*), and fringed sagebrush (*Artemisia frigida*).

Grass species dominating in the sagebrush type are: Indian ricegrass, western wheatgrass, Sandburg bluegrass, needle-and-thread, and bluebunch wheatgrass (*Agropyron spicatum*). Associated species: Idaho fescue (*Festuca idahoensis*), bluegrasses, junegrass (*Koeleria cristata*), sedges, cheatgrass, arrow balsamroot (*Balsamorhiza sagittata*), rabbitbrush, and broom snakeweed.

This type can be found adjacent to all other types throughout the region. The growth form is a mixture of low growing shrubs dominated by big sagebrush with a variable understory of perennial grasses and forbs. The annuals fluctuate from year to year depending on spring temperatures and moisture conditions. Type overstory varies from very open to completely closed stands. The EIS region contains approximately 3,626,283 acres of the sagebrush type--52 percent.

MOUNTAIN SHRUB, TYPE 5

A typical mountain shrub type of the study region supports a dense stand of shrubs 2 to 8 feet in height. This type usually exists as a transition zone between aspen and sagebrush types in the eastern part of the study region. In the western part of the region, mountain shrub type occurs on the sandiest soils and on areas of most favorable soil moisture conditions, and is usually bordered on all sides by sagebrush. Mountain shrub community is usually found on slopes, whereas sagebrush is usually on the flatter, deeper, heavier soils. Perhaps nothing characterizes vegetation of the mountain shrub type as much as its variability; a single species does not dominate the type for very large areas. Inconsistency of the vegetation is due to variability of soil moisture conditions and soil depths, that are found on the mountain slopes of the region. Soils of this type are well-drained.

The common species are: Utah serviceberry (*Amelanchier utahensis*), western serviceberry (*Amelanchier alnifolia*), and Gambel oak (*Quercus gambelii*).

Relative forage value of this type depends largely on plant density, species composition, and season of use. This type provides important big game winter range where snow depth does not prohibit access; its primary value to livestock is as summer range for cattle and sheep. When understory vegetation is crowded out by heavy grazing, this vegetative type will often close into dense stands of one or more less desirable browse species, such as Gambel oak or rabbitbrush.

JUNIPER, TYPE 9

The juniper type occurs in small isolated areas in the northeastern portion of the region. Examples of the type become more frequent and larger in the central section of the ES region, while the largest expansion of juniper occurs in the southwestern part. The growth form of this type consists of an 8 to 20 foot overstory of conifers with a thin understory of shrubs and herbaceous species. Juniper can be found on topography that varies from rolling to rugged. Canopy cover ranges from quite open to closed.

The dominant species in this type is the Rocky Mountain juniper (*Juniperus scopulorum*). Associated understory species are: big sagebrush, rabbitbrush, prickly pear (*Opuntia*, spp.), western wheatgrass squirreltail (*Sitanion hystrix*), broom snakeweed, antelope bitterbrush, Indian ricegrass, phlox, and goldenweed. Considerable variation exists within the juniper type, depending upon soil moisture conditions and soil texture. The open stands provide forage for livestock and wildlife, whereas closed stands usually provide little more than cover. During critical weather periods, the juniper type provides both food and cover since it offers essential survival food when grasses and low brush are unavailable due to deep snow cover.

SALTBUSH, TYPE 13

The saltbush type is found in the south and west portions of the study region in large rolling semi-arid basins, and lower foothill slopes along the drainage bottoms. This type occurs as mixed stands of low-growing shrubs with a grass-forb understory. Understory vegetation exhibits considerable variation within the type, often depending upon range condition. Stands in poor condition often have a high percentage of annual grasses and forbs and increase in perennial grasses and forbs as range condition improves.

The saltbush type occurs on soils that are moderately saline-alkaline and are slightly better drained than those supporting the greasewood type. This type appears to be strongly competitive on lower saline-alkaline soils in low precipitation zones. The effects of aspect on distribution of the saltbush type along the White River drainage are evident on lower foothill slopes where warm south exposures extend the semi-arid microclimate to higher elevations. The ability of sagebrush to strongly compete with other vegetation on well-drained soils is probably a major limiting factor to the extent of the saltbush type in this region.

Dominant species of this type are: Nuttall saltbush (*Atriplex nuttallii*), shadscale (*Atriplex confertifolia*), fourwing saltbush (*Atriplex canescens*), black sagebrush, big sagebrush, spineless horsebrush (*Tetradymia canescens*), and spiny hopsage (*Grayia spinosa*).

Saltbush type is generally regarded as valuable winter range for sheep, cattle, antelope, and deer, since it occupies lower elevations that do not accumulate large amounts of snow. Forage value is dependent on the species of both the browse overstory and the grass-forb understory. Heavy grazing and/or improper season of use will selectively decrease the quantity of desirable plant species, and often produces an increase in poisonous plants.

GREASEWOOD, TYPE 14

Greasewood type is found in low elevation drainage bottoms, alluvial fans, and basin flood plains in the south and west parts of the study region. This type is found in areas where the soils are very saline-alkaline and very poorly drained. Greasewood type is primarily composed of fairly dense stands of medium height shrubs (2 to 5 feet) with a grass-forb understory, usually quite sparse.

The primary dominant of this type is greasewood. Other shrubs appearing in more open stands are:

rabbitbrush, fourwing saltbush, Nuttall saltbush, and big sagebrush.

Dense stands of nearly all greasewood provide very little forage for grazing animals; greasewood is a poisonous plant to cattle and sheep if grazed in sufficient quantities in absence of other forage. Areas occupied by this type are in many cases natural livestock concentration areas near water. Heavy use of the palatable species in this type near watering areas tends to produce very dense stands of greasewood with little forage value.

ASPEN, TYPE 10

The aspen type occurs as open to very dense stands of deciduous trees at higher elevations. The trees are often clonal in habit, sharing a common root system. The type generally occurs along drainage bottoms and in isolated small patches except on the western slopes of the Sierra Madre Range of the Medicine Bow National Forest. The aspen type which stands on these slopes is extensive and is considered to be the largest expansion of aspen in the state of Wyoming. Growth characteristics can vary from dwarfed and twisted stands on snow accumulation sites to merchantable class stands on the more fertile sites in the national forest. Owing to its sprouting characteristic, aspen reproduces vigorously in cutover or burned areas of the conifer type if parent stock is present.

The dominant species of this type is quaking aspen (*Populus tremuloides*). Associated species are: aspen peavine (*Lathyrus leucanthus*), timothy, mountain brome, geranium (*Geranium* spp.), snowberry, mountain ninebark (*Physocarpus monogynus*), bluegrass, wheatgrass, carex, cowparsnip (*Heracleum lanatum*), larkspur (*Delphinium* spp.), and many others that make up this complex and varied plant community. This type is important for the production of water, shelter for livestock and wildlife, and for forage production, especially in the western mountain slope region.

RIPARIAN, TYPE 20

This type occurs along main drainages. It essentially occurs along the entire length of the rivers, but in many areas is too small to be differentially classified from the surrounding vegetative types. Included in this type are groves of deciduous trees, marshlands, open grasslands, and rocky canyons with very little vegetation.

Groves of trees included in this type contain mostly narrowleaf cottonwood (*Populus angustifolia*), and a small amount of boxelder (*Acer negundo*). Associated species are: willow (*Salix* spp.), dogwood (*Cornus* spp.), hawthorn (*Crataegus* spp.), bluegrass, wheatgrass, bromes, rushes, sedges, and in the poorly drained marshy areas, cattails (*Typha latifolia*).

Many areas of this type have been converted to croplands, usually hay production, with the result that only fringe strips remain along the stream banks. The riparian type is essentially the area between the summer low water level and the spring runoff flood level. It may also be subject to periodic flooding from flash thunderstorms. The riparian areas provide valuable nesting areas for raptors and other birds, as well as food and cover for many species of wildlife.

CROPLAND, TYPE 19

The croplands of the study region are composed of natural meadows, subirrigated valley bottoms, and adjacent mesas and slopes along the river basins. Areas immediately adjacent to rivers and streams are used for hay production, and mesas and foothill slopes are used for production of small grains, mostly winter wheat (*Triticum aestivum*), by the summer fallow method. The haylands are composed mostly of bromes, timothy, wheatgrasses, orchard grass (*Dactylis golmerata*), ryes (*Elymus* spp.), clovers (*Melilotus* spp.), and alfalfas (*Medicago* spp.).

These areas are limited in production by the short growing season, and the short supply of late season moisture from either natural precipitation, or irrigation where facilities are available. In a few areas where irrigation water is plentiful, salt accumulation in low places has produced small areas unsuitable for plant growth. Most of the areas used for small grain wheat production were formerly sagebrush lands. Sheet, rill, and gully erosion are quite prevalent on small grain and fallow lands. Most of these areas are steep and unprotected from wind and water erosion.

Cropland provides a significant amount of forage used by livestock during times when grazing lands are unavailable.

BARREN, TYPE 8

The barren areas include outcrops, windswept ridges, and other areas where soil, moisture, and climatic conditions are of such severity that only sparse vegetation exists. Low growing, cushion-like plants are major components of the living cover.

The dominant species in barren areas are: goldenweed (*Haplopappus* spp.), sandwort (*Arenaria* spp.), spiny phlox (*Phlox austromontana*), fringed sage, and stonecrop (*Sedum stenopetalum*). Associated species are: Sandberg bluegrass, bluebunch wheatgrass; and in the more protected areas, big sagebrush and snowberry. Due to the sparse vegetation, this type has little or no importance as a source of forage.

CONIFER WITH FORAGE, TYPE 6

The conifer type is confined primarily to the mountainous areas. It occurs at higher elevations where tree growth conditions are not favorable to producing dense stands of timber, at mid-elevations where soil or moisture conditions limit tree establishment, or on old burns that did not reforest to former standards. The dominant species are: Engelmann spruce (*Picea englemannii*), subalpine fir (*Abies lasiocarpa*), and lodgepole pine (*Pinus contorta*). Primary understory species are: mountain brome, bluegrasses, pinegrass (*Calamagrostis rubescens*), and timothy (*Phleum alpinum*). Associated species are: lupine (*Lupinus* spp.), eriogonum (*Eriogonum* spp.), fleabane, and aster.

The understory vegetation varies with stand location, density, and stage of succession. Ground cover can vary from dense to nonexistent. Due to the sparsity of vegetative cover, the conifer type is not an important forage source, but it does provide cover for both livestock and wildlife.

THREATENED AND ENDANGERED PLANTS

Distribution and occurrence of the four listed plant species is not known. The U. S. Fish and Wildlife Service Endangered Species Office in Salt Lake City, Utah, has been contacted (February 12,1980) for a biological opinion concerning the four plant species and the proposed Federal action. The four species consist of the following cacti:

(1) Spineless hedgehog cactus (*Echinocereus triglochidiatus*)

(2) Knowlton cactus (*Pediocactus knowltonii*)

(3) Peebles Navajo cactus (*Pediocactus peeblesianus*)

(4) Uinta Basin hookless cactus (*Sclerocactus glaucus*)

TRENDED BASELINE

The vegetation in the region has already been altered by development. The region will continue to be affected even without the Federal action as coal development of state, private and existing Federal leases takes place plus coal non-related activities such as oil and gas or oil shale developments. Table 3-11 depicts the extent of these disturbances.

WILDLIFE

The affected environment for wildlife is presented in two major sections--Habitat, and Animals. Within these sections Terrestrial, Aquatic, and Threatened or Endangered are discussed.

HABITAT

TERRESTRIAL

The geographical area for wildlife habitat discussion will be the same as the preceding vegetation section. It consists of the Southcentral Wyoming Coal Environmental Statement (SCWCES) area, and the BLM Williams Fork Planning Unit (WFPU) of the Craig District, Colorado. Hereafter, it will be referred to as the Habitat Analysis Area (HAA). See Map 3-2.

Within the HAA, 11 terrestrial habitat types or vegetative communities, provide the living space, food, and shelter necessary to support animals. Generally, the more important habitats are those which support (1) many animals, (2) many species, or (3) provide an essential element necessary for wildlife survival (table 3-12).

Plants and animals which are characteristic of each habitat type are summarized in the following section. Values of each type are presented.

GRASSLANDS (559,716 acres)

Composition of this type includes western wheatgrass, needle-and-thread, Indian ricegrass, Sandberg bluegrass, brome, cheatgrass, and sedge. Grasslands support pronghorn antelope, mule deer, cottontail, jackrabbit, prairie dog, wandering shrew, ground squirrel, pocket gopher, meadow vole, rough-legged hawk, Swainson's hawk, ferruginous hawk, golden eagle, marsh hawk, sharp-tailed grouse, greater sandhill crane, burrowing owl, horned lark, meadowlark, short-horned lizard, wandering garter snake, and gopher snake. Many small mammals and birds are produced in this type. Associated predators are abundant due to existence of this prey base. Black-footed ferret, an endangered species, may occur.

SAGEBRUSH (3,626,283 acres)

The sagebrush type is characterized by the dominance of Wyoming big sagebrush and basin big sagebrush. Black sagebrush, silver sagebrush, bud sagebrush and fringed sagebrush occur to a lesser degree. Associated grass and forb species are western and bluebunch wheatgrasses, Indian ricegrass, needle-and-thread, junegrass, cheatgrass, arrowleaf balsamroot, phlox, lupine, and rabbitbrush. Representative wildlife species are sage grouse, pronghorn antelope, mule deer, cottontail, jackrabbit, badger, coyote, deer mouse, prairie dog, ground squirrel, horned lark, sage sparrow, golden eagle, red-tailed hawk, American kestrel, and northern sagebrush lizard. This type is essential to the continued survival of sage grouse, pronghorn antelope and mule deer in the region. Sagebrush is the major source of food and shelter for sage grouse on a year-round basis. The sagebrush type supports high winter concentrations of mule deer and antelope. Black-footed ferret could occur.

MOUNTAIN SHRUB (479,008 acres)

Typical shrubs found in this type are serviceberry, gambel oak, mountain mahogany, antelope bitterbrush, and snowberry. Chokecherry and sagebrush are often associated. Understory species include junegrass, mountain bromegrass, Sandberg bluegrass, sedges, yarrow, and arrowleaf balsamroot. Elk, mule deer, coyote, red fox, skunk, golden-mantled ground squirrel, cottontail, yellow-bellied marmot, deer mouse, montane vole, sharp-tailed grouse, scrub jay, magpie, and wandering garter snake are representative species. Mountain shrub communities are essential to deer and elk survival. Much of the critical winter ranges for these species are in this type. Occurrence of vegetation of many height classes allows existence of diverse small mammal and bird populations.

PINYON-JUNIPER (83,248 acres)

Rocky Mountain juniper dominates this type. Utah juniper occurs. Big sagebrush, rabbitbrush, Indian ricegrass, western wheatgrass, prickly pear, broom snakeweed, antelope bitterbrush, and phlox are typical understory plants. Representative animals inhabiting this type are mule deer, cottontail, deer mouse, coyote, bobcat, mountain lion, mourning dove, mountain bluebird, red-tailed hawk, desert short-horned lizard and prairie rattlesnake. This type provides food and cover for mule deer. Mourning dove, raptors and songbirds use junipers as nest sites and perches.

SALTBUSH (474,500 acres)

Nuttall saltbush, fourwing saltbush, and shadscale are dominant. Associated species are big sagebrush, black sagebrush, bottlebrush, squirreltail, halogeton, broom snakeweed, cheatgrass, Indian ricegrass, western wheatgrass, and Sandberg bluegrass. Animal species composition is similar to that of the sagebrush and greasewood habitat types. Pronghorn antelope, mule deer, jackrabbit, prairie dog, cottontail, and golden eagle are important species. This type can be locally important in supporting wintering pronghorn antelope and mule deer. It does not provide year-round quality habitat for many animal species. Black-footed ferret could occur.

GREASEWOOD (350,200 acres)

This type is predominantly black greasewood with rabbitbrush, fourwing saltbush and some big sagebrush. Wheatgrass, bottlebrush, squirreltail, Indian ricegrass, bluegrass, carex and cheatgrass occur. Animals inhabiting this type are similar to those found in the sagebrush community. Key species are pronghorn antelope, mule deer, jackrabbit, prairie dog and golden eagle. Limited forage and cover is provided by this type. Generally, low animal productivity occurs. Black-footed ferret may occur.

ASPEN (312,132 acres)

Quaking aspen dominates this type. Characteristic understory plants are snowberry, mountain ninebark, carex, larkspur, geranium, mountain brome, timothy, wheatgrass, and bluegrass. Typical animals associated with aspen are elk, mule deer, black bear, coyote, long-tailed weasel, skunk, deer mouse, porcupine, beaver, blue grouse, red-tailed hawk, yellow-bellied sapsucker, and mountain bluebird. Great vegetative diversity allows many animal species to use this type. Deer and elk migration routes and fawning/calving areas often occur in the aspen vegetation.

RIPARIAN (101,316 acres)

Common tree and shrub species are narrowleaf cottonwood, plains cottonwood, box elder, willow, hawthorn and red osier dogwood. Rushes, sedges, bromes, blue grass, wheatgrass, and cattails occur. Animals inhabiting riparian areas are mule deer, beaver, mink, raccoon, red fox, weasels, great horned owl, bald eagle, great blue heron, kingfisher, killdeer, greater sandhill crane, mourning dove, common flicker, barn swallow, starling, song sparrow, boreal chorus frog, tiger salamander, and great basin gopher snake. Scarcity and diversity of this type makes it valuable. Many bird species nest and roost in riparian shrubs and trees. Deer and elk find food and cover here. Riparian habitat supports species which are not found in other types--raccoon, mink and beaver. Bald eagles, peregrine falcon, and greater sandhill crane hunt, roost or nest here.

CROPLAND (316,744 acres)

Croplands are those areas which are cultivated by man. Within the region they consist of dryland wheatfields, and hay meadows, irrigated and nonirrigated. Pronghorn antelope, mule deer, sage grouse, sharp-tailed grouse, deer mouse, skunk, mourning dove, meadowlark, robin, and wandering garter snake can be found in cropland areas, at least seasonally. Hay meadows can be locally important areas for rearing of sage grouse young, which need insects for food. Pronghorn and mule deer use green wheat as a spring food source. Use is limited by low plant species diversity and seasonal availability.

ROCK OUTCROP-BARREN (58,300 acres)

Sparse vegetation occurs on these rocky outcrops, windswept ridges, and other areas of poor soil and moisture. Vegetation varies from low growing forms such as sandwort, stonecrop, and goldenweed to shrubs--serviceberry, mountain mahogany, and wild buckwheat. Animals found here are canyon mouse, golden eagle, rock wren, sagebrush lizard, northern plateau lizard and prairie rattlesnake. Use is limited by low vegetative productivity. Cliffs provide nest sites for raptors.

CONIFER (600,656 acres)

Dominant plants are trees such as Engelmann spruce, subalpine fir, and lodgepole pine. Understory vegetation includes mountain brome, bluegrass, huckleberry, lupine, currant, and aster. Mule deer, elk, black bear, pine squirrel, masked shrew, snowshoe hare, red-backed vole, blue grouse, goshawk, downy woodpecker, mountain chickadee, gray-headed junco, boreal toad and boreal chorus frog are representative animals. This type provides important summer range for mule deer and elk. Trees are used by a wide variety of birds for nesting, perching and food seeking.

AQUATIC

Within the HAA, rivers, reservoirs, lakes, streams, and ponds support a variety of game and nongame fish, amphibians, and aquatic vegetation. Many terrestrial animals also are dependent upon surface water for survival. Aquatic habitat is scarce and valuable. Major drainages are the North Platte in Wyoming and the Yampa in Colorado. Approximately 1,270 miles of cold water trout streams, and 17,000 to 31,000 acres of lakes and reservoirs occur in the southcentral Wyoming EIS area outside Medicine Bow National Forest (SCWCES 1978). In the Williams Fork Planning Unit of Colorado, 314 miles of cold and warm water rivers and streams support fish. Data on surface acres of lakes and reservoirs have not been calculated according to the Williams Fork Unit Resource Analysis (BLM, 1974).

Both cold and warm water habitat exists. Perennial cold water streams, lakes, and upper reaches of major rivers support game fish populations. Characteristic species of these higher elevation tributaries are rainbow, brook, brown, and cutthroat trout, and mountain whitefish. Colorado River cutthroat trout may occur. Warm water lower elevation reservoirs and rivers contain catfish, sunfish, walleye, largemouth bass, suckers, carp, chubs and dace. The Yampa River contains known populations of bonytail chub, Colorado squawfish, humpback chub, and razorback sucker.

THREATENED OR ENDANGERED

Individual plant species are listed as threatened or endangered, not vegetation associations or habitat types. However, certain geographical areas or habitat types may be designated as critical or essential to a threatened or endangered animal species' survival. In this respect certain habitat types within a geographical area may be considered "threatened, endangered or essential". No areas are listed as critical habitat by the U. S. Fish and Wildlife Service at this time. The state of Colorado lists "essential" habitat for its threatened or endangered fish and wildlife (Colorado Division of Wildlife, 1978d).

ANIMALS

The affected environment discussed for animal populations will vary dependent upon data availability, and species characteristics--primarily, mobility. The largest area discussed will be the Habitat Analysis Area (HAA). Where appropriate, smaller areas such as counties, Data Analysis Units (DAU), Game Management Units (GMU), BLM Planning Units, EIS areas, or other analysis areas will be defined and used when necessary.

A minimum of 68 species of mammals, 189 bird species, 22 species of amphibians and reptiles, and 22 fish species occur regularly within the HAA. Good species diversity reflects the existence of varied habitats. General life history and occurrence data is available for most animals in the region. Detailed information such as reproductive success and survival rates is known for only a few species populations. Best data exists for those animals which are of economic or recreational interest. In recent years threatened or endangered wildlife has received more attention.

Tables 3-13 and 3-14 summarize the affected wildlife resources with emphasis on key species and habitats--those which are of high value or interest. Big game, small game and game fish provide many days of recreation, and are of economic benefit (Colorado Division of Wildlife, 1979, 1978 f, 1977; SCWCES, 1978). See Recreation Section for discussion.

Of the total land area within the HAA nearly all is available to at least some wildlife. Certain species will not use urban areas because of their intolerance to human activity, or the lack of some habitat component necessary for their existence. Habitat must supply the elements needed for population maintenance--food, water, cover, space, and suitable reproduction areas. If any of these is in short supply--limited--at a critical time, animal numbers will decline. Declines may be drastic as in winter deer die-offs, or subtle as in reduced birthrates.

Key species distribution and occurrence is a result of adaptation to climatic and environmental conditions (table 3-14). These conditions are variable over time, and therefore, affect changes in wildlife numbers. Fluctuations--up and down--occur both seasonally and year to year. Causes of declines are starvation, disease, reproductive failure, and accidents. Population increases result only from successful reproduction--births. Key wildlife populations and factors affecting their numbers are presented in the following section.

TERRESTRIAL

SMALL MAMMALS. Many shrews, voles, mice, bats, and ground squirrels are common or abundant within the HAA (Colorado Division of Wildlife, 1978 b; SCWCES 1978). These animals are important links in the food chain and serve as prey for many raptors and mammalian predators. Generally, occurrence and distribution data is available, but specific population numbers are not known. The regional carrying capacity for small mammals is given as 50 to 60 per acre (FCMPES, 1979). Population numbers experience great variability both seasonally and year to year. The reproductive rate of most of these small mammals is high enabling rapid population expansion when and where environmental conditions are favorable. Localized population losses usually would not represent a significant portion of HAA numbers.

ELK. Populations within the HAA are migratory. Summer ranges occur in the Medicine Bow National Forest, Wyoming, and Routt and White River National Forests in Colorado. Fall movement patterns are to lower elevation mountain shrub and sagebrush winter ranges. Winter ranges are limiting population growth, but trends are still stable to slightly increasing regionwide. Elk occurring in Colorado Game Management Units (GMU's) 11, 12, 13 and 131 (Map 3-3) are dependent upon winter ranges in the Yampa and White River drainages. Many of these elk migrate through and winter on or near proposed lease tracts. Elk numbers were estimated to be about 9,600 for the 1979 post-hunt population in this GMU area of 2,134 square miles. Average winter densities increase as animals are compressed to an 800 square mile winter range. The 1979 winter mean density was nearly 12 per square mile in this area. Many smaller areas within these GMU's support concentrations much higher due to more favorable conditions.

Estimates of the southcentral Wyoming EIS area elk population were 5,500 to 7,500 animals in 1978 (SCWCES, 1978). Average winter densities would have been 11.3 to 15.4 elk per square mile over 487 square miles of winter range. Most of the critical elk ranges are not on or near proposed lease tracts (BLM, 1979 b; SCWCES, 1978).

MULE DEER. Mule deer occur throughout the HAA, in nearly all habitats. Many migrate between higher, summer ranges in the aspen/conifer and lower, sagebrush/mountain shrub winter ranges. Some occupy these lower zones year round. Available winter range is limited. This results in crowding, high utilization of vegetation, and deer die-offs when weather conditions are severe. HAA population numbers are stable to slightly increasing. The estimated 1979 post-hunt deer population in Colorado GMU's 11, 12, 13 and 131 was about 35,300 on a range of 2,134 square miles. Winter range of 928 square miles supported an average density of 38 deer per square mile. Much higher concentrations occur within the GMU's where environmental conditions are more favorable--snow free, protected areas. These critical winter ranges are in the Yampa and White River valleys and are essential to herd survival.

Southcentral Wyoming EIS area estimates were 17,000 to 21,500 deer in 1978 (SCWCES 1978). Average densities on 1,640 square miles of winter range would have been 10.4 to 13.1 deer per square mile. Densities ranging from one per square mile to seven per square mile are reported for Hanna Basin and Red Rim/China Butte (Bureau of Land Management, 1979 b). See Map 3-2 for location of these analysis areas. Critical winter ranges occur in the Red Rim/China Butte area. Important mountain shrub habitat exist on the Seminoe Tract (Bureau of Land Management, 1979 b).

PRONGHORN ANTELOPE. Antelope are common year round throughout the lower elevation habitats--sagebrush, saltbush, and greasewood. Their numbers are stable to increasing within the HAA. Locally, forage condition and availability may limit individual herds. Movement patterns may be altered or blocked by manmade barriers--fences, roads, etc. Such restriction may lead to overuse of vegetation and herd declines. The estimated post-hunt population in Colorado Antelope Areas A2, A3 and A5 was 7,000 in 1979. Most of these animals occur in the western three-quarters of Moffat County (Map 3-4). There are currently no large scale development plans that would pose a serious threat to antelope in the area.

Southcentral Wyoming EIS area numbers were estimated at 34,000 to 40,400 in 1978 (SCWCES, 1978). Average densities would have been 22.5 to 26.8 per square mile on 1,510 square miles of winter range. The Hanna Basin population was estimated at 1,300 animals in the Preliminary Cumulative Analysis (Bureau of Land Management, 1980 b). Average density for winter/yearlong range was seven per square mile (Bureau of Land Management, 1979 b).

NONGAME BIRDS

A variety of birds occurs within the HAA in all habitats. Songbirds, shorebirds, woodpeckers and raptors, are examples. With the exception of some raptors little population data is available. Limited data from southcentral Wyoming indicate about 21 nesting pairs of small birds per 100 acres (SCWCES, 1978). Carrying capacity of occupied habitat for the Green River/Hams Fork region is given as 2.5 songbirds per acre (FCMPES, 1979). It is difficult to detect significant changes in songbird numbers without intensive surveys which have not been conducted for most of the region. Eagle densities in Colorado on occupied ranges average one bird per 2.5 square miles in portions of the Williams Fork Planning Unit. Ferruginous hawks are fairly common (Colorado Division of Wildlife, 1978 c).

In Wyoming important nesting habitat exists on the Red Rim/China Butte and Hanna Basin areas. Golden eagle, ferruginous hawk, prairie falcon, burrowing owl, as well as the more common raptors use the area for nesting and hunting (BLM, 1979 b; SCWCES, 1978). There are 11 active ferruginous hawk nests in the Red Rim/China Butte area with four occurring on areas proposed for mining (BLM, 1980 b). A total of 60 nests in good repair occur in the area. The ferruginous hawk is a species of high Federal interest.

GAME BIRDS

Sage grouse are common and occur throughout the sagebrush habitat type. These birds are dependent upon sagebrush for food and cover, especially in winter. Sage grouse congregate on strutting grounds in spring. Winter concentration areas, strutting grounds, nesting, and brooding areas are essential to population reproduction and survival. Population numbers are stable over the Habitat Analysis Area.

The Moffat County, Colorado, population is recovering from severe declines which occurred in the late 1950's through the mid 1960's. The 1979 post-hunt population, estimated at 48,900, is below the early 1950's level, but is increasing (Ellenberger, J. H., 1980). Total sage grouse numbers in southcentral Wyoming are not known, but are stable to slightly decreasing (SCWCES, 1978). Estimates of densities for Red Rim/China Butte are 18 birds per square mile and 6 to 7 per square mile for the Hanna Basin (Bureau of Land Management, 1979 b). An estimated population of 3,200 birds exists in the Red Rim/China Butte area (Bureau of Land Management, 1980 b).

AMPHIBIANS AND REPTILES

At least 10 species of amphibian and 12 species of reptile occur within the HAA (Colorado Division of Wildlife, 1978 a; SCWCES, 1978). Principal amphibians are boreal toad, leopard frog, and Utah tiger salamander. Short-horned lizard, northern sagebrush lizard, great basin gopher snake, wandering garter snake, and prairie rattlesnake are common reptiles.

Population numbers are not known. Carrying capacity of the GR/HF region for amphibians and reptiles is given as 4.5 per acre in the FCMPES (1979). The majority of reptiles occur in the lower elevation, dryer habitat types such as sagebrush, greasewood, and pinyon-juniper. Amphibians are generally found where surface water occurs at least seasonally--in aquatic and riparian habitats.

No widespread regional threat to the continued existence of these species exists currently. Local declines may occur where native vegetation is converted to agricultural or urban use.

AQUATIC

NONGAME FISH. A variety of chubs, dace, suckers, darters, minnows, and shiners occurs. Population numbers are unknown, but many are common inhabitants of rivers, streams, lakes and reservoirs within the HAA (Colorado Division of Wildlife, 1977; SCWCES, 1978). An estimate of 20 pounds of nongame fish per acre in the Medicine Bow River is given in the SCWCES (1978).

GAME FISH. Cold and warm water gamefish occur--rainbow, brown, brook and cutthroat trout, mountain whitefish, walleye, catfish, bass, perch, sunfish and northern pike (NWCCRES, 1977; NWSR, 1978; SCWCES, 1978). Highest quality fisheries exist in the upper tributaries and reaches of the Yampa and North Platte rivers, and Seminoe Reservoir.

THREATENED OR ENDANGERED SPECIES

One mammal, three bird, and five fish species are listed as threatened or endangered within the HAA (including the lower Yampa River) by U. S. Fish and Wildlife Service or the State of Colorado. Wyoming does not have a state list. Table 3-15 shows listed species, status and occurrence. High potential exists for locating black-footed ferret in Wyoming. Much potential habitat--prairie dog towns--face destruction from development (Bureau of Land Management, 1979 b). These species are protected by law and cannot be harmed. Formal consultation with the U. S. Fish and Wildlife Service under Section 7 of the Endangered Species Act has been requested to ensure their protection.

CULTURAL RESOURCES

BACKGROUND

Consultation with the State Historic Preservation Officers (SHPO) of Wyoming and Colorado (Wyoming Inventory and Colorado Inventory), and the National Register of Historic Places (Federal Register, March 18, 1980), has determined that 72 sites in the Green River/Hams Fork Region are either listed on the National Register or have been determined eligible for inclusion on the National Register. The notation NR used in this discussion indicates that the site, object, place or monument is on the National Register of Historic Places.

The Green River/Hams Fork Region includes 11 counties in Wyoming and Colorado. For Wyoming, Albany, Carbon, Lincoln, Sublette, Sweetwater and Uinta are included; for Colorado, Grand, Jackson, Moffat, Rio Blanco and Routt are included. For these counties, all sites on or eligible to the National Register as of March 18, 1980 are listed in table 3-16. Jackson County, Colorado, has no properties on or determined eligible to the National Register.

Tract delineation fell within only five of these counties (Carbon and Sweetwater in Wyoming; Routt, Moffat and Rio Blanco in Colorado). This five-county area has been selected as the maximum potential affected environment for this EIS. The zone of environmental impact is even smaller: The tracts themselves, the off-tract facilities and the disturbance due to infrastructure needs. The tracts are clearly defined, but other areas of disturbance are imprecise. Section 4 deals with the tracts in detail.

The five-county region excludes only Wardell (48 SU 301) Bridger Antelope Trap (48 UT 1) and Maud'Dib (5 JA 58) of the sites discussed below. The only on-tract site in the discussion is the Union Pacific Mammoth, 48 CR 182, on the China Butte Tract. Shoreline site, 48 CR 122, is near but not on Medicine Bow Tract.

Cultural Resources include both historic and prehistoric values. Historic sites usually consitute about 10 percent of an inventory. To estimate the potential encounterment of cultural resources, off-tract existing data were used to generate an acres surveyed to sites found ratio as shown in table 3-17 (see also Appendix C). Off-tract existing data does not generally include clear statements of whether a site is recommended as eligible to the National Register or not. Assuming that only sites recommended as "no further work" or "no information" are not likely to be eligible (a worst-case assumption) the existing data yields a regional percent of eligibility of 16 with a range of 2 to 31 percent on a county basis.

Fragmentary preliminary data on test excavation or mitigation of off-tract sites indicates that the Colorado and Wyoming situations are not comparable. In Wyoming at Black Butte Mine, Metcalf (1975:4) reports that 202 sites were found. Of these, 55 were intensively collected and "Forty sites were tested, seven of these rather extensively." (p. 11). He concludes "that none of the sites threatened with destruction are worthy of placement on the National Register . . ." The Southcentral Wyoming Coal ES (R2-59) states that of 78 sites, 18 will require further testing. Sixty sites were tested and are of no further significance.

In Colorado, physical mitigation measures have been necessary for nine archaeological sites which could not be prudently or feasibly avoided. In each case, excavation did yield data important to the prehistory of Northwestern Colorado, confirming an original recommendation of "eligible to the National Register."

The number of sites tested in Wyoming is 173 of 649 (26.6%); the number of sites recommended as may be eligible in Colorado is 203 of 708 (28.6%). Colorado assumes that a site which needs further work is *de facto* likely to contain important scientific data and, therefore, is likely to be eligible. Wyoming assumes that testing is necessary to determine whether such scientific data is present. In Colorado, few sites are tested but all have proved eligible. In Wyoming, many are tested but few have proved eligible.

The Wyoming baseline occurrence analysis is based on a professional judgment interpretation of Metcalf, 1977. The Colorado baseline occurrence analysis is based on 24 project reports (see Appendix C). The significance analysis is even more tenuous: Any recommendation for further work was interpreted as a justified statement of significance demonstrating the site's scientific potential.

The types or kinds of sites known to exist in the five-county region are characterized in tables 3-18 and 3-19. The types of sites found on the tracts seem to be few: Lithic scatters, campsites and tipi rings constitute the majority of the sites described (see table 3-18). One site with petroglyphs is mentioned but not described by Metcalf (1977, Appendix no page number, BP-3). The Union Pacific Mammoth is a unique site. Historic sites are limited to homesteads. An historic trash dump was also identified but not described in a manner to fit the types established in table 3-18 or 3-19.

CULTURE HISTORY

The Green River/Hams Fork Region has been inhabited for at least 9,000 years. Excavations at sites in the region have produced a number of radiocarbon dates documenting the occupation of this area (see table 3-20). Figure 3-2 is a timeline portraying the traditions discussed below.

The Paleo Indian tradition may be represented at the Union Pacific Mammoth site (48 CR 182). The mammoth itself dates to the time expected for Clovis kills, but no tools were found with the animal.

Tools from the next later period, Folsom, have been found at the Morgan (48 SW 773) and Mud Springs (48 SW 774) sites. Neither site has as yet been systematically investigated (Frison, 1978).

The latter portion of the Paleo Indian period shows a steady diversification of tool types though a continuing dependence on hunting large game, particularly bison, is apparent. Two excavated sites in Sweetwater County have produced evidence of the Plano portion of the Paleo Indian period. The lowest level of Pine Spring (48 SW 101) produced Agate Basin projectile points in a campsite context. Similar material culture was found in the next level along with material attributed to later time periods (Sharrock, 1966). The Finley Site (48 SW 5) is a bison kill site of slightly later date containing projectile points classified as Scotsbluff and Eden (Frison, 1978).

No sites from the Paleo Indian period are known in the three Colorado counties. Occasional surface finds of projectile points from this period indicate that such sites do exist in these counties.

A more equal balance between hunting and gathering activities seems a characteristic of sites which date from about 6,000 years ago until about 1,500 years ago. This less spectacular lifeway was successful for at least 4,500 years but is archaeologically poorly known. In fact, so little is known about the Archaic that radiocarbon dates are the existing criteria for assigning a site to the broad (Early, Middle and Late) subdivisions of this period. Though projectile points are a sensitive indicator of change through time, Archaic points have not been sufficiently studied to realize this potential. During the Archaic, the cultural emphasis is on diversity of resource base indicated by a decrease in the evidence of buffalo hunting and an increase in small game utilization. There is also increasing evidence of plant food dependence characterized by increasing frequency of tools for grinding nuts and seeds, and for other vegetal processing. Sites from this period are generally smaller in size and more frequent in number than in the Paleo Indian period. Archaeological attention to sites of this period is just beginning, so excavation data is widely scattered.

In the five-county region, Shoreline Site, 48 CR 122, seems the earliest documentation of the Archaic. Frison (1978:44) notes that: "Initial excavations . . . produced what appear to be pit house features with fire hearths. One structure has been excavated and a single large side-notched projectile point was recovered."

Data recovery at the Threemile Gulch Site, 5 RB 298, was limited to impacted areas at the periphery of the site. The excavated area produced an Archaic campsite, but no structural features were found (Jones, 1978). The Scoggin Site, 48 CR 304, was a bison pound (trap) made of posts connected by low walls of stone (Frison, 1978: 210). The bone bed contained both lanceolate and large side-notched projectile points.

A large and complex campsite, 5 RB 312, lacks excavation data, but samples from hearths in one of its bounding arroyos has produced an Archaic period date. The alluvial situation is such that the site has the potential for occupation from Archaic through Protohistoric times.

Bull Draw Shelter, 5 MF 607, has produced a tight cluster of dates for the late Archaic. Later materials of Fremont association were found in the upper levels of the excavation. The report of the test excavations at this site is in preparation and only raw data is used here.

At a campsite with associated rock art, 5 RB 704, a cobble-lined fire pit was dated. No excavations have been undertaken, but the fire pit had been exposed by a gully and was about 30 cm below present ground surface. This site is within Canyon Pintado, a district on the National Register (NR).

Muddy Creek, 48 CR 324, is a corral buffalo kill. Frison (1978: 221) characterizes it as a Besant culture site quite similar to the Ruby Site.

About 1,700 years ago, the Colorado portion of the region was occupied by a people called Fremont. These people added cultivation of corn, beans and squash to their hunting and gathering activities. They also made pottery and built structures of mud-mortared sandstone (Fremont Fortification Lookout (NR)). The style in which the Fremont did these things is in many ways similar to the Anasazi of Arizona and New Mexico. The Fremont were similar but not the same as the Anasazi, so they pose some interesting archaeological questions: Their culture is best known in Utah, but there is evidence of them in Rio Blanco and Moffat counties in Colorado. Their characteristic rock art style is present in Routt County and their pottery is present in at least one site in both Sweetwater (Pine Spring) and Carbon (48 CR 322) counties in Wyoming. Fremont rock art has endured well and is a highly visible indicator of the extent of this culture. So spectacular are these remains that Fra. Dominguez called the valley of Douglas Creek painted canyon (Canyon Pintado (NR)) in his journal. Other spectacular rock art from this period, Carrot Men Pictographs and Cedar Canyon Petroglyphs, are on the National Register of Historic Places. The chronology of the Fremont in Colorado is based on only test excavation and fortuitous exposure of hearths. It is doubtful that the Fremont were the exclusive inhabitants of even Rio Blanco County. On a regional basis, it is likely that an Archaic lifeway continued to be the preeminent livelihood.

Two dates from the exposed deposits of 5 RB 715, a rockshelter with associated pictographs, offer a potential for data on the Archaic and Fremont interface. Brady site, 5 RB 726, test excavations indicate the site is a single-component Fremont occupation with surface structures (Creasman, 1979). A nearby open campsite, 5 RB 707, featured a hearth hypothesized to be above the Fremont occupation by context, but the dated sample falls in the middle of the Brady site results. All three of these sites are within Canyon Pintado (NR).

Data recovery from Cherokee Trail #1, an extensive campsite quite literally on the Colorado-Wyoming border, produced four hearth areas, all of which were dated. Three of the dates cluster nicely, all from simple pit fires. The fourth, from the only slab-lined fireplace encountered, dated to the Archaic.

Wardell Buffalo Trap (NR), 48 SU 301, is a kill and campsite with a great deal of buffalo bone and many pits for cooking. It also contained arrow points and Athabascan pottery.

Limited test excavations at Dripping Brow Shelter, 5 RB 699, yielded cultural, environmental and chronological data for the period from late Archaic to Protohistoric. Auger testing demonstrated that more cultural deposit underlies the tested depth of the site. Dripping Brow is also in Canyon Pintado (NR). Muad'Dib, 5 JA 58, a campsite in a parabolic dune situation was dated simply to get some idea of time of occupation. No excavation has been undertaken.

About 700 years ago, all Fremont activity ceased in the region and the inhabitants resumed full dependence on hunting and gathering. Kill sites reflect an increasing utilization of antelope as a meat supply and pottery of the Intermountain or Shoshoni type is found.

Bridger Antelope Trap (NR), 48 UT 1, is the remnant of a juniper alignment. Frison (1978) does not note any cultural material in association with this structure and it does not seem to be dated.

The Eden-Farson Site, 48 SW 304, is an extensive campsite containing side- and side-and-base-notched projectile points (Frison, 1978). A draft-planning document mentions that the site contains lodge structures and antelope remains.

Frison (1978: 75-77) mentions two other sites which are probably within the region, but details of location, description and significance are lacking: Green Mountain War Lodge may be the wickiup structure pictured on p. 75. On p. 76, Frison mentions a "protohistoric Shoshonean campsite along the shore of Seminoe Lake northeast of Rawlins, Wyoming." The John Gale Site, 48 CR 303, is an extensive campsite containing both Shoshoni and Crow materials. The Garret Allen Site (NR) is mentioned in a draft-planning document as a large stratified Late Archaic and Late Prehistoric campsite.

Duck Creek Wickiup Village (NR) in the Piceance area of Rio Blanco County is a cluster of structures with little associated cultural material. Date of occupation is unknown but presumed to be Protohistoric.

At this writing it is not clear when or precisely which historic American Indians were the region's inhabitants. Ethnographic and early Euro-American explorer's evidence is that the Utes occupied the southern area, while the Shoshoni utilized the northern portion. Ethnographically, the Utes and Shoshoni were friendly with each other and both are known to have followed seasonal rounds. It is quite likely that there was never an actual boundary between the groups and that the archaeological evidence will show a great deal of "mixing."

Prehistory and the Protohistoric period are considered ended when Euro-American trade goods appear in a site. This may or may not coincide with the beginning of documented history.

The history of the Green River/Hams Fork Region dates from 1776 when the Dominguez-Escalante Expedition of that year visited the White River area (Canyon Pintado) (NR) of Colorado. Fur traders arrived in the territory during the early 1800's. The Green River was a major trapping, and later, rendezvous point as was Brown's Park in far northwestern Colorado. Evidence of this era is represented by the remains of White-Indian Contact Site (NR) (Fort Davy Crockett nee Ft. Misery) and the

Upper Green River Rendezvous Site (NR) (Bridger-Fraeb Trading Post) on the Green.

As fur trading died out during the 1840's, the northwestern parts of Colorado were abandoned to the Ute Indians. Southern Wyoming became the major overland immigration route to Oregon and California. The Oregon Trail, the Overland Trail and various lesser routes were transcontinental transportation corridors that linked the west and east. Remnants of many of these trails can be seen today and The Oregon Trail is part of the National Historic Trail System (NR).

As the trails became established, the military developed a series of forts along this transcontinental pathway in order to protect it from Indians. The newly constructed overland telegraph and the developing Union Pacific Railroad were also protected by these forts. Fort Halleck (NR), Fort Fred Steele (NR) and others were important in maintaining travel and communications in Wyoming.

During 1879, the last great Indian uprising occurred in Colorado when Nathan Meeker was killed and the White River Indian Agency was overrun by agency Ute. The Meeker Massacre and subsequent Thornburgh Battle (Battle of Milk River (NR)) allowed the Utes to be removed from the Colorado and the region was opened to settlement.

Ten years earlier, the southern Wyoming corridor was modernized by the construction of the Transcontinental Railroad (Union Pacific--Ames Monument (NR)), which was, to that time, the largest construction project ever undertaken in the United States. Towns such as Cheyenne, Laramie, Rawlins, Rock Springs, Green River and Evanston evolved due to this new and far cheaper form of transportation. Northwestern Colorado came to depend upon the Union Pacific in Wyoming for its supplies. Wamsutter, Fort Fred Steele (NR), Rawlins and other settlements became supply centers for towns in Colorado such as Steamboat Springs, Hahn's Peak, Hayden, Craig, Lay, and Axial.

As inexpensive transportation became available, ranching and homesteading occurred. Along the Union Pacific, settlers bought land from the railroad, while in northwest Colorado, the Homestead Act of 1862 (among many others) was used to take up the land. Ranchers began to run cattle in the early 1870's, beginning in Brown's Park and until about 1890 the cattle industry (Two Bar Ranch (NR)) was the single most important economic factor in this region. Cattle were displaced by sheep in the early 1900's and until 1920 sheepmen and cattle barons fought each other for rangeland. Homesteaders in Colorado raised hay, alfalfa, and some dry land wheat at the turn of the century. Great Divide, northwest of Craig, represented the last attempt at agricultural colonization in the region.

At the same time ranching was occurring, mineral development took place. Coal was mined along the Union Pacific from the 1870's into the early 1900's. Towns such as Gibralter (NR) and Hallville (NR) represent this mining phase. Other forms of mineral extraction that took place included (placer) gold mining north of Steamboat Springs, Colorado, near Hahn's Peak and in North Park on Independence Mountain. South Pass City, Miner's Delight and Atlantic City constituted Wyoming's gold boom.

Copper mining occurred at Pearl, Colorado, around 1900 and in the Grand Encampment Mining Region (NR) of Wyoming. Oil and gas developed as early as 1890 close to Rangely, and during the 1920's major fields were brought in at Axial, Rawlins, Rock Springs, and Baggs, Wyoming. This has continued to be a a major source of mineral production in both states. Soda ash (trona) and uranium have also played a major role in mineral development in Wyoming from the 1940's onward.

By 1908 northwestern Colorado received its first railroad, the Denver, Northwestern & Pacific (*Marcia* and Steamboat Springs Depot (NR)) and became much less dependent upon Wyoming. Denver became the main supply center and southern Wyoming lost its status as northern Colorado's supplier. The two areas, since that time, have become somewhat separated and the connections between them are not as strong as they were historically.

This summary is based upon a history of the Craig District prepared in 1976 (Athearn), while the histories of the Rawlins District and the Rock Springs District were prepared in 1979 (Murray, 1976; 1979a; 1979b). These documents represent detailed, professional studies of this region and are available at the Bureau of Land Management in Colorado and Wyoming.

ARCHITECTURAL HISTORY

The predominate architecture in the region represents the development of agriculture and ranching. Most of the architectural sites are those that have survived a second level of settlement and development. There are very few original historic features left in the region. Those that do remain, have been modified over the years. Such items as log cabins, line shacks, barns, log houses, wooden lap board homes, and other historic agricultural sites are the predominate bulk of historical architecture in the area.

There are other features such as transportation-related structures and engineering facilities that are common in the region. Railway stations (Steamboat Springs Depot), bridges, (Whiskey Creek Trestle), and rights of way (Union Pacific, Denver and Salt Lake, etc.) all constitute a major portion of historic architecture. Stage stations in Wyoming also represent the transportation theme, as do trails. The architecture found in these stage stations is possibly the most original (and primitive) of historic architecture.

Towns in the region represent several developmental phases. The first phase is transitory in nature and, as such, most buildings and structures were wooden and prone to destruction. Most towns suffered major fires because of this and the second phase (rebuilding) represents more permanent structures. Fireproof materials such as brick (and later concrete) were used and at this point, those towns that were going to survive did. Architectural styles represented in the region's towns are from Victorian, Victorian Gothic, Queen Anne, Georgian Revival, and, most importantly, Prairie. The third phase of development is represented in 1930-1960 vintage structures (Commercial), usually rather dull concrete, concrete block, and brick structures. These were built as functional buildings and do not contain the distinct features found in Victorian and various other architectural styles of structures.

On the whole, most historic architecture in the region is confined to towns and settlements such as ranches and farms. This is consistent with historic settlement patterns and in this manner, the architecture of the area portrays its history through physical presence.

RECREATIONAL RESOURCES

RECREATION

URBAN

Urban recreation facilities available to the public within the vicinity of the proposed coal lease areas are deficient or are only meeting present demand. The region's population is in a "boom" situation. Various communities are developing new facilities, but rapid growth is expected to place a continued strain on their ability to provide additional needs for the short term. There is a definite need for facilities that can be utilized during the winter months (October to May). Existing facilities have been developed primarily for moderate weather activities, thus public indoor facilities would tend to alleviate some of the "cabin fever" generated by harsh winter climates.

Two of the most heavily impacted communities, Craig and Meeker, Colorado, have recently developed community recreation surveys to determine public needs for the present and future. Within the region, 21 communities have been assessed, all of which are anticipated to have a significant population growth in comparison to present size, over 10 percent by 1987. These communities rely upon picnic areas, tennis courts, municipal swimming pools, quasi-public golf courses, baseball fields, school-yard playgrounds, high school playing fields and fairgrounds as major urban public facilities for spring, summer and fall recreation activities. During the winter months school district gymnasiums are open for public use in the evenings for volleyball, basketball, indoor archery, and other associated activities. Various publications containing inventories of facilities within each community are available for review at the BLM Craig District Office.

Privately-owned facilities used by adults include bars, restaurants, theaters, bowling alleys and health clubs, which are generally provided as demand and economic feasibility dictate. School districts, social clubs, churches and community sponsored activities also play a role in providing adult recreation. There is generally a deficient number of winter facilities to accommodate both the adult and school age populations. The primary issue involved is not the lack of planning, but the availability of funds for development and maintenance of indoor facilities.

When including Rock Springs and Laramie in the study region, an estimated 35,500 population increase is anticipated by 1987. The majority of the increase will be in Rawlins, Laramie and Rock Springs, Wyoming and Craig, Meeker, Hayden and Steamboat Springs in Colorado, accounting for 33,300 of the total growth. This is a 24 percent growth over 1978 estimates and actually doubles the populations of Craig, Meeker and Steamboat Springs. New estimates (November, 1979) indicate Wamsutter, Wyoming as already doubling in size since 1978, and is anticipated to triple by 1987.

There may be an increased use of facilities beyond the impact of population growth. As the cost of personal transportation (fuel) continues to spiral upward, long and short trips outside the community become more prohibitive. Therefore, use of urban recreation facilities by community residents may double or triple present use, as a result of lost mobility.

There is complete concurrence among county and community planners that a deficit exists and will continue to be compounded if additional funding is not provided for development of new facilities.

Anticipated recreation facility cost estimates as a result of natural population growth are shown in table 4-24 in Section 4. Facility costs do not include communities' needs at present, only the additional funding necessary to accommodate increased population.

DISPERSED

Public lands within the study region account for 11,356,212 acres. Opportunities for almost all types of dispersed recreation are available. The most popular activities pursued are hunting, fishing, hiking, camping, horseback riding, water-oriented activities, picnicking, snowmobiling, and cross-country skiing.

Offroad vehicle use is generally a secondary form of recreation, a means of travel to reach a specific destination for hunting, fishing, camping, etc. The activity, as a primary use, is limited to very low numbers, usually small clubs or organizations utilizing trail bikes, snowmobiles and 4 x 4's. Executive Order 11644 and 11989 mandates the classification of all public lands for O.R.V. use as open, limited, or closed, by 1987, thus providing management for this particular activity.

Hunting of big game is perhaps the most intensive, shortest-use season in the study region. Hunting in Colorado and Wyoming are of national significance in terms of out-of-state use. In 1978, 30 to 40 percent of big game licenses sold by state game departments were purchased by non-resident hunters.

As long as the Division of Wildlife, Colorado, continues to have open license sales to non-residents, no decrease in big game hunting is anticipated. With the increased Colorado population and open license sales to non-resident hunters, the quality and success of big game hunting may decrease.

Wyoming license sales are presently limited in number to out-of-state participants, holding hunting pressure at a manageable number. Wyoming doubled all hunting and fishing license fees for the 1980 season. Non-resident demand for permits would be expected to drop. Increased revenues would provide for additional game management, the result being better management of game populations.

Camping is one of the most popular dispersed recreation activities in the region. The U.S. Forest Service, National Park Service, Bureau of Land Management, Colorado and Wyoming Parks and Recreation Departments, and Fish and Game Divisions provide both undeveloped and developed sites within the region.

The National Park Service recently reported an overall decrease in 1979 of 18.6 percent for visitation in the Rocky Mountain Region, with Wyoming being the most affected, a 22.1 percent decline. Routt National Forest office reported an overall decrease of two percent visitation and a 14 percent decreased use of camping and picnic facilities. White River National Forest office noted a 2 percent decrease in camping and a 11 percent drop of dispersed use, but winter sports increased substantially. Medicine Bow Office reported an overall increase in visitation of 1 percent, the smallest increase over the past five years. However, historically holiday weekends produce overcrowding of facilities and this situation is expected to continue.

Fishing has the highest participation of any dispersed recreation. Primary lakes used are Steamboat, Avery, Trappers, Ralph White, Rio Blanco, Vaughn, and Elkhead in Colorado; Seminoe and Pathfinder in the Wyoming region. Major rivers include North Platte River and Little Snake River in Wyoming; Yampa, Elk, Green and White Rivers are the most popular in the Colorado portion. Many smaller streams and lakes located in the Medicine Bow, Routt, and White River National Forests are popular for fishing. Major species available are rainbow, brown and brook trout; smallmouth and largemouth bass, channel catfish and other sunfish. Deterioration of fishing quality in the Yampa River as a result of increased nitrates and phosphates from sewage effluents is probable due to natural population growth.

The majority of other water-oriented recreation takes place in areas mentioned in the previous paragraphs. Those activities with the highest participation are boating, swimming, waterskiing and floatboating. The Yampa and Green Rivers in Dinosaur National Monument are nationally known for their floatboating opportunities. The North Platte is considered a popular floatboating river in Wyoming.

Horseback riding, hiking, and picnicking are also considered high participation activities in the region. The vast quantity of accessible public land allows for horseback riding and hiking in a wide array of topographic and vegetative environments. Picnicking is quite common on all public lands in undeveloped areas; however, developed picnic areas are available and are heavily used, primarily on U.S. Forest Service lands and Colorado Division of Recreation facilities.

Winter activities such as downhill skiing, cross-country skiing, snowmobiling, sledding and ice fishing are significant recreation activities from November through March in the region. The majority of these activities take place on public lands administered by the U.S. Forest Service. Winter sports accounted for 39 percent of all use on the three

National Forests in the region. With the exception of downhill skiing, there is a surplus of public land, primarily BLM, available for these activities.

Other recreation activities with low participation or as secondary activities are rock hounding, wildlife observation, arrowhead collecting, general sightseeing, and historical site visitation. For activity-day estimates from region residents, see table 4-26 in Section 4 under existing and No Action.

As the cost of personal transportation becomes more prohibitive, a further decrease of use in "open space" areas is likely. Other assumptions may also be made; duration of stay may become longer, frequency of visits may decrease, and trips may be limited to less distance.

A 24 percent increase in population in the region by 1987 will result in a decrease in the quality of the recreation experience without new Federal coal leasing.

VISUAL RESOURCES

The scenic quality of the study region is highly diverse in topography and vegetative communities. Public agencies have the responsibility to protect and manage visual resources on public land and even private surface when mineral rights are government owned and leased for extraction. A method of categorizing scenic values has been established to provide a means of implementing all types of man made intrusions on various landscapes. The following visual resource management (VRM) classifications have been applied to lands in an effort to protect and also allow various types of uses that correspond to scenic quality.

Class I - This class provides for natural ecological changes only. It is usually applied to wilderness areas, primitive areas and some natural areas.

Class II - Changes in any of the basic elements (form, line, color, or texture) caused by a management activity should not be evident in the characteristic landscape--used for forested areas, high quality scenic areas, river bottoms with dense riparian habitat, unique sand dunes, etc.

Class III - Changes in basic elements caused by management activity may be evident in the characteristic landscape; however, the changes should remain subordinate to visual strength of the existing character. Areas where major transportation routes bisect the landscape are usually Class III.

Class IV - Changes may subordinate the original composition and character, but must reflect what could be a natural occurrence within the characteristic landscape. Class IV usually offers little variety in visual character, and variations in topography and vegetation are very limited.

Class V - Change is needed. This class applies to areas where reclamation is needed. Good examples would be strip mines, intense oil and gas fields, and areas that have been severely overgrazed or overused.

REGION SCENIC QUALITY

Changes in elevation range from valley floors at about 6,000 feet above sea level to the highest point of 13,804 feet. This variation in elevation causes significant differences in climate, resulting in a wide range of vegetative and scenic landscape categories.

The high rock faces of outstanding alpine scenery with precipitous rugged slopes and numerous natural and beaver-built lakes and ponds provide for some of the most outstanding, awe inspiring visual experiencing landscape in the United States. The highest visual resource management (VRM) classifications are usually applied to this type landscape, Class I or II.

Forested areas are common in the region, providing high scenic quality and the opportunity of access for the general public. Aspen, spruce, douglas fir, and alpine fir are the most predominant evergreen species within this landscape type. An abundance of streams, beaver ponds, and grass meadows are present. The variety of color, line, form, and texture make these areas outstanding for scenic observation. VRM Class I, II, or III are most frequent in this category.

Mountain shrub communities lie below the evergreens, adding to vegetative variety. Predominant species are gambles oak, serviceberry, greasewood, saltbush, and choke cherry. These areas are generally very dense, and lie on steep to moderate slopes. Mountain shrub communities usually fall into VRM CLass III and IV. This type of landscape is not considered to be of outstanding scenic quality, however, it does provide a more varied topography and vegetative relief than that of the rolling sage covered hills.

Another landscape type which is scattered throughout the region is the pinyon-juniper communities, located on steep to moderate hills with washes and limited vegetation. The topography can make these areas very scenic, with rock outcrops, variation in color of soil, and deep ravines or washes. Class III and IV are the most common VRM classifications for pinyon-juniper areas.

Some of the badlands areas located along the Colorado-Wyoming border are considered high quality scenic landscape due to their rugged terrain, lack of vegetation, wide range of rock and soil coloration, vistas, and changing of appearance during different phases of natural lighting throughout the day. VRM Class I to IV may be applied to such areas.

The last and perhaps the most predominant landscape in the region is rolling sagebrush covered hills. This type of landscape is probably the least scenic in the region. VRM Class III and IV are the most common classifications of these areas.

Visual sensitivity deals with psychological visual exposure in terms of the number of individuals viewing an area and how they perceive a particular landscape. As an example, the roads through oil/gas and coal fields of the Danforth Hills are used primarily by individuals working as miners or oil and gas workers. They may perceive the oil and gas pump, or coal mines, as not being a major intrusion upon the landscape, since it's directly related to their livelihood. On the other hand, the white collar worker, non oil, gas, or coal oriented, may perceive this intrusion to be a major destruction of the environment. An estimated 70,000 acres is expected to be disturbed by coal, oil, gas and uranium not associated with new Federal coal leasing by 1995.

WILDERNESS VALUES

Existing designated wilderness areas within the region contain 322,642 acres of pristine managed environment. The largest of the three areas is the Flat Tops Wilderness, 235,230 acres. Mount Zirkel has 72,422 acres; both are located in Colorado. The Savage Run Wilderness area in Wyoming contains 14,940 acres. The Bureau of Land Management presently is considering eleven Wilderness Study Areas (WSA's) in the region, nine in Colorado and two in Wyoming. The following list provides the unit number, name and acreage.

Unit No.	WSA Name	Acreage
CO-1	Bull Canyon	12,290
CO-2	Willow Creek	14,008
CO-3	Skull Creek	13,740
CO-7A	Black Mountain	5,077
CO-7C	Windy Gulch	12,274
CO-46	Oil Spring Mountain	17,740
CO-208	W. Cold Springs Mtn.	17,682
CO-214	Diamond Breaks	36,580
CO-230	Cross Mountain	17,480
WY030304	Bennett Mountain	5,722
LWY030401	Adobe Town	25,000

Primary recreation activities on wilderness areas are camping, hiking, hunting, and fishing. Total estimated visitor days recorded by the U. S. Forest Service for 1979 on region wilderness areas was 152,200. Savage Run accounted for 2,100, Flat Tops 96,400, and the Mount Zirkel Wilderness Area 53,700 visitor days.

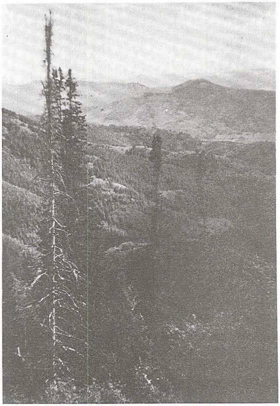
The natural growth of the region is expected to increase population dramatically over the next decade. As existing wilderness areas are expanded (Mount Zirkel) and new areas are designated, the impacts on existing wilderness areas as a result of increased demand will diminish. Other aspects also alleviate major impacts on wilderness areas, i.e., their expanse and prohibitive use restrictions.

VRM CLASS II & III

Class II - foreground. Scenic quality B but with high sensitivity because of proximity to road.

Class III - background. Scenic quality B but with low sensitivity

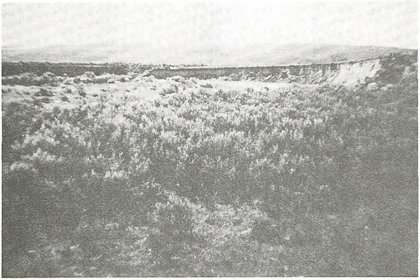
Photo: Wirth Associates 1979



VRM CLASS I

Scenic quality A. Potential wilderness area.

Photo: Wirth Associates 1979



VRM CLASS IV

Scenic quality C. Medium sensitivity, seldom seen.

Photo: Wirth Associates 1979

VRM CLASS V

Strip Mining Area

Photo: Bureau of Land Management 1975

SOCIOECONOMIC ENVIRONMENT

DEMOGRAPHY

The impacted area consists of Moffat, Rio Blanco, and Routt Counties in Colorado, Carbon County in Wyoming, and those portions of Albany and Sweetwater Counties adjacent to Carbon County. There are 16 incorporated communities in the impacted area, plus two unincorporated places. Table 3-21 shows the past, present, and future population picture of the impacted area by county and community.

The closely adjacent communities of Elmo and Hanna have been combined into a single community for purposes of analysis in this report, and the same has been done with Encampment and Riverside. Two small unincorporated places--Walcott Junction and Creston Junction--have been included among the impacted communities because of their location in sparsely settled areas fairly close to the tracts. The community of Sinclair has been excluded from this analysis because of its proximity to Rawlins and because of its restricted nature as a residence for workers at the refinery.

Table 3-22 shows population densities, natural increase, and migration by county. The entire impacted area is sparsely settled, with an overall 1978 population density of 3.0 persons per square mile, slightly below the 4.7 density of Wyoming and much below the 25.7 and 61.7 densities of Colorado and the United States, respectively.

Prior to the mid-1970's, the area's economy had depended mainly on the livestock industry and some mining and recreation developments. In line with the national decline in agricultural population, the impacted area was experiencing a net loss in population. Declines were widespread from 1960 to 1970, with the exception of some trade centers, resort areas, and towns near mineral developments. The principal exceptions were Craig, a trade center; Steamboat Springs, a ski resort; and Medicine Bow and Wamsutter, towns near uranium and oil developments.

The present steep growth trend that began about 1974 was a direct result of the previous year's petroleum shortage due to the Arab oil embargo. The area's reserves of energy minerals--coal, petroleum, uranium, and oil shale--became the scenes of large scale developments which have dramatically altered the area's population trend--from a six percent drop between 1960 and 1970 to a 71 percent increase between 1970 and 1978.

Coal has become most important around Meeker and the Routt County communities, except Steamboat Springs. Electric power derived from coal is important at Craig. Coal and uranium are both important in Carbon County. Petroleum is important around Wamsutter and Meeker, and oil shale exploration is also impacting Meeker.

Not surprisingly, considering the previous small labor base, the greater part of the recent growth consists of migration--people moving into the impacted area from other places. As can be seen in table 3-22, natural increase (the excess of births over deaths) comprised only 12 percent of the 1970 to 1978 population growth, leaving the remainder to be accounted for by net migration. Rates of migration have varied only slightly among the counties, ranging from 82 percent of the new population in Rio Blanco County to 91 percent in Carbon County, and all counties have shown major net in-migration.

Because of the impetus given by energy development, population in the area will continue to grow at a much more rapid rate than in the remainder of Colorado, and possibly Wyoming. Total population is expected to increase by 63 percent by 1990, which represents a 179 percent increase over the two decades from 1970 to 1990.

The distribution of growth among communities is expected to maintain the 1970 to 1978 pattern, with the exceptions of Hayden and the Wyoming communities where slower growth rates are projected. Anticipated total growth resulting under the No Action Alternative will vary from 11 percent in Yampa to 185 percent in Meeker. Meeker, Steamboat Springs, and Craig will experience the highest rates of increase and acquire the majority of the new people coming to the impacted area. Meeker's growth will result primarily from large scale energy development in its proximity--particularly oil shale in the Piceance Basin. Coal developments nearby, along with electric power production, will be primarily responsible for the increase in Craig's population. Growth in Steamboat Springs will differ from that of the other impacted area communities in being due mostly to skiing and other recreation-related development.

After 1987, the rate of future population growth becomes more difficult to foretell because little is known today of the energy projects and other developments that will stimulate it. It is entirely possible, even likely, that growth after 1987 will not slow as drastically as table 3-21 indicates, but the rate of growth beyond that time cannot be predicted in the absence of data on specific growth sources.

EMPLOYMENT AND INCOME

Table 3-23 shows labor force and employment totals and unemployment rates in 1973 and 1978 for the impacted area, each county, and the states of Colorado and Wyoming. Employment in the impacted area has increased by 63 percent over the five-year period from 1973 to 1978, from 16,625 to 27,118, representing an annual average growth rate of 10.3 percent. The area has outpaced both Colorado and Wyoming in rate of growth, although more narrowly in Wyoming than in Colorado. The most rapid growth has been recorded in Moffat and Routt Counties, with 95 percent and 71 percent respectively, while the least growth has occurred in Rio Blanco County (24 percent). Reasons for expansion of the economic base leading to these large employment increases are discussed under Demography.

Tables 3-24 and 3-25 show employment and income by major sector for the counties. Sectoral employment data has a couple of major problems--data withheld to preserve the confidentiality of large employers, and the estimation of nonreported and parttime employment. Total employment figures in table 3-24 differ from those in table 3-23 due to differences in methods of showing nonreported and parttime employment. The larger totals include the estimated components, while the smaller totals show just the reported wage and salary employment. Because of these differences in reporting procedures of different sources, it is impossible to compute total employment by sector. Also, employment and income figures for Wyoming are for Albany, Carbon, and Sweetwater counties combined. Because the projections were obtained from an economic model of that three-county region, figures for the individual counties were not available.

Income comparisons show the relative importance of the various economic sectors to the impacted area economy. Agriculture, which was previously one of the leading sectors, has declined to a much less important position. Mining has increased in importance, even assuming a dominant role in Rio Blanco and Carbon Counties.

Construction has fluctuated in importance as major projects have been undertaken and completed, but has remained significant in most of the counties. Trade and services are important sectors in those counties having local trade or recreation centers, notably Moffat and Routt counties. The large income proportions shown for government are mainly attributable to the education portion of local government. Mining and construction are relatively more important in the impacted area counties than in the state of Colorado, but roughly equal in importance in the state of Wyoming. The greater importance of the transportation, communication, and utilities sectors in most counties is due to large scale electric power generation and, in Wyoming especially, to railroad transportation. Manufacturing, trade, finance in general, and services are less significant in the impacted area, reflecting the absence of large commercial and industrial centers.

Table 3-26 shows average wages and salaries in the six counties and states of Colorado and Wyoming. In most types of employment, wages and salaries in the impacted area were about even with those in Colorado in 1973, but below those in Wyoming, and had fallen significantly behind both states by 1978. Mining wages and salaries exceeded the Colorado and Wyoming rates of growth in only one of the five counties for which a comparison can be made--Rio Blanco County. In only two of the six counties--Rio Blanco and Routt--did the rate of increase in average construction pay keep pace with Colorado and Wyoming. Rates of pay were significantly lower for workers in industries other than mining and construction. The location of numerous mining company headquarters and regional offices in the larger cities of Colorado and Wyoming, notably Denver, and the greater strength of construction unions in those cities, may account for the pay discrepancies shown in table 3-26 (Rubenstein, 1980). Wages in those sectors are presently rising more rapidly in some impacted area counties, and it is likely that local demand for mining and construction workers will bring pay rates up to or above the statewide averages. Wages and salaries in other industries will also increase as a result of the tight labor market, but will probably remain well behind those in mining and construction.

Unemployment rates (table 3-23) have increased slightly in half of the counties and in the total impacted area, but all have remained below the national average rates, which were 4.9 percent in 1973 and 6.0 percent in 1978 (Fischer, 1980). The labor markets in all impacted area counties are considered to be tight, and will probably remain so for at least the next several years. Employment and income are expectd to continue increasing at a rapid rate in most parts of the impacted area during the next 10 to 15 years. The expansion will result primarily from further mineral development, and the mining sector will continue to have the fastest growth. This will be especially true in the three Colorado counties, for reasons discussed under Demography. Less rapid growth is projected for the Wyoming counties because that area has a larger proportion of Federal land and will be more dependent on new Federal leasing and because development of Wyoming's oil shale deposits appears less likely. Other employment and income sectors will reflect the indirect effects of mining expansion and further recreation development. Agriculture is expected to continue declining, but at a slower rate. Construction activity will fluctuate but will remain important. The projected decline of construction shown for most counties merely signifies the completion of presently anticipated projects and does not include the likelihood that new ones will be started. In fact, the termination of major construction projects is the reason for the drop in employment and population shown for Rio Blanco County.

LOCAL FINANCES

The finances of three types of jurisdictions--counties, communities, and school districts--were analyzed for this study. Two types of budgets were examined--operating budgets and capital budgets. Operating budgets consist of the expenditures needed for day-to-day functions, and include such items as salaries, maintenance costs, office supplies, etc. Funds to pay for operating expenses are obtained primarily from local revenue sources such as property taxes, sales taxes, business licenses, etc., along with some monies from other government sources in the form of revenue sharing and similar transfers. Capital budgets consist of major expenditures required for new or expanded buildings, water and sewer system capacity, fire fighting equipment, etc., and are generally funded by means of bond issues or grants from Federal or state governments.

The ability of local jurisdictions to issue general obligation bonds is limited by state law. The maximum amount of general obligation bonds that a jurisdiction may have outstanding at any one time is usually based on a percentage of assessed valuation. Bonding capacities in the impacted area are determined as follows:

Colorado

Counties: 1 1/2 percent of assessed valuation
Communities: 3 percent of market valuation
School Districts: 20 percent of assessed valuation

Wyoming

Counties: 2 percent of assessed valuation
Communities: 4 percent of assessed valuation, plus an additional 4 percent for sewer bonds (8 percent assumed for this study)
School Districts: 10 percent of assessed valuation

Revenue bonds, which are repaid out of special revenue sources and not the general treasury, are exempt from these limits.

Table 3-27 shows 1978 operating revenues and bonding capacities for all jurisdictions that were included in the impacted area. Because it was not possible to project individual budget components (see explanation below), they are not displayed in table 3-27. It can be seen that counties and school districts generally have larger revenue sources and bonding capacities than communities because of mineral properties that lie outside city limits (counties) and larger mill levies and bonding limits (school districts).

Table 3-28 gives the information obtained on total bonded debt for each community and school district. County data was omitted because county expenditure requirements were not estimated (see notes to table 4-35). General obligation debt must be subtracted from the bonding capacities shown in table 3-27 to determine the jurisdiction's remaining bonding capability. Where this can be done, it reveals that most jurisdictions have been conservative in the use of bonded debt. Willingness to make do with present facilities, voter resistance to new bond issues, and the availability of revenue bonds and other funding sources are probably the main reasons for this situation. It leaves most jurisdictions in a better position to face the requirements of additional growth. In many cases, however, local financial resources will be inadequate to meet the level of growth that is anticipated.

Determination of the expected future fiscal positions of the jurisdictions requires projections of the four components discussed above--operating revenues, operating expenditures, bonding capacities, and capital requirements. For various reasons, a detailed projection was made of only one of these--capital requirements. Crucial data was not available for projections of operating revenues and bonding capacities (see Section 4, Socioeconomic Environment, Fiscal Impacts). As a result, projections of operating expenditures would not be useful. Capital requirements, probably the most serious fiscal problem facing impacted jurisdictions, were projected based on the anticipated deficiencies discussed under Community Facilities in this section. Determination of the capital requirements is described in Appendix D. In order to provide an admittedly rough indication of the capital capabilities likely to be available to meet these requirements, bonding capacities of the jurisdictions were projected on a per capita basis. These figures are shown in tables 4-33 and 4-35 as the No Action alternative.

The potential seriousness of the fiscal situation facing communities in the impacted area is clearly revealed in tables 4-33 and 4-35. Only half of the 18 communities would have a bonding capacity sufficient to finance their expected capital requirements. The rest are likely to encounter deficits of up to three times their local resources (for some small communities the ratio is even higher). Two factors--mismatches and front end funding--will be the primary causes of the potential deficits. Mismatches refer to the fact that the expected mining developments will be located outside city limits and will not contribute to the community tax bases, whereas population growth and its attendant capital requirements will mostly occur in the communities. Because revenue sharing arrangements between counties and communities are insufficient in many areas, particularly in Colorado, it will probably be difficult to alleviate these mismatches. Front end funding means that required facilities must be funded and constructed before population growth is sufficient to provide the added tax base.

Various types of assistance that are available to help impacted communities with these fiscal problems are discussed in Section 4, Socioeconomic Environment, Uncommitted Mitigation. However, none of these sources are automatically available, and all require that the community compete with similarly impacted communities for scarce grant funds.

School districts, in general, will probably be less seriously affected by the problems described above, both because their taxing districts will include the new mines and because of their more generous bonding limits. However, front end funding needs may become a problem in some cases.

EXISTING ATTITUDES AND VALUES

The EIS study region has throughout its history been both rural and isolated. The towns have been rural trade centers rather unlike their counterparts elsewhere. The prevailing value system is founded on that of the tenacious cattle and sheep ranchers and dry-land farmers of the early 20th century. These families were forced by circumstances to be highly independent and self-sufficient, with informal mutual aid among neighbors. The conditions produced individualism and conservatism.

Conservatism, as Peter Mariss points out (Bates, p. 76) is a "universal principle in human psychology to defend the predictability of life, to survive under any new situation with sufficient continuity to assimilate reality and the meaning of events to existing structures." Rural isolated regions may be less able to adjust to rapid change because their experiential base for "defending the predictability of life" is narrow. Any change is destructive to predictability, and rapid change may be disastrous.

Three conservative value elements are of particular importance to the present:

(1) The strong orientation to male dominance, which results in many negative impacts of energy boom development upon women (Moen, et al., pp. 45-46). These negative impacts include boredom, loss of career pursuits, depression, loss of self-esteem, etc. (p. 47).

(2) An anti-Federal government bias (Margolis, 1977; Moen, et al., 1979; Athearn, 1977) which shows itself as a belief in the "right" of an owner to "control" his land. The Federal government is seen as inefficient and indifferent. Some citizens feel powerless to influence events; others struggle to maintain control over their own destinies.

(3) The value of "neighborliness"--the informal but by necessity dependable structure of trust and helpfulness among people who need each other for mutual survival.

The images of independence and mutual neighborliness strongly affect the ability of oldtimers to accept and adjust smoothly to the shocks of the inevitable transition away from *Gemeinschaft* relational patterns and toward a more formal and impersonal social structure. The townspeople of the study region generally share the same values as the rural dwellers, and until the energy boom began, change and growth were gradual enough for predictability-of-life adjustments to be made comfortably.

The present affected social environment occurs at two levels with quite different sociological baseline ramifications. First, there are those usually small communities such as Walcott Junction or Yampa which have not yet felt much impact. Then there are those other towns, such as Rawlins and Craig, which are already in the process of making boom growth adjustments, and for whom impact from new leasing will continue changes already begun.

Rural America has traditionally encouraged industry (Albrecht, p. 5; Margolis p. 6-5, 6-13). But there are dilemmas. Oldtimers acknowledge the shortcomings of their towns--lack of amenities, limited shopping facilities--but they also regret the loss of small-town informality. The "solution" to the first problem creates the second. Recent studies indicate that towns in this region favor growth, but not at any cost. The people of the region are willing to "do what is right" (Gold, pp. 16-17) for the country, but do not feel they should have to make great sacrifices. Thus, the desire for growth, and the recognition of the priority of national needs, are tempered by resistance to an "unfair" demand for local sacrifices.

Moffat County has about 29 percent interstitial rural population remaining; Rio Blanco County, 21 percent; Routt County, 35 percent. Energy development in this study region has had at least two effects upon these. As is true for the lower-paying jobs in the towns, it has drained off an unknown number of farm laborers who go into construction or mining at higher wages, leaving a labor shortage detrimental to the agricultural community. On the other hand, for many marginal farm families the primary source of income comes from energy related employment which enables these families to maintain a life style not otherwise possible. In these instances, wives and children often take over most or all of the farm work. One farm wife near Craig estimated that about 90 percent of the farm husbands in the area had second jobs (Moen, et al., p. 93).

The combining of farm and energy employment has considerable impact upon the values and social relationships of the rural population. The standard of living is generally higher; when a person enters the "employee society" he necessarily begins developing new perspectives on such social issues as labor unions; he tends to become loyal to the very energy company he might once have condemned; he has to adjust to a time clock and the subordination of his own independence; he builds a new set of friends with dissimilar backgrounds to his own; and his family likewise must adjust to new roles and old-role redefinitions. Thus, the rural cornerstone of the whole regional value system is shaken and the impact is felt also in the towns. We lack data for evaluating the precise nature and degree of the shifts.

OLDTIMERS AND NEWCOMERS

Three principal factors affect the ability of the social institutions of communities to be effective, and of individual citizens to make ongoing social-psychological adjustments:

(1) Rate of population growth, especially in interaction with (2) and (3).

(2) Degree of cultural similarity between oldtimers and newcomers, actual and/or perceived.

(3) Actual and/or perceived differences in social power between oldtimers and newcomers.

Population growth rates will be discussed in Section 4. With respect to cultural similarities, if newcomers are too different, or if they are similar but are incorrectly perceived as different, stereotypes tend to develop leading to intergroup conflict and social-structural weakening. Perceived differences, real or not, weaken the "predictability of life," often bringing about avoidance behavior as a defense, and the greater the perceived differences, the more strongly negative the initial impacts will be.

In this EIS region, the newcomers are virtually all from the same race, geographic region (Colorado or adjoining states), and religious heritage, and hold many of the same conservative values as the oldtimers. Yet there is severely negative stereotyping especially of construction workers by oldtimers. Moen, et al., describe the phenomenon in detail (pp. 60 ff.). Construction workers both have and cause the biggest social problems because of their migratory life style and residency in one boom town after another during the "peak of activity and low point of availability of...services..." (p. 60). They get blamed for any troubles that develop. In Craig the stereotype was that the men are rootless migrants by choice, don't care about their children, are drunken, rowdy, barflies; the women are lazy, aloof, and unwomanly; the children are rough. This stereotype is seen in other boom towns (Moen, et al., p. 62, describe the "Gillette Syndrome" of delinquency, depression, divorce, and drunkenness).

These researchers found, however (p. 63), that the Shadow Mountain Trailer Park, at that time occupied largely by construction workers, contained a cross-section of people very similar to those in any other community. The residents in their turn resented "being judged by people who don't know them." Some of them had arrived with already-existing negative feelings from having experienced similar problems in other communities. The construction workers were thus producing some stereotypes of their own.

The third factor affecting social-structural and social-psychological adjustments (actual and/or perceived power differences between oldtimers and newcomers) interacts with the other two, causing magnification of some negative elements. Stereotypes are exaggerated if relative power is seen as threatening. The newcomers are not just newcomers: they are symbols of the power of the Federal government and the big energy companies. There is an apparent displacement onto the newcomers which magnifies cultural differences and masks commonalities. Negative stereotyping provides psychological comfort and justification for social rejection.

The construction phase of energy development makes the first and usually the most drastic impact upon communities. It is therefore important to understand the characteristics of construction workers. The nature and degree of transiency are of great significance to social impacts, but are hard to evaluate without adequate data. A construction electrician in Craig told of working on a 10-man crew which over a six-month period employed about 80 men. He explained that many of them (especially the single ones) continually moved to where there was overtime. He himself was leaving after 1 1/2 years on the job. Another construction employee (an executive) had been in Craig since 1974 and reported still facing distrust by oldtimers for being a construction "transient."

A study of Sweetwater County, Wyoming (Gilmore and Duff, 1974) found that for some construction companies there were annual turnover rates from 35 to more than 100 percent. There was also a serious labor turnover problem in the mining operations.

One study (Mountain West Research, Inc. 1975) collected data on 3,168 workers on 14 major construction sites in the western states (including Craig and Hayden power plants), and on 1,432 households in two pre-impact, five presently impacted, and two post-impact communities. Some of the findings from this study can probably be considered reasonably valid for our region:

(1) For the 14 projects, approximately 40 percent of all construction workers were from the closest local community (Craig 42 percent; Hayden 32 percent). Thus, nearly half are culturally exactly the same as the "oldtimers."

(2) Of the 60 percent non-local workers, almost all were from nearby cities and/or states, so were quite similar culturally to the locals.

(3) Approximately 25 percent of the workers (Craig 27 percent; Hayden 23 percent) were single; of the 75 percent married, approximately two thirds had their families with them. Of those with families present, there was an average of 79 children per 100 workers (Craig, 57; Hayden, 64). Thus, counting spouses and children, approximately 228 persons were added to local populations for every 100 non-local workers.

(4) Table 3-29, on education levels, clearly distinguishes among oldtimers, construction newcomers, and other newcomers. For all groups, education is higher than for the respective states and the U. S. The oldtimers, while less likely than newcomers to have completed high school, are still far ahead of the national level. Other newcomer families were significantly more likely to have higher education. These differences in education may account for some intra-community conflicts, since better educated persons generally have more sophisticated interests, make more "urban" type demands on community social structures, and are more likely to participate actively in local affairs. The other newcomers may also take leadership positions as they become more involved in the social structure. For construction workers, and particularly for their wives, more education may mean more frustration. Moen, et al., discuss these problems (Ch. 4).

(5) There are some startling differences in the age structure of heads of household between long-term residents and newcomers, between construction and other newcomers, and between all newcomers and the national age structure of household heads:

Age category	Long-time residents	Construction	Other	U.S.
14-24	7.0	24.0	19.6	8.4
25-34	23.7	40.6	52.6	20.5
35-44	23.1	15.9	16.7	16.8
45-64	29.9	18.9	10.1	34.5
65 +	16.3	.8	1.0	19.9

The oldtimers much more closely resemble the U. S. age structure; construction workers have a higher proportion in the youngest category, but are more evenly spread across the entire age distribution, with almost 19 percent in the oldest working-age category (45 to 64). Neither of the two newcomer groups closely resembles the general population. Obviously the older folk do not tend to migrate to energy boom towns. A comparison of these impacted communities with the Colorado portion of our study region confirms that extrapolation from the *Construction Worker Profile* study to our own region is probably valid. Figure 3-3 shows comparative population pyramids. The Colorado data are for the entire county populations rather than just for heads of households, and in spite of the fact that some household heads are female, the *Construction Worker Profile* graphs may be thought of as roughly comparable to the male (left) halves of the Colorado population pyramids, less the children. For Moffat and Routt counties the preponderance of males in the prime working years (25-44) is quite similar to the Construction Worker Profile. These two counties were being impacted in

1977; Rio Blanco County was less so, and it more nearly resembles the U. S. and state of Colorado.

The sociological implications of a high proportion of young adults rest upon the need for specific types of housing (singles, families with young children), recreation (for women, for children, for singles, and in these counties, winter indoor facilities), and certain social services.

The above analyses show that the stereotype of construction workers is far from accurate; the newcomers are not homogeneous; and the social competence (as implied by education) of newcomers is higher than for oldtimers. The conflicts between oldtimers and newcomers are thus due more to perceived than to real differences. But newcomers cannot immediately fit into the "shared history," so tend to be barred from participation in the existing social support system; and when oldtimers experience a loss of social support systems, many community and individual problems develop, including hostility and conflict.

HOUSING AND ITS IMPLICATIONS

Of all the purely physical conditions affecting the structuring of human relationships and the psychological well-being of individuals, housing is undoubtedly of the greatest significance. The construction influx will at least temporarily stretch the physical facilities' fiscal structure, and the existing informal social structures. But as the *EPA Action Handbook* states (p. 6), a community

should not provide permanent housing beyond the amount needed for the later operations workers.

To some extent construction-worker housing may be carried over to become housing for operations personnel. But not entirely: transients in general do not buy or build permanent dwellings; young single males in particular need housing different in form from family groups. As long as housing is in short supply and the turnover is great, incoming persons are forced to occupy transient housing. In combination with price inflation, these problems will impose a "transient syndrome" upon both the community and individual families. Very low housing vacancy rates and high costs of homes in this study region confirm that this problem exists.

Apart from the economics, housing is an important indicator of sociological impacts, and in particular the transient syndrome has serious implications for women and children. Moen, et al., state (p. 11), "It is important to study the effects of energy development on women because it is precisely the functions of social integration and stabilization that traditionally have been women's work." For the children there is restricted play space, often a lack of privacy within the family, and a lack of opportunity to form the peer relationships so important to adequate social and personality development. For the women there is frequently a lack of opportunities for social participation, combined with feelings of rejection by the community, and a lack of facilities even to practice the "womanly" pursuits of ordinary home-making (Moen, et al, p. 78). Such a narrowing of life's social space for women and children inevitably results in family tensions or personal bleakness and depression for many, which may translate to school discipline and achievement problems, mental health and divorce statistics, etc.

We analyze housing in some detail in figure 3-4, which shows the types, ages, and condition of housing in the counties and towns of Colorado and Wyoming included in this study area. Part 1 of the figure shows the percentages of single family, multi-family, and mobile homes for Colorado (1977) and Wyoming (1978) counties. Multi-family dwellings (apartments) may be lived in by either permanent or temporary persons or families, but they do indicate investor confidence that growth is permanent because of the sizeable financial investment involved.

Moffat County, Colorado, and Sweetwater County, Wyoming (which contains Rock Springs), show by far the highest proportions of mobile homes; these counties have been most heavily hit to date by the regional energy boom. Routt County reflects primarily a tourist boom. By contrast, Rio Blanco and Carbon counties show a much more stable housing (and thus social) condition, with 74 percent and 65 percent, respectively, single-family dwellings.

Figure 3-4, part 2, shows the percentages of mobile homes by community. Craig has almost double the proportion of Rawlins and well over twice that of Steamboat Springs. In Craig there has also been, for some time, an unknown and generally uncounted but significant number, possibly several hundreds, of people living in RV type trailers in the campground just east of Craig; there have also been cases of families camping alongside the highway near Craig for lack of better arrangements (Moen, et al., p. 76). Among the smaller communities of the EIS area, it is clear from part 2 of figure 3-4 that there are a number of instances of "mobile home overload." However, the implications for smaller communities are probably somewhat different from those of larger towns. If there are only, say, a hundred families in an entire village, even if a large proportion of them are in mobile homes and perhaps transient to some extent, it is likely that most of the people will know each other. The children will interact over the entire community; the women will not remain strangers, even if they do not become friends. Informal networks, rather than formal organizational structures, tend to be the rule. Under these circumstances type of housing may be of little importance to the structuring of relationships or to the well-being of individuals.

Somewhere between the very small villages and the larger towns, it must occur that a size threshold is reached beyond which a purely informal framework cannot accommodate more persons. Where this tipping point is, we cannot at present say, and no doubt it will vary according to other factors. As a rough commonsense guess we might say 250 families would be about as large as could interact as a single whole with only informal social arrangements and controls upon behavior, and without the "social class" symbolism of housing types as a barrier to interaction. Thus we would expect that Hayden or Hanna or Meeker or Saratoga would represent transitional cases.

Part 3 of Figure 3-4 shows the trends to be expected in energy boom growth--a steadily increasing proportion of mobile homes and a steadily declining proportion of single-family dwellings.

Part 4 of the figure shows proportions of sub-standard housing where data were obtained. Carbon and Moffat counties show worst conditions. From the fact that only a handful of Moffat County citizens (about 3 percent, much less than the state figure of about 7.6 percent in 1978) received public assistance, it seems clear that many families other than campground dwellers are having to live in substandard housing for other reasons than poverty.

Figure 3-4, part 5, shows the housing consequences of prior growth spurts in the EIS area. Moffat and Routt counties show boom growth in the 1970's, but with different patterns. Moffat County grew much more rapidly during the 30 years prior to 1970, whereas Routt County's ski-tourist boom has occurred since 1970. In both cases, more than 25 percent of the housing is over 35 years old. Rio Blanco is the exception, with a slow, steady growth from about 1940 and no "boom" growth in the 1970's. Carbon County grew somewhat faster earlier with moderate recent boom growth due to energy development; Albany County's growth was greater than the others in the 1940 to 1970 period, whereas Sweetwater County has had very rapid growth since 1970.

These housing facts clearly indicate that boom conditions already exist in Moffat, Routt, Carbon and Sweetwater counties. Thus social disintegration, the breakdown of traditional support systems, norms, facilities, etc., is already taking place to some extent in much of the region.

EDUCATION AND MEDICAL FACILITIES

Two types of community facilities are generally considered more important to social well-being than others: health and education. Significant indicators of these are summarized in tables 3-30 and 3-31.

In general a low teacher/student ratio implies a better classroom situation, with more individual attention for each child and a less hectic work load for teachers. Table 3-30 shows that the teacher/student ratios for Colorado communities declined from 1970 to 75 but from 1975 to 78, Craig's ratio rose while other schools continued to decline. This again reflects that Craig has felt more boom impact. The city has worked hard to keep up with demands. The Wyoming school districts show 1978 ratios comparable to northwest Colorado. Thus by this indicator, the communities under study maintain favorable education conditions.

Medical facilities are not--and probably cannot become--excellent, given the sparse population, remoteness of smaller communities, and the propensity of doctors to cling to less isolated, more prestigious locations. Table 3-31 shows three salient facts:

(1) The doctor/population ratio is at least twice as favorable for Craig (Moffat County) and Steamboat Springs (Routt County) as for Meeker and Rawlins (Rio Blanco and Carbon counties).

(2) In Meeker and Rawlins, however, the ratio of nurses is much higher, implying a substitution of nurses for doctors to at least some extent.

(3) There is a total lack of medical services in most of the smaller communities. Medical emergencies become crucial when there is no hospital, no doctor, and no adequate ambulance service.

One social consequence of this lack is that families concerned with medical problems may be drawn to the larger communities, thus affecting the population growth patterns.

A CASE HISTORY OF ENERGY BOOM SOCIAL IMPACT PROCESSES

Energy booms can be distinguished (Cortese and Jones, p. 2) from other past booms in the region in several ways:

(1) The rapidity and scale of population growth.

(2) Their pervasiveness--many communities being simultaneously affected.

(3) Energy towns are not being created new but are established communities being impacted upon. The communities of Creston Junction and Walcott Junction may be exceptions to this.

(4) A single large energy operation may affect many nearby communities.

(5) A very important difference: "...The projects which create (energy booms) are being monitored by a wiser, more skeptical, more environmentally conscious citizenry."

(6) The construction phase involves larger numbers of workers than does the operations phase, so there tends to be a "bust" built into the boom.

It must be emphasized that the social-structural *change processes themselves* (and not just the attitudes, structures, etc., which produce the processes and which the processes produce) are an integral part of the social environment.

The only community for which we have even marginally adequate data for analysis of these processes is Craig. Since it is expected to experience great further impacts, and because it seems representative, we analyze it further here. We should note parenthetically that Craig has recently been abused by the news media as a "horrible example" of boom growth problems. It is not our intention to add to that misleading and distorted stereotype. The citizens of Craig have gone far in coping with its growth problems and have been successful in many ways.

Our discussion will focus on several of the growth processes (and individual role changes associated with these) described by Cortese and Jones (pp. 4 ff).

(1)The local government is having to expand in two ways: it is having to do more of some things it has been doing (providing more water and sewage, paving more streets), and it is having to do new things it never had to do before (formalizing procedures and positions, writing grant applications, etc.). This means role changes--adding new duties to some positions, creating new positions, adding more highly trained specialists, etc. And it means new, more formalized, interaction between citizens and government.

(2) The economy is becoming much more complex and problematic. Larger numbers and a greater variety of jobs are available, so opportunities are broadened. More businesses are being established, often very different from the traditional ones (fast food, chain stores, specialty shops), using more aggressive, trained salespersons. Some of the older, slower-paced businesses have modernized; others, unable to change to meet the new competition, are fading. Inflation has given some oldtimers substantial wealth, and greatly deprived others on low and/or fixed incomes.

(3) A number of problems have arisen in the schools. According to Mr. Ray Merrick, Assistant Superintendent of Schools (personal conversation), between 1973 and the 1979-80 school year, school enrollment increased roughly 200 per year in Craig, an approximate 100 percent increase in six years, primarily due to power plant and other energy development, and the increase is expected to continue for several more years at least. Equally problematic socially is the student turnover rate. While average enrollment has increased by 200 per year, the actual number of students enrolled during each year has been about one third greater than the total average enrollment. Thus, 900 additional students would have entered during the year and 700 students would have left. In many instances, these have been the same students, with some remaining in the system no more than a few weeks. About another third of the Craig students move in and out sometime during their school careers. Furthermore, there are problems associated with teaching salaries that are low relative to other occupations in the area and the difficulty in providing suitable housing for teachers. These social-structural factors add up logically to social adjustment problems and poorer educational achievement for children (especially when combined with the transient syndrome in living arrangements), and higher frustration levels and lower job satisfaction for teachers. Predictably,

we find that discipline problems have risen considerably more rapidly than either the local enrollment increase or the general national trends would imply. There is also a high teacher turnover rate in Craig.

(4) The churches have been affected in several ways. In general population growth leads to expansion of both numbers of churches and their denominations, and to increases in membership and expansion of facilities and services (often toward "social services" such as counseling, and recreation) of existing churches (Cortese and Jones, p. 7). In Craig these changes are occurring. That all changes are not positive is shown by Moen, et al. (p. 151-2), who describe the splitting apart of one congregation over the issue of welcoming transients whom some saw as destructive to Christianity as they defined it.

(5) Problems in recreation have grown. Outdoor recreation in our study area (hunting, fishing, etc.) is heavily male-oriented and best pursued during daylight hours and on weekends. The shortage of evening indoor recreational facilities for families and for singles (especially men), of daytime activities for women, and after-school activities for children and youth, has become acute. These inadequacies are exacerbated by long cold winters, crowded housing conditions, and transiency. Local bars tend to become overcrowded centers of hostility and violence.

(6) New problems of family life, individual stress, and social control have greatly changed the social structures dealing with these; in all cases the changes are from informal to formal structures, with attendant expansion and formalization of social roles from "neighborly helpfulness" to professional competency.

Some social support systems have been disrupted (e.g., clubs for men and women, intra-church sodalities) by intrusions of newcomers, requiring considerable adjustments. There has been a great increase in the indicators of community and personal breakdown: divorce, mental health, child abuse, crime, and community structures for handling these have changed and grown drastically.

Divorce rates have jumped. Figures for Moffat, Routt, and Rio Blanco counties show that Moffat County, which had only an 18 percent increase in the four years between 1971 and 1974, tripled its number of divorces in the next four years, a considerably higher rate of increase than population growth would imply, and much higher than either of the other two counties. For Moffat county, the 1978 figure represents a divorce rate of 11.2 per thousand population. During the same year the marriage rate was 12.5 per thousand population. Comparable rates for Routt were 8.5 and 15.5; for Rio Blanco, 7.3 and 14.1. Thus Moffat County shows considerably greater family deterioration. Such increases in the divorce rates imply, of course, there are also increases in tensions in other families.

Another pertinent indicator of family deterioration is the rise in child abuse. Child abuse rates have grown over the country generally in recent years, at least partly because child abuse is being better reported. Moffat County again, however, shows abnormally high increases in known or suspected child abuse. While the rates for child abuse in Rio Blanco County almost quadruples between 1975 and 1978 (2 to 7 cases) and in Routt County does quadruple (4 to 16 cases) in the four year period, again Moffat County indicates a worse situation, with an increase of more than five times (9 to 46 cases), far more than sheer population increase would warrant.

Divorce and child abuse statistics measure both individual and social structural deterioration levels, since both the lives of individuals and the socially very important institution of the family are at stake. When families are under conditions of stress, crowding, and social isolation, the usual family functions of child socialization and control may be less effective, so that problems of youth become formal community problems in the form of "delinquency," with a consequent higher psychological cost for the child (and his/her family) and a higher social cost for the community. What was once "Boys will be boys!" is no longer an excuse.

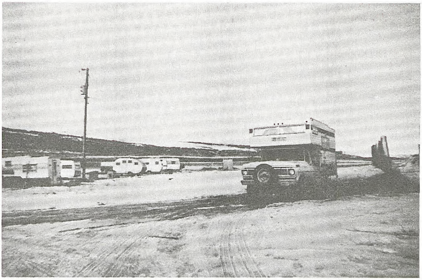
The same process holds for the case of adult deviance. In Craig, for instance, there was no mental health center at all in 1972. In 1973 a counselor came to Craig from Steamboat Springs on a part-time "visiting" basis. By 1979 there were 5 full-time mental health counselors plus the part-time services of two psychiatrists in Craig. From the first, the services have always been overloaded, and so the "rise" in the number of clients is certainly a function of the improvement of services as well as the rise in actual need. However, Dr. McKeown, executive Director of Colorado West Regional Mental Health Center in Glenwood Springs (personal conversation), reports that the number of persons in need of mental health counseling has also grown substantially, and is composed largely of children and women in depressive states. Thus there has arisen a formal mechanism to fill the growing need for "counseling."

Nor is the rise in mental health problems unique to Craig. Rock Springs, Wyoming, for instance, doubled its population (18,391 to 36,900) between 1970 and 1974. During this time the mental health caseload increased 9 times (Freudenberg, p. 11). Mental health problems affect both oldtimers and newcomers, for different reasons (McKeown and Lantz, p.2). Substantial change of any kind (even positive) produces stress (Freudenberg, p. 14). Oldtimers may experience a "breakdown" due to changes which "overwhelm the coping abilities" (Weisz, p. 32); newcomers experience isolation, a sense of rejection, lack of individual space, limits on meaningful communication.

Probably our best example of the shift from informal to formal social control structures is the Craig Police Department. Prior to November 1, 1975, there was no police department at all in Craig. Police matters were taken care of by an arrangement between the Moffat County Sheriff's Office and the Craig city fathers. But by February 7, 1980, according to a source in the department, there were 12 officers, two detectives, two animal control officers, two secretaries, and five dispatchers in a police department less than five years old. However, while the need for a police department was due to a rise in crime in the town, at least a substantial factor in the crime "increase" rests upon the fact that more personnel became available to act upon complaints and to keep records. In any case, the community's informal control devices, whatever they might have been, have given way to the formal system typical of growing towns. Of course we cannot dismiss the crime increase as only an improvement in police facilities and reporting. Figures released by the Craig Department of Public Safety (The Daily Press, February 4, 1980) show that in one year (1978 to 1979) crime jumped almost 30 percent. It is highly unlikely that this figure, in the fourth year of police department existence, is greatly distorted by improvement in facilities or reporting.

To summarize, structural and role changes in Craig have brought about cultural shifts (Cortese and Jones, p. 10 ff) such as increased diversity, less provincialism, growing professionalism and respect for expertise, more specialization, bureaucratization (formalization) of community structures, greater emphasis on profit, greater reliance on social institutions instead of on informal relationships.

There is a direct and obvious relationship between the individual and community levels of "breakdown" due to boom town growth, in Craig and elsewhere. The problems of individuals can be viewed as either individual pathology (in which case we "blame" the individual or his genes), or as manifestations of social disorganization (in which case we "blame" the society/community). But the problems of boom growth cannot be viewed as simply the sum of individual problems, for community-level breakdowns are neither the result nor the fault of individual limitations. Nor are all individual problems due to lack of community amenities, facilities, or group supports. These have interacted with each other and result in a more cosmopolitan value system, gained at the expense of the psychological comfort of many individuals (but "liberating" to others), and the loss forever of the isolated little "western cowtown" which was once Craig. The process is an integral part of the existing social environment.



HOME

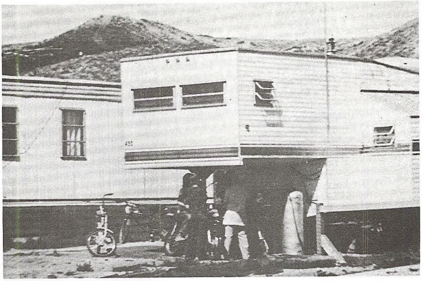
Camper truck used as a permanent dwelling near Craig, Colorado. This one was parked by the side of the road for lack of a regular campsite or hookups.

Photo: Dan Martin 1976

BACHELOR QUARTERS

Dining area at rooming facility provided for construction workers.

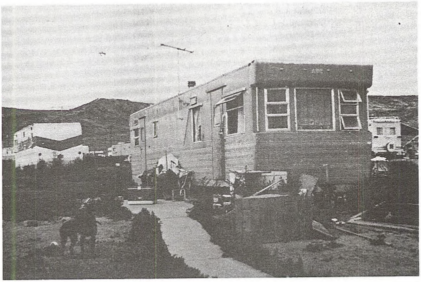
Photo: Tom Moen, Boulder , Colorado 1978



FAMILY HOUSING NEAR CRAIG, COLORADO

Large travel trailers typical of family housing near energy development areas.

Photo: Tom Moen, Boulder, Colorado 1978



FAMILY HOUSING AREA

Trailer camp consisting of travel trailers and recreational vehicles used as permanent homes.

Photo: Tom Moen, Boulder, Colorado 1978

TRANSPORTATION

Major transportation corridors in the area are U. S. 40 and the Denver and Rio Grande Western (D&RGW) railroad in Colorado and I-80 and the Union Pacific (UP) railroad in Wyoming. Map 3-5 shows all of the major roads in the study area. It also shows these roads broken out by road segment (A, B, C, etc.).

Table 3-32 and 3-35 show the trended traffic projections, in Average Daily Traffic (ADT), for both the Colorado and Wyoming roads by road segment. These tables also show volume to capacity coefficients. If the coefficient exceeds 1.00 a lowering of the service level will occur, indicating an impact on that road segment. As will be shown in this section, the transportation systems will be adequate to meet projected demands for the next twenty years.

The capacity figure is for level of service "C" which means traffic is able to average 50 miles per hour. The Peak Hour Traffic (PHT) is the highest traffic hour that can be expected for the year and corresponds to another designation used by both highway departments.

Table 3-32 indicates that road segment B and C (U. S. 40 between Craig and Steamboat Springs) will be at capacity by 1995. Most of the other road segments in Wyoming and Colorado will be at less than 50 percent of capacity during peak traffic hours.

Tables 3-33 through 3-34 show the projected number of traffic accidents per year for each of the road segments. The accident rate is based on the number of accidents which occur per million miles driven. The number of accidents for each year is determined by the following formula: Segment Length X ADT X Accident Rate X 365 divided by 1,000,000. The accident rates used in the document are assumed to remain relatively constant over time.

The D&RGW railroad runs between Craig and Denver. The line between Craig and Bond currently has four trains per day, while the line between Bond and Denver has 17 trains per day. Projected daily train traffic for the line between Craig and Bond is: 1987 - 30 trains, 1990 - 31 trains, 1995 - 33 trains. The nominal capacity of the line is 48 trains per day (computed by D&RGW).

The UP railroad runs east and west across the southern part of Wyoming. The line is a double-tracked mainline with an automatic block signalling system (ABS). Presently it carries 48 trains per day and is projected to carry the following traffic: 1987 - 69 trains per day, 1990 - 73 trains per day, 1995 - 79 trains per day. The capacity of the line is presently 80 trains per day, however, upgrades of the line are presently taking place.

Table 3-36 lists the major at-grade crossings in Colorado that occur on the D&RGW line from Craig to Denver. The exposure factor, which is listed on the table, is determined by multiplying the number of trains by the number of cars utilizing the particular crossing per day. Federal Highway Administration (FHWA) standards call for grade separation for crossings which have an exposure factor of 35,000 or greater for rural crossings and 75,000 or greater for urban crossings. As can be seen by the table, all but three of the at-grade crossings will need to be grade separated by 1990. The hazard rating is the number of accidents expected to happen at the grade crossing every five years.

The UP mainline has no at-grade crossings with state highways in Wyoming. However, at-grade crossings do occur with county roads, but no data is available to analyze the hazard ratings or exposure factors of these county roads.

LAND USE

There is a total of nearly 19 million acres of land within the study region comprised of Moffat, Routt and Rio Blanco counties in Colorado, and Carbon and Sweetwater counties in Wyoming. Of this, more than 11 million acres, or 60.2 percent of the total, are administered by the Federal government. Most of the remainder is in private ownership with scattered state and local holdings. Table 3-37 shows the breakdown of this ownership by county as well as the surface ownership of the proposed coal lease tracts themselves.

Agriculture, primarily livestock production, is the traditional land use of the region. Existing land uses are overwhelmingly rural, with a total of less than one percent of the land area in urban uses. An estimated breakdown of the existing land uses in the five-county region is shown in table 3-38, reflecting the complexion of the region as dominated by rangelands with pockets of farmlands along the lower river bottoms and woodlands in the upper elevations.

The land use patterns in the region have been influenced by land ownership, legal constraints and physical characteristics. Lands along river bottoms and fertile hills suitable for crop production were patented in the late 1800's and early 1900's under the agricultural homestead laws. Lands rich in minerals were developed and patented under the General Mining Law of 1872. Rangelands in private ownership were acquired through the *Stockraising Homestead Act*.

The most extensive land use is rangeland used for the production of livestock and wildlife. Approximately 83 percent of the region is grazed. Cattle and sheep are the main livestock in the region (table 3-39). Most operators have either BLM, U.S. Forest Service or state leases or permits to graze livestock on public lands in conjunction with their own lands. Because of severe winters, cattle and sheep use summer ranges on higher, more remote Federal land and use winter range on lower more accessible land. Over 95 percent of the ranch operators rely on leased lands to maintain operations at desired economic levels.

Livestock operations vary in size from small 50 AUM ranches to those with over 1,000 animal unit months. The region consists of 313 Section 3 and 236 Section 15 Grazing Allotments administered by the Bureau of Land Management.

In recent years there has been a transition from grazing to mineral or residential use. Recreational development has stimulated interest for land developers to subdivide former mountain, forest and rangeland into recreational homesites. In addition, new and expanding coal strip mines have at least temporarily taken grazing land away from the livestock industry. In some cases, grazing leases have been cancelled or modified to reduce usable forage land, and in others the mining company simply purchased the land from livestock operators.

Due to the limited precipitation and short growing season, only four percent of the region is in crop production; the main crops are hay and wheat. Most hay is irrigated along river bottoms and drainages with most wheat on drylands. Almost all the hay grown is used locally for livestock winter feed. Most farmlands are in private ownership or leased from the states. It is common to find mineral estates separate from surface estates with mineral rights beneath farmland either federally or state-owned and subject to leasing. Where this situation exists for strippable coal deposits, both uses cannot continue and economics dictate that it is usually the farmer that must lose a portion of his operation. Other land uses in the region are oil and gas leases, rights-of-way for roads, railroads, telephone lines, power lines, and gas lines, as well as power plants and withdrawals.

Lands adjacent to the proposed coal lease tracts are predominantly used for grazing and existing mineral production. Land ownership is primarily private and Federal, with federally-owned subsurface mineral estate. A major exception is in Wyoming where all five of the tracts are located within the checkerboard land ownership pattern that extends approximately 20 miles on each side of the Union Pacific railroad mainline. Alternating sections are in private or governmental (BLM or state) ownership. Most of the privately-owned land within this pattern is further divided between surface and mineral ownership, with Rocky Mountain Energy Company maintaining the mineral estate.

Population increases resulting from the proposed coal leasing will create land use pressures on communities near the proposed tracts within the five-county area. Lands within this region are administered and controlled by a variety of governmental jurisdictions, each of which exercises a different level of land use planning, development and resource use control. The authorities, responsibilities and institutional relationships of these various Federal, state, regional, county and municipal governments in land use planning have been described in detail in the *Southcentral Wyoming Coal EIS*, and the *Supplement to the Northwestern Colorado Coal EIS*. The conclusion in both documents is that all of the affected jurisdictions have sufficient authority to impose effective land and resource use controls.

It is the established policy of the states of Colorado and Wyoming to accomodate new growth. This policy was not necessarily arrived at because the states desire the growth, but because both feel that growth is inevitable and is caused by the resources and amenities available within both states. By recognizing this, both states have the opportunity to plan for growth, and to address the associated problems on their own terms.

Colorado has responded to this by preparing the state's *Human Settlement Policies*, 1979. These are basic guidelines that were developed to provide direction to growth, and for guiding state government dicisions, programs, and commitments of state resources. This means that, although the State of Colorado has given local governments the primary role concerning land use decisions, the state still controls distribution of state and Federal funds to local governments.

The communities that would be most heavily impacted by the proposed leasing would be Craig, Meeker, Hayden, Oak Creek, Steamboat Springs and Yampa in Colorado, and Rawlins, Hanna/Elmo, Saratoga, Medicine Bow, Baggs and Wamsutter in Wyoming. All of these communities have already been impacted to some extent, with or without the proposed coal leasing. These communities are familiar with the land use problems associated with rapid growth. This has not dissuaded them from their growth-accommodation stance, but has resulted in different approaches to addressing rapid growth development patterns within each community.

CLIMATE AND AIR QUALITY

CLIMATE

The climate of the Green River/Hams Fork study area can generally be described as a semi-arid steppe (Trewatha, 1971), however, the higher elevations in the mountains of the study area experience greater amounts of precipitation and cooler temperatures compared to lower elevations. Complex topography of these mountainous areas cause the temperature, wind speed and direction, and precipitation to be highly variable. Severe weather occurrences such as tornadoes, hurricanes, severe thunderstorms, and hail occur infrequently. However, extremely frigid conditions and blizzards occur during the winter (U.S. Dept. of Commerce, 1969).

MOISTURE

Precipitation varies widely from less than 8 inches at lower elevations to greater than 24 inches at higher elevations such as Columbine, Colorado. At Green River, Wyoming; Rawlins, Wyoming; and Craig, Colorado, which are climatologically representative of the mining areas, the average annual precipitation is 8.9 inches, 11.6 inches, and 13.1 inches, respectively. The spatial distribution of precipitation in the study area, as shown in Map 3-6 is strongly dependent on local topography (NOAA, 1978).

As can be seen in Table 3-40, at most locations in the study area, the highest amounts of precipitation occur in the spring; winter is generally the most arid season. Spring and summertime precipitation occurs mostly from showers and thunderstorms. Most of the precipitation which occurs above 2500 meters arrives in the form of snow. Table 3-41 shows the average annual snowfall at various locations within the study area. Green River, Rawlins, and Craig have average annual snowfalls of 30.4, 52.8, and 71.3 inches, respectively (U.S. Department of Commerce, 1975). Topographical effects are largely responsible for this variation in snowfall. The evaporation rates in the study area, shown in Table 3-42, indicate that evaporation generally decreases with elevation (U.S. Dept. of Commerce, 1968).

TEMPERATURE

Temperature data throughout the study region exhibit wide variations, from one location to another, and with respect to annual and diurnal extremes. These fluctuations are attributed to topography, and to the predominantly dry air which allows rapid surface heating and cooling. At Foxpark, Wyoming (about 2,750 meters msl) which is climatologically representative of the Wyoming mining areas, the average annual temperature is about 1 degree C (34 degrees F) while at Craig, Colorado (about 1,900 meters msl) the average annual temperature is about 6 degrees C (43 degrees F) (NOAA, 1978). Table 3-43 shows temperature extremes for selected sites in the study area. Average temperatures at the highest elevations are often less than 0 degrees C (32 degrees F), and high valleys can be extremely cold during the winter months. As seen in Table 3-44, the growing season, which is defined as the period from the last 0 degrees C (32 degrees F) temperature in the spring to the first 0 degrees C (32 degrees F) temperature in the fall, ranges from 113 days at Laramie, Wyoming, to 18 days at Grover, Wyoming. At highest elevations, freezing weather can occur at any time (NOAA, 1978).

WIND PATTERNS

Data from the National Weather Service at Grand Junction, Colorado, and Lander, Wyoming, indicate that the most frequent wind directions at the 700 millibar level (approximately 3,000 meters msl) are from the west and west-southwest (references).

On a regional scale, the direction and steepness of the slopes of the various mountain ranges and valleys determine the overall flow at night. Nighttime winds are generally downslope with steeper slopes causing higher wind speeds. Daytime wind patterns are also affected by the blocking caused by these mountain barriers.

Wind patterns at the surface are strongly influenced by local terrain. During the day higher elevations heat more rapidly than valleys, causing an up-valley flow. At night, especially during the winter months when clear calm conditions occur, cold air from higher elevations flows into and down the valleys, creating strong temperature inversions.

Mountain-valley flow is clearly visible from surface wind data within the study area. Two excellent examples close to the study area are Eagle and Grand Junction, Colorado.

The highest wind direction frequencies illustrated in these figures correspond to the up- and down-valley directions. At stations where mountain-valley flow does not take place, the frequent upper-level westerly direction components are reflected in the surface data. Two examples of this case (Lander and Rawlins, Wyoming) are shown in Figures 3-7 and 3-8. Generally, local topography affects the wind patterns far more than the synoptic flow.

ATMOSPHERIC STABILITY

Atmospheric stability conditions may be classified in three broad categories: unstable, neutral, and stable. Stable conditions generally associated with poor atmospheric dispersion occur approximately 36 percent of the time in the study region. Generally, calm or light nighttime drainage winds and clear conditions are associated with stable conditions. Neutral stability (indicative of a well-mixed atmosphere) occurs approximately 42 percent of the time. This condition is generally observed when the large scale westerly flow reaches the surface layer. Unstable conditions are typical of mid-afternoon, particularly during the summer, and are accompanied by up-valley flow. This condition occurs approximately 20 percent of the time. The frequency of occurrence of the separate stability categories varies from one location to another and is greatly affected by topography (National Climatic Center, 1965 to 1974 for Eagle, 1959 to 1966 for Lander). Stability data for Lander and Eagle are shown in Table 3-45.

AIR QUALITY

The direct air quality impacts of the proposed mining operations and the indirect air quality impacts from induced population growth are limited to the areas in the immediate vicinity of the proposed federal lease tracts and to nearby population centers. These areas are defined as the affected areas for the air quality assessment of the EIS. The air quality assessment is focused on three affected areas: the Yampa Valley; the Hanna/Elmo area; and the Rawlins area (see Map 3-7).

AIR QUALITY REGULATIONS

National and state ambient air quality standards have been established for seven pollutants--total suspended particulate matter (TSP), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), non-methane hydrocarbons (NMHC), ozone (O_3), and lead (Pb). The standards prescribe levels which are not to be exceeded for specific averaging periods. The current standards are presented in Table 3-46.

The Prevention of Significant Deterioration (PSD) provisions of the *Clean Air Act Amendments of 1977* (42 USC 7401, PL 95-95, 1977, Section 160-169) established maximum allowable increases of TSP and SO_2 in attainment areas. (The air quality regulations define attainment as areas which meet the national ambient air quality standards (NAAQS) or areas which are designated unclassified). Colorado estblished allowable increases for sulfur dioxide which are more stringent than the federal PSD increments (see Table 3-47).

The Federal PSD Class I areas which are nearest the affected areas are the Mt. Zirkel and Flat Tops Wilderness areas (see Map 3-7). The allowable increases in these Class I areas are extremely limited by the PSD increments (Table 3-47). In addition, the Clean Air Act Amendments of 1977 include legislation requiring the prevention and correction of any impairment of visibility in the Class I areas, if the impairment results from manmade air pollutants (PL 95-95, Section 169A).

EXISTING AIR QUALITY

The background concentrations for TSP, NO_2, SO_2, CO, NMHC, O_3 and Pb were estimated from monitoring data obtained at the monitoring sites throughout the EIS region.

Pollutant levels in the vicinity of cities are higher than the rural background concentrations because of anthropogenic sources (space heating, vehicular traffic, industrial activity, construction,and other development). Mining operations cause increased levels of TSP near existing mines. The SO2 and TSP concentrations are higher than background levels in the vicinity of the Yampa and Hayden power plants.

Particulate levels near existing mining activities in the three areas are higher than the background concentrations due to fugitive dust generated by the mining operations. Beyond several kilometers downwind of the mines, TSP levels are predicted to return to the rural background levels as a result of particulate deposition.

Ambient levels of NO_2, CO, O_3, NMHC, and Pb were measured outside of the affected areas but within the study area. Measured levels of NO_2 in rural areas are less than 10 percent of the 100 micrograms per cubic meter ($\mu g/m^3$) standard. A rural NO2 annual arithmetic mean (AAM) background concentration of 7 $\mu g/m^3$ is estimated for the three affected areas.

The only monitored concentrations of CO and Pb close to the affected areas were measured near existing sources. The measured values of CO and Pb at these sites were less than 50 percent and 80 percent of the NAAQS, respectively.

The three-hour national standard for NMHC has been exceeded at monitoring sites outside the affected areas. Since there are no large manmade sources of hydrocarbons in the vicinity of the monitoring sites, the higher concentrations may be attributable to naturally occurring hydrocarbons.

Ozone concentrations recorded at the sites within the study area are less than 50 percent of the NAAQS of 235 $\mu g/m3$.

YAMPA VALLEY. A rural TSP annual geometric mean (AGM) background concentration of 22 $\mu g/m^3$ was estimated in the Yampa Valley. This value is 29 percent of the NAAQS.

Space heating, local vehicular traffic, construction activities, and other municipal development contribute to higher TSP levels in and near population centers. Ambient levels of TSP which exceed the Federal and Colorado primary standards have been measured in Craig since 1974, resulting in the city being designated a particulate nonattainment area in March 1978 (43 FR 8952, 1978). Reevaluation and uncertainty regarding the monitoring data and the sources of particulate emissions led to the redesignation of the Craig area as unclassified in September 1978 (43 FR 40422, 1978). A subsequent study has concluded that the major contribution to the high particulate levels may be from fugitive dust generated by agricultural activities outside of the town (PEDCo, 1979).

Total suspended particulate levels in Steamboat Springs have also exceeded the National and Colorado standards. EPA has identified the sources of the elevated levels as fireplace usage and travel on paved and unpaved roadways (EPA, 1977), and has subsequently designated the city an unclassified area.

Ambient levels of sulfur dioxide were measured in the Yampa Valley and at sites outside of the affected areas. None of the measured values exceeded the NAAQS. The sites in the Yampa Valley recorded SO_2 concentrations which may be influenced by the Hayden Power Plant. A background concentration (AAM) of 3 $\mu g/m^3$ (less than 10 percent of the NAAQS) was estimated for the Yampa Valley based on the three monitoring sites in the Valley.

HANNA/ELMO AREA. A rural TSP background concentration (AGM) of 29 $\mu g/m^3$ (39 percent of the NAAQS, 48 percent of the Wyoming standard) was estimated in the Hanna/Elmo area. A major mining operation is within two kilometers of Hanna, and contributes to higher TSP levels in the town.

The levels of SO_2, which were measured outside of the affected areas, were at the detection limits of the sampling instruments. Therefore, a rural SO_2 background level (AAM) of one $\mu g/m^3$ was assumed in the Hanna/Elmo area.

RAWLINS AREA In the Rawlins area, a rural TSP background concentration (AGM) of 18 $\mu g/m^3$ was estimated. This level is 24 percent of the national TSP standard and 30 percent of the Wyoming TSP standard. The Rawlins area is expected to have a SO_2 background concentration (AAM) similar to the one $\mu g/m^3$ estimated for the Hanna/Elmo area.

EXISTING VISIBILITY

A documented record of visibility measurements is not available for the Yampa Valley and Hanna/Elmo areas. A review of National Weather Service (NWS) data measured at Rock Springs, Rawlins, and Fort Bridger, Wyoming, and Eagle, Colorado, indicates that the average visibility in the Yampa Valley, Rawlins, and Hanna/Elmo areas is very good. Objects at distances of 20 to over 50 miles from the observers are clearly visible most of the time, and visibilities restricted to less than three miles occur less than four percent of the time. Trijonis and Shapeland (1974) have used modified NWS data to estimate median visual ranges of 45 to 70 miles in the study area.

FUTURE AIR QUALITY WITHOUT THE PROPOSED ACTION

Future regional air quality will be influenced by population growth, increased vehicular traffic, additional coal mining activities (other than the proposed action) and non-coal-related developments.

In the Yampa Valley, future population increases in Craig, Hayden and Steamboat Springs will raise the levels of all pollutants. Sulfur dioxide and TSP concentrations are expected to increase in the vicinity of Craig with the addition of the proposed generating units at the Yampa Power Plant. The proposed expansion of the Steamboat Springs ski area is expected to contribute primarily to the increase of the TSP levels in Steamboat Springs.

If future developments result in Craig and/or Steamboat Springs being designated as nonattainment areas, the Colorado State Implementation Plan would have to be revised to include provisions showing how compliance with the primary NAAQS will be made within a reasonable period. Reasonable further progress toward the attainment of the standard must also be demonstrated after the revised state implementation plan is adopted.

The addition of several mines (not associated with the proposed lease tracts) in the Hanna/Elmo area is expected to result in elevated particulate levels near these towns. Population growth and commuter traffic associated with these mines and non-coal-related activities will also contribute to increases in sulfur dioxides, TSP, and NO_2 concentrations in these towns.

The increase in vehicular traffic due to regional population growth will increase pollutant levels in the immediate vicinity of major roadways and contribute to elevated concentrations within the cities.

A quantitative analysis of the future air quality without the proposed actions is presented in the impact analysis section for the No Action Alternative in Section 4.

FUTURE VISIBILITY WITHOUT THE PROPOSED ACTION

Future visibility conditions, in the absence of the proposed federal lease alternatives, were projected by computer simulation (see Section 4) of the dispersion of atmospheric pollutant emissions estimated for 1995. Within the accuracy of available modeling capabilities, the projected visibility conditions, in the absence of the proposed federal lease alternatives, are expected to be substantially the same as at present, and objects at distances of 20 to 50 miles from observers will continue to be visible most of the time.

NOISE

The general noise level in the study area is approximately 40 decibels (dB) based on representative levels according to population densities (U. S. Department of Commerce, 1977). However, specific areas such as highways or existing mining operations have noise levels significantly greater than the 40 dB figure. Table 3-48 indicates the existing and projected noise levels next to the highways. The existing and projected traffic noise levels were determined and were based upon the projected traffic volumes for each highway. The table indicates a range from minimum to maximize noise levels based upon traffic volumes. Noise generated from rail traffic in the area has an equivalent continuous sound (Leq) level of approximately 76 dB (at 100 feet) along the rail lines. Noise is also generated by mining operations in the area. Strip mines and gravel quarry operations have an Leq of approximately 78 dB at 500 feet.

TABLE 3-1

SOIL SUITABILITY FOR SURFACE RECLAMATION
AND EXTENT OF STEEP SLOPES ON COLORADO TRACTS 1/

	Unsuitable Surface Material 2/			Suitable Surface Material 3/			
	Shallow Topsoil	Shallow Profile	Total	Loamy Topsoil	Loamy Subsoil	Total	Steep 5/ Slopes
	Percent			Percent			Percent
Grassy Creek	10	15	25	50	25	75	50
Danforth Hills #1	20	30	50	50	4/	50	25
Danforth Hills #3	45	20	65	25	10	35	33
Hayden Gulch	10	20	30	55	15	70	50
Lay	4/	40	40	20	40	60	50
Danforth Hills #2	10	60	70	30	4/	30	75
Pinnacle	10	15	25	25	50	75	33
Iles Mtn.	25	40	65	35	4/	35	25
Williams Fork Mtns.	4/	15	15	45	40	85	33

1/ Area directly disturbed by mining.
2/ Percent of surface with soil deemed unsuitable for reclamation because the topsoil is too shallow with clayey subsoil or else the soil is shallow and cobbly with bedrock frequently exposed.
3/ Percent of surface with loamy topsoil greater than 6 inches deep or else topsoil is less than 6 inches but subsoil is loamy.
4/ Less than one percent.
5/ Estimated percent of area where slopes are greater than 25 percent (4:1) and frequently 3:1 or greater.

TABLE 3-2

SOIL SUITABILITY FOR SURFACE RECLAMATION
AND EXTENT OF STEEP SLOPES ON WYOMING TRACTS 1/

	Unsuitable Surface Material 2/ Percent		Suitable Surface Material 3/ Percent	Steep 4/ Slopes Percent
	Shallow	Sodic		
Medicine Bow	40	20	40	10
Red Rim	30	--	70	30
China Butte	30	--	70	40
Seminoe II	50	--	50	50
Rosebud	33	--	67	33

1/ Percent of entire tract.
2/ Percent of tract having shallow rocky soils, occasional rock outcroppings, often strongly alkaline at depths of one foot or less, and usually situated on steep terrain. Also soils having concentrations of sodium unfavorable to vegetation.
3/ Percent of tract covered with suitable material for surface reclamation. Usually depth to bedrock is 2-3 feet or more and soil is moderately alkaline and non-sodic.
4/ Estimated percent of tract having surface with slopes of 25 percent grade (4:1). Frequently slopes are 3:1 or steeper.

TABLE 3-3

APPROXIMATE AREAL EXTENT OF AQUIFERS REMOVED BY MINING WITHOUT NEW FEDERAL LEASING OF COAL 1/

Item	Cumulative to 1987	Cumulative to 1990	Cumulative to 1995
North Platte River Basin Above Seminoe Dam 2/			
Coal-Related:			
Area of aquifers removed (sq mi)	20.8	32.0	37.3
Non Coal-Related:			
Area of aquifers removed (sq mi)	0	0	0
Percent of watershed disturbed	0.29	0.44	0.52
Yampa River Subbasin 2/			
Coal-Related:			
Area of aquifers removed (sq mi)	16.6	28.0	28.0
Non Coal-Related:			
Area of aquifers removed (sq mi)	1.0	1.0	1.0
Percent of watershed disturbed	0.46	0.46	0.46

1/ Refers to the surface area from which aquifers are removed. For example, removal of several aquifers from a mined area of 5 sq mi is reported as an area of 5 sq mi of aquifers removed.

2/ Area of watershed - 7,230 sq mi.

3/ Area of watershed - 3,801 sq mi.

TABLE 3-4

HYDROLOGIC DATA FOR STREAMS DRAINING COAL AREAS

Station	Station Number 1/	Drainage Area (sq mi)	Average Annual Runoff (ac-ft)	Average Annual Runoff (ac-ft/sq mi)	Average Annual Runoff (inches)	Peak Discharge (cfs)	Peak Discharge (cfs/sq mi)	Minimum Discharge (cfs)	Annual Suspended Sediment Load (tons)	Annual Suspended Sediment Load (tons/sq mi)
NORTH PLATTE RIVER BASIN ABOVE SEMINOE DAM AND SEPARATION CREEK BASIN										
Hanna Draw near Hanna	06634990	21.6	174	8.1	0.15	385	17.8	0	8 E 2/	0.4
Big Ditch near Coyote Springs	06630300	110	157	1.4	0.03	396	3.6	0	--	--
North Ditch near Coyote Springs	06630330	22.6	4.1	0.2	0.003	27	1.2	0	--	--
Separation Creek near Riner	09216527	55.3	2,040	36.9	0.7	81	1.5	0	1,590 E	28.8
Averages for stations				11.6	0.2		6.0			14.6
YAMPA RIVER SUBBASIN										
Middle Creek near Oak Creek	09243700	23.5	1,480	63	1.2	33	1.4	0	109 E	4.6
Foidel Creek near Oak Creek	09243800	8.6	240	27.9	0.5	30	3.5	0	12 E	1.4
Foidel Creek at mouth	09243900	17.5	890	50.9	1.0	69	3.9	0	633	36.2
Good Spring Creek at Axial	09250400	35	670	19.1	0.4	58	1.7	0	120 E	3.4
Taylor Creek at mouth	09250510	7.2	8	1.1	0.02	0.1	0.01	0	2	0.3
Wilson Creek near Axial	09250600	22	2,060	93.6	1.8	33	1.5	0.12	820	37.3
Jubb Creek near Axial	09250610	7.5	24	3.2	0.06	5.5	0.7	0	--	--
Averages for stations				37.0	0.71		1.8			13.9

1/ U.S. Geological Survey (USGS) station number. Locations of stations are shown in table B-1, Appendix B.
2/ E, estimated from random samples collected by USGS.

TABLE 3-5

HYDROLOGIC DATA FOR STREAMS DRAINING MOUNTAIN AREAS

Station	Station Number 1/	Drainage Area (sq mi)	Average Annual Runoff (ac-ft)	Average Annual Runoff (ac-ft/ sq mi)	Average Annual Runoff (inches)	Peak Discharge (cfs)	Peak Discharge (cfs/ sq mi)	Minimum Discharge (cfs)	Annual Suspended Sediment Load (tons)	Annual Suspended Sediment Load (tons/ sq mi)
NORTH PLATTE RIVER BASIN ABOVE SEMINOE DAM										
North Platte River near Northgate	06620000	1,431	310,800	217	4.1	6,720	4.7	19	--	--
North Platte River near Sinclair	06630000	4,175	791,200	190	3.6	14,500	3.5	70	100,000 E 2/	24.0
Grizzly Creek near Spicer	06611100	119	58,000	487	9.1	810	6.8	1.2	6,050 E	50.8
Grizzly Creek near Hebron	06611300	223	45,630	205	3.8	640	2.9	0.5	3,600 E	16.3
Little Grizzly Creek above Coalmont	06611800	35.4	31,050	877	16.4	263	7.4	1.2	3,950 E	111
Michigan River near Cameron Pass	06614800	1.53	2,000	1,307	24.5	44	28.8	0.14	--	--
North Fork Michigan River near Gould	06616000	21.2	12,460	588	11.0	290	13.7	--	--	--
North Brush Creek near Saratoga	06622700	37.4	36,300	971	18.2	1,120	30.0	4.7	--	--
Encampment River above Hog Park Creek	06623800	72.7	78,250	1,076	20.2	1,680	23.1	9.5	130 E	1.8
Encampment River at mouth	06625000	265	171,000	645	12.1	4,510	17.0	5.2	--	--
Medicine Bow River near Hanna	06635000	2,338	127,500	54	1.0	6,590	2.8	1.1	5,000 E	2.2
Averages for stations				602	11.3		12.8			34.3
YAMPA RIVER SUBBASIN										
Yampa River at Steamboat Springs	09239500	604	337,600	559	10.5	6,820	11.3	4.0	--	--
Yampa River near Hayden	09244410	1,430	763,600	534	10.0	16,500	11.5	5.1	--	--
Yampa River near Maybell	09251000	3,410	1,116,000	327	6.1	17,900	5.2	2.0	300,000 3/	88
Elk River at Clark	09241000	206	242,700	1,178	22.1	4,470	21.7	22	--	--
Elkhead Creek near Elkhead	09245000	64.2	38,110	594	11.1	1,660	25.9	0	--	--
S. Fork Williams Fork River near Pagoda	09249200	46.7	30,430	652	12.2	910	19.5	0	--	--
Averages for stations				641	12.0		15.8			88

1/ U.S. Geological Survey (USGS) station number. Locations of stations are shown in table B-1, Appendix B.
2/ E, estimated from random samples collected by USGS.
3/ From records collected during the period 1950-58.

TABLE 3-6

QUALITY OF WATER DATA FOR STREAMS DRAINING COAL AREAS

Station	Station Number 1/	pH		Dissolved Solids Concentration (mg/L)		Water Type 2/	
		Range	Avg.	Spring	Fall	Spring	Fall
NORTH PLATTE RIVER BASIN ABOVE SEMINOE DAM AND SEPARATION CREEK BASIN							
Hanna Draw near Hanna	06634990	--	8.2	--	2,500	--	Mg,Ca,Na,SO_4,HCO_3
Separation Creek near Riner	09216527	8.0-8.8	8.3	400-800	1,000-1,500	Na,Mg,Ca,SO_4,HCO_3	Na,Mg,Ca,SO_4,HCO_3
YAMPA RIVER SUBBASIN							
Middle Creek near Oak Creek	09243700	7.6-8.8	8.2	250-350	300-600	Ca,Mg,Na,HCO_3,SO_4	Ca,Na,Mg,HCO_3,SO_4
Foidel Creek near Oak Creek	09243800	7.5-7.8	7.8	350-500	--	Ca,Mg,Na,HCO_3,SO_4	--
Foidel Creek at mouth	09243900	7.4-8.2	7.9	450-650	--	Ca,Mg,Na,HCO_3,SO_4	--
Good Spring Creek at Axial	09250400	8.1-8.8	8.2	900-1,000	1,000-1,100	Mg,Ca,Na,HCO_3,SO_4	Mg,Ca,Na,HCO_3,SO_4
Taylor Creek at mouth	09250510	8.1-8.5	8.2	600-700	800-900	Mg,Na,Ca,HCO_3,SO_4	Mg,Na,Ca,HCO_3,SO_4
Wilson Creek near Axial	09250600	7.5-8.5	8.1	700-1,000	1,200-1,300	Na,Mg,Ca,HCO_3,SO_4	Na,Mg,Ca,HCO_3,SO_4
Jubb Creek near Axial	09250610	7.8-8.4	8.1	1,100-1,200	1,200-1,600	Mg,Na,Ca,HCO_3,SO_4	Mg,Na,Ca,HCO_3,SO_4

1/ U.S. Geological Survey (USGS) station number. Locations of stations are shown in table B-1, Appendix B.
2/ Ca, calcium; Mg, magnesium; Na, sodium; HCO_3, bicarbonate; SO_4, sulfate.

TABLE 3-7

QUALITY OF WATER DATA FOR STREAMS DRAINING MOUNTAIN AREAS

Station	Station Number 1/	pH		Dissolved Solids Concentration (mg/L)		Water Type 2/	
		Range	Avg.	Spring	Fall	Spring	Fall
NORTH PLATTE RIVER BASIN ABOVE SEMINOE OAM							
North Platte River near Northgate	06620000	7.8-8.1	7.9	90-180	180-260	Ca,Na,HCO_3	Ca,HCO_3
North Platte River near Sinclair	06630000	--	--	100-200	300-400	Ca,Na,HCO_3	Ca,Na,Mg,HCO_3,SO_4
Grizzly Creek near Spicer	06611100	7.4-8.3	7.8	70-100	150-170	Ca,HCO_3	Ca,HCO_3
Grizzly Creek near Hebron	06611300	7.4-8.4	7.9	100-200	200-400	Ca,Na,HCO_3	Ca,HCO_3
Little Grizzly Creek above Coalmont	06611800	7.1-8.2	7.7	50-100	100-200	Ca,HCO_3	Ca,HCO_3
Encampment River above Hog Park Creek	06623800	6.4-7.7	7.0	25-50	50-75	Ca,HCO_3	Ca,HCO_3
Encampment River at mouth	06625000	--	--	40-100	200-400	Ca,Na,HCO_3	Ca,Na,HCO_3,SO_4
Medicine Bow River near Hanna	06635000	--	--	400-500	1,000-2,000	Ca,Na,SO_4HCO_3	Ca,Na,Mg,SO_4,HCO_3
YAMPA RIVER SUBBASIN							
Yampa River near Hayden	09244410	7.4-8.4	7.9	80-200	280-400	Ca,HCO_3	Ca, HCO_3
Yampa River below Elkhead Creek	09246550	7.3-8.6	8.2	100-250	400-650	Ca,HCO_3	Ca,Na,HCO_3,SO_4
Yampa River below Craig	09247600	7.4-8.9	8.3	80-200	400-600	Ca,HCO_3	Ca,Na,HCO_3,SO_4
Williams Fork at mouth	09249750	7.6-8.6	8.3	175-200	400-500	Ca,HCO_3	Ca,HCO_3
Yampa River near Maybell	09251000	7.5-8.7	8.0	100-200	500-600	Ca,HCO_3	Ca,Na,HCO_3

1/ U.S. Geological Survey (USGS) station number. Locations of stations are shown in table 8-1, Appendix B.

2/ Ca, calcium; Mg, magnesium; Na, sodium; HCO_3, bicarbonate; SO_4, sulfate.

TABLE 3-8

CONSUMPTIVE ANNUAL WATER USE AND WATER QUALITY IN THE NORTH PLATTE RIVER ABOVE SEMINOE DAM WITHOUT LEASING AND DEVELOPMENT OF NEW FEDERAL COAL

Supply, Consumption, and Quality Categories	Baseline 1/ Conditions	Present (1980)	1987	1990	1995
WATER SUPPLY:					
Total undepleted water supply (ac-ft) 2/	1,193,400	1,193,400	1,193,400	1,193,400	1,193,400
Import to basin (ac-ft)	--	8,000 3/	28,100 4/	28,100 4/	28,100 4/
Export from basin (ac-ft) 5/	--	8,000	28,100	28,100	28,100
Consumptive uses:					
Riparian vegetation (ac-ft) 6/	6,000	6,000	6,000	6,000	6,000
Irrigation (ac-ft) 7/	--	264,600	264,600	264,600	264,600
Reservoir evaporation (ac-ft) 8/	--	41,000	41,000	41,000	41,000
Municipal and rural (ac-ft) 9/	--	3,400	3,900	3,900	4,100
Industrial and existing mines (ac-ft) 10/	--	500	600	700	700
Total consumptive use (ac-ft)	6,000	315,500	316,100	316,200	316,400
Net discharge without leasing and development of new Federal coal (ac-ft)	1,187,400	877,900	877,300	877,200	877,000
SALT LOAD:					
Sources of salt:					
Natural sources (tons) 11/	250,000	250,000	250,000	250,000	250,000
Irrigation (tons)	--	70,610	70,610	70,610	70,610
Municipal wastes (tons) 12/	--	600	630	640	660
Industrial and existing mines (tons)	--	250	250	250	250
Import to basin (tons) 13/	--	2,180	7,640	7,640	7,640
Reduction in salt load from:					
Export of water from basin (tons) 14/	--	- 1,090	- 3,820	- 3,820	- 3,820
Consumptive use of water by people (tons) 15/	--	- 1,400	- 1,570	- 1,600	- 1,660
Consumptive use of water by industry & mines (tons)	--	- 340	- 410	- 480	- 480
Total salt load in North Platte River (tons)	300,000	320,810	323,330	323,240	323,200
Discharge weighted average dissolved solids in North Platte River (mg/L)	154.8	268.7 16/	271.0	271.0	271.0
Net increase in dissolved solids without leasing and development of new Federal coal (mg/L)	--	113.9	116.2	116.2	116.2

1/ Projected pristine conditions without man's use.
2/ Estimated from USGS water resources data and inferred consumptive uses.
3/ Import from Little Snake River basin.
4/ Import from Little Snake River basin increased to 28,100 ac-ft/yr. on completion of Cheyenne Stage II Water Diversion.
5/ Export for municipal water supply for Cheyenne.
6/ Does not include ground water, which is principal source of water consumed by riparian vegetation.
7/ Assumes 49,600 ac-ft used from Medicine Bow River and 215,000 ac-ft used from North Platte River.
8/ Seminoe Reservoir - 35,100 ac-ft/yr. Other reservoirs - 5,900 ac-ft/yr.
9/ Assumes consumptive use of 125 gal/day/person. Treated water supply of 200 gal/day/person less sewage effluent of 75 gal/day/person.
10/ Most of the water consumed by existing coal mines is not a consumptive use of river water.
11/ Estimate based on dissolved solids concentration during spring runoff when salt load from other sources is proportionately small.
12/ Based on 75 gal/day/person and increase in dissolved solids concentration of 200 mg/L.
13/ Based on dissolved solids concentration of 200 mg/L.
14/ Based on dissolved solids concentration of 100 mg/L.
15/ Based on dissolved solids concentration of 300 mg/L.
16/ Based on weighted average dissolved solids concentration of inflow to Seminoe Reservoir from North Platte and Medicine Bow Rivers and from Big Ditch.

TABLE 3-9

CONSUMPTIVE ANNUAL WATER USE AND WATER QUALITY IN THE YAMPA RIVER SUBBASIN
WITHOUT LEASING AND DEVELOPMENT OF NEW FEDERAL COAL 1/

Supply, Consumption & Quality Categories	Baseline 2/ Conditions	Present (1980)	1987	1990	1995
WATER SUPPLY:					
Total undepleted water supply (ac-ft) 3/	1,135,100	1,135,100	1,135,100	1,135,100	1,135,100
Consumptive uses:					
Export from basin (ac-ft) 4/	---	2,800	2,800	2,800	2,800
Riparian vegetation (ac-ft) 5/	3,100	3,100	3,100	3,100	3,100
Irrigation (ac-ft)	---	57,800 6/	59,000 7/	61,000	62,500 7/
Reservoir evaporation (ac-ft)	---	9,300 8/	47,300 9/	47,300 9/	47,300 9/
Power plants (ac-ft)	---	6,800 10/	12,500 11/	12,500 11/	12,500 11/
Municipal and rural (ac-ft) 12/	---	2,500	5,700	6,000	6,100
Existing mines (ac-ft) 13/	---	200	500	600	600
Total consumptive use (ac-ft)	3,100	82,500	130,900	133,300	134,900
Net discharge without leasing and development of new federal coal (ac-ft)	1,132,000	1,052,600	1,004,200	1,001,800	1,000,200
SALT LOAD:					
Sources of salt:					
Natural sources (tons)	171,800	171,800	171,800	171,800	171,800
Irrigation and dryland farming (tons)	---	65,900	67,300	69,500	71,200
Municipal wastes (tons) 14/	---	410	930	980	990
Existing mines (tons)	---	8,000	8,500	9,500	9,500
Reduction in salt load from:					
Export of water from basin (tons) 15/	---	- 480	- 480	- 480	- 480
Consumptive use of water by power plants (tons) 16/	---	-1,620	-2,980	-2,980	-2,980
Consumptive use of water by people (tons) 16/	---	- 590	-1,360	-1,430	-1,450
Consumptive use of water by mining (tons) 17/	---	- 80	- 200	- 240	- 240
Total salt load in Yampa River (tons)	171,800	243,340	243,510	246,650	248,340
Discharge weighted average dissolved solids in Yampa River (mg/L)	111.6	170.0 18/	178.3	181.0	182.6
Net increase in dissolved solids without leasing and development of new Federal coal (mg/L)	---	58.4	66.7	69.4	71.0
Discharge weighted average dissolved solids in Colorado River at Imperial Dam (mg/L)	---	854.90 19/	1,046.05 20/	1,046.05	1,046.05
Excess over adopted standard of 879 mg/L at Imperial Dam (mg/L)	---	- 24.1	+ 167	+ 167	+ 167

1/ Modified from Table RII-7, NWCCRES.
2/ Projected pristine conditions without man's use.
3/ Irons and others, 1965.
4/ Transbasin diversion from Bear River drainage to Egeria Creek in Colorado River basin.
5/ Does not include ground-water, which is principal source of water consumed by riparian vegetation.
6/ 82,600 irrigated acres X 0.7 ac-ft water applied per acre.
7/ Estimated increase in irrigation water consumption due to Juniper Reservoir.
8/ From CWCB & USDA, 1969.
9/ Increase due to Juniper Reservoir - 33,000 ac-ft and Cross Mountain Reservoir - 5,000 ac-ft.
10/ From Table 1-5, NWC-SR.
11/ From enlargement of Hayden and Craig plants.
12/ Assumes consumptive use of 125 gal/day/person. Treated water supply of 200 gal/day/person less sewage effluent of 75 gal/day/person.
13/ Much of the water used by existing mines is not a consumptive use of river water.
14/ Based on 75 gal sewage/day/person and increase in dissolved solids concentration of 200 mg/L.
15/ Based on dissolved solids concentration of 125 mg/L.
16/ Based on dissolved solids concentration of 175 mg/L.
17/ Based on dissolved solids concentration of 300 mg/L.
18/ Based on average dissolved solids concentration in Yampa River near Maybell for period 1966-76.
19/ Based on average dissolved solids concentration in Colorado River at Imperial Dam for period 1970-76.
20/ Furnished by Water and Power Resources Service, Colorado River Water Quality Office. Assumes that all projects currently approved and those for which environmental impact statements have been prepared will be completed by 1987.

TABLE 3-10

AFFECTED ENVIRONMENT

Vegetative Types	Wyoming		Colorado		Total Environment	
	Acres	Percent	Acres	Percent	Acres	Percent
Grasslands	526,500	9.6	33,216	2.2	559,716	8.0
Sagebrush	2,903,000	53.0	723,283	48.4	3,626,283	52.1
Mountain Shrub	105,600	2.0	373,408	25.0	479,008	6.9
Pinyon-Juniper	70,800	1.3	12,448	0.8	83,248	1.2
Saltbush	474,500	8.7	---	---	474,500	6.8
Greasewood	350,200	6.8	---	---	350,200	5.0
Aspen	164,900	3.0	147,232	9.8	312,132	4.5
Riparian	86,500	1.6	14,816	1.0	101,316	1.5
Cropland	175,400	3.2	141,344	9.5	316,744	4.5
Rock Outcrop-Barren	58,300	1.1	---	---	58,300	0.9
Conifers	550,800	10.1	49,856	3.3	600,656	8.6
Totals	5,466,500	100.0	1,495,603	100.0	6,962,103	100.0

TABLE 3-11

TRENDED ENVIRONMENT - ACRES DISTURBED

Vegetative Types	Non Coal-Related Disturbance						Coal-Related Disturbance						Total Disturbance					
	Colorado			Wyoming			Colorado			Wyoming			Colorado			Wyoming		
	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995
Grassland	88	102	118	448	500	596	370	533	533	1517	2227	2558	458	635	651	1965	2727	3154
Sagebrush	1932	2245	2593	2473	2759	3293	8136	11732	11732	8373	12297	13125	10068	13977	14325	10846	15056	17418
Mountain Shrub	998	1159	1340	93	104	124	4203	6060	6060	316	464	533	5201	7219	7400	409	568	657
Pinyon-Juniper	32	37	43	61	68	81	134	194	194	205	302	346	166	231	237	266	370	427
Saltbush	--	--	--	406	453	541	--	--	--	1375	2018	2319	--	--	--	1781	2471	2860
Greasewood	--	--	--	299	333	398	--	--	--	1011	1485	1705	--	--	--	1310	1818	2103
Aspen	391	454	525	140	157	186	1641	2376	2376	474	696	800	2038	2830	2901	614	853	986
Riparian	40	46	54	75	83	99	168	242	242	253	371	426	208	288	296	328	454	525
Cropland	380	441	509	149	166	199	1597	2303	2303	506	742	853	1977	2744	2812	655	908	1052
Rock Outcrop-Barren	--	--	--	51	57	68	--	--	--	174	255	293	--	--	--	225	312	361
Conifer	132	153	177	471	526	628	555	800	800	1596	2343	2692	687	953	977	2067	2869	3320
Totals	3993	4637	5359	4666	5206	6213	16810	24240	24240	15800	23200	26650	20803	28877	29599	20466	28406	32863

TABLE 3-12

RELATIVE VALUES OF HABITAT TYPES TO WILDLIFE WITHIN THE HABITAT ANALYSIS AREA

Habitat type	Percent of total area	Key Wildlife Species	Value Rating	Rationale for Rating
Grasslands	8.0	Rodents, raptors, songbirds	Moderate	Production and species diversity moderate
Sagebrush	52.1	Mule deer, pronghorn, sage grouse	High	Essential habitat for key species
Mountain Shrub	6.9	Mule deer, elk, birds	High	Essential habitat for deer and elk
Pinyon-Juniper	1.2	Mule deer, songbirds, reptiles	Moderate	Diversity moderate
Saltbush	6.8	Pronghorn, rodents	Low	Production and diversity limited
Greasewood	5.0	Pronghorn, rodents	Low	Production and diversity low
Aspen	4.5	Mule deer, elk, birds	High	Species diversity high, deer and elk production areas
Riparian	1.5	Mule deer, rodents, raptors, songbirds	High	Scarce type with high species diversity
Cropland	4.5	Rodents, songbirds	Low	Monoculture with low diversity
Rock Outcrop-Barren	0.9	Rodents, reptiles, raptors	Moderate	Sparse vegetation with low production except for raptors
Conifer	8.6	Mule deer, elk, birds	Moderate	Seasonally important, cover value good

TABLE 3-13

KEY WILDLIFE SPECIES WITHIN THE HABITAT ANALYSIS AREA 1/

Species	Rationale for Key Designation
Big Game	
Elk	High economic and recreational value
Mule Deer	High economic and recreational value
Pronghorn Antelope	High economic and recreational value
Game Birds	
Sage Grouse	High interest and recreational value
Sensitive Species	
Burrowing Owl	Rare in Wyoming
Ferruginous Hawk	Sensitive in Wyoming
Golden Eagle	Protected by law
Fish	
Coldwater Gamefish	High economic and recreational value
Warmwater Gamefish	High economic and recreational value
Threatened or Endangered	
Federal	
Bald Eagle	Protected by law
Black-footed Ferret	Protected by law
Colorado Squawfish	Protected by law
Peregrine Falcon	Protected by law
Humpback Chub	Protected by law
State	
Greater Sandhill Crane	Protected by law in Colorado
Razorback Sucker	Protected by law in Colorado
Bonytail Chub	Protected by law in Colorado
Colorado River Cutthroat Trout	Protected by law in Colorado

1/ HAA includes lower Yampa River.

TABLE 3-14

KEY SPECIES OCCURRENCE AND ABUNDANCE

Species	Habitat Type and Status 1/										
	Grasslands	Sagebrush	Mountain Shrub	Pinyon-Juniper	Saltbush/ Greasewood	Aspen	Riparian	Cropland	Rock-Outcrop Barren	Conifer	Aquatic
Elk			***			***				***	
Mule Deer	***	***	***	***	***	***	***	***	***	***	
Pronghorn Antelope	***	***			***						
Sage Grouse		***									
Burrowing Owl	*										
Ferruginous Hawk	**	**			**			**	**		
Golden Eagle	**	**		**	**		**		**		
Coldwater Fish											***
Warmwater Fish											***

1/ *** Common; ** Fairly common; * Rare

Source: Colorado Division of Wildlife 1978 b, 1978 c; SCWCES, 1978.

TABLE 3-15

THREATENED OR ENDANGERED WILDLIFE IN THE HAA 1/

Species	Status 2/	Occurrence
Black-footed ferret	E (F,S)	Possible in Wyoming
Bald eagle*	E (F)	Occurs in Colorado and Wyoming
Greater sandhill crane*	E (S)	Occurs in Colorado
Peregrine falcon*	E (F,S)	Occurs in Colorado
Bonytail chub*	E (S)	Yampa River
Colorado River cutthroat trout*	T (S)	Possible in upper tributaries of Yampa River
Colorado squawfish*	E (F,S)	Yampa River
Humpback chub*	E (F,S)	Yampa River
Razorback sucker*	T (S)	Yampa River

1/ Includes the lower Yampa River.
2/ T = Threatened; E = Endangered; (F) = Federal list; (S) = State list.

* Known to occur in the region within the last five years.

Source: Colorado Division of Wildlife, 1978 d; SCWCES, 1978.

TABLE 3-16, Part 1

PROPERTIES ON THE NATIONAL REGISTER OF HISTORIC PLACES (1980) COLORADO

Name	Type	Kind	Other
GRAND COUNTY			
Kauffman House	H	Architectural	
Grand River Ditch	H	Reclamation	
Holzwarth Historic District	H	Town	
Lulu City Site	H	Mining	
North Inlet Shelter Cabin	H	Homestead	
Shadow Mountain Lookout	H	Unique	
MOFFAT COUNTY			
White-Indian Contact Site *	A-H	Fort	
Old Ladore School*	H	Community Center	
Two Bar Ranch*	H	Ranch	
Marcia*	H	Railroad	
RIO BLANCO COUNTY			
St. James Episcopal Church	H	Architectural	
Battle of Milk River Site*	H	Site	
Duck Creek Wickiup Village*	A	Wickiup	
Canyon Pintado*	A-H	Trail	
Carrot Men Pictograph Site*	A	Rock art	
Fremont Fortification Lookout Site*	A	Rock wall	
ROUTT COUNTY			
Hahn's Peak Schoolhouse*	H		
Steamboat Springs Depot*	H	Railroad	

The following sites have been determined eligible for the National Register of Historic Places:

RIO BLANCO COUNTY		
Whiskey Creek Trestle	H	Railroad
Collage Shelter	A	Rock art

* Sites whose themes are discussed or considered in the text.
H = Historic Type A = Archaeological Type

TABLE 3-16, Part 2 (contd.)

PROPERTIES ON THE NATIONAL REGISTER OF HISTORIC PLACES (1980) WYOMING

Name	Type	Kind	Other
SUBLETTE COUNTY			
Union Pass	H	Trail	Natural Landmark
Wardell Buffalo Trap*	A	Kill	48 SU 301
Father DeSmet's Prairie Mass Site	H	Site	
Upper Green River Rendezvous Site*	H	Site	Nat'l.Hist.Landmark
Fort Bonneville	H	Site	
SWEETWATER COUNTY			
Parting of the Ways (Oregon Trail)*	H	Trail	
Granger Station	H	Stage station	
Expedition Island	H	Site	Nat'l.Hist.Landmark
Red Rock	H	Rock art	
Dug Springs Station	H	Stage station	
Laclede Station	H	Stage station	
Point of Rocks Stage Station	H	Stage station	
UINTA COUNTY			
Uinta County Courthouse	H	Architectural	
Bridger Antelope Trap*	A	Kill	48 UT 1
Fort Bridger*	H	Fort	
Piedmont Charcoal Kilns	H	Unique	

The following sites have been determined eligible for the National Register of Historic Places:

Name	Type	Kind	Other
LINCOLN COUNTY			
Comberland (sic)*	H	Town	
Lander Cutoff of the Oregon Trail*	H	Trail	
SWEETWATER COUNTY			
Cedar Canyon Petroglyphs*	A	Rock art	
Black Butte Stage Station	H	Stage station	
Gibralter Townsite and Mine*	H	Town	
Hallville Townsite and Mine*	H	Town	

* Represents sites whose origins are discussed or considered in the text.

TABLE 3-16, Part 3

PROPERTIES ON THE NATIONAL REGISTER OF HISTORIC PLACES (1980) WYOMING

Name	Type	Kind	Other
SUBLETTE COUNTY			
Union Pass	H	Trail	Natural Landmark
Wardell Buffalo Trap*	A	Kill	48 SU 301
Father DeSmet's Prairie Mass Site	H	Site	
Upper Green River Rendezvous Site*	H	Site	Nat'l.Hist.Landmark
Fort Bonneville	H	Site	
SWEETWATER COUNTY			
Parting of the Ways (Oregon Trail)*	H	Trail	
Granger Station	H	Stage station	
Expedition Island	H	Site	Nat'l.Hist.Landmark
Red Rock	H	Rock art	
Dug Springs Station	H	Stage station	
Laclede Station	H	Stage station	
Point of Rocks Stage Station	H	Stage station	
UINTA COUNTY			
Uinta County Courthouse	H	Architectural	
Bridger Antelope Trap*	A	Kill	48 UT 1
Fort Bridger*	H	Fort	
Piedmont Charcoal Kilns	H	Unique	

The following sites have been determined eligible for the National Register of Historic Places:

Name	Type	Kind	Other
LINCOLN COUNTY			
Comberland (sic)*	H	Town	
Lander Cutoff of the Oregon Trail*	H	Trail	
SWEETWATER COUNTY			
Cedar Canyon Petroglyphs*	A	Rock art	
Black Butte Stage Station	H	Stage station	
Gibralter Townsite and Mine*	H	Town	
Hallville Townsite and Mine*	H	Town	

* Represents sites whose origins are discussed or considered in the text.

TABLE 3-17

BASELINE ANALYSIS: CULTURAL RESOURCES

	Occurrence			Significance 1/		
	Acres Done	Sites Found	Acre/ Site	R	T	E
Wyoming (T)	204,730	649	315	14	173	18
Carbon	41,860	45	930	3	78	18
Sweetwater	91,330	448	204	9	95	0
Colorado (T)	101,615	708	144	203	9	203
Moffat	20,183	200	101	48	8	8
Routt	7,344	28	262	5	--	--
Rio Blanco	74,088	480	154	150	1	150
Region (5 counties)	306,345	1,357	226	217	182	221

1/ R = Recommended for testing or as eligible to National Register
T = Tested or mitigated
E = Eligible or tested and still need more work

TABLE 3-18

ARCHAEOLOGICAL SITE TYPES

Kind	Characteristics
Lithic scatter (open lithic; chippings; chipping station)*	Area where the waste from the manufacture of stone tools or the tools themselves are found.
Campsite (habitation; camp; burnt spots; fire pots; hearths)	A lithic scatter with the addition of features connected with fire making: charcoal, ash, fire cracked rocks, or burnt bone.
Quarry (chippings; manufacturing areas)	An area containing a natural source of rocks suitable for making tools. Unmodified rock, waste, and tools in all stages of manufacture are found.
Kill site (trap; jump)	An area containing stone and/or bone tools in association with the remains of one or more animals.
Rock shelter (cave; overhang)	An area protected from the weather by an overhanging rock formation. Usually has a drip line. May or may not have surface material culture.
Rock art (petrograph)	Any artistic expression or message on a rock surface.
(a) pictograph	(a) Painted figures of people, animals, plants, letters, numbers, or abstracts.
(b) petroglyph	(b) Incised figures of people, animals, plants, letters, numbers, or abstracts.
Burial	Remains of human beings, fragmentary or whole.
Tipi rings (stone circles, tipis)	Circular arrangement of spaced rocks, 3 to 15 m in diameter.
Wickiup (tipi poles)	Poles or branches of pinyon or juniper laid up against living trees. Interior floored with juniper bark.
Granary (cist, corncrib)	Mud-mortared sandstone slab structures, usually about 1.5x1.5x1.5m. Most often built into sandstone ledges, sometimes mud lined and capped or lidded with a large slab.
Rock walls (forts)	Alignments or walls of mud-mortared or dry-laid stone masonry. May be single or multiple. May have "doorway," usually built on ridge.

* Words in parentheses are synonyms for that kind of site.

TABLE 3-19

HISTORIC SITE TYPES

Kind	Characteristics
Trails	Identified routes followed by early explorers or by many emigrants. Physical evidence may (Overland) or may not (Dominguez-Escalante) remain.
Forts	Military establishments for the protection of persons or property. Also gathering and exchange points prior to the establishment of towns.
Stage Stations	Wayfarers' resting places and fresh harness animal acquisition points.
Homestead	One or more structures of varied size, shape and materials used to shelter isolated Euro-American families claiming land under various homestead laws.
Ranch	Cluster of structures of single and multiple uses associated with a livestock-based family economic operation.
Railroad	Roadbed, tracks, trestles, bridges, depots and rolling stock associated with early (and continued) industrial transportation of goods and pecple.
Town	Aggregation of structures sheltering domestic, business, educational, social, political and religious activities. Individual structures may be single or multiple use, but population is multifamily.
Unique Structure	Any structure whose merit is associated with a particular person.
Site	The location where a historic event occurred but no tangible evidence remains of the action itself.
Architectural	A structure whose merit is its manner or style of construction.
School	A structure built for educational purposes but whose historical function is as a community center in the absence of nearby towns.
Community Center	A structure, often a public school, which provides a relatively local meeting place for residents of areas with few towns.
Mine	An outcropping of valuable mineral resource and the structures associated with the removal activity.
Reclamation Projects	Structures associated with irrigation, water and soil retention or flood control. Usually, these are engineering features.

TABLE 3-20

RADIOCARBON DATES

Years Before Present 1/	Site
11,280 ± 350	Union Pacific Mammoth 48 CR 182
9,695 ± 195	Pine Springs 48 SW 101
8,950 ± 120) 8,840 ± 120)	Finley 48 SW 5
5,220 ± 150	Shoreline 48 CR 122
4,945 ± 415) 4,605 ± 500)	Threemile Gulch 5 RB 298
4,540 ± 110	Scoggin 48 CR 304
3,690 ± 130) 3,600 ± 130)	5 RB 312
2,470 ± 140	Cherokee Trail #1
2,300 ± 95) 2,490 ± 60) 2,330 ± 110) 2,120 ± 100)	Bull Draw Shelter 5 MF 607 (Raw Data)
1,825 ± 100	5 RB 704
1,720 ± 110	Muddy Creek 48 CR 324
1,775 ± 65) 1,450 ± 60)	5 RB 715
1,645 ± 65) 1,340 ± 50) 1,150 ± 50)	Brady 5 RB 726
1,375 ± 60	5 RB 707
1,390 ± 110) 1,270 ± 100) 1,250 ± 100)	Cherokee Trail #1
1,580 ± 110) 1,170 ± 100) 990 ± 110)	Wardell 48 SU 301
1,255 ± 85	Dripping Brow 5 RB 699 2/
955 ± 75	Muad'Dib 5 JA 58
230 ± 100	Eden-Farson 48 SW 304

1/ Present is defined as AD 1955
2/ A selected central date

TABLE 3-21

TOTAL POPULATION

	1960	1970	1978	1987	1990	1995	Annual Rate of Growth 1960-70	1970-78	1978-95
Moffat County	7,061	6,525	11,363	20,304	21,926	22,170	- 0.7	7.2	4.0
Craig	3,984	4,205	7,715	16,472	18,032	18,274	0.5	7.9	5.2
Rio Blanco County	5,150	4,842	6,760	18,573	17,031	16,119	- 0.6	4.3	5.2
Meeker	1,655	1,597	2,976	9,635	8,749	8,494	- 0.3	8.1	6.4
Routt County	5,900	6,592	11,485	18,600	19,976	20,292	1.1	7.2	3.4
Hayden	764	763	1,548	2,553	2,690	2,707	0	9.2	3.3
Oak Creek	666	492	792	1,187	1,249	1,257	- 2.3	6.1	2.8
Steamboat Springs	1,843	2,340	4,780	10,560	11,763	12,100	2.4	9.3	5.6
Yampa	312	286	312	337	341	345	- 0.8	1.1	0.6
Albany County									
Rock River	497	344	450	507	515	535	- 2.7	3.4	1.0
Other, excluding Laramie	3,273	2,944	1,623	1,832	1,860	1,931	- 1.0	- 4.7	1.0
Carbon County	14,937	13,354	24,496	27,633	28,056	29,135	- 1.0	7.9	1.0
Baggs	199	146	396	448	455	472	- 2.4	13.3	1.0
Dixon	108	72	68	77	79	82	-2.9	- 0.7	1.1
Elk Mountain	190	127	239	271	275	286	- 2.9	8.2	1.0
Elmo/Hanna	716	513	2,376	2,680	2,721	2,826	- 2.5	21.1	1.0
Encampment/Riverside	420	367	767	865	878	912			1.0
Medicine Bow	392	455	1,487	1,677	1,703	1,768	1.5	16.1	1.0
Rawlins	8,968	7,855	13,494	15,223	15,456	16,050	- 1.2	7.0	1.0
Saratoga	1,133	1,181	2,700	3,045	3,092	3,211	0.4	10.9	1.0
Walcott Junction	0	0	140	158	160	166	0	1/	1.0
Sweetwater County									
Creston Junction	0	0	35	42	43	44	0	1/	1.4
Wamsutter	110	139	463	521	529	549	2.4	16.2	1.0
Total Impacted Area	28,041	26,464	45,190	71,279	73,827	75,371	- 0.5	6.9	3.1
State of Colorado	1,753,925	2,207,259	2,670,000				2.3	2.4	
State of Wyoming	330,066	332,416	459,151				0.1	4.1	
United States (000)	179,323	203,213	218,228				1.3	0.9	

Sources: U. S. Department of Commerce, Bureau of the Census. 1970 Census of Population Washington, Government Printing Office, 1971.
Colorado Department of Local Affairs, Division of Planning. Colorado Population Reports, Series CP-26, No. 79 (A)-1, Denver, 1979.

1/ Cannot be calculated.

TABLE 3-22

POPULATION DENSITY AND COMPONENTS OF GROWTH 1970-1978

	Moffat County	Rio Blanco County	Routt County	Carbon County	Total Impacted Area	State of Colorado	State of Wyoming	United States
Area (square miles)	4,743	3,263	2,330	7,905	18,241	103,766	97,203	3,536,855
Population: 1970	6,525	4,842	6,592	13,354	31,313	2,207,259	332,416	203,212,926
1978	11,363	6,760	11,485	24,496	54,104	2,670,000	459,151	218,228,000
Persons per square mile: 1970	1.4	1.5	2.8	1.7	1.7	21.3	3.4	57.5
1978	2.4	2.1	4.9	3.1	3.0	25.7	4.7	61.7
Population 1970	6,525	4,842	6,592	13,354	31,313			
Births 1970-1977	1,129	680	1,127	2,139	5,075			
Deaths 1970-1977	489	330	472	1,148	2,439			
Natural Increase	640	350	655	991	2,636			
Net Migration	4,198	1,568	4,238	10,151	20,155			
Total Growth	4,838	1,918	4,893	11,142	22,791			
Population 1978	11,363	6,760	11,485	24,496	54,104			

Sources: Allen, 1979
Wyoming Department of Administration and Fiscal Control. Wyoming Data Handbook.

TABLE 3-23

LABOR FORCE, EMPLOYMENT, AND UNEMPLOYMENT RATES 1973 AND 1978

	1973	1978	Percent Change
Labor Force			
Moffat County	3,498	6,911	98
Rio Blanco County	2,035	2,496	23
Routt County	5,545	9,552	72
Carbon County	6,141	9.240	50
Total Impacted Area	17,219	28,199	64
State of Colorado	1,104,817	1,328,848	20
State of Wyoming	142,985	208,000	45
Total Employment			
Moffat County	3,355	6,558	95
Rio Blanco County	1,966	2,440	24
Routt County	5,326	9,104	71
Carbon County	5,978	9,016	51
Total Impacted Area	16,625	27,118	63
State of Colorado	1,071,400	1,279,513	19
State of Wyoming	138,207	201,000	45
Unemployment Rate			
Moffat County	4.1	5.1	
Rio Blanco County	3.4	2.2	
Routt County	3.9	4.7	
Carbon County	2.7	2.4	
Total Impacted Area	3.4	3.8	
State of Colorado	3.0	3.7	
State of Wyoming	3.3	3.3	

SOURCES: Larson, 1979.
Wolford, 1980.

TABLE 3-24, Part 1

EMPLOYMENT BY SECTOR

	Employment					Percent of Total				
	1973	1978	1987	1990	1995	1973	1978	1987	1990	1995
Moffat County										
Agriculture	243	128	134	134	135	10.5	2.7	1.6	1.5	1.5
Mining	280	400	902	929	929	12.1	8.5	10.8	10.3	10.2
Construction	115	600	650	764	774	5.0	12.7	7.8	8.5	8.5
Manufacturing	84	250	363	375	380	3.6	5.3	4.4	4.2	4.2
Transp., Comm. and Utilities	248	390	746	750	754	10.7	8.2	9.0	8.3	8.3
Trade	474	1,016	1,410	1,645	1,683	20.5	21.5	16.9	18.3	18.5
Finance, Insurance & Real Estate	59	240	415	445	455	2.5	5.1	5.0	5.0	5.0
Services	279	889	1,436	1,569	1,591	12.0	18.8	17.3	17.4	17.5
Government	535	814	2,268	2,386	2,397	23.1	17.2	27.2	26.5	26.3
Total	2,317	4,727	8,324	8,997	9,098	100.0	100.0	100.0	100.0	100.0
Rio Blanco County										
Agriculture	128 1/	91	95	95	95	1/	2.7	0.9	1.0	1.0
Mining	304	470	5,081	5,093	5,114	17.8	14.1	50.4	52.6	53.2
Construction	109	1,500	298	200	200	6.4	45.0	3.0	2.0	2.1
Manufacturing	33	40	120	100	100	1.9	1.2	1.2	1.0	1.0
Transp., Comm. and Utilities	111	203	310	310	310	6.5	6.1	3.1	3.2	3.2
Trade	203 1/	286	1,070	925	875	1/	8.6	10.6	9.6	9.1
Finance, Insurance & Real Estate	38	81	170	140	135	2.2	2.4	1.7	1.4	1.4
Services	163	188	951	925	890	9.6	5.7	9.4	9.6	9.3
Government	601	472	1,990	1,895	1,890	35.2	14.2	19.7	19.6	19.7
Total	1,705	3,331	10,085	9,683	9,609	100.0	100.0	100.0	100.0	100.0

TABLE 3-24, Part 2

EMPLOYMENT BY SECTOR

	Employment					Percent of Total				
	1973	1978	1987	1990	1995	1973	1978	1987	1990	1995
Routt County										
Agriculture	185	119	123	123	124	5.8	2.4	1.5	1.4	1.4
Mining	136	601	1,084	1,131	1,131	4.2	11.9	13.3	13.0	12.8
Construction	404	471	540	640	645	12.6	9.3	6.6	7.3	7.3
Manufacturing	87	112	188	195	200	2.7	2.2	2.3	2.2	2.2
Transp., Comm. and Utilities	164	393	727	729	732	5.1	7.8	8.9	8.4	8.3
Trade	747	1,131	1,406	1,643	1,696	23.3	22.4	17.2	18.8	19.1
Finance, Insurance & Real Estate	183	320	502	532	547	5.7	6.3	6.1	6.1	6.2
Services	734	1,100	1,575	1,705	1,738	22.8	21.7	19.3	19.5	19.6
Government	571	811	2,021	2,035	2,051	17.8	16.0	24.8	23.3	23.1
Total	3,211	5,058	8,166	8,733	8,864	100.0	100.0	100.0	100.0	100.0
Albany, Carbon and Sweetwater Counties										
Agriculture	789	1,139	1,139	1,139	1,139	2.5	2.8	2.8	2.8	2.8
Mining	W	7,595	7,608	7,536	7,536		18.7	18.7	18.2	18.2
Construction	3,911	4,873	4,651	4,737	4,737	12.2	12.0	11.4	11.4	11.4
Manufacturing	1,276	1,274	1,269	1,272	1,272	4.0	3.1	3.1	3.1	3.1
Transp., Comm. and Utilities	W	2,856	2,859	2,877	2,877		7.0	7.0	7.0	7.0
Trade	5,130	8,284	8,282	8,359	8,359	16.0	20.4	20.3	20.2	20.2
Finance, Insurance & Real Estate	W	1,211	1,210	1,219	1,219		3.0	3.0	2.9	2.9
Services	4,412	3,575	3,573	3,607	3,607	13.8	8.8	8.8	8.7	8.7
Government	7,087	9,818 2/	10,167 2/	10,653 2/	10,653 2/	22.1	24.2	24.9	25.7	25.7
Other	W									
Total	32,051	40,625	40,758	41,399	41,399	100.0	100.0	100.0	100.0	100.0

TABLE 3-24, Part 3

EMPLOYMENT BY SECTOR (THOUSANDS)

	State of Colorado				State of Wyoming			
	Employment		Percent of Total		Employment		Percent of Total	
	1973	1978	1973	1978	1973	1978	1973	1978
Agriculture	51.5	38.3	5.2	3.3	15.5	14.8	14.4	8.0
Mining	15.0	27.3	1.5	2.3	13.0	29.2	12.0	15.8
Construction	73.0	72.3	7.4	6.2	11.7	20.3	10.8	11.0
Manufacturing	143.3	165.9	14.5	14.1	8.4	9.6	7.8	5.2
Transp., Comm. & Utilities	59.1	68.8	6.0	5.9	7.9	11.1	7.3	6.0
Trade	223.8	284.5	22.7	24.2	27.5	41.8	25.5	22.6
Finance, Ins. and Real Estate	52.9	67.6	5.3	5.8	4.0	6.4	3.7	3.5
Services	171.6	231.7	17.4	19.7	16.0 3/	42.8 3/	14.8	23.1
Government	197.2	216.6	20.0	18.5	4.0 3/	8.8 4/	3.7	4.8
Total	987.4	1,173.0	100.0	100.0	108.0	184.8	100.0	100.0

Sources: U. S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System.
Centaur Associates, Inc., Potential Socioeconomic Impacts, prepared for the BLM Wyoming State Office.
Wolford, 1980.
BLM estimates.

Note: Some changes within sectors between years result from the use of different data sources and classification differences occurring in the original data.

W: Withheld to avoid disclosure of confidential information. Data are included in totals.

1/ An additional 15 employees in non-covered businesses belong in these categories and are included in the total. Therefore, percents of total cannot be calculated.
2/ Includes "other".
3/ Many more firms were included in covered employment in 1978 than in 1973. A sizeable portion of government employment was also excluded in 1973.
4/ Represents public administration only. Beginning in 1978, other government employment is classified in other sectors according to closely related activities.

TABLE 3-25, Part 1

INCOME BY SECTOR
(Thousand 1978 Dollars)

	Income					Percent of Total				
	1973	1978	1987	1990	1995	1973	1978	1987	1990	1995
					Moffat County					
Agriculture	8,061	1,120	1,173	1,173	1,181	23.2	2.1	1.2	1.1	1.1
Mining	4,598	8,194	18,478	19,031	19,031	13.2	15.5	19.0	18.3	18.2
Construction	2,418	9,421	10,206	11,996	12,153	6.9	17.8	10.5	11.5	11.6
Manufacturing	W	2,581	3,747	3,872	3,923		4.9	3.9	3.7	3.8
Transp., Comm. and Utilities	3,186	5,949	11,562	11,614	11,678	9.1	11.2	11.9	11.2	11.1
Trade	6,072	7,270	10,087	11,596	11,858	17.4	13.7	10.4	11.2	11.3
Finance, Insurance & Real Estate	935	2,434	4,209	4,513	4,615	2.7	4.6	4.3	4.3	4.4
Services	2,832	5,906	9,453	10,365	10,512	8.1	11.1	9.7	10.0	10.0
Government	5,374	10,157	28,304	29,777	29,914	15.4	19.2	29.1	28.7	28.5
Other	W									
Total	34,817	53,032	97,219	103,937	104,865	100.0	100.0	100.0	100.0	100.0
					Rio Blanco County					
Agriculture	10,504	796	832	832	832	35.5	1.6	0.5	0.5	0.5
Mining	4,875	10,954	109,626	109,910	110,406	16.5	22.5	68.0	70.0	70.4
Construction	1,706	23,552	4,679	3,140	3,140	5.8	48.4	2.9	2.0	2.0
Manufacturing	W	413	1,239	1,032	1,032		0.8	0.8	0.7	0.7
Transp., Comm. and Utilities	1,973	3,013	4,788	4,788	4,788	6.7	6.2	3.0	3.0	3.0
Trade	2,297	1,990	7,082	6,118	5,795	7.8	4.1	4.4	3.9	3.7
Finance, Insurance & Real Estate	W	822	1,724	1,420	1,369		1.7	1.1	0.9	0.9
Services	1,644	1,237	6,321	6,147	5,912	5.6	2.5	3.9	3.9	3.8
Government	5,348	5,889	24,835	23,649	23,587	18.1	12.1	15.4	15.1	15.0
Other	W									
Total	29,608	48,666	161,126	157,036	156,861	100.0	100.0	100.0	100.0	100.0

TABLE 3-25, Part 2

INCOME BY SECTOR
(Thousand 1978 Dollars)

	Income					Percent of Total				
	1973	1978	1987	1990	1995	1973	1978	1987	1990	1995
Routt County										
Agriculture	4,535	1,041	1,076	1,076	1,085	11.0	1.9	1.1	1.1	1.1
Mining	3,329	12,312	22,207	23,170	23,170	8.1	21.9	23.3	23.0	22.8
Construction	5,330	7,395	8,479	10,049	10,127	12.9	13.2	8.9	10.0	9.9
Manufacturing	W	1,156	1,941	2,013	2,065		2.1	2.0	2.0	2.0
Transp., Comm. and Utilities	3,108	5,988	11,224	11,250	11,295	7.5	10.7	11.8	11.2	11.1
Trade	6,748	7,585	9,503	11,020	11,374	16.3	13.5	10.0	10.9	11.2
Finance, Insurance & Real Estate	2,573	3,245	5,091	5,396	5,548	6.2	5.8	5.4	5.4	5.5
Services	8,391	7,359	10,417	11,308	11,531	20.3	13.1	11.0	11.2	11.3
Government	6,126	10,120	25,221	25,396	25,595	14.8	18.0	26.5	25.2	25.1
Other	W									
Total	41,346	56,202	95,159	100,678	101,790	100.0	100.0	100.0	100.0	100.0
Albany, Carbon and Sweetwater Counties										
Agriculture	26,390	5,784	5,784	5,784	5,784	5.6	1.1	1.1	1.0	1.0
Mining	W	162,572	162,791	162,181	162,181		29.4	29.4	28.8	28.8
Construction	82,899	79,351	75,737	77,131	77,131	17.5	14.3	13.7	13.7	13.7
Manufacturing	20,022	17,754	17,680	17,721	17,721	4.2	3.2	3.2	3.2	3.2
Transp., Comm. and Utilities	W	70,478	70,586	71,051	71,051		12.7	12.7	12.6	12.6
Trade	44,248	59,880	59,877	60,419	60,419	9.4	10.8	10.8	10.7	10.7
Finance, Insurance & Real Estate	W	11,635	11,624	11,711	11,711		2.1	2.1	2.1	2.1
Services	33,881	26,177	26,169	26,417	26,417	7.2	4.7	4.7	4.7	4.7
Government	74,388	119,788 1/	123,680 1/	130,544 1/	130,544 1/	15.7	21.7	22.3	23.2	23.2
Other	W									
Total	472,576	553,419	553,928	562,959	562,959	100.0	100.0	100.0	100.0	100.0

TABLE 3-25, Part 3

INCOME BY SECTOR
(Million 1978 Dollars)

	State of Colorado				State of Wyoming			
	Income		Percent of Total		Income		Percent of Total	
	1973	1978	1973	1978	1973	1978	1973	1978
Agriculture	851	425	5.7	2.5	213	104	10.6	3.5
Mining	292	679	2.0	4.0	227	688	11.3	23.4
Construction	1,373	1,311	9.2	7.7	235	348	11.7	11.8
Manufacturing	2,283	2,832	15.4	16.6	120	158	6.0	5.4
Transp., Comm. & Utilities	1,151	1,432	7.7	8.4	213	284	10.6	9.6
Trade	2,626	3,003	17.7	17.6	279	421	13.9	14.3
Finance, Ins. and Real Estate	848	1,093	5.7	6.4	60	103	3.0	3.5
Services	2,239	2,919	15.1	17.2	219	337	10.9	11.5
Government	3,193	3,330	21.5	19.6	442	499	22.0	17.0
Total	14,856	17,025 2/	100.0	100.0	2,008	2,942 2/	100.0	100.0

Sources: U. S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System.
Centaur Associates, Inc., Potential Socioeconomic Impacts, prepared for the BLM Wyoming State Office.
Coleman, 1979.
BLM estimates.

Note: Some changes within sectors between years result from the use of different data sources and classification differences occurring in the original data.

W: Withheld to avoid disclosure of confidential information. Data are included in totals.

1/ Includes "other".
2/ Detail did not add to total in source. Total altered to permit percents of total to be calculated. Since original data are estimates, error involved should be slight.

TABLE 3-26

AVERAGE WAGE AND SALARY

	1973	1978	Percent Change	1973	1978	Percent Change
	Moffat County			Rio Blanco County		
Mining	$11,186	$20,485	83	$10,924	$23,306	113
Construction	14,322	15,702	10	10,661	15,701	47
Other Employment	9,853	9,503	- 4	12,141	10,404	- 14
All Employment	10,236	11,219	10	11,829	14,610	24
	Routt County			Albny,Crbn&Swtwtr Counties		
Mining	16,676	20,486	23	NA	21,405	
Construction	8,988	15,701	75	14,439	16,284	13
Other Employment	8,336	9,156	10	NA	11,063	
All Employment	8,771	11,112	27	10,043	13,623	36
	State of Colorado			State of Wyoming		
Mining	13,267	24,872	87	11,923	23,562	98
Construction	12,808	18,133	42	13,675	17,143	25
Other Employment	9,991	14,007	40	12,641	14,087	11
All Employment	10,249	14,514	42	12,667	15,920	26

Note: Figures for 1973 were calculated from current dollar data, not that shown in Table 3-25.

Derived from: U. S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System and Tables 3-24 and 3-25.

NA: Not available because of confidential data withheld.

Table 3-27

TOTAL OPERATING REVENUES AND GROSS BONDING CAPACITIES - 1978
(Thousand Dollars)

	Total Operating Revenue	Gross Bonding Capacity
Carbon County	3,756	4,617
Moffat County	7,173	1,611
Rio Blanco County	4,173	3,083
Routt County	4,312	1,688
Baggs	106	23
Craig	2,749	2,006
Dixon	36	6
Elk Mountain	57	18
Elmo/Hanna	343	145
Encampment/Riverside	105	53
Hayden	346	317
Medicine Bow	197	54
Meeker	667	661
Oak Creek	270	93
Rawlins	2,868	1,252
Rock River	81	49
Saratoga	550	220
Steamboat Springs	2,342	4,295
Wamsutter	128	25
Yampa	60	78
Carbon County School District #1	5,161	9,831
Carbon County School District #2	4,284	13,256
Moffat County School District #1	4,734	21,476
Rio Blanco County Sch. Dist. #1	1,808	4,658
Routt County School District #1	1,808	10,620
Routt County School District #2	3,421	9,636
Routt County School District #3	1,514	4,047

Notes: Operating revenues shown for Wyoming communities are general fund revenues only.
Gross bonding capacity figures have not had presently outstanding general obligation bonds deducted from them.
Operating revenues for Colorado jurisdictions exclude large non-recovering items such as special project grants.

Sources: Colorado: data from individual jurisdictions.
Wyoming: Centaur Associates, Inc. "Description of the Existing Socioeconomic Environment in Southcentral Wyoming," prepared for the BLM Wyoming State Office. 1977
Stuart/Nichols Associates. Impact Analysis - Baggs, Wyoming and Dixon, Wyoming 1978 to 1985 (separate documents). 1978
Wyoming Taxpayers Association.

TABLE 3-28

PRINCIPAL VALUE OF MUNICIPAL AND SCHOOL DISTRICT BONDS
OUTSTANDING ON DECEMBER 31, 1978
(Thousand Dollars)

	Gen. Oblig. Bonds	Revenue Bonds	Total Bonded Debt
Baggs	NA	NA	$ 75
Craig	425	2,303	2,728
Dixon	NA	NA	149
Elk Mountain	NA	NA	26
Elmo/Hanna	NA	NA	294
Encampment/Riverside	NA	NA	43 1/
Hayden	120	127	247
Medicine Bow	NA	NA	38
Meeker	0	0	0
Oak Creek	179	0	179
Rawlins	NA	NA	3,548
Rock River	0	0	0
Saratoga	NA	NA	282
Steamboat Springs	3,150	378	3,528
Wamsutter	NA	NA	198
Yampa	26	230	256
Carbon County School District #1	9,122	0	9,122
Carbon County School District #2	9,813	0	9,813
Moffat County School District #1	7,977	0	7,977
Rio Blanco County Sch. Dist. #1	895	0	895
Routt County School District #1	1,860	0	1,860
Routt County School District #2	605	0	605
Routt County School District #3	0	0	0

Sources: Colorado: Data from individual jurisdictions.
Wyoming: Centaur Associates, Inc. "Description of the Existing Socioeconomic Environment in Southcentral Wyoming" (prepared for the Bureau of Land Management, Wyoming State Office). 1979.

NA: Data not obtained.

1/ Excludes Riverside.

TABLE 3-29

EDUCATIONAL ATTAINMENTS--CURRENTLY AFFECTED COMMUNITIES
MONTANA, NORTH DAKOTA, WYOMING, AND THE UNITED STATES

Highest Educational Level Completed	Percentage of Residents: Currently Affected Communities 1/ — Long Time Residents	Newcomer Construction Workers	Other Newcomers	Montana 2/	North Dakota 2/	Wyoming 2/	United States 2/
Less than High School Graduation	27.1	16.6	11.8	40.8	49.7	37.1	47.7
High School Graduate	43.8	45.5	32.4	34.0	27.6	36.2	31.1
Some College	13.7	21.6	28.8	14.1	14.3	14.8	10.6
College Graduate	8.3	6.4	16.3	6.9	5.2	7.2	6.1
Some Graduate School	2.0	1.3	4.0				
Advanced Degree	2.2	0.9	3.6	4.1	3.2	4.6	4.6
Vo-Tech School	2.9	7.7	3.3	---	---	---	---
TOTAL 3/	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1/ Educational attainments for household heads and spouses are included for the currently affected communities. Data for the United States and for the states were reported for persons 25 and over. Because of the method of data analysis for the Household Survey, it was not possible to present data for persons 25 and over only. Some household heads and spouses were under 25, but only six listed their occupastions as "student," and so the rest were assumed to have completed their educations. As a result of the procedure of including only heads and spouses in this analysis, some household members over 25 (48 persons) were left out of the educational attainment data for communities presented here.

2/ Source: U.S. Bureau of the Census, 1970 Census of Population: Characteristics of the Population, United States Summary (Washington, D.C.: U.S. Government Printing Office, 1973), pp. 1-493, 1-494.

3/ Totals may not add to 100.0 percent because of rounding.

TABLE 3-30

TEACHER STUDENT RATIOS FOR IMPACTED AREA SCHOOLS

Schools		Average Number of Students per Teacher 1970	1975	1978
Craig:	Elementary	22.1	24.2	26.0
	Secondary	20.5	18.5	18.7
Hayden:	Elementary	23.4	20.8	19.4
	Secondary	19.8	16.1	14.6
Oak Creek/Yampa:	Elementary	30.1	20.1	17.4
	Secondary	10.3	12.2	16.7
Steamboat Springs:	Elementary	24.6	20.6	19.4
	Secondary	17.9	15.9	15.3
Rawlins Dist. #1:	All 1/			19.0
Rawlins Dist. #2:	All			14.4

1/ Figures for other years and breakdown by grades not available; figures for other Wyoming schools of impacted area not available.

TABLE 3-31

MEDICAL CARE FOR IMPACTED AREA

Hospitals	1978 Ratio Primary Care Physicians/Population (Number of persons per doctor)	1978 Ratio Nurses to Population (Number of persons per nurse)
	(Whole County)	(Whole County)
Craig Memorial (Craig)	758	494
Routt County (Steamboat)	574	499
Pioneers (Meeker) 1/	1,488	313
Rawlins (Rawlins)	2,041	355

Communities Without Hospitals	Number of miles to Nearest Hospital	Doctor	Ambulance Service
Hayden	17 (Craig)	No	Yes
Oak Creek	25 (Steamboat)	No	Yes
Yampa	31 (Steamboat)	No	Yes
Elk Mountain	44 (Rawlins)	No	(
Elmo	43 (Rawlins)	No	(Served
Encampment	60 (Rawlins)	No	(from
Hanna	41 (Rawlins)	Yes	(County
Medicine Bow	55 (Rawlins)	No	(Hospital
Saratoga	41 (Rawlins)	Yes	(in Rawlins.
Wamsutter	40 (Rawlins)	No	(
Rock River	37 (Laramie)	No	Yes

1/ Accreditation dropped 1979.

TABLE 3-32

TRENDED TRAFFIC PROJECTIONS AND VOLUME TO CAPACITY RATIOS FOR THE COLORADO ROAD SEGMENTS

Road Segment	1978 ADT1/	1987 ADT1/	1990 ADT1/	1995 ADT1/	PHT as a % of The ADT	PHT 2/ 1978	PHT 2/ 1987	PHT 2/ 1990	PHT 2/ 1995	Capacity Vol @ Sv Level C	PHT 3/ 1978	PHT 3/ 1987	PHT 3/ 1990	PHT 3/ 1995
A	1,450	1,700	1,800	1,950	17	247	290	306	332	910	.27	.32	.34	.36
B	3,400	4,000	4,200	4,550	15	510	600	630	682	680	.75	.88	.93	1.00
C	3,400	4,000	4,200	4,550	15	510	600	630	682	680	.75	.88	.93	1.00
D	1,450	3,100	3,000	2,700	16	232	496	480	432	790	.29	.63	.61	.55
E	1,250	3,100	2,950	2,650	16	200	496	472	424	790	.25	.63	.60	.54
F	1,000	2,650	2,500	2,200	16	160	424	400	352	760	.20	.54	.51	.45
G	1,200	1,450	1,550	1,700	15	180	218	233	255	760	.24	.29	.31	.34
H	750	900	950	1,050	20	150	180	190	210	740	.20	.24	.26	.28
I	150	200	250	250	20	28	40	45	50	640	.04	.06	.07	.08
J	380	500	550	650	20	76	100	110	130	600	.13	.16	.18	.22
K	1,600	1,900	2,000	2,150	17	272	323	340	366	680	.40	.48	.50	.54

1/ Average Daily Traffic.
2/ Peak Hour Traffic.
3/ Maximum Peak Hour Divided by Capacity.
Source: Colorado Department of Highways

TABLE 3-33

TRENDED ACCIDENT PROJECTIONS FOR COLORADO

Road Segment	Segment Length	1978 ADT 1/	1987 ADT 1/	1990 ADT 1/	1995 ADT 1/	Accidnt Rate	Total Accdnts 1978	Total Accdnts 1987	Total Accdnts 1990	Total Accdnts 1995
A	30.4	1,450	1,700	1,800	1,950	2.15	35	41	43	47
B	15.1	3,400	4,000	4,200	4,550	9.20	172	203	213	231
C	13.2	3,400	4,000	4,200	4,550	4.45	73	86	90	98
D	18.2	1,450	3,100	3,000	2,700	5.40	52	111	108	97
E	12.1	1,250	3,100	2,950	2,650	5.41	30	74	71	63
F	16.2	1,000	2,650	2,500	2,200	7.73	45	121	114	101
G	36.7	1,200	1,450	1,550	1,700	3.29	53	64	68	75
H	9.4	750	900	950	1,050	9.74	25	30	32	35
I	12.1	140	200	250	250	8.79	5	8	9	10
J	60.8	380	500	550	650	3.38	29	38	41	49
K	59.1	1,600	1,900	2,000	2,150	1.40	48	57	60	65

1/ Average Daily Traffic.
Source: Colorado Department of Highways

TABLE 3-34

TRENDED ACCIDENT PROJECTIONS FOR WYOMING

Road Segment	Segment Length	1978 ADT 1/	1987 ADT 1/	1990 ADT 1/	1995 ADT 1/	Accident Rate	1978 Total Accidents	1987 Total Accidents	1990 Total Accidents	1995 Total Accidents
A	38.4	6,150	8,250	8,950	10,100	1.31	113	151	164	185
B	51.4	7,100	9,950	11,000	12,500	1.02	136	190	210	239
C	53.2	900	1,650	1,900	2,300	1.12	20	36	41	50
E	38.2	1,250	2,000	2,350	2,650	1.85	32	52	61	68
F	17.6	1,500	2,100	2,250	2,500	4.07	39	55	59	65
G	18.43	1,000	1,700	1,900	2,150	2.50	17	29	32	58

1/ Average Daily Traffic
Source: Wyoming Department of Highways

TABLE 3-35

TRENDED TRAFFIC PROJECTIONS AND VOLUME TO CAPACITY RATIOS FOR THE WYOMING ROAD SEGMENTS

Road Segment	1978 ADT 1/	1987 ADT 1/	1990 ADT 1/	1995 ADT 1/	Max Peak Hour As A % of ADT	1978 MPH	1987 MPH	1990 MPH	1995 MPH	Capacity Vol @Svc Level C	1978 MPH/Capac	1987 MPH/Capac	1990 MPH/Capac	1995 MPH/Capac
A	6,150	8,250	8,950	10,100	12	738	990	1,074	1,212	2,470	.30	.40	.43	.49
B	7,100	9,950	11,000	12,500	12	852	1,194	1,320	1,500	1,950	.43	.61	.68	.77
C	900	1,650	1,900	2,300	14*	126	231	266	322	700	.18	.33	.38	.46
E	1,250	2,000	2,350	2,650	13*	163	260	293	345	860	.19	.30	.34	.40
F	1,500	2,100	2,250	2,500	14*	210	294	315	350	790	.27	.37	.40	.44
G	1,000	1,700	1,900	2,150	12	120	204	228	258	820	.15	.25	.28	.31

1/ Average Daily Traffic
Source: Wyoming Department of Highways

TABLE 3-36

COLORADO AT-GRADE CROSSINGS

Rural At-Grade Crossings

National Crossing Number	Exposure Factor				Hazard Rating (in accidents per 5 years)			
	1976	1987	1990	1995	1976	1987	1990	1995
253-690(C)	2,140	66,500	71,000	93,500	.63	7.09	7.15	8.53
253-678(U)	2,150	66,500	71,000	93,500	1.25	7.09	7.15	8.53
253-679(C)	1,900	66,500	71,000	93,500	.15	7.09	7.15	8.53
253-621(U)	1,200	11,500	13,200	15,600	.15	.75	.80	.83
253-614(J)	1,350	11,500	13,200	15,600	1.66	.75	.80	.83
253-302(B)	4,650	28,500	31,000	37,950	4.00	.94	.98	.99

Urban At-Grade Crossings

National Crossing Number	Exposure Factor				Hazard Rating (in accidents per 5 years)			
	1976	1987	1990	1995	1976	1987	1990	1995
* 253-288(H)	179,550	330,000	354,950	400,950	1.25	13.91	14.60	15.32
* 253-297(R)	89,300	219,000	248,000	301,950	.31	11.52	12.65	13.26
* 253-284(F)	133,950	258,000	279,000	320,100	2.50	12.65	13.26	13.91
253-285(M)	115,500	192,000	206,150	232,650	.31	11.27	11.42	12.65
253-294(L)	66,500	139,500	155,000	181,500	.31	9.71	10.82	11.12
253-282(S)	60,750	172,200	199,950	247,500	3.75	9.28	10.92	12.07
253-290(J)	54,000	144,150	163,200	198,900	1.25	9.88	10.97	11.27
253-293(E)	68,400	150,350	164,800	190,400	.31	9.86	10.95	11.32
253-295(T)	3,600	72,850	78,400	88,400	2.50	7.36	7.62	7.90
* 253-281(K)	170,300	373,100	411,600	481,800	5.00	14.60	14.60	15.32
* 253-279(J)	389,400	303,800	321,600	357,000	8.75	13.26	14.60	15.32

* Proposed grade separated by Colorado Department of Highways.

TABLE 3-37

SURFACE LAND OWNERSHIP BY COUNTY AND BY TRACT 1/

County	BLM Acres	BLM Percent	USFS Acres	USFS Percent	Other Federal Acres	Other Federal Percent	(Total Federal) Acres	(Total Federal) Percent	State Acres	State Percent	Private Acres	Private Percent	County, Municipal Acres	County, Municipal Percent	Total Acres	Total Percent
Moffat	1,516,363	50.0	41,763	1.3	173,093	5.7	(1,731,219)	(57)	208,733	6.9	1,088,097	35.9	7,460	.2	3,035,509	16.1
Routt	79,902	4.7	582,698	34.5	8,828	.5	(671,428)	(39.7)	67,761	4.0	949,424	56.1	2,841	.2	1,691,454	9.1
Rio Blanco	1,189,460	53.9	358,661	16.3	35,696	1.6	(1,583,817)	(71.8)	58,531	2.7	561,048	25.4	1,365	.1	2,204,761	11.7
Sweetwater	4,333,593	65.5	95,517 3/	1.4	31,184	.5	(4,460,294)	(67.4)	346,280	5.2	1,810,460	27.4	2/	--	6,617,034	35.2
Carbon	2,232,314	42.5	630,738	12.0	17,176	.3	(2,880,228)	(54.8)	361,143	6.9	2,013,866	38.3	2/	--	5,255,237	27.9
Total Region	9,351,632	49.7	1,709,377	9.1	265,977	1.4	(11,326,986)	(60.2)	1,042,448	5.5	6,422,895	34.2	11,666	.1	18,803,995	100.0
Tract																
China Butte	6,240	37.8	--		--		(6,240)	(37.8)	1,920	11.7	8,320	50.5	--		16,480	15.1
Medicine Bow	6,880	43.4	--		--		(6,880)	(43.4)	640	4.0	8,320	52.6	--		15,840	14.5
Red Rim	10,320	50.4	--		--		(10,320)	(50.4)	--		10,160	49.6	--		20,480	18.8
Rosebud	3,040	61.3	--		--		(3,040)	(61.3)	--		1,920	38.7	--		4,960	4.5
Seminoe II	5,480	47.9	--		--		(5,480)	(47.9)	640	5.6	5,320	46.5	--		11,440	10.5
Bell Rock	69	15.6	--		--		(69)	(15.6)	--		374	84.4	--		443	0.4
Empire	308	44.6	--		--		(308)	(44.6)	--		383	55.4	--		691	0.6
Grassy Creek	40	5.6	--		--		(40)	(5.6)	--		680	94.4	--		720	0.7
Danforth #1	--		--		--		--		--		880	100	--		880	0.8
Danforth #2	723	27.7	--		--		(723)	(27.7)	--		1,890	72.3	--		2,613	2.4
Danforth #3	1,621	74.2	--		--		(1,621)	(74.2)	--		563	25.8	--		2,184	2.0
Hayden Gulch	366	6.5	--		--		(366)	(6.5)	132	2.3	5,144	91.2	--		5,642	5.2
Lay	1,879	15.8	--		--		(1,879)	(15.8)	640	5.4	9,343	78.8	--		11,862	10.9
Pinnacle	--		--		--		--		--		313	100	--		313	0.3
Iles Mountain	1,635	43.9	--		--		(1,635)	(43.9)	--		2,087	56.1	--		3,722	3.4
Williams Fork	136	1.3	--		--		(136)	(1.3)	471	4.4	10,213	94.3	--		10,820	9.9
Total Tracts	38,737	35.5	--		--		(38,737)	(35.5)	4,443	4.1	65,910	60.4	--		109,090	100.0

1/ Approximations from a variety of Federal, state, and local public documents.
2/ Figure unavailable, included in state acreage.
3/ Flaming Gorge National Recreation Area administered by Ashley National Forest.

TABLE 3-38

EXISTING LAND USES BY COUNTY 1/

USE CATEGORY	Moffat		Routt		Rio Blanco		Sweetwater		Carbon		Regional Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Rangelands	2,659,896	87.6	784,054	46.4	1,707,905	77.5	6,347,569	96.0	4,061,657	77.3	15,561,081	82.7
Irrigated agricultural	30,000	1.0	60,600	3.6	52,000	2.3	35,103	.5	315,314	6.0	493,017	2.6
Nonirrigated agricult.	96,760	3.2	79,754	4.7	24,000	1.1	73,484	1.1	3/	--	273,998	1.5
Woodlands	55,760	1.8	735,118	43.5	381,460	17.3	4/	--	683,938	13.1	1,856,276	9.9
Urban and built-up	20,000	.7	23,100	1.3	3,700	.2	16,550	.2	84,328	1.6	147,678	.8
Other 2/	173,093	5.7	8,828	.5	35,696	1.6	144,328	2.2	110,000	2.0	471,945	2.5
Total	3,035,509	100.0	1,691,454	100.0	2,204,761	100.0	6,617,034	100.0	5,255,237	100.0	18,803,995	100.0

1/ Approximations from a variety of Federal, state and local public documents.
2/ Includes National Parks, recreation areas, and wildlife refuges for Colorado. Includes these uses plus rights-of-way and extractive industries for Wyoming.
3/ Included under rangelands.
4/ Insignificant.

TABLE 3-39

DOMESTIC LIVESTOCK NUMBERS BY COUNTIES AND REGION

Item	Moffat County	Routt County	Rio Blanco County	Sweetwater County 1/	Carbon County	Regional Total
Cattle 2/	34,500	31,000	32,500	18,000	91,000	207,000
Sheep 2/	100,007	19,500	31,000	25,080	98,000	273,587
Section 3 grazing 3/ allotments	11	10	4/	34	258	313
Section 15 grazing 3/ allotments	96	95	4/	--	45	236

1/ Numbers are for portion of Sweetwater County in Rawlins, Wyoming, District, BLM.
2/ Source of information: Colorado Wool Growers and Cattlemen's Association.
3/ Section 3 and 15 allotments are within the Craig District Williams Fork Planning Unit and the Rawlins District Grazing Area.
4/ Not within the Williams Fork Planning Unit.

TABLE 3-40

MONTHLY PRECIPITATION AT SELECTED SITES WITHIN THE GREEN RIVER-HAMMS FORK STUDY REGION
(Inches)

Location	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
Jackson WY	1.47	1.41	1.28	1.16	1.51	1.59	.78	1.19	1.08	1.09	1.10	1.67	15.33
Dixon WY	0.93	0.69	1.20	1.36	1.34	0.98	1.23	1.19	0.82	1.34	0.82	1.05	12.95
Evanston WY	0.75	0.85	0.93	1.02	1.09	0.07	0.74	0.98	0.64	0.98	0.85	0.74	10.65
Lander WY	0.50	0.61	1.14	2.41	2.57	1.35	0.88	0.60	1.23	1.53	0.87	0.49	14.18
Lovell WY	0.32	0.27	0.47	0.59	1.10	1.53	0.63	0.42	0.66	0.60	0.32	0.28	7.19
Laramie WY	0.38	0.40	0.75	1.36	1.46	1.50	1.75	0.25	0.81	0.65	0.44	0.41	11.16
Saratoga WY	0.47	0.41	0.73	1.04	1.24	1.06	0.87	0.96	0.80	0.91	0.54	0.50	9.53
Hayden CO	1.24	1.14	1.30	1.50	1.47	1.21	1.25	1.19	1.24	1.46	1.09	1.36	15.45
Steamboat Springs CO	2.41	2.31	2.27	2.35	2.06	1.56	1.40	1.49	1.48	1.79	1.90	2.45	23.47
Craig CO	0.92	0.83	0.96	1.40	1.36	1.38	0.96	1.51	1.09	1.32	0.94	1.11	13.78
Meeker CO	1.05	0.96	1.46	1.41	1.50	0.91	1.52	1.72	1.67	1.45	1.07	1.07	15.79

Source: U.S. Department of Commerce, 1931-1952, 1951-1974.

TABLE 3-41

ANNUAL SNOWFALL AT SELECTED SITES IN THE GREEN RIVER-HAMS FORK STUDY REGION

Location	Period of Record (years)	Snowfall (inches)
Alta WY	23	111.4
Dixon WY	23	65.8
Elk Mountain WY	23	141.8
Evanston WY	23	58.4
Green River WY	23	30.4
Kemmerer WY	15	55.4
Leo 6SW WY	11	51.8
Rawlins WY	28	52.8
Sage WY	8	41.5
Worland WY	23	18.9
Colombine CO	9	30.7
Hayden CO	38	100.8
Meeker CO	10	53.6
Pyramid CO	24	194.9
Yampa CO	26	118.9

Source: U.S. Department of Commerce, 1931-1952, 1951-1974.

TABLE 3-42

EVAPOARTION DATA FROM SELECTED STATIONS WITHIN THE GREEN RIVER-HAMMS FORK STUDY REGION

Station	Length of Record (years)	Elevation (feet)	Mean Annual (inches)
Dixon WY	24	6360	35
Fox Park WY	24	9045	38
Green River WY	24	6089	37
Laramie WY	24	7266	39
Lovell WY	24	3837	41
Rock Spring WY	24	6741	37
Worland WY	24	4060	42
Craig CO	24	6285	35
Grand Junction CO	24	4843	36

Source: U.S. Department of Commerce, 1968.

TABLE 3-43

TEMPERATURE EXTREMES DATA FOR SELECTED SITES IN THE GREEN RIVER-HAMMS FORK STUDY REGION

Site	Highest (^oF)	Date of Occurrence	Lowest (^oF)	Date of Occurrence
Dixon WY	106	July 1973	-35	January 1963
Fox Park WY	89	July 1974	-49	January 1962
Lander WY	101	July 1954	-37	January 1963
Laramie WY	94	August 1958	-40	January 1963
Worland WY	106	July 1954	-40	December 1964
Craig CO	99	July 1959	-45	January 1963
Hayden CO	100	July 1956	-45	January 1963
Meeker CO	100	June 1954	-43	January 1963

Source: NOAA, 1978.

TABLE 3-44

FREEZE DATA AT SELECTED SITES IN THE
GREEN RIVER-HAMMS FORK STUDY REGION

Location	Freeze Temperature (°F)	Mean Date of Spring Occurrence	Mean Date of Fall Occurrence	Mean Number of Days Between Dates
Basin WY	32	5/12	9/25	136
	28	4/27	10/05	161
Dixon WY	32	6/10	9/01	83
	28	5/28	9/19	114
Grover 2S WY	32	6/27	7/14	18
	28	6/16	8/09	54
Lovell WY	32	5/29	9/19	129
	28	5/16	9/28	154
Saratoga WY	32	6/10	8/29	80
	28	5/26	9/16	112
Worland WY	32	5/13	9/23	133
	28	4/30	10/04	157
Craig CO	32	6/08	9/10	94
	28	5/24	9/21	120
Hayden CO	32	5/27	8/26	76
	28	5/27	9/16	112
Meeker CO	32	6/11	9/10	91
	28	5/23	9/23	123

Source: NOAA, 1978.

TABLE 3-45
ANNUAL STABILITY CLASS PERCENT FREQUENCY FOR
LANDER, WYOMING AND EAGLE, COLORADO

	Stability Classification					
	Unstable			Neutral		Stable
Location	A	B	C	D_1	D_2	E + F
Lander	3.8	14.89	14.82	16.31	18.19	49.91
Eagle	4.78	10.08	9.49	17.40	15.89	42.37

Table 3-46

NATIONAL AND STATE AMBIENT AIR QUALITY STANDARDS

		Standards ($\mu g/m^3$)				
Pollutant	Averaging Time[a]	Federal Primary[b]	Federal Secondary[c]	Colorado Primary	Colorado Secondary	Wyoming State
Total Suspended Particulate	Annual Geometric Mean	75	60	75	60	60
	24-hour	260	150	260	150	150
Sulfur Dioxide	Annual Arithmetic Mean	80	-	-	-	60
	24-hour	365	-	-	-	260
	3-hour	-	1300	700	-	1300
Nitrogen Dioxide	Annual Arithmetic Mean	100	100	100	100	100
Carbon Monoxide	8-hour	10,000	10,000	10,000	10,000	10,000
	1-hour	40,000	40,000	40,000	40,000	40,000
Non-Methane Hydrocarbons[d]	3-hour (6 a.m. - 9 a.m.)	160	160	160	160	160
Ozone	1-hour	235	235	235	235	235
Lead	3-month	1.5	1.5	1.5	1.5	1.5

[a] Standards for averaging times other than annual or 3-month are not to be exceeded more than once per year.

[b] Levels deemed necessary to protect public health with an adequate margin of safety.

[c] Levels deemed necessary to protect public welfare from any known or anticipated adverse effects.

[d] For use as guide in achieving ozone standards.

Table 3-47

FEDERAL AND STATE MAXIMUM ALLOWABLE INCREASES (INCREMENTS) FOR THE PREVENTION OF SIGNIFICANT DETERIORATION OF AIR QUALITY

Pollutant	Averaging Time	Maximum Allowable Air Quality Increases ($\mu g/m^3$) Class I	Class II	Class III
Federal[a/] and Wyoming				
Sulfur Dioxide (SO_2)	Annual Mean	2	20	40
	24-hour[b]	5	91	182
	3-hour[b]	25	512	700
Total Suspended Particulates (TSP)	Annual Mean	5	19	37
	24-hour[b/]	10	37	75
Colorado[c/]		Category I	Category II	Category III
Sulfur Dioxide (SO_2)	Annual Mean	2	20	40
	24-hour[b]	5	91	182
	3-hour[b]	25	512	700

a/ All areas of the nation were designated Class II except Mandatory Class I areas.

b/ The increments for these averaging times are not to be exceeded more than once per year.

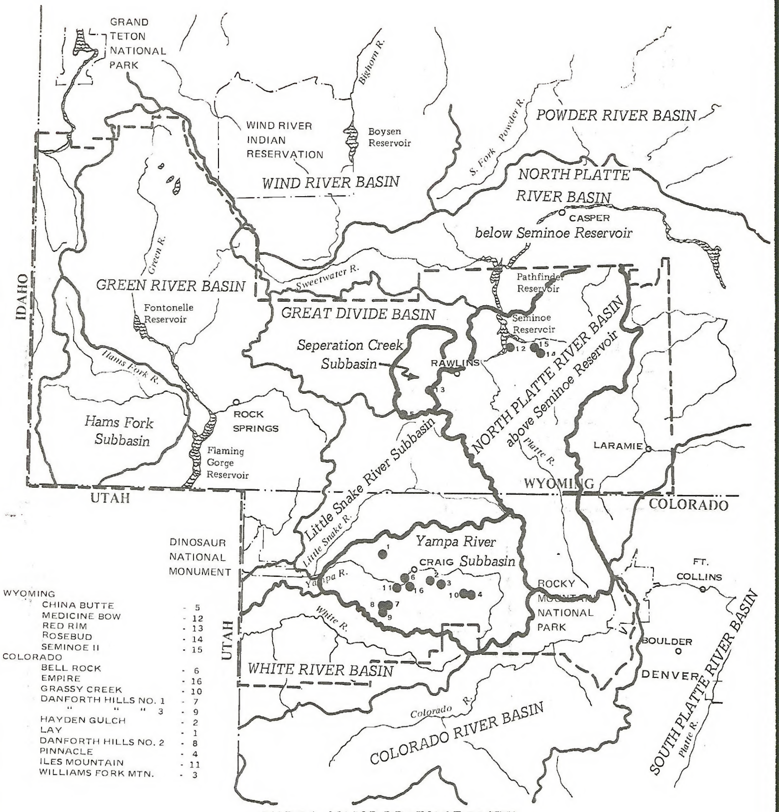
c/ All areas of the state were designated Category II except Colorado Category I areas.

TABLE 3-48

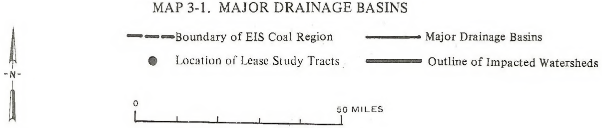
NOISE LEVELS 1/

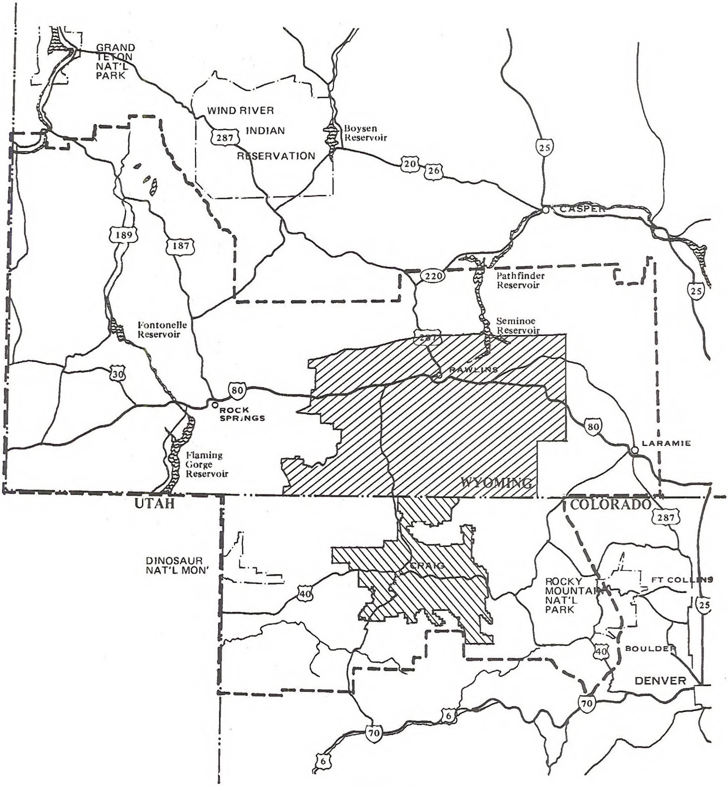
State	1978		1987		1990		1995	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Colorado	61	68	62	69	62	69	64	70
Wyoming	60	69	65	70	66	70	67	72

1/ All figures represent equivalent continuous sound (Leq) in decibels.



MAP 3-1. MAJOR DRAINAGE BASINS





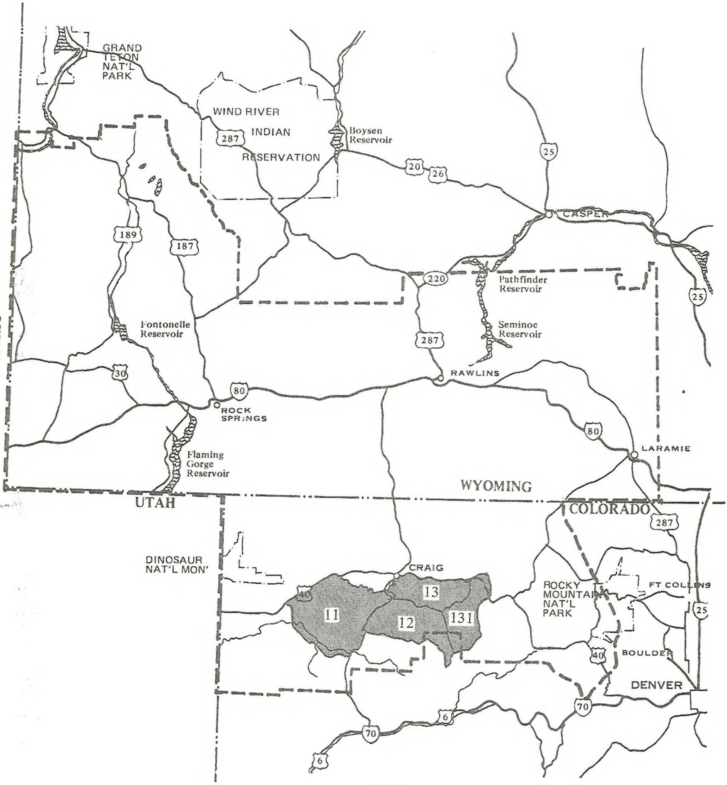
MAP 3-2

WILDLIFE HABITAT ANALYSIS AREA (HAA)

Southcentral Wyoming Coal EIS Area

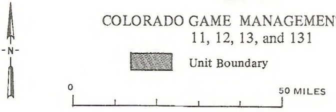
Williams Fork Planning Unit

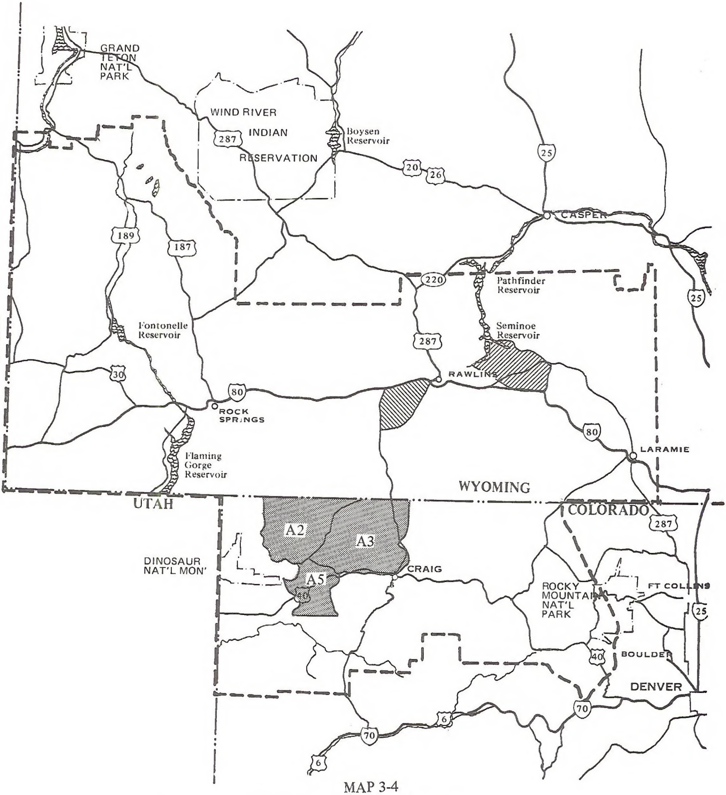
0 50 MILES



MAP 3-3

COLORADO GAME MANAGEMENT UNITS
11, 12, 13, and 131





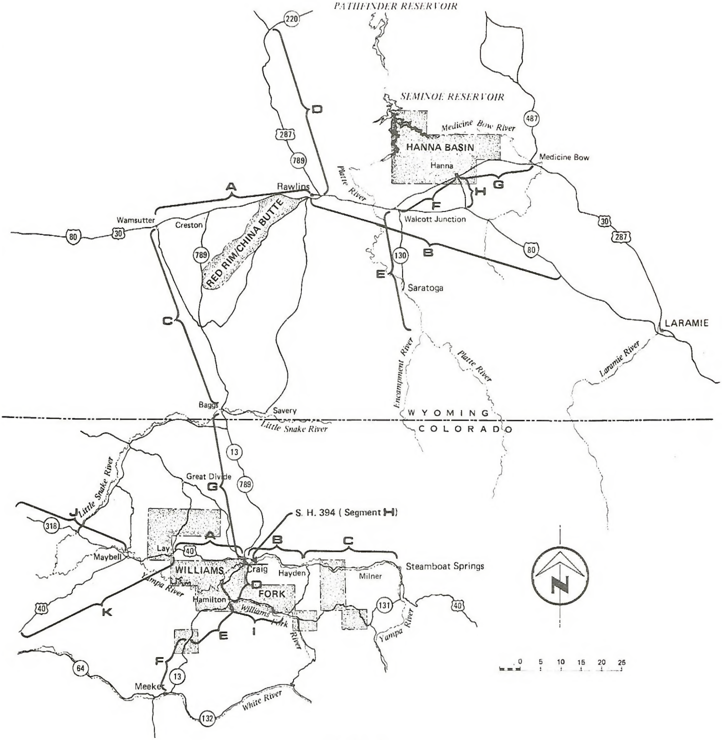
MAP 3-4

WILDLIFE ANALYSIS AREAS

Red Rim/China Butte

Hanna Basin

Antelope Areas A2, A3, and A5



MAP 3-5

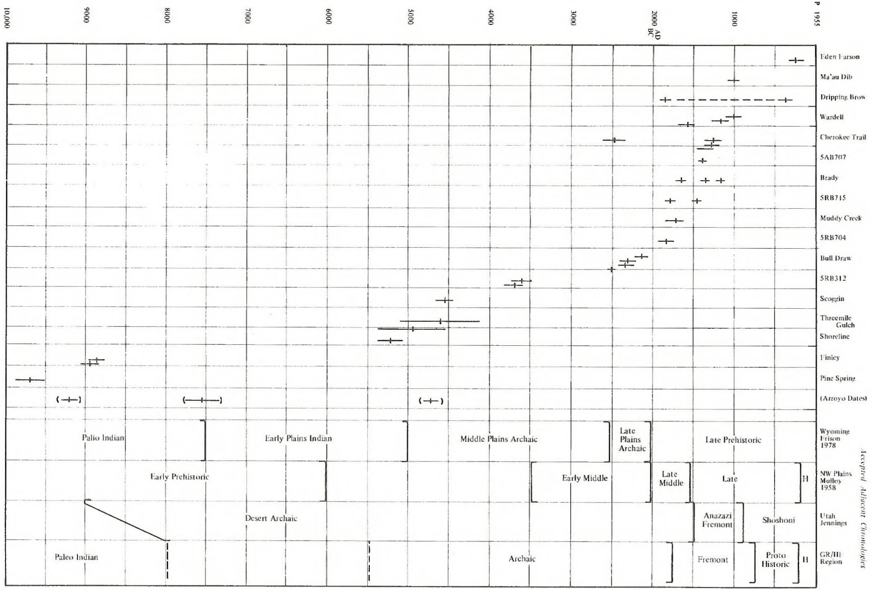
HANNA BASIN, RED RIM/CHINA BUTTE and WILLIAMS FORK

Study Areas within the Green River - Hams Fork Coal Region

MAJOR TRANSPORTATION ROUTES

ERAS	PERIODS AND SYSTEMS	EPOCHS AND SERIES	FORMATION	ENVIRDNMENT	CDMMON FOSSILS PRESENT	REFERENCES
CENOZOIC	TERTIARY	Miocene	Browns Park Formation	Fluvial Lacustrine; Eolian, Tuffs Airborne From Distant Volcanoe	Dstracodes and Diatoms Vertebrate Fossils; Camel, Horse	Eapstd, 1965 Peterson, 1928 McGrew, 1951
			Bishop Conglonbrate	Fluvial	Non Fossiliferous	
		Eocene	Bridger Formation	Fluvial	Vertebrate Fossils	Gazin, 1959
			Green River Formation	Fluvial Lacustrine	Vertebrate Fossils; Fossil Fish; Fossil Leaves and Insects. Fresh Water Gastropods and Pelecypods	Robinson, 1974 Bradley, 1964
		Paleocene and Eocene	Wasatch Formation	Fluvial and Lacustrine	Vertebrate Fossils, Mammals Some Dstracodes and Gastropods. Fossil leaves, Genus Aralia	Miser, 1929 McKenna, 1955
		Paleocene	Fort Union Formation	Fluvial in Part of Swamps and Marshes	Vertebrate Fossils Fossil Leaves	Robinson, 1974 Hansen, 1965
			Dhio Creek Formation	Fluvial	Non Fossiliferous	
MESOZOIC	CRETACEOUS	Upper Cretaceous	Lance Formation	Fluvial Import Swamps	Non Fossiliferous; A few leaf fossils; Vertebrate fossils	Dorf, 191D Robinson, 1974
			Lewis Shale	Marine off-shore	All Marine Fossils--Armonites, Pelecypods, Crinoids, Gastropods	Hancock, 1925 Miser, 1929 Dorf,1938,1942
			MESAVERDE GROUP: Williams Fork Formation	Fluvial in Part Swamps Litteral some Marine Shales	Fossil plants from Genera Picus, Myrica, Eriocaulos, & Salix. Fossil Leaves in Coal. Ammonities & Inoceramus Clams in Marine Shales. Pelecypods, Gastropods	Hancock, 1925 Miser, 1929 Bass, Eby, Campbell, 1955
			MESAVERDE GROUP: Iles Formation	Fluvial in Part Swamps Litteral some Marine Shales	Pelecypods, Fossil Leaves in Steamboat Springs & in the Coal Ammonities and Inoceramus Clams in Marine Shales--Fossil Plants of Genera Picus & Halymenites	Hancock, 1925 Miser, 1929 Bass, Eby, Campbell, 1955
			Mancos Shale	Marine Offshore	Ammonites--Baculites' Scaphites, Inoceramus Clams Pelecypods, Cephalopods	Hancock, 1925 Miser, 1929
			Frontier Sandstone	Marine Brackish Water	Pelecypods, Shark Teeth, and Plant Fossils	
		Lower Cretaceous	Mowry Shale Member of Mancos	Marine Offshore	Carbonized Wood, Cyclord Fish Scales, Fish Bones	
			Dakota Sandstone	Fluvial, Marshes and Swamps	Silicified Wood, Ferns Dinosaur, Mollusk	Waage, 1959

FIGURE 3-1. Fossiliferous Formations in the Study Region



CHRONOLOGY GR/HF REGION ARCHAEOLOGY

C^{14} dates with first Σ graphed for 17 sites (all accessible data)

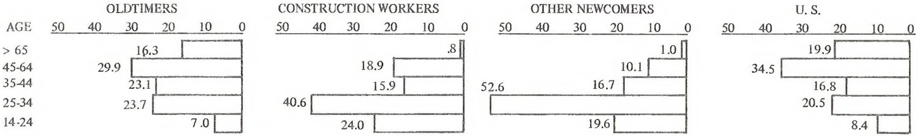
UP Mammoth falls off chart at 11,280 ± 350

FIGURE 3-2

FIGURE 3–3

Age Distribution Comparisons: Five Impacted Communities (Construction Worker Profile Study, Household Heads Only); Colorado Area of Green River - Hams Fork E.I.S. Study Region (Percent of Total Population)

Part A. Construction Worker Profile (Final Report Table III - 7, p. 38) 1975 - Household Heads Only



Part B. Colorado Area, Green River - Hams Fork E.I.S. Study Region

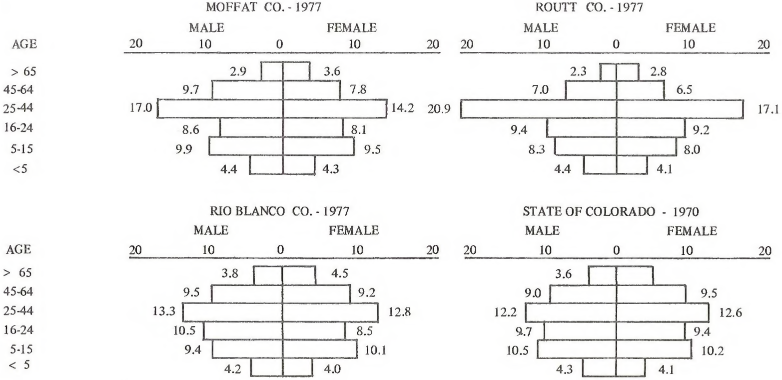
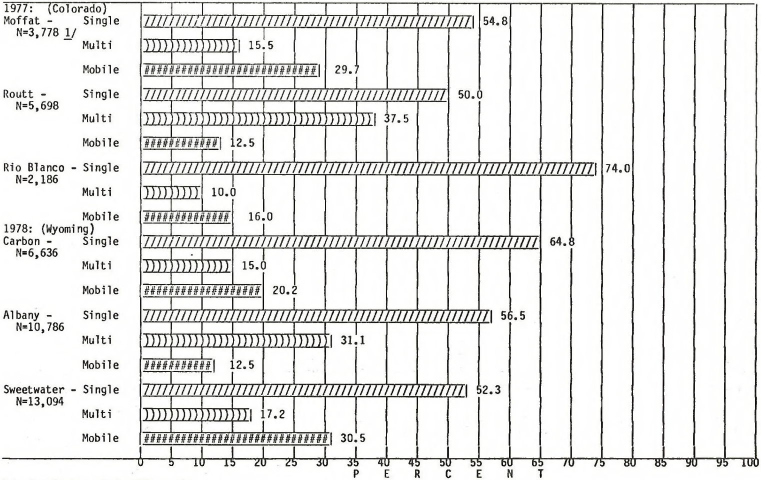


FIGURE 3-4, Part 1

HOUSING - COLORADO AND WYOMING COUNTIES AND TOWNS
(TYPE/PERMANENCE, PERCENT MOBILE HOMES, PERCENT SUBSTANDARD, AGE)

Part 1: TYPE/PERMANENCE (COUNTIES)



1/ N = Number of dwelling units

FIGURE 3-4, Part 2

PERCENT MOBILE HOMES (TOWNS)

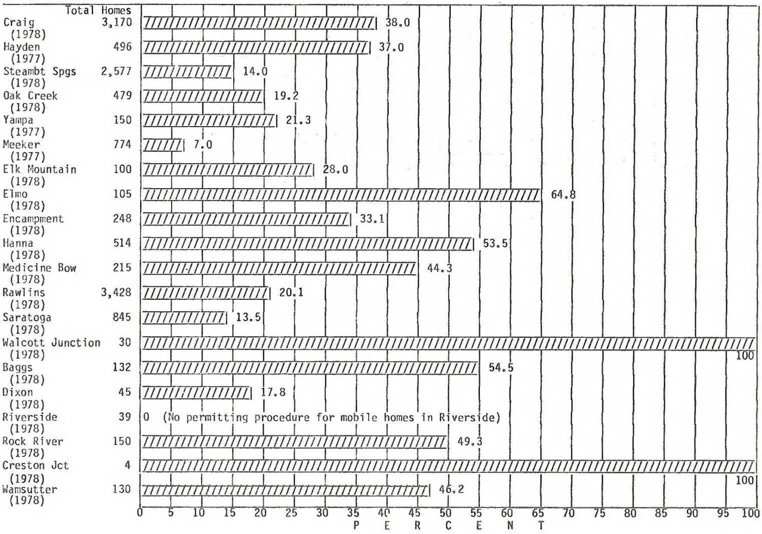


FIGURE 3-4, Part 3

TYPE/PERMANENCE (CARBON COUNTY CHANGE 1970-1978)

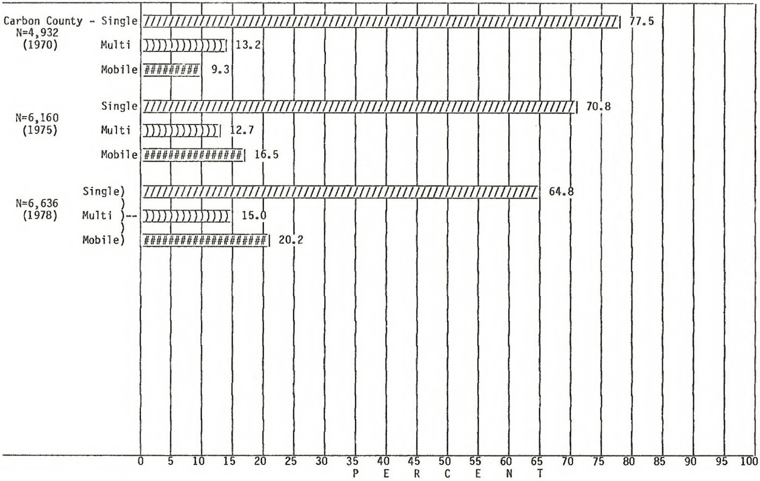


FIGURE 3-4, Part 4

HOUSING - COLORADO AND WYOMING COUNTIES ANO COMMUNITIES -(PERCENT SUBSTANOARD)

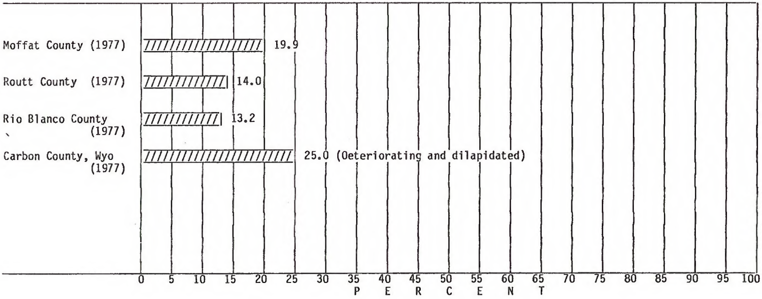
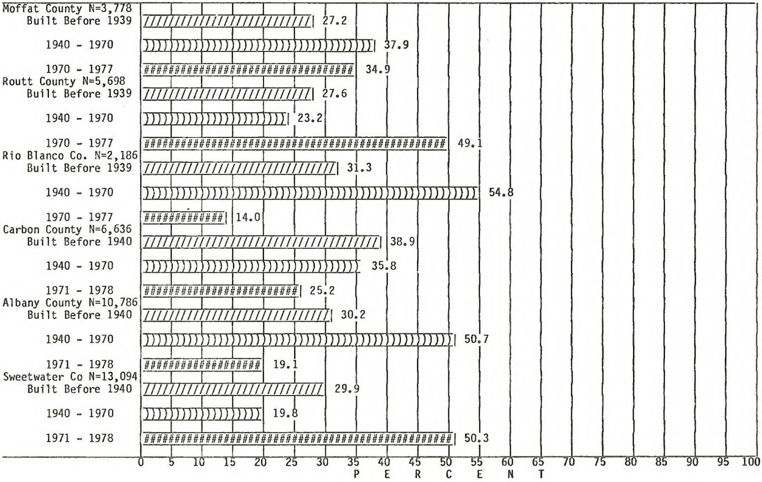


FIGURE 3-4, Part 5

HOUSING - 1977 - COLORADO AND WYOMING - CONDITION (AGE)



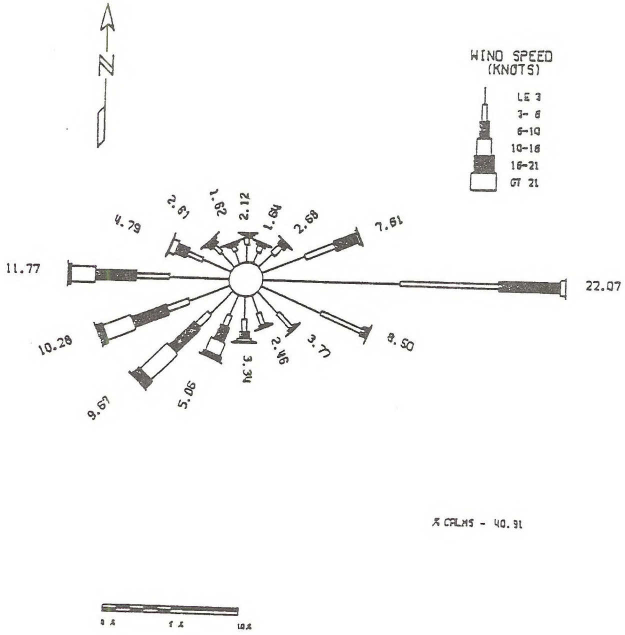


Figure 3-5 Annual wind rose for Eagle, Colorado, 1965-1974

Source: National Climatic Center, 1965-1974.

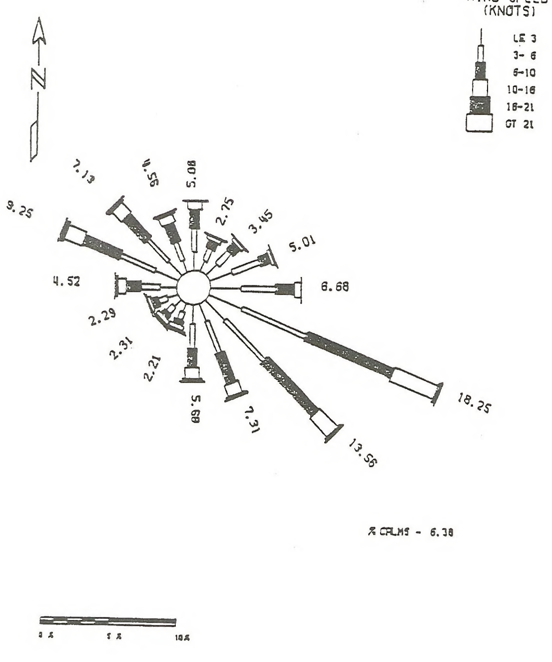


Figure 3-6 Annual wind rose for Grand Junction, Colorado, 1959-1968.

Source: National Climatic Center, 1959-1968.

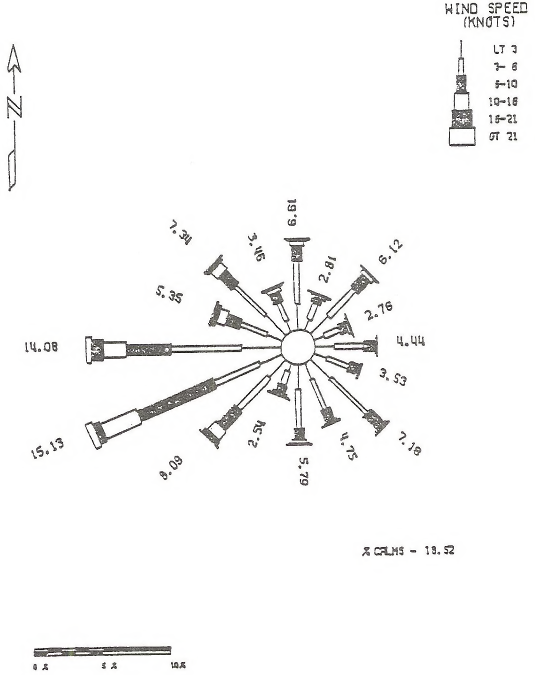


Figure 3-7 Annual wind rose for Lander, Wyoming, 1963-1964

Source: National Climatic Center, 1963-1964.

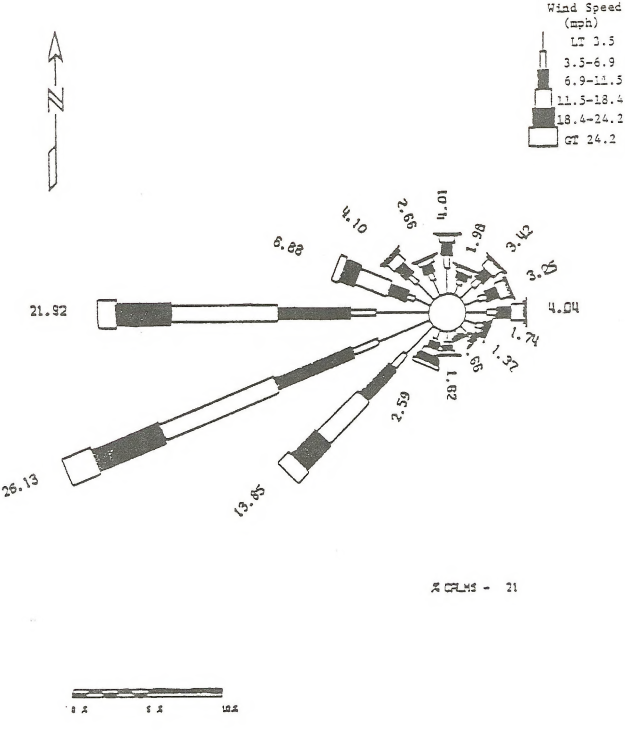


Figure 3-8 Annual wind rose for Rawlins, Wyoming, 1955-1964.

Source: National Climatic Center, 1955-1964.

SECTION 4

ENVIRONMENTAL CONSEQUENCES

GEOLOGY AND MINERAL RESOURCES

The primary impact on the geology of the region would be the removal of the coal beds and destruction of the overlying strata by surface mining. Underground mining would result in the removal of most of the minable coal beds and the disruption of the beds immediately overlying the coals due to subsidence. Underlying coal beds would not be affected and could be mined at a later date.

Construction of mine and transportation facilities would result in the consumption of scoria, sand, and gravel. The location of the quarries for these commodities and the amount of material to be used cannot be approximated at this time.

There are no other solid minerals known to occur on the tracts; however, uranium has been discovered in Tertiary rocks near the Lay, Red Rim, and China Butte tracts. If it were discovered on the tracts, it could be recovered prior to coal mining. Mining would temporarily preclude exploration for, or recovery of, oil and gas. Once mining is completed, exploration and/or recovery could continue.

Impacts to paleontological resources would consist of losses of plant, invertebrate, and vertebrate fossil materials for scientific research, public education (interpretative programs), and to other values. Losses would result from destruction, disturbance or removal of fossil materials as a result of coal mining activities, unauthorized collection, and vandalism.

A beneficial impact of development would be the exposure of fossil materials for scientific examination and collection which otherwise may never occur except as a result of overburden clearance, exposure of rock strata, and mineral excavation.

All exposed fossiliferous formations within the region could also be effected by increased unauthorized fossil collecting and vandalism as a result of increased regional population. The extent of this impact cannot be presently assessed due to a general lack of specific data on such activities.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The removal of coal beds and the destruction of overlying strata would result from surface mining, and there would be removal of most minable coal beds and disruption of overlying beds from possible cracking and subsidence from underground mining. There would be a loss of paleontological resources including plant, invertebrate, and vertebrate fossils as a result of mining and related surface disturbance.

IRREVERSIBLE/IRRETRIEVABLE

The coal mined and consumed, and the coal which is unrecoverable due to technological constraints would be irretrievably lost. The amount of coal that would be irretrievably committed by the Federal actions would range from about 421 million tons for the Low Alternative to 845 million tons for the Maximum Alternative. An indeterminate amount of coal would also be committed as a result of projected mining over the No Action Alternative. The destruction of fossils would be an irretrievable commitment of resources. Fossils destroyed would lose their value to scientific research, and public education and interpretative programs.

SOILS

Impacts to soils differ among the alternatives primarily in the amount of soil disturbed. Without any further Federal coal development, less soil disturbance would occur within the region (SCWCES and WFMFP). Major actions that will affect soils without new Federal coal leasing include the following: existing mines on current Federal leases, state and private coal, oil and gas developments, and urbanization. Urbanization will result in permanent utilization of around 6,000 acres. Of the remaining acreage, approximately half will be reclaimed to some degree by l995. This reclamation will consist of recontouring spoil piles, replacement of topsoil, and initial revegetation.

Table 4-1 shows the soil disturbance from each alternative for new leasing, the cumulative disturbance from existing and new development, and the soil disturbance from the mining itself.

The only soil data available is on the soils directly affected by mining. The Alternative Matrix in Section 2, Table 2-1, gives a comparison of this soil disturbance by alternative and its significance. This comparison is based upon anticipated reclamation problems.

Impacts to soils are expected to be proportional to the reclamation potential. That is to say, the degree of reclamation success will determine the magnitude of erosion and the vegetative productivity.

As a result of additional Federal leasing, direct impacts to soils would result from mining itself and from the construction of buildings, haul roads, rail lines, access roads, power and telephone lines. Additional soil disturbance would result from urbanization connected with an increase in population.

Impacts to soils would result from the removal, handling, and stockpiling of topsoil (and possibly subsoil if it is suitable), and the utilization of unconsolidated overburden as soil material. Removal of vegetation and the subsequent effects from wind and water would also impact soils. The impacts resulting from these actions must be mitigated according to Office of Surface Mining Regulations (30 CFR 816.100-816.103).

Primary impacts to topsoil would occur in the form of destruction of the soil structure, which consists of aggregations of soil particles, and the channels created by plant roots. The texture of the topsoil would be altered by mixing within itself and by introduction of quantities of the heavier subsoil during the removal process. Consequently, permeability and infiltration rates will be decreased, both of which affect the amount of water which the soil absorbs.

Microclimates within the soil can be expected to be altered drastically, with a probable decrease in all forms of soil microbiota which contribute to soil fertility.

Loss of topsoil is inevitable during the removal process because of the importance of limiting the amount of the inferior subsoil which is introduced into the topsoil. Proper removal procedures should limit this loss to below 10 percent. Loss of topsoil will also result from wind and water erosion. Estimates of this loss vary greatly but localized water erosion might be well over 5 tons per acre per year during periods of heavy runoff before a protective cover of vegetation can be established (refer to Water Resources, Erosion and Sedimentation). Other factors contributing to water erosion are length and steepness of slope, and the soils' absorbency. OSM regulations (30 CFR 816.114 and 826.12) requiring soil stabilization by soil treatment and grading are expected to lessen these impacts.

Reconstruction of disturbed soil profiles could involve using overburden as soil material. This excavated overburden material would differ greatly from the premining soil mainly in texture, structure, and nutrient levels. This overburden material can be expected to have coarser texture, faster infiltration rate, lower waterholding capacity, and lower nutrient levels.

Since moisture is the major factor limiting plant growth in the study area, the primary considerations for soil protection are directed at preserving the soils' capacity for absorbing and retaining moisture so that it may be used by vegetation. Therefore, one consideration for the soils' postmining productivity is the degree of damage to topsoil structure caused by compaction from heavy machinery.

Another property influencing moisture regime is that of soil texture. Concerning the topsoil, the amount of heavier subsoil which contaminates the surface layer will determine the degree to which the textural quality of the surface layer is degraded. With respect to the reconstructed subsoil, the weatherability of the overburden will be very important. Soft shale could break down to become fairly absorptive. Random replacement of unconsolidated overburden could be the greatest detriment to soil productivity and successful revegetation. Subsoil high in sandstone or sodic shale could result in very unproductive soils for centuries to come.

Where rainfall is low, ecosystems are fragile and slow to recover from major disturbances; productivity is low and the natural balance is delicate. One factor which is as important as any soil property with respect to moisture regimes is that of precipitation. Droughts are more likely to hamper revegetation on the Wyoming tracts than on the Colorado tracts. See Climate Section for precipitation distribution. Failure of initial revegetation can result from drought, as well as an increase in soil loss from wind erosion.

All soil disturbance can be expected to significantly affect vegetation. The changes in soil moisture regime will be one of the major factors responsible for a vegetative species composition which may bear little resemblance to the premining community (see Vegetation).

Generally speaking, the impacts to soils from mining would involve the complete alteration of soil horizons which formed during many thousands of years of weathering. The new soils on the reclaimed areas would have properties that would depend upon the soil types salvaged and used in the reclamation.

OSM REGULATIONS

OSM Regulations (30 CFR 816.22) require the segregation of topsoil when it is six inches or thicker. Since most of the tracts contain extensive area having inadequate topsoil, selected subsoil and/or overburden materials would be substituted for topsoil. Overburden consists of those minerals (sandstone, shale, etc.) which lie below the subsoil and above the coal or mineral being mined. The overburden should be selected based upon its weatherability, giving consideration also to its chemical properties. On all of the tracts at some depth there exists material with adequate physical and chemical properties (EMRIA 2, 3, and 7, Bureau of Land Management 1975a, 1975b, 1976a, 1976b). The utilization of subsoil is also feasible. Deep (60 + inches) clay loams and sandy loams occur extensively on some tracts. These materials may be mixed with each other or with suitable overburden to supply soils with adequate permeability and water-holding capacity.

The existence of large areas of shallow, steep, rocky soils and sodic soils presents the opportunity for a possible improvement in productive acreage. The selective segregation and replacement of suitable overburden to a depth of about four feet would expose material to the weather which will form more productive soils for future generations. This material would ideally be a mixture of soft shale and sandstones and would be low in sodium and circumneutral in soil reaction.

A more gently-sloping postmining topography could be expected to decrease runoff on some soils allowing greater infiltration of moisture. The resultant enhancement of soil moisture regimes by slope reductions could be expected to significantly offset some of the unfavorable characteristics of the reconstructed soils.

However, the alteration of slopes and their aspects will have significant impacts in terms of microclimates and their econiches. This means that a vegetative community which was dependent upon that microclimate would not be favored to compete successfully in the reconstructed econiche.

Regulations (30 CFR 780.18) specify that applicants shall submit a mine plan which will include the detailed procedures designed to mitigate the impacts to soils resulting from mining.

COMMITTED MITIGATION

Data collection and analyses on this study were sufficient to point out reclamation problems resulting primarily from soil characteristics. Based upon the mine plans, OSM will develop mitigations and stipulations over and above those proposed within the mine plans, where necessary. Therefore, no mitigations beyond OSM regulations are proposed at this time.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The residual impacts which can be expected, assuming compliance with OSM regulations, include large-scale destruction of soil structure in the deep loamy topsoil, degradation of shallow (less than six inches) loamy topsoil from incorporation of clay loam subsoil, and loss of as much as 10 percent of the deep topsoils during the removal and handling operation. Water erosion from probable high runoff events can be expected to further degrade topsoil quality primarily on bare reclaimed surface. Wind erosion is predicted at roughly one to two tons per acre per year as the result of soil disturbances during the life of the mine. A significant decrease in productive capacity can be expected from the complete destruction of the natural soil profiles and from the impacts to the soils' properties which determine moisture regime and fertility.

SHORT-TERM VS LONG-TERM

Return of a significant part of the disturbed land to a productive state during the life of the mine is anticipated. Several years after initial revegetation, vegetative productivity could vary from 50 to 100 percent of the premining level, which exhibits wide variation due to different soils and terrain.

IRREVERSIBLE/IRRETRIEVABLE

Soil loss resulting from disturbance can be considered to be irretrievable. The drastic disturbance of natural soil profiles is irreversible.

UNCOMMITTED MITIGATION

Mitigating measures outlined in this section would assist in stabilization of drastically disturbed land surface. Mine plans will be reviewed on a case-by-case basis and certain of these actions could be included where appropriate.

Mitigation of major impacts to soils would require:

Careful planning and implementation of topsoil removal.

The benefits to soil structure and fertility from the incorporation of vegetative cover during topsoil removal by bulldozers should be considered.

Where slope permits, mature shrubs should be transplanted to areas under reclamation. The practice of transferring topsoil and vegetation integrally is a concept which might have highly significant potential for limiting soil loss and degradation, limiting period of productivity loss, and increasing both quantity and diversity of vegetative production.

Mitigating measures related to impacts to topsoil quality are primarily directed at increasing surface permeability and available water-holding capacity as well as preserving, as much as possible, a favorable environment for root proliferation. Soil structure would be impacted most by compaction from heavy machinery. The use of bulldozers may cause less destruction of soil structure than self-loading scrapers. Careful segregation of loamy topsoils from clayey subsoils during removal is necessary to minimize degradation of topsoil texture.

Long-term decrease in vegetative productivity might be mitigated by selective segregation of the overburden strata having physical and chemical properties most favorable to soil development and vegetative productivity. Shallow loam topsoils (less than six inches deep) stockpiled with the clayey textured underlying subsoils may be too impermeable for use as surface material. They may be beneficial as an amendment to overburden used as surface material. This practice would further mitigate major impacts of soil loss and decreased productivity. The organic matter content is high enough in much of this topsoil to contribute significant amounts of needed nitrogen for years to come. An increase in the available water-holding capacity of this surface backfill might be expected to benefit both vegetation establishment and ability to survive droughts.

Measures for mitigating topsoil loss, and degradation and subsequent decrease in productivity are primarily directed at creating the most favorable environment for timely soil stabilization. Increased infiltration, decreased soil detachability, and decreased exposure of bare soil surface to the forces of erosion can be expected from mulching, surface manipulations, and manipulation of drainages. Application of surface mulch at the rate of three to four tons per acre might be recommended, especially where slopes exceed 4:1. Mulching also has long-term benefits for soil productivity, but heavy application of mulch with a high carbon to nitrogen ratio may require proportionally large increases in nitrogen application.

Timing of topsoil replacement should be such that bare topsoil is not subjected to heavy runoff from melting snow. Other measures aimed at limiting erosion include surface manipulation and use of water bars. Contour furrowing should be required on any slope greater than 15 percent and is recommended for slopes of lesser grade. Decreased infiltration and increased soil detachability and resultant increased erosion of natural drainages may necessitate construction of man-made drainages within the many draws and tributaries. Some drainage manipulations include water diversion, grading, and underground conduits.

In Wyoming the use of snow fences would aid in the accumulation of blowing snow to retain its moisture. Wind fences are recommended for slopes exposed to the strong prevailing westerly winds of summer. This measure would help to minimize soil loss from wind and damage to seedlings from abrasion. Gravel mulch may also be used on topsoil highly subject to wind erosion.

WATER RESOURCES

GROUND WATER

Impacts to the ground-water resources in both the North Platte and the Yampa River basins as a result of leasing and development of new Federal coal would occur almost entirely in the vicinity of the mined areas and should have no significant effect on the respective regional ground-water systems. Local impacts stem from (1) removal of parts of certain aquifers, (2) interruption of premining ground-water flow by the mined areas, (3) modification of ground-water flow by replaced spoil materials, (4) changes in water quality caused by leaching of spoil materials and by exchange of water between aquifers not interconnected before mining, and (5) subsidence and/or fracturing of overlying rocks from underground mining. Amplification of these impacts are as follows:

REMOVAL OF PARTS OF CERTAIN AQUIFERS:

Leasing and mining new Federal coal would result in the unavoidable local removal of parts of certain aquifers within the mined areas with consequent impacts on existing wells and springs and on future groundwater development in the affected areas. Aquifers adversely affected by surface mining include (1) the mined coal beds, (2) all saturated beds and lenses of permeable sandstone in the overburden and interburden, and (3) alluvial aquifers. Underground mining would remove only the mined coal beds.

The approximate extent of aquifers that would be removed during the time frames addressed in this report and the relationship of the affected areas to the total area of the respective watersheds and to the cumulative removal of all aquifers by previous mining operations are summarized in Table 4-2.

Those parts of the coal and overlying aquifers that are removed by surface mining would be replaced by a single aquifer comprised of broken spoil materials. Because of the preponderance of sandstone in the coal-bearing formations in both Wyoming and Colorado, the spoil materials should be moderately permeable unless they are compacted during final placement. Studies by Rahn (1975) indicate that dragline-laid spoils, which undergo gravity sorting and minimal compaction by machinery, may be as much as a hundred times more permeable than scraper-laid spoils, which are not sorted and undergo considerable compaction by the scraper wheels. The permeability of spoils removed and placed by truck-shovel operations has not been determined to date, but presumably these materials would be only minimally sorted and would undergo at least moderate compaction. Thus, dragline-laid spoil aquifers, once resaturated, can be expected to have a higher recharge capacity and yield larger quantities of water to wells than the combined total of the original aquifers. Conversely, scraper-laid spoils probably would have less capacity to store and transmit ground water than the removed aquifers. Truck-laid spoils should lie between these extremes. As movement of spoils with scrapers is no longer economically feasible, presumably future mining in the Green River/Hams Fork area would utilize dragline and/or truck-shovel operations. All replaced spoil aquifers, therefore, should have at least as much capacity to store and transmit ground water as the original aquifers.

Those parts of the coal aquifers that are removed by underground mining would not be replaced. Subsequent collapse of pillars or roof collapse induced by longwall mining would leave a rubble zone that should include interconnected voids for a period of many decades. If penetrated below the top of the saturated zone, these permeable rubble zones should yield adequate supplies of water to wells for use by livestock and wildlife. The quality of the water thus obtained should not be significantly different from water occurring in the coal aquifers prior to mining. Most existing wells, however, obtain their water from sandstone beds in the coal sequence. The occurrence of ground water in these sandstone aquifers should return to essentially premining conditions following the completion of mining and reestablishment of hydrologic equilibrium in the mined areas.

Because those parts of aquifers removed by mining would be replaced by spoils aquifers or rubble zones having a recharge capacity and a permeability equal to or greater than the original aquifers and because an insignificant percentage of the principal watersheds would be disturbed (Table 4-2), any impacts to the respective ground-water systems would be very local and should be limited primarily to the period of active mining in each tract. Table 4-2 shows that a cumulative total of 43.0 sq mi of aquifers (0.59 percent of the watershed) would be removed in Wyoming by 1995 whereas 36.2 sq mi (0.95 percent of the watershed) would be removed in Colorado. Of these cumulative totals to 1995, only 13 percent of the total aquifers removed in Wyoming and 20 percent of those in Colorado would be attributable to the leasing and development of new Federal coal.

Data are not available from which to approximate the effects of past and current mining operations on ground-water supplies, but the number of wells and springs that probably would be destroyed or seriously impacted at the alternative levels of new Federal coal development are listed in Table 4-3. At maximum development only eight wells and one spring in Wyoming and six wells and eight springs in Colorado would be severely impacted. In all cases, new wells can be completed on the post-mining surface, although their depth and pumping lift is expected to be several hundred feet greater than under present conditions. Most impacted springs would probably be permanently impaired, but in most cases, new, possibly larger springs should occur lower on the slopes following completion of reclamation and resaturation of the spoils aquifers. Thus, impacts to ground-water supplies should be very local, largely short term, and principally a matter of increased drilling and pumping costs.

INTERRUPTION OF PREMINING GROUND-WATER FLOW:

Water pumped from both surface and underground mines would create a local cone of drawdown or low point in the ground-water flow system. The effect would be to interrupt ground-water movement through the mine areas towards natural discharge areas, usually the nearest incised valley holding a perennial or intermittent stream. As a result, water levels in the affected aquifers would be lowered in the vicinity of the mines. Additional lowering of water levels would occur in the vicinity of those mines where wells tapping these same aquifers are pumped to supply water for mining operations.

The magnitude of water-level declines in the vicinity of the mines would depend on aquifer properties, recharge characteristics, rate of pumping, and duration of pumping, but declines probably would not generally exceed 100 feet within the mined areas and should not greatly exceed 10 feet more than a mile from the mined areas. Should any nearby domestic or stockwater wells be significantly impacted, the responsible mining company must replace the interrupted supplies (30 CFR 816.54 and 817.54).

Dewatering of those mines that extend below the level of nearby perennial or intermittent streams could cause a reversal of the hydraulic gradient in the immediate vicinity of the mines so that water would tend to move from the streams toward the mines instead of from the mine areas toward the streams as is currently happening. A reduction in stream flow could result, but the magnitude should be small and should not materially impact any of the principal streams in the report area because of the restrictions placed on mining on alluvial valley floors (30 CFR 822.11) and within 100 feet of intermittent or perennial streams (30 CFR 816.57 and 817.57). The impact on streamflow stemming from the interruption of ground-water flow by coal mining is discussed under surface water.

MODIFICATION OF FLOW BY REPLACED SPOIL MATERIALS:

Relatively impermeable shale interbedded with the sandstone and coal gives rise to perched ground-water conditions in most, if not all, of the coal areas under consideration in both Wyoming and Colorado. Removal of these perching layers and replacement of the mined interval in surface-mined areas with spoil materials that should have much higher vertical permeability than the premining stratigraphic sequence would largely eliminate this ground-water perching. The effect would be to reduce the amount of ground water moving laterally on top of perching layers toward discharge areas along nearby valley side slopes (described in Section 3) and to increase ground-water recharge to depth. As a result, vegetation along the valley side slopes would be locally deprived of most or all of this additional moisture and must readjust accordingly in vigor, density, and type. Increased ground-water recharge to depth would cause increased leaching of spoil materials and eventual transport over the long-term of at least a part of these leached materials into the surface-water system.

Selective placement and compaction of backfilled materials as required by 30 CFR 816.101 (b)(1) to prevent leaching would theoretically mitigate these impacts, but no restoration of perched ground-water conditions by compaction of spoils has been achieved to date. Given the complexities of most natural ground-water systems and the technological complications introduced by selectively placing and compacting backfill materials segment by segment as mining progresses, it appears very unlikely that the impacts identified above would be more than partially mitigated at best at most mining operations.

Impacts stemming from modification of flow by replaced spoil materials should be largely local in aspect and cannot be quantified in the absence of specific mine plans and adequate data defining local ground-water occurrence. It is important to note, however, that the effects should be minor during the period of active mining in each tract and should become locally significant only after completion of mining and reclamation. These impacts would then continue over the long-term.

CHANGES IN WATER QUALITY:

As water entering at the surface or from aquifers truncated by mining operations percolates through replaced spoil materials, solution and interaction with soluble minerals in the spoils are expected to significantly degrade the quality of the local ground-water resource. Although definite analytical data are lacking from which to predict the local effects of leaching on water quality, some inferences can be drawn from the known effects of several ongoing mining operations.

Water-quality studies at the Energy Fuels and Edna Mines near Steamboat Springs in the eastern part of the Yampa River subbasin by Colorado School of Mines Research Institute and Engineering Enterprises, Inc. (1976) and by McWhorter and Skogerboe (1975) show that ground water in or discharging from the spoils generally contains 2,500 to 3,000 milligrams per liter (mg/L) dissolved solids. These concentrations are approximately double those found locally in undisturbed aquifers. Similar results are reported in southeastern Montana by Van Voast and Hedges (1975) where dissolved solids concentrations in spoil waters, although much higher than in northwestern Colorado, averaged about two to three times those in the undisturbed coal aquifers.

Water in the spoils materials is typically a calcium, magnesium, sulfate type with lesser amounts of sodium and bicarbonate, whereas water in the coal aquifers is typically a sodium bicarbonate type. Possible sources of the increased calcium, magnesium, and sulfate ions are described in the *NWCCRES* (p.III-4). A calcium, magnesium, sulfate water containing as much as 3,000 mg/L dissolved solids, which is about the maximum concentration expected in the Yampa River subbasin and in the Red Rim and China Butte areas in Wyoming, would be generally unsuitable for domestic use, but would be only mildly cathartic and should have no deleterious effects on livestock and wildlife. Higher concentrations of dissolved solids of as much as 7,000 mg/L, however, are expected in the Hanna area in Wyoming. This water would be highly cathartic and marginal for use by livestock and wildlife, possibly necessitating drilling to deeper undisturbed aquifers for postmining water supplies in reclaimed areas. Because of the low sulfur content of all coals in the tracts to be mined, no acid mine-water drainage problems are expected. Also trace elements and heavy metals are normally filtered out of the ground water in mined areas by coal wastes and other carbonaceous materials in the spoils and should present no significant impacts onsite or offsite.

Impacts onsite and offsite from leaching of spoils aquifers could be minimized by selective placement and compaction of backfilled materials (30 CFR 816.101 (b) (1)) so as to retard recharge to the spoils aquifer from surface infiltration and from adjacent truncated aquifers. Other regulations (30 CFR 816.51), however, seem to preclude this approach by requiring that reclaimed areas must be restored to approximate premining recharge capacity so as to minimize disturbances to the prevailing hydrologic balance, both onsite and offsite. If premining recharge capacity is restored in a mined area, then it follows that a corresponding amount of discharge must occur from the spoils aquifer so that discharge equals recharge over the long-term. Discharge may occur as obvious springs and seeps, as less obvious contribution to adjacent streams, as movement into those truncated aquifers down gradient that have lower head or confining pressures, as transpiration losses, or as pumpage from wells.

Where discharge is to a nearby perennial stream, the increased salt load from leaching of the spoils aquifer can be significant and may contribute directly to salinity problems downstream. For example, Rowe and McWhorter (1978) report that the increase in salt load in Trout Creek adjacent to the Edna Mine near Steamboat Springs is about 5,800 tons per year. This abnormally high load is attributed largely to the high infiltration (recharge) that is occurring on old unreclaimed spoils, which pond and absorb virtually all surface water and have little or no plant cover to return the bulk of the annual precipitation to the atmosphere. Also, a good hydraulic connection exists between the saturated spoils aquifer and the nearby stream. This example, therefore, is not typical of the effects of leaching at most mines in the region. With proper reclamation procedures as now required by the Office of Surface Mining, the salt load contributed by the Edna mine to Trout Creek could probably be reduced to a tenth of the present amount.

Where discharge from a spoils aquifer is indirect to the upper reaches of an ephemeral stream, miles from its confluence with a perennial stream or river, it may take decades or even centuries before any effects are felt downstream. This is especially true when the premining dissolved solids concentration of underflow in the alluvium underlying the stream approaches that of the expected leachate from the spoils aquifer. In those cases where the underflow currently has a higher dissolved solids concentration than that expected in the leachate, such as downstream from the Hayden Gulch, Lay, China Butte, and Red Rim tracts, no long-term salinity impacts are expected downstream.

Much less is known about the long-term effects of the movement of salts leached from reclaimed spoils aquifers into adjacent undisturbed parts of the coal and any permeable overlying rocks. Consequent degradation of water quality in these adjacent aquifers is often conceived of as a saline ground-water plume or front that expands inexorably outward, polluting forever the affected aquifers. In fact, movement of the leachate would occur only down the slope of the hydraulic gradient, which is usually downdip from a mined area. The rate of movement of this polluting front is typically only a few inches or at the most a few feet per year. Moreover, a significant reduction in dissolved solids concentrations can be expected with increasing distance from the mined area because of salt sieving as a result of the selective retention of ions on particle surfaces (Riffenburg 1925, and Qayyum and Kemper 1962). Thus, degradation of water quality in areas adjacent to reclaimed spoils is expected to be a slow process, requiring centuries to become significant more than a few hundred feet from reclaimed mine areas.

Aquifers truncated by mining below the top of the saturated zone that were not hydraulically connected before mining would be connected through the resaturated mine fill after mining and reclamation. Compaction of the fill around the periphery of the mined area would minimize circulation between such aquifers, but premining head differences between aquifers would probably be largely eliminated. Local changes in hydraulic gradients, however, would probably be insignificant when considering the total aquifer system.

EFFECTS OF SUBSIDENCE FROM UNDERGROUND MINING

Subsidence both during and following the completion of underground mining could introduce shear stresses in the overlying rocks that eventually could cause local rupture within the Empire and Bell Rock tracts. Cracks thus formed commonly extend upward to the surface and would open all intersected aquifers to intercirculation of ground water and equalization of pressures. Upper perched zones could be drained, adversely impacting a few stockwater wells, but no domestic wells should be significantly affected. Mixing of waters could slightly degrade water quality in the deeper aquifers within and immediately adjacent to these tracts but no existing water supplies should be affected. Equalization of pressures could extend as much as a mile outside the tracts, but again, no existing water supplies should be significantly impacted. Such impacts, although minor, would be long-term and would be the same under all alternative levels of development.

SURFACE WATER

Impacts to the surface-water resources in both the North Platte and the Yampa River basins as a result of leasing and development of new Federal coal would occur both onsite and to receiving waters downstream. Impacts include (1) alteration or removal of existing stream channels in surface mined areas, (2) effects of subsidence from underground mining on surface drainage, (3) increased consumptive use of water, (4) increased salinity of receiving waters downstream, (5) pollution of rivers and lakes by sewage effluent, and (6) effects of erosion and sedimentation. Amplification of these impacts are as follows.

ALTERATION OR REMOVAL OF EXISTING STREAM CHANNELS

Surface disturbances in conjunction with surface and underground mining as a result of the leasing of new Federal coal would alter or remove all natural stream channels and existing reservoirs within disturbed areas. These impacts should be very local, relatively minor, and generally short lived, however, because of regulations enforced by the Office of Surface mining (OSM). Restrictions on mining on alluvial valley floors (30 CFR 822) and within 100 feet of perennial or intermittent streams (30 CFR 816.57) would limit disturbance primarily to ephemeral stream channels. Moreover, regulations (30 CFR 816.44 (d)) require that disturbed channels be restored to a condition that approximates premining stream channel characteristics.

Current technology may not be adequate to assure initial reestablishment of channels that would be as stable as those draining the premining surface. Studies show, however, that natural stream channels are not actually stable, but undergo continuous readjustment in width, depth, slope, and roughness to accommodate changing flow conditions. Similarly, reconstructed channels, if not initially "stable", would undergo a period of geomorphic readjustment, eventually reaching quasi-equilibrium with postmining flow conditions. Thus, the protection afforded perennial and intermittent streams and the required efforts to reconstruct "stable" channels in reclaimed areas should minimize impacts to stream channels.

The number of reservoirs removed at the alternative levels of development are listed in Table 4-2. As most of these reservoirs have a remaining capacity of less than three acre-feet and are rapidly filling with sediment, the impact is minor and could be easily mitigated by the construction of new reservoirs on the reclaimed surface.

EFFECTS OF SUBSIDENCE FROM UNDERGROUND MINING ON SURFACE DRAINAGE

Underground mining by continuous miners using conventional room-and-pillar methods as anticipated in the Empire and Bell Rock tracts should cause little or no subsidence at the surface. Any consequent changes in channel geometry should be very minor and short-lived inasmuch as these channels are continuously readjusting their size, shape, gradient, etc., to maintain approximate equilibrium with fluctuating flow conditions. Any cracks intersecting stream channels would be rapidly filled with sediment, introducing little or no changes in channel geometry.

INCREASED CONSUMPTIVE USE OF WATER

Any appraisal of the effects of leasing new Federal coal on the available water supply in the North Platte and Yampa River watersheds is tenuous at best and requires a clarification of the concept of consumptive use of water in relation to established water rights. Logic dictates that any impact on the available water supply stemming from the development of new Federal coal depends not so much on the total amount of water used in the course of that development as on how much the use of that water reduces the currently available supply elsewhere in the watershed. For example, field observations show that most of the ground-water and surface-water supplies on or discharging from the prospective lease tracts are currently being dissipated by evapotranspiration losses onsite or enroute downstream and never reach the principal streams and rivers draining the region. Interception and use of this water in mining operations would merely exchange one form of consumptive use for another and would not decrease the actual amount of water available for use downstream.

In appraising the adequacy of the current water supply, U. S. Geological Survey (USGS) water-supply records show that the average annual discharge in both the North Platte and Yampa watersheds is more than sufficient for current uses. Most of that runoff, however, occurs during the spring snowmelt period and cannot be effectively utilized within the region in the absence of adequate storage reservoirs. Throughout the remainder of the year, virtually all flow in the North Platte and Yampa Rivers is fully appropriated and will not satisfy all existing water rights during many, if not most, years. Any increased use of water by coal-related development, therefore, must depend on existing permitted uses that are not being fully utilized or on the transfer of current water rights from other uses such as irrigation. Maximum utilization of existing rights could further decrease river flows during critical low-flow periods, but the transfer of existing rights from one consumptive use to another would not. Legal constraints to utilization of North Platte River water are described in the *SCWCES*, p. RII-31. Constraints to the use of Colorado River water are described in the *NWCCRES*, p. II-24.

To estimate the increased consumptive use of water attributable to the leasing of new Federal coal, it was assumed that (1) all water consumed by the increased population would decrease flow in the respective river systems accordingly, (2) increased consumptive use by mining would be limited to that estimated fraction of total use, based on field observations, that formerly reached a perennial stream, and (3) water obtained from aquifers more than 1,000 feet deep in the coal areas would not affect the base flow of streams within the projected mine lives and, therefore, would not be treated as increased consumptive use. The results (Tables 4-4 and 4-5) should be on the high side and probably exaggerate slightly the effects of this increased consumptive use.

Table 4-4 shows a maximum increased consumptive use of 447 acre-feet annually in the North Platte watershed by 1995, which represents a flow of only 0.62 cubic feet per second (cfs). This is less than one percent of the lowest flow on record in the North Platte River near Rawlins. Any impact, therefore, would be to existing uses of the river water and not to aquatic biology.

Table 4-5 shows an increased consumptive use ranging from 156 to 712 acre-feet annually in the Yampa River subbasin over the long term at the alternative levels of development. This represents a loss of flow of 0.22 to 0.99 cfs, which may be critical to aquatic biology during infrequent periods of low flow when discharge may be less than 5 cfs in the reach between Steamboat Springs and Maybell (see Pollution of Rivers and Lakes by Sewage Effluent). The increased consumptive use of water in the Yampa River subbasin also reduces the volume of good-quality water delivered to the Colorado River, which in effect, reduces dilution and thereby increases dissolved solids concentration downstream as discussed in the next section.

Consumptive use of water in the mining operations would also decrease the flows in several perennial streams adjacent to tracts in the Yampa River subbasin. No perennial streams occur adjacent to tracts in Wyoming. The magnitude of that effect can be approximated by assuming that the maximum reduction in flow would be proportional to the percentage of the watershed disturbed by mining. Results are summarized in Table 4-6 for alternative levels of development for the periods 1987, 1990, and 1995. Presumably, stream flows would return to approximately premining conditions on completion of mining and reclamation. Table 4-6 shows that the cumulative effects of existing and projected mining at maximum development in the Danforth Hills area would reduce flows in Good Spring and Wilson Creeks by a maximum of 8.8 percent, which is regarded as a minor impact. The greatest reduction in flow of up to 18 percent would occur in the Grassy Creek watershed because of its small size in relation to the mined area. Again, impacts from this moderate use would be local and relatively minor.

INCREASED SALINITY OF RECEIVING WATERS DOWNSTREAM

Additional development within the region can be expected to increase the salinity of receiving waters because of (1) the increased salt loading from municipal and industrial wastes, mine effluent, and leaching of spoils and (2) the salt concentrating effects of the consumptive use of good-quality water that formerly diluted poorer-quality water entering the surface-water system downstream.

Any assessment of the effects of leasing and development of new Federal coal on receiving waters downstream is greatly complicated by the complexities of the hydrologic system, which tend to counterbalance any induced changes in water yield and salt load. For example, consumptive use of an acre-foot of water upstream would not necessarily decrease water yield downstream by a corresponding amount because of natural evapotranspiration losses that normally occur enroute. Very probably the net decrease downstream would be slightly less than an acre-foot. Similarly, addition of a ton of salt in the upper reaches of Good Spring Creek in the Danforth Hills coal field, for example, does not mean that an additional ton of salt would pass undiminished through the river system to Imperial Dam on the lower Colorado River, especially if the water containing that additional salt load is subject to irrigation activities enroute. Obvious precipitation of calcium carbonate is occurring in Lake Powell and Lake Meade. More probably the increase in salt load downstream would be somewhat less than one ton. For purposes of this analysis, however, it was assumed that any change in discharge or salt loading upstream would cause a corresponding change downstream. The results, therefore, should be regarded as the probable "worst case" condition.

On that basis, cumulative development in the North Platte watershed would increase the discharge weighted average dissolved solids concentration in the North Platte River about 75 percent from an inferred pristine level of about 154.8 mg/L (Table 3-2 in Section 2) to a maximum of about 271.5 mg/L over the long term. Only about 0.5 mg/L or about 0.43 percent of this total increase would be attributable to the leasing and development of new Federal coal (Table 4-7). Although a 75 percent increase in salinity as a result of cumulative development appears large, water containing only 271.5 mg/L is suitable for all current downstream uses and no salinity problems are anticipated in the foreseeable future. At low flow, dissolved solids concentrations can be expected to increase to no more than 500 mg/L, which should present no significant impacts to aquatic biology or to use of the water downstream. A maximum of about 10 mg/L or less than 5 percent of this increase in salinity at low flow would occur as a result of leasing of new Federal coal.

Cumulative development in the Yampa River subbasin would increase the discharge weighted average dissolved solids concentration in the Yampa River near Maybell about 64 percent from an inferred pristine level of about 111.6 mg/L (Table 3-3 in Section 3) to a maximum of about 183.5 mg/L over the long term. Increases for the alternative levels of development and time frames addressed in this analysis are listed in Table 4-8. Less than one mg/L (1.4 percent) of this total increase would be attributable to the leasing and development of new Federal coal. As in the North Platte River, the cumulative increase in average salinity appears to be large, but water containing only 183.5 mg/L would be suitable for all current uses within the watershed and would have no impact on aquatic biology. Conversely, significant impacts would occur during periods of low flow and to downstream uses of the water.

USGS water-supply records show that the Yampa River flowed less than 5 cfs in the reach between Steamboat Springs and Maybell in the late summer of 1934 and can be expected to flow less than 30 cfs over a seven-day period on an average of once every 10 years (Steele, et al. 1979). Although it is not possible to predict the salinity during these extreme periods of low flow from available data, dissolved solids concentrations could exceed 1,000 mg/L without leasing new Federal coal. The impact of this increased salinity on aquatic biology may be significant, but it would be minor compared to the effect of the toxic constituents introduced in sewage effluent. Those impacts are discussed in the next section.

Of all impacts to the water resources as a result of coal development within the Colorado River basin, perhaps greatest emphasis has been placed on the salinity problem in the lower Colorado River. Studies by the Water and Power Resources Service (WPRS) (formerly the Bureau of Reclamation) show that the cost to downstream water users is increased about $393,000 in 1978 dollars for each one mg/L increase in dissolved solids concentration. As required by Section 303 of the *Federal Water Pollution Control Act Amendments of 1972*, P.L. 92-500, the states of the Colorado River Basin have adopted salinity standards for locations on the Colorado River. The adopted standard at Imperial Dam is 879 mg/L. Despite the ongoing salinity control program of WPRS, however, their Colorado River Water Quality Office estimates that the cumulative effects of all projects that have been approved to date or for which final environmental impact statements have been completed will increase the flow-weighted average dissolved solids concentration at Imperial Dam to about 1,046 mg/L during the time frames addressed in this analysis. This is 167 mg/L or 19 percent above the standard adopted by the states. The increase in salinity at Imperial Dam at the alternative levels of new Federal coal development (Table 4-8) were computed using a mathematical model prepared by the WPRS Colorado River Water Quality Office as described in Appendix B.

Table 4-8 shows that the increase in salinity at Imperial Dam at maximum development of new Federal coal would be only 0.06 mg/L by 1987, 0.10 mg/L from 1990 through 1995, and 0.20 mg/L over the long term. The consequent increase in cost to downstream users at the various alternative levels of development would range from $7,900 to $79,000 per year. This small increase in salinity in the lower Colorado River is significant only because projected salinity levels for the time frames addressed in this analysis are expected to appreciably exceed adopted standards in spite of ongoing salinity control projects.

No significant increase in salinity is expected in any of the perennial streams adjacent to the tracts (Table 4-6) during the period of active mining. All inflow to the pits, except on the Pinnacle tract, would probably be used for dust control, thereby eliminating virtually all mine effluent over the respective mine lives. Effluent from the Pinnacle tract should be no more saline than springs presently discharging from the tract into Fish Creek.

On completion of mining, ground-water discharge would resume once the spoils have resaturated to a level higher than the adjacent streams. Considerable uncertainty exists, as to both the amount of postmining discharge from each mine area and the dissolved solids concentration in the water reaching the streams. On a "worst case" basis, however, where it is assumed that concentrations in leachate from the reclaimed spoils reaching the streams would increase three fold over premining levels and ground-water discharge from the spoils aquifers would increase 25 percent, the increase in dissolved solids concentrations during low flow for the various streams at the alternative levels of development of new Federal coal are shown in Table 4-9.

The effect would be to increase dissolved solids concentrations in Good Springs Creek at low flow from about 1,050 mg/L before mining to about 1,550 mg/L after mining. Wilson Creek would increase from about 1,550 mg/L before mining to about 2,080 mg/L after mining. These increases, although appreciable, would have no significant impact on current uses of the water or on aquatic biology downstream. Fish Creek would increase from about 570 mg/L before mining to about 635 mg/L after mining. This small increase would be insignificant. Grassy Creek would increase from about 620 mg/L before mining to about 825 mg/L after mining. In the absence of a fisheries on Grassy Creek, this increase in salinity is also insignificant to downstream uses of the water.

POLLUTION OF RIVERS AND LAKES BY SEWAGE EFFLUENT

Solid pollutants in wastes are minimized by effluent standards enforced by the Colorado Department of Health (WCCCES, Table R2-26) which must issue National Pollutant Discharge Elimination System (NDPES) permits for all unnatural polluting sources. Municipal effluents, however, are typically characterized by downstream increases in biological oxygen demand, fecal coliforms, suspended solids, nitrates, nitrites, chlorine, ammonia, and orthophosphates. The effects tend to be most pronounced immediately downstream from the polluting source and decrease progressively downstream until the next polluting source is encountered. Point discharge sources to the Yampa River are listed in Table RII-8 in the *NWCCRES*. A comparable list for the North Platte River is available from the Water Quality Division of the Wyoming Department of Environmental Quality. Most communities discharge directly to the rivers or to perennial streams tributary to these rivers.

USGS water-supply records show that the lowest flow on record in the North Platte River immediately downstream from the mouth of Sugar Creek, which carries sewage effluent from Rawlins, was 70 cfs in September 1944. As sewage effluent discharged by Rawlins at maximum cumulative development in 1995 would be about 2 cfs, dilution even at the lowest flow on record would be at least 35 to 1, which is more than adequate to prevent any significant impact to the aquatic biology downstream. Introduction of orthophosphates and nitrogen into the river would increase fertilization of the aquatic plant life and could accelerate eutrophication of the upper reaches of Seminoe Reservoir, but some fertilization of this lake may actually be beneficial to the aquatic biology. Low levels of dissolved nitrate (0.0 to 0.07 mg/L) and total phosphorous (0.0 to 0.1 mg/L) currently in the North Platte River during low flow would indicate that excessive amounts of these nutrients would be unlikely at the projected levels of development by 1995.

In marked contrast, the Yampa River is reduced to little more than a trickle during periods of extreme drouth. During 1934, USGS records show a minimum discharge of 4.0 cfs at Steamboat Springs and only 2.0 cfs downstream near Maybell. Minimum flow in 1977, which was an unusually dry year, was 28 cfs at Steamboat Springs, 5.1 cfs below Diversion near Hayden, and 22 cfs near Maybell. Obviously, contaminants in sewage effluent entering the river during these periods of extreme low flow when dilution is minimal present a great hazard to the aquatic biology.

Recognizing this potential threat, the U. S. Geological Survey and the Colorado Department of Health cooperatively undertook an analysis of the waste-load assimilative capacity of the Yampa River between Steamboat Springs and Hayden during September 1975 (Bauer, Steel, and Anderson 1978). The simulations used a steady-state water-quality model based on seven-day low-flow values with a ten-year (Q 7,10) recurrence interval. The Q 7,10 value used for the study reach was 28 cfs. Assuming a permanent population of 11,500 for Steamboat Springs and a peak-day population of 26,000 during the winter season, the study showed that total nitrogen, nitrite nitrogen, nitrate nitrogen, orthophosphate, carbonaceous biochemical oxygen demand, dissolved oxygen, and fecal-coliform bacteria would not exceed the standards established for the Yampa River in the study reach, which is classified as a cold-water-fishery secondary-body-contact type B1 (Colorado Department of Health, 1974). Only the proposed acceptable concentration for nonionized ammonia nitrogen of 0.02 mg/L (U. S. Environmental Protection Agency 1976) would be equaled or exceeded with existing treatment facilities. Results of that study indicate that the cumulative population of Steamboat Springs at maximum development of new Federal coal would exceed the proposed standard for nonionized ammonia nitrogen by less than 0.003 mg/L by 1995, which is within the limits of accuracy of the model. Construction of a regional wastewater-treatment plant as proposed in the Steamboat Springs area (U. S. Environmental Protection Agency 1977) and implementation of 1985 standards for effluent would eliminate this potential impact to aquatic biology.

No comparable analysis has been made for the Yampa River downstream from the Craig wastewater treatment plant, but contaminant levels and carbonaceous biochemical oxygen demand during the time frames addressed in this analysis are expected to be much higher than upstream because of the greater volume of sewage effluent in relation to the flow of the river and the decreased gradient, which greatly reduces the opportunity for reoxygenation of the water downstream between the point of discharge and the upper end of Juniper Reservoir. In the absence of more definitive data it is not possible to quantify the extent of degradation in water quality in the reach downstream from Craig, but the impacts on aquatic biology are expected to be severe with or without any additional development of new Federal coal. Assuming that the increase in pollutants would be approximately proportional to the increase in population, the development of new Federal coal at maximum level would increase pollutant levels by about 20 percent by 1995. Effective dilution would occur in Juniper Reservoir, but fertilization of the upper reaches by nitrates, nitrites, and orthophosphates could excessively stimulate aquatic plant growth and accelerate eutrophication in that part of the reservoir.

The foregoing analysis is based on Q 7,10 flow conditions in the Yampa River and not on the minimum flows of record. Should a repeat of the 1934 drouth occur, the flow downstream from Steamboat Springs would be as much as 50 percent sewage effluent and the flow below Craig would be as much as 65 percent sewage effluent. The consequent impacts on aquatic biology could be disastrous with or without the development of new Federal coal.

EFFECTS OF EROSION AND SEDIMENTATION

Changes in local sediment yield stemming from disturbances directly and indirectly associated with coal development in the Green River/Hams Fork Region would range widely, depending on required mitigation measures. For example, runoff from areas disturbed by surface activities associated with surface or underground mining must not transport offsite more than 30 mg/L total suspended solids as an average of daily values for 30 consecutive discharge days (30 CFR 816.42 and 817.42). The effect of these controls is to reduce sediment yields from disturbed areas to less than five percent of premining rates. In contrast, existing regulations generally do not apply to disturbances stemming indirectly from coal mining such as housing construction and related urbanization. Thus, any increased sediment yield from the increased population would be virtually unmitigated.

To quantify changes in sediment yield from the leasing and development of new Federal coal, it was assumed that:

(1) Disturbances onsite would result in decreased sediment yield equal to the difference between premining rates and the amount permitted by effluent standards.

(2) Disturbances offsite would initially double the sediment yield for the first two years, decreasing to 1.5 times the premining rate over the next five years, and thereafter returning to approximately the predisturbance rate.

(3) Urbanization initially would double the premining rate for the first two years, decreasing to about the premining rate over the next five years, and thereafter dropping to about half the premining rate as building nears completion and lawns become well established.

Computed changes in annual sediment yield at the alternative levels of development of new Federal coal for the time frames addressed in this analysis are presented in Table 4-10. Details of the computation are shown in Appendix B. Results indicate that the cumulative sediment yield from all disturbed areas in both Wyoming and Colorado would increase less than one percent initially during the period of active construction. Thereafter, the sediment yield would decrease progressively as the controlled acreages onsite increase in proportion to the uncontrolled acreages offsite and disturbed areas offsite return to or drop below premining rates. An overall small decrease in cumulative sediment yield is expected by 1995.

These inferred small changes in annual sediment yield are insignificant compared to annual and seasonal fluctuations in sediment load in both the North Platte and Yampa Rivers and should have no measurable effect on water and sewage treatment facilities or on aquatic biology. Thus, any impacts from increased erosion and sediment yield over the period of mining should be very local and very short-lived.

On completion of mining and reclamation and removal of sedimentation ponds, sediment yields from most reclaimed areas are expected to return to approximate predisturbance rates. The notable exceptions would be the urbanized areas, which should remain stable over the long term, and possibly the steeper slopes on the Danforth Hills #1, #2 and #3 tracts, which may be difficult to stabilize if the original contour is approximately restored as required by 30 CFR 816.101 (b) (1). At this time, no sufficient proof exists that these steep slopes can be returned to their present erosional stability, but then, no proof exists that they cannot. Certainly, successful rehabilitation of the steep slopes depends on the reconstruction of stable channels and on reestablishment of deep-rooted woody plants with a grass understory that is at least comparable to the existing cover. If that stability is not achieved, sediment yield from those tracts could increase to more than ten times the premining rate. Most of that sediment would be deposited on the bottoms of Good Spring Creek and Wilson Creek Valleys adjacent to the tracts.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

A description of adverse impacts that cannot be avoided, their magnitude, and their significance is summarized in Table 4-11.

SHORT TERM VS LONG TERM

The short-term use of the environment for leasing and development of new Federal coal would create a number of long-term impacts on the local and regional water resources.

GROUND WATER. At maximum development aquifers would be removed from only about 8.7 sq mi (0.1 percent) of the North Platte watershed and about 25.2 sq mi (0.7 percent) of the Yampa watershed on completion of mining on all tracts. Aquifers removed by underground mining would not be replaced. Aquifers removed by surface mining would be replaced by spoil materials that would have different hydrologic characteristics than the original aquifers.

These actions, coupled with the elimination of relatively impermeable shale "perching" layers in reclaimed spoil aquifers and consequent increased vertical permeability, would permanently impair or destroy eight wells and one spring in Wyoming and six wells and eight springs in Colorado. Leaching of the reclaimed spoils materials would increase the dissolved solids concentrations of ground water in the mined areas to two to three times premining levels. This water should still be usable by livestock and wildlife, but replacement wells in reclaimed mined areas would probably be at least 100 to 200 feet deeper than premining wells and would require at least 100 feet additional pumping lift.

Subsidence and/or fracturing of overlying rocks from underground mining would probably drain shallow perched aquifers in the immediate vicinity of the mines and cause intercirculation of ground water and equalization of pressures between aquifers over the long-term.

All impacts to the ground-water systems in both Wyoming and Colorado should be very local and should have no regional significance.

SURFACE WATER. Consumptive use of water by the increased population, which is assumed to be permanent, would be about 234 ac-ft/yr over the long-term at maximum development in the North Platte River basin and about 712 ac-ft/yr in the Yampa River subbasin. This would reduce annual water yield from these watersheds by less than 0.07 percent. This long-term consumptive use of water, coupled with the increased salt load in sewage effluent, would increase the dissolved solids concentration in the North Platte River by a maximum of 0.5 mg/L. Concentrations in the Yampa River and in the Colorado River at Imperial Dam would increase by a maximum of 0.43 mg/L and 0.20 mg/L, respectively. The increased salinity in the North Platte and Yampa Rivers is insignificant, whereas the increased salinity in the Colorado River would cost downstream users about $79,000 per year over the long term. Leaching of spoils aquifers would increase the salinity of perennial streams adjacent to the tracts over the long term, but no fisheries are threatened and the water would still be suitable for all current uses.

Plant nutrients in the increased volume of sewage effluent may increase fertilization of the upper reaches of Seminoe and Juniper Reservoirs, accelerating eutrophication. During periods of drought, low flow in the Yampa River could be as much as 50 percent sewage below Steamboat Springs and 65 percent sewage below Craig. Impacts on aquatic biology could be disastrous with or without development of new Federal coal.

As disturbed areas are stabilized over the long term, sediment yields in both the North Platte and Yampa watersheds can be expected to return to approximate premining rates. Should reclamation of mined areas be less successful than expected, however, local erosion could greatly increase sediment yield downstream. Although any impact on the principal rivers would probably be very minor, deposition of large quantities of sediment on valley floors and in channels downstream from the eroding mine areas could impair local productivity and cause local flooding.

IRREVERSIBLE/IRRETRIEVABLE

Aquifer removal and associated disturbances in mined areas would permanently change conditions of ground-water occurrence in about 8.7 sq mi (0.1 percent) of the North Platte watershed and about 25.2 sq mi (0.7 percent) of the Yampa watershed at maximum development. Consequent elimination of or fracturing of "perching" layers would increase vertical permeability and probably destroy one spring in Wyoming and eight springs in Colorado. Leaching of replaced spoil aquifers would permanently degrade water quality in surface-mined areas. These impacts to the ground-water resources should be very local and should have no regional significance.

Water consumed by the increased population as a result of leasing and development of new Federal coal would be essentially irretrievable as long as the population remains in the area. Increased consumptive use at maximum development would be about 234 ac-ft/yr in the North Platte watershed and about 712 ac-ft/yr in the Yampa watershed.

Increased consumptive use of water and increased salt load from leaching of replaced spoil aquifers and sewage effluent would irreversibly increase the dissolved solids concentration in the Colorado River at Imperial Dam by about 0.2 mg/L.

UNCOMMITTED MITIGATIONS

(1) Impacts to existing water uses, especially to irrigated agriculture in the Yampa River subbasin, stemming from the increase in consumptive use of water (Tables 4-4 and 4-5) could be minimized or eliminated by completion of upstream water-storage projects that would supplement low flows during the late summer and fall months when supplies are often currently inadequate. For example, completion of the 9,000 ac-ft Yamcolo Reservoir on the Bear River, a tributary of the Yampa River, as proposed by the Upper Yampa Water Conservancy District and the Colorado Water Conservation Board would increase low flow in the Yampa River at Steamboat Springs by about 20 cfs (Bauer, Steele, and Anderson 1978). This would be more than adequate to compensate for the increased consumptive use of water in the Yampa watershed as a result of development of new Federal coal.

Augmentation of low flow in the Yampa River by 20 cfs also would greatly reduce the inferred impacts of pollutants in sewage effluent on aquatic biology during periods of extreme low flow.

Construction of water-storage projects, however, would introduce additional impacts on land use, vegetation, fisheries, and wildlife. Careful analysis is necessary to determine whether the benefits of such water-storage projects would outweigh their impact on the environment.

(2) The impact of pollutants in sewage effluent on aquatic biology could be minimized by adopting suggested 1985 effluent standards (EPA 1977) for the proposed regional wastewater-treatment plant at Steamboat Springs and by upgrading sewage treatment at plants in Hayden and Craig to those standards. The benefit to aquatic biology, however, must be carefully weighed against the economic impact that the higher cost of plant construction and operation would entail.

VEGETATION

Impacts to the vegetative communities have been assessed in both southcentral Wyoming and the Williams Fork Planning Unit in northwest Colorado. The vegetation of the region is a complex mosaic where soils, climate, aspect, altitude, grazing and general land use history are the controlling factors in plant distribution. Vegetation would be disturbed on and off the proposed tracts from the new Federal action to a varying degree. The following mining-associated operations would result in vegetative type destruction: (1) onsite--coal removal, topsoil stockpiles, haul roads, mine facilities, and (2) offsite--access roads, power plants, railroads, power lines and associated population increases. Disturbances by alternatives on- and off-tract is depicted in Table 4-14.

Vegetative loss would begin with the construction of roads and surface facilities. The mining operations would produce the largest vegetation impact. The first disturbance would result from stockpiling topsoil and placing the boxcuts on undisturbed lands. Total removal of vegetation by mining of these tracts would have a secondary effect on surrounding vegetation. Once the vegetation is removed and is unavailable to herbivores, vegetation on surrounding areas will be subjected to increased utilization. Magnitude of this impact would depend on the importance of the area as wildlife food and the amount of overstocking of domestic livestock that would take place.

Population increases from development of these tracts would disturb or destroy vegetative communities. These developments would be social facilities (schools, shopping areas, etc.), housing, off-road vehicle use and increased recreational activities.

Length of the impact of total vegetative loss would depend upon the success of reclamation. Loss of the native vegetation would be long, depending on the rate and ability of native species to invade the area, and the extent to which trees and shrubs would be transplanted from undisturbed areas to spoil or reclaimed areas. Since current reclamation techniques such as replacing topsoil have only been utilized for a few years sufficient information is not available to predict the amount of time needed for native species invasion or the extent of acres unable to be revegetated. For some years, climatic conditions might be such that revegetation attempts fail, extending the impacts of vegetative loss. Also, the loss of existing soil geomorphologic conditions and creation of a different soil might prove difficult for mature vegetation reestablishment. Federal Regulation (30 CFR 816.133 (c) (9)) allows for a change of postmining land use from native vegetation to cropland. Since over 60 percent of the tracts are private surface, this could result in loss of a significant amount of native vegetative types. The loss of this native vegetation would result in the only significant impact. This loss of mature vegetative types would result in the following impacts on vegetative ecosystems. These impacts are not quantifiable by time frames but are impacts that are secondary to the loss of native vegetative types:

(1). Loss of aboveground and belowground primary productivity.

(2). Loss of a diverse vegetation capable of withstanding climatic extremes and utilizing precipitation and sunlight throughout the growing season.

(3). Loss of present vegetative successional stage, and a setback to a very juvenile stage.

(4). Loss of natural seed source, necessary for ecological succession and stability.

(5). Loss of nutrient cycling systems that utilize the soil, plants, micro organisms and physical forces to cycle nutrients from the soil to forms useable by plants.

(6). Loss of soil stability and erosion prevention by roots and shoots of vegetation.

The preceding narrative explained the impacts to vegetation of all alternatives. The following is a discussion of the magnitudes. The No Action Alternative would result in the loss of native vegetative types in Colorado and Wyoming. The types, acreage lost and time frames are exhibited in Section 3. This table also shows the breakdown between coal related and non coal-related impacts. Coal-related disturbances are mined land, mine facilities, powerplants, railroads, etc., that will be disturbed regardless of the Federal action. The non coal-related impacts are population increases and oil and gas developments.

The result of the Federal action of leasing the new tracts would result in an increased disturbance of mature vegetation. Table 4-12 reveals the acres of each vegetative type disturbed by time frames and the magnitude of the alternatives.

The impacts of the new coal leasing become significant in combination with the trended baseline. The magnitude of this is depicted in Table 4-13. This table shows the differences in Low, Medium, Preferred or High and Maximum Alternatives and the magnitude by percent change from the no action or trended baseline. The Maximum Alternative would result in a loss of 27.4 percent additional native vegetation in 1995 (Table 4-13) than the No Action Alternative. This loss of native vegetation is a long-term impact in that the conditions cannot be duplicated with today's technology to reestablish the same exact ecosystem.

The significance of the losses of native vegetative types is not high in relationship of the loss to the total regional area but it is high on a site-specific basis. The loss of any acreage of grasslands, sagebrush, mountain shrub, aspen or riparian communities is significant to livestock production. This loss will result in loss of red meat production and/or an increased cost to consumers. For a more detailed analysis, see the Land Use section. The loss of sagebrush, mountain shrub, aspen and riparian is significant to wildlife since these types are considered winter range for big game. See Wildlife section for a more detailed analysis.

The destruction of mountain shrub, aspen or conifer in highly scenic areas are significant Visual Resource impacts. The loss of any riparian vegetation is very significant. This vegetative type is the most highly utilized type for grazing production and provides the highest diversity for nongame and game wildlife species. The riparian type comprises only 1.5 percent of the region thus any loss of this type results in significant impacts to wildlife and livestock production.

THREATENED AND ENDANGERED PLANTS. Distribution and occurrence of the four listed plant species, identified in Section 3, is not known, but formal consultation with U. S. Fish and Wildlife Service under the *Threatened and Endangered Species Act 1973* has been initiated (February 12, 1980). This consultation will result in a biological opinion as to the distribution of these plants and any potential impacts the federal action could create. Once this opinion is received, appropriate measures will be taken to alleviate any impacts.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The Federal action would result in a loss of 17,107 acres of native vegetation by 1995. This loss coupled with the loss of vegetation without a new Federal action would result in a removal of approximately 80,000 acres of native vegetative communities. The activities causing these losses are roads, railroads, power plants, powerlines, mine facilities, mining and urbanization. See Table 4-15 for an explanation of the significant impacts to each vegetative type.

The existing stage of plant succession would be unavoidably destroyed when vegetation is removed. Since most of the mining companies plan to return only a few native species and since there is a lack of native seed sources, return to native vegetation would depend almost entirely on natural succession. The soil and microclimate condition produced after mining might be very different from existing conditions, thus making it impossible to establish and sustain native vegetation, loss of existing vegetation would be a permanent unavoidable impact. Even if native vegetation is planted or transplanted it will take 20 to 50 years to establish a self sustaining ecosystem comparable to premining conditions

SHORT-TERM VS LONG-TERM

The following elements describe the relationship between the short-term use of the native vegetation and the long-term impairment.

(1) The Federal action would result in the total destruction of the vegetative ecosystems by types shown in table 4-13.

(2) The loss of species diversity of each vegetation type.

(3) The development of housing and infrastructures would result in the complete loss of vegetative productivity (see table 4-14).

(4) Vegetative losses of sagebrush, mountain shrub and aspen communities would result in loss of productivity for wildlife populations for 20 to 50 years.

(5) With successful reclamation, livestock productivity should increase since there should be more grasses and forbs, utilized in reseeding.

(6) An unquantifiable amount of cropland would be permanently removed from production due to urbanization.

(7) Urbanization could result in the loss of some Threatened and Endangered plant species.

IRREVERSIBLE/IRRETRIEVABLE

The following irreversible and/or irretrievable losses would result from the proposed Federal action.

(1) Vegetative productivity would be irretrievably lost for the life of the mines.

(2) Vegetative productivity would be irreversibly lost on land committed to urban uses (table 4-14).

(3) Vegetative successional stages would be irretrievably lost.

(4) Native vegetative seed sources would be irretrievably lost.

UNCOMMITTED MITIGATION

Since over half of the tracts are in private surface the possibility of changes in postmining land use arises in loss of significant amounts of native vegetative types.

The following list of possible mitigative measures could reduce impacts of loss of native vegetative communities.

(1) Require that reclamation be in conformance with premining land use and postmining land use set out by BLM land use plans. This would reduce losses of wildlife production and VRM impacts.

(2) Require that vegetation planting should be in consultation with state and Federal wildlife departments to insure vegetation goals of highest possible wildlife and livestock carrying capacities.

(3) Require that management tools, such as water developments, fertilization, vegetative manipulation, spraying, transplanting of native stock, seeding and livestock management, be implemented to ensure complete reclamation success to premining capacities for wildlife and livestock enhancement.

(4) Require that only native seed sources be utilized in order to ensure existing vegetative types, diversity, vigor and land use patterns be maintained after mining.

(5) Require detailed baseline data to be collected for premining areas on climatic conditions, soils, vegetation, wildlife and current land use, so post-mining land use can be determined.

(6) Require topsoil segregation by horizons and replacement to insure the highest degree of vegetative ecosystems

(7) Require that all replaced topsoil be analyzed for soil fertility and treated accordingly.

(8) Require a pedestrian survey of 100% on all new lease tracts to sample for proposed threatened-endangered and sensitive plant species.

WILDLIFE

GENERAL IMPACTS

Within the Habitat Analysis Area (HAA), development and human population growth is expected to increase in the analysis years 1987, 1990 and 1995 independent of additional Federal coal leasing. This growth would adversely affect wildlife habitats and populations. Impacts would be of major significance in Colorado without additional Federal coal leasing. These expected losses of habitat and wildlife are presented under the No Action portion of the wildlife tables.

The impacts, their magnitude, and the significance of additional Federal coal leasing are given for the Alternatives - Low, Medium, Preferred or High and Maximum production. These effects would be the Federal action portion of the total cumulative impacts. Total cumulative impacts would be the Federal action portion plus the trended baseline (No Action). Analysis time points are 1987, 1990 and 1995.

Types of actions that would impact wildlife in the HAA are (1) primary--those directly resulting from mining activities, and (2) secondary--those resulting from other human activities. Primary impacts that affect wildlife are caused by railroad construction, road building, mine facility construction, mining, and transportation of coal by truck haul or rail. Secondary impacts result from increased human population, construction of housing and infrastructure, additional vehicle traffic, and conversion of natural, rural lands to other uses.

Wildlife would be adversely affected by these activities through (1) the loss of living space, habitat, and food source, and (2) direct death or additional stress from disturbance or pollution which leads to death or lowers reproductive success. Aquatic systems would be impacted most by pollution from sewage effluent.

Most impacts upon wildlife would be significant due to increased human population growth and habitat loss without additional Federal coal leasing. Any further leasing would be additive.

TERRESTRIAL HABITAT LOSSES

Due to continued growth and development, wildlife habitats would be converted to other uses--housing, roads, private energy development, and agriculture. These uses would eliminate or, at best, reduce the capacity of the land to support animals.

Complete loss would occur on mined areas, facility sites, railroads, roads, and housing areas. Vegetation removal would make these areas incapable of supporting wildlife populations. Some losses would be temporary--mined areas and facility sites would eventually be reclaimed. Where roads, railroads and housing areas would not be reclaimed losses would be permanent.

For analysis years 1987, 1990, and 1995, all disturbed lands would be out of production for wildlife. Reclamation of mined lands would have reestablished very few acres of grassland by 1995. Other types such as sagebrush, mountain shrub, and riparian would require an additional minimum of 20 years to reclaim.

An additional number of acres would be unusable by species which are intolerant of human activity. Immediately adjacent to intense human activity wildlife use would be reduced nearly l00 percent. Farther away from the disturbance, use would increase until pre-disturbance levels are reached approximately one mile distant (WCCCES).

Estimates of unusable acres in Table 4-16 are based on the assumption that wildlife use would be reduced l00 percent around human, high use areas for a distance of a quarter mile, on the average. Such lands would remain unusable throughout mine life and beyond, where permanent structures remain.

Total estimated habitat losses are also shown in Table 4-16. Big game winter range and riparian losses would be of major significance in Colorado in l987 without additional Federal coal leasing. Loss of a part of the Red Rim/China Butte winter ranges will have a locally significant impact on the estimated 2,500 antelope in the northern portion of the Baggs DAU (data analysis unit).

ANIMAL LOSSES

Large mammals would be killed by vehicle traffic on roads throughout the HAA. Existing limited data allows rough projections of expected deer losses to be calculated for portions of Colorado highways (Table 4-17). Deer losses, as well as elk and antelope, would occur each year in proportion to increasing vehicle traffic. Kill frequency is not known for Wyoming roads, but antelope and deer losses would increase as traffic increases (Table 4-18).

Losses of other birds, mammals, reptiles and amphibians cannot be quantitatively analyzed, because appropriate data does not exist. Death rate should be directly related to numbers of vehicles. Therefore, increases in traffic flow would kill a proportionate number of animals. Estimated wildlife death increases are shown in table 4-18.

Human population increase in the HAA would result in direct animal mortality through increased hunting pressure, illegal shooting, dog attacks, fence kills and harrassment. It is expected that wildlife losses would be in direct proportion to human population growth. An increase in population of 125 percent in Colorado by 1987 without additional Federal coal leasing would have a significant adverse effect upon wildlife. Quantification of absolute numbers of these animal losses is not possible due to lack of data. However, expected percent increases with additional Federal coal leasing can be estimated (tables 4-19 and 4-20).

Loss of big game winter ranges can be expected to bring about population declines. Many critical winter ranges are near carrying capacity and, therefore, cannot support the additional animals that would be displaced by surface disturbance and human harrassment. Any loss of winter ranges in Colorado would cause probable deer and elk population declines (table 4-19). Pronghorn antelope and deer losses would be locally significant in Wyoming with loss of winter ranges (table 4-20). At any given time a maximum of 15 percent of the total Red Rim winter range will be unusable as a result of mining disturbance, prior to reclamation. This maximum will not be reached until about the thirtieth year of mining, assuming that four years following mining disturbance are required before initial plant regrowth and an additional 25 years will be needed to restore the wildlife habitat. During winters of heavy snow depth, about 275-300 of the estimated 1,875 pronghorn dependent on the Red Rim range would be displaced and subject to mortality depending on the severity of the winter and the availability of other portions of winter range. A maximum of 700 acres of the China Butte winter range could be disturbed during mining. Pronghorn displaced would likely have available range to the south, although some mortality could occur if animal movement is hindered. This possibility would be reduced if mine facilities are located outside the winter range.

Destruction of sagebrush would result in locally significant impacts upon sage grouse in Wyoming. Local populations would decline substantially, particularly where strutting/nesting complexes are impacted (table 4-20).

AQUATIC

Removal by mining of surface water sources such as springs, stock ponds, and intermittent drainages may be locally significant in Wyoming. Where water is scarce, dependent terrestrial species would have to alter movement and use patterns, if substitute water is unavailable.

With increased human population in the Yampa Valley, pollution from sewage effluent would cause significant impact upon aquatic biology. Under low flow conditions in the Yampa River, increased biological oxygen demand (BOD), fecal coliforms, nitrates, nitrites, chlorine, ammonia, and orthophosphates would pose a serious threat. Such increases under minimum recorded flows could result in major fish kills downstream from Craig due to insufficient oxygen levels and toxicity reactions (see Water Resources).

THREATENED OR ENDANGERED

In Colorado, formal consultation with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the *Endangered Species Act* has been requested (February 12, 1980). Conclusions regarding impacts upon Federally listed threatened and endangered wildlife are awaiting USFWS reply. Initial review indicates that the bald eagle, black-footed ferret, humpback chub and Colorado squawfish may be adversely affected. In Wyoming, the USFWS has indicated that leasing will not adversely affect black-footed ferret or the bald eagle.

In addition to Federal species, Colorado lists state threatened and endangered wildlife. Indirect impacts of population growth may affect these animals and their habitats. Additional Federal coal leasing would not directly impact these state listed species--razorback sucker, bonytail chub, and greater sandhill crane.

COMMITTED MITIGATION

Under agreement with the State of Colorado Division of Wildlife the following statement reflects the commitment of the Bureau of Land Management and the State of Colorado to mitigate adverse impacts upon wildlife.

> Losses of habitat for resident wildlife species of high interest to the State of Colorado will be mitigated when such loss results from new Federal coal leasing. The extent of such mitigation and the measures to achieve this mitigation will be jointly agreed upon by the surface management agency and the State of Colorado. Proposed management alternatives for mitigation of adverse impacts will be developed by the Colorado Division of Wildlife. A system entitled WILDMIS developed by the Colorado Cooperative Wildlife Research Unit will be used by the Division of Wildlife to present various mitigation alternatives for lands in Colorado included within the scope of the Green River/Hams Fork Environmental Impact Statement. Implementation of these mitigating measures should lessen adverse impacts upon affected wildlife.

In Wyoming, mitigating measures will be developed to lessen adverse impacts on ferruginous hawks. Lease stipulations and input to the mine plan should afford adequate protection for this bird (BLM, 1980 a). Studies are currently underway at Red Rim to evaluate methods of reclaiming the habitat types in that area.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The following adverse impacts would occur with new Federal coal leasing:

(1) Temporary loss of wildlife habitat and production on lands being used for mining operations.

(2) Permanent loss of wildlife habitat and production on lands converted to uses other than wildlife production.

(3) Loss of wildlife production on lands unusable due to human activity.

(4) Loss of animals killed due to construction, mining, vehicles, illegal and indiscriminate shooting, and increased hunting pressure.

(5) Loss of animals killed due to harassment by humans and their pets.

A summary of these impacts by alternative is given in table 4-21. The resulting magnitude of these unavoidable adverse impacts upon wildlife populations could be lessened by implementing appropriate uncommitted mitigating measures described later in this discussion.

SHORT-TERM VS LONG-TERM

Long-term wildlife productivity within the Habitat Analysis Area (HAA) will be influenced by: (1) number of acres of land permanently converted to other uses, (2) success of reclamation, and (3) permanent human population increase. Since the scope of this document focuses on analysis of impacts through 1995, our ability to predict long-term changes is limited and imperfect. However, some trends are evident.

Human population within the Habitat Analysis Area will continue to increase. Some of this increase will be due to new Federal coal leasing. With this growth additional lands will be converted to uses other than wildlife production. Reclamation of mined lands will be, at least partially, successful.

These long-term trends suggest some cumulative loss in wildlife productivity. Much of this potential loss will result from impacts that will occur without new Federal coal leasing. The extent of these losses could be significant to species and habitats already being limited.

IRREVERSIBLE/IRRETRIEVABLE

Except in the case of extremely rare species at very low population levels, wildlife is a renewable resource. If breeding populations are maintained, favorable environmental conditions allow repopulation and expansion to new habitats. Population declines in most common species are not irreversible or irretrievable.

The loss of an individual common animal is irreversible and irretrievable. The importance of that loss can be measured in terms of human values a deer killed by a vehicle collision is not available for viewing or hunting.

Threatened, endangered, rare or sensitive species could be irreversibly and irretrievably impacted, if not adequately protected.

UNCOMMITTED MITIGATION

Techniques and methods exist for mitigating adverse impacts upon wildlife (Rocky Mountain Forest and Range Experiment Station, 1979). Mitigation recommendations were included in the Site-Specific Analysis (SSA) prepared for each proposed coal lease tract covered in the GR/HF EIS. Many of these were general recommendations that must be tailored to the specific operation when mine plans are submitted. The following are suggested mitigating measures from the SSA to reduce impacts upon Wyoming wildlife (BLM, 1979 b). The expected effectiveness of these measures is presented in table 4-22.

(1) As determined by the authorized agency, the lease holder would develop new reliable water reservoirs and other water sources destroyed or disturbed by mining. This measure would eliminate the long-term loss of water sources for wildlife and livestock.

(2) In cooperation with Wyoming Game and Fish Department, the BLM would adjust livestock grazing to provide some forage for pronghorn and mule deer displaced by habitat disturbance. An alternative would be to enhance habitat to increase wildlife carrying capacity on surrounding areas. This measure would compensate for decreased livestock and wildlife carrying capacity caused by the proposed action and partially mitigate reduction in population sizes.

(3) Until vegetative cover is reestablished, the lease holder would exclude livestock and big game from areas being reclaimed. This measure would lessen the duration of vegetative cover and productivity losses.

(4) The lease holder would not disturb prairie dog colonies, except on areas that would be mined. This measure would reduce the losses of burrowing owl and other raptor hunting/nesting habitat and reductions in area raptor populations.

(5) The lessee would not disturb the area within one-half mile of the center of sage grouse strutting/nesting complexes, except on areas that would be mined. This measure would partially mitigate losses of sage grouse.

(6)The lease holder would attempt to relocate sage grouse strutting/nesting complexes which would be destroyed by the proposed action. Relocation efforts would be coordinated with the BLM and the Wyoming Game and Fish Department. This measure would partially mitigate a reduction in the area sage grouse population.

(7) After reclamation is complete, the lease holder would remove any fences from the LMU which could prevent the migration of big game animals. This measure would partially reduce area population losses of big game.

In Colorado, many of the Wyoming recommendations would apply. The following are additional examples of mitigating measures that could lessen adverse impacts, if implemented.

(1) Impose seasonal restrictions upon activity at critical times in important wildlife areas such as sage grouse strutting grounds, eagle nesting areas, and elk calving areas.

(2) Allow no surface occupancy within specified buffer zones that are important wildlife areas.

(3) Require revegetation and/or new establishment of browse plants where big game winter ranges would be destroyed.

(4) Require improvement of wildlife habitat on lands that will not be mined within leased tracts while mining is occurring.

(5) Retain existing and acquire new access to and across lands within leased tracts for wildlife management.

(6) Limit the number of acres of land leased in a coal tract to that actually required for the mine operation.

(7) Permit surface disturbance only where actually necessary for mine operation.

(8) Require mass transit of employees to mine site.

CULTURAL RESOURCES

Legislation, the *Historic Preservation Act of 1966*, and regulations, 36CFR 800, require that adequate consideration be given to significant cultural resources. This adequate consideration tends to become a mitigation of impacts. Basically, there are four steps in this process:

(1) Identification of the known significant cultural resources within the region of this EIS. This was done by checking the National Register of Historic Places and its supplements as published in the Federal Register (March 18, 1980).

(2) Identification of all cultural resources in the zone of environmental impact. This inventory process is only partially complete at this writing, but is part of standard lease stipulation.

(3) Evaluation according to the Criteria of Eligibility (36CFR 60.6) of all cultural resources in the zone of environmental impact. This process has not been initiated. It cannot be completed until the identification process is complete.

(4) Cultural resources which meet both the criteria of Eligibility and the Criteria of Effect and Adverse Effect (36CFR 800.3) are dealt with on a case by case basis (36CFR 800.4).

Avoidance of adverse effect to significant cultural resources is preferred because these resources are non-renewable and because this is often the least costly and least time consuming mitigation. When avoidance of the significant cultural resources themselves is not prudent or not feasible then physical mitigation measures are undertaken. The specific mitigation required for each cultural resource is tailored to its significance, as determined under the Criteria of Eligibility. Commitment to mitigate direct effect is part of standard lease stipulations and is usually a documentation and data recovery program. When data is recovered it is limited by the state of the art at that time and may not provide all the data that future techniques would provide.

Destruction of all or part of a significant cultural resource is the most common type of adverse effect of coal leasing and mining. This effect is lessened by controlling the manner in which the destruction occurs. For example, removing a prehistoric site by scientific archaeological excavations rather than by bulldozer or dragline.

Adverse effect to a significant cultural resource may be direct or indirect. In the case of coal leasing, direct effect will occur if a significant cultural resource is located in an area of planned surface disturbance for the mine and its facilities. For instance, an area to be strip mined, an office-parking lot-bath house complex, a loadout point, a haul road, a railroad right-of-way. A power line right-of-way to a mine may be a direct or an indirect effect of the leasing action, but if a significant cultural resource is in the area of surface disturbance then there will be a direct effect on the resource.

Indirect effect may also occur or increase in conjunction with socioeconomic changes and population growth. Old buildings in communities experiencing rapid growth may be torn down before their historic merit and community character are recognized. These secondary losses can be mitigated in several ways: The creation of historic districts in downtown areas that contain historic buildings in the core area; zoning to prevent destruction of older parts of towns and small cities; the implementation (in Colorado) of House Bill 1041 (Land Use Planning) and assistance from other agencies such as the Heritage Conservation and Recreation Service, the National Trust for Historic Preservation, Energy Impact Funds and the State Historic Preservation Officer (SHPO). By the terms of the 1966 National Historic Preservation Act, the SHPO is designated as the official responsible for identification and preservation of historic sites on state and private lands.

Most of the sites already on the National Register in Colorado towns are well known and growth impacts should have no effect on these sites. In Wyoming, the historic sites listed on the National Register are generally developed as visitor use sites and are certainly well identified. There would be no inadvertent losses from secondary impacts. Visitor use increases would occur, but monitoring of the sites by the appropriate state agency would limit vandalism.

Though not well documented or studied, increase in population seems to increase the rate of vandalism to cultural resources, (Williams 1977).

Table 4-23 shows the cumulative analysis and magnitude of various cultural resource components by alternative. Change by alternative is a slow, smooth growth curve, without peaks, valleys or critical points. Some comparative analytical results are high-lighted in the following brief discussion.

The Colorado data is scant for most tracts. Bell Rock and Grassy Creek (all leasing Alternatives) have no significant data base. Danforth Hills #1 and #3 (all leasing Alternatives) are adjacent tracts with 590 of 3,062 acres inventoried. Class III inventory in similar steep terrain and heavy vegation, about three miles south of the Danforth Hills tracts found only one site per 497 acres of survey, indicating that the low end of the range of expected sites should be found. In contrast to other tracts, inventory for Empire Tract (all leasing Alternatives) is 90 percent complete and two sites have been found. The 66 acres of remaining inventory are on steep slopes with heavy vegetative cover, a situation not conducive to archaeological site location. The leasing of the Hayden Gulch Tract (Medium, Preferred or High and Maximum Alternatives) adds a two percent inventory that is neither random nor representative of the available stratification factors, so is not considered a significant addition of data. The inclusion of Lay Tract (Preferred or High and Maximum Alternatives) adds the only other Colorado tract with identified cultural resources. The nine sites found were evenly divided between prehistoric (five) and historic (four). Inventory data for Lay Tract is limited to the west portion and is poorly distributed with respect to stratification factors.

Since the data was collected on a non-random, non-stratified basis, it is not demonstrable that this density is representative of the tract as a whole, but it has been assumed representative for a worst case analysis. The Lay Tract is in a different ecological situation from the other Colorado tracts and this may have been its attraction for prehistoric use. With the addition of both Lay and Danforth Hills #2 tracts, the expected number of sites and of eligible sites becomes quite evenly split between the two states. Adding the Iles Mountain acreage (Maximum Alternative) increases the negative data substantially: the area surveyed with no cultural resources found is 45 percent of the total, making it likely that the expected sites range is too high for this tract.

COMMITTED MITIGATION

In summation, for all leasing, BLM will require:

(1) That all leased tracts be examined by a qualified archaeologist (and historian as necessary) and an acceptable report of the work undertaken will be submitted to the BLM and the State Historic Preservation Officer;

(2) That all cultural resources be evaluated according to the Criteria of Eligibility (36CFR 60.6);

(3) That all prudent and feasible means be utilized to avoid adverse effect to significant cultural resources;

(4) That if adverse effect cannot be prudently or feasibly avoided then mitigating measures specific to the qualifying characteric(s) of the cultural resource be completed.

In view of these requirements, all impacts are manageable. In terms of time available prior to surface disturbance, it is both prudent and feasible to conclude that the requirements can be met for any alternative. Not fulfilling the requirements would produce unacceptable adverse effects in any alternative, because requirement 2 (Determination of Eligibility) has not been fulfilled.

Immediate Determination of Eligibility is necessary for two archaeological sites in Wyoming:

(1) The Union Pacific Mammoth (48 CR 182) is located on the China Butte Tract. This Mammoth died 11,280 ± 350 years ago. This radiocarbon date is precisely correct for Clovis mammoth kills. No Clovis points were associated with this mammoth, nevertheless, since its discovery this mammoth has been a focus of question or controversy in every major archaeological publication about the earliest inhabitants of North America.

(2) The shoreline Site (48 CR 122) is an Early Plains Archaic site (Frison 1978: 43), based on a radiocarbon date of 5,220 ± 15 years ago. "Initial excavations...have produced what appear to be pit house features with fire hearths...This site will undoubtedly be important to studies of the Early Plains Archaic" (Frison 1978: 44). This site is located within a half mile of the Medicine Bow tract but not on that tract.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The residual effect of excavating any site is that it is done at present state of the art. Future techniques might give better data yield, but this is a calculated risk.

SHORT-TERM VS LONG-TERM

See Unavoidable Adverse Environmental Effects.

IRREVERSIBLE/IRRETRIEVABLE

Cultural resources removed by project surface disturbance are gone forever.

UNCOMMITTED MITIGATION

Adequate consideration of historic structures in towns is not a committed mitigation. Local jurisdictions and concerned citizens should be encouraged to identify and protect historical and architectural values.

RECREATIONAL RESOURCES

The EIS study region encompassed will include Moffat, Rio Blanco, and Routt counties in Colorado and Carbon County and the eastern portion of Sweetwater County in Wyoming.

RECREATION

URBAN

Existing urban recreation facilities, at best are only meeting existing recreation demands of the community populations within the study region. Laramie, and Rock Springs, Wyoming, have been included as major communities affected by significant population growth. Areas such as Craig, Hayden, Rawlins, and Rock Springs have been experiencing a rapid population growth over the past five years.

Projected growth is expected to continue at an accellerated pace through 1987, without implementation of a Federal coal leasing program. Significant demands will be placed on local governments in providing recreation facilities to accommodate natural growth of communities. Deficiencies that may exist at present will be compounded by the additional population increases. If additional urban facilities are not provided, severe overcrowding will become apparent.

The following communities are aware of recreational needs for the future, and those needs have been brought forth in their Land Use or Recreation Master plans: Craig, Meeker, Steamboat Springs, in Colorado and Baggs, Medicine Bow, Rawlins, Rock Springs, Encampment, Wamsutter, Dixon and Sinclair in Wyoming.

Table 4-24 illustrates the estimated financial impact that natural growth and federal coal leasing will have on Colorado and Wyoming communities, if recreation facility demands are to be provided. Facilities include baseball fields, picnic areas, tennis courts, swimming pools, and 9 hole golf courses. Cost figures are from 1976 and do not reflect inflation or necessary maintenance costs. Tract-related costs are included in the cumulative. Major financial burdens will be placed on Craig, Meeker, Hayden, and Steamboat Springs in Colorado, and Rawlins, Laramie, and Rock Springs in Wyoming. Costs imposed on communities that are directly related to coal leasing are significant (10 percent or more of total) in Wyoming for all alternatives and are also significant in Colorado for the Preferred or High and Maximum alternatives. Wyoming and Colorado combined coal leasing will have a minimum of 10 percent impact with the low alternative and 16 percent if the Maximum Alternative is implemented.

Table 4-25 illustrates the overall anticipated funding needs by alternative, for development of urban recreation facilities necessary to accommodate population increases. The tract related percentage column reflects the significance by state and region. It is assumed that urban recreation demand will increase dramatically over the next decade as travel becomes more financially prohibitive. Forms of urban recreation such as theaters, roller rinks, bowling alleys, downhill skiing facilities, etc., fall into the private sector; therefore, supply and demand will dictate their availability.

DISPERSED

The study region provides for a vast array of dispersed recreation opportunity. There are 11,356,212 acres of public land within the region. Primary intensive use activities that would be impacted are fishing, hunting, and camping. Other less intensive recreation activities, yet high in participation by region residents are boating, swimming, waterskiing, picnicking, horseback riding, and hiking; all the above listed activities are generally participated in during the summer and fall seasons. Other popular activities that would be impacted are considered winter sports, i. e., sledding, ice fishing, snowmobiling, and cross country skiing. The significance of the impact is psychological, so in effect, the significance will be on an individual basis. For instance: Prior to a large increase in population, a fisherman catches a limit of trout every time the attempt is made. Increased population doubles the number of fishermen that are competing for the same fish, and the catch declines to only half of the previous situation. The opportunity to fish is still there, but to the individual who previously caught a limit every time, the quality of that recreation experience has diminished. On the other hand the newcomer may think catching one half the limit is fantastic, therefore he sees no loss of quality. Big game hunting has a very short season, is intensive, and has a high participation rate in the region, yet continues to grow in numbers of participants.

Two major factors dictate quality for hunting: economics and politics. Wyoming has increased their out-of-state license fees by 100 percent for 1980. Existing nonresident participation is 30 percent to 40 percent in the region. This will likely decrease nonresident demand for permits. The additional funds generated to manage big game, should increase the hunting quality. The other factor that will affect not only hunting, but all other facets of dispersed recreation, is the escalating cost of personal transportation. Thus producing the probability of: decreasing frequency of trips, limiting distance traveled, and increase length of stay, all of which may alleviate some of the additional demand on dispersed recreation.

Historically, holiday weekends and short season activities prompt overcrowding; this situation is expected to continue. As public agencies become aware of constant overcrowding of their facilities, additional accomodations should be provided.

The additional dispersed recreational demand from natural population and proposed coal leasing population growth will impact recreation, but only in terms of diminishing the quality of the recreation experience. The opportunity to engage in a particular activity will still be available. For anticipated increase of activity by alternative see Table 4-26. A secondary impact would be the increased sewage effluent that will result in added nitrates and phosphates, which at low flows in the Yampa River could deteriorate aquatic communities and cause a fish loss downstream from Craig, decreasing fishing opportunity in the region.

Impacts associated with the removal of accessible public land are not considered significant on a regional basis; however, two specific situations would create a notable local impact. The Wyoming proposed lease areas for all alternatives will remove approximately 32,000 acres of land that is accessible for public use; however, only 16,717 on site acreage will actually be used for mining. This point should be scrutinized closely prior to actual lease.

In the Colorado leasing areas, 2,078 acres of accessible public land will be removed from public use. One tract (Maximum Alternative only), Iles Mountain, contains 1,635 of those acres. On this tract public use is considered high; the primary recreation activity is hunting. Another associated impact is the degradation of aesthetic quality that would be created by the mining activity, affecting float boaters on the Yampa River. Table 4-27 illustrates the significance of impacts on a more site specific basis for all the proposed lease areas.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

URBAN. If additional funding is not provided from city, county, state and/or Federal agencies to affected communities for development of new urban recreation facilities, an unavoidable and adverse condition of severe overcrowding of existing facilities will prevail.

DISPERSED. Increased pressure placed on "open space" recreation as a result of increased demand from population growth will be unavoidable.

SHORT TERM VS LONG TERM

URBAN. Short-term impacts will be significant because of the capital outlay required to provide additional public recreation facilities to accommodate anticipated population growth. New Federal leasing will bring additional use to already crowded facilities. On the long-term, minimal impacts are anticipated because the population of the study region is expected to eventually stabilize. Note: If additional facilities are not developed to accommodate the increased urban recreation demand, severe overcrowding will exist on the short-term and be compounded on the long-term.

DISPERSED. The major impact on dispersed recreation will arise from anticipated population growth without new Federal action. New Federal leasing has significance only in combination with this expected growth. The loss of quality of a particular recreation activity experience would be the major impact on the short-term.

The long-term increase of dispersed recreation demand would be considered minimal. The local population may be sensitive to increased participation or the loss of "breathing room" but should become accustomed to this impact after a time.

IRREVERSIBLE/IRRETRIEVABLE

Any loss in quality, of a recreation experience, due to increased participation, would be an irreversible impact.

UNCOMMITTED MITIGATION

URBAN. The financial strain placed on affected region communities to provide public recreation facilities could be supplemented by state and federal funding in the form of public use facility grants.

DISPERSED. Increased funding could be provided to county, state, and Federal agencies within the study region to intensify management of public lands, provide additional facilities, and management personnel for the welfare and safety of the public.

VISUAL RESOURCES

Existing energy related landscape disturbance is extensive within the study region. As removal and exploration for coal, oil, natural gas, uranium, and oil shale continue, an estimated 70,000 acres will be disrupted by 1995 without a new Federal coal leasing program.

The visual consciousness of active mining disturbance is experienced primarily on major transportation routes bisecting the study region. Colorado State Highway 13, running north and south and U. S. Highway 40, traveling east and west are the primary transportation routes in Colorado. Highway 30 in Wyoming, in the vicinity of Hanna, allows for viewing of large numbers of inactive and active mining areas.

The majority of landscapes affected by present mining operations fall within premining VRM classifications III or IV, one exception would be the area west of Steamboat Springs off Highway 40 on the Yampa River. Due to the diversity of vegetation, i.e., riparian and coniferous plant communities and a free flowing river the scenic quality is considered high, a VRM Class II.

Although mining operations do exist along highly traveled transportation routes, the most intensively mined areas are located off county roads, with low to moderate traffic volumes, thus decreasing the visual sensitivity. The continuing process of reclamation has not decreased the severity of visual disruption in the study region. The visual quality of the mined areas can not be reestablished on the short term. Complete reclamation will not occur until end of mine life. OSM regulations require that vegetation be reestablished and landmass be returned to a contour that blends with surrounding topography.

Once reclamation has begun and soils contoured, the vegetation generally planted are grasses. This will decrease the visual contrast so that only the elements of color and texture of the vegetation feature would contrast with the surrounding plant communities. It will take approximately 20 to 50 years for the original vegetative types to regain a foothold on the reclaimed Federal surface. In the long term a mined area would feasibly be returned to its original VRM classification. If natural vegetative seeding or use of native species plugs from the surrounding area are utilized, natural plant succession would be accellerated.

In the situation where the mined surface is under private ownership the postmine land use may be changed. If an owner wishes to change a previous mountain shrub community into livestock pasture use, and meets the criteria formulated by OSM, it will not be reclaimed to its original vegetative community. Therefore, it is possible that a premining VRM classification may never be reestablished. On the other hand, in a very dry area that has limited vegetative cover, diversity, texture, or color, a postmine land use change to pastures (if possible) may actually increase the scenic quality, thus possibly upgrading a premining VRM classification.

Landscape disturbance within the study region is illustrated by Table 4-28. Existing surface disturbance includes coal, oil, gas, oil shale, and uranium for Colorado and coal for Wyoming. Many of these activities are not as visually obvious as strip mining. Therefore, the visual degradation in the No Action Alternative may not be as great as the number of acres indicate. The majority of surface disturbance is in Moffat County, Colorado and Carbon County in Wyoming.

If a new Federal coal leasing program is implemented, activities and developments which would adversely affect the visual quality would be the placement of access roads, rail spurs, additional power lines, and facility structures on the lease areas. The most significant visual impact will arise from the actual strip mining of coal. From the time the mining operation begins an intrusion on the landscape will create a strong contrast with the basic elements of form, line, color, and texture. This will result in a VRM classification change from class III and IV's to Class V (for definitions of VRM classifications see Section 3, Affected Environment). Primary vegetative or scenic types lost will be mountain shrub communities and sage/grasslands (see Table 4-29 for specific tract information). Major losses to scenic quality from all alternatives will be from the following proposed lease areas: Danforth Hills #1 and #3 in Colorado and Red Rim in Wyoming. Their significance is based on high visibility from major transportation routes, Colorado State Highway 13 and Interstate Highway 80 in Wyoming. The severity of acreage disturbed within the study region continues to increase as additional proposed lease areas are put into operation. Iles Mountain has an overall moderate visitation, yet high sensitivity level. Visitation is high during the months of October and November due to big game hunting. During the summer months, floatboaters on the Yampa River will be impacted by the disruption to the scenic quality of the river corridor. Table 4-29 provides additional site-specific information for all proposed lease areas by time frame and alternative.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The decreasing of VRM Class III and IV areas to Class V for a period of 20 to 50 years after end of mine life would be unavoidable and adverse.

SHORT-TERM VS LONG TERM

Impacts associated with the proposed lease areas are visual contrasts to the landscape created by new access roads, rail spurs, power lines, facility structures and the strip mining process. This would change the visual resource management (VRM) Class III and IV's to Class V on the short term.

On the long term, facilities would be removed and disturbed surface areas reclaimed to match the surrounding topography and vegetative communities. It would take approximately 20 to 50 years for the disturbed areas to be returned to its premining VRM classification if native vegetative species are reintroduced at end of mine life.

IRREVERSIBLE/IRRETRIEVABLE

Disturbed landscape areas which may have segments of unsuccessful reclamation, as a result of soil deterioration, would result in an irreversible landscape change.

UNCOMMITTED MITIGATION

In an effort to provide the same visual quality as existed during the premining period, all disturbed surfaces should be returned to its original form and native vegetative communities. To accelerate the return of the native vegetation, plugs from the surrounding area should be planted to enhance and speed natural plant succession.

WILDERNESS VALUES

Three designated Wilderness areas in the study region provide 322,642 acres of opportunity to enjoy a pristine area. Although the projected natural population growth within the study region (Wyoming 13 percent (3,468) Colorado 125 percent (22,621)) will increase recreational demand, a significant impact is not anticipated on wilderness areas. Several new wilderness areas are being proposed in the study region, reducing pressure that existing wilderness areas may receive. The nature of these areas are in themselves prohibitive to major impacts by their expanse and enforced use restrictions.

The most probable recreation activities to increase would be camping, hiking, and hunting, however, no significant impacts are anticipated on wilderness areas due to increased recreational demand as a result of the proposed Federal coal lease related population growth. No wilderness potential has been assessed within or surrounding the proposed lease areas.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

Increased recreation demand as a result of population growth on wilderness areas would be unavoidable.

SHORT-TERM VS LONG-TERM

Increased population without new Federal leasing and in combination with it would create additional recreation demand on existing wilderness areas. However, proposed wilderness areas now under consideration may increase availability by 36%, thus reducing impacts associated with increased pressure on existing wilderness area during the short term. On the long term, demand will continue to increase, but at a significantly slower pace.

IRREVERSIBLE/IRRETRIEVABLE

The increased demand on wilderness areas generated by increased population would be irreversible.

SOCIOECONOMIC ENVIRONMENT

Five major types of socioeconomic impacts are considered in this EIS: Demographic impacts, increased employment and income, fiscal impacts, (additions to the revenues and costs--especially capital improvement costs--of local governments), changes in community social structures, and increases in personal social adjustment problems. Population growth underlies each of these impacts.

Each of the first three types is discussed under the heading of Economics. The last two are considered together under the heading "Social-Structural and Social-Psychological Impacts." A final section summarizes the significance of each type of impact.

ECONOMICS

DEMOGRAPHIC IMPACTS

Two economic models were used to estimate the impacts of population, employment and income growth on the total impacted area, one covering Moffat, Rio Blanco, and Routt Counties in Colorado and the other covering Albany, Carbon, and Sweetwater Counties in Wyoming. Overall impacts on each of the three-county areas were then allocated to communities by means of a gravity model in Colorado, and on the basis of recent growth patterns in mining areas in Wyoming. The gravity model used each community's present population as a positive factor, attracting new population to it, and distance from the community to the mine (measured in terms of driving time) as a negative factor. In Colorado, all population impacts are assumed to occur in the established communities, therefore, no figures are shown for other county areas. In Wyoming, however, it was estimated that some of the population impacts would occur in rural areas, and these are shown under the other county areas. Further descriptions of the economic and gravity models are given in McKean and Weber and *NWCCRES*, Appendix D, page XI-15.

Because of the generally tight labor market in the impacted area, as well as the magnitude of the anticipated growth under the No Action Alternative, most of the new jobs provided by mine construction and operation resulting from new federal leasing would be filled by migration of new people into the area. Population impacts would result from an influx of construction workers, mining personnel, employees of mine service establishments, workers in industries serving the general population, and the families of all of these employees.

Table 4-30 shows the population growth expected to occur as a result of each of the alternatives. Increments shown in Table 4-30 are cumulative, not additive. Figures for the higher alternatives include all of the lower alternatives.

Under the No Action Alternative, a population growth of 67 percent is expected to occur in the impacted area between 1978 and 1995 as a result of mining and recreation developments already under way or planned. Measured against this, population growth resulting from new Federal leasing would have a moderately significant impact on the impacted area as a whole, but highly significant impacts would occur in some communities. All impacts are calculated as a percent of the population projected for the No Action Alternative.

Impacts on individual communities would vary from one percent to 84 percent, depending on the alternative and the year. Some of the large percentage impacts are the result of very small population bases, particularly in the cases of Creston Junction, Dixon and Walcott Junction. Omitting these cases, the range of population impacts would be as follows for each alternative (the year of the impacts varies):

ALTERNATIVE	SMALLEST	LARGEST
LOW	Oak Creek (0%) Steamboat Springs (0%) Yampa (0%)	Baggs (15%)
MEDIUM	Steamboat Springs (1%)	Baggs (15%) Hayden (15%)
HIGH	Steamboat Springs (1%)	Hayden (22%)
MAXIMUM	Steamboat Springs (1%)	Hayden (28%)

If a growth in population of 20 percent over the No Action Alternative is taken to represent a highly significant impact, the following communities would be considered highly impacted:

CITY	ALTERNATIVES
Craig:	Maximum Alternative
Creston Junction:	All Alternatives
Dixon:	All Alternatives
Hayden:	High and Maximum Alternatives
Walcott Junction:	All Alternatives

If a growth rate of 10 to 19 percent were used as a measure of a moderately significant impact, these communities and alternatives would be included:

CITY	ALTERNATIVES
Baggs:	All Alternatives
Craig:	High Alternative
Hayden:	Medium Alternative
Meeker:	High and Maximum Alternatives

All other impacts would represent less than 10 percent growth and would be of relatively low significance. Nevertheless, a small amount of growth may significantly impact a community which has already experienced a major influx of population under the No Action Alternative. This situation affects both the community's fiscal position and its social environment, and these subjects are discussed later in this section.

The resultant population impact that was shown earlier does not include the secondary impacts that are likely to occur outside the study region. For example, it is reasonable to assume that Casper, Laramie, and Rock Springs will grow as a result of the new Federal leasing. This is especially true for Casper and Rock Springs given their strategic location with regard to coal producing areas. Laramie, on the other hand, may experience minor growth resulting from mining company employees locating there. The main growth impetus for Laramie, however, will be the increase in the service sector that will supply coal related employment located in western Carbon County.

Although it is likely that Casper, Laramie, and Rock Springs will grow as a result of the new Federal leasing, the distribution of this growth is unclear. On the aggregate, it is estimated that the total change in population for these three cities will peak at 2,122 in 1987 and by 1995 it will level off at 1,750. On the average, this change will contribute less than a 2 percent increase in the population of these three communities. Given the fact that the relative change is small compared to the total population of the three communities, the secondary impact is considered insignificant.

EMPLOYMENT AND INCOME

Tables 4-31 and 4-32 show the impacts on employment and income respectively. New Federal leasing would increase employment in the impacted area by 1987 from three percent for the Low Alternative to four percent for the Maximum Alternative. By 1995, the percent increase would range from three percent for the Low Alternative to five percent for the Maximum Alternative. The impacts on area income would be the same as for employment, except for a six percent increase by 1995 under the Maximum Alternative.

Impacts would vary somewhat between counties, however. Employment and income impacts would be greatest in Moffat County, reaching 17 percent and 24 percent, respectively, in l995 under the Maximum Alternative. Impacts in Rio Blanco and Routt Counties would be small under the Low Alternative (and in Rio Blanco County under the Medium Alternative also) but would rise to average levels under the higher alternatives. Impacts in Wyoming would remain at an average level compared to the total impacted area under all alternatives and in all of the years analyzed.

In terms of employment sectors, mining would have the largest impact. Increases in both mining employment and income in 1995 would range from seven percent under the Low Alternative to l3 percent under the Maximum Alternative. Construction employment and income would also be raised more than the average of all types of employment and income, with increases in 1987 varying from five percent under the Low Alternative to eught percent under the Maximum Alternative.

Impacts on other sectors of employment and income, which represent the indirect (also called secondary) effects on local commercial and governmental service activities, would be large in numbers but a relatively small percentage. The contrast stems from the fact that these economic sectors will be fairly well developed under the No Action conditions, especially in the larger trade centers. Impacts on employment and income in these secondary activities in 1987 would vary from three percent under the Low Alternative to six percent under the Maximum Alternative, and would decrease by about two percent, by 1995. The reason for declining proportionate impacts is that the permanent mining employees would be expected to require less of these services than would the more temporary construction force.

Impacts by sector would again be highest in Moffat County, with the Maximum Alternative causing a rise in construction employment and income of 29 percent in 1987 and a growth in mining of 87 percent in 1995. Construction impacts would be above average in Rio Blanco County, ranging from 9 percent under the Low Alternative to l8 percent under the Maximum Alternative. Percent impacts on mining would be reduced by the large growth expected to result from oil shale development in that area. Impacts on the construction and mining sectors in Routt County would be minor under the Low Alternative, but would grow to 8 percent and l8 percent respectively under the Maximum Alternative. Construction impacts in Wyoming would be at an average level, but mining impacts would reach around 10 percent by 1995.

Mining's present dominance in the impacted area's economic base would be increased if the new Federal leasing takes place. Mining employment in 1995 would be 23 percent of total employment under the Maximum Alternative, as compared to 21 percent in the case of the No Action Alternative. In terms of income the importance of mining would be even greater, amounting to 36 percent under the Maximum Alternative in 1995 and 34 percent in the case of No Action. Construction employment and income would rise from 9.1 percent and 10.9 percent, respectively, in 1987 under the No Action Alternative to 9.4 percent and 11.3 percent under the Maximum Alternative.

Under ordinary circumstances, employment growth at the rates projected here would not have a significant impact on the impacted area labor market. However, given the degree of growth that is projected to occur without the new Federal leasing, the impact of even the Low Alternative would aggravate an already tight situation. Likewise, the new Federal leasing would help to keep unemployment rates in the impacted area at or below their current low levels as compared to the United States average. The additional income accruing to area residents would enlarge the local commercial sector and would likely allow a greater variety of goods and services to become available in the trade centers. Per capita and family incomes would probably rise to levels more nearly equal to the state averages because of the increase in relatively high-paying construction and mining employment. Conversely, workers in the lower-paying services industries along with people on fixed incomes would be at a disadvantage if, as is likely, the rapid increase in total area income would cause an equally rapid escalation of prices. Employers in these industries would experience increased difficulty in hiring and keeping employees as they could not compete with the wages and salaries offered by mining and construction firms, and the ability of some firms to stay in business might be threatened. This problem would also affect the labor market for agriculture, which is still an important segment of the area's economic and social base.

Under the No Action Alternative, the gains in employment and income from new Federal leasing would not become available to the impacted area. However, considering the degree of growth already projected under that alternative and the present tight labor market, this would not be a significant loss to the area. Unemployment rates would likely remain at or near the present relatively low levels. Growth and diversification of the retail and service sectors might proceed at a somewhat slower pace; conversely, the local inflation rate might also be reduced.

In summary, the new Federal leasing would cause relatively slight impacts on employment and income in the impacted area. Of course, this is largely due to the growth that is expected to take place without this action. Only in Moffat County would the increase reach a significance level of ten percent. Measured in terms of income, Moffat County would experience a moderately significant impact under the High Alternative and a highly significant impact under the Maximum Alternative. In all the other counties and alternatives the impacts would be less than ten percent and rated as not significant, although the Carbon County results might show greater significance if separate projections for that county were available.

A potentially serious effect of the new Federal leasing combined with No Action Alternative developments would be creation of a heavy economic dependence on a single industry--energy minerals. This dependence would carry the risk of large and sudden fluctuations in employment, income, and population caused by changes in the minerals markets or the decisions of mining companies headquartered elsewhere. Maintenance of a viable economic base under these circumstances would be by no means guaranteed, especially in the long-term. Given the impacted area's topography, climate, and relative isolation, shrinkage of the energy minerals sector could not readily be replaced by growth in agricultural, manufacturing, or service activities.

FISCAL IMPACTS

Requirements for funds are balanced by local and external sources of revenue that are available to local counties, communities, and school districts. Unfortunately, data was not available to permit projections of the revenue generating capabilities of local government entities in the EIS area. Specifically, projection of new capital investment by commercial and industrial firms moving into the area or expanding present facilities could not be obtained. This new capital investment would be the basis for growth in assessed valuation and a resulting increase in property tax revenues. Property tax revenues, and total operating revenues, can be projected to grow at the same rate as population. However, projection of assessed valuation and property tax revenues as a function of population growth does not provide a satisfactory estimate because it fails to account for the differential growth in revenues that would result from commerical and/or industrial concentration in a particular community. Lack of data to project assessed valuation also makes it impossible to satisfactorily project the bonding capacity that each jurisdiction will have available because state laws in Colorado and Wyoming limit the total value of general obligation bonds outstanding to a percentage of assessed valuation.

Nevertheless, to place the capital requirements to be described below in at least an order-of-magnitude perspective, the figures in Table 4-33 are provided, showing total operating revenue and bonding capacity projected on a per capita basis. To these have been added the estimated additional property taxes that would be derived from the major private investments expected to take place between 1978 and 1990 in the three Colorado counties, which are described in Section 3. Unfortunately, no similar figures were available for Carbon County, Wyoming.

Another source of local revenue (which is not included in table 4-33) is Federal mineral royalty payments, 50 percent of which are distributed to the states where they originated and, through state formulas, to local governments. Colorado law has established the limit that no county may receive more than $200,000 per year in Federal mineral royalty distribution. All three Colorado counties are now receiving that amount, and no increase in Federal royalty payments can, therefore, be anticipated under present state policy. No Federal royalty payments are distributed directly to communities.

In Wyoming, Federal mineral royalty payments are distributed according to the following formula (only those parts pertaining to counties and communities are shown in detail):

2.25% Highway Fund--Counties
7.50% Incorporated Cities and Towns
90.25% State Programs

Another 2.25 percent was distributed to counties for roads through fiscal year 1979 (and is included below), but that distribution was repealed by the 1979 legislature. Additional amounts are made available to counties and communities in both states through various grant programs, but a local jurisdiction has no assurance of receiving these distributions. Distributions of Federal mineral royalty payments in 1978 (or fiscal year 1979), in thousands of dollars, were (data from local jurisdictions and Wyoming State Treasurer, 1979):

JURISDICTION	THOUSANDS
Carbon County	$23
Moffat County	200
Rio Blanco County	200
Routt County	200
Baggs	14
Dixon	11
Elk Mountain	13
Elmo/Hanna	31

—Continued

JURISDICTION	THOUSANDS
Encamp./Riverside	28
Medicine Bow	22
Rawlins	154
Rock River	12
Saratoga	34
Wamsutter	13

The contributions to property taxes and bonding capacities which would come from the mines to be developed as a result of the new federal leasing are included in the figures in Table 4-33 for both Colorado and Wyoming jurisdictions, and are shown in Table 4-34. Methods of assessing mining properties for tax purposes, in both Colorado and Wyoming, take into account both annual production and investments in land improvements and equipment. Estimated total investments required to mine the individual tracts are shown below and are described in detail in Appendix D.

TRACT	DOLLARS
China Butte	$71,250,000
Danforth Hills #2	83,731,150
Danforth Hills #3	84,445,000
Empire	17,500,000
Hayden Gulch	44,450,000
Iles Mountain	23,850,000
Lay	59,953,000
Red Rim	26,940,000
Rosebud	12,524,000
Williams Fork Mountains	16,444,000

Comparison of these contributions with the county and school district revenue projections (since none of the mines would be within city limits) indicates that the operations would make a significant contribution to local revenues and bonding capacities.

For further perspective, Table 3-28 in Section 3 gives the total of general obligation and revenue bonds outstanding at the end of 1978 for each jurisdiction. As indicated above, general obligation bonds apply directly against the bonding limits that are set by state law. While revenue bonds do not come under a statutory limit, the amount outstanding tends to restrict the willingness of governments to incur additional indebtedness. Besides the above considerations, there is the additional factor that all new bond issues, whether general obligation or revenue, must meet the test of voter approval.

By comparing table 4-34 with table 4-33, it can be seen that property tax increases received by the county governments would be relatively small because the larger part of the mill levy in all cases goes to the schools. Bonding capacity increments would be greater for the school districts because of their larger bonding limits allowed under state laws. County governments would receive revenue increases ranging from zero to eight percent and bonding capacity increases from zero to 30 percent, depending on the alternative. Benefits to the school districts would average considerably larger in the case of tax revenues, from zero to 44 percent, but would be equivalent proportionally to the counties for bonding capacity. However, the amounts received by the school districts would be considerably greater in both cases.

In developing estimates of the requirements and costs of community facilities such as water systems and landfill sites, the choice was made to use a single set of facility standards. By implication, the requirements projected for individual communities do not account for local circumstances which may cause actual requirements to be higher or lower than those shown. This choice was made both to assure that all communities were treated equally and because individualized estimates for each community would require detailed studies beyond the scope of this EIS. The standards used were taken from studies of small western communities and are generally applicable to those in the impacted area. A full description of the capital requirements analysis is included in Appendix D.

Estimated capital costs for additional community facilities required as a result of population growth with and without the new federal leasing are shown in Table 4-35.

Impacts of the new Federal leasing on community and school district capital requirements would vary widely, depending partly on overall size of the jurisdiction. Not surprisingly, impacts would be proportionately greatest on the small communities such as Creston Junction, Dixon and Walcott Junction. Excluding these cases, impacts would vary from zero in Oak Creek, Steamboat Springs, and Yampa to 187 percent in Hayden under all alternatives. Impacts to most of the communities would be more than l0 percent. Exceptions to this would be:

COMMUNITY	ALTERNATIVES
Elk Mountain	All Alternatives
Hayden	Low Alternative
Meeker	Low and Medium
Oak Creek	All Alternatives
Rock River	All Alternatives
Steamboat Springs	All Alternatives
Yampa	All Alternatives

However, even impacts of less than ten percent may be significant if a community's capital resources will have already been expended to accommodate the growth that is expected to occur without the new federal leasing. Comparison of the capital requirements under the No Action Alternative with the rough estimates of bonding capacities of the various communities reveals that only half of them will be able to finance their needs from their own resources. Therefore, the impacts to the financial positions of most communities in the impacted area would have to be rated as significant on the grounds that their capital resources would be inadequate to meet the requirements of cumulative population growth resulting from both the new Federal leasing and other Federal and private actions.

If a figure of 20 percent is taken to represent a highly significant impact, six of the nine significantly impacted communities would be rated as highly impacted by one or more of the alternatives. However, if that same criterion is applied to the ratio of capital requirements to bonding capacity, 12 of the communities would clearly belong in the highly impacted category. Therefore, it can be concluded that the new Federal leasing would have a highly significant impact on the financial positions of all but six of the impacted area communities.

Two courses of action would be available to the communities facing such fiscal deficits. They could allow the quality of their facilities to deteriorate until such time as funds became available for improvements, thus imposing additional hardships and dissatisfaction on the population. Otherwise, they would have to seek financing from outside sources such as grants from state or Federal government sources. Information on such sources is included in the Uncommitted Mitigation section presented later. In most cases, a combination of both courses of action would likely be followed. The same conclusions would probably be drawn regarding the communities' operating revenues and expenditures if the data were available for such an analysis. Some grant monies are also available to alleviate those situations, and these sources are also described in Uncommitted Mitigation.

Impact of the new Federal leasing on the capital requirements of school districts would also be quite significant. However, taken on a county basis, the capital resources of all school districts would appear to be adequate to meet the needs imposed on them by the new Federal leasing and other expected developments. Therefore, with the possible exceptions of Moffat County School District #1, Routt County School District #1, and Rio Blanco County School District #1 (for which an estimate of bonding capacity cannot be made) none of the school districts in the impacted area would be significantly impacted by the new Federal leasing. In the cases of the Rio Blanco and Routt County School Districts it would be reasonable to rate the impacts as moderately significant. However, the impacts on Moffat County's School District must be rated highly significant.

If the new Federal leasing were not undertaken, the counties and school districts would not gain the potential increase in property tax revenues and bonding capacities that would occur under the other alternatives. The communities, on the other hand, would come out ahead since their costs for needed capital investments would be reduced by more than their bonding capacities. The same conclusions would probably hold for operating revenues and expenditures in each case. However, the communities would still face financial difficulties because of the growth expenses engendered by other federal and private developments without a concomitant increase in their revenue bases.

SOCIAL-STRUCTURAL AND SOCIAL-PSYCHOLOGICAL IMPACTS

GROWTH RATES AND COMMUNITY SERVICES

The purpose of this sub-section is to assess, as well as possible, those impacts from the proposed coal tract development alternatives which are purely sociological or social-psychological as different from the purely economic impacts discussed separately.

We lack data for analyzing the impacts directly, particularly in the detail needed for estimating the effects of the various alternatives on specific communities; nor is there a method for identifying the exact combinations of factors which in each case would lead to some 'social disintegration threshold'.

Rate of population growth is an excellent secondary indicator for . evaluating social impact. According to Weisz (p. 31), boom growth above a threshold of seven to ten percent annually will tend to cause the social institutions to become inadequate or to break down. Gilmore (p. 536) puts the figure at 15 percent. An annual growth rate of ten percent will double a population in a little more than seven years; at fifteen percent doubling will occur in just under five.

There is no sharply drawn point at which the rate of population growth in a community would become so rapid that social support systems would suddenly go to pieces. High growth rate is simply an indicator of some slope of decline in the ability of present stable social structures to function adequately. The slope would represent a continuing balance between the disruption of old components and the re-stabilizing adjustments through modifications or replacements of those components.

In the time frame of this EIS, the dates of concern are the 1978 base, the year 1987 (construction), and the year 1990 (full mine operation). The relationships of these dates with growth rates are:

Population Growth (percent annual)	Growth Ratio(1987/1978)	Growth Ratio(1990/1978)
10	2.358	3.138
15	3.518	5.351

These figures mean that at a ten percent annual growth rate, the 1987 population will be 2.358 times as large as that for 1978; at a fifteen percent rate, the population will have grown to 3.518 times its 1978 figure; and so on.

We shall accept an annual population increase of ten percent as a reasonable and conservative estimate for a threshold beyond which the normal social structures of a town will tend to disintegrate because adjustments in attitudes and their structural manifestations cannot be made rapidly enough.

Table 4-36 presents the growth percentages postulated for each community and each EIS alternative. From this table several important conclusions may be drawn:

(1) The Colorado communities will experience considerably more rapid population expansion than will those in Wyoming, from No Action (baseline) through Maximum Alternatives, except that Yampa, Colorado's growth will be less and the two unincorporated villages of Walcott Junction and Creston Junction in Wyoming will be more than the other relevant towns in their respective states.

(2) In all cases, the additional growth rate due to the development of tracts

in the alternatives will be small compared to what will happen with baseline growth factors, alone.

(3) In only two communities (Craig and Meeker) would the "threshold" 10% growth rate be exceeded. Craig through 1987 for the Preferred or High and Maximum Alternatives will exceed this rate (ratio 2.40 and 2.45, respectively) and it will be approached in all cases, so we may postulate that Craig will have a continuing problem of "slope decline" without much respite for catch-up adjustments in the social structure. We cannot estimate what may be the cumulative effects of a long-term strain of this sort for the community's social functioning.

Based upon the ten percent criterion (especially recalling the present small size, homogeneity, stability, and relative geographic isolation of the town), Meeker is the community in most danger of social-structural breakdown over the next dozen years. The baseline (No Action Alternative) by itself will bring about an almost fourteen percent growth rate (a 3.24 multiplication of the 1978 population) by 1987; the Low and Middle Alternative ratio is 3.35; the High and Maximum, 3.47 for 1987, continuing at almost a fifteen percent rate in spite of a relative decline, at 3.26 in 1990. The threshold thus will be exceeded through 1987 with or without new Federal coal development. All alternatives become aggravating factors on an already-overloaded social system.

Unless measures are taken to prepare the people (as different from preparation of facilities) for drastic changes, it is likely that the social-psychological shocks and the social-structural breakdown may be very severe for many individuals and a number of social structures in Meeker. A consequent drastic rise will come in such indicators as alcoholism, depression/suicide, intracommunity personal conflicts, marital stresses, delinquency, etc., and general positive attitudes of life satisfaction will be likely to be replaced (through a breakdown of the present informal social support systems) by anomie and attitudes of general dissatisfaction on the part of many citizens.

Of the other Colorado communities, Steamboat Springs and Hayden will probably receive some strong negative social structural and social-psychological impacts based upon rapid growth, although these probably will not become unmanageable.

Nevertheless, we may guess that the 'slope of decline' would be increasingly steep as the boom growth rate approaches the ten percent thresholds. If the rate of expansion exceeds ten percent, then we may assume that this rate in itself may be a cause of social-structural breakdown. But apart from rapid population growth, and especially in interaction with it, two other factors affect the seriousness of social-structural decline/adjustment in social change situations: cultural similarity and relative power (as discussed in Section 3).

First, the degree of cultural similarity between the in-migrants and the oldtimers. If newcomers are too different in their attitudes, habits, beliefs, dress, hair length, etc., stereotypes may tend to develop which in turn may lead to conflict; social psychological support systems become strained; informal social control definitions and mechanisms are weakened, tending to be replaced by more impersonal legal or other public mechanisms, etc. As Albrecht (p. 6,7) states, social problems growing out of rapid population growth are also related to population diversification, an element independent of growth rate, per se, but interacting with it to compound deleterious effects.

Equally important is the extent to which people define each other as "different," because behavior follows definitions of situations rather than objective reality, and these frequently are not identical. Most persons feel apprehensive about strangers, especially in large numbers, because it is difficult to predict the behavior of strangers. This "fear of the unknown" colors their perceptions of those strangers by exaggerating the differences, often bringing about an avoidance of contact, even open confrontation between the strangers and the oldtimers. This avoidance behavior in the study region, particularly in Craig, has been documented vividly by Moen, et al., in many places of their study.

The greater the differences between old and new residents (actual or perceived), the more strongly negative the initial social-structural impact will be at any given population growth rate. In this impacted area, the principal objective differences between oldtimers and newcomers are those associated with the imposition of "liberal urbanism" upon an essentially conservative, individualistic, and relatively isolated population within the same general culture. The actual cultural differences between, e.g., construction workers and oldtimers, are fairly insignificant, and it is necessary to look at the perceived differences and why they depart from the objective reality.

We unfortunately do not have adequate data on relative power, but undoubtedly there is an association between these perceptual distortions and the second factor which affects the seriousness of social-structural and social-psychological impact of population growth: the relative "power" of the "old" vs. the "new." The newcomers are not just newcomers: they are symbols of the power of the Federal government and the big energy companies taking precedence over local wishes or well-being. In general, the feeling of the local people of the region (Margolis, various places; Moen, et al., various places; and others) seems to be that neither the Federal government nor the energy companies are much concerned about local problems, but that "what can we do--they are going to do what they want to do anyhow." As one local resident put it, "The government don't need to make all these surveys. All they need to do is get out and ask people what they think!" The contradiction in his words escaped him until it was called to his attention. Widespread fatalism and frustration have occurred, and there is but one safe outlet for expressing these; by rejection of those vulnerable persons who symbolize the power: the newcomers. Thus there is apparently a displacement onto the newcomers which magnifies cultural differences and masks the commonality. Negative stereotyping provides psychological comfort and justification for social rejection. Thus, the transition from "rural" values to "urban" values seems to be more difficult than would be the case on the basis of population growth rates and initial cultural differences alone, because of the interjection of what is perceived as an overwhelming power by the Federal government and/or energy companies.

TRANSIENCY, HOUSING, HEALTH, AND EDUCATION

Section 3 analyzes in some detail the connections between existing housing and transiency in the study region, and the social-structural and social-psychological consequences of these conditions. With respect to the impacts to be expected from the various leasing alternatives being considered here, again we cannot establish numbers for what nevertheless are obviously important factors. But as in other instances, we can relate them to population growth rates. The 'transient syndrome' is particularly negative for social well-being and particularly difficult to assess because we lack appropriate data on the nature of the phenomena of transiency and the number and variety of transients. We can say with confidence that the various leasing alternatives will affect the community structures and the lives of individual citizens proportionately to population growth rates. Breakdown indicators such as crime, mental health, anomie, etc., can be expected to rise in at least the medium and larger-sized communities.

On the other hand, health facilities should improve in those communities having hospitals. Increased population may attract more or better medical personnel, and will support more sophisticated hospital equipment. An opposite, negative, impact will probably be felt in the communities small enough that even a substantial increase in numbers will be insufficient to attract doctors or support ambulance service, since it will raise the doctor/citizen ratios.

Because of advance planning in most of the affected communities, it is unlikely that in themselves crowding or teacher/student ratios will become a significant problem over the years of concern. However, school discipline problems, largely unrelated to school crowding, will increase with the other effects of transiency and housing problems.

A final comment should perhaps be made regarding "transiency." In the region being considered, there are two groups of other highly transient peoples: hunters, and other outdoor recreationists such as skiers and campers. Their presence has little to do directly with energy development, although the abundance of wildlife and the adequacy of service facilities such as motels and restaurants (factors which are so related) will affect the degree to which they will be attracted to the area. Their presence is both economically and socially a factor further complicating the picture regarding the social significance of transiency. Skiers will tend to impact only those facilities specifically designed for skiers; campers and other outdoor enthusiasts are more likely to be family groups, and generally will purchase supplies, etc., but will not use most other community facilities. Hunters are, however, a different case. They are nearly all male, appear in a concentrated mass over a period of a few weeks, and are likely to congregate in local bars at night. It is almost certain that to some extent community negativism toward occupational transients and other strangers is due to the behavior of some of these socially uninvolved (sometimes even irresponsible) vacationers. According to a BLM wildlife expert, the number of hunters seems to be decreasing in northwest Colorado. The decrease may be offset by an increase in winter and summer outdoor enthusiasts whose impact may be socially less negative.

IMPACTS ON MEASURABLE COMMUNITY FACILITIES

For those community services for which present system capacities are known and where reasonable estimates can be made of per capita use, it is possible to establish tentative thresholds of demand beyond which those services delivery systems are overloaded. We have done this for six types of service: hospital beds, fire pumping, water, sewer, solid waste disposal (landfill), and school classrooms. By then comparing present capacities with the EIS target dates for the trended growth baseline (No Action Alternative) and for each of our alternatives, we can obtain a clear picture of the interactive effects of trended growth and alternative impacts on these six services for each community. Table 4-37 summarizes these comparisons.

As can be seen from Part 1 of the Table, expected growth in the EIS area prior to 1987 (when the first impacts from new Federal leasing should be felt) will already have overloaded the capacities of the counties/communities in many service areas. Thus, even small impacts may seem more significant in one sense, since they will be atop already inadequate facilities. On the other hand, the additional amounts of impact will in most cases be relatively small compared to the trended growth and in some cases will be almost unnoticeable.

Fire pumping capacity will be particularly problematic throughout the region, and none of the communities have any present plans for expansion. Water systems are also a problem in the case of Wyoming communities, and there are a number of difficulties (Footnote b, Table 4-37); but planning is being done (Footnote a, Table 4-37) in most cases. School space is considerably more of a problem for Colorado than for Wyoming communities, with less advance planning taking place.

Among the communities, Craig and Meeker will be most seriously impacted by 1987, but Craig is doing advance planning in several areas (including for its Moffat County hospital). The case of Meeker has already been discussed in the section on Growth Rates and Community Service.

Part 2 of the Table summarizes the expected effects of the low level alternative development upon these six community services. Here it is clear that except for the Elmo/Hanna water system and the Carbon County District 2 schools, the impacts from this alternative will be upon already-overloaded facilities.

Since the five Wyoming tracts are included in all alternatives, this portion of Part 2 of the Table is not repeated for the three higher level alternatives. Part 3 thus summarizes the changes expected for the Colorado communities only, in the Medium, Preferred or High, and Maximum Alternative levels. Since each higher alternative contains the impacts of all lesser ones, the cumulative impacts as shown may be thought of as simply greater loads upon already overburdened facilities, except that Steamboat Springs and Hayden water systems do not become overloaded until 1990 (Hayden, Preferred or High) and 1995 (Steamboat, Medium) where, in each instance, it is the coal tract development which pushes the system to overload. Some facilities, as can be seen in the maximum level section (cells containing dashes) remain adequate through 1995 in spite of both trended growth and all coal-tract development.

Thus in summary we can say that a number of infrastructure components will be impacted beyond their present threshold capacities by 1995, but that:

(1) The heaviest impacts by far will occur through the trended growth expected without regard to new federal leasing;

(2) Some communities are planning ahead for growth; and

(3) The impacts on community services by new Federal leasing will generally be piggyback on facilities whose capacities will already be stretched beyond their limits.

Using these more measureable facilities as representative of all the community infrastructural components, we may generalize somewhat regarding the effects of these conditions upon the social structures of the communities and the well-being of their citizens. Physical facilities, such as sewer and water systems, are visible, tangible, easily measureable structures. Social structures are intangible, invisible, existing often even below the level of individual consciousness because they form such an integral part of human existence.

A "social structure" is an abstraction. It is made up of a set of interrelated statuses (positions), each of which has attached to it a set of expectations of behavior which define how these positions relate to each other reciprocally, and which make social interaction both possible and meaningful. A social structure, being abstract, is invisible until people "occupy" it by assuming the various positions, and acting out the expected behaviors. Thus, for example, we may talk about a 'family' in the abstract by discussing how "father" (one status) ought (is expected by society) to behave toward his "child" (another status), and how the child, in turn, ought to behave toward its father. This is an entirely different level of discussion than talking about how Mr. Jones, a real father, actually does behave toward Johnny, his child. To examine the social impact of problems with community facilities, then, requires that we ask, "How do these external problems affect the structuring of relationships among the people, and how do they change the behavior of individuals who occupy various positions relative to each other?"

The state of these infrastructural facilities can help determine the nature and extent of actual physical comforts and conveniences for the people of a community. Table 4-37 shows that we can expect that there will be a continued lessening of physical conveniences and comforts, especially when combined with the problems of housing discussed elsewhere, and when certain other tangible discomforts are considered, such as unpaved streets with their mud-or-dust conditions, severe winter climate which tends to keep people within closed doors for many weeks at a time, etc.

As mentioned earlier, for some communities the structural impacts are already being felt. The following can be predicted to continue, if not already begun:

(1) Political structures would be drastically affected because of differences of opinion about such things as who is to blame, how problems can best be solved, and who gets hurt financially. Often the town's elected officials bear the brunt of these conflicts. Newcomers (as discussed in Section III) may be hardest hit by the inconveniences and discomforts, and at least some of this group will seek help through the political structure, producing even greater conflict if oldtimers do not accept their right to participate (or, conversely, producing cooperative joint action if opinions seem in harmony).

(2) Family structures would suffer through a build-up of stress and tension over physical inconvenience and discomfort. For those whose family bonds are already weak, these additional strains may lead to personal abuses or divorces, school problems for children (affecting the educational structure), and so on.

(3) New social groupings would be created. It is entirely possible for physical facility problems to become (like "outsiders") safe emotional scapegoats against which individual stresses can be directed, and around which new cohesive groups may form through defining a common "enemy," thus draining off inter-personal conflicts of other kinds, strengthening the sense of belonging to the community, producing new channels of action and interaction among individuals and groups.

Physical discomforts and inconveniences in themselves may or may not produce psychic or emotional distress for individuals, depending upon the strength of such things as family bonds, felt sense of community support, ability or opportunity to participate in community affairs, already-existing "ego strength," and so on. Since these elements tend to be weakened in energy boom towns, we can predict that in interaction with these, the physical discomforts will have an exaggerated impact upon the sense of well-being of the citizenry.

Persons would tend to turn either inward (producing depression, alcoholism, suicidal feelings, etc.), or outward toward other persons or the community in general (producing crime, delinquency, marital breakdown, etc.).

Thus the state of physical facilities has a direct impact upon both the social structure of the community, and the social-psychological well-being of individuals. We have no method of quantifying these impacts, nor even specifying which will occur under what conditions. We can assume, however, that there is a direct inverse relationship between the adequacy of these facilities and the human problems, although as noted the adverse effects may be mitigated somewhat if action coalitions form to bring persons together, provide them with meaningful common purpose, and thus give these new groups a "place" in the general social structure and help to relieve the sense of powerlessness and frustration felt by individuals. Such actions would, of course, help to preserve and stabilize the social structure as well.

SOCIAL IMPACT ASSOCIATED WITH HOUSING NEEDS

The Socioeconomic Section in Section 3 discussed the implication of housing types and conditions for transiency, and as social-psychological and social-structural impactors. We have also discussed population growth rates, etc., as causal to social impacts from energy development. One further brief comment needs to be made emphasizing the significance of housing.

In climate like that of this region, adequate shelter is paramount to basic health and well-being. If population grows, so must housing, to accommodate that increase. In this study area as of 1978, only two communities (Oak Creek and Yampa), both quite small, were identified as having any housing surplus. Most of the communities already had shortages severe enough that market prices and rents had become severely inflated.

Table 4-38 summarizes the estimates of numbers of households who will need housing in addition to presently available supply, for each development alternative for the three time periods of concern. We should note that these figures do not take into account at all the need for replacement of substantial numbers of substandard dwellings currently still in use.

It seems obvious housing will be a continuing problem, not likely to level off much during these years. Crowding, inconvenience, discomfort, heavy economic burdens, and other adverse social consequences will also continue to be felt, especially among newcomers. In Meeker the problem is likely to become very acute.

We have tried to show that the major social and social-psychological impacts from the coal alternatives will be primarily due to rapidity of population growth and a perceived helplessness among local peoples who feel unable to cope with the Federal government and energy companies. These problems lead to conflicts between oldtimers and newcomers. Even when the general attitude toward energy development is positive, as most of the studies show it to be, community social structures may be strained to the breaking point due to these factors (especially when these are compounded by excessive strains on the financial and service facilities, housing, etc.), leading to painful and often destructive community and human consequences during the time it takes for new and frightening social settings to be transformed into the "familiar and predictable."

We may expect that the rate of "personal failures" will rise with the rate of population growth, that newcomers in general will continue to experience rejection and a lack of integration into the community, that women and children will be especially severely affected, and that the structuring of personal and group interactions will tend to be disintegrative, at least in the short-run. As the strange becomes the familiar, such disintegrative tendencies should be slowed and gradually reversed, so that even in the "bad" cases (such as Meeker and Craig), the social structures will become stable enough, once again, to support the social needs of communities. As this occurs, it will become clear that not all changes were negative. For example, however, one may regret the loss of an old "neighborly helpfulness" spirit in Craig, it remains a positive thing that the town now has mental health facilities and a good police department.

SUMMARY

Table 4-39 presents the conclusions of the social and economic analyses in matrix form. Because each jurisdiction (county, community, or school district) represents a separate impact analysis, totals for the entire impacted area would be meaningless. Therefore, the summary is presented in terms of the number of jurisdictions that would experience impacts of varying significance under each alternative. Jurisdictions of three types (counties, communities and school districts) are included in the table. Detail on the impacts to individual jurisdictions has been discussed previously in the analytical sections.

Because socioeconomic impacts may be either beneficial or adverse, the results in Table 4-39 are so classified. The significance criteria used are described under each subject heading.

Population impacts would be low in most jurisdictions because of the growth projected to occur without the new Federal leasing Of the eight jurisdictions that would experience moderate or high impacts under the higher alternatives, four are communities with a small population base. The other four represent major population impacts, which would occur in Craig, Hayden, and Meeker, plus Moffat County.

Employment and income impacts to counties would be almost entirely of low significance, again largely because of growth expected without this action. The only exception would occur in Moffat County because of the proximity of Craig to many of the tracts proposed for leasing.

A highly important, but unquantifiable, impact would be the creation of a largely one-industry economy, with the resultant risk of boom and bust that is so familiar in western mining history.

Impacts of capital expenditure requirements on the fiscal positions of the jurisdictions would be quite significant. In this instance a threshold can be clearly defined. The capital capabilities of many of the communities probably will already have been exhausted by No Action Alternative growth, and a further impact of any size would therefore be significant. This would be the case in half of the communities. Although the school districts would generally be in better financial shape, the impacts alone would be of significant magnitude in three cases.

To summarize the sociological and social-psychological effects of the alternatives, we may note first that energy boom town growth and problems are one variation of a long-term worldwide pattern of population growth, human migration, and cultural contact, with which they have much in common. Two general types of impacts are felt: Community social-structural change or breakdown depending upon the speed, degree, and intensity of growth; and personal social adjustment problems.

At the personal level, response to such stresses may in turn take either of two forms. Individuals may turn inward upon themselves to become depressed, alcoholic, suicidal, or develop some other kind of mental or physical illness; or they may turn aggression outward against other persons or the community at large, through marital fights and/or divorce, child abuse, delinquent or criminal acts, etc. Of these, the most negative impact upon the individual may be aggression turned inward upon himself. The most serious community impact is individual aggression turned outward; both represent irretrievable "losses" for the persons involved.

Such personal failures are directly related to a failure at the community level to provide and/or maintain a social-structural framework within which all or most individuals can find personal satisfaction and the fulfillment of the need for social interaction and emotional/psychological support. These issues will be addressed in the section on uncommited mitigations.

Community social structures which change so rapidly that in effect they "break down," particularly to the extent that the change is from informal to formal mechanisms, tend to have a short-term negative impact on both the adequacy of the community services delivery and the social well-being of citizens. However, such conditions tend to be transitional toward some new structural integration which is often more effective than the old.

Table 4-39, our Social-Economic Impact Matrix, indicates (based upon population growth rates in Table 4-36) that in terms of sociological impact (community social structure), most of the communities will not be seriously affected, as in most cases the growth rate would be acceptably small (below 5%), especially in the Wyoming communities. Moderately affected (5 - 10% growth rate) would be several, and seriously affected (more than 10%) would be only Craig (High and Maximum Alternatives) and Meeker (all Alternatives). As just noted above, social-structural change has both positive and negative components.

With respect to the impacts on individual lives, since these correlate with social-structural impacts from growth rates, for Table 4-39 we have used the same criteria for judging seriousness of impact (less than 5%, 5%-10%, more than 10% growth rates.) These are generally negative, to whatever degree they happen, because personality breakdown and/or publicly defined wrong-doing usually become permanent blots upon the lives of individuals. Suicides are, of course, utterly irretrievable human losses.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

Unavoidable adverse impacts on the social-economic environment in the EIS area, all of them stemming from rapid population growth, would include the following items.

Inflation would be higher than average because of the pressure of added buying power on the supply of goods and services. High prices would impose a particular hardship on two groups--those with fixed incomes, and those in lower-paying types of employment such as trade and service workers.

Wage pressures would create problems for small businesses in the lower-paying industries, making it difficult for them to hire and keep better quality workers against the competition from higher paying industries such as mining and construction. Such pressures could threaten the existence of some establishments.

Capital expenditure requirements of the counties, communities, and school districts would be increased. For most of the communities, these requirements would aggravate an already difficult financial situation brought about by growth unrelated to new Federal Leasing. In the majority of cases, local fiscal resources would be inadequate to meet the demand, and external sources of funds such as state and Federal loans and grants would have to be sought.

Another possibility that would be likely to occur, at least temporarily, would be deterioration in services if necessary improvements were delayed by funding problems, causing inconvenience and dissatisfaction among those affected. It is also likely that some of the communities would experience difficulty in meeting operating expenses, although the available data did not permit an analysis of this question.

The shortage of adequate housing, the invasion of new values and attitudes, the overloading of community facilities, all related to rapid population growth, would combine to:

(1) Bring about a decline in the functional efficiency of the social-structural systems of the communities, giving rise to intracommunity conflicts, political and other social decision-making power shifts, school discipline problems, social isolation for many (especially for many women), anomie, and loss of community cohesion. Medical services would probably decline in quality in the smaller communities.

(2) Bring about an unspecifiable amount of personal stress, leading to a breakdown of an unknown number of families (tensions, divorce, child abuse) and individuals (depression, suicide, alcoholism, delinquency, crime). Such losses of human potential are always serious for both the individual and the

community; often they are irretrievable.

The town of Craig would continue to experience many social difficulties from the persistence, without respite, of a high population growth rate. Steamboat Springs and Hayden would suffer somewhat less but still serious pressures. Meeker would suffer the most drastic social problems of the study region, and it is possible these would be serious enough to produce a several-year period of severe social disintegration in that town.

SHORT-TERM VS LONG-TERM

From a socioeconomic viewpoint, the only long-term impacts of the new Federal leasing would be growth of the population and infrastructure in the impacted area and changes in the social structures and institutions of the communities. Economically, most of the changes would be beneficial after the initial problems of local government finances have been overcome. A growth in population resulting from the new Federal leasing would increase the area's potential productivity by enlarging the labor force. Additionally, infrastructure improvements such as roads, water systems, fire-fighting capability, etc., would contribute to increased productivity by providing facilities useful for commerce and industry as well as resident populations. Enhancement of buying power in the area would attract trade and service establishments, thereby providing a larger and more diversified trade and service capability.

The greatest long-term danger to the area from the new Federal leasing, combined with the growth anticipated under the No Action Alternative, would be the uncertain prospect of maintaining a viable economic base which could continue to provide the necessary employment and income. With the area's increasing dependence on a single industrial sector--energy minerals--maintenance of that base is by no means guaranteed in the long term.

Social-structurally, the most important long-term impacts would be the replacement of informal with formal organizational structures, a greater complexity of relationships associated with increased population, greater heterogeneity of values and roles. The tight-knit small town neighborliness of most communities would give way to more urbanity.

Social-psychologically, the short-term impacts would generally be negative for those who felt stress leading to mental problems or community control problems such as crime or school discipline. For these persons the short-term impacts would in most cases lead to long-term adverse effects from waste or ruin of individual potential. However, some persons would experience a positive "release from prison" impact--persons who became more prosperous, those who did not "fit" into the more narrow small-town mold and saw the changes as broadening their life options, etc.

IRREVERSIBLE/IRRETRIEVABLE

Growth in population by 1995 of from 3,493 to 7,994 in the total impacted area from the Federal action would be irreversible except at considerable economic and human cost. Likewise, the additional infrastructure that would be required to serve the growth in population, commerce, and industry would be an irreversible consequence of new Federal leasing. Economic resources would be irretrievably committed to the construction of housing and other infrastructure. Anywhere from 14 million to 36 million board feet of lumber and from 50,000 to 130,000 cubic yards of concrete would be consumed in housing alone--plus additional amounts of brick, stone, insulation, roofing, metal, glass, and paint--exclusive of commercial, industrial, and public structures (Harris, 1980). Between two million and five million man-hours of labor would be required for new housing. In addition to materials and labor, wealth in the forms of capital equipment and financial resources would also be committed to these developments.

The "small-town" sense of community of most of the impacted communities would be lost or modified. Even if the populations declined after mining was finished, there could be no return to the prior social structures and value systems.

Suicides are totally irretrievable and irreversible. Likewise, those children who, because of adjustment and school problems do not fulfill their reasonable potential and/or grow into unhappy adults, represent a human loss that is irretrievable in most cases (though not all); the same is true for the adults, most often women, whose occupational skills and intellectual potential are wasted and whose emotional well-being is damaged. Again, for some portion of these latter, full recovery would occur. These losses cannot be quantified at the present time.

UNCOMMITTED MITIGATION

Four basic problems would have to be overcome in order to reduce the social and economic impacts described in this section: Rapidity of change, inadequate local financial resources, inflation, and economic dependence on a single industry. Compounding these problems are two further factors: Uncertainty as to time, place, and degree of growth; and problems in local planning and land use controls.

The two compounding factors will be addressed first. Uncertainty could be reduced in two ways. First, the Federal government could establish and publicize a schedule for new Federal leasing in the coal regions of the country. While market and political conditions would preclude maintaining a rigid schedule, a degree of predictability to future Federal actions would greatly reduce the difficulties of planning for and mitigating the impacts of those actions. Second, mining companies could be required to give maximum advance notice of major developments. This could be accomplished through Federal lease stipulations and state and local permits and land use regulations. Reducing uncertainty would assist local planning efforts, improve the timeliness of state and Federal assistance, and encourage participation by private capital.

In addition to reduced uncertainty, local planning and land use control efforts would require additional staff and specialized expertise. Assistance may be available through some of the programs listed below. The formation of impact advisory groups--composed of local government, industry, and citizen representatives--would enable some problems to be anticipated and resolved early on.

The first of the four basic problems, rapidity of change, would affect each of the other factors and problems, but its primary impact would be upon community social structures and the adjustments required of individuals. Possible mitigating projects for community organizations such as churches, clubs, interested citizen groups, civic groups, local governmental agencies, and local industries include:

(1) Organize interest groups (singing, drama, rock collecting, Great Books, travel) with free public performances/ demonstrations of these.

(2)Continuously seek out, welcome and involve isolates, especially migrant isolates, in membership and/or activities.

(3)Provide a variety of daytime activities and recreation for women, particularly tapping those special talents, training, and interests that can be shared by oldtimers and newcomers. This would need to include baby-sitting arrangements.

(4) Provide after-school programs, both recreational and intellectual, for school age children and youth. Church, school, or other facilities, and supervision, would be needed on a voluntary basis. To include migrant children and youth would require special efforts.

(5)Develop community education (informal by, e.g., churches or clubs, or formal but non-credit and to some extent non-academic, by colleges) for short courses on many topics.

(6)Form political and/or community action coalitions on topics of local concern.

(7)Provide community-wide activities to encourage "singles" participation and give single people of all ages ways to meet and interact other than in local bars.

(8)Seek funds to expand or develop new services for the community at the local governmental or non-governmental level (see list of sources).

(9)Endeavor to reduce confusion, misunderstanding, and conflict between the citizenry and energy companies, state, and Federal government by actively seeking regular information exchange systems with these, and by inviting local representatives of government and energy companies more often as speakers and/or discussants on program agenda of local organizations.

Several approaches to the problem of inadequate local financial resources would be possible. The mismatch situation, which was described in Section 3, local finances, could be dealt with through state legislation requiring sharing of *ad valorem* tax revenues between counties and communities. Lease stipulations and local permits could require company contributions toward local impact mitigation, thus shifting part of the burden from local residents to consumers of the end product. The exemption from property taxes given to electric power plants could be removed, with the same effect. Efforts could be made to encourage commercial development within the communities through transportation, parking, and other facilities improvements to prevent loss of that tax base to rural areas or regional trade centers.

A variety of Federal and state aid programs would be available to supplement local financial resources. However, there is no way to determine beforehand how much of a contribution these programs could make to reducing the projected deficits which have been described because of frequent changes in program funding and the competition between impacted communities throughout the states. A partial list of Federal and state programs is given at the end of this section. Descriptions of the programs can be found through the sources following that list.

Inflation, particularly in land values and housing costs, could be lessened by measures to make additional land available for development. Communities anticipating growth could purchase blocks of developable land (land banking) and make it available for housing or business at non-inflationary prices. When it is available, Federal and state land could similarly be provided for developments adjacent to impacted communities. Measures to attract new trade and service establishments to the community would dampen inflation by increasing consumer choice.

Alleviating the risks inherent in a one-industry economy would require efforts to attract different types of industry to the area. State development and promotion agencies could assist local chambers of commerce in such efforts. Research into the most feasible types of development could be carried on by state development agencies and university business research departments.

How much could the mitigation measures described above reduce the social and economic impacts of new Federal leasing? An estimate can be made of the effect of lease phasing on the problem of overly rapid social-structural change. Taking the threshold of 10 percent annual population growth described under social-structural and social-psychological impacts as a basis, postponing the start of mine construction from 1987 until 1988 would keep Craig's growth below that threshold. In the case of Meeker, construction would have to be delayed until 1991. The degree to which community fiscal problems could be alleviated through sharing of county revenue sources cannot be directly determined. However, comparison of county bonding capacities with community capital deficits (should county bonds be made available for community facilities) reveals that all or a large part of the deficits in the communities could be overcome by this means. The effects of other sources of revenue or aid cannot be evaluated because the amounts involved are not known.

The following is a partial list of Federal and state impact aid programs. Initials in parentheses indicate the administering agency or contact and are shown in the sources that follow.

MULTI-PURPOSE PROGRAMS

- Coal Tax Grants (PLC)
- Community Development Block Grants (HUD)
- Community Facilities Program (FmHA)
- Energy Impacted Area Development Assistance Program (FmHA)
- Joint Powers Loans (PLC)
- Mineral Lease and Severance Tax Fund (DLA)
- Mineral Royalty Grants (PLC)
- Mortgage Insurance - Land Development, Title X (HUD)
- Old West Supplements to Federal Grants-in-Aid (DEPD)
- Rural Housing Site Loans (FmHA)
- Surplus Land for Community Development (HUD)

HEALTH-RELATED PROGRAMS OF ALL TYPES

- Alcohol Clinical or Service-Related Training Programs (HEW)
- Alcohol and Drug Abuse Prevention (HEW)
- Alcoholism Treatment and Rehabilitation/Occupational Alcoholism Services Programs (HEW)
- Community Health Centers (HEW)
- Community Mental Health Centers - Comprehensive Services Report (HEW)
- Drug Abuse Community Service Programs (HEW)
- Emergency Medical Services (HEW)
- Medical Facilities Construction - Loans and Loan Guarantees (HEW)
- Mental Health - Children's Services (HEW)
- Mortgage Insurance - Hospitals, Sec. 242 (HUD)
- National Health Service Corps. (HEW)

HOUSING PROGRAMS

- Condominium Housing (HUD)
- Graduated Mortgage Payment (HUD)
- Low to Moderate Income Housing Loans (FmHA)
- Lower-Income Rental Assistance, Sec. 8 (HUD)

Mobile Home Loan Insurance, Title 1 (HUD)

Mortgage Insurance - Investor Sponsored Cooperative Housing, Sec. 213 (HUD)

Mortgage Insurance - Mobile Home Parks, Sec. 207 (HUD)

Mortgage Insurance - Rental Housing for Moderate Income Families, Sec. 221:d:4 (HUD)

One-to Four-Family Home Mortgage Insurance, Sec. 203:b and i (HUD)

Public Housing - Homeownership For Low-Income Families (HUD)

Rural Rental Housing Loans (FmHA)

PLANNING AND OTHER COMMUNITY FACILITIES

Airport Development Aid Program (FAA)

Airport Planning Grant Program (FAA)

Area Development Assistance Planning Grants (FmHA)

Comprehensive Planning Assistance, 701 (HUD)

Federal Aid Urban Assistance Program (WHD)

Land Lease for Airports (BLM)

Law Enforcement Assistance - Narcotics and Dangerous Drugs Training (DEA)

Library Services - Grants for Public Libraries (HEW)

Public Land for Recreation, Public Purposes and Historic Monuments (BLM)

Rural Community Fire Protection (USFS)

SERVICES FOR THE AGING, CHILDREN, EDUCATION AND POVERTY

Child Abuse and Neglect Prevention and Treatment (HEW)

Child Welfare Services (HEW)

Community Action (CSA)

Community Education (HEW)

Community Food and Nutrition (CSA)

Environmental Education (HEW)

Head Start (HEW)

Maternal and Child Health Research (HEW)

Runaway Youth (HEW)

Special Programs for the Ageing (HEW)

WATER AND WASTE PROGRAMS

Additional Water Resources Research (OWRT)

Construction Grants for Waste Water Treatment Works (EPA)

Flood Control Projects (FRC)

Loan Guarantees for Construction of Treatment Works (EPA)

Resource Conservation and Development Loans (FmHA)

Small Reclamation Projects (WPRS)

Solid and Hazardous Waste Management Program Support Grants (EPA)

Solid Waste Management Technical Assistance and Information Services (EPA)

Waste Water Treatment Plants (EPA)

Water and Waste Disposal Systems for Rural Communities (FmHA)

Water Resources Investigations (USGS)

Watershed Protection and Flood Prevention Loans (FmHA)

Further information on mitigation strategies and sources of technical and financial aid can be obtained from the following sources.

FEDERAL AGENCIES

Farmers Home Administration (FmHA): Consult local telephone directory for county office

Forest Service (USFS), 11177 W. 8th Ave., Denver, CO 80215

Community Services Administration (CSA), 1961 Stout St., Denver, CO 80294

Department of Defense, FRC Energy Impact Office (FRC), 1961 Stout St., Denver, CO 80294

Environmental Protection Agency (EPA), 1860 Lincoln St., Denver, CO 80295

Department of Health, Education and Welfare (HEW), 1961 Stout St., Denver, CO 80294

Department of Housing and Urban Development (HUD), 1405 Curtis St., Denver, CO 80202

Bureau of Land Management (BLM) 1600 Broadway, Denver, CO 80202

2515 Warren Ave., Cheyenne, WY 82001

Geological Survey (USGS), Water Resources Division, Denver Federal Center, Denver, CO 80225

Office of Water Research and Technology (OWRT), Interior Bldg., Washington, D.C. 20240

Water and Power Resources Service (WPRS), P.O. Box 11568, Salt Lake City, UT 84147

Drug Enforcement Administration (DEA), New Custom House, Denver, CO 80202

Federal Aviation Administration (FAA), 10455 E. 25th Ave., Aurora, CO 80010

STATE AGENCIES

Department of Economic Planning and Development (DEPD), Barrett Bldg., Cheyenne, WY 82002

Department of Local Affairs (DLA), 1313 Sherman St., Denver, CO 80203

Public Land Commission (PLC), 2420 Pioneer, Cheyenne, WY 82002

Wyoming Highway Department, Cheyenne, WY.

REFERENCES (complete reference in Bibliography)

Carbon County Council of Governments, 1979

Colorado Department of Local Affairs, *Summary and Status Report of the Mineral Lease and Severance Tax Fund*, 1980

Gilmore and others, *Analysis of Financing Problems in Coal and Oil Shale Boom Towns*, 1977

Gilmore and others, *Socioeconomic Impact Mitigation Mechanisms in Six States - Categories, Generalizations and Unresolved Issues*, 1977

Mountain Plains Federal Regional Council, 1979

Young and Johnson, 1976

TRANSPORTATION

New Federal coal leasing will have an effect on the existing transportation systems. Increased traffic volumes, accidents, train traffic exposure ratings, and time delays would result from new coal leasing.

NO ACTION ALTERNATIVE

The No Action Alternative would have no significant effect on the transportation systems in the study areas. Traffic volumes, acidents, rail traffic, and exposure ratings for this Alternative would remain the same as in Section 3. A 155 percent increase in traffic volumes and accidents in Colorado between 1978 and 1995 can be expected. The increase in Wyoming during this time frame would be 180 percent rail traffic between 1978 and 1995 will increase 194 percent on the D&RGW line and 165 percent on the UP line. Exposure factors and time delays at grade crossing would also increase proportionately.

AVERAGE DAILY TRAFFIC (ADT)

As a result of leasing, an increase in the ADT can be expected. The ADT for each affected road segment by alternative is listed in tables 4-41 through 4-45. The ADT figure listed in these tables includes the trended analysis as well as direct and indirect trips associated with the proposed leasing. The increase in ADT for Wyoming for all alternatives is 7 percent, while for Colorado the increase is 12 percent for the low alternative, 18 percent for the medium alternative, 40 percent for the high alternative and 45 percent for the maximum alternative.

Five towns in the study area will experience significant increases in their internal traffic. These towns are Craig, Hayden, Meeker, Hanna, and Rawlins. Table 4-40 lists these increases by alternative.

These increases assume five trips per household per day. With the increased traffic, these towns may experience serious traffic disruptions unless local traffic plans are updated.

The impacts of the increased ADT are increased noise, increased air pollution (see Air Quality), increased animal road kills (see Wildlife), increased traffic accidents, increased at-grade hazard ratings, increased road congestion, and increased maintenance costs.

HIGHWAY CAPACITY

Capacity figures listed in tables 4-41 through 4-45 were determined by the existing traffic mix and road geometrics. The total peak hour traffic was computed by multiplying the Design Hourly Volume (DHV) figure times the trended ADT and then adding the peak hour employee traffic. This method assumes that both peak hours will occur together. By dividing the total peak hour traffic by the capacity a coefficient is determined. If the coefficient is greater than 1.00, a drop in the service level and resulting congestion may be expected.

The Wyoming road segments have enough excess capacity to absorb the increased peak hour traffic for all alternatives without a decline in the service level. In Colorado, the low alternative will have no significant effect on the carrying capacity of the road segments. However, all of the rest of the alternatives will result in a decline in the level of service for road segments B and C (U. S. 40 between Craig and Hayden and between Hayden and Steamboat Springs, respectively). Traffic congestion can be expected to occur on these two road segments during peak traffic hours.

ACCIDENTS

The increased number of accidents can be projected by using the following formula: (Increased ADT X Segment length X Accident Rate X 365) divided by 1,000,000

This method assumes that the accident rates will remain constant over time. The Wyoming road segments will experience an increase of 7 percent in the number of accidents for all the affected road segments for all alternatives. The increase in accidents for the affected Colorado road segments is 12 percent for the low alternative, 18 percent for the medium alternative, 40 percent for the high alternative, and 45 percent for the maximum alternative. Tables 4-46 through 4-50 show specific increases for specific road segments. An increase in accidents of 10% or more is significant because of the loss of life and property involved in traffic accidents.

Of the total number of accidents projected for 1990 on table 4-46, one will be a fatal accident and 10 will be injury accidents. Total fatal accidents for the Medium Alternative will be one per year, while the total number of injury accidents will be 19 per year. The High Alternative would cause three fatal accidents and 42 injury accidents in 1990, while the Maximum Alternative would cause three fatal accidents and 52 injury accidents. In Wyoming all of the alternatives would increase fatal accidents in 1990 by two.

ROAD MAINTENANCE

Road maintenance costs will increase as a result of the increased ADT. This amount is unquantifiable but it is expected to increase at least proportionately to the increase in ADT. Due to the 288 truck trips per day hauling coal from Williams Fork (Maximum and High Alternatives) to the Hayden rail spur, road maintenance for County Road 22 would be approximately $92,000 per year.

RAILROAD CONSTRUCTION

The assumed method of coal transportation from the mine site was rail except for Williams Fork Mountain Tract and the Pinnacle Tract (Maximum and High Alternatives). Four of the tracts would require significant additional track mileage to tie to existing rail facilities. In Wyoming, the Red Rim and China Butte tracts would require an additional 8 and 20 miles of track, respectively, to tie into the existying UP mainline. In Colorado, the Hayden Gulch and Lay tracts would require an additional 10 miles of track each to tie into existing or proposed rail lines. Of the four tracts mentioned, only the Lay Tract would cause another major at grade crossing to be built. However, no projections for exposure factors or hazard ratings can be made for the new crossing.

RAILROAD TRACK CAPACITY

The maximum alternative would have a significant impact on the DRGW's track capacity. With the trended rail traffic projections of 33 trains per day by 1995 added to the maximum alternatives 12 trains per day by 1995, a resulting figure of 45 trains per day would use the line between Craig and Denver. The lines capacity is 48 trains per day. The total traffic would use 94 percent of the line's capacity. The significance of the impact would be a limiting of the future rail service in the area. Only three more trains per day, which represents 10 years of general freight growth, could be added to the line before it was at capacity.

The High Alternative would add nine trains to the line. The cumulative total would represent 88 percent of the track capacity. A total of six trains, representing twenty years of general freight growth, could be added to the line before it reached capacity. The Medium Alternative's four trains added to the line would use 77 percent of the line capacity. The remaining capacity would be adequate to handle 37 years of growth in general freight. The Low Alternative would add two trains to the system and contribute to the use of 73 percent of the line's capacity.

Because of improvements underway to the UP, the addition of four trains per day will have an insignificant impact on the line's capacity. However, if the UP does not continue to upgrade its main line, by 1995 the line will be over capacity, resulting in delays in getting products to market.

Over the next few years, the major constraint on rail traffic will not be the lines' capacity, but rather the ability to get enough rolling stock, power equipment and train crews. Presently there is a two year wait for rolling stock and power equipment.

GRADE CROSSINGS

Tables 4-51 through 4-54 list the new exposure factors and hazard ratings by alternative for the Colorado at-grade crossings which would be impacted. The increase is due to the increased ADT at each crossing as well as the increased rail traffic. The tables indicate that no grade crossing would need to be separated as a result of new Federal leasing because, as shown in the 1995 trended table, all but two grade crossings would need grade separation. These two crossings, 253-614(J) and 253-621(U), are not sufficiently impacted by any alternative to warrant grade separation.

The tables reflect what the exposure factor and grade crossing hazard ratings would be if these crossings are not grade separated by 1995. The average increase in the exposure factor is 6 percent for the Low Alternative, 12 percent for the Medium Alternative, 22 percent for the High Alternative, and 32 percent for the Maximum Alternative. The average increase in hazard ratings is 2 percent for the Low Alternative, 4 percent for the Medium Alternative, 6 percent for the High Alternative, and 9 percent for the Maximum Alternative. A 2 percent increase in hazard rating (Low Alternative) may seem insignificant; however, even with the Low Alternative a total increase in the hazard ratings of 2.77 accidents per five years for all affected grade crossings will occur. The Medium Alternative will experience an increase of 6.73 accidents per five years; the High Alternative would increase 10.41 accidents per five years; and the Maximum Alternative's increase would be 14.70 accidents per five years for all the affected grade crossings.

These tables do not include grade crossings beyond Denver because no specific information regarding markets for the coal is available. Grade crossings between Denver and the destination point of the coal will experience similar increases in exposure factors and hazard ratings as indicated above.

The UP has no grade crossings with state highways in Wyoming. However, the mainline does cross a number of county roads. Data for evaluating the exposure factor for these roads is limited and no accurate projections can be made. The exposure factors for these roads should range from 4,000 to 96,000 with the average about 28,000. Coal leasing would increase the exposure factor by approximately five percent.

Again, because markets for the coal have not been identified, no attempt has been made at analyzing grade crossing in Nebraska or Wyoming. However, since rail traffic will increase 5 percent on the UP as a result of the new Federal leasing, it is reasonable to assume that a 5 percent increase in the exposure factor and hazard rating would occur at all grade crossings along the UP mainline.

TIME LOSS AT GRADE CROSSINGS

Assuming a 3 minute delay in auto traffic per train at each grade crossing along the D&RGW line the low alternative would result in an increased delay of 6 minutes. The Medium Alternative would have an increase delay of 24 minutes, the Preferred or High alternative would have an 18 minute delay, and the Maximum a 36 minute delay. Traffic at grade crossings along the UP would have an increased delay of 12 minutes.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

Unavoidable adverse impacts which will result from the new Federal leasing are increases in traffic, traffic congestion, road maintenance, accidents, grade crossing hazard ratings, and increased delays for auto traffic at grade crossings.

SHORT-TERM VS LONG-TERM

All impacts to the transportation system are projected to last only through mine life. Therefore, all of the impacts are short-term. However, new mines in the area are expected to utilize the new rail extensions resulting from the proposed leasing. The use will be long-term in nature.

IRREVERSIBLE/IRRETRIEVABLE

Loss of life and property in traffic accidents is irretrievable.

UNCOMMITTED MITIGATION

Lease stipulations could be imposed that would assure that the state would not bear the total burden of increased road maintenance costs (up to $500,000 a year). Stipulations which could be imposed are listed below:

(1) Require that lease holders transport their product by a mode other than trucks. In situations where alternative transportation modes would be cost prohibitive, the lease holder would be required to pay for maintenance of the roadway to the standards acceptable to the appropriate jurisdiction.

(2) Require that all lease holders producing more than 500,000 tons of coal per year use non-highway transportation for coal movement.

(3) Require the use of conveyor systems rather than trucks to transport the coal to the nearest rail line.

Lease stipulations could also be imposed that would decrease employee traffic. Ride sharing would decrease trips per day by a minimum of 400 trips. Secondary benefits would include: a decrease in the energy used for employee transportation, decrease in the projected number of accidents and decreased air and noise pollution. Some stipulations might be:

(1) Require lease holders to support and participate in ride sharing programs for their employees.

(2) Require lease holders to support and participate in ride sharing programs.

(3) Require lease holders to institute a minimum auto occupancy standard for vehicles transporting employees to and from the mine site.

State governments can also take mitigating measures. These include:

(1) Placement of weight restrictions on roadways and bridges in affected areas.

(2) Increase licensing fees.

LAND USE

The impacts to the variety of land uses have been separated into three elements. First is direct land use impacts, second, indirect, and third, conflicts with existing land use plans and policies. The first element (direct land uses) was further separated into two types of impacts; those losses of existing roads, railroads, wells, etc., and loss of vegetative production which eliminate Animal Unit Months (AUM's) or livestock production. Specifically, the AUM is the amount of forage or feed required to sustain one animal unit for 30 days.

DIRECT IMPACTS

The impacts to existing land uses such as roads, powerlines, pipelines, wells, etc., have been shown in Table 4-55. The impacts are by alternative and are not cumulative in relationship to trended baselines. Because the numbers of each element already impacted are not known, projected impacts cannot be determined without detailed land use plans. These impacts are not significant since disturbances will have to be reclaimed to equivalent premining standards. The costs will be incurred by coal companies. The land withdrawals and oil-gas leases may result in a temporary impact delaying development or exploration until after mining.

The most drastic change would be from grazing to intensively developed surface mines and ancillary facilities. These changes would cause impacts to grazing lands since grazing is the dominant land use in the area premining, and will be for postmining. The disturbances would be a permanent loss of grazing from roads, railroads, population, infrastructures and temporary loss from the mined area, mine facilities, haul roads (table 4-14). Besides direct loss of livestock forage, other impacts associated with population increases could occur. Recreation use could result in nuisance problems of gates left open, molestation, and increased vandalism of range facilities. Rustling and harrassment by offroad vehicles could result in problems, especially during calving and lambing. Mine development will cause some loss of watering facilities (see Hydrology Section) for the duration of mine life. This would eliminate existing grazing areas and cause overuse of adjacent areas that have water.

The impact to vegetative production and loss of grazing lands through single-use oriented mining would result in large numbers of AUM's being lost. The loss of these AUM's has been exhibited in Table 4-56. The land becomes single use once the mineral lease is let but the assumption was made that livestock production would not be lost until 1987 when construction begins. Due to safety problems associated with livestock grazing and mine-associated equipment, the entire lease tract will be out of production pending development of detailed mine plans from 1987 through mine life. The loss of AUM's shown on Table 4-56 was derived by calculating the number of acres required for one AUM in the area. The figures used were 7.1 acres per AUM with Bureau of Land Management grazing files in Craig and Rawlins used to determine this figure. Table 4-57 depicts the loss by alternative from the Federal action plus the cumulative loss including trended baseline.

The significance of this loss is not to the region but to individual ranches and the agricultural communities. The development of these Federal actions would result in impacts to 34 large ranches and four small ranches. The impacts to these ranches are shown by the loss of Section 3 and 15 Allotments in Table 4-57. The effect on Section 3 Allotments is much more significant than Section 15 in that Section 3 Allotments are within grazing districts and Section 15 outside districts. Section 3 Allotments are also mainly Federal surface with small portions of private and Section 15 Allotments vice-versa. Therefore, the loss of Section 3 grazing probably will not result in compensation whereas Section 15 will, since the surrounding land within the lease tract is private and the permittee will receive surface disturbance compensation. In most cases, the loss of this Section 3 grazing privilege will affect small portions of large permit holders, but in two cases the loss will be significant. This significance will be the loss of all of one ranch's Federal grazing and 30 percent of another. This could result in the loss of both of these ranches to the agricultural community.

INDIRECT IMPACTS

Conversion of grazing land to mining would cause economic losses to four groups: The ranches owning or having grazing rights on those lands; businesses which serve the ranches; employees of the ranches; and the Federal government. The losses to some, and possibly all, of these groups could be offset by mining lease and royalty payments, business generated by mining, etc. Following is an analysis of the agricultural losses alone.

The analysis is based on factors developed by Colorado State University in a study of grazing in Colorado (Bartlett, Taylor, and McKean, 1979). Results of the study are classified by region of the state and by type and size of ranch. Factors used in this analysis are for the northwest region and for a small cattle ranch (model No. 1) and a large cattle and sheep ranch (model No. 8). The factors were used to provide estimates of gross and net income losses, secondary income losses, and losses in hired employment.

Gross income is defined as the total value of animals and crops sold during the year. Net income is what remains after deduction of operating costs, including grazing fees, and depreciation. Secondary income is that portion of ranch income which is spent in the local economy for supplies, business services, and consumer goods.

Tables 4-58, Parts 1 through 3, show the economic losses to agriculture and other sectors of the study area economy that would result from conversion of grazing land to mining. Total cumulative losses would vary from about \$8.7 million to about \$12.6 million by 1995 under the different alternatives. Of these amounts, about \$3.6 million to \$5.2 million would be direct losses of gross income to ranches, the remainder being losses to local businesses serving the ranches and their families. In addition, about \$233,000 to \$340,000 in Federal grazing fees would be lost by 1995, along with 55 to 80 man-years of hired ranch employment.

Annual direct and indirect agricultural income losses would be the same as those shown for 1987, and would range from \$1.0 million to \$1.4 million, depending on the alternative. These losses would represent less than one percent of the projected total study area personal income in 1995 of \$926 million to \$978 million. Compared to projected agricultural income in that year of \$8.9 million under the No Action Alternative, the gross income losses shown above would represent reduction of 11 percent to 16 percent. Therefore, these losses would not be significant impacts to the total study area economics although they would significantly affect the agricultural sector and a certain number of ranching operations.

In order to accommodate the increased population associated with the proposed mining, lands adjacent to the impacted communities will be converted to urban uses. Table 4-59 shows the number of acres anticipated to be converted to urban uses for each alternative in each county or for those communities that would be most heavily impacted by the mining action. The No Action Alternative shows projected community expansion without the proposed coal leasing. These figures include anticipated growth of both primary and secondary populations, and assume an average expansion of 100 acres per increase in population of 1,000. This figure is a general rule of thumb; it will vary considerably according to the specific needs of each community, and should be used primarily for the purpose of comparison.

Most of the lands will be converted from agricultural and range uses to primarily residential development, with large amounts also committed to roadway construction, schools, parks, and commercial or industrial facilities. These land use requirements assume a concentrated pattern of development. However, more or less land may be required to support urban functions, depending on the existence and effectiveness of local land use planning and zoning.

The lands taken out of agricultural and range uses for urban purposes would have localized, irreversible impacts on other resources (see Vegetation, Wildlife, Hydrology, etc.). Additionally, when combined with the lands taken from range use at the mine sites, the cumulative economic impact on the communities increases. Short-term use for mining and urban activities reduces the amount of land available for ranching, the long-term economic base for many of the impacted communities. However, the overall impacts of the proposed Federal action alone, are not as significant when compared to the anticipated conversion of lands to urban uses without the leasing.

Overall, if cumulative coal and non coal-related development occurs as projected, human land use in the five county area would increase dramatically compared to present development in the region. However, because of the low populations and small percentage of urban and developed land presently existing in the region, even a doubling of urban lands would not significantly change the complexion of the regional land use pattern. However, this land conversion is a permanent and irretrievable commitment of lands to urban development. It is unlikely that these lands will ever be returned to agricultural, range, wildlife or other uses in the foreseeable future.

The Colorado tracts are predominantly comprised of privately-owned and BLM-administered surface lands underlain by Federal mineral estate. However, in the checkerboard land ownership pattern of Wyoming where the mineral estate alternates between private (Rocky Mountain Energy Company) and Federal ownership, the proposed leasing will generate an additional impact. The Federal action in this case will serve as a springboard for RME to lease lands for mining that were hitherto impractical if not impossible to mine without Federal leasing. The problem arises where the alternating sections of RME mineral estate within the delineated tracts are overlain by other private surface ownership, mostly ranchers in this case.

These surface owners do not meet the criteria established under the Federal Coal Management Regulations (43 CFR 3420) for consultation prior to competitive leasing. However, their impact on the coal leasing process and the need for close consultation with these owners is clear, if the proposed coal lease tracts are to be realistic, economically viable mining units. Successful implementation of any land use plans must involve mutual consent of the owners in this area.

CONFLICTS WITH EXISTING LAND USE PLANS AND POLICIES

A potential conflict concerns the conversion of rural lands to urban and industrial uses. The State of Wyoming and both Carbon and Sweetwater counties have established policies to encourage the maintenance of agricultural-rural land uses. Colorado has similarly established policies to discourage development that would convert prime, unique or other agricultural lands of statewide or local importance to other uses.

Agricultural lands are easily and irreversibly committed to urban use as communities expand, and may or may not be irretrievably lost by mine development. In order to reconcile the anticipated community expansion and mining that will take place on predominantly agricultural and range lands, it is in the best interest of all parties concerned to establish development guidelines and controls in local land use plans to minimize the impact on prime agricultural lands and direct the development toward less desirable lands. Local governments in Wyoming may be hampered somewhat in doing this since they are prevented by state law from zoning or planning against any use or occupancy necessary to extract or produce mineral resources within their jurisdiction.

Another potential problem involves the policy in both states to encourage new urban development adjacent to and contiguous with the existing urban areas. This should not prove difficult for most communities; however, Rawlins, Wyoming, presently abuts BLM lands on several sides. The BLM Rawlins District Office is aware of this problem and is prepared to make certain lands available to the community for urban expansion under the provisions of the *Federal Lands Policy and Management Act of 1976*.

UNAVOIDABLE ADVERSE IMPACTS ENVIRONMENTAL EFFECTS

The following adverse environmental effects cannot be avoided should the proposed action be implemented:

(1) The conversion of existing rural land uses to urban and mine-related uses, due to the proposed action and the accompanying increase in population.

(2) The loss of the existing onsite improvements identified in table 4-59.

(3) The loss of the AUM's identified in table 4-56, and the accompanying economic loss to the affected ranchers.

SHORT-TERM VS LONG-TERM

The following elements describe the relationship between local short-term land use and the maintenance and enhancement of long-term productivity of those lands:

(1) Urban expansion due to population increases would result in the loss of the long-term productivity of wildlife. (See Wildlife Section for details).

(2) Urban expansion to accommodate population increases would also permanently remove farmlands from production.

(3) The conversion of agricultural and ranch lands to urban and mining uses would force some ranchers and farmers out of business, reduce their production, or cause them to seek other employment.

IRREVERSIBLE/IRRETRIEVABLE

The following irreversible and/or irretrievable commitments of land use resources would result from the proposed action should it be implemented:

(1) The action would result in the irretrievable loss of productivity of wildlife winter range converted to urban and mining uses for the life of the mine, plus the 20 to 50 years required for subsequent successful reclamation.

(2) The action would irretrievably reduce the number of AUM's on the proposed tracts for the mine life as shown in table 4-56.

(3) Lands used for urban expansion would be permanently and irreversibly lost to agricultural, wildlife or other uses.

(4) Some threatened and endangered plant species would be irreversibly lost due to the conversion of these lands to urban and recreation uses resulting from increased populations.

UNCOMMITTED MITIGATION

The following potential measures could be used to mitigate the adverse environmental impacts on land use caused by the proposed action:

(1) An increase in AUM's would be anticipated at reclaimed mines if the areas are revegetated with grasses and forbs instead of the predominant shrub communities.

(2) Impacts on important farmlands would be lessened by directing urban expansion toward less desirable lands adjacent to existing urban areas. Prime farmlands presently exist in the floodplains near Meeker and Craig and should be protected from urban expansion through available zoning and planning tools.

(3) The best and most efficient use of lands within the jurisdiction of the various counties and communities in the impacted region should be identified, and land use planning and zoning should be used to direct urban growth to minimize impacts.

(4) Energy impact funds, severance taxes and technical assistance should be funnelled by the state to the impacted communities in an amount proportionate with the impacts felt by those communities from increased urbanization. Realistic solutions to rapid rural-to-urban land conversion problems must be sought by all affected jurisdictions.

CLIMATE AND AIR QUALITY

IMPACT ON CLIMATE

On a regional basis, no substantial changes in climate are expected to result from any of the proposed lease action alternatives. In the immediate vicinity of any mining operations, alterations to the terrain may change local wind patterns. Removal of vegetation and topsoil will alter evapotranspiration potential and could alter the specific heat of the surface material, which in turn would alter the absorption, reflection, and reradiation of solar heat. All of these potential impacts would be very localized, and reclamation actions at the conclusion of mining activities in each specific area will result in a return of the localized climatic conditions to their original state.

IMPACTS ON AIR QUALITY

Emissions of air pollutants from mining activities and the induced development associated with the proposed alternatives (increases in population and transportation) will not significantly affect the air quality or visibility in those portions of the study area which are far removed from the region where the proposed lease tracts are located. The direct effects from mining activities and the indirect effects of mining-related development (associated population and transportation growth) were assessed only for the areas in which significant increases in concentrations, above background levels, are expected. These areas--the Yampa Valley, the Hanna/Elmo area, and the Rawlins area--are delineated on Map 3-7, in Section 3.

The development accompanying the proposed alternatives will have a greater impact on ambient air quality than the direct impact of the mining activities. Coal mining is a significant source of particulate emissions, but within several kilometers downwind, the concentrations are greatly reduced due to deposition of the larger particles (Slade, 1968). Thus, the population and transportation growth which will accompany the implementation of the proposed action will have a greater effect on regional air quality than the direct mining emissions.

The significant pollutant emissions associated with the development of the proposed lease tracts and the accompanying secondary growth are TSP, SO_2, and NO_2. Impacts of emissions of the other criteria pollutants will be insignificant, and virtually unmeasurable on a regional scale. Mining activities generate significant quantities of TSP, and relatively small quantities of NO_2, SO_2, CO, NMHC, O_2, and Pb. Power plants in the affected regions are significant sources of TSP, NO_2, and SO_2, while emitting smaller amounts of the other pollutants. The principal emissions from cities and towns are TSP, NO_2, and SO_2. Vehicular traffic may produce localized hotspots of CO, but these emissions are not significant on a regional basis. Thus, the air quality analysis will address the impacts from the implementation of the proposed alternatives on ambient levels of TSP, NO_2, and SO_2.

FUTURE PARTICULATE AIR QUALITY IN CRAIG

Between 1976 and 1978, the annual TSP concentrations measured at the Moffat County Courthouse in the center of Craig ranged from 97.8 to 118.7 $^{m}g/m^{T13}$. These concentrations are well above the national and Colorado ambient air quality standard of 75 $^{m}g/m^{T13}$. Although the TSP concentrations measured in Craig have exceeded the national ambient air quality standard, Craig has been redesignated as an "unclassified" area (an "unclassified" area is functionally the same under federal law as an area meeting the national standards). Craig was redesignated as "unclassified" under EPA's Fugitive Dust Policy (U.S., EPA, 1977) which considers Craig to be a "rural area". Craig lacks any significant industrial particulate sources and has a population less than 25,000. As "rural area" for fugitive dust, EPA generally exempted the Craig area from having to follow the offset provisions, retrofit controls, and new source control requirements established for nonattainment areas by the Clean Air Act Amendments of 1977.

A recent study attributed as much as 80 percent of the measured TSP concentrations in Craig to fugitive dust emissions (PEDCo, 1979). About 30 percent of the fugitive dust was attributed to general fugitive sources in the area. The other 50 percent of the fugitive dust was speculated to be from wind blown dust from agricultural fields northwest of Craig.

Another plausible explanation for the "unexplained" 50 percent of the TSP concentrations is that the particulates are resuspended road dust from unpaved roads or from mud carried onto paved roads in Craig. From 1976 through 1978, Craig was experiencing a large boom in commercial and residential building throughout the town. The main artery passing in front of the building with the TSP monitor, and other major vehicular arteries were being reconstructed during this period. Several hundred people were constructing the Yampa Power Plant four miles south-southwest of the center of Craig.

The population of Craig is expected to increase from 7,715 in 1978 to 18,274 by 1995 without the leasing of any of the proposed Federal tracts. Because 50 percent of the existing TSP concentrations are from "unexplained" fugitive sources, the impact of the anticipated population increase on future TSP emission levels in Craig presently can not be projected. In general, the fugitive particulate emissions per capita are anticipated to decrease in the future. The major traffic arteries in the center of Craig are not expected to be reconstructed again in the near future. Also, commercial and residential construction will move away from the center of Craig, causing these activities to have less of an impact on air quality in the center of Craig.

The potential increase of TSP concentrations caused by the projected large growth in Craig population is not expected to cause EPA to redesignate Craig to a "nonattainment" area. No major new industrial sources are expected to be located in Craig or near enough to significantly affect the measured TSP concentrations in Craig. The population of Craig is expected to remain below the 25,000 level which is used by EPA to define "rural areas."

The EPA "Fugitive Dust Policy" is expected to remain in effect until the ambient particulate concentration standard is revised. Within a few years, EPA is expected to promulgate ambient air quality standards for inhalable particulates, which would replace the present total suspended particulate (TSP) standard. The inhalable particulates would probably be based only on the fraction of the TSP that would be less than a nominal 15 microns in size. The current TSP samplers collect all particulates about 100 microns or less in size. As of yet, EPA has not selected the specific size range to be considered inhalable, or has a sampling method. No sampling data is available for Craig or similar rural towns in Colorado or Wyoming.

In any case, fugitive dust emissions are not expected to significantly contribute to the measured inhalable particulate concentrations or to health risks to the adult, healthy population. Fugitive dust emissions are not anticipated to cause a significant health risk because these particulates are typically larger than inhalable size range and are composed of mostly non-toxic substances, such as silicates (or sands). However, if fugitive dust entrained into the atmosphere from traffic, construction, or from other of man's direct activities do impact measured inhalable paticulate cocnetration, then controls on these sources may be required in the future.

MODELING METHODOLOGIES--AIR QUALITY

The impacts of the proposed alternatives on future air quality were assessed utilizing atmospheric dispersion models.

Annual average TSP, NO_2, and SO_2 concentrations were predicted using a Gaussian long-term dispersion model (Radian, 1979a). Model input parameters include statistical meteorological data, receptor locations, and emission source characteristics.

METEOROLOGICAL DATA

Meteorological data obtained from observations at Rawlins from 1955 to 1964, Craig in 1974, and the Colowyo Mine from November 1976 to November 1977 were input into the annual model. The Rawlins and Craig data are reasonably representative of synoptic wind flow, while the Colowyo data represents canyon and valley induced wind flow with its nighttime downslope flow and daytime upslope flow. To obtain valley flow in dispersion areas with other valley orientations within the affected area, the Colowyo data were rotated to reflect the changes in valley alignments.

RECEPTOR LOCATIONS

Pollutant concentrations were computed for an array of receptors spaced two kilometers apart. The modeled concentrations were added to the ambient background concentrations (presented in Section 3) to arrive at the total projected ambient concentration.

SOURCE CHARACTERIZATION

Emissions of TSP, NO_2 and SO_2 were estimated from mines, cities, major roadways, and major point sources.

Surface coal mining activities that generate total suspended particulate emissions include haul road traffic, truck loading and unloading, drilling, blasting, topsoil removal, stockpiling, access road traffic, wind erosion of exposed areas, and coal screening and crushing. Table 4-60 lists these emission sources and the corresponding emission factors.

Underground coal mines also contribute significant quantities of total suspended particulate matter emissions. Emissions resulting from mining operations include coal loading, conveying, transferring, crushing and hauling. Emission factors which relate the level of activity of a mining operation to total particulate matter emission rates were derived and applied to underground mines (PEDCo, 1978, CAPCD, 1978; MRI, 1977). Exhaust emissions from mining equipment were estimated using emission factors developed by the U.S. Environmental Protection Agency (U. S. EPA, 1979).

Emissions generated by vehicular traffic on major roadways were determined from projected traffic volumes and emission factors developed by the EPA mobile source emissions model, MOBLE 1 (U. S. EPA, 1978).

Emissions from several major point sources which could interact with emissions from the proposed lease tracts or towns were also modeled. In the Yampa Valley, the TSP, NO_2, and SO_2 emissions from the Yampa and Hayden power plants were modeled.

For towns within the affected area, the National Emissions Data System (NEDS) area source emissions of suspended particulate matter, NO_2, and SO_2 for the appropriate county were apportioned to cities within the county based on the percentage of the county population in each city (EPA, 1979). For each city, the future emissions were scaled based on the projected changes of population.

The short-term total suspended particulate concentrations were predicted utilizing TEMP-24, a short-term dispersion model (Radian, 1979b). To project maximum ground level concentrations, a postulated set of 'worst-case' meteorological conditions was used. The worst-case 24-hour dispersion regimes were characterized by light-to-moderate, directionally persistent winds, relatively low mixing heights during daylight hours and stable conditions at night. The short-term worst case meteorological data developed for the Yampa Valley reflect nighttime downvalley flow and daytime upvalley flow.

For each alternative, the annual concentrations of TSP, NO_2, and SO_2 were predicted for 1987, 1990 and 1995. Twenty-four hour concentrations were predicted in those areas in which significant air quality impacts were shown by the annual modeling. The predicted concentrations were compared to the state and national ambient air quality standards. Based on the court decision in the Alabama Power Company, et al., vs. Costle case, it is not expected that any of the existing or proposed mines will be subject to PSD review. Since EPA's revised PSD regulations are not yet final, it is unclear to what extent, if any, fugitive emissions will affect the consumption of PSD increments. Consequently, PSD issues have been addressed only indirectly.

MODELING METHODOLOGY--VISIBILITY

A simple model box was used to predict visibility impacts in the Yampa Valley region. These results were then extrapolated to the Rawlins and Hanna/Elmo areas. Inputs to the model consisted of the box dimensions, source emission rates, and observer-vista distance.

Worst case meteorological conditions were assumed. Specifically, the pollutants were assumed to be trapped within the box for a stagnation period of six days (Holzworth, 1972). The mixing height was assumed to be 350 meters, with wind speeds ranging between three and six miles per hour.

Pollutants were allowed to escape the box at the conservative rate of 1.5 percent per hour. Chemical gas-to-particulate conversions and pollutant removal processes were considered in the model.

Ambient pollutant concentrations within the box were then used to predict visibility parameters (atmospheric coloration, visual range, and contrast transmittance) for an observer looking down the length of the box. In practice, an observer's sight path would be shorter than this length, passing through less (polluted) atmosphere. Hence, these predictions represent a worst-case observer-vista orientation. The assumptions used as the bases for estimating visibility impacts from the calculated concentrations (e.g., background pollutant-free atmosphere, high extinction coefficient for particulates) were also very conservative.

TOTAL SUSPENDED PARTICULATE MATTER (TSP)

YAMPA VALLEY.

NO ACTION ALTERNATIVE. The 1995 annual predicted TSP concentrations in the Yampa Valley are shown on Figure 4-1. These levels represent the maximum concentrations which were predicted for the three study years. In 1987, 1990 and 1995 TSP concentrations near the existing mines south and southwest of Hayden are predicted to approach the Colorado and national standards where the emissions from the clustered mines interact. The Trapper, Utah International, and Wisehill mines southwest of Craig are predicted to generate TSP levels that will exceed the state and national standards within several kilometers of the mines in all three study years. The Yampa and Hayden power plants will add less than five $^{m}g/m^{T13}$ to the TSP background concentration. Urban population and transportation growth are expected to cause TSP concentrations to increase by 20 to 30 $^{m}g/m^{T13}$ above rural background levels in 1987. In 1990 and 1995 the population and transportation growth in excess of that anticipated by 1987 is predicted to increase the TSP concentrations around Craig by one to two $^{m}g/m^{T13}$. Concentrations of TSP south and southwest of Craig are predicted to approach the state and national standards due to the interaction of emissions from Craig with emissions from existing mines.

LOW ALTERNATIVE. The predicted 1995 TSP concentrations, the highest of the three study years, are shown of Figure 4-2. Predicted 1987, 1990 and 1995 TSP concentrations at the boundaries of the proposed Empire tract increase one to two $^{m}g/m^{T13}$ over the concentrations predicted at the same location for the No Action Alternative. Concentrations at the boundary of the proposed Danforth Hills #3 tract are predicted to increase from 5 to 10 $^{m}g/m^{T13}$ over the No Action Alternative. Concentrations are not predicted to exceed the state and national standards near the proposed Danforth Hills #3 tract, but the emissions from the Empire tract would interact with the nearby existing mines (Trapper, Utah International, Wisehill) to increase the already high concentrations predicted for the No Action Alternative. Emissions from this tract will increase the likelihood of exceeding the Colorado and national standards within several kilometers of the existing cluster of mines. The small population and transportation growth associated with the leasing of the proposed tracts is not predicted to significantly increase TSP levels near the cities in the area in the study years.

MEDIUM ALTERNATIVE. The 1995 TSP concentrations, highest for the three study years, are shown on Figure 4-3. Predicted levels of TSP in 1987, 1990 and 1995 at the boundary of the Hayden Gulch tract will increase 10 $^{m}g/m^{T13}$ over the concentrations projected in the same area for the No Action Alternative. The emissions from mining activities do not have an impact on concentrations near Craig or Hayden, and the growth associated with the tract leasing is not predicted to have a significant impact on TSP levels in the vicinity of the cities.

HIGH ALTERNATIVE. Predicted 1995 TSP concentrations, highest for the three study years, are presented in Figure 4-4. The predicted levels of TSP at the western boundary of the Lay Creek tract increase from 5 to 10 $^{m}g/m^{T13}$ above the levels predicted for the same area for the No Action Alternative for the study years.

The mining emissions will not increase concentrations in the vicinity of Craig. The population and transportation growth accompanying the leasing of the proposed tracts are predicted to increase the concentrations near Craig and Hayden by one to two $^{m}g/m^{T13}$ above the levels predicted for the No Action Alternative. The projected TSP levels at the western boundary of the Danforth Hills #2 tract are predicted to increase from 5 to 10 $^{m}g/m^{T13}$ over predicted levels for 1987 through 1995 for the No Action Alternative. The interaction of emissions from the Danforth Hills #3 tract, the existing Colowyo mine and the Danforth Hills #2 tract is predicted to be less than 5 $^{m}g/m^{T13}$ in all three study years.

MAXIMUM ALTERNATIVE. Predicted 1995 TSP concentrations, highest of the three study years, are presented in Figure 4-5. Concentrations of TSP at the boundary of the proposed Pinnacle tract are predicted to increase from 5 to 10 $^{m}g/m^{T13}$ over the levels predicted for the No Action Alternative in 1987, 1990 and 1995. Concentrations in the immediate vicinity of the proposed Williams Fork and Iles Mountain tracts are predicted to increase less than 5 $^{m}g/m^{T13}$ over predicted levels for the No Action Alternative. The interaction of emissions from the proposed Iles Mountain and Empire tracts and the cluster of existing mines will increase TSP concentrations from one to five $^{m}g/m^{T13}$ over levels predicted for the No Action Alternative. Concentrations around Craig will increase from 3 to 5 $^{m}g/m^{T13}$ due to the secondary population and transportation growth associated with the leasing of all tracts.

HANNA/ELMO AND RAWLINS AREA

NO ACTION ALTERNATIVE. Regional levels of TSP are predicted to increase slightly, less than 10 $^{m}g/m^{T13}$, over background levels (see Chapter 3) due to the growth in population associated with the existing mines and other projected development in the region. The 1995 concentrations, the highest for the three study years, are presented on Figures 4-6 and 4-7. No violations of state or federal standards are predicted to occur. An increase of less than 10 $^{m}g/m^{T13}$ above background levels is predicted around the Cherokee, Medicine Bow, Seminoe II and Carbon Basin mines for 1987, 1990 and 1995. Small further increases (less than 5 $^{m}g/m^{T13}$) are predicted around the four mines in 1990 and 1995 due to increased production levels but concentrations will remain well below state and federal standards.

LOW, MEDIUM, HIGH AND MAXIMUM ALTERNATIVES. Predicted 1995 TSP concentrations, highest for the three study years, are presented on Figures 4-8 and 4-9. Regional levels of TSP are predicted to increase slightly, less than one $^{m}g/m^{T13}$, above levels predicted for the No Action Alternative in 1987, 1990 and 1995. This increase is predicted to occur near the Red Rim and China Butte mines due to construction operations in 1987 and mining operations in 1990 and 1995. A small interaction, less than 5 $^{m}g/m^{T13}$, is predicted between the two mines during these years. Very small increases (less than one $^{m}g/m^{T13}$) are predicted in the four towns in the region for 1987, with little or no further increases (less than one $^{m}g/m^{T13}$) predicted for 1990 and 1995. No violations of state or federal air quality TSP standards are predicted in 1987, 1990 or 1995.

NITROGEN DIOXIDE (NO_2)

YAMPA VALLEY

NO ACTION ALTERNATIVE. Predicted concentrations of NO_2 throughout the Yampa Valley do not exceed the state or national ambient air quality standards in 1987, 1990 or 1995. Concentrations of NO_2 in the vicinity of Craig and Hayden in 1987 are predicted to range from 20 to 25 $^{m}g/m^{T13}$ above the rural background level of 7 $^{m}g/m^{T13}$. The total concentrations are predicted to be less than 40 percent of the standards. Concentrations in the Steamboat Springs area are predictd to be less than 50 percent of the state and national standards. Impacts of emissions from the Yampa and Hayden power plants will be less than 20 percent of the standards for the three study years. Concentrations around Craig are predicted to increase by approximately 10 $^{m}g/m^{T13}$ in 1990 and 1995 due to the increase in population and transportation. Predicted concentrations in the Steamboat Springs area increase by approximately 5 $^{m}g/m^{T13}$ from 1987 to 1990 and 1995.

LOW, MEDIUM AND HIGH ALTERNATIVES. No increase in NO_2 concentrations is predicted in the vicinity of Craig, Hayden, and Steamboat Springs in 1987, 1990 and 1995. An increase of less than 10 $^{m}g/m^{T13}$ over the No Action levels is predicted for the Meeker area in the study years.

MAXIMUM ALTERNATIVE. Nitrogen dioxide concentration in the Steamboat Springs area are predicted to increase less than 5 $^{m}g/m^{T13}$ above No Action levels near Hayden for the three study years. No significant change is predicted for the areas around Craig and Steamboat.

HANNA/ELMO AND RAWLINS AREA

NO ACTION ALTERNATIVE. Regional levels of NO_2 are predicted to increase very slightly over background levels, less than 5 $^{m}g/m^{T13}$, for 1987, 1990 and 1995. No violations of standards are predicted for these three years.

LOW, MEDIUM, HIGH AND MAXIMUM ALTERNATIVES. Regional levels of NO_2 are predicted to increase very slightly, less than one $^{m}g/m^{T13}$, in 1987, 1990 and 1995. No violations of standards are predicted for these three years.

SULFUR DIOXIDE (SO_2)

YAMPA VALLEY

Predicted 1987, 1990 and 1995 SO_2 concentrations throughout the Yampa Valley are less than 15 $^{m}g/m^{T13}$ (19 percent of the state and federal standards). The highest concentrations are predicted in the vicinity of Craig and Hayden resulting from the interaction of the cities' emissions and the emissions from the Yampa and Hayden power plants.

LOW, MEDIUM, AND HIGH ALTERNATIVES. Sulfur dioxide levels are predicted to increase less than 5 $^{m}g/m^{T13}$ throughout the affected area in 1987, 1990 and 1995.

MAXIMUM ALTERNATIVE. The predicted SO_2 concentrations are predicted to increase up to 10 $^{m}g/m^{T13}$ in the three study years. No violations of the state or federal SO_2 standards are predicted. The highest projected concentration (25 percent of the standard) is due to the Yampa power plant plume.

HANNA/ELMO AND RAWLINS AREA

NO ACTION ALTERNATIVE. Regional levels of SO_2 are predicted to increase very slightly above background levels, less than 5 $^{m}g/m^{T13}$ for 1987, 1990 and 1995. No violations of standards are predicted for these three years.

LOW, MEDIUM, HIGH AND MAXIMUM ALTERNATIVES. Regional levels of SO_2 are predicted to increase very slightly, less than one $^{m}g/m^{T13}$, in 1987, 1990 and 1995. No violations of standards are predicted for these three years.

AIR QUALITY IMPACTS--SHORT-TERM (24-HOUR) MODELING

YAMPA VALLEY

Predicted 24-hour TSP concentrations over background (22 $^{m}g/m^{T13}$) in the vicinity of Craig in 1995 (No Action Alternative) are less than 23 $^{m}g/m^{T13}$. The Maximum Action Alternative and its associated population and transportation growth represent a worst-case scenario. The 1995 emissions from the city and nearby mines for this alternative generate a 24-hour concentration of 25 $^{m}g/m^{T13}$ over background. This level is two $^{m}g/m^{T13}$ higher than the concentration predicted for the 1995 No Action Alternative, indicating that the proposed mining tracts and the accompanying growth have a small effect on the concentration in the vicinity of the city.

HANNA/ELMO AND RAWLINS AREA

The Maximum Alternative and its accompanying growth was used as a worst-case scenario for the 24-hour modeling in the Hanna/Elmo area. The maximum TSP concentration was predicted north of Hanna. The interaction of emissions from the town and several nearby mines generated a concentration of 31 $^{m}g/m^{T13}$. The total predicted concentration, including background, at this location is 60 $^{m}g/m^{T13}$.

No short-term (24-hour) modeling was performed in the Rawlins area, as annual modeling indicated that there would be no significant air quality impact in this area due to the implementation of any of the proposed alternatives.

VISIBILITY

YAMPA VALLEY

MAXIMUM ALTERNATIVE. The visibility degradation resulting from the proposed action is displayed in Table 4-61. Definitions of the parameters in Table 4-61 may be found in the glossary. The variation in the predicted visibility impairment parameters reflects the uncertainties associated with the various atmospheric chemical reaction rates. Table 4-61 also gives threshold values of which visibility degradation will actually be perceived, and table 4-61 indicates that a visibility degradation on a regional scale may result from the proposed action but may not be perceivable.

HANNA/ELMO AND RAWLINS AREA

MAXIMUM ALTERNATIVE. Based upon the analysis of regional visibility in the Yampa Valley, the impacts from the proposed action upon regional visibility in the Hanna/Elmo and Rawlins area are expected to be minimal for the following reasons:

(1) Unlike the Yampa Valley area, the primary increase in emissions in the Wyoming areas will come from mining activities. The resulting particulate coal dust is not as significant optically as sulfates and nitrates (Charlson, et al., 1978).

(2) It can be shown that fugitive coal dust does not result in atmospheric discoloration (Latimer, et al., 1978).

(3) Contrast reduction effects are approximately proportional to the absolute increase in source emissions. The absolute increase in source emissions in the Wyoming areas is less than that predicted in Craig.

It is therefore unlikely that a perceivable regional visibility degradation will occur in the Hanna/Elmo or Rawlins areas.

Unlike regional effects, local visibility impairments near individual sources will probably be noticeable, since pollutant concentrations near the sources are higher than regional concentrations. Possible local visibility effects include visible urban plumes around Craig, Hayden, Hanna/Elmo and Rawlins, manifested as brown haze layers over these cities, opaque clouds of dust in the immediate vicinity of the proposed mines, and brown haze layers in the vicinity of the highways running through the study region.

COMMITTED MITIGATION

ALL ALTERNATIVES EXCEPT NO ACTION ALTERNATIVE

Each specific mining project on each of the proposed lease tracts will be required to obtain all applicable federal and state air quality permits. Based on the court's decision in the Alabama Power Company et al. versus Costle case, it is not expected that the mines will be subject to PSD review. Since EPA's revised PSD regulations are not yet final, however, and considerable latitude in rulemaking on this issue is allowed by the court decision, it is possible that fugitive emissions will be considered in determining PSD applicability. If so, the mines will be subject to the Best Available Control Technology (BACT) requirements of the PSD regulations. Table 4-62 lists control measures and resultant control effectiveness for various mining operations. This information is based on guidance from EPA Region VIII regarding BACT determinations in previous permitting actions (U. S. EPA, 1979). Additional control measures might also be required by State Air Pollution Control Agencies and the Office of Surface Mining (OSM) in the air quality analysis of its permit review.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

ALL ALTERNATIVES EXCEPT THE NO ACTION ALTERNATIVE

The predicted violations of the annual TSP standards in the area southwest of Craig by the cluster of three existing mines will be aggravated by the development of the Iles Mountain and Empire tracts.

Though emmissions from Craig and areas in the the immediate vicinity of some existing and proposed mine clusters or consume a portion of the PSD increment, there will be a potential restriction on the nearby development of other industrial activities that emit air pollutants. Near the mines, this impact will cease when mining activities are completed and the areas are reclaimed. Air pollutant emissions that result from the portion of the induced increased population that chooses to remain in the area after mining is completed may continue to consume a minor portion of the PSD increments, and thus might result in a very small localized long-term impediment to industrial siting opportunities.

IRREVERSIBLE/IRRETRIEVABLE

ALL ALTERNATIVES EXCEPT NO ACTION ALTERNATIVE

The proposed leasing actions will only irreversibly commit a relatively minor portion of the air resource near the mines and affected towns for the period of federal mining. Upon completion of the mining activities, reclamation of the leased properties, and relocation of the population increments that result from the mining activities, it will be possible to retrieve the air resource committment and return the quality of the air to the current conditions.

UNCOMMITTED MITIGATION

ALL ALTERNATIVES EXCEPT NO ACTION ALTERNATIVE

If EPA's final PSD regulation exempt fugitive emissions at surface mines from Best Available Control Technology (BACT) requirements, the lease contracts will require control measures at least as stringent as BACT. It is expected that the control technology requirements for the leases will be reviewed on a case-by-case basis, similar to EPA's BACT review procedures, with consideration of effects on ambient air quality, economic and energy costs, and technical feasibility. Control measures that will be considered include at least those suggested by EPA Region VIII (EPA, 1979), as presented in Table 4-62.

NOISE

General noise levels in the area will remain at approximately 40 decibels. However, noise will increase around highways and rail lines as a result of the increased traffic caused by the proposed coal leasing. Increased Colorado highway noise in decibels (dB) for the alternatives is: Low 0 dB, Medium 1 dB, High 2 dB, Maximum 3 dB. Wyoming highway noise would increase by 2 dB for all alternatives.

Both railroads would experience increases in noise levels as a result of increased train traffic. The D&RGW noise level would increase by 2 dB for the Low Alternative, 3 dB for the Medium Alternative, 5 dB for the High Alternative, and 6 dB for the Maximum Alternative. The UP noise level would increase 2 dB for all alternatives.

The proposed mines would increase noise in and around each specific tract. The noise level would be approximately 78 dB at 500 feet for each strip mine while underground mines would have significantly less noise (12 to 18 dB less). Noise levels at the tract boundary are projected to be 60 dB or less.

The increased noise would affect those people who live or work within 500 feet of the railroad lines or affected road segments or those people seeking recreational opportunities near the mines. The impacts associated with noise are: minor physiological reactions; behavioral interference with activities such as speech, sleep, and work; and subjective effects such as annoyance. The increased noise may also affect animals living on or near the tracts. Because the increase in noise levels is generally small, the significance of the noise impacts would be low.

UNAVOIDABLE ADVERSE

The impacts of increased noise levels are unavoidable and adverse.

SHORT-TERM VS LONG-TERM

The noise impacts are of short-term duration.

TABLE 4-1

SOILS DISTURBED

Alternatives	Cumulative Acres Disturbed 1987	1990	1995
No Action			
Direct Mining 1/	23,900	38,400	41,800
Direct and Indirect 2/	41,300	57,300	63,500
Low			
Direct Mining 1/	0	1,300	4,600
Direct and Indirect 2/	2,800	5,400	9,300
Total 3/	44,100	62,700	72,800
Medium			
Direct Mining 1/	0	1,500	5,100
Direct and Indirect 2/	3,700	6,500	10,600
Total 3/	47,800	69,200	83,400
High			
Direct Mining 1/	0	1,900	6,500
Direct and Indirect 2/	6,000	9,200	14,300
Total 3/	53,800	78,400	97,700
Maximum			
Direct Mining 1/	0	2,200	7,500
Direct and Indirect 2/	7,500	11,000	16,900
Total 3/	61,300	89,400	114,600

1/ Direct disturbance by surface mining.

2/ Includes disturbance from mining, all ancillary facilities and urbanization resulting from additional federal leasing.

3/ Cumulative disturbance from existing development and new leases.

TABLE 4-2

REMOVAL OF AQUIFERS BY MINING

Item	No Action	Low Devel	Med Devel	High Devel	Max Devel
NORTH PLATTE RIVER ABOVE SEMINOE DAM 1/					
1987					
Area of aquifers removed because of developmnt of new federal coal (sq. mi.) 2/	0	0	0	0	0
Percent of watershed disturbed	0	0	0	0	0
Cumulative area of aquifers removed through 1987 (sq. mi.)	20.8	20.8	20.8	20.8	20.8
Percent of watershed disturbed	0.29	0.29	0.29	0.29	0.29
1990					
Area of aquifers removed because of developmnt of new federal coal (sq. mi.)	0	1.6	1.6	1.6	1.6
Percent of watershed disturbed	0	0.02	0.02	0.02	0.02
Cumulative area of aquifers removed through 1990 (sq. mi.)	32.0	33.6	33.6	33.6	33.6
Percent of watershed disturbed	0.44	0.46	0.46	0.46	0.46
1995					
Area of aquifers removed because of developmnt of new federal coal (sq. mi.)	0	5.7	5.7	5.7	5.7
Percent of watershed disturbed	0	0.08	0.08	0.08	0.08
Cumulative area of aquifers removed through 1995 (sq. mi.)	37.3	43.0	43.0	43.0	43.0
Percent of watershed disturbed	0.52	0.59	0.59	0.59	0.59
YAMPA RIVER SUBBASIN 3/					
1987					
Area of aquifers removed because of developmnt of new federal coal (sq. mi.)	0	0	0	0	0
Percent of watershed disturbed	0	0	0	0	0
Cumulative area of aquifers removed through 1987 (sq. mi.)	17.6	17.6	17.6	17.6	17.6
Percent of watershed disturbed	0.46	0.46	0.46	0.46	0.46
1990					
Area of aquifers removed because of developmnt of new federal coal (sq. mi.)	0	0.8	1.2	1.8	2.3
Percent of watershed disturbed	0	0.02	0.03	0.05	0.06
Cumulative area of aquifers removed through 1990 (sq. mi.)	29.0	29.8	30.2	30.8	31.3
Percent of watershed disturbed	0.76	0.78	0.79	0.81	0.82
1995					
Area of aquifers removed because of developmnt of new federal coal (sq. mi.)	0	2.6	3.4	5.6	7.2
Percent of watershed disturbed	0	0.07	0.09	0.15	0.19
Cumulative area of aquifers removed through 1995 (sq. mi.)	29.0	31.6	32.4	34.6	36.2
Percent of watershed disturbed	0.76	0.83	0.85	0.91	0.95

1/ Area of watershed - 7,230 sq. mi.

2/ Refers to the surface area from which aquifers are removed. For example, removal of several aquifers from a mined area of 5 sq. mi. is reported as an area of 5 sq. mi. of aquifers removed.

3/ Area of watershed - 3,801 sq. mi.

TABLE 4-3

NUMBER OF WELLS, SPRINGS, AND RESERVOIRS THAT PROBABLY WOULD BE DESTROYED OR SERIOUSLY IMPAIRED AT THE ALTERNATIVE LEVELS OF NEW FEDERAL COAL DEVELOPMENT 1/

Item	No Action	Low	Medium	High	Maximum
Wyoming					
Number of Wells Impacted	0	8	8	8	8
Number of Springs Impacted	0	1	1	1	1
Number of Reservoirs Removed	0	19	19	19	19
Colorado					
Number of Wells Impacted	0	3	5	5	6
Number of Springs Impacted	0	2	2	2	8
Number of Reservoirs Removed	0	7	12	17	28

1/ Numbers listed are mine-life totals. Without a mining sequence for each of the tracts, it is not possible to determine the numbers of wells, springs, or reservoirs affected during each of the time frames addressed in this study.

TABLE 4-4

ESTIMATED CHANGE IN ANNUAL CONSUMPTIVE USE OF WATER
AT THE ALTERNATIVE LEVELS OF NEW FEDERAL COAL DEVELOPMENT
NORTH PLATTE RIVER ABOVE SEMINOE DAM

Item	No Action	Low Development	Medium Development	High Development	Maximum Development
1987					
Total consumptive use without leasing (ac-ft)	316,100	316,100	316,100	316,100	316,100
Inc.(+) or dec.(-) in consump. use from leas. new Fed. coal(ac-ft)	0	+ 269	+ 269	+ 269	+ 269
Percent change in total consump. use from leasing new Fed. coal	0	+ 0.09	+ 0.09	+ 0.09	+ 0.09
Net discharge without leasing (ac-ft)	877,300	877,300	877,300	877,300	877,300
Percent inc.(+) or dec.(-) in discharge from leas. new Fed. coal	0	- 0.03	- 0.03	- 0.03	- 0.03
1990					
Total consumptive use without leasing (ac-ft)	316,200	316,200	316,200	316,200	316,200
Inc.(+) or dec.(-) in consump. use from leas. new Fed. coal(ac-ft)	0	+ 345	+ 345	+ 345	+ 345
Percent change in total consump. use from leasing new Fed. coal	0	+ 0.11	+ 0.11	+ 0.11	+ 0.11
Net discharge without leasing (ac-ft)	877,200	877,200	877,200	877,200	877,200
Percent inc.(+) or dec.(-) in discharge from leas. new Fed. coal	0	- 0.04	- 0.04	- 0.04	- 0.04
1995					
Total consumptive use without leasing (ac-ft)	316,400	316,400	316,400	316,400	316,400
Inc.(+) or dec.(-) in consump. use from leas. new Fed. coal(ac-ft)	0	+ 447	+ 447	+ 447	+ 447
Percent change in total consump. use from leasing new Fed. coal	0	+ 0.14	+ 0.14	+ 0.14	+ 0.14
Net discharge without leasing (ac-ft)	877,000	877,000	877,000	877,000	877,000
Percent inc.(+) or dec.(-) in discharge from leas. new Fed. coal	0	- 0.05	- 0.05	- 0.05	- 0.05
Long Term					
Total consumptive use without leasing (ac-ft)	316,400	316,400	316,400	316,400	316,400
Inc.(+) or dec.(-) in consump. use from leas. new Fed. coal(ac-ft)	0	+ 234	+ 234	+ 234	+ 234
Percent change in total consump. use from leasing new Fed. coal	0	+ 0.07	+ 0.07	+ 0.07	+ 0.07
Net discharge without leasing (ac-ft)	877,000	877,000	877,000	877,000	877,000
Percent inc.(+) or dec.(-) in discharge from leas. new Fed. coal	0	- 0.03	- 0.03	- 0.03	- 0.03

TABLE 4-5

ESTIMATED CHANGE IN ANNUAL CONSUMPTIVE USE OF WATER
AT THE ALTERNATIVE LEVELS OF NEW FEDERAL COAL DEVELOPMENT
YAMPA RIVER SUBBASIN

Item	No Action	Low Development	Medium Development	High Development	Maximum Development
1987					
Total consumptive use without leasing (ac-ft)	130,900	130,900	130,900	130,900	130,900
Inc.(+) or dec.(-) in consump. use from leas. new Fed. coal(ac-ft)	0	+ 62	+ 131	+ 353	+ 486
Percent change in total consump. use from leasing new Fed. coal	0	+ 0.05	+ 0.10	+ 0.27	+ 0.37
Net discharge without leasing (ac-ft)	1,004,200	1,004,200	1,004,200	1,004,200	1,004,200
Percent inc.(+) or dec.(-) in discharge from leas. new Fed. coal	0	- 0.01	- 0.01	- 0.04	- 0.05
1990					
Total consumptive use without leasing (ac-ft)	133,300	133,300	133,300	133,300	133,300
Inc.(+) or dec.(-) in consump. use from leas. new Fed. coal(ac-ft)	0	- 214 1/	- 72 1/	+ 283	+ 566
Percent change in total consump. use from leasing new Fed. coal	0	- 0.16	- 0.05	+ 0.21	+ 0.42
Net discharge without leasing (ac-ft)	1,001,800	1,001,800	1,001,800	1,001,800	1,001,800
Percent inc.(+) or dec.(-) in discharge from leas. new Fed. coal	0	- 0.02	- 0.01	- 0.03	- 0.06
1995					
Total consumptive use without leasing (ac-ft)	134,900	134,900	134,900	134,900	134,900
Inc.(+) or dec.(-) in consump. use from leas. new Fed. coal(ac-ft)	0	- 214 1/	- 72 1/	+ 283	+ 566
Percent change in total consump. use from leasing new Fed. coal	0	- 0.16	- 0.05	+ 0.21	+ 0.42
Net discharge without leasing (ac-ft)	1,000,200	1,000,200	1,000,200	1,000,200	1,000,200
Percent inc.(+) or dec.(-) in discharge from leas. new Fed. coal	0	+ 0.02	+ 0.01	- 0.03	- 0.06
Long Term					
Total consumptive use without leasing (ac-ft)	134,900	134,900	134,900	134,900	134,900
Inc.(+) or dec.(-) in consump. use from leas. new Fed. coal(ac-ft)	0	+ 156	+ 298	+ 613	+ 712
Percent change in total consump. use from leasing new Fed. coal	0	+ 0.12	+ 0.22	+ 0.45	+ 0.53
Net discharge without leasing (ac-ft)	1,000,200	1,000,200	1,000,200	1,000,200	1,000,200
Percent inc.(+) or dec.(-) in discharge from leas. new Fed. coal	0	- 0.02	- 0.03	- 0.06	- 0.07

TABLE 4-6

EFFECT OF LEASING OF NEW FEDERAL COAL ON THE FLOW OF PERENNIAL STREAMS ADJACENT TO THE TRACTS

Item	No Action	Low Development	Medium Development	High Development	Maximum Development
1987					
Good Spring Creek:					
Percent reduction in flow from present mines	4.2	4.2	4.2	4.2	4.2
Percent reduction from leasing new Federal coal	0	0	0	0	0
Cumulative percent reduction in flow	4.2	4.2	4.2	4.2	4.2
Wilson Creek:					
Percent reduction in flow from present mines	0	0	0	0	0
Percent reduction from leasing new Federal coal	0	0	0	0	0
Cumulative percent reduction in flow	0	0	0	0	0
Fish Creek:					
Percent reduction in flow from present mines	2.2	2.2	2.2	2.2	2.2
Percent reduction from leasing new Federal coal	0	0	0	0	0
Cumulative percent reduction in flow	2.2	2.2	2.2	2.2	2.2
Grassy Creek:					
Percent reduction in flow from present mines	8.3	8.3	8.3	8.3	8.3
Percent reduction from leasing new Federal coal	0	0	0	0	0
Cumulative percent reduction in flow	8.3	8.3	8.3	8.3	8.3
1990					
Good Spring Creek:					
Present reduction in flow from present mines	4.9	4.9	4.9	4.9	4.9
Present reduction from leasing new Federal coal	0	0.7	0.7	0.7	0.7
Cumulative percent reduction in flow	4.9	5.6	5.6	5.6	5.6
Wilson Creek:					
Percent reduction in flow from present mines	0	0	0	0	0
Percent reduction from leasing new Federal coal	0	0.3	0.3	1.3	1.3
Cumulative percent reduction in flow	0	0.3	0.3	1.3	1.3
Fish Creek:					
Percent reduction in flow from present mines	2.2	2.2	2.2	2.2	2.2
Percent reduction from Leasing new Federal coal	0	0	0	0	0.05
Cumulative percent reduction in flow	2.2	2.2	2.2	2.2	2.25
Grassy Creek:					
Percent reduction in flow from present mines	10.4	10.4	10.4	10.4	10.4
Percent reduction from leasing new Federal coal	0	1.2	1.2	1.2	1.2
Cumulative percent reduction in flow	10.4	11.6	11.6	11.6	11.6
1995					
Good Spring Creek:					
Percent reduction in flow from present mines	6.0	6.0	6.0	6.0	6.0
Percent reduction from leasing new Federal coal	0	2.8	2.8	2.8	2.8
Cumulative percent reduction in flow	6.0	8.8	8.8	8.8	8.8
Wilson Creek:					
Percent reduction in flow from present mines	0	0	0	0	0
Percent reduction from leasing new Federal coal	0	1.2	1.2	4.7	4.7
Cumulative percent reduction in flow	0	1.2	1.2	4.7	4.7
Fish Creek:					
Percent reduction in flow from present mines	2.2	2.2	2.2	2.2	2.2
Percent reduction from leasing new Federal coal	0	0	0	0	0.2
Cumulative percent reduction in flow	2.2	2.2	2.2	2.2	2.4
Grassy Creek:					
Percent reduction in flow from present mines	13.9	13.9	13.9	13.9	13.9
Percent reduction from leasing new Federal coal	0	4.1	4.1	4.1	4.1
Cumulative percent reduction in flow	13.9	18.0	18.0	18.0	18.0

TABLE 4-7

ESTIMATED CHANGE IN SALINITY OF RECEIVING WATERS
AT THE ALTERNATIVE LEVELS OF NEW FEDERAL COAL DEVELOPMENT
NORTH PLATTE RIVER ABOVE SEMINOE DAM

Item	No Action	Low Development	Medium Development	High Development	Maximum Development
1987					
Net salt load without leasing (tons) 1/	323,330	323,330	323,330	323,330	323,330
Increase (+) or decrease (-) in salt load from leasing new Federal coal (tons) 1/	0	- 66	- 66	- 66	- 66
Total salt load with new mines (tons)	323,330	323,264	323,264	323,264	323,264
Percent increase (+) or decrease (-) in salt load from leasing new Federal coal	0	- 0.02	- 0.02	- 0.02	- 0.02
Dsch. weighted avg. dissolved solids in N.P. River (mg/L) 1/	271.00	271.02	271.02	271.02	271.02
Cum. inc. in salinity from all devel. in the watershed (mg/L) 2/	116.20	116.22	116.22	116.22	116.22
Increase attributable to new mines (mg/L)	0	0.02	0.02	0.02	0.02
Percent increase attributable to new mines 3/	0	0.02	0.02	0.02	0.02
1990					
Net salt load without leasing (tons) 1/	323,240	323,240	323,240	323,240	323,240
Increase (+) or decrease (-) in salt load from leasing new Federal coal (tons) 1/	0	- 182	- 182	- 182	- 182
Total salt load with new mines (tons)	323,240	323,058	323,058	323,058	323,058
Percent increase (+) or decrease (-) in salt load from leasing new Federal coal	0	- 0.06	- 0.06	- 0.06	- 0.06
Dsch. weighted avg. dissolved solids in N.P. River (mg/L) 1/	270.95	270.91	270.91	270.91	270.91
Cum. inc. in salinity from all devel. in the watershed (mg/L) 2/	116.15	116.11	116.11	116.11	116.11
Increase attributable to new mines (mg/L)	0	- 0.04	- 0.04	- 0.04	- 0.04
Percent increase attributable to new mines	0	- 0.03	- 0.03	- 0.03	- 0.03
1995					
Net salt load without leasing (tons) 1/	323,200	323,200	323,200	323,200	323,200
Increase (+) or decrease (-) in salt load from leasing new Federal coal (tons) 1/	0	- 336	- 336	- 336	- 336
Total salt load with new mines (tons)	323,200	322,864	322,864	323,864	323,864
Percent increase (+) or decrease (-) in salt load from leasing new Federal coal	0	- 0.10	- 0.10	- 0.10	- 0.10
Dsch. weighted avg. dissolved solids in N.P. River (mg/L) 1/	270.98	270.84	270.84	270.84	270.84
Cum. inc. in salinity from all devel. in the watershed (mg/L) 2/	116.18	116.04	116.04	116.04	116.04
Increase attributable to new mines (mg/L)	0	- 0.14	- 0.14	- 0.14	- 0.14
Percent increase attributable to new mines	0	- 0.12	- 0.12	- 0.12	- 0.12
Long Term					
Net salt load without leasing (tons) 1/	323,200	323,200	323,200	323,200	323,200
Increase (+) or decrease (-) in salt load from leasing new Federal coal (tons) 1/	0	+ 516	+ 516	+ 516	+ 516
Total salt load with new mines (tons)	323,200	323,716	323,716	323,716	323,716
Percent increase (+) or decrease (-) in salt load from new Federal coal leasing	0	+ 0.16	+ 0.16	+ 0.16	+ 0.16
Dsch. weighted avg. dissolved solids in N.P. River (mg/L) 1/	270.98	271.48	271.48	271.48	271.48
Cum. inc. in salinity from all devel. in the watershed (mg/L) 2/	116.68	116.68	116.68	116.68	116.68
Increase attributable to new mines (mg/L)	0	0.50	0.50	0.50	0.50
Percent increase attributable to new mines	0	0.43	0.43	0.43	0.43

1/ From Table B-2, Appendix B.
2/ Increase in salinity from estimated pristine conditions. From Table 3-8.
3/ An increase in salinity occurs because of the consumptive use of water, despite the decrease in total salt load (see table B-2, Appendix B).

TABLE 4-8

ESTIMATED CHANGE IN SALINITY OF RECEIVING WATERS
AT THE ALTERNATIVE LEVELS OF NEW FEDERAL COAL DEVELOPMENT
YAMPA RIVER SUBBASIN

Item	No Action	Low Development	Medium Development	High Development	Maximum Development
1987					
Net salt load without leasing (tons) 1/	243,510	243,510	243,510	243,510	243,510
Increase (+) or decrease (-) in salt load from leasing new Federal coal (tons) 1/	0	+ 92	+ 88	+ 76	+ 44
Total salt load with new mines (tons)	243,510	243,602	243,598	243,586	243,554
Percent increase (+) or decrease (-) in salt load from leasing new Federal coal	0	+ 0.04	+ 0.04	+ 0.04	+ 0.04
Dsch. weighted avg. dissolved solids in Yampa River (mg/L) 1/	178.30	178.38	178.39	178.42	178.42
Cum. inc. in salinity from all dev. in the watershed (mg/L) 2/	66.70	66.78	66.79	66.82	66.82
Increase attributable to new mines (mg/L)	0	0.08	0.09	0.12	0.12
Percent increase attributable to new mines	0	0.12	0.13	0.18	0.18
Discharge weighted average dissolved solids in Colorado River at Imperial Dam (mg/L)	1046.05	1046.07	1046.08	1046.10	1046.11
Inc. in diss. solids in Co. Riv. from leas. new Fed. coal (mg/L)	0	0.02	0.03	0.05	0.06
Percent increase attributable to new mines	0	0.002	0.003	0.005	0.006
Increased cost to downstream users (dollars) 3/	0	7,900	12,000	20,000	24,000
1990					
Net salt load without leasing (tons) 1/	246,650	246,650	246,650	246,560	246,650
Increase (+) or decrease (-) in salt load from leasing new Federal coal (tons) 1/	0	+ 414	+ 406	+ 359	+ 279
Total salt load with new mines (tons)	246,650	247,064	247,056	247,009	246,929
Percent increase (+) or decrease (-) in salt load from leasing new Federal coal	0	+ 0.17	+ 0.16	+ 0.15	+ 0.11
Dsch. weighted avg. dissolved solids in Yampa River (mg/L) 1/	181.04	181.30	181.32	181.35	181.34
Cum. inc. in salinity from all devel. in the watershed (mg/L) 2/	69.44	69.70	69.72	69.75	69.74
Increase attributable to new mines (mg/L)	0	0.26	0.28	0.31	0.30
Percent increase attributable to new mines	0	0.37	0.40	0.44	0.43
Discharge weighted average dissolved solids in Colorado River at Imperial Dam (mg/L)	1046.05	1046.07	1046.09	1046.12	1046.15
Inc. in diss. solids in Co. Riv. from leas. new Fed. coal (mg/L)	0	0.02	0.04	0.07	0.10
Percent increase attributable to new mines	0	0.002	0.004	0.007	0.010
Increased cost to downstream users (dollars) 3/	0	7,900	16,000	28,000	39,000
1995					
Net salt load without leasing (tons) 1/	248,340	248,340	248,340	248,340	248,340
Increase (+) or decrease (-) in salt load from leasing new Federal coal (tons) 1/	0	+ 414	+ 406	+ 359	+ 279
Total salt load with new mines (tons)	248,340	248,754	248,746	248,699	248,619
Percent increase (+) or decrease (-) in salt load from leasing new Federal coal	0	+ 0.17	+ 0.16	+ 0.14	+0.11
Dsch. weighted avg. dissolved solids in Yampa River (mg/L) 1/	182.57	182.83	182.85	182.88	182.88
Cum. inc. in salinity from all devel. in the watershed (mg/L) 2/	70.97	71.23	71.25	71.28	71.28
Increase attributable to new mines (mg/L)	0	0.26	0.28	0.31	0.31
Percent increase attributable to new mines	0	0.37	0.39	0.43	0.43
Discharge weighted average dissolved solids in Colorado River at Imperial Dam (mg/L)	1046.05	1046.07	1046.09	1046.12	1046.15
Inc. in diss. solids in Co. Riv. from leas. new Fed. coal (mg/L)	0	0.02	0.04	0.07	0.10
Percent increase attributable to new mines	0	0.002	0.004	0.007	0.010
Increased cost to downstream users (dollars) 3/	0	7,900	16,000	28,000	39,000
Long Term					
Net salt load without leasing (tons) 1/	248,340	248,340	248,340	248,340	248,340
Increase (+) or decrease (-) in salt load from leasing new Federal coal (tons) 1/	0	+ 254	+ 246	+ 319	+ 1,060
Total salt load with new mines (tons)	248,340	248,594	248,586	248,659	249,400
Percent increase (+) or decrease (-) in salt load from leasing new Federal coal	182.57	182.78	182.80	182.91	183.48
Dsch. weighted avg. dissolved solids in Yampa River (mg/L) 1/	0	+ 0.10	+ 0.10	+ 0.13	+ 0.43
Cum. inc. in salinity from all devel. in the watershed (mg/L) 2/	70.97	71.18	71.20	71.31	71.88
Increase attributable to new mines (mg/L)	0	0.21	0.23	0.34	0.91
Percent increase attributable to new mines	0	0.30	0.32	0.48	1.27
Discharge weighted average dissolved solids in Colorado River at Imperial Dam (mg/L)	1046.05	1046.10	1046.11	1046.16	1046.25
Inc. in diss. solids in Co. Riv. from leas. new Fed. coal (mg/L)	0	0.05	0.06	0.11	0.20
Percent increase attributable to new mines	0	0.005	0.006	0.011	0.019
Increased cost to downstream users (dollars) 3/	0	20,000	24,000	43,000	79,000

1/ From Table B, Appendix B.
2/ Increase in salinity from estimated pristine conditions. From Table 3-8.
3/ Based on $393,000 (1978 dollars) for each 1 mg/L increase in dissolved solids concentration.

TABLE 4-9

EFFECT OF LEASING OF NEW FEDERAL COAL ON THE SALINITY OF PERENNIAL STREAMS ADJACENT TO THE TRACTS 1/

Item	No Actn	Low Devel	Med Devel	High Devel	Max Devel
Good Spring Creek:					
Estimated cumulative increase in dissolved solids conc. during low flow (mg/L)	180	360	360	360	360
Percent increase from premining conditions	17	34	34	34	34
Increase from leasing new Federal coal (mg/L)	0	180	180	180	180
Percent increase from leasing new Federal coal	0	17	17	17	17
Wilson Creek:					
Estimated cumulative increase in dissolved solids conc. during low flow (mg/L)	0	0	0	530	530
Percent increase from premining conditions	0	0	0	34	34
Increase from leasing new Federal coal (mg/L)	0	0	0	530	530
Percent increase from leasing new Federal coal	0	0	0	34	34
Fish Creek:					
Estimated cumulative increase in dissolved solids conc. during low flow (mg/L)	25	25	25	25	65
Percent increase from premining conditions	4	4	4	4	11
Increase from leasing new Federal coal (mg/L)	0	0	0	0	40
Percent increase from leasing new Federal coal	0	0	0	0	7
Grassy Creek:					
Estimated cumulative increase in dissolved solids conc. during low flow (mg/L)	140	205	205	205	205
Percent increase from premining conditions	23	33	33	33	33
Increase from leasing new Federal coal (mg/L)	0	65	65	65	65
Percent increase from leasing new Federal coal	0	10	10	10	10

1/ No increase in salinity is expected during 1987, 1990, and 1995. Increase in salinity should occur only after mining and reclamation and should be long term.

TABLE 4-10, Part 1

ESTIMATED CHANGE IN ANNUAL SEDIMENT YIELD AT THE ALTERNATIVE LEVELS OF NEW FEDERAL COAL DEVELOPMENT

Item	No Action	Low Develpmnt	Medium Develpmnt	High Develpmnt	Maximum Develpmnt
NORTH PLATTE RIVER ABOVE SEMINOE DAM					
1987					
Total sediment yield without leasing (tons) 1/	100,000	100,000	100,000	100,000	100,000
Increase (+) or decrease (-) in sediment yield from leasing new Federal coal (tons) 2/	0	+ 855	+ 855	+ 855	+ 855
Cumulative sediment yield with leasing (tons)	100,000	100,855	100,855	100,855	100,855
Percent increase (+) or decrease (-) in sediment yield from leasing new Federal coal	0	+ 0.86	+ 0.86	+ 0.86	+ 0.86
1990					
Total sediment yield without leasing (tons) 1/	100,000	100,000	100,000	100,000	100,000
Increase (+) or decrease (-) in sediment yield from leasing new Federal coal (tons) 2/	0	- 2,017	- 2,017	- 2,017	- 2,017
Cumulative sediment yield with leasing (tons)	100,000	97,983	97,983	97,983	97,983
Percent increase (+) or decrease (-) in sediment yield from leasing new Federal coal	0	- 2.02	- 2.02	- 2.02	- 2.02
1995					
Total sediment yield without leasing (tons) 1/	100,000	100,000	100,000	100,000	100,000
Increase (+) or decrease (-) in sediment yield from leasing new Federal coal (tons) 2/	0	- 6,441	- 6,441	- 6,441	- 6,441
Cumulative sediment yield with leasing (tons)	100,000	93,559	93,559	93,559	93,559
Percent increase (+) or decrease (-) in sediment yield from leasing new Federal coal	0	- 2.02	- 2.02	- 2.02	- 2.02

TABLE 4-10, Part 2

ESTIMATED CHANGE IN ANNUAL SEDIMENT YIELD AT THE ALTERNATIVE
LEVELS OF NEW FEDERAL COAL DEVELOPMENT

Item	No Action	Low Develpmnt	Medium Develpmnt	High Develpmnt	Maximum Develpmnt
YAMPA RIVER SUBBASIN					
1987					
Total sediment yield without leasing (tons) 1/	300,000	300,000	300,000	300,000	300,000
Increase (+) or decrease (-) in sediment yield from leasing new Federal coal (tons) 2/	0	+ 519	+ 571	+ 337	+ 97
Cumulative sediment yield with leasing (tons)	300,000	300,519	300,571	300,337	300,097
Percent increase (+) or decrease (-) in sediment yield from leasing new Federal coal	0	+ 0.17	+ 0.19	+ 0.11	+ 0.03
1990					
Total sediment yield without leasing (tons) 1/	300,000	300,000	300,000	300,000	300,000
Increase (+) or decrease (-) in sediment yield from leasing new Federal coal (tons) 2/	0	+ 173	+ 90	- 1,194	- 1,655
Cumulative sediment yield with leasing (tons)	300,000	300,173	300,090	298,806	298,345
Percent increase (+) or decrease (-) in sediment yield from leasing new Federal coal	0	+ 0.06	+ 0.03	- 0.40	- 0.55
1995					
Total sediment yield without leasing (tons) 1/	300,000	300,000	300,000	300,000	300,000
Increase (+) or decrease (-) in sediment yield from leasing new Federal coal (tons) 2/	0	- 352	- 629	- 3,751	- 4,775
Cumulative sediment yield with leasing (tons)	300,000	299,648	299,371	296,249	295,225
Percent increase (+) or decrrease (-) in sediment yield from leasing new Federal coal	0	- 0.12	- 0.21	- 1.25	- 1.59

1/ Estimated from incomplete USGS records and indicates only approximate magnitude.
2/ Methods and details of analysis presented in Appendix B.

TABLE 4-11

ADVERSE IMPACTS ON WATER RESOURCES THAT CANNOT BE AVOIDED

Type of Impact	Description and Magnitude of Impact	Significance
1. Removal of parts of certain aquifers.	Would change character of aquifer in mined areas; depending on extent of compaction. Cumulative disturbance by 1995 would affect less than one percent of respective watersheds.	Would effect only mined areas. No effect on regional ground-water system.
2. Interruption of premining ground-water flow in surface-mined areas.	Would impair or destroy 8 wells and 1 spring in Wyoming and 6 wells and 8 springs in Colorado.	Minor and very local. Little or no effect more than a few miles from mined areas.
3. Modification of ground-water flow by replaced spoil aquifers.	Would eliminate perching and create water table in surface mined areas.	Minor and very local. No effect on regional ground-water system.
4. Changes in ground-water quality caused by leaching of spoils materials.	Leaching of spoils materials would increase dissolved solids concentrations in postmining areas to two to three times premining levels. Effect would be long term.	Effect largely local, but could contribute to salinity problems downstream if a mine area is adjacent to a perennial stream. Water in reclaimed mined areas would generally be suitable for livestock and wildlife.
5. Subsidence and/or fracturing of overlying rocks from underground mining.	Would drain shallow perched aquifers and cause intercirculation of ground water and equalization of pressures between aquifers. Effect would be long term.	Would occur only in the vicinity of the Bell Rock and Empire tracts. Effects should be very minor more than a mile from the tracts.

TABLE 4-11, (Cont'd.)

ADVERSE IMPACTS ON WATER RESOURCES THAT CANNOT BE AVOIDED

Type of Impact	Description and Magnitude of Impact	Significance
6. Alteration or removal of existing stream channels.	Reestablished channels would not initially be as stable as premining channels. Nineteen reservoirs would be removed in Wyoming and twenty eight in Colorado.	Minor. Channels would eventually adjust naturally to flow conditions and return to approximate stability.
7. Disruption of channels by subsidence from underground mining.	Cracks intersecting the surface could intercept surface runoff on the Bell Rock and Empire tracts.	Very minor. Any cracks would rapidly fill with sediment with little or no long-term change in channel geometry.
8. Increased consumptive use of water.	Consumptive use in the North Platte basin would increase from 269 ac-ft/yr in 1987 to 447 ac-ft/yr by 1995, decreasing to 234 ac-ft/yr over the long term. Consumptive use in the Yampa Riv. basin at maximum development would increase from 486 ac-ft/yr in 1987 to 566 ac-ft/yr by 1995 and would be about 712 ac-ft/yr over the long term. Increased consumptive use would decrease flows in perennial streams adjacent to the mines by a maximum of about 4 percent.	Reduction in mean annual flows in the North Platte and Yampa River basins would be less than 0.07 percent at maximum development. Because of the shortage of water in these basins, however, any increase in consumptive use is a significant impact.

TABLE 4-11, (Cont'd.)

ADVERSE IMPACTS ON WATER RESOURCES THAT CANNOT BE AVOIDED

Type of Impact	Description and Magnitude of Impact	Significance
9. Increased salinity of receiving waters downstream.	Dissolved-solids concentration in the North Platte River would decrease slightly during mining and would increase by a maximum of 0.50 mg/L over the long term. Concentrations in the Yampa River would increase by less than 1mg/L during mining and over the long-term. Concentrations in the Colorado River at Imperial Dam would increase by a maximum of 0.10mg/L by 1995 and 0.20 mg/L over the long term. The salinity of perennial streams adjacent to the tracts would increase by as much as 34 percent from leasing new Federal coal. Dissolved solids concentrations could increase to a total of about 2,100 mg/L in Wilson Creek with lesser amounts in other streams.	Increased salinity in the North Platte and Yampa Rivers would be insignificant. The increased salinity in the Colorado River would cost downstream users up to $79,000 per year and is significant primarily because salinity levels are expected to exceed adopted standards by about 167 mg/L by 1995 without new Federal coal development. Increased salinity of streams adjacent to the tracts would be a minor impact. No fisheries are threatened and the water would still be suitable for all current uses.
10. Pollution of rivers and lakes by sewage effluent.	Possibly some fertilization of the upper reaches of Seminoe Reservoir would accelerate eutrophication. During periods of drouth, low flow in the Yampa River could be as much as 50 percent sewage below Steamboat (cont.)	Polluting effects would be insignificant in the North Platte River. Pollutants in the Yampa River would probably drastically alter the present fisheries.

TABLE 4-11, (Cont'd.)

ADVERSE IMPACTS ON WATER RESOURCES THAT CANNOT BE AVOIDED

Type of Impact	Description and Magnitude of Impact	Significance
10. (cont.)	Springs and 65 percent sewage below Craig. Impacts on aquatic biology could be disastrous with or without development of new federal coal. Fertilization and consequent eutrophication of the upper reaches of Juniper Reservoir is expected.	
11. Effects of erosion and sedimentation.	Sedimentation would increase about 1 percent in the North Platte basin during the initial construction period, but would decrease by about 6 percent below premining levels by 1995 as disturbed areas are stabilized. Corresponding changes in the Yampa basin would be an increase of up to 0.19 percent during construction and an overall decrease of up to 1.6 percent by 1995.	Minor and very local. Changes in sediment yield in the rivers would be insignificant.

TABLE 4-12

ACRES OF VEGETATIVE COMMUNITIES LOST BY DEVELOPMENT OF NEW FEDERAL ACTION

	1987					1990					1995				
	No Action	Low Altern.	Medium Altern.	High Altern.	Maximum Altern.	No Action	Low Altern.	Medium Altern.	High Altern.	Maximum Altern.	No Action	Low Altern.	Medium Altern.	High Altern.	Maximum Altern.
Grassland	0	150	247	286	396	0	202	333	419	556	0	299	471	671	870
Sagebrush	0	1500	1830	3047	3595	0	3163	3584	5038	5704	0	5861	6364	8320	9185
Mountain Shrub	0	281	599	1225	1745	0	454	872	1597	2245	0	839	1367	2292	3215
Pinyon-Juniper	0	26	29	71	129	0	35	38	90	163	0	50	53	128	236
Saltbush	0	125	125	125	125	0	189	189	189	189	0	254	254	254	254
Greasewood	0	96	96	96	96	0	187	187	187	187	0	316	316	316	316
Aspen	0	128	188	359	431	0	166	242	436	523	0	260	350	583	690
Riparian	0	31	46	105	121	0	44	64	148	167	0	72	98	242	269
Cropland	0	128	157	394	439	0	138	172	439	504	0	138	172	496	593
Rock Outcrop-Barren	0	133	181	181	376	0	377	443	443	688	0	738	826	826	1197
Conifer	0	167	177	235	251	0	191	203	263	282	0	191	203	263	282
Totals	0	2765	3675	6124	7704	0	5146	6327	9249	11208	0	9018	10474	14391	17107

TABLE 4-13

ACRES OF VEGETATIVE COMMUNITIES LOST BY DEVELOPMENT OF FEDERAL ACTION INCLUDING TRENDED BASELINE

	1987					1990					1995				
	No Action	Low Altern.	Medium Altern.	High Altern.	Maximum Altern.	No Action	Low Altern.	Medium Altern.	High Altern.	Maximum Altern.	No Action	Low Altern.	Medium Altern.	High Altern.	Maximum Altern.
Grassland	2423	2573	2670	2709	2819	3362	3564	3695	3781	3918	3805	4104	4276	4476	4675
Sagebrush	20914	22414	22744	23961	24509	29033	32617	34071	34737	31743	31743	37604	38107	40063	40928
Mountain Shrub	5610	5891	6209	6835	8580	7787	8241	8659	9384	10032	8057	8896	9424	10349	11272
Pinyon-Juniper	432	458	461	503	561	601	636	639	691	764	664	714	717	792	900
Saltbush	1781	1906	1906	1906	1906	2471	2660	2660	2660	2660	2860	3114	3114	3114	3114
Greasewood	1310	1406	1406	1406	1406	1818	2005	2005	2005	2005	2103	2419	2419	2419	2419
Aspen	2652	2780	2840	3011	3083	3683	3849	3925	4119	4206	3887	4147	4237	4470	4577
Riparian	536	567	582	641	657	742	786	806	890	909	821	893	919	1063	1090
Cropland	2632	2760	2789	3026	3071	3652	3790	3824	4091	4156	3864	4002	4036	4360	4457
Rock Outcrop -Barren	225	358	406	406	601	312	689	755	755	1000	361	1099	1187	1187	1558
Conifer	2754	2921	2931	2989	3005	3822	4013	4025	4085	4104	4297	4488	4500	4560	4579
Totals	41269	44034	44944	47393	48973	57283	62429	63610	66532	68491	62462	71480	72936	76853	79569
Percent Change		6.6	8.9	14.8	18.7		9.0	11.0	16.1	19.6		14.4	16.8	23.0	27.4

TABLE 4-14

ACRES DISTURBED BY ALTERNATIVE

		Total Acres Onsite	Stripping	Facilities Onsite	Facilities Offsite	Housing & Infrastr.	Total Acres Offsite
1 China Butte, Medicine Bow							
Red Rim, Rosebud,	87	2913	0	2913	4222	570.3	4792.3
M Seminoe II, Bell, Empire,	90	5692	2192	3770	4454	789.4	5243.4
A Grassy, Danforth 1, 2, 3,	95	11859	7537	4322	4454	793.2	5247.2
X Hayden, Lay, Pinnacle,	EOM	34157	28666	5491	4454	793.2	5247.2
Iles Mtn., Williams Fork							
2 China Butte, Medicine Bow	87	1813	0	1813	3787	525.7	4312.7
H Red Rim, Rosebud,	90	4558	1888	2670	4019	672.7	4691.7
I Seminoe II, Bell, Empire,	95	9695	6473	3222	4019	676.5	4695.7
G Grassy, Danforth 1 & 3,	EOM	28737	24346	4391	4019	676.5	4695.7
H Hayden, Lay, Danforth 2							
3 China Butte, Medicine Bow	87	1113	0	1113	2196	367.4	2563.4
M Red Rim, Rosebud,	90	3460	1490	1970	2428	440.6	2868.6
E Seminoe II, Bell, Empire,	95	7602	5080	2522	2428	444.4	2872.4
D Grassy, Danforth 1,	EOM	22067	18376	3691	2428	444.4	2872.4
Danforth 3, Hayden							
4 China Butte, Medicine Bow	87	513	0	513	1936	318.2	2254.2
L Red Rim, Rosebud,	90	2640	1270	1370	2168	339.3	2507.3
O Seminoe II, Bell, Empire,	95	6507	4585	1922	2168	343.1	2511.1
W Grassy, Danforth 1,	EOM	19817	16726	3091	2168	343.1	2511.1
Danforth 3							

TABLE 4-15

ADVERSE IMPACTS AND SIGNIFICANCE BY VEGETATIVE TYPE

Vegetative type	Description of Impact	Significance
Grassland	Loss of this type will result in livestock grazing reduction and habitat loss for small game.	Moderate
Sagebrush	Loss of this type will create loss of wildlife winter range, sage grouse habitat and livestock grazing.	Moderate - High
Mountain Shrub	Same as Sagebrush.	Moderate - High
Pinyon - Juniper	Loss of wildlife habitat for small and big game.	Low
Saltbush	Loss of wildlife habitat.	Low
Greasewood	Loss of wildlife habitat.	Low
Aspen	Loss of wildlife habitat, livestock production, potential elk calving areas and possible VRM sensitive areas.	High
Riparian	Loss of most diverse habitat type for wildlife and area utilized by livestock most extensively. Also high scenic area of VRM.	High
Cropland	Reduction of food grain and livestock feed.	Low
Rock Outcrop-Barren	No Impact.	Low
Conifer	Loss of wildlife habitat and high scenic VRM potential.	Low-Moderate

TABLE 4-16

WILDLIFE HABITAT LOSSES IN THE HABITAT ANALYSIS AREA 1/

Habitat Losses (Acres)	1987					1990					1995				
		Federal Portion					Federal Portion					Federal Portion			
	No Action	Low Prod.	Medium Prod.	High Prod.	Maximum Prod.	No Action	Low Prod.	Medium Prod.	High Prod.	Maximum Prod.	No Action	Low Prod.	Medium Prod.	High Prod.	Maximum Prod.
Direct Destruction															
All Types	41,269	2,765	3,701	6,124	7,705	57,283	5,146	6,327	9,243	11,208	62,462	9,018	10,474	14,391	17,107
Big Game Wint. Range	35,638	2,337	3,129	5,349	6,647	49,466	4,412	5,439	8,101	9,715	53,917	7,829	9,095	12,719	14,938
Sagebrush	20,914	1,500	1,830	3,047	3,596	29,033	3,163	3,584	5,032	5,704	31,743	5,861	6,364	8,320	9,185
Riparian	536	31	46	105	121	742	44	64	148	167	821	72	98	242	269
Unusable-Human Activity 2/															
All types	23,111	1,548	2,073	3,429	4,315	32,078	2,882	3,543	5,176	6,276	34,979	5,050	5,865	8,059	9,580
Big Game Wint. Range	19,957	1,309	1,752	2,995	3,722	27,701	2,471	3,046	4,537	5,440	30,194	4,384	5,093	7,123	8,365
Sagebrush	11,712	840	1,025	1,706	2,014	16,258	1,771	2,007	2,818	3,194	17,776	3,282	3,564	4,659	5,144
Riparian	300	17	26	59	68	416	25	36	83	94	460	40	55	136	151
Total Losses															
All Types	64,380	4,313	5,774	9,553	12,020	89,361	8,028	9,870	14,419	17,484	97,441	14,068	16,339	22,450	26,687
Big Game Wint. Range	55,595	3,646	4,881	8,344	10,369	77,167	6,883	8,485	12,638	15,155	84,111	12,213	14,188	19,842	23,303
Sagebrush	32,626	2,340	2,855	4,753	5,610	45,291	4,934	5,591	7,850	8,898	49,519	9,143	9,928	12,979	14,329
Riparian	836	48	72	164	189	1,158	69	100	231	261	1,281	112	153	378	420

1/ Losses shown for Alternatives are additive to the No Action Base

2/ Number of acres is estimated by .56 X acres disturbed due to direct destruction. This assumes one quarter mile radius around human activity areas is unusable. Area of circle = 3.14 X $(\text{radius})^2$. If radius is increased .25, then area increases by .56.

TABLE 4-17

COLORADO ESTIMATED NUMBER OF DEER THAT WOULD BE KILLED BY VEHICLES (NO ACTION)

Highway	Average Known Killed 1/	Average Estimated Killed 2/	Minimum Estimated Kill 3/ 1987	1990	1995
U.S. 40 Moffat County	16	32	37	40	43
U.S. 40 Routt County	15	30	35	37	42
S.H. 13 Craig to Meeker	35	70	167	160	143
S.H. 13 Craig to Wyoming	34	68	82	88	97
Total	100	200	321	325	325

1/ Colorado Division of Wildlife, 1978 e.
2/ Colorado Division of Wildlife, 1980 a.
3/ Assuming direct relationship between number of vehicles and number of deer killed. Example: Traffic increase in 1987 will be + 139% = deer kill will increase + 139%.

TABLE 4-18

ESTIMATED INCREASED WILDLIFE KILLED DUE TO VEHICLE COLLISIONS - NO ACTION

Highway	Percent Estimated Increased Deaths 1/		
	1987	1990	1995
Colorado			
U.S. 40 Moffat County	+ 17	+ 24	+ 35
U.S. 40 Routt County	+ 18	+ 24	+ 35
S.H. 13 South of Craig	+ 139	+ 128	+ 104
S.H. 13 North of Craig	+ 21	+ 29	+ 42
Wyoming			
I-80 Wamsutter to Elk Mountain	+ 37	+ 51	+ 71
S.H. 789 Rawlins to Baggs	+ 83	+ 111	+ 156
S.H. 130 Riverside to I-80	+ 60	+ 88	+ 112
U.S. 30 and 287 I-80 to Medicine Bow	+ 52	+ 66	+ 86

1/ Increase in percent over 1978 (based on projected traffic increases).

TABLE 4-19

ESTIMATED ANIMAL LOSSES-COLORADO 1/

	1987					1990					1995				
		Federal Portion					Federal Portion					Federal Portion			
Animal Losses	No Action	Low Prod.	Medium Prod.	High Prod.	Maximum Prod.	No Action	Low Prod.	Medium Prod.	High Prod.	Maximum Prod.	No Action	Low Prod.	Medium Prod.	High Prod.	Maximum Prod.
<u>Direct Death</u>															
Due to Veh. Coll.:															
Deer Numbers	321	33	34	145	93	325	44	65	143	183	325	79	64	143	182
Other Animals 2/	+ 139%	+ 15	% 15	+ 65	+ 44	+ 128%	+ 24	+ 33	+ 68	+ 91	+ 104%	+ 31	+ 37	+ 76	+ 101
Other Human Causes:															
All Animals 3/	+ 125%	+ 2.8%	+ 4.0%	+ 7.9%	+ 9.0%	+ 136%	+ 3.4%	+ 5.7%	+ 11.0%	+ 13.9%	+ 138%	+ 3.3%	+ 5.7%	+ 11.0%	+ 13.8%
<u>Population Loss</u>															
Due to Habitat Loss:															
Deer Numbers 4/	2,091	91	117	428	587	2,902	117	236	529	726	2,975	188	335	728	1,001
Elk Numbers 4/	640	28	57	131	180	888	36	72	162	222	910	58	102	223	306

1/ Losses shown for Alternatives are additive to the No Action Base.
2/ Maximum shown - see Table 4-18 for breakdown by road segment.
3/ Based on estimated human population increase.
4/ Calculated by total loss of big game winter ranges (square miles) x 10 year average animal densities on winter ranges--deer=47.4, elk=14.5 (Colorado Division of Wildlife 1980 a).

TABLE 4-20

ESTIMATED ANIMAL LOSSES - WYOMING 1/

Animal Losses	1987 No Action	1987 Federal Portion All Alternatives	1990 No Action	1990 Federal Portion All Alternatives	1995 No Action	1995 Federal Portion All Alternatives
Direct Death						
Due to Veh. Coll.:						
All Animals 2/	+ 83%	+ 27%	+ 111%	+ 76%	+ 156%	+ 81%
Other Human Causes:						
All Animals 3/	+ 12.8%	+ 7.3%	+ 14.5%	+ 6.9%	+ 18.9%	+ 6.7%
Population Loss						
Due to Habitat Loss: 4/						
Antelope 5/	763	69	1,059	149	1,226	266
Deer 5/	304	28	422	59	488	106
Sagegrouse 6/	477	43	662	97	766	166

1/ Losses shown for Alternatives are additive to the No Action Base.
2/ Maximum shown - see Table 4-18 for breakdown by road segment.
3/ Based on estimated human population increase.
4/ Maximum loss of available habitat will not be reached until approximately the 30th year of mining, after which reclamation will reduce the amounts of non-available habitat.
5/ Calculated by total loss of big winter ranges (square miles) x average maximum density per square mile--antelope=18, deer=7 (Bureau of Land Management, 1979 b).
6/ Calculated by total loss of sagebrush x average maximum density of 18 per square miles (Bureau of Land Management, 1979 b).

TABLE 4-21

SUMMARY OF ADVERSE IMPACTS 1/

Impacted Element	COLORADO No Action	COLORADO Low Produc.	COLORADO Medium Produc.	COLORADO High Produc.	COLORADO Maximum Produc.	WYOMING No Action	WYOMING All Alternatives
Habitat							
Big Game Winter Range	Major	Major	Major	Major	Major	Minor	Minor
Sagebrush	Minor	Minor	Minor	Minor	Minor	Minor	Minor
Riparian	Major	Major	Major	Major	Major	Minor	Minor
Aquatic	Minor	Minor	Minor	Minor	Minor	Minor	Minor
Animals							
Antelope	Minor	Minor	Minor	Minor	Minor	Minor	Minor 2/
Mule Deer	Major	Major	Major	Major	Major	Minor	Minor
Elk	Major	Major	Major	Major	Major	None	None
Sage Grouse	Minor	Minor	Minor	Minor	Minor	Minor	Minor 2/
Ferruginous Hawk	None	None	None	None	None	Minor	Minor
Golden Eagle	Minor	Minor	Minor	Minor	Minor	Minor	Minor
Burrowing Owl	None	None	None	None	None	Minor	Minor
Bald Eagle)							
Black-footed Ferret) 3/							
Colorado Squawfish)							
Humpback Chub)							

1/ These impacts would occur in 1987 without additional Federal coal leasing. Federal leasing would be additive, but would not significantly increase the magnitude of these impacts through 1995.
2/ Impacts to these species will be significant in the short term, but reclamation of habitat should mitigate these in the long-term.
3/ Awaiting USFWS Consultation under Section 7 Endangered Species Act.

Definitions: Major - an impact that would cause significant animal losses in sufficient numbers to bring about a downward trend in regional populations over the long term.
Minor - an impact that would cause significant animal losses, but these numbers would still maintain the current stable or increasing regional trend over the long term.
None - an impact that would not cause a measurable reduction in regional animal numbers.

TABLE 4-22

ESTIMATED EFFECTIVENESS OF MITIGATION - WYOMING

Impact	Mitigation Measure	Residual Impact
Long-term loss of stockwater reservoirs	1	Short-term loss of stockwater reservoirs
Long-term loss of aquatic habitat	1	Short-term loss of aquatic habitat
Long-term heavier use of vegetation on adjacent areas and around available water sources	1	Short-term heavier use of vegetation on adjacent areas and around available water sources
Losses of pronghorn and mule deer	3, 8	Reduced loss of pronghorn and mule deer
Restrictions in big game movement patterns resulting from changes in topography and destruction in wildlife habitat	9	None
Long-term loss of raptor nesting/hunting habitat	2, 6	Short-term loss of raptor nesting/hunting habitat
Loss of undiscovered threatened and endangered species	5	None
Loss of sage grouse from disturbance of sage grouse strutting/nesting complexes adjacent to mine areas	7	None
Loss of prey species (prairie dogs) outside mined areas	6	None

Source: SSA (BLM, 1979 b)

TABLE 4-23

CUMULATIVE ANALYSIS: CULTURAL RESOURCES

	No Action 1/	Low	Medium	High	Maximum
Tract acres	0	74,027	79,674	93,850	108,704
Acres of inventory done	0	29,857	29,988	31,752	34,586
Identified cul. res.	0	87	87	96	96
Expected cul. res. from Federal leasing only	Not Applic.	169-343	191-399	273-586	329-732
Expected cul. res. 1/	356	525-699	547-755	629-942	685-1088
Expected eligible from Federal leasing only	Not Applic.	22-52	25-61	37-90	45-112
Expected eligible 1/	57	79-109	82-118	94-147	102-169

1/ Expected sites and expected eligible data developed from Table 3-8. Briefly, 80552 acres divided by 226 acres/site = 356.4; 16% of 356 = 56.96. Subsequent alternatives include this baseline figure.

TABLE 4-24, Part 1

ESTIMATED COST ANALYSIS FOR
URBAN RECREATION FACILITY DEVELOPMENT ($000)

Community	Recreation Facility Cost Cumulative from 1978 Base Line			Facility Cost Related to Tract Populatn Growth			Total Cost	Total Tract	Tract % of
	1987	1990	1995	1987	1990	1995	78-95	Relatd	Total
COLORADO									
Craig									
No Action-Base	*813	104	16	0	0	0	933	0	0
Low	861	116	16	47	12	0	992	59	6
Medium	875	132	16	62	28	0	1,023	90	9
High	950	167	16	36	63	0	1,133	199	18
Maximum	975	208	16	161	104	0	1,199	265	22
Meeker									
No Action-Base	444	0	0	0	0	0	444	0	0
Low	467	0	0	23	0	0	467	23	5
Medium	467	0	0	23	0	0	467	23	5
High	490	0	0	46	0	0	490	46	9
Maximum	490	0	0	46	0	0	490	46	9
Hayden									
No Action-Base	67	9	1	0	0	0	77	0	0
Low	71	11	1	5	1	0	83	6	7
Medium	82	21	1	15	12	0	104	27	26
High	90	25	1	23	17	0	116	40	34
Maximum	97	34	1	30	25	0	132	55	42
Steamboat Springs									
No Action-Base	385	80	23	0	0	0	488	0	0
Low	385	80	23	0	0	0	488	0	0
Medium	392	88	23	7	8	0	504	15	3
High	392	88	23	7	8	0	504	15	3
Maximum	392	88	23	7	8	0	504	15	3
Oak Creek									
No Action-Base	26	4	0	0	0	0	30	0	0
Low	26	4	0	0	0	0	30	0	0
Medium	28	6	0	2	2	0	34	4	12
High	28	6	0	2	2	0	34	4	12
Maximum	28	6	0	2	2	0	34	4	12
Yampa									
No Action-Base	2	0	0	0	0	0	2	0	0
Low	2	0	0	0	0	0	2	0	0
Medium	2	1	0	0	0	0	3	0	0
High	2	1	0	0	0	0	3	0	0
Maximum	2	1	0	0	0	0	3	0	0

TABLE 4-24, Part 2

ESTIMATED COST ANALYSIS FOR
URBAN RECREATION FACILITY DEVELOPMENT ($000)

Community	Recreation Facility Cost Cumulative from 1978 Base Line			Facility Cost Related to Tract Populatn Growth			Total Cost	Total Tract	Tract % of
	1987	1990	1995	1987	1990	1995	78-95	Relatd	Total
WYOMING									
Rawlins									
No Action-Base	115	16	40	0	0	0	171	0	0
Low-Max Alts.	207	16	40	92	0	0	263	92	35
Laramie									
No Action-Base	230	31	79	0	0	0	340	0	0
Low-Max Alts.	281	31	79	51	0	0	391	51	13
Rock Springs									
No Action-Base	394	38	*364	0	0	0	796	0	0
Low-Max Alts.	481	38	364	87	0	0	883	87	10
Elmo/Hanna									
No Action-Base	20	3	7	0	0	0	30	0	0
Low-Max Alts.	30	3	7	10	0	0	40	10	25
Saratoga									
No Action-Base	23	3	8	0	0	0	34	0	0
Low-Max Alts.	32	3	8	9	0	0	43	9	21
Medicine Bow									
No Action-Base	12	2	4	0	0	0	18	0	0
Low-Max Alts.	17	2	4	5	0	0	23	5	22
Rivrsd/Encmpmnt									
No Action-Base	6	1	2	0	0	0	9	0	0
Low-Max Alts.	9	1	2	3	0	0	12	3	25
Baggs									
No Action-Base	3	0	0	0	0	0	3	0	0
Low-Max Alts.	8	0	0	5	0	0	8	5	63
Wamsutter									
No Action-Base	4	0	1	0	0	0	5	0	0
Low-Max Alts.	7	0	1	3	0	0	8	3	38
Sinclair									
No Action-Base	4	0	1	0	0	0	5	0	0
Low-Max Alts.	5	0	1	1	0	0	6	1	17

TABLE 4-24, Part 2 (Cont'd.)

ESTIMATED COST ANALYSIS FOR
URBAN RECREATION FACILITY DEVELOPMENT ($000)

Community	Recreation Facility Cost Cumulative from 1978 Base Line			Facility Cost Related to Tract Populatn Growth			Total Cost	Total Tract	Tract % of
	1987	1990	1995	1987	1990	1995	78-95	Relatd	Total
WYOMING									
Rock River									
No Action-Base	4	0	0	0	0	0	4	0	0
Low-Max Alts.	5	0	0	1	0	0	5	1	20
Walcott Junction									
No Action-Base	1	0	0	0	0	0	1	0	0
Low-Max Alts.	4	0	0	3	0	0	4	3	75
Elk Mountain									
No Action-Base	2	0	0	0	0	0	2	0	0
Low-Max Alts.	3	0	0	1	0	0	3	1	33
Creston Junction									
No Action-Base	1	0	0	0	0	0	1	0	0
Low-Max Alts.	3	0	0	2	0	0	3	2	33
Dixon									
No Action-Base	1	0	0	0	0	0	1	0	0
Low-Max Alts.	2	0	0	1	0	0	2	1	50

* Includes $230,000 for one municipal swimming pool and 9 hole golf course.

TABLE 4-25

ESTIMATED COST ANALYSIS FOR COLORADO, WYOMING EIS REGION
URBAN RECREATION FACILITY DEVELOPMENT ($000)

	Recreation Facility Costs - Cumulative from 1978 Pop Base			Facility Cost Relatd to Pop Growth			Total Cost	Total Tract	Tract % of
	1987	1990	1995	1987	1990	1995	78-95	Related	Total
Colorado									
No Action-Base	1,737	197	40	0	0	0	1,974	0	0
Low Alternative	1,812	211	40	75	13	0	2,063	88	4
Medium "	1,846	248	40	109	50	0	2,134	159	7
High "	1,952	328	40	214	90	0	2,230	304	13
Maximum "	1,984	337	40	246	139	0	2,361	385	16
Wyoming									
No Action-Base	820	94	506	0	0	0	1,420	0	0
Low-Max Alts.	1,094	94	506	274	0	0	1,694	274	16
Combined									
No Action-Base	2,557	291	546	0	0	0	3,394	0	0
Low Alternative	2,906	305	546	350	13	0	3,757	363	10
Medium "	2,940	342	546	383	50	0	3,828	433	11
High "	3,046	422	546	488	90	0	4,014	578	14
Maximum "	3,078	431	546	520	139	0	4,055	659	16

TABLE 4-26, Part 1

DEMAND FOR MAJOR DISPERSED RECREATION ACTIVITY DAYS CAUSED BY POPULATION GROWTH

Hunting (Big Game)	1987	1990	1995	Hiking	1987	1990	1995
(90,542 existing)				(81,919 existing)			
No Action - Base	144,564	150,049	153,079	No Action - Base	130,985	135,759	138,501
Low Alternative	151,481	157,193	160,325	Low Alternative	137,055	142,223	145,056
Medium "	152,515	159,321	162,452	Medium "	137,989	144,147	146,980
High "	155,839	164,195	167,326	High "	140,997	148,557	151,390
Maximum "	156,776	166,646	169,777	Maximum "	141,845	150,775	153,607
Fishing				Swimming (Lake/Stream)			
(388,035 existing)				(129,345 existing)			
No Action - Base	620,460	643,068	656,055	No Action - Base	206,820	214,356	218,685
Low Alternative	649,206	673,686	687,105	Low Alternative	216,402	224,562	229,035
Medium "	653,634	682,803	696,222	Medium "	217,878	227,601	232,074
High "	667,881	703,692	717,111	High "	222,627	234,564	239,037
Maximum "	671,895	714,195	727,614	Maximum "	223,965	238,065	242,538
Camping				Horseback Riding			
(112,099 existing)				(168,149 existing)			
No Action - Base	179,244	185,775	189,527	No Action - Base	268,866	278,663	284,291
Low Alternative	187,548	194,620	198,497	Low Alternative	281,323	291,931	297,746
Medium "	188,828	197,254	201,131	Medium "	283,241	295,881	301,696
High "	192,943	203,289	207,165	High "	289,415	304,933	310,748
Maximum "	194,103	206,323	210,200	Maximum "	291,155	309,485	315,299
Boating				Waterskiing			
(60,361 existing)				(17,246 existing)			
No Action - Base	96,516	100,033	102,053	No Action - Base	27,576	28,581	29,158
Low Alternative	100,988	104,796	106,883	Low Alternative	28,854	29,942	30,538
Medium "	101,676	106,214	108,301	Medium "	29,050	30,347	30,943
High "	103,893	109,463	111,551	High "	29,684	31,275	31,872
Maximum "	104,517	111,097	113,097	Maximum "	29,862	31,742	32,338

TABLE 4-26, (Cont'd)

DEMAND FOR MAJOR DISPERSED RECREATION ACTIVITY DAYS CAUSED BY POPULATION GROWTH

Picnicking (64,672 existing)	1987	1990	1995	Cross Country Skiing (30,181 existing)	1987	1990	1995
No Action - Base	103,410	107,178	109,343	No Action - Base	48,258	50,016	51,027
Low Alternative	108,201	112,281	114,518	Low Alternative	50,494	52,348	53,442
Medium "	108,939	113,801	116,037	Medium "	50,838	53,107	54,151
High "	111,314	117,282	119,519	High "	51,946	54,732	55,775
Maximum "	111,983	119,033	121,269	Maximum "	52,259	55,549	56,592
Ice Fishing (68,984 existing)				Snowmobiling (34,492 existing)			
No Action - Base	110,304	114,324	116,632	No Action - Base	55,152	57,162	58,316
Low Alternative	115,414	119,766	122,152	Low Alternative	57,707	59,883	61,076
Medium "	116,202	121,387	123,773	Medium "	58,101	60,694	61,886
High "	118,734	125,101	127,486	High "	59,367	62,550	63,743
Maximum "	119,448	126,968	129,354	Maximum "	59,724	63,484	64,677

Source of base data - Green River Basin Type IV Study 1975 USDA 1975, Colorado SCORP Div of Parks and Outdoor recreation 1976.

TABLE 4-27

IMPACT ANALYSIS RELATED TO LOSS OF ACCESSIBLE PUBLIC LANDS

Proposed Lease Areas	Acres of Public Surface	Public Access Yes/No	Probable 1/ Rate of Public Use	Probable 1/ Rate of Private Use	Alternatives Represented
Bell Rock	69	No	--	Low	Low-Maximum
Danforth I	-0-	No	--	Low	"
Danforth III	1,622	No	--	Low	"
Empire	308	Yes	Low	--	"
Grassy Creek	40	No	--	Low	"
Hayden Gulch	534	No	--	Low	Medium-Maximum
Danforth II	723	No	--	Moderate	High-Maximum
Lay	1,879	No	--	Moderate	High-Maximum
Iles Mountain	1,635	Yes	High	--	Maximum
Pinnacle	-0-	No	--	Low	Maximum
Williams Fork	135	Yes	Low	--	Maximum
China Butte	6,240	Yes	Moderate	--	Low-Maximum
Seminoe II	5,480	Yes	Moderate	--	Low-Maximum
Medicine Bow	6,880	Yes	Moderate	--	Low-Maximum
Rose Bud	3,040	Yes	Moderate	--	Low-Maximum
Red Rim	10,320	Yes	Moderate	--	Low-Maximum

Total accessible public surface removed - 34,038 (Colorado 2,078, Wyoming, 31,960)

1/ Primary use consists of big game hunting.

TABLE 4-28

ACREAGE DISTURBED FOR ALTERNATIVES BY TIME FRAME

	On Site Cumulative Acrg. Dist. 1987	1990	1995	Off Site Facility Disturbance by 1995
Colorado				
No Action - Base	27,943	37,863	43,370	Included in base
Low Alternative	27,963	38,116	44,328	772
Medium "	28,563	38,936	45,423	1,032
High "	29,263	40,034	47,516	2,623
Maximum "	30,363	41,438	49,680	3,058
Wyoming				
No Action - Base	15,800	23,200	26,650	Included in base
Low - Maximum Alts.	16,293	25,592	32,199	1,396
Combined				
No Action - Base	43,743	61,063	70,020	Included in base
Low Alternative	44,265	63,708	76,527	2,168
Medium "	44,856	64,528	77,622	2,428
High "	45,556	65,626	79,715	4,019
Maximum "	46,656	67,030	81,879	4,454

* Acreage disturbed does not include housing, urban development.
* Disturabance resulting from new Federal coal leasing may be more disruptive to visual resources than many of the activities in the No Action Alternative.

TABLE 4-29

VISUAL RESOURCE ANALYSIS FOR PROPOSED LEASE AREAS

Proposed Lease Areas	On Site Acreage Disturbed 1987	1990	1995	Class	Predominant Vegetative Type	Sensitivity 1/ Visitation by Traffic Volume	Severity 2/ Short Term	Impacts Long Term 20-50 Years After EOML	Alternatives Represented
Existing									
Colorado	27,943	37,868	43,370	II to IV	Sage/Mountain Shrub	Low to High	Medium to High 2/	High to Low 2/	No Action
Wyoming	15,800	23,200	26,650		Sage	Low to High	Medium to High	High to Low	No Action
Total	43,743	61,068	70,020	--	--	--	--	--	--
Bell Rock	0	0	0	III & IV	Sage/Grasses	Low	None	Low	Low-Maximum
Danforth I	0	54	189	IV	Sage/Mountain Shrub	High	High	Low	"
Danforth III	0	140	630	III & IV	Sage/Mountain Shrub	High	High	Low	"
Empire	20	20	20	IV	Sage/Mountain Shrub	High	Medium	Low	"
Grassy Creek	0	34	119	IV	Mountain Shrub/Aspen	Medium	Medium	Low	"
Hayden Gulch	600	820	1,095	IV	Sage/Mountain Shrub	Medium	Medium	Low	Medium-Maximum
Danforth II	0	170	595	IV	Sage/Grasses	Medium	Medium	Low	High-Maximum
Lay	700	928	1,498	III & IV	Sage/Mountain Shrub	Low	Medium	Low	High-Maximum
Iles Mountain	600	720	1,020	III & IV	Sage/Mountain Shrub	Medium	Medium	Low	Maximum
Pinnacle	0	24	84	IV	Sage/Cropland	Medium	Medium	Low	Maximum
Williams Fork	500	660	1,060	III & IV	Sage/Mountain Shrub	Low	Medium	Low	Maximum
Total Colorado	2,420	3,570	6,310						
China Butte	140	672	1,499	III & IV	Sage	Low	Medium	Low	Low-Maximum
Seminoe II	88	357	937	III	Sage	Medium	Medium	Low	"
Medicine Bow	0	283	948	III & IV	Sage	Medium	Medium	Low	"
Rose Bud	190	437	1,211	IV	Sage	Low	Medium	Low	"
Red Rim	75	643	1,438	III	Sage	High	High	Low	"
Total Wyoming	493	2,392	5,549						
Total Colorado and Wyoming									
Region Cumulative Total 3/	46,656	67,030	81,879						

1/ Based on traffic volumes less than 100 low, less than 500 medium, more than 500 High ADT
2/ All short term impacts are considered severe to VRM classifications.
3/ Does not include 4,454 acres of offsite facility disturbance by 1995.

TABLE 4-30, Part 1

POPULATION IMPACTS BY COMMUNITY

	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995
	Craig			Meeker			Hayden			Oak Creek		
No Action Alternative	16,472	18,032	18,274	9,635	8,749	8,494	2,553	2,690	2,707	1,187	1,249	1,257
Low Alternative												
Increment	703	883	883	349	459	459	74	95	95	0	0	0
Total	17,175	18,915	19,157	9,984	9,208	8,953	2,627	2,785	2,802	1,187	1,249	1,257
Medium Alternative												
Cumulative Increment	924	1,340	1,340	349	459	459	219	399	399	20	40	40
Total	17,396	19,372	19,614	9,984	9,208	8,953	2,772	3,089	3,106	1,207	1,289	1,297
High Alternative												
Cumulative Increment	2,037	2,981	2,981	686	938	938	352	600	600	20	40	40
Total	18,509	21,013	21,255	10,321	9,687	9,432	2,905	3,290	3,307	1,207	1,289	1,297
Maximum Alternative												
Cumulative Increment	2,419	3,989	3,989	686	938	938	416	759	759	20	40	40
Total	18,891	22,021	22,263	10,321	9,687	9,432	2,969	3,449	3,466	1,207	1,289	1,297
	Steamboat Springs			Yampa			Rock River			Other Albany County 1/		
No Action Alternative	10,560	11,763	12,100	337	341	345	507	515	535	1,832	1,860	1,931
Low Alternative												
Increment	0	0	0	0	0	0	20	18	18	43	36	35
Total	10,560	11,763	12,100	337	341	345	527	533	553	1,875	1,896	1,966
Medium Alternative												
Cumulative Increment	100	203	203	6	9	9	20	18	18	43	36	35
Total	10,660	11,966	12,303	343	350	354	527	533	553	1,875	1,896	1,966
High Alternative												
Cumulative Increment	100	203	203	6	9	9	20	18	18	43	36	35
Total	10,660	11,966	12,303	343	350	354	527	533	553	1,875	1,896	1,966
Maximum Alternative												
Cumulative Increment	100	203	203	6	9	9	20	18	18	43	36	35
Total	10,660	11,966	12,303	343	350	354	527	533	553	1,875	1,896	1,966
	Baggs			Dixon			Elk Mountain			Elmo/Hanna		
No Action Alternative	448	455	472	77	79	82	271	275	286	2,680	2,721	2,826
Low Alternative												
Increment	68	66	69	18	17	17	8	7	6	153	142	144
Total	516	521	541	95	96	99	279	282	292	2,833	2,863	2,970
Medium Alternative												
Cumulative Increment	68	66	69	18	17	17	8	7	6	153	142	144
Total	516	521	541	95	96	99	279	282	292	2,833	2,863	2,970
High Alternative												
Cumulative Increment	68	66	69	18	17	17	8	7	6	153	142	144
Total	516	521	541	95	96	99	279	282	292	2,833	2,863	2,970
Maximum Alternative												
Cumulative Increment	68	66	69	18	17	17	8	7	6	153	142	144
Total	516	521	541	95	96	99	279	282	292	2,833	2,863	2,970

TABLE 4-30, Part 2

POPULATION IMPACTS BY COMMUNITY

	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995
	Encampment/Riverside			Medicine Bow			Rawlins			Saratoga		
No Action Alternative	865	878	912	1,677	1,703	1,768	15,223	15,456	16,050	3,045	3,092	3,211
Low Alternative												
Increment	42	39	39	71	64	65	1,376	1,323	1,353	137	125	126
Total	907	917	951	1,748	1,767	1,833	16,599	16,779	17,403	3,182	3,217	3,337
Medium Alternative												
Cumulative Increment	42	39	39	71	64	65	1,376	1,323	1,353	137	125	126
Total	907	917	951	1,748	1,767	1,833	16,599	16,779	17,403	3,182	3,217	3,337
High Alternative												
Cumulative Increment	42	39	39	71	64	65	1,376	1,323	1,353	137	125	126
Total	907	917	951	1,748	1,767	1,833	16,599	16,779	17,403	3,182	3,217	3,337
Maximum Alternative												
Cumulative Increment	42	39	39	71	64	65	1,376	1,323	1,353	137	125	126
Total	907	917	951	1,748	1,767	1,833	16,599	16,779	17,403	3,182	3,217	3,337
	Walcott Junction			Other Carbon County			Creston Junction			Wamsutter		
No Action Alternative	158	160	166	3,189	3,237	3,362	42	43	44	521	529	549
Low Alternative												
Increment	43	44	45	75	63	61	35	35	37	42	40	41
Total	201	204	211	3,264	3,300	3,423	77	78	81	563	569	590
Medium Alternative												
Cumulative Increment	43	44	45	75	63	61	35	35	37	42	40	41
Total	201	204	211	3,264	3,300	3,423	77	78	81	563	569	590
High Alternative												
Cumulative Increment	43	44	45	75	63	61	35	35	37	42	40	41
Total	201	204	211	3,264	3,300	3,423	77	78	81	563	569	590
Maximum Alternative												
Cumulative Increment	43	44	45	75	63	61	35	35	37	42	40	41
Total	201	204	211	3,264	3,300	3,423	77	78	81	563	569	590

	1987	1990	1995
	Total Impacted Area		
No Action Alternative	71,279	73,827	75,371
Low Alternative			
Increment	3,257	3.456	3,493
Total	74,536	77,283	78,864
Medium Alternative			
Cumulative Increment	3,749	4,469	4,506
Total	75,028	78,296	79,877
High Alternative			
Cumulative Increment	5,332	6,790	6,827
Total	76,611	80,617	82,198
Maximum Alternative			
Cumulative Increment	5,778	7,957	7,994
Total	77,057	81,784	83,365

1/ Excludes Laramie.

Source: BLM estimates.

TABLE 4-31, Part 1

EMPLOYMENT IMPACTS

	Moffat County			Rio Blanco County			Routt County			Albany, Carbon and Sweetwater Counties			Total Impacted Area		
	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995
No Action Alternative															
Construction	650	764	774	298	200	200	540	640	645	4,651	4,737	4,737	6,139	6,341	6,356
Mining	902	929	929	5,081	5,093	5,114	1,084	1,131	1,131	7,608	7,536	7,536	14,675	14,689	14,710
Other	6,772	7,304	7,395	4,706	4,390	4,295	6,542	6,962	7,088	28,499	29,126	29,126	46,519	47,782	47,904
Total	8,324	8,997	9,098	10,085	9,683	9,609	8,166	8,733	8,864	40,758	41,399	41,399	67,333	68,812	68,970
Low Alternative															
Increment															
Construction	54	0	0	27	0	0	6	0	0	218	0	0	305	0	0
Mining	0	181	181	0	93	93	0	19	19	- 22	710	710	- 22	1,003	1,003
Other	231	164	164	115	86	86	24	18	18	1,330	573	573	1,700	841	841
Total	285	345	345	142	179	179	30	37	37	1,526	1,283	1,283	1,983	1,844	1,844
Total															
Construction	704	764	774	325	200	200	546	640	645	4,869	4,737	4,737	6,444	6,341	6,356
Mining	902	1,110	1,110	5,081	5,186	5,207	1,084	1,150	1,150	7,586	8,246	8,246	14,653	15,692	15,713
Other	7,003	7,468	7,559	4,821	4,476	4,381	6,566	6,980	7,106	29,829	29,699	29,699	48,219	48,623	48,745
Total	8,609	9,342	9,443	10,227	9,862	9,788	8,196	8,770	8,901	42,284	42,682	42,682	69,316	70,656	70,814
Medium Alternative															
Cumulative Increment															
Construction	71	0	0	27	0	0	27	0	0	218	0	0	343	0	0
Mining	0	277	277	0	93	93	0	135	135	- 22	710	710	- 22	1,215	1,215
Other	304	247	247	115	86	86	112	118	118	1,330	573	573	1,861	1,024	1,024
Total	375	524	524	142	179	179	139	253	253	1,526	1,283	1,283	2,182	2,239	2,239
Total															
Construction	721	764	774	325	200	200	567	640	645	4,869	4,737	4,737	6,482	6,341	6,356
Mining	902	1,206	1,206	5,081	5,186	5,207	1,084	1,266	1,266	7,586	8,246	8,246	14,653	15,904	15,925
Other	7,076	7,551	7,642	4,821	4,476	4,381	6,654	7,080	7,206	29,829	29,699	29,699	48,380	48,806	48,928
Total	8,699	9,521	9,622	10,227	9,862	9,788	8,305	8,986	9,117	42,284	42,682	42,682	69,515	71,051	71,209

TABLE 4-31, Part 2

EMPLOYMENT IMPACTS

	Moffat County			Rio Blanco County			Routt County			Albany, Carbon and Sweetwater Counties			Total Impacted Area		
	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995
High Alternative															
Cumulative Increment															
Construction	156	0	0	53	0	0	37	0	0	218	0	0	464	0	0
Mining	0	605	605	0	183	183	0	175	175	- 22	710	710	- 22	1,673	1,673
Other	671	562	562	226	185	185	157	157	157	1,330	573	573	2,384	1,477	1,477
Total	827	1,167	1,167	279	368	368	194	332	332	1,526	1,283	1,283	2,826	3,150	3,150
Total															
Construction	806	764	774	351	200	200	577	640	645	4,869	4,737	4,737	6,603	6,341	6,356
Mining	902	1,534	1,534	5,081	5,276	5,297	1,084	1,306	1,306	7,586	8,246	8,246	14,653	16,362	16,383
Other	7,443	7,866	7,957	4,932	4,575	4,480	6,699	7,119	7,245	29,829	29,699	29,699	48,903	49,259	49,381
Total	9,151	10,164	10,265	10,364	10,051	9,977	8,360	9,065	9,196	42,284	42,682	42,682	70,159	71,962	71,120
Maximum Alternative															
Cumulative Increment															
Construction	186	0	0	53	0	0	42	0	0	218	0	0	499	0	0
Mining	0	812	812	0	183	183	0	208	208	- 22	710	710	- 22	1,913	1,913
Other	795	750	750	226	185	185	177	187	187	1,330	573	573	2,528	1,695	1,695
Total	981	1,562	1,562	279	368	368	219	395	395	1,526	1,283	1,283	3,005	3,608	3,608
Total															
Construction	836	764	774	351	200	200	582	640	645	4,869	4,737	4,737	6,638	6,341	6,356
Mining	902	1,741	1,741	5,081	5,276	5,297	1,084	1,339	1,339	7,586	8,246	8,246	14,653	16,602	16,623
Other	7,567	8,054	8,145	4,932	4,575	4,480	6,719	7,149	7,275	29,829	29,699	29,699	49,047	49,477	49,599
Total	9,305	10,559	10,660	10,364	10,051	9,977	8,385	9,128	9,259	42,284	42,682	42,682	70,338	72,420	72,578

* Source: BLM estimates

TABLE 4-32, Part 1

INCOME IMPACTS
(Thousand 1978 dollars)

	Moffat County			Rio Blanco County			Routt County			Albany, Carbon and Sweetwater Counties			Total Impacted Area		
	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995
No Action Alternative															
Construction	10,206	11,996	12,153	4,679	3,140	3,140	8,479	10,049	10,127	75,737	77,131	77,131	99,101	102,316	102,551
Mining	18,478	19,031	19,031	109,626	109,910	110,406	22,207	23,170	23,170	162,791	162,181	162,181	313,102	314,292	314,788
Other	68,535	72,910	73,681	46,821	43,986	43,315	64,473	67,459	68,493	315,400	323,647	323,647	495,229	508,002	509,136
Total	97,219	103,937	104,865	161,126	157,036	156,861	95,159	100,678	101,790	553,928	562,959	562,959	907,432	924,610	926,475
Low Alternative															
Increment															
Construction	848	0	0	424	0	0	94	0	0	3,550	0	0	4,916	0	0
Mining	0	3,708	3,708	0	1,905	1,905	0	389	389	- 477	15,485	15,485	- 477	21,487	21,487
Other	2,439	1,886	1,886	1,216	972	972	254	205	205	18,504	5,675	5,675	22,413	8,738	8,738
Total	3,287	5,594	5,594	1,640	2,877	2,877	348	594	594	21,577	21,160	21,160	26,852	30,225	30,225
Total															
Construction	11,054	11,996	12,153	5,103	3,140	3,140	8,573	10,049	10,127	79,287	77,131	77,131	104,017	102,316	102,551
Mining	18,478	22,739	22,739	109,626	111,815	112,311	22,207	23,559	23,559	162,314	177,666	177,666	312,625	335,779	336,275
Other	70,974	74,796	75,567	48,037	44,958	44,287	64,727	67,664	68,698	333,904	329,322	329,322	517,642	516,740	517,874
Total	100,506	109,531	110,459	162,766	159,913	159,738	95,507	101,272	102,384	575,505	584,119	584,119	934,284	954,835	956,700
Medium Alternative															
Cumulative Increment															
Construction	1,115	0	0	424	0	0	424	0	0	3,550	0	0	5,513	0	0
Mining	0	5,675	5,675	0	1,905	1,905	0	2,766	2,766	- 477	15,485	15,485	- 477	25,831	25,831
Other	3,212	2,833	2,833	1,216	972	972	1,186	1,346	1,346	18,504	5,675	5,675	24,118	10,826	10,826
Total	4,327	8,508	8,508	1,640	2,877	2,877	1,610	4,112	4,112	21,577	21,160	21,160	29,154	36,657	36,657
Total															
Construction	11,321	11,996	12,153	5,103	3,140	3,140	8,903	10,049	10,127	79,287	77,131	77,131	104,614	102,316	102,551
Mining	18,478	24,706	24,706	109,626	111,815	112,311	22,207	25,936	25,936	162,314	177,666	177,666	312,625	340,123	340,619
Other	71,747	75,743	76,514	48,037	44,958	44,287	65,659	68,805	69,839	333,904	329,322	329,322	519,347	518,828	519,962
Total	101,546	112,445	113,373	162,766	159,913	159,738	96,769	104,790	105,902	575,505	584,119	584,119	936,586	961,267	963,132

Source: BLM estimates

TABLE 4-32, Part 2

INCOME IMPACTS

	Moffat County			Rio Blanco County			Routt County			Albany, Carbon and Sweetwater Counties			Total Impacted Area		
	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995
High Alternative															
Increment															
Construction	2,449	0	0	832	0	0	581	0	0	3,550	0	0	7,412	0	0
Mining	0	12,394	12,394	0	3,749	3,749	0	3,585	3,585	- 477	15,485	15,485	- 477	35,213	35,213
Other	7,092	6,387	6,387	2,389	2,069	2,069	1,662	1,786	1,786	18,504	5,675	5,675	29,647	15,917	15,917
Total	9,541	18,781	18,781	3,221	5,818	5,818	2,243	5,371	5,371	21,577	21,160	21,160	36,582	51,130	51,130
Total															
Construction	12,655	11,996	12,153	5,511	3,140	3,140	9,060	10,049	10,127	79,287	77,131	77,131	106,513	102,316	102,551
Mining	18,478	31,425	31,425	109,626	113,659	114,155	22,207	26,755	26,755	162,314	177,666	177,666	312,625	349,505	350,001
Other	75,627	79,297	80,068	49,210	46,055	45,384	66,135	69,245	70,279	333,904	329,322	329,322	524,876	523,919	525,053
Total	106,760	122,718	123,646	164,347	162,854	162,679	97,402	106,049	107,161	575,505	584,119	584,119	944,014	975,740	977,605
Maximum Alternative															
Cumulative Increment															
Construction	2,921	0	0	832	0	0	659	0	0	3,550	0	0	7,962	0	0
Mining	0	16,635	16,635	0	3,749	3,749	0	4,261	4,261	- 477	15,485	15,485	- 477	40,130	40,130
Other	8,403	8,598	8,598	2,389	2,069	2,069	1,873	2,134	2,134	18,504	5,675	5,675	31,169	18,476	18,476
Total	11,324	25,233	25,233	3,221	5,818	5,818	2,532	6,395	6,395	21,577	21,160	21,160	38,654	58,606	58,606
Total															
Construction	13,127	11,996	12,153	5,511	3,140	3,140	9,138	10,049	10,127	79,287	77,131	77,131	107,063	102,316	102,551
Mining	18,478	35,666	35,666	109,626	113,659	114,155	22,207	27,431	27,431	162,314	177,666	177,666	312,625	354,422	354,918
Other	76,938	81,508	82,279	49,210	46,055	45,384	66,346	69,593	70,627	333,904	329,322	329,322	526,398	526,478	527,612
Total	108,543	129,170	130,098	164,347	162,854	162,679	97,691	107,073	108,185	575,505	584,119	584,119	946,086	983,216	985,081

Source: BLM estimates

TABLE 4-33, Part 1

PER CAPITA PROJECTIONS OF OPERATING REVENUES AND BONDING CAPACITIES
(Thousand 1978 dollars)

	Operating Revenue			Bonding Capacity		
	1987	1990	1995	1987	1990	1995
Carbon County						
No Action	4,228	4,293	4,458	5,208	5,288	5,491
All Alternatives	4,533	4,926	5,027	5,584	7,296	7,156
Moffat County						
No Action	13,509	14,541	14,695	3,633	3,873	3,908
Low	13,953	15,190	15,344	3,733	4,091	4,126
Medium	14,092	15,479	15,633	3,764	4,156	4,191
High	14,794	17,425	17,579	3,922	5,341	5,375
Maximum	15,035	18,358	18,512	3,976	5,763	5,798
Rio Blanco County						
No Action	14,538	14,356	13,793	16,570	17,892	17,476
Low	14,753	15,292	14,729	16,729	18,643	18,227
Medium	14,753	15,292	14,729	16,729	18,643	18,227
High	14,961	15,588	15,025	16,883	18,861	18,446
Maximum	14,961	15,588	15,025	16,883	18,861	18,446
Routt County						
No Action	7,363	8,110	8,229	3,097	3,519	3,566
Low	7,391	8,146	8,265	3,108	3,533	3,580
Medium	7,492	8,879	8,998	3,148	3,932	3,978
High	7,542	8,955	9,074	3,167	3,961	4,008
Maximum	7,566	9,070	9,189	3,177	4,028	4,074
Baggs						
No Action	120	122	126	26	26	27
All Alternatives	138	140	144	30	30	31
Craig						
No Action	5,864	6,419	6,506	4,282	4,688	4,751
Low	6,114	6,733	6,820	4,465	4,918	4,980
Medium	6,193	6,896	6,983	4,523	5,036	5,099
High	6,589	7,480	7,567	4,812	5,463	5,526
Maximum	6,725	7,839	7,926	4,911	5,725	5,788
Dixon						
No Action	41	42	43	6	6	7
All Alternatives	51	51	52	8	8	8
Elk Mountain						
No Action	64	65	68	21	21	22
All Alternatives	66	67	69	21	22	22

TABLE 4-33, Part 2

PER CAPITA PROJECTIONS OF OPERATING REVENUES AND BONDING CAPACITIES
(Thousand 1978 dollars)

	Operating Revenue			Bonding Capacity		
	1987	1990	1995	1987	1990	1995
Elmo/Hanna						
No Action	386	392	407	164	166	173
All Alternatives	408	412	428	173	175	182
Encampment/Riverside						
No Action	119	120	125	59	60	63
All Alternatives	125	125	130	62	63	65
Hayden						
No Action	569	600	604	523	551	554
Low	586	621	625	538	570	574
Medium	618	689	693	568	633	636
High	647	734	738	595	674	677
Maximum	662	769	773	608	706	710
Medicine Bow						
No Action	221	225	233	61	62	64
All Alternatives	230	233	242	63	64	66
Meeker						
No Action	2,158	1,960	1,903	2,141	1,944	1,888
Low	2,236	2,063	2,006	2,219	2,046	1,990
Medium	2,236	2,063	2,006	2,219	2,046	1,990
High	2,312	2,170	2,113	2,294	2,153	2,096
Maximum	2,312	2,170	2,113	2,294	2,153	2,096
Oak Creek						
No Action	404	425	427	140	147	148
Low	404	425	427	140	147	148
Medium, High and Maximum	411	439	441	142	152	152
Rawlins						
No Action	3,242	3,292	3,419	1,411	1,433	1,488
All Alternatives	3,535	3,574	3,707	1,539	1,556	1,614
Rock River						
No Action	91	93	96	55	56	58
All Alternatives	95	96	99	57	58	60
Saratoga						
No Action	621	631	655	248	252	261
All Alternatives	649	657	681	259	262	272

TABLE 4-33, Part 3

PER CAPITA PROJECTIONS OF OPERATING REVENUES AND BONDING CAPACITIES
(Thousand 1978 dollars)

	Operating Revenue			Bonding Capacity		
	1987	1990	1995	1987	1990	1995
Steamboat Springs						
No Action	5,174	5,764	5,929	9,489	10,570	10,873
Low	5,174	5,764	5,929	9,489	10,570	10,873
Medium, High and Maximum	5,223	5,863	6,028	9,579	10,753	11,056
Wamsutter						
No Action	144	146	152	29	29	30
All Alternatives	156	157	163	31	31	32
Yampa						
No Action	64	65	66	84	85	86
Low	64	65	66	84	85	86
Medium, High and Maximum	65	67	68	85	87	88
Carbon County School Districts # 1 & 2						
No Action	10,666	10,830	11,246	26,041	26,440	27,457
All Alternatives	11,435	16,700	16,042	27,918	36,478	35,784
Moffat County School District #1						
No Action	9,836	10,530	10,632	48,437	51,634	52,095
Low	10,129	11,067	11,169	49,765	54,548	55,009
Medium	10,221	11,258	11,360	50,183	55,412	55,873
High	10,685	13,669	13,771	52,286	71,207	71,668
Maximum	10,845	14,595	14,697	53,008	76,848	77,310
Routt County School Districts # 1,2, & 3						
No Action	11,824	13,176	13,361	41,301	46,919	47,538
Low	11,867	13,232	13,417	41,446	47,105	47,724
Medium	12,027	14,118	14,303	41,977	52,427	53,047
High	12,105	14,236	14,421	42,238	52,821	53,440
Maximum	12,142	14,406	14,599	42,363	53,702	54,321

Notes: The figures shown for each jurisdiction are cumulative, in that the succeeding figures include all those above them. Thus, for Moffat County, the Low Alternative figure of $13,953,000 = $13,509,000 No Action impact + $444,000 Low Alternative impact. The figures are displayed in this manner to facilitate comparison with Table 4 J.

TABLE 4-33, Notes (cont.)

Property tax revenues and bonding capacities that would result from projects expected to be developed between 1978 and 1990 that are not part of the new federal leasing have been added to the no action figures for the Colorado counties. An inaccuracy results from the fact that the investment figures from which these were derived were given for 1985 but have been applied to 1987. Similar figures were not available for Carbon County.

Similarly, property tax revenues and bonding capacities that would result from the new federal leasing have been added to the figures for the appropriate alternatives for all counties.

Since all Wyoming tracts are included in each alternative, the figures are shown once in order to save space. For the same reason, figures of the medium, high, and maximum alternatives are combined for Oak Creek, Steamboat Springs, and Yampa and their school districts.

Because Creston Junction and Walcott Junction presently have no municipal governments, projections cannot be made for them.

Because the school districts include rural areas for which population figures are not available, separate per capita projections could not be made for them. Therefore, only the county totals are shown for school districts.

For the same reason, since Rio Blanco County School District #1 includes only about half of the county, and the remainder of the county would not be impacted by the new federal leasing, it would be misleading to compare a projection of operating revenue and bonding capacity for the entire county to capital requirements that must be borne by one part of the county alone.

Source: BLM estimates

TABLE 4-34

ADDITIONS TO PROPERTY TAX REVENUES AND BONDING CAPACITIES FROM NEW MINING OPERATIONS UNDER EACH ALTERNATIVE, BEGINNING IN 1989
(Thousand 1978 dollars)

	Carbon County 1990	Carbon County 1995	Moffat County	Rio Blanco County	Routt County	Carbon County Sch. Dist. #1 1990	Carbon County Sch. Dist. #1 1995	Carbon County Sch. Dist. #2 1990	Carbon County Sch. Dist. #2 1995	Moffat County S.D.#1	Rio Blanco County S.D.#1	Routt County S.D.#1
Addns to Property Tax Revenue												
Low	$ 344	$ 274	$ 92	$ 653	$ 0	$4,447	$3,477	$ 693	$ 576	$ 169	$ 1,561	$ 0
Medium	344	274	92	653	525	4,447	3,477	693	576	169	1,561	560
High	344	274	1,003	653	525	4,447	3,477	693	576	1,896	1,561	560
Maximum	344	274	1,300	653	581	4,447	3,477	693	576	2,402	1,561	637
Addns to Bonding Capacity												
Low	1,652	1,302	93	542	0	7,093	5,546	1,164	967	1,245	7,221	0
Medium	1,652	1,302	93	542	317	7,093	5,546	1,164	967	1,245	7,221	4,233
High	1,652	1,302	1,045	542	317	7,093	5,546	1,164	967	13,939	7,221	4,233
Maximum	1,652	1,302	1,325	542	360	7,093	5,546	1,164	967	17,675	7,221	4,802

Notes: Separate figures for 1990 and 1995 are provided for the Carbon County entities because Wyoming assessments specify a depreciation rate for capital equipment, thus requiring a changed value for each year. Although Colorado assessments also take depreciation into account, no rate is specified and no change in values is therefore assumed.

None of the proposed tracts are located in Routt County School Districts #2 or #3.

Source: BLM estimates.

TABLE 4-35, Part 1

CUMULATIVE CAPITAL REQUIREMENTS UNDER ALL ALTERNATIVES (COMMUNITIES)

	1987		1990		1995	
	amt (000)	%Increase From No Action	amt (000)	%Increase From No Action	amt (000)	%Increase From No Action
Baggs						
No Action	$ 9		$ 9		$ 12	
All Alternatives	22	1/	22	1/	25	1/
Craig						
No Action	4,459		5,651		5,865	
Low	4,994	12	6,318	12	6,535	11
Medium	5,132	15	6,625	17	6,842	17
High	5,973	34	7,817	38	8,116	38
Maximum	6,196	39	8,544	51	8,847	51
Creston Junction						
No Action	70		70		71	
All Alternatives	141	101	141	101	142	100
Dixon						
No Action	2		2		2	
All Alternatives	5	1/	5	1/	6	1/
Elk Mountain						
No Action	166		232		233	
All Alternatives	168	1	233	0	235	1
Elmo/Hanna						
No Action	147		162		386	
All Alternatives	371	152	385	138	611	58
Encampment/Riverside						
No Action	169		222		231	
All Alternatives	224	33	229	3	238	3
Hayden						
No Action	227		261		276	
Low	242	7	282	8	297	8
Medium	274	21	348	33	365	32
High	302	33	517	98	534	93
Maximum	318	40	750	187	775	181
Medicine Bow						
No Action	113		123		143	
All Alternatives	127	12	137	11	157	10
Meeker						
No Action	3,137		3,137		3,158	
Low	3,356	7	3,356	7	3,380	7
Medium	3,356	7	3,356	7	3,380	7
High	3,523	12	3,523	12	3,553	13
Maximum	3,523	12	3,523	12	3,553	13
Oak Creek						
No Action	85		97		99	
Low	85	0	97	0	99	0
Medium, High and Max.	89	5	106	9	107	8
Rawlins						
No Action	1,557		1,734		2,101	
All Alternatives	2,310	48	2,487	43	2,860	36
Rock River	$		$		$	
No Action	269		272		275	
All Alternatives	273	1	274	1	280	2
Saratoga						
No Action	154		163		188	
All Alternatives	182	18	191	17	217	15
Steamboat Springs						
No Action	1,971		2,411		2,530	
Low	1,971	0	2,411	0	2,530	0
Medium, High and Max.	2,067	5	2,530	5	2,650	5
Walcott Junction						
No Action	261		261		262	
All Alternatives	381	46	381	46	382	46
Wamsutter						
No Action	11		14		18	
All Alternatives	19	1/	22	1/	26	1/
Yampa						
No Action	5		5		6	
Low	5	0	5	0	6	0
Medium, High and Max.	6	1/	7	1/	7	1/

Table 4-35, Part 2

CUMULATIVE CAPITAL REQUIREMENTS UNDER ALL ALTERNATIVES (SCHOOLS)

	1987		1990		1995	
	Amt (000)	%Increase From No Action	Amt (000)	%Increase From No Action	Amt (000)	%Increase From No Action
Moffat County School District #1						
No Action	12,388		15,549		16,044	
Low	13,814	12	17,340	12	17,835	11
Medium	14,260	15	18,264	17	18,759	17
High	16,516	33	21,592	39	22,087	38
Maximum	17,291	40	23,631	52	24,126	50
Rio Blanco School District #1						
No Action	12,404		12,404		12,404	
Low	13,111	6	13,111	6	13,111	6
Medium	13,111	6	13,111	6	13,111	6
High	13,792	11	13,792	11	13,792	11
Maximum	13,792	11	13,792	11	13,792	11
Routt County School District #1						
No Action	31		66		97	
Low	33	6	258	1/	289	1/
Medium	233	1/	872	1/	903	1/
High	500	1/	1,281	1/	1,312	1/
Maximum	630	1/	1,603	1/	1,634	1/
Routt County School District #2						
No Action	12,994		15,436		16,118	
Low	12,994	0	15,436	0	16,118	0
Medium, High and Maximum	13,199	2	15,845	3	16,527	3
Routt County School District #3						
No Action	3		66		91	
Low	3	0	66	0	91	0
Medium, High and Maximum	4	33	165	1/	190	1/
Carbon County School District #1						
No Action	39		44		57	
All Alternatives	68	1/	73	1/	86	1/
Carbon County School District #2						
No Action	23		26		34	
All Alternatives	33	1/	36	1/	172	1/

Notes: The figures shown for each jurisdiction are cumulative, in that the succeeding figures include all those above them. Thus, for Craig, the Low Alternative figure of $20,464,000 = $20,006,000 No Action impact + $458,000 Low Alternative impact. The figures are displayed in this manner to facilitate comparison with Table 4-33.

Since all Wyoming tracts are included in each alternative, the impact figures are shown once in order to save space. For the same reason, impact figures of the medium, high and maximum alternatives are combined for Oak Creek, Steamboat Springs, and Yampa and their school districts.

Because most of the population impacts were projected to occur in the communities, capital requirements were not calculated for the counties. It is recognized that some increase in county capital requirements would occur. However, the fact that mine property taxes and assessed valuations would accrue to the counties makes it reasonable to assume that their capital resources would not be significantly strained by the new federal leasing.

Source: BLM estimates.

1/ Percent increase is not meaningful. Comparison of the amounts gives a better measure of the impacts.

TABLE 4-36

POPULATION GROWTH RATES, 1978 TO 1987 AND 1990
FOR BASELINE AND ALL ALTERNATIVES

Town	1978 Population	Percent Growth 1978-87	Percent Growth 1978-90	Alternative
Craig	7,715	8.8	7.3	Baseline (No Action)
		9.3	7.8	Low
		9.5	8.0	Medium
		10.2	8.7	High
		10.5	9.1	Maximum
Hayden	1,548	5.7	4.7	Baseline
		6.1	5.0	Low
		6.7	5.9	Medium
		7.2	6.5	High
		7.5	6.9	Maximum
Steamboat Springs	4,780	9.2	7.8	Baseline
		9.2	7.8	Low
		9.3	7.9	Medium
		9.3	7.9	High
		9.3	7.9	Maximum
Oak Creek	792	4.6	3.9	Baseline
		4.6	3.9	Low
		4.8	4.1	Medium
		4.8	4.1	High
		4.8	4.1	Maximum
Yampa	312	.9	.7	Baseline
		.9	.7	Low
		1.1	1.0	Medium
		1.1	1.0	High
		1.1	1.0	Maximum
Meeker	2,976	13.9	9.4	Baseline
		14.4	9.9	Low
		14.4	9.9	Medium
		14.8	10.3	High
		14.8	10.3	Maximum
Baggs	396	1.4	1.2	Baseline
		3.0	2.3	All
Dixon	68	1.4	1.3	Baseline
		3.8	2.9	All
Elk Mountain	239	1.4	1.2	Baseline
		1.7	1.4	All
Elmo/Hanna	2,376	1.3	1.1	Baseline
		2.0	1.6	All
Encampment/Riverside	767	1.3	1.1	Baseline
		1.9	1.5	
Rawlins	13,494	1.3	1.1	Baseline
		2.3	1.8	All
Medicine Bow	1,487	1.3	1.1	Baseline
		1.8	1.4	All
Saratoga	2,700	1.3	1.1	Baseline
		1.8	1.5	All
Walcott Junction	140	1.4	1.1	Baseline
		4.1	3.2	All
Creston Junction	35	2.0	1.7	Baseline
		9.2	6.9	All
Rock River	450	1.3	1.1	Baseline
		1.8	1.4	All
Wamsutter	463	1.3	1.1	Baseline
		2.2	1.7	All

Sources: Tables 3-9 and 4-28.

Note: Growth rates are annual rates and were calculated by the use of logarithms:
1987 population divided by 1978 population = total growth ratio
Log of total growth ratio divided by number of years = log of annual growth rate.
Antilog of annual growth ratio x 100 = annual growth rate

TABLE 4-37, Part 1

COMMUNITY SERVICES THRESHOLDS - TRENDED ENVIRONMENT BASELINE

SERVICE	BASELINE YEAR BY WHICH 1978 CAPACITY EXCEEDED																					
	COLORADO									WYOMING												
	Communities						Counties			Counties		Communities										
	Craig	Hayden	Stmbt Sprgs	Oak Crk	Ympa	Mekr	Mfft	Rout	RioBln	Albny	Crbon	Rock Rvr	Bggs	Dixn	Rwlns	Elk Mtn	Elmo Hnna	Encmt Rvrsd	Medn Bow	Srtga	Wlct Jnct	Crst Jct	Wmstr
Hospital Beds							a 87	87	e --	--	--												
Fire Pumpg Cap	87	--	87	--	87	87						87	--	--	--	87	87	87	87	87	d 87	d 87	--
Watr Systm Cap	a --	--	--	b --	--	--						a,b --	--	--	a,b --	a 87	b 95	a,b --	--	b --	87	87	--
Sewr Systm Cap	a 87	--	--	--	--	87						a 87	--	--	a 87	b 87	a --	b 87	--	a,b --	87	87	a,b --
Landfill Cap	a 87	a 87	a 87	--	--	90						c	c	c	c	c	c	c	c	c	c	c	c
School Clssrms	87	90	a 87	b 90	b 90	a 87						a 87	Carbon Dist. #1 a --			Carbon Dist. #2 a --							

Note: Baseline growth estimates were computed from 1978 to 1987 (construction phase); 1990 (full operational phase); and 1995 (continuing operations phase), the three pivotal years for this EIS area. Thus, an entry of "87" in the table indicates that 1978 service capacity will already have been exceeded by the time impact from the proposed EIS alternatives begin. Century digits are omitted for all year dates: "87" = 1987, and so on. Baseline growth estimates are shown in table B-3, Appendix B, upon which this table is based.

a) Planning for expansion is at some stage. See Site Specifics, on file in Craig District Office of BLM.
b) Special problems exist (such as need for repairs or replacement of portions of system, or system does not meet EPA requirements); see Site Specifics, on file in Craig District Office of BLM.
c) No capacity given, so impossible to compute threshold date.
d) Walcott Junction and Creston Junction are not incorporated and have no municipal government at the present time. They are included because projected populations are expected to locate there and services will be needed in the future.
e) Dash (--) indicates that capacity is not exceeded by baseline growth prior to 1995.

TABLE 4-37, Part 2

COMMUNITY SERVICES THRESHOLDS - LOW ALTERNATIVE

SERVICE	BASELINE YEAR BY WHICH 1978 CAPACITY EXCEEDED																					
	COLORADO									WYOMING												
	Communities						Counties			Counties		Communities										
	Craig	Hayden	Stmbt Sprgs	Oak Crk	Ympa	Mekr	Mfft	Rout	RioBln	Albny	Crbon	Rock Rvr	Bggs	Dixn	Rwlns	Elk Mtn	Elmo Hnna	Encmt Rvrsd	Medn Bow	Srtga	Wlct Jnct	Crst Jct	Wmstr
Hospital Beds							87_/ /	87_/ /	--		--												
Fire Pumpg Cap	87_/ /	--				87_/ /						87_/ /	--	--	--	87_/ /	87_/ /	87_/ /	87_/ /	87_/ /	87_/ /	87_/ /	
Watr Systm Cap	--	--				--											87_/ /				87_/ /	87_/ /	
Sewr Systm Cap	87_/ /	--				87_/ /									87_/ /								
Landfill Cap	87_/ /	87_/ /				90_/ /						a	a	a	a	a	a	a	a	a	a	a	a
School Clssrms	87_/ /	90_/ /				87_/ /						87_/ /	(Carbn Dist #1) --			(Carbon Dist #2) 95							--

Note: Empty cells indicate no impact on community/county by this alternative. All century digits omitted for all year dates: "87" = 1987, etc. Diagonal below date indicates that baseline growth will have caused capacity to be exceeded already, so impact from this alternative will be additional to an already-exceeded capacity. Year date alone indicates that impact from this alternative will cause capacity to be exceeded when added onto baseline growth. Thus, for the low alternative only two instances occur (Rawlins sewer, Carbon Dist #2 schools) in which the EIS area impact will be the factor overloading the services delivery system.

a) No 1978 capacity given, so impossible to compute thresholds; however, this alternative does impact landfill use in all Wyoming communities shown.

b) Dash (--) indicates that this alternative affects this facility, but does not exceed capacity by 1995.

TABLE 4-37, Part 3

COMMUNITY SERVICES THRESHOLDS - COLORADO - MID, HIGH, MAXIMUM ALTERNATIVES
Baseline Year By Which 1978 Capacity Exceeded

SERVICE	MID-LEVEL ALTERNATIVE								
	COLORADO								
	Communities						Counties		
	Craig	Hayden	Steambt Springs	Oak Creek	Yampa	Meeker	Moffat	Routt	RioBlanco
Hospital Beds							87/	87/	--
Fire Pumpg Cap	87/	--	87/	--	87/	87/			
Watr Systm Cap	--	--	95	--		--			
Sewr Systm Cap	87/	--	--			87/			
Landfill Cap	87/	87/		--	--	90/			
School Clssrms	87/	90/	87/	90/	90/	87/			

SERVICE	HIGH LEVEL ALTERNATIVE								
	Colorado								
	Communities						Counties		
	Craig	Hayden	Steambt Springs	Oak Creek	Yampa	Meeker	Moffat	Routt	RioBlanco
Hospital Beds							87/	87/	--
Fire Pumpg Cap	87/	--	87/	--	87/	87/			
Watr Systm Cap	--	90	95		--				
Sewr Systm Cap	87/	--	--			87/			
Landfill Cap	87/	87/	87/	--	--	90/			
School Clssrms	87/	90/	87/	90/	90/	87/			

SERVICE	MAXIMUM LEVEL ALTERNATIVE								
	COLORADO								
	Communities						Counties		
	Craig	Hayden	Steambt Springs	Oak Creek	Yampa	Meeker	Moffat	Routt	RioBlanco
Hospital Beds							87/	87/	--
Fire Pumpg Cap	87/	--	87/	--	87/	87/			
Watr Systm Cap	--	90	95	--		--			
Sewr Systm Cap	87/	--	--			87/			
Landfill Cap	87/	87/	87/	--	--	90/			
School Clssrms	87/	90/	87/	90/	90/	87/			

Note: All century digits omitted for all year dates: "87" = 1987, etc. Empty cells indicate no impact on community/county by this alternative. Diagonal below date indicates that baseline growth will have caused capacity to be exceeded already, so impact from this alternative will be additional to an already-exceeded capacity. Year date alone indicates that impact from this alternative, when added onto baseline growth will cause capacity to be exceeded.

Note: All three of these alternatives include impacts from the five Wyoming tracts as shown in Table 4 E, Part A. Wyoming impacts are not repeated here.

Source: BLM estimates.

TABLE 4-38

HOUSING SUPPLY AND NEEDS 1978-95, BY ALTERNATIVES

Town	1978 Housing Supply	Alternative	Add'l. Needed 1978-87	Add'l. Needed 1987-90	Add'l. Needed 1990-95
Craig	3,170	Baseline	2,818	558	84
		Low	238	288	--
		Medium	75	149	--
		High	377	436	--
		Maximum	129	329	--
Hayden	497	Baseline	365	47	6
		Low	25	31	--
		Medium	49	99	--
		High	45	66	--
		Maximum	22	52	--
Steamboat Springs	2,577	Baseline	1,052	419	81
		Low	--	--	--
		Medium	34	66	--
		High	--	--	--
		Maximum	--	--	--
Oak Creek	479	Baseline	--	--	--
		Low	--	--	--
		Medium	7	13	--
		High	--	--	--
		Maximum	--	--	--
Yampa	150	Baseline	--	--	--
		Low	--	--	--
		Medium	2	3	--
		High	--	--	--
		Maximum	--	--	--
Meeker	774	Baseline	2,560	--	--
		Low	118	150	--
		Medium	--	--	--
		High	232	307	--
		Maximum	--	--	--
Baggs	132	Baseline	15	2	5
		All	22	22	23
Dixon	45	Baseline	--	--	--
		All	6	6	6
Elk Mountain	100	Baseline	--	--	--
		All	3	2	2
Elmo/Hanna	619	Baseline	258	13	34
		All	50	46	47
Encampment/Riverside	248	Baseline	35	4	11
		All	14	13	13
Rawlins	3,428	Baseline	1,552	76	194
		All	450	433	443
Medicine Bow	255	Baseline	294	8	21
		All	23	21	21
Saratoga	845	Baseline	151	15	39
		All	45	41	41
Walcott Junction	30	Baseline	22	--	2
		All	14	14	15
Creston Junction	4	Baseline	10	--	--
		All	11	11	12
Rock River	150	Baseline	16	2	7
		All	7	6	6
Wamsutter	130	Baseline	40	3	7
		All	14	13	13

SOCIAL-ECONOMIC IMPACT MATRIX
(NUMBER OF COUNTIES, COMMUNITIES, AND SCHOOL DISTRICTS IMPACTED)

Subject and Alternative	Significance Level: Low	Moderate	High
Population Growth			
Number of counties and communities incurring impacts (both beneficial and adverse)			
Low	18	1	3
Medium	17	2	3
High	14	4	4
Maximum	14	3	5
Income Growth			
Number of counties incurring beneficial impacts			
Low	4	0	0
Medium	4	0	0
High	3	1	0
Maximum	3	0	1
Capital Expenditure Requirements			
Number of communities and school districts (by county) incurring adverse impacts			
Low	12	3	10
Medium	11	3	11
High	10	3	12
Maximum	10	3	12
Community Social Structures			
Number of communities incurring impacts (both beneifical and adverse)			
Low	13	4	1
Medium	13	4	1
High	13	3	2
Maximum	13	3	2
Personal Social Adjustments			
Number of communities incurring adverse impacts			
Low	13	4	1
Medium	13	4	1
High	13	3	2
Maximum	13	3	2

Significance Criteria: Percent Change from No Action Alternative

Population Growth	0% - 9%	10% - 19%	20% or more
Income Growth	0% - 9%	10% - 19%	20% or more
Capital Expenditure Requirements (or fiscal deficit)	0% - 9%	10% - 19%	20% or more
Community Social Structures (based on population growth)	0% - 4%	5% - 9%	10% or more
Personal Social Adjustments (based on population growth)	0% - 4%	5% - 9%	10% or more

TABLE 4-40

TRAFFIC INCREASES
MOVEMENTS PER DAY

Town	Alternative			
	Low	Medium	High	Maximum
Craig	1,440	2,200	4,350	6,000
Hayden	150	650	1,000	1,250
Meeker	750	750	2,300	2,300
Hanna/Elmo	250	250	250	250
Rawlins	2,150	2,150	2,150	2,150

TABLE 4-41 LOW ALTERNATIVE

INCREASED TRAFFIC AND VOLUME TO CAPACITY RATIOS FOR COLORADO ROAD SEGMENTS

Segmnt	1987 ADT	1990 ADT	1995 ADT	Increasd PHT 1987	Increasd PHT 1990	Increasd PHT 1995	Total PHT 1987	Total PHT 1990	Total PHT 1995	Capacity Vol @ Svc Level C	PHT Cap. 1987	PHT Cap. 1990	PHT Cap. 1995
A	1,750	1,850	2,000	--	--	--	--	--	--	--	--	--	--
B	4,450	4,900	5,100	2	6	6	602	632	684	680	.89	.93	1.01
C	4,200	4,450	4,800	--	--	--	--	--	--	--	--	--	--
D	3,500	3,700	3,400	16	54	54	550	534	485	790	.70	.68	.61
E	3,550	3,650	3,350	25	84	84	584	556	508	790	.74	.70	.64
F	3,100	3,100	3,100	9	30	30	454	430	382	760	.60	.57	.50
G	1,500	1,600	2,300	--	--	--	--	--	--	--	--	--	--
H	900	950	1,100	--	--	--	--	--	--	--	--	--	--
I	200	250	250	--	--	--	--	--	--	--	--	--	--
J	500	550	650	--	--	--	--	--	--	--	--	--	--
K	1,950	2,000	2,200	--	--	--	--	--	--	--	--	--	--

ADT--Average Daily Traffic
PHT--Peak Hour Traffic

TABLE 4-42

INCREASED TRAFFIC AND VOLUME TO CAPACITY RATIOS FOR WYOMING ROAD SEGMENTS
LOW, MEDIUM, PREFERRED OR HIGH ALTERNATIVES

Segmnt	1987 ADT	1990 ADT	1995 ADT	Increasd PHT 1987	Increasd PHT 1990	Increasd PHT 1995	Total PHT 1987	Total PHT 1990	Total PHT 1995	Capacity Vol @ Svc Level C	PHT Cap. 1987	PHT Cap. 1990	PHT Cap. 1995
A	8,700	9,450	10,600	60	63	63	1,050	1,138	1,275	2,470	.43	.46	.52
B	10,650	11,800	13,300	30	34	34	1,224	1,354	1,534	1,950	.63	.69	.79
C	2,100	2,450	2,850	72	76	76	289	323	376	700	.41	.46	.54
D	--	--	--	--	--	--	357	397	462	790	.45	.50	.58
E	2,150	2,450	2,850	7	9	9	267	302	353	860	.31	.35	.41
F	2,350	2,500	2,750	16	19	19	307	334	376	790	.39	.42	.48
G	--	--	--	3	4	4	173	188	206	820	.21	.23	.25
H	--	--	--	--	--	--	97	112	138	650	.15	.17	.21

ADT--Average Daily Traffic
PHT--Peak Hour Traffic

TABLE 4-43 MEDIUM ALTERNATIVE

INCREASED TRAFFIC AND VOLUME TO CAPACITY RATIOS FOR COLORADO ROAD SEGMENTS

Segmnt	1987 ADT	1990 ADT	1995 ADT	Increasd PHT 1987	Increasd PHT 1990	Increasd PHT 1995	Total PHT 1987	Total PHT 1990	Total PHT 1995	Capacity Vol @ Svc Level C	PHT Cap. 1987	PHT Cap. 1990	PHT Cap. 1995
A	1,750	1,900	2,050	--	--	--	290	306	332	910	.27	.32	.34
B	4,350	5,100	5,450	8	38	38	608	668	720	680	.89	.98	1.06
C	4,250	4,650	5,200	3	17	17	603	647	699	680	.89	.95	1.03
D	3,550	3,900	3,600	16	54	54	550	534	486	790	.70	.68	.62
E	3,600	4,050	3,750	25	84	84	521	556	508	790	.66	.70	.64
F	3,050	3,300	3,000	9	30	30	433	430	382	760	.57	.57	.51
G	1,500	1,600	1,750	--	--	--	--	--	--	--	--	--	--
H	900	950	1,050	--	--	--	--	--	--	--	--	--	--
I	200	225	250	--	--	--	--	--	--	--	--	--	--
J	500	550	650	--	--	--	--	--	--	--	--	--	--
K	1,950	2,050	2,200	--	--	--	--	--	--	--	--	--	--

ADT--Average Daily Traffic
PHT--Peak Hour Traffic

TABLE 4-44 HIGH ALTERNATIVE

INCREASED TRAFFIC AND VOLUME TO CAPACITY RATIOS FOR COLORADO ROAD SEGMENTS

Segmnt	1987 ADT	1990 ADT	1995 ADT	Increasd PHT 1987	Increasd PHT 1990	Increasd PHT 1995	Total PHT 1987	Total PHT 1990	Total PHT 1995	Capacity Vol @ Svc Level C	PHT Cap. 1987	PHT Cap. 1990	PHT Cap. 1995
A	2,300	2,400	2,550	17	69	69	612	681	733	910	.90	1.00	1.08
B	4,530	5,750	6,100	12	51	51	537	599	689	680	.79	.88	1.01
C	5,200	5,400	5,750	3	17	17	603	647	699	680	.89	.95	1.03
D	5,000	4,900	4,600	31	108	108	427	588	540	790	.54	.74	.68
E	5,350	5,200	4,900	49	168	168	445	640	592	790	.56	.81	.75
F	4,250	4,100	3,800	18	60	60	442	460	412	760	.58	.61	.54
G	1,600	1,700	1,850	--	--	--	--	--	--	--	--	--	--
H	950	1,000	1,100	--	--	--	--	--	--	--	--	--	--
I	200	225	250	--	--	--	--	--	--	--	--	--	--
J	550	600	700	--	--	--	--	--	--	--	--	--	--
K	1,900	2,150	2,300	--	--	--	--	--	--	--	--	--	--

ADT--Average Daily Traffic
PHT--Peak Hour Traffic

TABLE 4-45 MAXIMUM ALTERNATIVE

INCREASED TRAFFIC AND VOLUME TO CAPACITY RATIOS FOR COLORADO ROAD SEGMENTS

Segmnt	1987 ADT	1990 ADT	1995 ADT	Increasd PHT 1987	Increasd PHT 1990	Increasd PHT 1995	Total PHT 1987	Total PHT 1990	Total PHT 1995	Capacity Vol @ Svc Level C	PHT Cap. 1987	PHT Cap. 1990	PHT Cap. 1995
A	1,750	2,350	2,450	17	70	70	307	376	402	910	.34	.41	.44
B	5,050	6,200	6,550	18	57	57	618	687	759	680	.91	1.01	1.16
C	4,800	5,300	5,850	3	18	18	603	648	700	680	.89	.95	1.03
D	4,400	5,700	5,400	37	155	155	533	635	587	790	.67	.80	.74
E	4,450	5,750	5,450	48	168	168	544	640	592	790	.69	.81	.75
F	3,850	4,650	4,350	18	60	60	442	460	412	760	.58	.61	.54
G	1,600	1,750	1,900	--	--	--	218	233	255	760	.29	.31	.34
H	1,050	1,100	1,250	--	--	--	180	190	210	740	.24	.26	.28
I	160	230	250	--	--	--	40	45	50	640	.06	.07	.08
J	530	600	700	--	--	--	100	110	130	600	.16	.18	.22
K	2,050	2,200	2,400	--	--	--	323	340	366	680	.48	.50	.54

ADT--Average Daily Traffic
PHT--Peak Hour Traffic

TABLE 4-46 LOW ALTERNATIVE

PROJECTED INCREASED TRAFFIC ACCIDENTS FOR COLORADO

Segmnt	Segment Length	Increasd ADT 1987	Increasd ADT 1990	Increasd ADT 1995	Accident Rate	Increasd Accident 1987	Increasd Accident 1990	Increasd Accident 1995
A	30.4	50	50	50	2.15	1	1	1
B	15.1	250	300	300	9.2	13	15	15
C	13.2	200	250	250	4.45	4	5	5
D	18.2	400	700	700	5.40	14	25	25
E	12.1	450	900	900	5.41	11	21	21
F	16.2	350	600	600	7.73	16	27	27
G	36.7	50	50	50	3.29	2	2	2
H	9.4	0	0	0	9.74	--	--	--
I	12.1	0	0	0	8.79	--	--	--
J	60.8	0	0	0	3.38	--	--	--
K	59.1	50	50	50	1.40	2	2	2

ADT--Average Daily Traffic

TABLE 4-47

LOW, MEDIUM, PREFERRED AND MAXIMUM ALTERNATIVES
PROJECTED INCREASED TRAFFIC ACCIDENTS FOR WYOMING

Segmnt	Segment Length	Increasd ADT 1987	Increasd ADT 1990	Increasd ADT 1995	Accident Rate	Increasd Accident 1987	Increasd Accident 1990	Increasd Accident 1995
A	38.4	450	500	500	1.31	8	9	9
B	51.4	700	800	800	1.02	14	15	15
C	53.2	450	550	550	1.12	10	12	12
D	57.0	--	--	--	1.41	--	--	--
E	38.2	150	200	200	1.85	4	5	5
F	17.6	250	250	250	4.07	7	7	7
G	18.43	--	--	--	2.50	--	--	--
H	15.97	--	--	--	26.40	--	--	--

ADT--Average Daily Traffic

TABLE 4-48 MEDIUM ALTERNATIVE 18% INCREASE

PROJECTED INCREASED TRAFFIC ACCIDENTS FOR COLORADO

Segmnt	Segment Length	Increasd ADT 1987	Increasd ADT 1990	Increasd ADT 1995	Accident Rate	Increasd Accident 1987	Increasd Accident 1990	Increasd Accident 1995
A	30.4	50	100	100	2.15	1	2	2
B	15.1	350	900	900	9.2	18	46	46
C	13.2	250	650	650	4.45	5	14	14
D	18.2	450	900	900	5.40	16	31	31
E	12.1	500	1,100	1,100	5.41	12	26	26
F	16.2	400	800	800	7.73	18	36	36
G	36.7	50	50	50	3.29	2	2	2
H	9.4	0	0	0	9.74	--	--	--
I	12.1	0	0	0	8.79	--	--	--
J	60.8	0	0	0	3.38	--	--	--
K	59.1	50	50	50	1.40	2	2	2

ADT--Average Daily Traffic

TABLE 4-49 HIGH ALTERNATIVE 40% INCREASE

PROJECTED INCREASED TRAFFIC ACCIDENTS FOR COLORADO

Segmnt	Segment Length	Increasd ADT 1987	Increasd ADT 1990	Increasd ADT 1995	Accident Rate	Increasd Accident 1987	Increasd Accident 1990	Increasd Accident 1995
A	30.4	250	600	600	2.15	6	14	14
B	15.1	800	1,550	1,550	9.2	41	79	79
C	13.2	650	1,200	1,200	4.45	14	26	26
D	18.2	1,150	1,900	1,900	5.40	41	68	68
E	12.1	1,250	2,250	2,250	5.41	30	54	54
F	16.2	1,050	1,600	1,600	7.73	48	73	73
G	36.7	100	150	150	3.29	4	7	7
H	9.4	0	50	50	9.74	0	2	2
I	12.1	0	0	0	8.79	--	--	--
J	60.8	50	50	50	3.38	4	4	4
K	59.1	100	150	150	1.40	3	5	5

ADT--Average Daily Traffic

TABLE 4-50 MAXIMUM ALTERNATIVE 45% INCREASE

PROJECTED INCREASED TRAFFIC ACCIDENTS FOR COLORADO

Segmnt	Segment Length	Increasd ADT 1987	Increasd ADT 1990	Increasd ADT 1995	Accident Rate	Increasd Accident 1987	Increasd Accident 1990	Increasd Accident 1995
A	30.4	275	650	650	2.15	7	16	16
B	15.1	1,050	2,000	2,000	9.20	53	101	101
C	13.2	800	1,300	1,300	4.45	17	28	28
D	18.2	1,300	2,700	2,700	5.40	47	97	97
E	12.1	1,350	2,800	2,800	5.41	32	67	67
F	16.2	1,200	2,150	2,150	7.73	55	98	98
G	36.7	150	200	200	3.29	7	9	9
H	9.4	150	200	200	9.74	5	7	7
I	12.1	20	30	30	8.79	1	1	1
J	60.8	30	50	50	3.38	2	2	2
K	59.1	150	220	220	1.40	5	7	7

ADT--Average Daily Traffic

COLORADO AT-GRADE CROSSINGS

Rural At-Grade Crossings

National Crossing Number	Exposure Factor		Hazard Rating (in accidents per 5 years)	
	1990	1995	1990	1995
253-690(C)	78,100	102,000	7.52	8.80
253-678(U)	78,100	102,000	7.52	8.80
253-679(C)	78,100	102,000	7.52	8.80
253-621(U)	14,400	16,900	.81	.83
253-614(J)	14,400	16,900	.81	.83
253-302(B)	33,000	40,250	1.01	1.02

Urban At-Grade Crossings

National Crossing Number	Exposure Factor		Hazard Rating (in accidents per 5 years)	
	1990	1995	1990	1995
253-288(H)	377,850	425,250	14,60	15.32
253-297(R)	264,000	320,250	13,26	13.91
253-284(F)	297,000	339,500	13.91	13.91
253-285(M)	219,450	246,750	11.52	12.65
253-294(L)	165,000	192,500	11.12	11.42
253-282(S)	209,250	258,500	11.17	12.65
253-290(J)	173,400	210,600	11.12	11.42
253-293(E)	175,100	201,600	11.12	11.42
253-295(T)	83,300	93,600	7.90	8.05
253-281(K)	431,200	503,700	13.91	15.32
253-279(J)	341,700	378,000	15.32	15.32

TABLE 4-52 MEDIUM ALTERNATIVE

COLORADO AT-GRADE CROSSINGS

Rural At-Grade Crossings

National Crossing Number	Exposure Factor		Hazard Rating (in accidents per 5 years)	
	1990	1995	1990	1995
253-690(C)	88,750	114,750	7.90	9.28
253-678(U)	88,750	114,750	7.90	9.28
253-679(C)	88,750	114,750	7.90	9.28
253-621(U)	16,200	18,850	.84	.86
253-614(J)	16,200	18,850	.84	.86
253-302(B)	36,000	44,850	1.02	1.03

Urban At-Grade Crossings

National Crossing Number	Exposure Factor		Hazard Rating (in accidents per 5 years)	
	1990	1995	1990	1995
253-288(H)	389,300	449,550	15.32	15.32
253-297(R)	272,000	338,550	13,26	14.60
253-284(F)	306,000	358,900	13.91	14.60
253-285(M)	226,100	260,850	12.07	13.26
253-294(L)	170,000	203,500	11.27	11.52
253-282(S)	218,550	269,500	11.32	12.65
253-290(J)	183,600	222,300	11.27	11.52
253-293(E)	185,400	212,800	11.27	11.52
253-295(T)	88,200	98,800	8.05	8.21
253-281(K)	450,800	525,600	13.91	15.32
253-279(J)	361,800	399,000	15.32	15.32

TABLE 4-53 HIGH ALTERNATIVE

COLORADO AT-GRADE CROSSINGS

Rural At-Grade Crossings

National Crossing Number	Exposure Factor		Hazard Rating (in accidents per 5 years)	
	1990	1995	1990	1995
253-690(C)	102,950	131,750	8.84	9.86
253-678(U)	102,950	131,750	8.48	9.86
253-679(C)	102,950	131,750	8.48	9.86
253-621(U)	18.600	21,450	.86	.88
253-614(J)	18,600	21,450	.86	.88
253-302(B)	40,000	48,300	1.04	1.06

Urban At-Grade Crossings

National Crossing Number	Exposure Factor		Hazard Rating (in accidents per 5 years)	
	1990	1995	1990	1995
253-288(H)	458,000	510,300	15.32	15.32
253-297(R)	320,000	384,300	13,91	14.60
253-284(F)	360,000	407,400	14.60	14.60
253-285(M)	266,000	296,100	12.65	13.26
253-294(L)	200,000	231,000	11.52	12.07
253-282(S)	241,800	251,100	11.52	12.65
253-290(J)	209,100	219,300	11.52	12.07
253-293(E)	211,150	221,450	11.52	12.07
253-295(T)	100,450	105,350	8.32	8.43
253-281(K)	499,800	519,400	14.60	15.32
253-279(J)	412,050	451,500	15.32	15.32

TABLE 4-54 MAXIMUM ALTERNATIVE

COLORADO AT-GRADE CROSSINGS

Rural At-Grade Crossings

National Crossing Number	Exposure Factor		Hazard Rating (in accidents per 5 years)	
	1990	1995	1990	1995
253-690(C)	113,600	144,500	8.91	10.29
253-678(U)	113,600	144,500	8.91	10.29
253-679(C)	113,600	144,500	8.91	10.29
253-621(U)	18,700	23,400	.85	.89
253-614(J)	18,700	23,400	.85	.89
253-302(B)	43,000	51,570	1.07	1.08

Urban At-Grade Crossings

National Crossing Number	Exposure Factor		Hazard Rating (in accidents per 5 years)	
	1990	1995	1990	1995
253-288(H)	492,350	546,750	15.32	15.32
253-297(R)	344,000	411,750	14.60	15.32
253-284(F)	387,000	436,500	15.32	15.32
253-285(M)	285,950	317,250	12.65	13.91
253-294(L)	215,000	247,500	12.07	12.07
253-282(S)	255,750	313,500	12.07	13.26
253-290(J)	224,400	269,100	12.07	12.07
253-293(E)	226,600	257,600	12.07	12,07
253-295(T)	107,800	119,600	8,58	8.69
253-281(K)	529,200	503,700	15.32	15.32
253-279(J)	442,200	483,000	15.32	15.32

TABLE 4-55

LAND USE IMPACTS BY ALTERNATIVE OF THE NEW FEDERAL COAL DEVELOPMENT 1/

Item	No 2/ Action	Low Altern.	Medium Altern.	High Altern.	Maximum Altern.
Oil and Gas Leases	0	60	69	114	134
Roads (Miles)	0	6.5	6.5	6.5	6.5
Railroads (Miles)	0	12	12	12	12
Telephone line (Miles)	0	9.5	9.5	9.5	9.5
Power line (Miles)	0	8.5	8.5	12.5	17.5
Stockwater Reservoir (#)	0	26	31	36	47
Fence (Miles)	0	14.5	14.5	14.5	14.5
Pipelines (Miles)	0	5	5	6.5	6.5
Withdrawal (Acres)	0	1,629	1,629	1,629	2,186
Water Wells (Number)	0	11	13	13	14
Springs (Number)	0	3	3	3	9

1/ Impacts are by mine life since it is not possible to determine impacts by time frames without a detailed mine plan.
2/ Impacts from No Action are impossible to evaluate on a cumulative basis in relationship to a trended baseline.

TABLE 4-56

REMOVAL OF ANIMAL UNIT MONTHS

Item	No Action	Low Altern.	Medium Altern.	High Altern.	Maximum Altern.
1987					
Animal unit months lost because of development of new Federal coal	0	10,939	12,393	13,866	15,913
Cumulative animal unit months lost	4,984	15,923	17,377	18,850	20,897
1990					
Animal unit months lost because of development of new Federal coal	0	43,822	49,650	55,554	63,766
Cumulative animal unit months lost	20,772	64,594	70,422	76,326	84,538
1995					
Animal unit months lost because of development of new Federal coal	0	98,847	112,005	125,334	143,901
Cumulative animal unit months lost	50,857	149,704	162,862	176,191	194,758

TABLE 4-57

IMPACTS TO SECTIONS 3 & 15
ALLOTMENT WITH PERCENT OF EACH TYPE LOST

Item	No Action	Low Altern.	Medium Altern.	High Altern.	Maximum Altern.
Number of Section 3 allotments affected	0	14	14	15	16
Percent of Section 3 allotments removed	0	9.6	9.6	9.8	10.0
Number of Section 15 allotments affected	0	4	7	14	21
Percent of Section 15 allotments removed	0	23.0	20.0	17.7	20.6

TABLE 4-58, Part 1

ECONOMIC LOSSES RESULTING FROM CONVERSION OF GRAZING LAND - 1987

Number of Ranches	Type of Ranch	Total AUM Loss	Average AUM Loss per Ranch	Gross Income Loss per Ranch	Net Income Loss per Ranch 1/	Gross Income Losses All Ranches	Net Income Losses All Ranches	Secondary Income Losses	Total Primary and Secondary Income Losses 2/	Federal Grazing Feet Lost 3/	Loss in Hired Employment (man-years)
					Low Alternative						
19	Large cattle and sheep	10,939	576	20,851	5,748	396,000	109,000	567,000	936,000	26,000	6.1
					Medium Alternative						
22	Large cattle and sheep	12,393	563	20,381	5,619	448,000	124,000	642,000	1,090,000	29,000	6.9
					High Alternative						
28	Large cattle and sheep	13,812	493	17,487	4,920	500,000	138,000	716,000	1,216,000	33,000	7.7
1	Small cattle	54	54	1,579	- 544	2,000	- 1,000	4/	2,000	4/	0
	Total					502,000	137,000	716,000	1,218,000	33,000	7.7
					Maximum Alternative						
34	Large cattle and sheep	15,784	464	16,797	4,631	571,000	157,000	817,000	1,388,000	37,000	8.8
4	Small cattle	129	32	936	- 323	4,000	- 1,000	2,000	6,000	4/	0.1
	Total	15,913	496	17,733	4,308	575,000	156,000	819,000	1,394,000		8.9

TABLE 4-58, Part 2

ECONOMIC LOSSES RESULTING FROM CONVERSION OF GRAZING LAND - 1990

Number of Ranches	Type of Ranch	Total AUM Loss	Average AUM Loss per Ranch	Gross Income Loss per Ranch	Net Income Loss per Ranch 1/	Gross Income Losses All Ranches	Net Income Losses All Ranches	Secondary Income Losses	Total Primary and Secondary Income Losses 2/	Federal Grazing Feet Lost 3/	Loss in Hired Employment (man-years)
					Low Alternative						
19	Large cattle and sheep	43,822	2,306	83,477	23,014	1,586,000	437,000	2,270,000	3,856,000	103,000	24.5
					Medium Alternative						
22	Large cattle and sheep	49,650	2,257	81,703	22,525	1,797,000	496,000	2,573,000	4,370,000	117,000	27.7
					High Alternative						
28	Large cattle and sheep	55,338	1,976	71,531	19,720	2,003,000	552,000	2,867,000	4,870,000	131,000	30.9
1	Small cattle	216	216	6,316	- 2,177	6,000	- 2,000	2,000	8,000	1,000	0.1
	Total					2,009,000	550,000	2,869,000	4,878,000	132,000	31.0
					Maximum Alternative						
34	Large cattle and sheep	63,250	1,860	67,332	18,563	2,289,000	631,000	3,276,000	5,565,000	149,000	35.3
4	Small cattle	516	129	3,772	- 1,300	15,000	- 5,000	6,000	21,000	1,000	0.2
	Total					2,304,000	626,000	3,282,000	5,586,000	150,000	35.5

TABLE 4-58, Part 3

ECONOMIC LOSSES RESULTING FROM CONVERSION OF GRAZING LAND - 1995

Number of Ranches	Type of Ranch	Total AUM Loss	Average AUM Loss per Ranch	Gross Income Loss per Ranch	Net Income Loss per Ranch 1/	Gross Income Losses All Ranches	Net Income Losses All Ranches	Secondary Income Losses	Total Primary and Secondary Income Losses 2/	Federal Grazing Feet Lost 3/	Loss in Hired Employment (man-years)
					Low Alternative						
19	Large cattle and sheep	98,847	5,202	188,312	51,916	3,578,000	986,000	5,121,000	8,699,000	233,000	55.2
					Medium Alternative						
22	Large cattle and sheep	112,005	5,091	184,294	50,808	4,054,000	1,118,000	5,804,000	9,858,000	264,000	62.5
					High Alternative						
28	Large cattle and sheep	124,848	4,459	161,416	44,501	4,520,000	1,246,000	6,650,000	11,170,000	295,000	69.7
1	Small cattle	486	486	14,211	- 4,899	14,000	- 5,000	5,000	19,000	1,000	0.2
	Total					4,534,000	1,241,000	6,655,000	11,189,000	296,000	69.9
					Maximum Alternative						
34	Large cattle and sheep	142,740	4,198	151,968	41,896	5,167,000	1,424,000	7,395,000	12,562,000	337,000	79.7
4	Small cattle	1,161	290	936	8,480	- 2,923	34,000	- 12,000	46,000	3,000	0.5
						5,201,000	1,412,000	7,407,000	12,608,000	340,000	80.2

1/ Because the average small cattle ranch surveyed had negative net income, a drop in AUM's would have the effect of reducing the loss.
2/ Sum of gross income losses and secondary income losses. Net income losses are included in gross income losses.
3/ Based on 1980 fee of $2.36 per AUM
4/ Less than $500.

NOTE: Oata for alternatives are cumulative. Each higher alternative includes all lower ones. Likewise, the figures for each time point are cumulative totals for the period since 1987.

Sources:
BLM grazing files.
Bartlett, E. T., R. G. Taylor, and J. R. McKean. Impacts of Federal Grazing on the Economy of Colorado. Fort Collins, Colorado State University 1979.

TABLE 4-59

CUMULATIVE COMMUNITY EXPANSION - ACRES CONVERTED TO URBAN USES TO SUPPORT POPULATION INCREASES ABOVE 1978 LEVEL 1/

	Alternative														
	No Action			Low			Medium			High			Maximum		
	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995
Carbon County 2/	314	356	464	513	545	656	513	545	656	513	545	656	513	545	656
Rawlins	173	196	256	311	329	391	311	329	391	311	329	391	311	329	391
Saratoga	35	39	51	48	52	64	48	52	64	48	52	64	48	52	64
Hanna/Elmo	30	35	45	46	49	59	46	49	59	46	49	59	46	49	59
Medicine Bow	19	22	28	26	28	35	26	28	35	26	28	35	26	28	35
Baggs	5	6	8	12	13	15	12	13	15	12	13	15	12	13	15
Sweetwater County	598	678	884	737	795	998	737	795	998	737	795	998	737	795	998
Wamsutter	6	7	9	10	11	13	10	11	13	10	11	13	10	11	13
Wyoming total 2/	1,283	1,456	1,897	1,704	1,832	2,272	1,704	1,832	2,272	1,704	1,832	2,272	1,704	1,832	2,272
Moffat County															
Craig	876	1,032	1,056	946	1,120	1,144	968	1,166	1,190	1,079	1,330	1,354	1,118	1,431	1,455
Routt County															
Hayden	101	114	116	108	124	125	122	154	156	136	174	176	142	190	192
Oak Creek	40	46	47	40	46	47	42	50	51	42	50	51	42	50	51
Steamboat Springs	578	698	732	578	698	732	588	719	752	588	719	752	588	719	752
Yampa	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Rio Blanco County															
Meeker	666	666	666	701	701	701	701	701	701	735	735	735	735	735	735
Colorado total 3/	2,264	2,559	2,620	2,376	2,692	2,752	2,424	2,793	2,853	2,583	3,011	3,071	2,628	3,128	3,188
TOTAL	3,547	4,015	4,517	4,080	4,524	5,024	4,128	4,625	5,125	4,287	4,843	5,343	4,332	4,960	5,460

1/ Assumes approximately 100 acres converted to urban uses per 1,000 population increase; also assumes that converted urban lands will not revert to non-urban uses.

2/ Numbers do not add; county figures include communities other than those listed; state figures include Albany as well as Carbon and Sweetwater counties.

3/ Colorado figures assume growth only in communities indicated.

Table 4-60

PARTICULATE EMISSION FACTORS FROM SURFACE COAL MINING OPERATIONS

Process Operation	Emission Factor
Topsoil Removal	0.38 lb/yd^3
Drilling	
Coal	0.22 lb/hole
Overburden	0.5 lb/hole
Blasting	
Coal	72.4 lb/blast
Overburden	85.3 lb/blast
Overburden Removal	0.053 lb/yd^3
Coal Removal	
Truck/shovel	0.12 lb/ton
Front-end loader	0.12 lb/ton
Coal Dumping	0.007 lb/ton
Coal Storage	1.6 U lb/acre/hr U = wind speed (m/s)
Coal Loading (Silo and Train)	0.0003 lb/ton
Coal Crushing	
Primary	0.02 lb/ton
Secondary	0.06 lb/ton
Coal Screening	0.10 lb/ton
Conveying and Transfer Points	0.20 lb/ton
Haul and Access Road Travel	$E = \frac{sS}{60} \times \frac{365 - w}{365}$ VMT[a/]
Distrubed Areas	Soil loss equation[b/]
Overburden Stockpile	Soil loss equation[b/]

a/ $E = \frac{sS}{60} \quad \frac{365 - w}{365} \quad VMT$

where E = Pounds of suspended particulate matter
s = Silt content of road (%)
S = Vehicle speed (mph)
W = Mean annual number of days with greater than 0.01 inches of rain
VMT = Vehicle miles traveled

b/ E - 0.025 IKCLV

where E = tons of suspended particulate matter per acre per year
I = Soil erodibility
K = Soil ridge roughness factor
C = Localized climate factor
L = Field width
V = Vegetative cover

Source: EPA Region VIII Interim Policy Paper on the Air Quality Review of Surface Mining Operations

TABLE 4-61

PREDICTED VISIBILITY DEGRADATION FROM THE MAXIMUM ALTERNATIVE
RELATIVE TO 1995 BASELINE CONDITIONS

Parameter	Predicted Value	Threshold of Perceptibility
Reduction in Visual Range	1 - 4 percent	> 5 - 10[2/] percent
Decrease in Apparent Contrast[1/]	.02 - .05	> 0.01 - 0.05[3/]
Blue/Red Luminance Ratio	. .97 - .92	< 0.90[4/]

1/ The inherent contrast of the viewed object is assumed to equal -0.7, a typical value for a tree-covered hill. The object is assumed to be observed over a maximum distance of 21 miles, the length of the modeled region. Observation over a smaller distance would result in less contrast reduction.

2/ Cramer, et al, 1978.

3/ Eigsti, 1979.

4/ Latimer and Samuelson, 1975.

TABLE 4-62

PARTICULATE CONTROL MEASURE FOR MINING PROCESS OPERATIONS

Process Operation	Control	Control Efficiency
Topsoil Removal	-	-
Drilling	Bag collector on air drill	90%
Blasting	Minimize area blasted	function of area blasted
	Prevent over shooting	function of amount of blasting
Overburden Removal	Minimize fall distance of material	-
Coal Removal	Minimize fall distance	-
Coal Dumping	Negative pressure	85%
	Spray system on dumped material	50%
Coal Storage	Enclosed	99%
Coal Loading (silo & train)	Baghouse on silo Chute on loadout Minimize number of openings Spraying of coal in cars	95%
Coal Crushing	Baghouse or equivalent	99%
Coal Screening	Baghouse or equivalent	99%
Conveying	Cover - Full	100%
	- Partial	90%
Transfer Points	Enclose & vent to baghouse	99%
	Duct to baghouse	99%
Haul & Access Road Travel	Paving	85-100%
	Watering and/or chemical stabilization	85%
	Speed control	function of speed
	Restrict off road use	100%

TABLE 4-62 (Contd.)

PARTICULATE CONTROL MEASURE FOR MINING PROCESS OPERATIONS (Contd.)

Process Operation	Control	Control Efficiency
Disturbed Areas	Chemical dust suppressant	85%
	Mulch	85%
	Revegation within one growing season	75%
	Minimize area disturbed	function of area
Overburden Stockpile	Temporary vegetation	75%
	Mulch	85%
	Chemical dust suppressant	85%
Transportation	Bus service	function of miles traveled
Construction	Chemical dust suppression of all roads & disturbed areas	50%
	Gravel parking lots	50%
	Confine traffic to specified roads	100%
	Minimize area of land disturbed	100%
	Prewater areas to be disturbed	50%
Miscellaneous	Extinguish smoldering or burning areas in mine	100%
	Chipping & mulching of vegetative material; removal from mine site rather than open burning	function of amount burned
	Minimize all haul distances	function of miles traveled
	Prevent overloading of trucks	function of present practice
	Covered haul trucks if on public roadway	function of miles traveled

Source: EPA Region VIII Interim Policy Paper on the Air Quality Review of Surface Mining Operations

TABLE 4-63

AIR QUALITY MATRIX

COLORADO

Element	Regulatory Threshold	Anticipated Impacts: No Action (1987, 1990, 1995)	Low (1987, 1990, 1995)	Medium (1987, 1990, 1995)	High (1987, 1990, 1995)	Maximum (1987, 1990, 1995)
Climate						
Wind Erosion Potential	None	Moderate	Moderate	Moderate-high	Moderate-high	High
Inversions	None	No change in the number or duration of inversions in the region is predicted	No change in the number or duration of inversions in the region as a result of the proposed mines is predicted	Same as low alternative	Same as low alternative	Same as low alternative
Atmospheric Stability Potential	None	No change in the atmospheric stability in the region is predicted	No change in the atmospheric stability in the region as a result of the proposed mines is predicted	Same as low alternative	Same as low alternative	Same as low alternative
Air Quality						
TSP	Annual: 75 $\mu g/m^3$ Federal and Colorado Primary 60 $\mu g/m^3$ Federal secondary	High concentrations are predicted around existing mines southwest of Craig with violations of standards predicted to occur. High concentrations are predicted around existing mines south and southwest of Hayden with possible violations of standards predicted to occur. High existing con-concentrations around Craig are expected to increase (20 $\mu g/m^3$). Present violations are predicted to continue to occur.	Negligible increases (<1 $\mu g/m^3$) around present and proposed mines. Negligible increases (<1 $\mu g/m^3$ around Craig and Hayden. Regional increase negligible (<1 $\mu g/m^3$). Violation of standards in Craig are predicted to continue.	Negligible increases (<1 $\mu g/m^3$) around present and proposed mines. Negligible increases (<1 $\mu g/m^3$) around Craig and Hayden are in region. Violations in Craig are predicted to continue.	Very small increases (<5 $\mu g/m^3$) around present and proposed mines. Negligible increases (<1 $\mu g/m^3$) around Craig and Hayden. Very small increases in region (<5 $\mu g/m^3$) with some small interaction between Danforth mines (<5 $\mu g/m^3$). Violation of standards in Craig are predicted to continue.	Very small increases (<5 $\mu g/m^3$) around present and proposed mines. Very small increase around Craig (3-5 $\mu g/m^3$). Negligible increase around Hayden (<1 $\mu g/m^3$). Very small increase in region (<5 $\mu g/m^3$) with some interaction between Danforth mines (<5 $\mu g/m^3$) and Isles Mt. mine with Empire mine (<5 $\mu g/m^3$). Violation of standards in Craig are predicted to continue.

TABLE 4-63 (Contd.)

AIR QUALITY MATRIX (Contd.)

COLORADO (Continued

Element	Regulatory Threshold	Anticipated Impacts: No Action 1987 1990 1995	Low 1987 1990 1995	Medium 1987 1990 1995	High 1987 1990 1995	Maximum 1987 1990 1995
TSP	24-hour: 260 μg/m^3 Federal and Colorado Primary 150 μg/m^3 Federal Secondary	Small increases (<15 μg/m^3) around present mines and towns-no violations of standards presently occurring or predicted to occur	Negligible increases (1 μg/m^3) around present and proposed mines and towns-no violations of standards predicted to occur	Same as low alternative	Same as low alternative	Very small increases (<5 μg/m^3) around present and proposed mines and towns-no violation of standards predicted to occur.
SO_2	Annual: 80 μg/m^3 Federal and Colorado Primary	Very small increases (<5 μg/m^3) around present mines and towns-no violations of stsndards predicted	Negligible increases (1 μg/m^3) around present and proposed mines and towns-no violations of standards predicted	Ssme as low alternative	Same as low alternative	Same as low alternative
	24-hour: 365 μg/m^3 Federal and Colorado Primary	Small increases (<10 μg/m^3) around present mines and towns-no violations of standards predicted	Negligible increases (1 μg/m^3) present and proposed mines and towns-no violations of standards predicted	Same as low alternative	Same as low alternative	Same as low alternative
	3-hour: 1300 μg/m^3 Federal Secondary	Very small increase (<10 μg/m^3) around present mines and towns-no violations of standards predicted	Negligible increases (1 μg/m^3) around and proposed mines and towns-no violations of standards predicted	Same as low alternative	Same as low alternative	Same as low alternative
NO_x	Annual: 100 μg/m^3 Federal and Colorado	Very small increases (<5 μg/m^3) around present mines and towns-no violations of standards are predicted	Very small increases (<5 μg/m^3) around present snd proposed mines and towns-no violations of standards are predicted	Same as low alternative	Same as low alternative	Same as low alternative

TABLE 4-63 (Contd.)

AIR QUALITY MATRIX (Contd.)

COLORADO (Continued)

Element	Regulatory Threshold	Anticipated Impacts: No Action 1987 1990 1995	Low 1987 1990 1995	Medium 1987 1990 1995	High 1987 1990 1995	Maximum 1987 1990 1995
Visibility	None	A negligible decrease is predicted	A negligible decrease is predicted in the region	Same as low alternative	Same as low alternative	Same as low alternative
PSD Classes Class I	Federal and Colorado SO_2 2 $\mu g/m^3$ Annual 5 $\mu g/m^3$ 24-hour 25 $\mu g/m^3$ 3-hour Federal TSP 5 $\mu g/m^3$ Annual 10 $\mu g/m^3$ 24-hour Closest areas with this PSD classification are Mt. Zirkel and Flat Tops Wilderness areas	There is predicted to be no significant impact to the air quality in these areas from present mines and towns	There is predicted to be no significant impact to the air quality in these areas from present or proposed mines and towns	Same as low alternative	Same as low alternative	Same as low alternative
Class II	Federal SO_2 10 $\mu g/m^3$ Annual 91 $\mu g/m^3$ 24-hour 512 $\mu g/m^3$ 3-hour Colorado SO_2 10 $\mu g/m^3$ Annual 50 $\mu g/m^3$ 24-hour 300 $\mu g/m^3$ 3-hour Federal TSP 19 $\mu g/m^3$ Annual 37 $\mu g/m^3$ 24-hour Entire study region excluding above mentioned Class I areas	Based on the court's decision in the Alabama Power Co. et al, vs. Costle case, it is not expected that any of the existing or proposed mines will be subject to PSD review. Since EPA's revised PSD regulations are not yet final, it is unclear to what extent, if any, fugitive emissions will affect the consumption of PSD increments	Same as no action alternative	Same as no action alternative	Same as no action alternative	Same as no action alternative

TABLE 4-63 (Contd.)

AIR QUALITY MATRIX (Contd.)

COLORADO (Continued)

		Anticipated Impacts														
		No Action			Low			Medium			High			Maximum		
Element	Regulatory Threshold	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995
Class III	Federal SO_2 40 $\mu g/m^3$ Annual 182 $\mu g/m^3$ 24-hour 700 $\mu g/m^3$ 3-hour Colorado SO_2 15 $\mu g/m^3$ Annual 100 $\mu g/m^3$ 24-hour 700 $\mu g/m^3$ 3-hour Federal TSP 37 $\mu g/m^3$ Annual 75 $\mu g/m^3$ 24-hour No areas in this classification exist near the proposed lease tracts	None			None			None			None			None		
Nonattainment Areas	Significance thresholds-Federal SO_2 1 $\mu g/m^3$ Annual 5 $\mu g/m^3$ 24-hour 25 $\mu g/m^3$ 3-hour TSP 1 $\mu g/m^3$ Annual 5 $\mu g/m^3$ 24-hour No areas in this classification exist near the proposed lease tracts	None			None			None			None			None		
Noise	Federal-None pertaining to areas outside mine boundaries Colorado-Standard for heavy industrial activity: 80 db 7am - 7pm 70 db 7pm - 7am may be exceeded by 10 db for 15 minutes each hour if noise is not periodic (hammering) or shrill	Significant noise levels are not expected to occur outside mining areas or in region.			Same as no action alternative			Same as no action alternative			Same as no action alternative			Same as no action alternative		

TABLE 4-63 (Contd.)

AIR QUALITY MATRIX (Contd.)

WYOMING

Element	Regulatory Threshold	Anticipated Impacts: No Action 1987 1990 1995	Low 1987 1990 1995	Medium 1987 1990 1995	High 1987 1990 1995	Maximum 1987 1990 1995
Climate						
Wind Erosion Potential	None	Moderate	Moderate-high	Moderate-high	Moderate-high	Moderate-high
Inversions	None	No change in the number or duration of inversions in the region is predicted	No change in the number or duration of inversions in the region as a result of the proposed mines is predicted	Same as low alternative	Same as low alternative	Same as low alternative
Atmospheric Stability Potential	None	No change in the atmospheric stability in the region is predicted	No change in the atmospheric stability in the region as a result of the proposed mines is predicted	Same as low alternative	Same as low alternative	Same as low alternative
Air Quality						
TSP	Annual: 75 $\mu g/m^3$ Federal Primary 60 $\mu g/m^3$ Wyoming & Federal secondary	Small increases (<10 $\mu g/m^3$) around present mines and towns-no violations of standards predicted	Small increases (<10 $\mu g/m^3$) around present and proposed mines and towns. Regional increases very small (<5 $\mu g/m^3$) no violations of standards predicted	Same as low alternative	Same as low alternative	Same as low alternative
	24-hour: 260 $\mu g/m^3$ Federal Primary and Wyoming 150 $\mu g/m^3$ Federal Secondary	Small increases (<15 $\mu g/m^3$) around present mines and towns-no violations of standards predicted	Small increases (<15 $\mu g/m^3$) around present and proposed mines and towns. Regional increasea - very small (<10 $\mu g/m^3$) no violations of standards predicted	Same as low alternative	Same as low alternative	Same as low alternative

TABLE 4-63 (Contd.)

AIR QUALITY MATRIX (Contd.)

WYOMING (Continued)

Element	Regulatory Threshold	Anticipated Impacts: No Action (1987 1990 1995)	Low (1987 1990 1995)	Medium (1987 1990 1995)	High (1987 1990 1995)	Maximum (1987 1990 1995)
SO_2	Annual: 80 $\mu g/m^3$ Federal Primary; 60 $\mu g/m^3$ Wyoming	Very small increases (<5 $\mu g/m^3$) around present mines and towns-no violations of standards predicted	Negligible increases (1 $\mu g/m^3$) around present and proposed mines and towns and in region. No violations of standards predicted.	Same as low alternative	Same as low alternative	Same as low alternative
	24-hour: 365 $\mu g/m^3$ Federal Primary; 260 $\mu g/m^3$ Wyoming	Small increases (<10 $\mu g/m^3$) around present mines and towns-no violations of standards predicted	Very small increases (<5 $\mu g/m^3$) around present and proposed mines and towns and in region-no violations of standards predicted	Same aa low alternative	Same as low alternative	Same as low alternative
	3-hour: 1300 $\mu g/m^3$ Federal and Wyoming Secondary	Small increases (<10 $\mu g/m^3$) around present mines and towns-no violations of standards predicted	Very small increases (<10 $\mu g/m^3$) around present mines and towns and in region-no violations of standards predicted	Same as low alternative	Same as low alternative	Same as low alternative
NO_x	Annual: 100 $\mu g/m^3$ Federal Primary and Wyoming	Very amall increases (<5 $\mu g/m^3$) around present mines and towns-no violations of standards predicted	Negligible increases (1 $\mu g/m^3$) around present and proposed mines and towns and in region-no violations of standards predicted	Same as low alternative	Same as low alternative	Same as low alternative
Visibility	None	A negligible decrease is predicted	A negligible decrease is predicted in the region	Same as low alternative	Same as low alternative	Same as low alternative

TABLE 4-63 (Contd.)

AIR QUALITY MATRIX (Contd.)

WYOMING (Continued)

Element	Regulatory Threshold	Anticipated Impacts: No Action 1987 1990 1995	Low 1987 1990 1995	Medium 1987 1990 1995	High 1987 1990 1995	Maximum 1987 1990 1995
PSD Classes Class I	SO_2 2 $\mu g/m^3$ - Annual 5 $\mu g/m^3$ - 24-hour 25 $\mu g/m^3$ - 3-hour TSP 5 $\mu g/m^3$ - Annual 10 $\mu g/m^3$ - 24-hour No areas in this classification exist near the proposed lease tracts	None	None	None	None	None
Class II	SO_2 20 $\mu g/m^3$ - Annual 91 $\mu g/m^3$ - 24-hour 512 $\mu g/m^3$ - 3-hour TSP 19 $\mu g/m^3$ - Annual 37 $\mu g/m^3$ - 24-hour The entire study area near the proposed lease tracts is this classification	Based on the court's decision in the Alabama Power Co. et al, vs Costle case, it is not expected that any of the existing or proposed mines will be subjected to PSD review. Since EPA's revised PSD regulations are not yet final, it is unclear to what extent, if any, fugitive emissions will affect the consumption of PSD increments	Same as no action alternative	Same as no action alternative	Same as no action alternative	Same as no action alternative
Class III	SO_2 40 $\mu g/m^3$ - Annual 182 $\mu g/m^3$ - 24-hour 700 $\mu g/m^3$ - 3-Hour TSP 1 $\mu g/m^3$ - Annual 5 $\mu g/m^3$ - 24-hour No areas in this classification exist near the proposed lease tracts	None	None	None	None	None

TABLE 4-63 (Contd.)

AIR QUALITY MATRIX (Contd.)

WYOMING (Continued)

		Anticipated Impacts														
		No Action			Low			Medium			High			Maximum		
Element	Regulatory Threshold	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995	1987	1990	1995
Nonattainment areas	Significance thresholds SO_2 1 μg/m^3 - Annual 5 μg/m^3 - 24-hour 25 μg/m^3 - 3-hour TSP 1 μg/m^3 - Annual 5 μg/m^3 - 24-hour No areas in this classification exiat near the proposed leaae tracts	None			None			None			None			None		
Noise	Federal - none pertaining to areaa outaide mine boundary Wyoming - none pertaining to mines	Significant noiae levels are not expected to occur outside of mining areaa or in region			Same as no action alternative			Same as no action alternative			Same as no action alternative			Same as no action alternative		

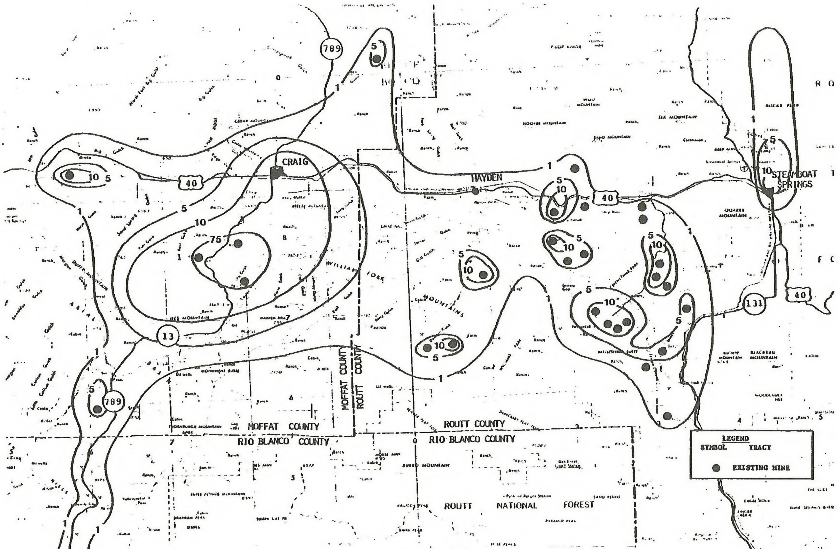


FIGURE 4-1

NO ACTION ALTERNATIVE - YAMPA VALLEY
1995 ANNUAL AVERAGE TOTAL SUSPENDED PARTICULATE CONCENTRATIONS ($\mu g/m^3$)
(Number indicates predicted increase above background level of 22 $\mu g/m^3$)

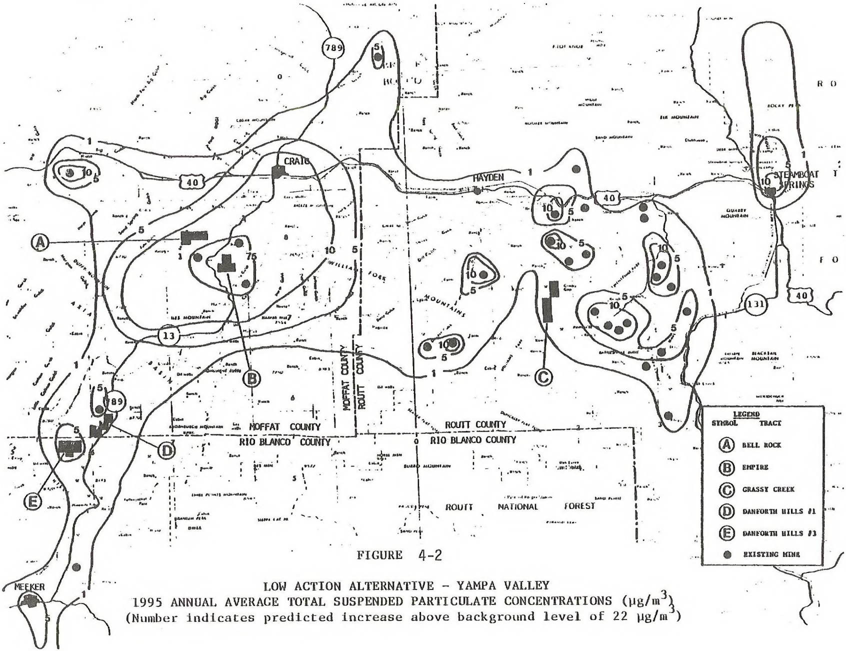


FIGURE 4-2

LOW ACTION ALTERNATIVE - YAMPA VALLEY

1995 ANNUAL AVERAGE TOTAL SUSPENDED PARTICULATE CONCENTRATIONS ($\mu g/m^3$)

(Number indicates predicted increase above background level of 22 $\mu g/m^3$)

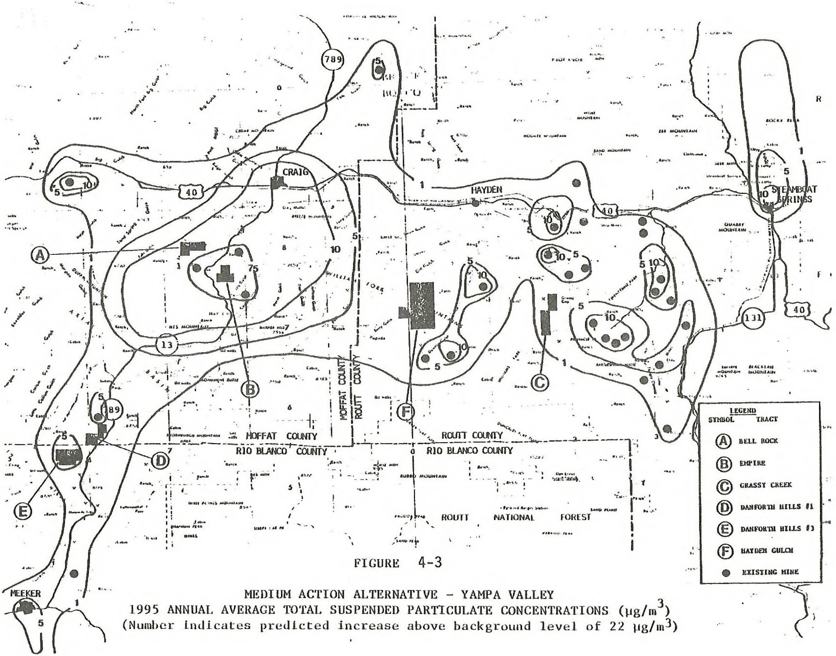


FIGURE 4-3

MEDIUM ACTION ALTERNATIVE - YAMPA VALLEY
1995 ANNUAL AVERAGE TOTAL SUSPENDED PARTICULATE CONCENTRATIONS ($\mu g/m^3$)
(Number indicates predicted increase above background level of 22 $\mu g/m^3$)

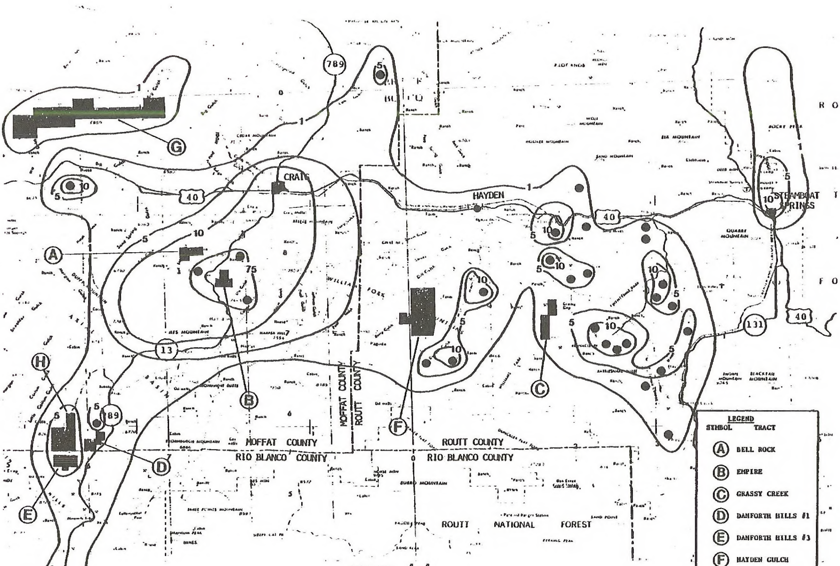


FIGURE 4-4

PREFERRED OR HIGH ACTION ALTERNATIVE - YAMPA VALLEY

1995 ANNUAL AVERAGE TOTAL SUSPENDED PARTICULATE CONCENTRATIONS ($\mu g/m^3$)

(Number indicates predicted increase above background level of 22 $\mu g/m^3$)

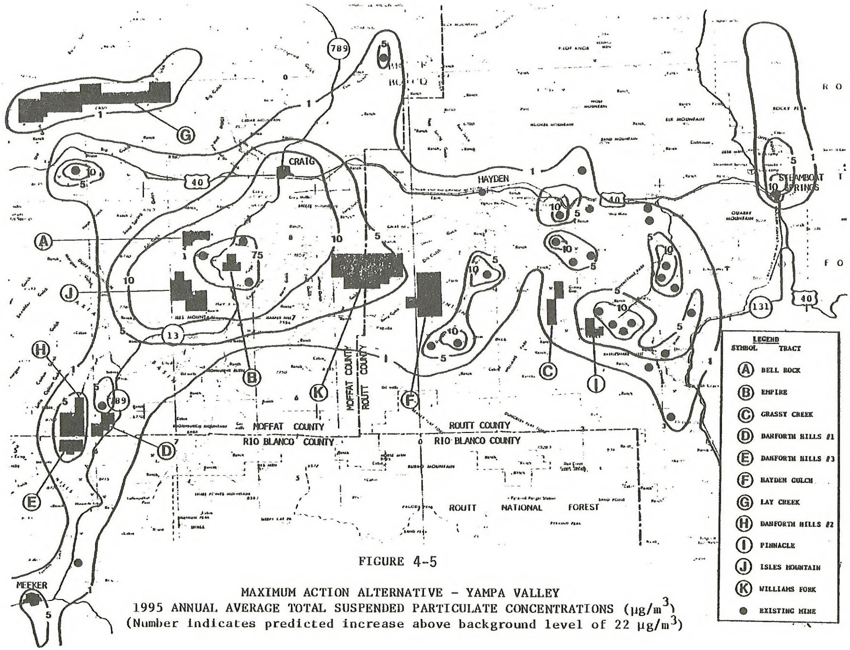


FIGURE 4-5

MAXIMUM ACTION ALTERNATIVE - YAMPA VALLEY
1995 ANNUAL AVERAGE TOTAL SUSPENDED PARTICULATE CONCENTRATIONS ($\mu g/m^3$)
(Number indicates predicted increase above background level of 22 $\mu g/m^3$)

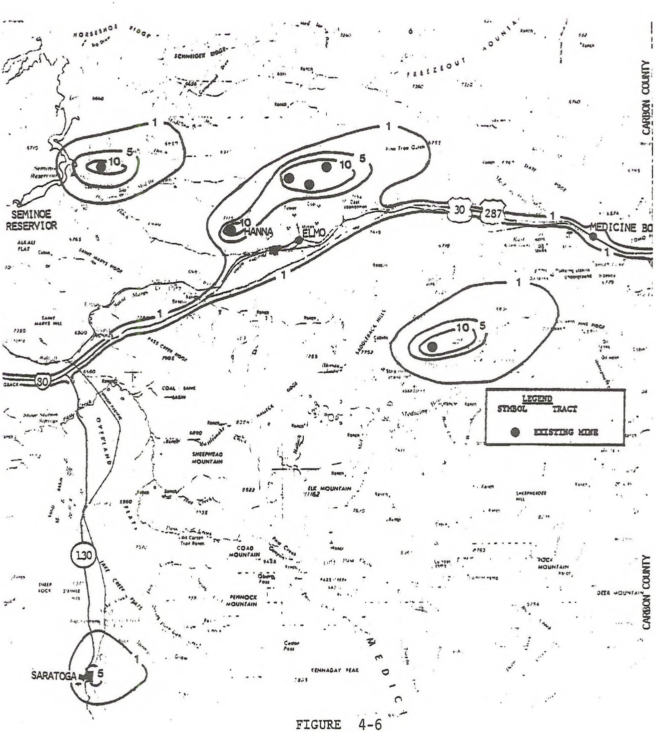


FIGURE 4-6

NO ACTION ALTERNATIVE - HANNA/ELMO AREA
1995 ANNUAL AVERAGE TOTAL SUSPENDED PARTICULATE CONCENTRATIONS ($\mu g/m^3$)
(Number indicates predicted increase above background level of 29 $\mu g/m^3$)

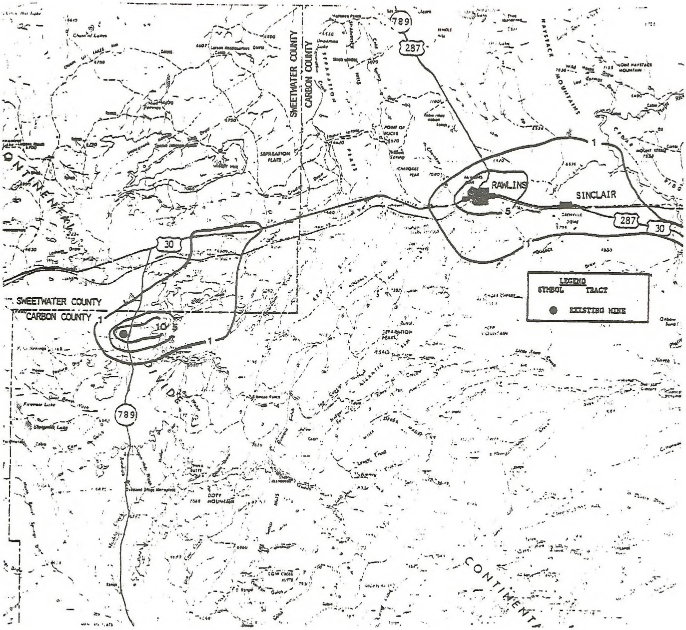


FIGURE 4-7

NO ACTION ALTERNATIVE - RAWLINS AREA
1995 ANNUAL AVERAGE TOTAL SUSPENDED PARTICULATE CONCENTRATIONS ($\mu g/m^3$)
(Number indicates predicted increase above background level of 18 $\mu g/m^3$)

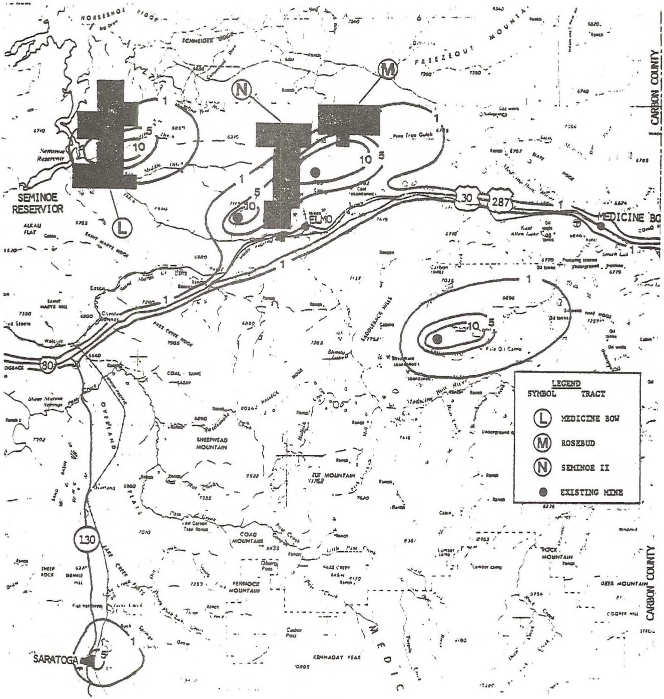


FIGURE 4-8

LOW ACTION ALTERNATIVE - HANNA/ELMO AREA
1995 ANNUAL AVERAGE TOTAL SUSPENDED PARTICULATE CONCENTRATIONS ($\mu g/m^3$)
(Number indicates predicted increase above background level of 29 $\mu g/m^3$)

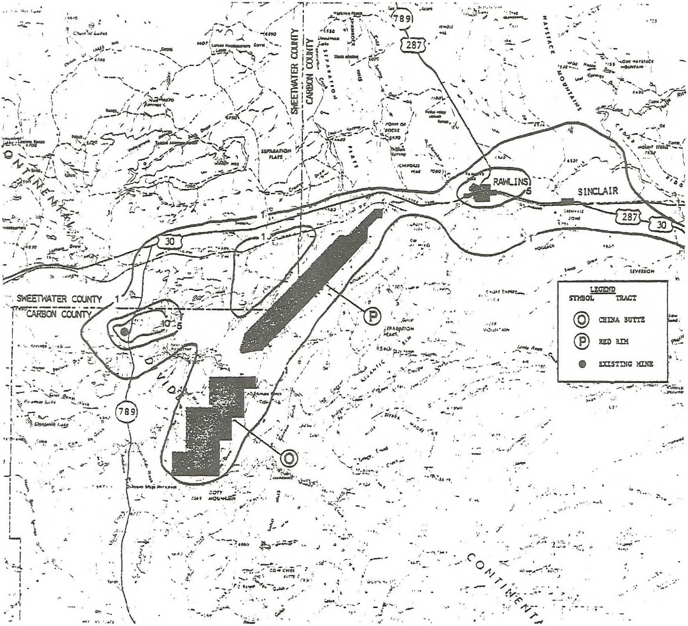


FIGURE 4-9

LOW ACTION ALTERNATIVE - RAWLINS AREA
1995 ANNUAL AVERAGE TOTAL SUSPENDED PARTICULATE CONCENTRATIONS ($\mu g/m^3$)
(Number indicates predicted increase above background level of 18 $\mu g/m^3$)

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GLOSSARY

ACID MINE DRAINAGE. Any acid water which drains off, flows on, or has drained or flowed off any area of land affected by mining.

ACRE-FOOT. The volume of water (43,560 cubic feet) required to cover 1 acre to a depth of 1 foot.

ACTIVITY DAY. Participation in a recreation activity by one person for any period of a day; actual visits.

AD VALOREM. In proportion to the value. Ad valorem taxes are based on property or other values.

AIRSHEDS. These are the areas in which weak dispersion conditions result from the effects of obstructions on the normal wind flow pattern. These obstructions are elevated topographic features, such as mountain ranges or canyon walls.

ALLUVIAL. Pertaining to or composed of any sediment deposited by flowing water; for example: in a river bed.

ALLUVIUM. Gravel, sand, silt, clay, or similar detrital material deposited or moved by running water; alluvium is unconsolidated.

AMBIENT AIR QUALITY. The state of the atmosphere at ground-level as defined by the range of measured and/or predicted ambient concentrations of all significant pollutants for all averaging periods of interest.

ANGLE OF DIP. The angle an inclined stratum makes with the horizontal (see dip).

ANOMIE. Normlessness. At the community level, the sense of a coherent and meaningfully integrated set of behavioral expectations by large numbers of citizens has been lost: i.e., people in the town no longer know "what to expect" from other people or from the community institutions. At the individual level, a person feels confused about what is expected of him--old values no longer seem to apply, the old ways no longer seem to be the "right" ways. For an individual, anomie may lead to mental breakdown; for a community, structural breakdown has occurred.

ANTHROPOGENIC. Relating to man's activities. Anthropogenic pollutant sources include space heating, vehicular traffic, industrial activity and construction.

ANTICLINE. A fold with strata (horizontal layers) sloping downward on both sides from a common crest or axis.

AQUIFER. A water-bearing bed or stratum (layer) of permeable rock, sand, or gravel capable of yielding adequate quantities of water.

ARCHAEOLOGICAL. Pertaining to human activity prior to the time or scope of written records.

ARTESIAN. Is synonymous with confined. Artesian water and artesian water body are equivalent respectively to confined ground water and confined water body (see ground water confined).

ARTESIAN WELL. A well deriving its water from an artesian or confined water body. The water level in an artesian well stands above the top of the artesian water body it taps.

ATMOSPHERIC DISPERSION MODEL. A mathematical simulation of the atmospheric transport and dispersion of pollutants used to predict pollutant concentrations.

ATTITUDE. An intellectual or emotional position regarding a fact, condition, state, person, or other entity, producing a readiness to act in a certain manner.

BACKGROUND CONCENTRATION. A pollutant level which could be expected in an area in the absence of any anthopogenic pollutant sources.

BASE FLOW. Stream flow derived from ground-water discharge into the waterway.

BED. A subdivision of a stratified sequence of rocks, lower in rank than a member or formation, internally composed of relatively homogeneous material exhibiting some degree of lithologic unity, and separated from the rocks above and below by visually or physically more or less well-defined boundary planes; "the smallest rock-stratigraphic unit recognized in classification".

BEDROCK. The more or less solid rock in place either on or beneath the surface of the earth.

CHANNEL STABILITY. A relative term describing a channel's condition with respect to erosion or movement of the channel walls or bottom due to water flows.

CLIMATE. The statistical collective of an area's weather conditions during a relatively long interval of time (usually several decades.)

COMMUNITY FACILITIES AND SERVICES. Equipment and activities which support the economic and residential functions of an area. Examples are schools, police, and water systems. As used in this study, the term is limited to those that are provided by local communities and school districts.

CONSUMPTIVE USE. The quantity of water discharged to the atmosphere or incorporated in the products of the process in connection with domestic use, vegetative growth, food processing, or an industrial process.

CONTINUOUS MINER. A mining machine designed to remove coal from the face and load it onto cars or conveyors without the use of cutting machines, drills, or explosives.

CONTRAST. The relative difference in luminance between an object and its background. Inherent contrast is contrast as perceived at the position of the observed object. Apparent contrast is contrast as perceived at the observer's position.

CUBIC FEET PER SECOND (cfs). A unit expressing rates of discharge, equal to the discharge through a rectangular cross section, one foot wide and one foot deep, flowing at an average velocity of one foot per second.

CULTURAL RESOURCE. Evidence of human activity which occurred at least 50 years ago. For convenience the evidence is subdivided as Archaeological and Historical.

DEMOGRAPHY. The statistical study of human population; includes size, density, distribution, and vital statistics.

DEWATER. To remove water from; dehydrate.

DIP. The angle that a structural surface, e.g., a bedding or fault plane, makes with the horizontal, measured perpendicular to the strike of the structure.

DIP SLOPE. A slope of the land surface, roughly determined by and approximately conforming with the direction and the angle of dip of the underlying rocks; specifically the long, gently inclined face of a cuesta.

DISCHARGE WEIGHTED AVERAGE DISSOLVED SOLIDS. See weighted-average concentration.

DISPERSION POTENTIAL. The ability of the atmosphere to dilute or disperse air pollutants, as determined by normal ventilation values. A high dispersion potential results from high ventilation values, which can be caused by high transport wind speeds, high mixing heights, or high values of both.

DISSOLVED OXYGEN. The amount of dissolved oxygen, in parts per million by weight, present in water, now generally expressed in milligrams per liter. A critical factor for fish and other aquatic life, and for self-purification of a surface-water body after inflow of oxygen-consuming pollutants.

DISSOLVED SOLIDS. Solids that originate mostly from rocks and are in solution. Some colloidal material is treated as if it were in solution in determining dissolved solids. The total dissolved mineral constituents of water.

DISSOLVED-SOLIDS YIELD. A unit for expressing the discharge of dissolved solids from an area. Dissolved-solids yield is usually given in tons per square mile per year.

DOWN DIP. A direction that is downwards and parallel to the dip of a structure or surface.

ECONOMIC BASE. Economic activites which sell products or services outside of the area and, thus, bring additional money into the area.

ECONOMIC MODEL. A mathematical representation of an area's economy.

EFFLUENT. Liquid wastes (as industrial refuse or sewage) discharged into the environment.

EMISSION FACTOR. An empirically derived mathematical relationship between pollutant emission rate and some characteristic of the source such as volume, area, mass, or process output.

EPHEMERAL STREAM. A stream that flows for less than 30 consecutive days, which flows only in direct response to precipitation in the immediate watershed, and which has a channel bottom that is always above the local water table.

EROSION. The process by which the surface of the earth is worn away by the action of water, glaciers, winds, etc.

EUTROPHICATION. A state in which there is an abundant accumulation of nutrients that support a dense growth of plant and animal life in a body of water, the decay of which depletes the shallow water of oxygen in the summer.

EVAPOTRANSPIRATION. The combined loss of water from a given area during a specific period of time, by evaporation from the soil or water surface and by transpiration from plants.

EVAPORATION. The physical process by which a liquid or solid is transformed to the gaseous state.

FAULT. Breaks in the continuity of the body of rock, with dislocation along the plane of fracture.

FECAL COLIFORM. A type of bacteria found in the waste excretions of warm-blooded animals used as the prime indicator of organic fecal pollution.

FUGITIVE DUST. A type of particulate emission made airborne by forces of wind, man's activity, or both, such as unpaved roads, construction sites, tilled land, or windstorms.

GAGING STATION. A particular site on a stream or reservoir where systematic observations of gage height, discharge, or water quality parameters (or any combination of these) are or have been obtained. Usually equipped with a device to automatically record the gage height of the stream.

GALLONS PER MINUTE (GAL/MIN). A unit expressing rate of discharge. One cubic foot per second is equal to 448.8 gal/min or 646,272 gal/day (gallons per day).

GEMEINSCHAFT. A model of social relations based upon informal rather than formal structures and social controls, and upon primary rather than secondary group interaction. The opposite end of the continuum is Gesellschaft relationships, based upon formal structures and secondary group interaction. Gemeinschaft relationships typify small, rural isolated communities or societies. Neither extreme of the continuum is pure.

GROUND WATER. That part of subsurface water that completely saturates the rocks and is under hydrostatic pressure.

GROUND WATER, CONFINED. Confined ground water is under pressure significantly greater than atmospheric, and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the material in which the confined water occurs.

GROUND WATER, PERCHED. Perched ground water is unconfined ground water separated from an underlying body of ground water by an unsaturated zone. Its water table is a perched water table. It is held up by a perching bed whose permeability is so low that water percolating downward through it is not able to bring water in the underlying unsaturated zone above atmospheric pressure. Perched ground water may be either permanent, where recharge is frequent enough to maintain a saturated zone above the perching bed, or temporary, where intermittent recharge is not great or frequent enough to prevent the perched water from disappearing from time to time as a result of drainage over the edge of or through the perching bed.

GROUND WATER, UNCONFINED. Unconfined ground water is water in an aquifer that has a water table.

GROWING SEASON. Generally, the period of the year during which the temperature of cultivated vegetation remains sufficiently high to allow plant growth.

HISTORICAL. For this region, pertaining to human activity from 1776 until 50 years ago.

HYDRAULIC. Of or pertaining to fluids in motion; conveying, or acting, by water.

HYDRAULIC GRADIENT. Pressure gradient. As applied to an aquifer it is the rate of change of pressure head per unit of distance of flow at a given point and in a given direction.

IMPERMEABLE. Applied to strata such as clays, shales, etc., that do not permit water to move through them under the head differences ordinarily found in ground water.

INDIRECT IMPACTS. Impacts caused by something which, itself, is a result of something else. In economics, indirect impacts are caused by growth in trade and service activities which, themselves, result from a primary source of growth such as mining.

INFRASTRUCTURE. See COMMUNITY FACILITIES AND SERVICES.

INTERMITTENT STREAM. A stream that flows for at least one month of the calendar year as a result of ground-water discharge or surface runoff.

JOINT FREQUENCY DISTRIBUTION. Set of meteorological data describing the concurrent frequencies of occurrence of defined wind directions, wind speed classes, and atmospheric stabilities.

LITHOLOGY. The physical character of rocks.

LONGWALL. Pertaining to a means of extracting coal or other minerals in an underground mine from a continuous face.

mg/L. Abbreviation for milligrams per liter, the unit of expression for the concentration of dissolved minerals in water.

MIXING HEIGHT. The height above the ground to which turbulence causes the air to be well mixed.

MODELING. A mathematical or physical representation of an observable situation. In air pollution control, models afford the ability to predict pollutant distribution or dispersion from identified sources for specified weather conditions.

NATIONAL REGISTER OF HISTORIC PLACES. "...A register of districts, sites, buildings, structures, and objects of national, state, or local significance in American history, architecture, archaeology, and culture..." --36 CFR 800.2 (d).

OVERBURDEN. All the earth and other materials which lie above a natural deposit of minerals.

PER CAPITA. Per unit of population. Per capita projections assume the same growth rate as population.

PERENNIAL STREAM. A stream that flows continuously during all of the calendar year as a result of ground-water discharge or surface runoff.

PERMEABILITY. (1) The quality of a soil horizon that enables water or air to move through it. (2) The property or capacity of a porous rock sediment, or soil for transmitting a fluid without impairment of the structure of the medium; it is a measure of the relative ease of fluid flow under unequal pressure.

pH. A measure of the acidity or alkalinity of a solution. Water is considered to be neutral at a pH of 7, acid if pH is less than 7, and basic if greater than 7.

POINT SOURCE. A pollutant source whose origin of emissions can be approximated by a single point.

POLLUTANT. Any gaseous, chemical, or organic waste that contaminates air, soil, or water.

POLLUTION. The contamination of soil, water, or the atmosphere by the discharge of noxious substances.

PREVAILING WIND. The most frequent compass direction from which the wind blows.

QUASI-EQUILIBRIUM. A condition of approximate equilibrium.

RADIATIONAL COOLING. The cooling of the earth's surface and adjacent air, accomplished (mainly at night) whenever the earth's surface suffers a net loss of heat.

RECHARGE. Inflow to a ground-water reservoir (aquifer system in which ground water is stored).

RECLAMATION. The process of returning disturbed lands to their former uses or other productive uses.

REGIONAL VISIBILITY. Visibility predicted to occur in the region around a source or group of sources resulting from particulate, sulfate, and nitrate concentrations in the vicinity of these sources.

RIPARIAN. Situated on or pertaining to the bank of a river, stream, or other body of water. Normally used to refer to the plants of all types that grow along streams, around springs, etc.

ROOM-AND-PILLAR. A system of mining in which the coal or ore is mined in rooms separated by narrow ribs or pillars. The coal or ore in the pillars is removed by subsequent working in which the roof is caved in successive blocks.

RUNOFF. That part of the precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage, or other works of man, in or on the stream channels or on the drainage area.

SALINITY. Measure of the total dissolved solids concentration in water.

SANDSTONE. A medium-grained, sedimentary rock composed of abundant, rounded or angular fragments of sand size set in a fine-grained matrix (silt or clay) and more or less firmly united by a cementing material (commonly silica, iron oxide, or calcium carbonate); the consolidated equivalent of sand.

SECONDARY IMPACTS. See INDIRECT IMPACTS.

SEDIMENT. Fragmented material that originates mostly from rocks and is transported by, suspended in, or deposited from water or air.

SEDIMENTATION. The settling out of solids from water by gravity to form unconsolidated alluvial deposits.

SEDIMENT YIELD. A unit for expressing the discharge of sediment from an area. Sediment yield is usually given in acre-feet or tons per square mile per year.

SHALE. A fine-grained, fissile (capable of being split) sedimentary rock formed by the consolidation (as by compression or cementation) of clay, silt, or mud, and characterized by finely stratified structure.

SILTSTONE. A very fine-grained rock, mainly consolidated silt.

SITE-SPECIFIC. A specific project area analyzed in the environmental statement.

SOCIAL GROUP. An abstract structuring of two or more social statuses tied meaningfully together by reciprocal behavioral expectations (norms). Becomes "visible" only when actual persons occupy the various positions and behave toward each other in recognizable conformity to the expectations.

SOCIAL IMPACT. "The difference which (energy development)...makes in the lives of those concerned." (Gold, 1976, p.3).

SOCIAL-PSYCHOLOGICAL. Having to do with the psychological consequences for the individual of living and interacting with other people within a particular social-structural system and in a particular cultural context.

SOCIAL STRUCTURE. A more or less integrated system of interacting groups in a community or society which provide the social framework within which the ongoing activities of the community or society are carried out, and which provide the various dimensions defining the overall position of each individual within that community or society.

SOCIAL SUPPORT SYSTEM. A range of more or less enduring relationships which help individuals define and cope with life events. They help reduce susceptibility to psychological stress by supplying cognitive guidance, helping master emotional burdens, providing refuge from stressful environment, and helping realistic interpretation of responses from others (adapted from Lantz and McKeown, 1979, p. 51).

SPECIFIC CONDUCTANCE. A measure of the ability of water to conduct an electrical current, expressed in micromhos per centimeter at 25 degrees Centrigrade. Conductance serves as an index to the concentration of dissolved solids in the water.

SPOIL. The overburden removed in strip mining. Debris or waste material from a strip mine.

SPOILS AQUIFER. Unconfined aquifer formed by partial saturation of spoils materials replaced in surface mined areas.

STREAM FLOW. Water flowing within a stream channel.

STREAM(S). Any body of running water, great or small, moving under gravity flow to progressively lower levels in a relatively narrow but clearly defined channel on the surface of the ground.

STRUCTURE. Any visible signs of displacement or deformation of the rock such as faulting or folding.

SUBSIDENCE. A sinking down of a part of the earth's crust. Lowering of the strata, including the surface, due to underground excavations.

SURFACE RUNOFF. The runoff that travels over the soil surface to the nearest surface stream; runoff of a drainage basin that has not passed beneath the surface since precipitation.

SURFACE WATER. Waters on the surface of the earth, including water in streams, lakes, ponds, ice, snow, glaciers, etc.

SUSPENDED SEDIMENT. Sediment that is supported by the upward components of turbulent currents, or by colloidal suspension if the sediment particles are very small.

SYNCLINE. A low, troughlike area in bedrock, in which rocks incline together from opposite sides.

TOPOGRAPHY. The exact physical features and configuration of a place or region; the detailed and accurate description of a place or region.

TOTAL SUSPENDED PARTICULATES (TSP). The portion of the total particulate matter in the atmosphere consisting of particles so small that the particles settle out very slowly.

TRANSPORT WIND. The average horizontal wind speed component perpendicular to a vertical cross section of the atmosphere. In this report, the vertical limits are defined by the ground and the mixing height.

USE (WATER). The total quantity of water pumped, diverted, applied, or utilized for any purpose.

VENTILATION. A measure of the amount of air moving through a vertical cross-section of the atmosphere. The higher the ventilation, the higher the dispersion. As used in this report, it is the product of the mixing height and the transport wind.

VISIBILITY. A measurement of the maximum distance to which large objects may be viewed. Fixed reference objects such as mountains, hills, towers, or buildings are normally used to estimate visibility.

VISITOR DAY. Participation in a recreation activity by one or more individuals aggregating a total of 12 hours of use.

VISUAL RANGE. A standardized form of visibility that approximates actual observed visibility. It is the maximum distance at which an average human eye with a threshold perceivable brightness contrast of .02 at a wavelength of 5,500 Angstroms can detect an ideal black object against the horizon sky in daylight.

WATER DISCHARGE. The flow of a stream or canal, outflow from a basin, or flow of water from a pipe. Water discharge includes the sediment mixed with and solids dissolved in the water.

WATER RESOURCES. A general term referring to the total availability of water on or in the ground for use by animals or people.

WATERSHED. The region draining into a river, river system, or body of water.

WATER SUPPLY. A source or volume of water available for use; also, the system of reservoirs, wells, conduits, treatment facilities, etc., required to make the water available and usable; often but not always equivalent to WATER RESOURCES.

WATER TABLE. The surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere. Synonyms: water level, ground-water level.

WATER-TABLE AQUIFER. Unconfined AQUIFER.

WATER TYPE. A term used to denote the predominate cations and anions in water. Whether certain cations (calcium, magnesium, sodium, and potassium), and certain anions (bicarbonate, sulfate, and chloride), predominate depends on the concentrations in equivalents per million and the relation of the concentration of the individual ions to each other. For example, if the concentration of sodium makes up most of the total cations, and the concentration of bicarbonate makes up most of the total anions, the water is classified as a sodium bicarbonate type. However, if the second most abundant cation or anion is more than half the most abundant cation or anion, and the third most abundant cation or anion is more than half the second, they are included in the water-type classification in order of magnitude. Examples of these more complex water types would be calcium magnesium bicarbonate, calcium magnesium bicarbonate sulfate, and sodium magnesium calcium chloride sulfate.

WATER YIELD. The runoff from a drainage basin.

WEIGHTED-AVERAGE CONCENTRATION. A discharge-weighted average that approximated the dissolved-solids concentration of water that would be found in a reservoir containing all the water passing a given station during a specified period after thorough mixing in the reservoir. The effects of evaporation, precipitation, or the addition or removal of dissolved constituents by plants or animals is not considered in this definition.

WIND ROSE. A graphical display of wind speed and wind direction frequencies at a meteorological station. The bar graphs extend into the direction from which the wind blows. These directions are the sixteen compass point directions (i.e., north, north-northeast, ..., northwest, and north-northwest).

ABS. Automatic Block Signal System

ADT. Average Daily Traffic

AUM. Animal Unit Month

DHV. Design Hourly Volume

D&RGW. Denver and Rio Grande Western Railroad

EIS. Environmental Impact Statement

FCLAA. *Federal Coal Leasing Amendments Act of 1976*

FCMPES. (Bureau of Land Management 1979a) *Final EIS, Federal Coal Management Program*

FLPMA. *Federal Lands Policy and Management Act of 1976*

GR/HF. Green River/Hams Fork

HAA. Habitat Analysis Area

NWCCRES. *Northwest Colorado Coal Regional Environmental Statement* (Bureau of Land Management 1978b)

NWSR. *Northwest Supplemental Report* (Bureau of Land Management 1978b)

RCT. Regional Coal Team

SCWCES. *Southcentral Wyoming Coal ES* (Bureau of Land Management 1979c)

SMCRA. *Surface Mining Control and Reclamation Act of 1977*

SSA. Site-Specific Analysis

TSP. Total Suspended Particulates

UP. Union Pacific Railroad

WCCCES. *West Central Colorado Coal ES* (Bureau of Land Management 1979b)

WFMFP. *Williams Fork Management Framework Plan* (Bureau of Land Management, Craig District 1979a)

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