Volume 1

FINAL
West-Central Colorado Coal
Environmental Statement

U.S. Department of the Interior
Bureau of Land Management

TABLE R1-2

MOST PROBABLE LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROJECTED COAL MINING DEVELOPMENT IN WEST-CENTRAL COLORADO BY 1990: ACREAGE DISTURBED

Map Unit	Company and Mine Name	Total Project Acres	Federal Lease Acres (in project acres)	Total Disturbance as of 1977	Cumulative Surface Disturbance (acres): Railroads 1980	Railroads 1985	Railroads 1990	Roads 1980	Roads 1985	Roads 1990	Mine Facilities 1980	Mine Facilities 1985	Mine Facilities 1990	Refuse Disposal 1980	Refuse Disposal 1985	Refuse Disposal 1990	Power Lines and Communications Lines 1980	Power Lines and Communications Lines 1985	Power Lines and Communications Lines 1990	Cumulative Total Disturbed Base Level 1977	Cumulative Total Disturbed 1980	Cumulative Total Disturbed 1985	Cumulative Total Disturbed 1990
	Site-Specific Actions:																						
	Anschutz Coal Corporation: North Thompson Creek No. 1 and No. 3 Mines 1/	4,000.00	1,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Atlantic-Richfield Company: Mt. Gunnison No. 1 Mine	12,578.00	7,461	0	0	0	0	7	7	7	70	70	70	0	14	29	0	0	0	0	77	91	106
	Mid-Continent Coal and Coke Company: Coal Canyon Mine	2,020.00	2,020	0	0	0	0	0	19	19	0	34	34	0	46	46	0	0	0	0	0	99	99
	Cottonwood Creek No. 1 and No. 2 mines	5,567.33	5,113	0	0	0	0	0	10	10	0	16	16	0	35	35	0	0	0	0	0	61	61
	Sheridan Enterprises: 3/ Loma Project	15,432.00	14,935	20	0	497	497	3	45	45	16	57	74	0	30	40	0	0	0	20	39	649	676
	GEX Colorado Company: Cameo No. 1 Mine	4,814.72	2,560	0	7	7	7	0	0	0	165	165	165	51	51	51	0	0	0	0	223 2/	223 2/	223 2/
	Cameo No. 2 Mine			0	0	0	0	0	0	0	10	10	10	0	0	0	0	0	0	0	10	10	10
			GEX Colorado Subtotals:	0	7	7	7	0	0	0	175	175	175	51	51	51	0	0	0	0	233	233	233
	Subtotal	44,412.05	33,289	20	7	504	504	10	81	81	261	352	369	51	176	201	0	0	0	20	349	1,133	1,175

Note: For the purposes of this analysis it was assumed that a period of 5 years would be needed to reclaim disturbed areas.

1/ Anschutz' M&R plan proposes to extend the existing workings from private coal onto federal coal some time after 1990. See Anschutz Coal Corporation under Existing Operations on this table for acreage disturbed through 1990.

2/ The 233 acres of disturbance to result from construction of Cameo No. 1 and No. 2 mines includes only 90 acres of disturbance which would result from the site-specific proposed federal action.

3/ Estimated acreage disturbances for the proposed water line, power line, and railroad spur corridor are included in acreage disturbance for railroads.

TABLE R1-2

MOST PROBABLE LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROJECTED COAL MINING DEVELOPMENT IN WEST-CENTRAL COLORADO BY 1990: ACREAGE DISTURBED
(Continued)

Map Unit	Company and Mine Name	Total Project Acres	Federal Lease Acres (in project acres)	Total Disturbance as of 1977	Cumulative Surface Disturbance (acres): Railroads 1980	Railroads 1985	Railroads 1990	Roads 1980	Roads 1985	Roads 1990	Mine Facilities 1980	Mine Facilities 1985	Mine Facilities 1990	Refuse Disposal 1980	Refuse Disposal 1985	Refuse Disposal 1990	Power Lines and Communications Lines 1980	Power Lines and Communications Lines 1985	Power Lines and Communications Lines 1990	Cumulative Total Disturbed: Base Level 1977	Cumulative Total Disturbed 1980	Cumulative Total Disturbed 1985	Cumulative Total Disturbed 1990
	Existing Operations:																						
	Colorado Westmoreland, Inc.: Orchard Valley Mine	608	311	139	-13	-13	-13	-5	-5	-2	0	0	1	2	8	15	3	3	5	139	126	132	145
	U.S. Steel Corporation: Somerset Mine	7,600	4,095	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	39	39	39
	Sunflower Energy Corporation: Blue Ribbon Mine	240	80	10	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	10	11	11	11
	Atlantic-Richfield Company (Bear Coal Company operator): Bear Mine	12,578	7,461	25	0	0	0	0	0	0	0	0	-25	0	0	0	0	0	0	25	25	25	0 4/
	Western Slope Carbon, Inc.: Hawksnest East Mine, Hawksnest No. 3 Mine	1,260	1,250	35	14	14	14	0	0	0	0	0	0	15	40	65	0	0	0	35	64	89	114
	Belden Enterprises Inc.: Red Canyon No. 1 Mine	60	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	17	17	17
	Coalby-Red Canyon Mine	100	40	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	18	18	18
	Quinn Coal Company: Tomahawk Strip Mine	480	0	30	0	0	0	0	0	0	0	0	0	20	40	65	0	0	0	30	50	70	95
	General Exploration: Roadside Mine	1,360	810	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	60	60	60
	Coal Fuels Corporation: Farmers Mine	440	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	26	26	26
	Louis Bendetti Coal Co.: Eastside Mine	500	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10

4/ 25 acres of existing disturbance will be reclaimed as the Bear Mine operation ceases and the Mt. Gunnison No. 1 Mine opens.

TABLE R1-2

MOST PROBABLE LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROJECTED COAL MINING DEVELOPMENT IN WEST-CENTRAL COLORADO BY 1990: ACREAGE DISTURBED
(Continued)

Map Unit	Company and Mine Name	Total Project Acres	Federal Lease Acres (in project acres)	Total Disturbance as of 1977	Cumulative Surface Disturbance (acres): Railroads 1980	Railroads 1985	Railroads 1990	Roads 1980	Roads 1985	Roads 1990	Mine Facilities 1980	Mine Facilities 1985	Mine Facilities 1990	Refuse Disposal 1980	Refuse Disposal 1985	Refuse Disposal 1990	Power Lines and Communications Lines 1980	Power Lines and Communications Lines 1985	Power Lines and Communications Lines 1990	Cumulative Total Disturbed: Base Level 1977	Cumulative Total Disturbed 1980	Cumulative Total Disturbed 1985	Cumulative Total Disturbed 1990
	Existing Operations: (cont.)																						
	Henry Bendetti Coal Co.: NuGap No. 3 Mine	800	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10
	Mid-Continent Coal and Coke Company: Coal Basin Mines	6,050	5,310	290	0	0	0	0	0	0	0	0	0	15	40	65	0	0	0	290	305	330	355
	Carbon King, Ltd.: Sunlight Mine	480	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2
	O.C. Mine Company: Ohio Creek No. 2 Mine	80	80	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10
	Peabody Coal Company: Nucla Strip Mine		0	220	0	0	0	0	0	0	0	0	0	20	80	120	0	0	0	220	240	300	340
	Western States Coal Company: Fairview Mine	600	0	0	0	0	0	0	0	0	0	10	10	0	15	40	0	0	0	0	0	25	50
	Anchor Coal Company: Edward's Mine	280	280	0	0	0	0	0	0	0	5	5	5	0	0	0	0	0	0	0	5	5	5
	Anschutz Coal Corporation: North Thompson Creek No. 1 and No. 3 Mines	(2,800) 5/	0	46	40	40	40	0	0	0	0	0	0	0	0	0	0	0	0	46	86	86	86
	Subtotal	33,516	19,717	987	41	41	41	-5	-5	-2	5	15	-20	73	224	371	3	3	5	987	1,104	1,265	1,393
	TOTAL	77,928.05	53,006	1,007	48	545	545	5	76	79	266	367	349	124	400	572	3	3	5	1,007	1,453	2,398	2,568

5/ This acreage is included in the total 4,000 acres listed for Anschutz under Site-Specific Actions at the beginning of this table.

TABLE R1-3

MOST PROBABLE LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROJECTED COAL MINING DEVELOPMENT IN WEST-CENTRAL COLORADO BY 1990: EMPLOYMENT AND MARKETS

Map Unit	Company and Mine Name	Employment 1977 Const./Perm.	Employment 1980 Const./Perm.	Employment 1985 Const./Perm.	Employment 1990 Const./Perm.	Estimated Number and Direction of Unit Trains per Year 1977	1980	1985	1990	Market Area
	Site-Specific Actions:									
	Anschutz Coal Corporation: North Thompson Creek No. 1 and No. 3 mines a/	0 / 0	0 / 0	0 / 0	0 / 0	0	0	0	0	
	Atlantic-Richfield Company: Mt. Gunnison No. 1 Mine	0 / 0	70 / 10	0 / 565	0 / 565	0	0	213 East	244 East	Unspecified utilities market.
	Mid-Continent Coal and Coke Company: Coal Canyon Mine	0 / 0	0 / 0	0 / 60	0 / 200	0	0	20 East	50 East	Unspecified market.
	Cottonwood Creek No. 1 and No. 2 Mines	0 / 0	0 / 0	0 / 400	0 / 400	0	0	40 East	100 East	Unspecified market.
	Sheridan Enterprises: Loma Project	0 / 30	92 / 83	0 / 470	0 / 900	0	0	351 East	500 East	Unspecified market.

a/ Anschutz' M&R plan proposes to extend the existing workings from private coal onto federal coal some time after 1990. See Anschutz Coal Corporation under Existing Operations on this table for employment, etc., through 1990.

DEPARTMENT OF THE INTERIOR

FINAL

ENVIRONMENTAL STATEMENT

PROPOSED

DEVELOPMENT OF COAL RESOURCES

IN

WEST-CENTRAL COLORADO

Prepared by the

DEPARTMENT OF THE INTERIOR

Frank Gregg

Director, Bureau of Land Management
Washington, D. C.

ERRATA

1. In order to comply with the requirements of the Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201 et seq.), the following wording change should be made in volumes 1 and 2 throughout the chapter 8s, Alternatives to the Proposed Action(s).

   Wherever the wording, "...approval subject to such additional requirements or modifications as may be imposed under existing laws and regulations..." appears, replace with, "...approval after such additional requirements or modifications as may be imposed under existing laws and regulations..."

2. There are no pages numbered 217 or 218 in Volume 1.

SUMMARY

Draft ( )   Final (x)   Environmental Statement

Department of the Interior, Bureau of Land Management.

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

2. Brief Description of Actions: The proposed actions are the review and consideration for approval of six mining and reclamation plans to mine federal and private coal on existing leases in west-central Colorado. This environmental statement is developed in two parts: (1) a two-level analysis of regional impacts (aggregate impacts of the six proposed actions and cumulative impacts of coal- and non-coal-related development) and (2) site-specific analyses of the six proposed actions. Annual production for the proposed actions would total 1.53 million tons by 1980, 7.63 million tons by 1985, and 10.54 million tons by 1990. Combined with existing mining expected to continue through 1990, a total of 15.56 million tons would be produced annually by that date.

3. Summary of Environmental Impacts of the Proposed Actions by 1990:

A. The proposed actions would not cause the regional air quality to deteriorate; however, within and at the boundaries of some mines, the Class II PSD increments and Colorado air quality standards for total suspended particulates would be exceeded.

B. Surface subsidence would cause some alteration of the existing topography on approximately 3,920 acres and may cause significant local impacts to water resources in the Mount Gunnison and Cottonwood Creek areas.

C. Approximately 87.94 million tons of coal would be produced by 1990.

D. An estimated 3,920 acres of potential coal aquifers would be removed. No impact on the regional ground-water system is predicted, but local disruptions may occur in the Somerset coal field.

E. Stream channels would be temporarily altered on approximately 2,467 acres.

F. Increased consumptive use of water would reduce water yield from the Upper Main Stem of the Colorado River by 3,920 acre-feet, which would increase the salinity in the Colorado River below Hoover Dam by 0.2 milligrams per liter. However, salt concentration downstream would be more than offset by the effects of the Grand Valley salinity control project.

G. A short-term increase in sediment yield to receiving streams would occur during construction phases. Any impacts on channel morphology and aquatic biology would be local and very minor. A minor increase in water pollution from sewage may degrade some aquatic habitats.

H. Soil and vegetative productivity would be lost on 2,275 acres due to mine-site development, but it would be regained over time following successful reclamation or natural revegetation. However, successful revegetation in the Cottonwood Creek, Coal Canyon, Cameo, and Loma Project areas may be difficult due to arid climate and erosive soils.

I. Wildlife habitat, carrying capacity, and populations would be lost on 1,175 acres for the lives of the mines. Peregrine falcon habitat may be disturbed in the Cottonwood Creek, Coal Canyon, Cameo area. Mining activity at the proposed Coal Canyon Mine could adversely impact the Little Bookcliffs Wild Horse Area.

J. Cultural resources could be disturbed or destroyed by surface disturbance (including subsidence) or vandalism.

K. All transportation arteries including rail lines would experience heavier average daily traffic, which could result in longer waiting times at railroad crossings, increased accidents, and deterioration of roads.

L. Livestock forage would be reduced by 69 animal unit months annually. Urban expansion would encroach on some irrigated croplands.

M. The present visual quality of some landscapes would be changed.

N. Population of the region would increase by 15,200 people.

O. Social support and recreational facilities would not keep pace with population increases in some areas.

P. The six proposed mines would employ 2,464 people, reducing unemployment and generating additional employment.

Q. Total payrolls from the mines would be about $39 million by 1990, which would generate a total increase in regional income of $60 million.

4. Alternatives Considered: Seven alternatives are presented in chapter 8: Approval as Proposed, Rejection on Environmental or Other Grounds, Approval or Rejection in Part, Approval Subject to Additional Requirements or Modifications, Defer Action, Prevention of Further Development (which includes the No Action Alternative), and Socioeconomic Alternatives Available to State and Local Governments. In addition, two scenarios are presented: a low-level scenario based on 4.19 million tons of coal produced by 1990 and a high-level scenario based on 33.70 million tons of coal produced by 1990. Alternatives specific to each proposed action are presented in the appropriate chapter 8s in volume 2.

5. Comments on the draft environmental statement were requested from various agencies, state clearing house, and interest groups. See attached.

6. Date draft statement was made available to EPA and the public: July 28, 1978 (DES-78-28)

Date final statement was made available to EPA and the public:

COORDINATION IN REVIEW OF DRAFT ENVIRONMENTAL STATEMENT

Major organizations that were sent a copy of the draft environmental statement for public review and comment:

Federal

Advisory Council on Historic Preservation*
Department of Agriculture
- Rural Electrification Administration
- Soil Conservation Service*
- U.S. Forest Service*

Department of Commerce
Department of Defense
- Army Corps of Engineers*

Department of Energy
Department of Health, Education and Welfare*
Department of Housing and Urban Development*
Department of the Interior
- Bureau of Reclamation*
- Bureau of Mines*
- Fish and Wildlife Service*
- Heritage Conservation and Recreation Service*
- National Park Service
- Office of Surface Mining*

Environmental Protection Agency*
Interstate Commerce Commission
Department of Labnr
- Occupational Safety and Health Administratinn
- Mine Safety and Health Administration

Office of Economic Opportunity
Office of Management and Budget
Department of Transportation*
Water Resources Council

State

The state of Colorado Clearing House cnordinated comments from all interested state agencies.

Local

All entities included under the local contacts heading of Chapter 9 (volume 3) were requested to privide comments on the document.

Nongovernment Organizations

American Horse Protective Association
American Institute nf Mining Engineers
American Mining Congress
American Sportsman's Club
Anschutz Coal Corporation*
Atlantic Richfield Company*
Bear Coal Company
Belden Enterprises, Inc.
Bendetti Brothers
Carbon King, Ltd.

Nongovernment Organizations - continued

Coal Fuels Corporation
Colorado Association of Commerce and Industry
Colorado Cattlemen's Association
Colorado Environmental Health Association
Colorado Farm Bureau
Colorado Four Wheel Drive Clubs, Inc.
Colorado Mining Association
Colorado Mountain Club
Colorado Open Space Council*
Colorado Sportsman's Association
Colorado Stock Growers Association
Colorado University Wilderness Group
Colorado Westmoreland, Inc.
Colorado Wildlife Association
Colorado Wool Growers Association
Defenders of Wildlife
Denver and Rio Grande Western Railroad
Denver Wildlife Research Center
Empire Energy
Envirnnmental Defense Fund
Environmental Policy Institute
Friends of the Earth
GEX Colorado Company*
International Society for the Protection of Mustangs and Burros*
Izaak Walton League of America
Keep Colorado Beautiful
League of Women Voters*
Mid-Continent Coal and Coke Company
National Audubon Society
National Council of Public Land Users
National Environmental Health Association
Natinnal Wildlife Federation*
Natural Resource Defense Council, Inc.*
Nature Conservancy
O. C. Mine Company
Peabody Coal Company
Quinn Coal Company
Recreational Use of Public Land Committee
Rocky Mountain Association of Geologists
Rocky Mountain Center on Environment
Rocky Mountain Chapter, Sierra Club*
Sheridan Enterprises*
Society fnr Range Management
Sunflower Energy Corporation
Thorne Ecological Institute
Trout Unlimited
U. S. Steel Corporation
Weaver Brothers
Western Slope Carbon, Inc.
Western Slope Energy Research Center*
Western States Coal Company
Wilderness Society
Wildlife Society, Colorado Chapter

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*Responded with written comments.

VOLUME 1

TABLE OF CONTENTS

CHAPTER 1

DESCRIPTION OF THE PROPOSAL

Background

Scope

The proposed federal actions analyzed in this environmental statement (ES) are the review and consideration for approval of six mining and reclamation (M&R) plans for underground coal mining on existing federal leases in west-central Colorado. (Note: Mid-Continent Coal and Coke Company's proposed Coal Canyon Mine is primarily an underground mining operation; however, 40 acres are proposed for auger mining, as discussed in the Coal Canyon chapter 1 in volume 2. The five other proposed operations would all be underground mines.) In accordance with Section 102(2)(c) of the National Environmental Policy Act of 1969 (NEPA), the Department of the Interior has determined that approval of these six M&R plans would constitute a major federal action. In addition, it has been concluded that these six site-specific proposed actions, in combination with other existing and possible future minerals development on public and private lands, could have a significant cumulative impact on regional values and resources. Therefore, the purpose of the West-Central Colorado Coal Environmental Statement (ES) is to analyze through 1990 the site-specific environmental impacts of each of the six proposed M&R plans (volume 2) and the aggregate impacts of these proposals in the context of other projected development in the seven-county ES area (volume 1). Impacts that extend beyond the principal ES area are analyzed to the extent that they are significant to the region and are more associated with the proposed coal actions than with other actions outside the region. Specific time frames of analysis in this ES are 1980, 1985, and 1990.

This regional ES examines the aggregate impacts of the six proposed M&R plans in the context of four possible levels of coal-related and non-coal related development. Under the most probable level (mid-level) of development, which is covered in chapters 1 through 7 of this volume, approximately 15.56 million tons of coal would be produced annually by 1990 in the ES area. The most probable level would include (1) the full implementation of all six site-specific M&R plans (see Specific Proposed Actions below), (2) the development of other private and federal coal reserves (see Regional Coal Projections later in this chapter), and (3) the development of non-coal-related projects (see Other Major Regional Development near the end of this chapter). The production level evaluated as most probable is dependent in part on federal approval of the six M&R plans and, in some cases, future analysis and consideration for approval of short-term competitive leases under agreed-upon criteria. However, the Secretary of the Interior is not proposing a particular production level for coal in this ES region. Instead, he is considering actions within his authority that will allow federal coal to be available where needed and under environmentally acceptable conditions to meet market demands and the energy needs of the nation. Moreover, any future proposals beyond the six site-specific M&R plans would require environmental assessment at the time they are submitted.

The other three possible levels of development are considered in chapter 8, Alternatives to the Proposed Actions. They are (1) the low-level scenario, which would result if no new coal development were allowed after January 1, 1978 (4.19 million tons of coal per year by 1990); (2) the high-level scenario, which would result from maximum development of coal resources (33.8 million tons of coal per year by 1990); and (3) the diligent-development and continuous operations alternative, which would allow development of current inactive federal leases only to meet the requirements of the diligent development and continuous operations sections of the Federal Coal Leasing Amendment Act (9.41 million tons of coal per year by 1990). Neither the low-level scenario nor the high-level scenario is an alternative to the proposed actions. Both scenarios are included to provide additional perspective on the most probable level of development (see chapter 8).

ES Area

The ES area includes Delta, Garfield, Gunnison, Mesa, Montrose, Ouray, and Pitkin counties in west-central Colorado, covering 9,285,650 acres of private and public lands (see map 1 in the appendix and figure R1-1). This region is considered an area of economic interdependence, with Grand Junction as the primary economic center and Montrose,

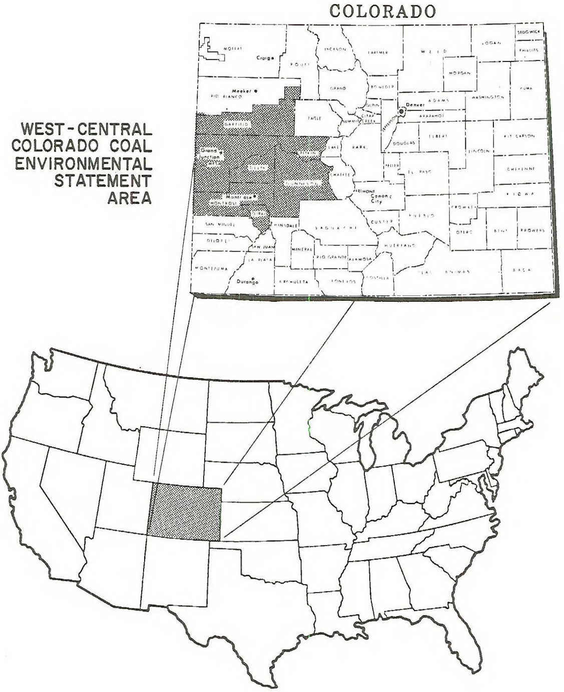
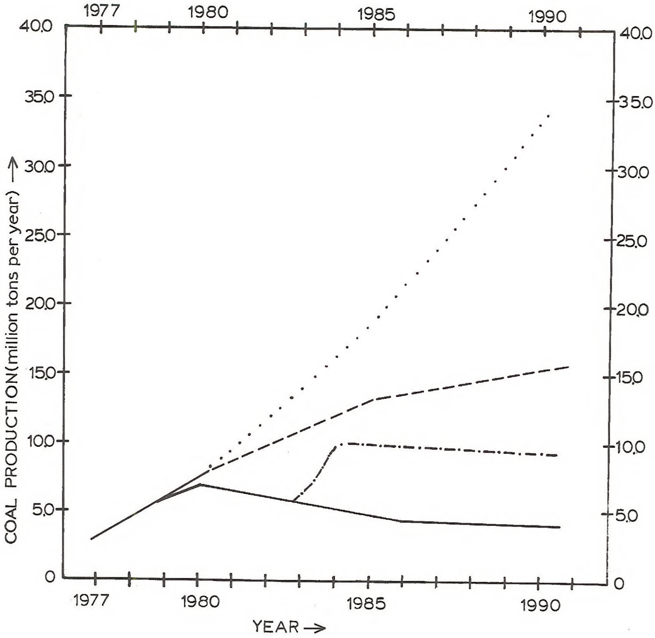


Figure R1-1. LOCATION MAP



—— Low-level production - production from private and federal reserves which requires no federal action.

—·— Diligent development production - production from private reserves, federal leases with approved M&R plans and development of inactive leases only to meet diligent development, continuous operations requirements.

— — Mid-level production - production from both federal and private reserves which will occur with currently anticipated federal actions.

····· High-level production - production at a maximum level.

Figure R1-2. Projected west-central Colorado coal production (low-level, mid-level, high-level, diligent development)

Delta, and Glenwood Springs as subcenters. Although some portions of each county probably would not be impacted, all of the area within the county boundaries has been included for evaluation because most sociological, economic, and resource data are compiled by county.

The ES area lies south of and adjacent to the area for which the Northwest Colorado Coal Environmental Statement was prepared by the Bureau of Land Management (BLM). That regional ES assessed the impacts of projected coal development for 5.6 million acres in Routt, Moffat, and Rio Blanco counties in Colorado. The Northwest ES was made available to the Council on Environmental Quality (CEQ) and the public in January 1977. Although most of the impacts identified in the Northwest ES are not closely related to those that would occur in west-central Colorado, the impacts due to rail transportation of coal outside the regions are closely related. The assessment of environmental impacts of projected coal development in the northwest Colorado region has been updatted in the Northwest Colorado Coal Environmental Report which was made available to the public on December 4, 1978.

Agency Roles In Preparing ES

This ES was prepared by the Department of the Interior as a joint effort of the BLM and the Geological Survey (USGS). In addition employees of the U.S. Forest Service (USFS) and the state of Colorado participated as team members. The ES team examined environmental impacts on public lands administered by the BLM, on national forest systems lands administered by the USFS, on private land overlying federally leased subsurface coal, on private land and coal to be developed in conjunction with federal leases, and on private land and coal to be developed without federal involvement before 1990.

Future NEPA Review Points

This ES does not propose new coal leasing nor does it commit the Secretary of the Interior to a new coal leasing program or to the issuance of new coal leases. Any future coal-related actions beyond the six M&R plans proposed and analyzed in this ES may require additional assessment of environmental impacts in compliance with the National Environmental Policy Act of 1969 (NEPA).

Examples of coal-related actions which may require environmental assessment in compliance with NEPA include the following:

1. Issuance of federal coal leases under current short-term criteria;
2. Approval of exploration and/or mining and reclamation plans not examined site specifically in this ES, including new plans on existing leases and modifications of existing operations on federal leases;
3. Approval and issuance of applications for rights-of-way for ancillary facilities, including roads, railroad spurs, power lines, telephone lines, water pipelines, and conveyor systems to be constructed on public lands outside the immediate area of operations;
4. Reevaluation of mining plans at a minimum of every five years for renewal in accordance with the Surface Mining Control and Reclamation Act, Sect. 506(b); and
5. Exchange or replacement of unleased federal coal for leased federal coal located in areas of high environmental concern, pursuant to the Federal Coal Leasing Amendment Act (FCLAA), and regulations published December 23, 1977, 43(CFR): 3526, *Federal Register*, Vol. 42, No. 247, page 64346.

Specific Proposed Actions

Applications

The proposed federal actions for the regional ES are the review and consideration for approval of six comprehensive M&R plans describing the development of underground mining operations (plus 40 acres of auger mining at the proposed Coal Canyon Mine) on all or parts of seventeen existing federal coal leases and adjacent private coal reserves. The following six companies submitted the M&R plans which are analyzed as site-specific proposed action in volume 2:

1. Anschutz Coal Corporation: North Thompson Creek No. 1 and No. 3 mines;
2. Atlantic Richfield Company: Mt. Gunnison No. 1 Mine;
3. Mid-Continent Coal and Coke Company: Coal Canyon Mine;
4. Mid-Continent Coal and Coke Company: Cottonwood Creek No. 1 and No. 2 mines;
5. GEX Colorado Company: Cameo No. 1 and No. 2 mines; and
6. Sheridan Enterprises: Loma Project.

The Area Mining Supervisor of the USGS has accepted each of these six M&R plans as suitable for environmental analysis in this environmental statement. The interim regulations 30(CFR): 700 required under Sections 502 and 523 of the Surface Mining Control and Reclamation Act (SMCRA) of 1977 (PL 95-87) were published in the *Federal Register* (Volume 42, No. 239, p. 62639-62716) on December 13, 1978. Of the six M&R plans, three were submitted prior to December 13, 1977; two were submitted after December 13, 1977; and one, originally submitted before December 13, 1977, was resubmitted after that date. None of the M&R plans has been officially reviewed for compliance with SMCRA, and the applicants' plans may not fully reflect the requirements of the interim regulations. However, it is believed that the M&R plans present sufficient data to permit analysis of impacts that will be associated with mining in this area. However, in this ES the interim regulations are considered as requirements with which the M&R plans will have to comply as they will have to comply with all other applicable regulations.

Each M&R plan will be returned to the applicant for revision in accordance with the appropriate regulations. As each applicant's plan is resubmitted to the Office of Surface Mining (OSM), it will be evaluated for compliance with the requirements of 30(CFR): 211 and 30(CFR): 700. The M&R plans will not be considered for approval until they conform to all applicable federal requirements. In addition, the BLM must evaluate all the M&R plans in relation to the Department of the Interior's proposed unsuitability criteria developed in compliance with Section 522 of SMCRA.

The mining operations described in four of the M&R plans are wholly dependent upon approval of the M&R plan. In these four cases, all mining on the property (including mining of any associated private coal) and construction of surface facilities would commence only after the M&R plan is approved. However, in the other two cases (Anschutz Coal Corporation and GEX Colorado Company), mining of adjacent private coal reserves has begun, and construction of surface facilities is either under way (GEX Colorado) or is largely completed (Anschutz).

Surface ownership on the mine properties of the six proposals includes 24,724 acres of public land; 6,747 acres of national forest systems land; and 12,942 acres of private land; totaling 44,412 project acres containing 307 million tons of recoverable coal reserves.

Tables R1-1, R1-2, and R1-3 summarize production, acreage disturbed, employment, etc., for the proposed actions. These proposals are analyzed individually in the site-specific volume of this ES. (A discussion of typical mining operations can be found in the appendix, volume 3.) The following is a brief description of each proposal.

ANSCHUTZ COAL CORPORATION: NORTH THOMPSON CREEK NO. 1 AND NO. 2 MINES

On November 18, 1976, Anschutz Coal Corporation submitted an M&R plan to USGS for the company's federal coal lease, C-08173. Under the M&R plan, Anschutz proposes to extend workings from its existing private coal operation onto a contiguous 1,200-acre parcel of land whose surface is administered by the USFS and which is a portion of the existing federal coal lease C-08173 (containing a total of 2,480 acres; no M&R plan has been filed on the remainder). The total mine property, including both federal and private coal reserves, would involve approximately 4,000 acres. Anschutz submitted a revised M&R plan on April 17, 1978, which clarified some of the information contained in the original M&R plan.

If both federal and private coal are mined, the operation would last 30 years and employ 320 people at full production of 1 million tons per year. Anschutz has not proposed any surface-disturbing activities which would result from development of federal coal; the company would use existing or proposed facilities constructed on private land for the use by the existing operation.

The North Thompson Creek mines are located on private land 12 miles southwest of Carbondale, Colorado, in Pitkin County (see map 1 in volume 3). Anschutz' existing private operation is discussed under Regional Coal Projections later in this chapter.

ATLANTIC RICHFIELD COMPANY: MT. GUNNISON NO. 1 MINE

On August 4, 1976, Atlantic Richfield Company (ARCO) submitted an M&R plan to the USGS covering proposed underground coal production from the company's federal coal leases C-1362, C-0117192, and D-044569, totaling 7,460 acres, together with 5,118 acres of adjacent private coal leases. Of the federal coal lease acres, 96 acres are public lands; 5,546 acres are national forest system lands; and 1,818 acres are private surface owned by ARCO with underlying federal coal reserves.

The proposed Mt. Gunnision No. 1 Mine would be located approximately 1 mile east of Somerset, Colorado, in Gunnison County (see map 1 in the appendix volume). This new mine would produce 2.4 million tons of coal per year for 27 years to supply unspecified utilities. The operation would utilize continuous mining equipment to develop longwall panels and then mine the panels on retreat using longwall methods. Approximately 106 acres would be disturbed from mining and surface facilities by 1990. At full production the mine would employ 565 persons.

MID-CONTINENT COAL AND COKE COMPANY: COAL CANYON MINE

On October 13, 1977, Mid-Continent Coal and Coke Company, for Mid-Continent Limestone Company, submitted an M&R plan to the USGS covering proposed coal production from the company's federal leases C-037277, C-059420, and D-040389, totaling 2,020 acres of public lands.

The proposed Coal Canyon Mine would be located 4.5 miles northeast of Palisade, Colorado, in Mesa County (see map 1 in the appendix volume). This new mining operation would produce 0.5 mil-

TABLE R1-1

MOST PROBABLE LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROJECTED COAL MINING DEVELOPMENT IN WEST-CENTRAL COLORADO BY 1990: PRODUCTION

Map Unit	Company and Mine Name	Mining Method	Recoverable Reserves (million tons)	Annual Coal Production (million tons/year) 1977	1980	1985	1990	Time Points: Start Construction	Full Mine Operation	Mine Life (years)
	Site-Specific Actions:									
	Anschutz Coal Corporation: North Thompson Creek: No. 1 and No. 3 mines a/	Retreating longwall and advancing entries by continuous mining units (underground)	-	0.00	0.00 a/	0.00 a/	0.00 a/	-	-	30
	Atlantic-Richfield Company: Mt. Gunnison No. 1 Mine	Retreating longwall and advancing entries by continuous mining units (underground)	77	0.00	0.00	2.13	2.44	1980	1986	27
	Mid-Continent Coal and Coke Company: Coal Canyon Mine	Auger, retreating longwall and advancing entries by continuous mining units, conventional room & pillar by continuous mining units (underground)	8	0.00	0.00	0.20	0.50	1983	1989	15-25
	Cottonwood Creek: No. 1 and No. 2 mines	Retreating longwall and advancing entries by continuous mining units (underground)	62	0.00	0.00	0.40	1.00	1982	1988	25
	Sheridan Enterprises: Loma Project	Retreating longwall and advancing entries by continuous mining units, conventional room & pillar by continuous mining units (underground)	100	0.07	0.73	3.50	5.00	1977	1986	20

a/ Anschutz' M&R plan proposes to extend the existing workings from private coal onto federal coal by 1980, which would extend the life of the existing mines for another fifteen years. See Anschutz Coal Corporation under Existing Operations on this table for proposed annual production to 1990, which would be the same with or without the proposed action.

TABLE R1-1

MOST PROBABLE LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROJECTED COAL MINING DEVELOPMENT IN WEST-CENTRAL COLORADO BY 1990: PRODUCTION (continued)

Map Unit	Company and Mine Name	Mining Method	Recoverable Reserves (million tons)	Annual Coal Production (million tons/year) 1977	1980	1985	1990	Time Points: Start Construction	Full Mine Operation	Mine Life (years)
Site-Specific Actions: (cont.)										
	GEX Colorado Company: Cameo No. 1 Mine	Conventional room & pillar by continuous mining units (underground)	30	0.00	0.80	1.00	1.20	1977	1986	47 (to 2025)
	Cameo No. 2 Mine	Conventional room & pillar by continuous mining units (underground)		0.00	0.00	0.40	0.40	1982	1984	43 (to 2025)
		Subtotal	30	0.00	0.80	1.40	1.60			
		Subtotal	277	0.07	1.53	7.63	10.54			
Existing Operations:										
	Colorado Westmoreland, Inc.: Orchard Valley Mine	Conventional room & pillar by continuous mining units (underground)	Unknown	0.29	0.70	0.70	0.70	1976	1979	Indefinite
	U.S. Steel Corporation: Somerset Mine	Conventional room & pillar by continuous mining units (underground)	Not available	0.92	0.94	0.94	0.94	1961	1970	25 + (or indefinite)
	Sunflower Energy Corporation: Blue Ribbon Mine	Conventional room & pillar (underground)	0.7	0.01	0.07	0.07	0.00	1977	1980	10 (to 1988)

TABLE R1-1

MOST PROBABLE LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROJECTED COAL MINING DEVELOPMENT IN WEST-CENTRAL COLORADO BY 1990: PRODUCTION (continued)

Map Unit	Company and Mine Name	Mining Method	Recoverable Reserves (million tons)	Annual Coal Production (million tons/year)				Time Points		
				1977	1980	1985	1990	Start Construction	Full Mine Operation	Mine Life (years)
	Existing Operations: (cont.)									
	Atlantic-Richfield Company (Bear Coal Company operator): Bear Mine	Conventional room & pillar by continuous mining units (underground)	Not available	0.23	0.24	0.00	0.00	1932	1937	49 (1932-1981)
	Western Slope Carbon, Inc.: Hawksnest East Mine	Conventional room & pillar by continuous mining units (underground)	Not available	0.19	0.60	0.75	0.75	1975	1981	Indefinite
	Hawksnest No. 3 Mine			0.01	0.00	0.00	0.00	1970	1972	Indefinite
			Subtotal	0.20	0.60	0.75	0.75			
∞	Belden Enterprises, Inc.: Red Canyon No. 1 Mine	Conventional room & pillar (underground)	Unknown	(412 tons)	0.00	0.00	0.00	1916	1916	63 (1916-1979)
	Coalby-Red Canyon Mine	Conventional room & pillar (underground)	2	0.00	0.01	0.01	0.01	1978	1978	19
	Quinn Coal Company: Tomahawk Strip Mine	Surface	3	0.02	0.25	0.25	0.00	1976	1980	1988
	General Exploration: Roadside Mine	Conventional room & pillar by continuous mining units (underground)	9	0.30	0.80	0.20	0.00	1973	1975	14 (to 1987)
	Coal Fuels Corporation: Farmers Mine	Retreating longwall and advancing entries by continuous mining units (underground)	7	0.00	0.20	0.20	0.20	1977	1980	35

TABLE R1-1

MOST PROBABLE LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROJECTED COAL MINING DEVELOPMENT IN WEST-CENTRAL COLORADO BY 1990: PRODUCTION (continued)

Map Unit	Company and Mine Name	Mining Method	Recoverable Reserves (million tons)	Annual Coal Production (million tons/year) 1977	1980	1985	1990	Time Points: Start Construction	Full Mine Operation	Mine Life (years)
Existing Operations: (cont.)										
	Louis Bendetti Coal Co.: Eastside Mine	Raise methods and recovery on steeply pitching beds (updip or upslope mining) (underground)	Unknown	(257 tons)	(1,000 tons)	(1,000 tons)	(1,000 tons)	1973	1977	Unknown
	Henry Bendetti Coal Co.: NuGap No. 3 Mine	Raise methods and recovery on steeply pitching beds (updip or upslope mining) (underground)	Unknown	(397 tons)	(1,000 tons)	(1,000 tons)	(1,000 tons)	1970	1977	Unknown
	Mid-Continent Coal and Coke Company: Coal Basin Mines	Advancing longwall and conventional room & pillar by continuous mining units (underground)	Not available	0.92	0.90	0.90	0.90	1973	1975	Not available
	Carbon King, Ltd.: Sunlight Mine	Conventional room & pillar (underground)	Unknown	(1,792 tons)	0.03	0.05	0.05	1977	Unknown	Unknown
	O.C. Mine Company: Ohio Creek No. 2 Mine	Conventional room & pillar (underground)	0.04	(3,696 tons)	(4,000 tons)	(4,000 tons)	0.00	1968	1969	20 (to 1988)
	Peabody Coal Company: Nucla Strip Mine	Surface	Not available	0.09	0.10	0.10	0.10	1963	1972	Not available

TABLE R1-1

MOST PROBABLE LEVEL OF OEVELOPMENT OF PROPOSEO, EXISTING, ANO PROJECTED COAL MINING DEVELOPMENT IN WEST-CENTRAL COLORAOO BY 1990: PRODUCTION (continued)

Map Unit	Company and Mine Name	Mining Method	Recoverable Reserves (million tons)	Annual Coal Production (million tons/year) 1977	1980	1985	1990	Time Points: Start Construction	Full Mine Operation	Mine Life (years)
Existing Operations: (cont.)										
	Western States Coal Company: Fairview Mine	Conventional room & pillar by continuous mining units (underground)	7	0.00	0.00	0.25	0.25	Unknown	by 1985	less than 30
	Anchor Coal Company: Edward's Mine	Conventional room & mining units (underground)	1.1	0.00	0.12	0.12	0.12	1979	1979	11
	Anschutz Coal Corporation: North Thompson Creek No. 1 and No. 3 mines	Retreating longwall and advancing entries by continuous mining units (underground)	30	0.02	1.0	1.0	1.0	1974	1980	15
			Subtotal	3.00	5.96	5.54	5.02			
			TOTAL	3.07	7.49	13.17	15.56			

TA8LE R1-3

MOST PROBABLE LEVEL OF OEVELOPMENT OF PROPOSED, EXISTING, ANO PROJECTEO COAL MINING OEVELOPMENT IN WEST-CENTRAL COLORAOO BY 1990: EMPLOYMENT ANO MARKETS
(continued)

Map Unit	Company and Mine Name	Employment 1977 Const./Perm.	Employment 1980 Const./Perm.	Employment 1985 Const./Perm.	Employment 1990 Const./Perm.	Estimated Number and Direction of Unit Trains per Year 1977	1980	1985	1990	Market Area
Site-Specific Actions: (cont.)										
	GEX Colorado Company: Cameo No. 1 Mine	0 / 0	0 / 213	0 / 257	0 / 301	0	80 East	100 East	120 East	Mississippi Power Company, Jackson Co., Mississippi.
	Cameo No. 2 Mine	0 / 0	0 / 0	0 / 98	0 / 98	0	0	40 East	40 East	
	GEX Colorado Subtotal	0 / 0	0 / 213	0 / 355	0 / 399	0	80	140 East	160 East	
	Site-Specific Subtotals					0	80 East	764 East	1,054 East	
	Site-Specific Totals	0 / 30	162 / 306	0 / 1,850	0 / 2,464	0	80	764	1,054	
Existing Operations:										
	Colorado Westmoreland, Inc.: Orchard Valley Mine	200 / 100	0 / 160	0 / 160	0 / 160	29 East	70 East	70 East	70 East	No. Indiana Public Service Co., Hammond, Indiana; local domestic sales.
	U.S. Steel Corporation: Somerset Mine	0 / 298	0 / 298	0 / 298	0 / 298	92 West	94 West	94 West	94 West	Geneva works, Orem, Utah.

TABLE R1-3

MOST PROBABLE LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROJECTED COAL MINING DEVELOPMENT
IN WEST-CENTRAL COLORADO BY 1990: EMPLOYMENT AND MARKETS
(continued)

Map Unit	Company and Mine Name	Employment 1977 Const./Perm.	Employment 1980 Const./Perm.	Employment 1985 Const./Perm.	Employment 1990 Const./Perm.	Estimated Number and Direction of Unit Trains per Year 1977	1980	1985	1990	Market Area
	Existing Operations: (cont.)									
	Sunflower Energy Corporation: Blue Ribbon Mine	20 / 8	0 / 10	0 / 10	0 / 0	0	0	0	0	Local domestic market and public utilities (no information on locations available).
	Atlantic-Richfield Company (Bear Coal Company operator): Bear Mine	0 / 49	0 / 55	0 / 0	0 / 0	23 East	24 East	0	0	Various public utilities and industries; local domestic sales. (Bear and Hawksnest production are combined and shipped approximately once per week by unit train. This is broken out here into 23 for Bear and 20 for Hawksnest, in proportion to their production.)
	Western Slope Carbon, Inc.: Hawksnest East Mine, Hawksnest No. 3 Mine	20 / 102	0 / 150	0 / 200	0 / 200	20 East	60 East	75 East	75 East	Colorado Fuel and Iron, Pueblo, Colorado; local domestic sales.
	Belden Enterprises, Inc.:									
	Red Canyon No. 1 Mine	0 / 1	0 / 0	0 / 0	0 / 0	0	0	0	0	Local domestic sales only.
	Coalby-Red Canyon Mine	0 / 0	0 / 1	0 / 1	0 / 1	0	0	0	0	
	Quinn Coal Company: Tomahawk Strip Mine	3 / 5	0 / 18	0 / 18	0 / 0	0	0	0	0	Various unspecified utilities and local domestic sales.

TABLE R1-3

MOST PROBABLE LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROJECTED COAL MINING DEVELOPMENT IN WEST-CENTRAL COLORADO BY 1990: EMPLOYMENT AND MARKETS
(continued)

Map Unit	Company and Mine Name	Employment 1977 Const./Perm.	Employment 1980 Const./Perm.	Employment 1985 Const./Perm.	Employment 1990 Const./Perm.	Estimated Number and Direction of Unit Trains per Year 1977	1980	1985	1990	Market Area
	Existing Operations: (cont.)									
	GEX-Colorado Company: Roadside Mine	0 / 102	0 / 213	0 / 213	0 / 0	0	80 West	20 West	0	Arizona Electric Power Company, Page (or Benson), Arizona; local domestic sales.
	Coal Fuels Corporation: Farmers Mine	0 / 0	0 / 50	0 / 50	0 / 50	0	0	0	0	Not available (unspecified).
	Louis Bendetti Coal Co.: Eastside Mine	0 / 1	0 / 1	0 / 1	0 / 1	0	0	0	0	Local and domestic market.
	Henry Bendetti Coal Co.: NuGap No. 3 Mine	0 / 1	0 / 1	0 / 1	0 / 1	0	0	0	0	Local and domestic market.
	Mid-Continent Coal and Coke Company: Coal Basin Mines a/	0 / 344	0 / 492	0 / 492	0 / 492	145 West	140 West	140 West	140 West	U.S. Steel Geneva Works, Orem, Utah; Kaiser Steel Fontana Plant, Fontana, California.
	Carbon King, Ltd.: Sunlight Mine	0 / 4	0 / 10	0 / 10	0 / 10	0	0	0	0	Local and domestic market.
	O.C. Mine Company: Ohio Creek No. 2 Mine	0 / 5	0 / 6	0 / 6	0 / 0	0	0	0	0	Local and domestic market.
	Peabody Coal Company: Nucla Strip Mine	0 / 24	0 / 24	0 / 24	0 / 24	0	0	0	0	Nucla Power Plant, Nucla, Colorado; local and domestic market.

a/ Mid-Continent is using 60-ton coal cars.

TABLE R1-3

MOST PROBABLE LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROJECTED COAL MINING DEVELOPMENT IN WEST-CENTRAL COLORADO BY 1990: EMPLOYMENT AND MARKETS (continued)

Map Unit	Company and Mine Name	Employment 1977 Const./Perm.	Employment 1980 Const./Perm.	Employment 1985 Const./Perm.	Employment 1990 Const./Perm.	Estimated Number and Direction of Unit Trains per Year 1977	1980	1985	1990	Market Area
Existing Operations: (cont.)										
	Western States Coal Company: Fairview Mine	0 / 0	0 / 0	0 / 60	0 / 60	0	0	0	0	Local industrial and domestic market.
	Anchor Coal Company: Edward's Mine	0 / 0	0 / 30	0 / 30	0 / 30	0	13 East	13 East	13 East	Northern Indiana Public Service Co., Hammond, Indiana; local domestic sales (Anchor Coal trucks coal 7 miles to the Westmoreland loadout facilities).
	Anschutz Coal Corporation: North Thompson Creek No. 1 and No. 3 mines	0 / 112	0 / 320	0 / 320	0 / 320	0	100 West	100 West	100 West	Metallurgical market
	Existing Subtotals					72 East 237 West	167 East 414 West	158 East 354 West	158 East 334 West	
	Existing Totals	243 / 1,156	0 / 1,839	0 / 1,894	0 / 1,647	309	581	512	492	
	GRAND TOTAL	243 / 1,186	162 / 2,145	0 / 3,744	0 / 4,111	309	661	1,276	1,546	

lion tons of coal per year for 15 to 25 years to supply unspecified out-of-state utilities. The operation would utilize traditional room-and-pillar methods to develop longwall panels which would be mined on retreat by longwall methods; about 40 acres would be developed by auger mining. Approximately 99 acres would be disturbed by mining and surface facilities by 1990. At full production, the mine would employ 200 persons.

MID-CONTINENT COAL AND COKE COMPANY: COTTONWOOD CREEK NO. 1 AND NO. 2 MINES

On September 1, 1977, Mid-Continent Coal and Coke Company submitted an M&R plan to the USGS covering proposed underground coal production from three federal leases; C-020740, C-024998, and C-029889, totaling 5,113 acres of public lands, together with 454 acres of adjacent private coal. Although Mid-Continent does not control any of these three federal leases, the company is negotiating with the lessees to reach an agreement whereby Mid-Continent could develop the leases.

The proposed Cottonwood Creek No. 1 and 2 mines would be located approximately 2.5 miles east of Palisade, Colorado, in Mesa County (see map 1 in the appendix volume). This new mining operation would have a combined production of over 1 million tons per year (from two mine portals) for at least 25 years. The coal would be used to supply unspecified out-of-state utilities. The operation would utilize continuous mining units to develop longwall panels, which would then be mined on retreat. Approximately 61 acres would be disturbed due to surface facilities by 1990. At full production, the mining operation would employ 400 people.

GEX COLORADO COMPANY: CAMEO NO. 1 AND NO. 2 MINES

On February 22, 1978, GEX Colorado Company submitted an M&R plan to the USGS covering proposed underground coal production from the company's federal lease C-01538 containing 2,560 acres of public lands together with 2,255 acres of private coal leases.

The M&R plan describes the Cameo mining operation which is located approximately 3 miles northeast of Palisade, Colorado, in Mesa County (see map 1 in appendix A). In late 1977, GEX Colorado Company began construction of surface facilities (including the Cameo No. 1 mine portal) on private land adjacent to the federal lease. Production for 1978, from the private reserves of the No. 1 mine, is projected to be 200,000 tons. All of the reserves to be mined through the No. 2 Mine and the majority of reserves for the No. 1 Mine, lie on the federal lease. At full production, the mining operation would produce 1.6 million tons per year for 47 years and would supply coal to the Mississippi Power Company of Jackson County, Mississippi. Both mines would employ conventional room-and-pillar mining techniques with potential later conversion to longwall mining (depending upon roof conditions found once mining has begun).

A total of 233 acres would be disturbed for surface facilities by 1990; of this approximately 90 acres would result from the proposed action. At full production, the mining operation would employ 399 people.

SHERIDAN ENTERPRISES: LOMA PROJECT

On March 14, 1978, Sheridan Enterprises submitted an M&R plan to the USGS covering proposed underground coal production from the company's federal leases C-0125436, C-0125437, C-0125438, C-0125439, C-0125515, and C-0125516, totaling 14,935 acres of public lands.

The proposed mining operation would consist of six sequentially-developed mine portals and processing facilities in a central location. The operation would be located approximately 20 miles north of Loma, Colorado, in the Douglas Pass area of western Garfield County (see map 1 in appendix volume). At full production the operation would produce 5 million tons of coal for 25 years to supply unspecified utilities. The operation would utilize both longwall and more traditional room-and-pillar mining techniques; all mining would be done on retreat. Approximately 676 acres would be disturbed by surface facilities by 1990. At full production, Sheridan would employ 900 people.

Ancillary Facilities

Although no applications for rights-of-way over public lands or national forest systems lands have been officially filed by the applicants of the six M&R plans, rights-of-way are anticipated to be required for construction of power transmission lines, railroad spurs, roads, and water developments to meet the most probable coal production schedules. Estimated acreage disturbances resulting from these rights-of-way are tabulated in table R1-2 to facilitate impact analysis. Table R1-2 shows existing surface disturbance (1977) and projects cumulative disturbance through 1990 for known right-of-way requirements of the applicants.

The major right-of-way action would involve Sheridan Enterprises requirements for a railroad spur, power line, and water line to their Loma Project. The proposal would involve a 200-foot-wide utility corridor to be constructed along East Salt Creek for about 20 miles starting near Mack, Colorado. Although Sheridan Enterprises has made no firm commitments as to route location, the company has identified a 2,000-foot-wide corridor as the probable route for their ancillary facilities. Additional discussion of this proposal and other applicants' right-of-way requirements can be found in the individual site-specific analyses of this ES.

Required Authorizations

FEDERAL AGENCIES

Assistant Secretary of Energy and Minerals

The assistant Secretary must approve the mining permit application, including the proposed M&R plan, and significant modifications or amendments to it before the mining company can commence mining operations.

Office of Surface Mining (OSM)

OSM, with concurrence of the surface managing agency (BLM or USFS) and USGS, recommends approval or disapproval of M&R plans to the Assistant Secretary of Energy and Minerals. Whenever a state has entered into a State-Federal Cooperative Agreement with the Secretary of the Interior, pursuant to section 523(c) of SMCRA, the state regulatory authority and OSM will jointly review exploration plans on existing leases and mining and permit applications. Both agencies will recommend approval or disapproval to the officials of the state and the department of the Interior authorized to take final actions on the permit.

U.S. Geological Survey (USGS)

The USGS is responsible for development, production, and coal resources recovery requirements included in the mining permit.

Bureau of Land Management)BLM)

The BLM develops the special requirements to be included in federal coal leases and reclamation plans related to management and protection of all resources (other than coal) and the post-mining land use of the affected public lands. BLM is also responsible for granting various rights-of-way for ancillary facilities, such as access roads, power lines, communication lines, and railroad spurs on public lands.

U.S. Forest Service (USFS)

The USFS develops the special requirements to be included in federal coal leases and reclamation plans related to management and protection of all resources (other than coal) and the post-mining land use of the affected forest lands. The USFS is also responsible for granting various rights-of-way for ancillary facilities, such as access roads, power lines, communication lines, and railroad spurs on forest lands. The USFS must consent to the terms of approval before OSM can approve the M&R plan for mining on national forest systems lands.

U.S. Fish and Wildlife Service (USFWS)

The USFWS is responsible for protection of migratory birds, including eagles, and threatened or endangered species and their habitats. Coordination is required with the USFWS under provisions of the Fish and Wildlife Coordination Act, the Bald Eagle Act, and the Endangered Species Act.

Environmental Protection Agency (EPA)

The EPA administers both the Clean Air Act of 1970, as amended, and the Clean Water Act (33 USC 1344), as amended, and ensures that any entity proposing a new industrial facility (e.g., fossil fuel-fired steam generators) obtains permits certifying that the plant complies with EPA's new source performance standards. In Colorado, this authority has been delegated to the Air Pollution Control Division and the State Water Quality Control Commission of the Colorado Department of Health.

Mine Safety and Health Administration (MSHA)

MSHA (Department of Labor) enforces federal health and safety standards in all mining operations, including approval of roof control and ventilation plans for underground mines.

Occupational Safety and Health Administration (OSHA)

OSHA (Department of Labor) is responsible for enforcement of the Employee Safety and Health Act of 1970, which applies to surface structures and facilites of underground coal mining operations.

Corps of Engineers

The Department of Army Corps of Engineers is responsible for ensuring compliance with Section 404 of the Federal Water Pollution Control Act and Section 10 of the River and Harbor Act of 1899. These regulations are contained in 33(CFR): 209.12 and require issuance of permits for a wide variety of actions relating to crossings of navigable streams and alteration of stream beds.

STATE OF COLORADO AGENCIES

The Division of Mines of the Colorado Department of Natural Resources requires the filing of a notice of activity for any proposed exploration or mining in the state. The division also monitors mine safety practices in concert with MSHA; common procedure is for the state to conduct the monitoring with MSHA overview. The division also issues permits to store and use explosives.

The Colorado Mined Land Reclamation (Colorado Department of Natural Resources) issues a permit based on an acceptable M&R plan of activity, and a performance bond. The plan must comply with the Colorado Mined Land Reclamation Act of 1976, which set standards, practices, time factors, and reporting procedures.

The Department of the Interior is negotiating a cooperative agreement pursuant to Section 523(c) of SMRCA with the state of Colorado and other states. Whenever this agreement is consummated with the state, the OSM's functions and responsibilities specified in this agreement will be delegated to the state regulatory authority. Under this agreement, OSM and the state regulatory authority will jointly review and act on mining permit applications and recommend approval or disapproval to the officials uahtorized to take final action on the application. The Secretary is prohibited by law from delegating his authority to approve mining plans on federal lands.

The State Engineer (Colorado Department of Natural Resources) has authority over water wells and other water sources, such as retention dams and mine drainage.

The State Water Pollution Control Commission of the Department of Health has regulatory authority over water quality and related health hazards during construction and operation phases. Standards are established by state law, and permits are required. The commission works in concert with EPA.

The Colorado Public Utilities Commission (PUC) works in concert with The Interstate Commerce Commission (ICC) in matters involving railroad construction and abandonment. Of particular concern to PUC is the crossing of a public road by a railroad; approval is required for the location and safety features of a crossing.

The State Highway Department also is concerned with railroad crossings of state and federal highways, and with any impingement on these road systems, including actions that will tend to significantly increase traffic volume or load tonnages.

The state of Colorado requires licenses for all contractors.

COUNTY AGENCIES

Regulations in Garfield, Gunnison, Mesa, and Pitkin counties require use-permits prior to mine construction and development.

Related Reviews

ENVIRONMENTAL PROTECTION

Interim regulations required under Section 502 of SMRCA were published in the *Federal Register* Vol. 42, No. 239, on December 13, 1977. These regulations require the review of proposed M&R plans in compliance with environmental requirements which have been established. Under the authority of Sections 523(c) and 702(b) of SMCRA, these 30(CFR): 700 interim regulations will be modified to meet all the requirements of the Federal Coal Leasing Amendments Act of 1975 (30 USC 181 et seq.) and the Federal Land Policy and Management Act of 1976 (43 USC 1701 et seq.).

The basic changes in requirements in the regulations are (1) post-mining land use incorporated into a reclamation plan will be that found in the surface management agency's comprehensive land use plan; (2) resource data collected in the process of developing the land use plan or lease stipulations will be available for use in developing the reclamation plan; and (3) permanent roads, dams, power lines, etc., to be constructed on public lands will meet the design standards of the surface management agency.

Section 516 of SMCRA specifically indicates requirements for surface effects of underground coal mining operations; and 30(CFR): 717 in the interim regulations provides the underground mining general performance standards.

The interim regulations require the identification of alluvial valley floors, prime farmlands, and lands unsuitable for surface coal mining. With respect to these requirements, no lands within the areas covered by the six proposed M&R plans have been identified as unsuitable for surface coal mining. However, the Anschutz, ARCO, GEX Colorado, and Sheridan tracts include some lands that qualify as alluvial valley floors as defined in 30(CFR): 710.5 (see Water Resources, chapter 2, in the appropriate site-specifics in volume 2). In addition, Sheridan's proposal to construct a rail spur and a water line to their preparation facilities may require right-of-way acquisition and construction over private lands near Mack and Loma that may be classified as prime farmland (see Soils, Chapter 3, Sheridan site-specific in volume 2). No prime farmland occurs within any of the areas included in the other five proposed M&R plans. Prime and unique farmlands in the ES area as a whole are discussed under Agriculture in volume 1.

Other environmental protection requirements and reviews are as follows:

1. Archeological and historical sites: Cultural meetings will be conducted by a qualified archeologist as contracted for by the lessee. Should mitigation be required, the lessee will be responsible for funding this work prior to the initiation of any surface-disturbing activities. The cultural inventories and the resulting recommendations will be reviewed by the surface management agency, the State Historic Preservation Office,

and the Advisory Council on Historic Preservation.

2. Rare or endangered flora and fauna species: Inventories will be conducted on the impacted public lands by the surface management agency, and stipulations necessary to protect these resources will be included in the M&R plan.

3. Performance bonds: Surety bonds are required at the time of lease issuance and may be readjusted prior to approval of the M&R plans.

4. Use of explosives: The requirements of 30(CFR): 715.19 will be included in all M&R plans submitted for approval.

5. Water rights: The area around the proposed M&R plan will be inventoried for water uses and water rights. Special requirements will be included in the M&R plan to protect the water rights of others.

6. Revegetation: Disturbed areas no longer required for surface operations, such as roads and areas upon which support facilities were located, will be regraded; topsoil will be distributed; and revegetation will be effectively and permanently established. Species and quantity of seed used in the reclamation process will be specified by the surface management agency and listed in the M&R plan. Inspection of reclamation procedures will be made to assure success of the revegetation.

Department of Energy Review

The Department of Energey (DOE), under its organization, is authorized to set coal production rates on federal coal leases, review and concur on stipulations included in federal coal leases, and establish diligence requirements for each lease. Guidelines and procedures are being developed for coordination of DOE's responsibilities with those of the Department of the Interior.

Diligent Development and Continuous Operations Requirements

The Federal Coal Leasing Amendments Act of 1975 (30 USC 181 et seq.) imposed diligent development and continuous operations requirements on all federal coal leases (final regulations 43[CFR]: 3520.2-.5; published in the *Federal Register*, Vol. 41, No. 251, December 29, 1976). Although the requirements were essentially the same for all federal leases, those leases effective before August 4, 1976, were required to meet different criteria from those effective after August 4, 1976.

All of the federal coal leases for the M&R plans considered site-specifically in this ES were issued and effective before August 4, 1976. The regulations which apply to these leases require that 2.5 percent of the logical mining unit (LMU) reserves must be produced by June 1, 1986. (The LMU is essentially the mine property, that is, all contiguous coal lands consisting of either federal leases alone or private holdings together with federal leases which can be developed and mined in an efficient, economical, and orderly manner by one unified mining operation.) In addition, an average of 1 percent of the LMU reserves must be produced for each of the next 2 years. Advanced royalties can be paid in lieu of productio of an average of 1 percent of the reserves thereafter for a period of 10 years. Then production must average 1 percent annually.

The procedure by which diligent development and continuous operations requirements will be computed and enforced has not been established at this time. Accordingly, the estimates of recoverable reserves for federal leases used in table R1-1 were obtained from a study made in 1977 of the in-place and recoverable reserves on federal leases by the Conservation Division, USGS, Central Rock Mountain Area. Table R1-4 shows diligent development and continuous operations requirements for the six site-specific tracts.

Preference Right Lease Applications (PRLAs)

On May 7, 1976, the revised regulations 43(CFR): 3520, governing PRLA's were published in the *Federal Register* (Volume 41, No. 90). These regulations apply not only to all future applications but also to all applications pending on the effective date of the regulations.

These regulations gave all preference right lease applicants a 60-day period to submit an initial showing (that is, information concerning the reserves, physical characteristics of the area, and a description of the proposed mining operation). The Department of the Interior was to use the information submitted to prepare technical reports and an environmental analysis as a joint product of BLM and USGS. The proposed lease terms and stipulations which resulted from the environmental analysis were then to be given to the applicant, and based on that information the applicant would be required to make a final showing of the costs and revenues of the proposed operation. Depending on the results of this procedure, a preference right lease would either be granted or denied.

The Department of the Interior announced on August 2, 1977, that prospecting permits issued for areas covered by prior mining claims were invalid. Lease applicants were required to submit abstracts of title identifying prior or existing mining claims in the area covered by the prospecting permit within 180 days.

On September 27, 1977, a decision on the case of NRDC vs. Royston Hughes by the District Court of Appeals of the District of Columbia enjoined the

TABLE R1-4

DILIGENT DEVELOPMENT AND CONTINUOUS OPERATIONS REQUIREMENTS FOR COAL PRODUCTION FROM SITE-SPECIFIC TRACTS (43(CFR): 3500)

Company Name	Property Name	Federal Coal Leases	(Recoverable) Logical Mining Unit Reserves (tons) a/	Production Before June 1, 1986 (tons)	First Year Production b/ (tons)	Second Year Production c/ (tons)	Annual Average Production d/ (tons)
Anschutz Coal Company	Thompson Creek	C-08172	27,480,000	687,000	274,800	274,800	274,800
		C-08173	27,600,000	690,000	276,000	276,000	276,000
Totals			55,080,000	1,377,000	550,800	550,800	550,800
Atlantic Richfield Company	Mt. Gunnison	C-044569	26,225,000	655,625	262,250	262,250	262,250
		C-0117192	25,366,000	634,150	253,660	253,660	253,660
		C-1362	83,300,000	2,082,500	833,000	833,000	833,000
Totals			134,891,000	3,372,275	1,348,910	1,348,910	1,348,910
Mid-Continent Coal & Coke Company	Coal Canyon	C-037277	12,621,000	315,525e/	126,210	126,210	126,210
		C-059420	2,663,000	66,575e/	26,630	26,630	26,630
		C-040389	567,000	14,175	5,670	5,670	5,670
Totals			15,851,000	396,275	158,510	158,510	158,510
Mid-Continent Coal & Coke Company	Cottonwood Creek	C-020740	210,000	5,250	2,100	2,100	2,100
		C-024998	13,500,000	337,500	135,000	135,000	135,000
		C-029889	13,000,000	325,000	130,000	130,000	130,000
Totals			26,710,000	667,750	267,100	267,100	267,100
Sheridan Enterprises	Loma	C-0125436	13,000,000	325,000	130,000	130,000	130,000
		C-0125437	12,500,000	312,500	125,000	125,000	125,000
		C-0125438	13,500,000	337,500	135,000	135,000	135,000
		C-0125439	13,000,000	325,000	130,000	130,000	130,000
		C-0125515	13,500,000	337,500	135,000	135,000	135,000
		C-0125516	13,000,000	325,000	130,000	130,000	130,000
Totals			78,500,000	1,962,500	785,000	785,000	785,000
General Exploration Company	Cameo	C-01538	29,724,000	743,100	294,240	294,240	294,240
Grand Totals			340,756,000	8,518,900	3,404,560	3,404,560	3,404,560

a/ Reserve estimates provided by the USGS, Conservation Division, CRMA.

b/ Production for the first year means production from June 1, 1986, to June 1, 1987.

c/ Production for the second year means production from June 1, 1987, to June 1, 1988.

d/ Annual average production is the average amount of coal produced in any year after 1988 and the two preceding years.

e/ Includes both surface and underground reserves.

Department of the Interior from issuing any new coal leases (including preference right leases) until a supplemental coal programmatic statement is issued correcting the deficiencies of the September 1975 Federal Coal Programmatic Environmental Statement. The final draft of the supplemental statement is scheduled to be completed in April 1979.

However, on June 14, 1978, the District Court of Appeals issued a second, amended order allowing the Department of the Interior to process, but not issue, leases for twenty PRLAs. The applications are to be processed according to the May 7, 1976 43(CFR): 3520 regulations. The PRLAs which could be processed were those (1) on tracts for which at least 90 percent of the coal would be mined by deep mining rather than surface methods and involve less than 50 acres of surface disturbance; and (2) operations which would not require substantial additional transportation or water storage or supply systems in the region and would not involve substantial new industrial development in the region.

On July 28, 1978, the Department of the Interior announced in the *Federal Register* (Vol. 43, No. 144) the public participation in the process by which twenty pending PRLAs would be chosen under the June 14, 1978 appended decision. Accordingly, the Department of the Interior will publish in the *Federal Register* a list of twenty PRLAs which it believes meet the above standards and will cause the least environmental damage. The public will then be given an opportunity to comment. If adverse comment is received a list of twice the number of disputed applications (and at least twenty PRLAs) will be published for additional public comment. The Department will then select the PRLAs to be processed.

At this time, five PRLAs are pending in the west-central Colorado region. Kemmerer Coal Company has applied for 3,457 acres in two PRLAs (C-0120075 and C-0124288) which are located 15 miles southeast of Montrose, Colorado, in Ouray, Gunnison, and Montrose counties (see map 1 in the appendix). Production and employment to result from issuance of the five PRLAs were included only under the high-level scenario in chapter 8.

EXPLORATION DRILLING PROGRAM

The Federal Coal Leasing Amendments Act of 1975 authorized the USGS to conduct and publish the results of a comprehensive exploratory program to evaluate the extent, location, and potential for developing the known recoverable coal reserve on public lands. As a part of that program and its ongoing coal studies, the USGS is carrying out an exploration drilling program in the region. In 1977, the USGS drilled 26 holes in the Cedaredge area and 1 hole in the Palisade area. The results of that drilling will be used to supplement an ongoing stratigraphic study of the Grand Mesa field being conducted by the Conservation Division, USGS. The USGS contemplates continuing the drilling program and stratigraphic studies and has plans to drill 3 holes in the Gunnison area in 1979.

In addition to the federal coal lands exploration program, three private companies (Sundance Oil, Western Slope Carbon, and Pittsburg-Midway) in the west-central region have applied for coal exploration licenses allowing them to do exploratory drilling on unleased federal coal reserves. In addition, both Colorado Westmoreland and Sundance Oil have done exploratory drilling under coal exploration licenses which have not yet expired. Finally, exploratory drilling by federal leaseholders on their leases in order to supplement existing resource information is an ongoing process subject to environmental review as applications to drill are filed.

Regional Coal Projections

The proposed federal actions analyzed in this ES are the review and approval of the six M&R plans discussed above. However, the most probable level of development presented in this regional volume also includes other existing or projected operations on both federal and private coal. These operations indicate a background of coal activity in the ES area. Tables R1-1, R1-2, and R1-3 summarize production, acreage disturbed, unemployment, etc., for these existing and projected operations. In addition, each operation is discussed below and indicated on map 1 in volume 3.

In some cases, applications which were pending federal action as of January 1, 1978, were included in these coal projections (see specifically the discussions of Sunflower Energy and Belden Enterprises below). In addition, production from an existing mining operation was continued at the existing level through 1990 if (1) the current reserves of the operation would be exhausted before 1990 at the current rate of production; (2) additional unleased federal reserves lie adjacent to the existing operation; and (3) the company appeared to meet the June 14, 1978, criteria of the Court of Appeals amended decision of NRDC vs. Hughes (see discussion of Colorado Westmoreland, Inc., below). However, none of these projections is meant to indicate that any of the above pending actions are certain of approval. Nor is the regional ES meant to provide a final environmental analysis of these proposals.

The production schedules projected in table R1-1 indicate that by 1990 15.56 million tons of coal would be produced annually in the ES area. Approximately 68 percent or 10.54 million tons per year would be produced by the six proposed site-specific operations.

COLORADO WESTMORELAND, INC.

In 1976, Colorado Westmoreland, Inc., opened the Orchard Valley Mine in Delta County 2.5 miles north of Paonia, Colorado (see map 1 in volume 3). The mine property consists of federal lease C-25079 containing 311 acres and an adjoining 120-acre private tract. Federal lease C-25079 was issued March 1, 1978, under the September 27, 1977, short-term criteria. The company is operating under an approved M&R plan which allows them to produce a maximum of 700,000 tons per year. Production from the Orchard Valley Mine was approximately 290,000 tons in 1977. Mining is done on retreat using room-and-pillar methods with continuous mining units. The coal supplies Northern Indiana Public Service Company (NIPSCO) in Hammond, Indiana. At full production, the mining operation will employ 160 persons.

The company has indicated that at the present rate of mining the existing reserves will be exhausted by 1979. In order to supplement these reserves, the company filed a short-term lease application, C-25079A, in 1978 for an additional 856 acres of federal coal. At this time short-term leasing is being conducted using the criteria listed in the June 14, 1978, amended decision of NRDC vs. Hughes. Because the Department of the Interior has found that the company had a binding contract for 700,000 tons of coal per year for fifteen years with NIPSCO prior to Sept. 27, 1977, thus qualifying for the initial short-term lease (C-25079) under the September 27, 1977 criteria and because the short-term criteria of June 14, 1978, have not substantially changed the September 1977 criteria, production at the Orchard Valley Mine was projected to be 700,000 tons per year through 1990. However, if the company does not obtain a new short-term lease, production would presumably end before 1980.

United States Steel Corporation

U.S. Steel currently operates, on an approved M&R plan, the Somerset Mine at Somerset, Colorado; this underground mine has been the largest producer in the North Fork Valley since 1903. U.S. Steel has 3,945 acres of private coal reserves, which they either own or lease, and 4,095 acres of federal coal reserves, under leases D-052504, C-033301, and C-033302. The production rate of the Somerset Mine is determined by the requirements for coking coal at the U.S. Steel Geneva Steel Plant at Orem, Utah. U.S. Steel also operates the Geneva Coal Mine at Horse Canyon, Utah. Coal from the above two mines is washed and blended at the U.S. Steel Wellington Coal Cleaning Plant near Wellington, Utah, and shipped to the Geneva Steel Plant.

U.S. Steel has projected that the production from the Somerset Mine should continue at the current 937,000 tons of coal annually for at least twenty years. However, the company is considering developing another portal to mine private coal reserves of the D and E seams; neither seam is mined presently.

Sunflower Energy Corporation

In 1977, Sunflower Energy Corporation reopened the Blue Ribbon Mine northeast of Paonia, Colorado, on the Delta-Gunnison County line (see map 1 in volume 3). Sunflower has subleased 80 acres of federal lease C-033301 from U.S. Steel Corporation and owns an additional 160 acres of private land adjoining the federal lease. An M&R plan was submitted to the USGS in 1977. At this time, the M&R plan has not been approved. The company has proposed to mine 70,000 tons of coal annually by conventional room-and-pillar methods. At full production, 20 persons would be employed. At that rate of production, the 7 million tons of reserves lying on the private land federal lease would be exhausted in 10 years.

Bear Coal Company

Bear Coal Company is currently producing approximately 240,000 tons annually from the Bear Mine located in Gunnison County 1 mile east of Somerset, Colorado, (see map 1 in volume 3). The Bear Mine lies on federal coal lease D-044569 (containing 1,381 acres) and operates under an "assignment of operating interest" from the leaseholder, Atlantic-Richfield Company (ARCO). An M&R plan for the operation has been approved by the USGS. The coal produced is used to supply various public utilities, industries, and local domestic markets. The operation employed 49 persons in 1977. If the site-specific M&R plan for ARCO's Mt. Gunnison No. 1 Mine is approved, production at the Bear Mine would stop in 1981.

Western Slope Carbon

Western Slope Carbon operates the Hawksnest mining operation in Gunnison County east of Somerset, Colorado (see map 1 in volume 3). The mine property consists of federal leases C-056724, D-042921, and C-17130 totaling 1,248 acres and 10 acres of adjacent private land. The company is currently operating under an approved M&R plan. In 1977 the Hawksnest No. 3 Mine was closed due to chronic squeeze and heaving problems and only the Hawksnest East Mine produces at this time. The company has projected that it will produce

600,000 tons per year by 1980 and that the full production rate of 750,000 tons will be reached by 1981. Production at that rate is projected to continue through 1990. Coal produced is used to supply Colorado Fuel and Iron in Pueblo, Colorado. At full production, 200 persons will be employed.

Belden Enterprises

Belden Enterprises is currently producing less than 1,000 tons per year from the Red Canyon No. 1 Mine on a 60-acre tract of private land located in Delta County northwest of Cedaredge, Colorado (see map 1 in volume 3). In 1977 the company submitted an M&R plan to the USGS describing the proposed Coalby-Red Canyon Mine. The proposed mine would be located on federal lease C-036906 containing 41 acres adjacent to the 60 acres of private land. At this time the M&R plan has not been approved. Production from the proposed mining operation would be 10,000 tons annually, and 1 person would be employed. The coal would be used for local domestic markets.

Quinn Coal Company

In 1976 Quinn Coal Company opened the Tomahawk Strip mine in Delta County northwest of Cedaredge, Colorado (see map 1 in volume 3). The company controls 480 acres of private coal in the area. The Tomahawk Mine produced 20,000 tons of coal in 1977. At full production 250,000 tons per year would be produced. Mine life is estimated to be twelve years. Coal is trucked from the mine site to rail loadout facilities in Delta, Colorado. The coal is used to supply various utilities and the local domestic market. At full production, eighteen people woud be employed by the operation.

After the available strippable coal reserves are exhausted at the end of the 1980s, Quinn Coal has indicated that the Tomahawk Mine will be converted from a strip operation to a punch (or underground) mine. Production and employment rates for the underground operation are dependent on the availability of additional (possibly federal) reserves and have not been projected past 1988.

GEX Colorado Company

GEX Colorado Company operates the Roadside Mine in Mesa County 3 miles east of Palisade, Colorado (see map 1 in volume 3). GEX Colorado Company controls federal lease C-078049 containing 810 acres and 550 acres of adjacent private coal. The company is operating under an approved M&R plan. Production from the operation reached 300,199 tons in 1977 and is projected to increase to 800,000 tons per year by 1980. According to information supplied by the company, the current reserves will be exhausted by 1988. Coal is mined using conventional room-and-pillar techniques with continuous mining units and all coal is mined on retreat. At full production 213 persons would be employed. Coal is supplied to Arizona Electrical Public Service Company of Page, Arizona.

In late 1977, GEX Colorado began construction of surface facilities on private land to be used by both the Cameo and Roadside mining operations (refer to the Cameo No. 1 and No. 2 mines site specific proposed action for further details).

Coal Fuels Corporation

In late 1977, Dorchester Colomine opened the Farmers Mine for Coal Fuels Corporation. The Farmers Mine is located in Mesa and Garfield counties north of Fruita, Colorado (see map 1 in volume 3). Coal Fuels controls 440 scattered acres of private coal reserves. No production was recorded for the period from January to November 1978. The company reports that production will reach 200,000 tons per year by 1980 and remain at that level through 1990 or until preference right lease applications (C-0127832, C-0127833, C-0127834) held by Coal Fuels are issued as leases (refer to both the discussion of preference right lease applications above and the high-level scenario in chapter 8). At the full production rate, 50 persons would be employed.

Bendettis

Louis and Henry Bendetti are currently operating two small mines, the Eastside and Nu Gap No. 3 mines on private land located in Garfield County north of Silt, Colorado (see map 1 in volume 3). Production from both mines totaled 654 tons in 1977 and is expected to remain below 2,000 tons per year through 1990. Mining is by raise methods in the steeply-dipping coal seams of the Grand Hogback. Two persons are employed at the operations. Coal is supplied to the local domestic market.

Mid-Continent Coal and Coke Company

In 1973 Mid-Continent opened five mines in the Coal Basin area west of Redstone, Colorado near the border of Pitkin and Gunnison counties (see map 1 in volume 3). All five mines form one mining operation. Production in 1977 totaled 920,000 tons and is expected to remain at that level. Mid-Continent controls federal leases C-09004, C-09005, C-0125456, C-0125457, C-0115606, C-011646, C-030345, and C-12646 totalling 5,310 acres, as well as 740 acres of adjacent private coal. The company is operating on approved M&R plan. A variety of mining methods, including advancing longwall and conventional room-and-pillar, are used. At full production, 492 persons will be employed. The coal is trucked from the mine site to Carbondale, Colorado. Mid-Continent has submitted two M&R plans which are being examined site specifically in the ES (see the Coal Canyon and Cottonwood Creek No. 1 and No. 2 analyses in volume 2).

Carbon King, Ltd.

Carbon King, Ltd. operates the Sunlight (or Fourmile) Mine in Garfield County west of Carbondale, Colorado (see map 1 in volume 3). The company owns 480 acres of private coal. Production in 1977 was 1,792 tons. According to the company production will increase to 30,000 tons per year by 1980 and 50,000 tons per year by 1985. Mining is by conventional room-and-pillar methods. At the full production level of 50,000 tons per year, 10 people would be employed.

Ohio Creek Mine Company

The Ohio Creek Mining Company operates the O.C. No. 2 Mine in Gunnison County northwest of Gunnison, Colorado (see map 1 in volume 3). The mine is producing from an 80-acre federal coal lease (C-069942) under an approved M&R plan. Coal is produced by conventional room-and-pillar mining techniques. At the current rate of production of approximately 4,000 tons per year, the reserves on the federal lease will be exhausted by 1988. Six people are employed by the operation, which supplied coal to the local domestic market.

Peabody Coal Company

Peabody Coal Company operates the Nucla Strip Mine in Montrose County northwest of Nucla, Colorado (see map 1 in volume 3). No information was available from the company concerning the acreage of the mine property. In 1977, the operation produced 90,000 tons. Production is projected to remain at 200,000 tons per year through 1990. The coal is used to supply the Nucla Power Plant in Nucla, Colorado. Coal is trucked from the mine site to the power plant. Approximately 24 people are employed.

Western States Coal Company

Western States Coal Company owns 600 acres of private coal reserves at the old Fairview Mine east of Cedaredge, Colorado, in Delta County (see map 1 in volume 3). The company has preliminary plans to develop the property in the early to mid 1980s and has projected production at 250,000 tons per year. At that production level 60 people would be employed. The coal would be used to supply a local industrial market.

Anchor Coal Company

Anchor Coal Company has acquired federal lease D-052501 (containing 280 acres) in Gunnison County east of Somerset, Colorado (see map 1 in volume 3). The company has indicated that it plans to develop a 125,000-ton-per-year mining operation at the site of the old Edward's Mine. The mine would employ 30 people at full production. Mining would be by conventional room-and-pillar methods. The coal would be used to supply Northern Indiana Public Service Company, Hammond, Indiana, and would be trucked to loadout facilities located 2 miles east of Paonia.

Anschutz Coal Corporation

Anschutz Coal Corporation is currently producing coal from the North Thompson Creek No. 1 and No. 3 mines located on private land in Pitkin County 12 miles southwest of Carbondale, Colorado (see map 1 in volume 3). The mines are in initial development states; production from both mines in 1977 totalled 15,868 tons. Production will reach 1 million tons per year by 1980 and will remain at that level for the life of the mine (15 years). At full production, the operation will employ 320 people.

Construction of surface facilities at the mine site began in 1974 and is virtually completed. Total surface disturbance at the mine site is 46 acres. In addition, by 1980 Anschutz will construct a rail siding and loadout facility on private land 2.5 miles north of Carbondale. Disturbance at that site is estimated at 40 acres. Coal will be trucked from the mine site to the loadout facility, where it will be shipped by rail to metalurgical coal markets.

Anschutz has submitted an M&R plan which is being considered site-specifically in this ES (see volume 2).

Other Major Regional Development

Oil and Gas

The Oil and Gas Conservation Commission of the Colorado Department of Natural Resources reported that 24 oil and gas fields were producing in the ES area in 1977. Of these, 3 were producing both oil and gas while 21 produced only gas. In 1977, 34 gas wells were drilled in established oil and gas fields, and 4 wildcat wells were drilled outside those fields. Map 3 in volume 3 shows the oil and gas fields of the ES area. It should be noted that no producing oil and gas field overlaps the areas involved with the six site-specific proposed actions. However, approximately 65 to 70 percent of the area covered by federal coal leases or preference right lease applications is also covered by nonproducing oil and gas leases.

The majority of wells in the area produce only natural gas. In 1977 production of natural gas amounted to 4,916,839 million cubic feet or 2.5 percent of the state's natural gas production. Production of oil amounted to 1,641 barrels, a negligible percentage of the state's total petroleum production of 39,459,358 barrels. In a number of cases, transportation systems designed in support of the site-specific actions may be forced to cross existing oil or gas pipelines.

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Oil Shale

Most of the high-grade oil shale resources in Colorado are located just north of the ES area in the Piceance Creek Basin of Rio Blanco County (see map 3 in volume 3). Conflict between the development of oil shale and coal resources is minimized by their occurrence in different geologic units which are widely separated stratigraphically. Where mineable coal occurs near the surface, sediments containing oil shale are absent. Where oil shale occurs near the surface, coal is too deep to be currently mineable. However, activities related to oil shale development in the Piceance Creek Basin are of importance to the regional ES area. Cumulative impacts on air and water by the development of the two resources are related. At the same time, socioeconomic impacts of the development of the two energy mineral resources overlap considerably through competition for employment and cumulative effect on regional housing and services availability.

Two federal prototype oil shale lease tracts, Ca and Cb, lie within the Piceance Creek Basin. The approved development plans are for modified *in-situ* oil shale recovery facilities.

The Rio-Blanco Oil Shale Project, for tract Ca, will develop increasingly larger *in-situ* retorts between 1978 and 1983. A decision to develop a commercial oil shale operation will be made between 1983 and 1985, based on the results of the previous experimental phase (1978 to 1983). Tract Cb, will follow a similar scheme of modular retort development between 1978 and 1985. Tract Cb is scheduled to begin commercial production in 1985.

Colony Development Operation is proposing to develop an oil shale plant, mine, service corridor, products pipeline, and power line corridor to be located 15 miles north of Grand Valley, Colorado in the northern part of the ES area. The oil shale plant would consist of retorting and upgrading facilities capable of producing 47,000 barrels per day of low sulphur fuel oil and by-products. A project life of twenty years is anticipated. Receiving a right-of-way to construct a products pipeline from the site to Lisbon Valley, Utah, over federal and state lands, and obtaining a land exchange with the federal government are integral parts of Colony's development plans. A complete discussion of the proposed Colony oil shale development is provided in the Final Environmental Statement for Proposed Development of Oil Shale Resources by Colony Development Operation (U.S. Department of the Interior 1977).

Superior Oil Shale Company holds oil shale property at the confluence of Piceance Creek and the White River, west of the town of Meeker and 30 miles north of the coal ES area. The company plans to develop a combination oil shale-nahcolite-dawnsonite operation. Full-scale production would begin at the conclusion of a pilot mine (which would be driven to prove the mining techniques to be used in full-scale production) and after construction of a shale and process water storage area. Currently, full-scale production is anticipated to begin in January 1985 and continue until January 2008. At full-scale production, Superior would mine 25,500 tons per day of oil shale and extract approximately 13,000 barrels of shale oil per day. The shale oil would then be trucked to Rangely, Colorado, and from there to existing refineries in Utah and Wyoming by way of existing pipelines. Superior is seeking a land exchange with the BLM before beginning development on that site. The Draft Environmental Statement for the Proposed Superior Oil Company Land Exchange and Oil Shale Development is being prepared by the U.S. Department of the Interior.

Union Oil Company has announced plans to develop a commercial operation of about the same type as the Colony proposal on adjacent private property. The operation would produce about 9,000 barrels per day. A water intake from the Colorado River was completed in the summer of 1974, but no site development has yet occurred.

Under a lease approved in May 1972, and in cooperation with the federal government, Paraho undertook to demonstrate the engineering, economic, and environmental feasibility and desirability of its process and equipment for retorting oil shale. The lease covers the Anvil Points Oil Shale Research Facilities located on the Naval Oil Shale Reserves near Rifle, Colorado, in the north-central portion of the ES area. Production was scheduled to reach 200 barrels a day by 1978 using one single surface retorting module.

Occidental Oil Shale, Inc., is actively engaged in a pilot oil shale operation (known as the DA shale project) investigating a modified *in-situ* process on a 4,360 acre patented tract in the Roan Creek drainage west of Parachute Creek. Commercial production would require practically no water, produce surplus electric power, and require surface disposal of raw oil shale only. The operation would produce 1,000 to 1,500 barrels per day. An improved road has been constructed to the site along a right-of-way granted by the BLM. Public Service Company of Colorado has constructed a power line across public and private land to the site. A pipeline about 2,000 feet long carries oil along a right-of-way granted by the BLM to a loading dock on the all-weather road. Several hundred barrels of oil per day are produced and transported to a refinery when research retorting operations are under way.

Uranium

At present, uranium is being mined in the Paradox Basin area (the Uravan Mineral Belt in western Montrose County) and the Grand Hogback area in northern Garfield County (see map 3 in the appendix volume). Intensive exploration for uranium is occurring throughout western Montrose, Delta, and Mesa counties. In addition, recently some exploration has begun near the Black Canyon of the Gunnison in eastern Montrose County, along the Grand Hogback in Garfield County, and in southern Gunnison County (1,200 acres is being developed at Homestake's Pitch Mine in Saguache County). Mining activity occurs on both patented and unpatented mining claims in these areas. A total of 38 Department of Energy uranium lease tracts for some 21,000 acres exists in the west end (western Montrose, Mesa, and San Miguel counties) of Colorado. Of these, 22 are considered to be currently active. In 1977 production royalties paid to the U.S. government from the uranium lease tracts amounted to $6.1 million. The DOE estimates that uranium claims exist on 535,000 acres of public lands and national forest lands in the west end of Montrose County.

The potential for increased uranium mining in west-central Colorado is good at present and probably will increase in the future, even beyond 1990. Uranium prices have increased since the commodity was put on the open market in the United States. Demand for uranium is expected to increase at an annual rate of about 15 percent through 1985. The result would be increased exploration activity and development of new mine and mill capacity. Most exploration and development centers around major producing districts. Some portions of the western part of the ES area contain known uranium deposits that are now marginally or submarginally recoverable at current prices. These deposits tend to be deeper and of lower grade. Increased prices could make them mineable. Included in the western portion are large areas of favorable ground where future exploration is likely to find commercially mineable uranium deposits.

For the most part, uranium in west-central Colorado is in geologic units that underlie the principal coal-bearing units. Future exploration may find some uranium deposits in geologic units that overlie the coal-bearing units. The chances of resource conflicts between uranium and coal are minimized by their occurrence in different geologic units which are separated stratigraphically.

Where mineable coal occurs near the surface, sediments containing uranium are either absent or at such a depth to be unfeasible to mine. Future exploration may find shallow uranium deposits. The difference in depth in this case is sufficient to allow underground mining of coal to precede or follow surface mining of uranium without loss to either resource, although there could be cumulative impacts from the extraction of the two resources. Cumulative impacts may occur to air, water, and socioeconomic resources of the ES area.

Gypsum and Limestone

Traditionally, limestone has been the largest source of rock dust used for suppression of explosive coal dust in coal mines. Recently, the high free silica content of limestones has been suspected to be the most prevalent cause of miner's silicosis. Gypsum, with a lower free silica content, has become a popular substitute for the traditional limestone.

Currently, the rock dust which is supplied to the operating coal mines in the ES area is produced at the Mid-Continent limestone plant in Glenwood Springs, Colorado. Limestone to supply that plant is produced either from the Marble Head Quarry near Glenwood or from the Salida area in Chaffee County, Colorado. However, gypsum deposits in the Black Canyon area of Montrose County may be commercially mineable, and several mining claimants have plans for small strip mining operations. Gypsum from these operations would be used only to supply the North Fork Valley coal mines.

In the future, increased production from coal mines will create a larger market for both gypsum and limestone as constituents of rock dust. The increased demand will be in direct proportion to the quantity of coal produced.

U.S. Bureau of Reclamation Water Projects

USBR projects will result in cumulative impacts to the resources of the ES area in the form of competition for available employees, housing, and services, contributing to the overall problem of population growth in the ES area. In addition, the projects will also provide new water storage capabilities for agricultural and municipal water, for recreation, and for flood control. Certain of the projects will result in beneficial reductions in salinity of the region's waters. The following is a discussion of USBR projects in the ES area.

PARADOX VALLEY PROJECT

The Paradox Valley project, which will be located in the Paradox Valley north of Uravan, Colorado, will diminish a point source of salinity into the Colorado River Basin. Construction is scheduled to begin in 1980 and to continue for about five years. Construction employment is expected to average 160 employees over the construction period. Construction workers and their families will live onsite in housing provided by USBR. Operating the facility will require only four full-time employees. Both the Paradox Valley and Grand Valley projects will remove 200,000 tons of salt from the Colorado River annually. The Draft Environmental Statement for the Paradox Valley Project has been prepared by the USBR; the final draft was scheduled for publication in September 1978.

GRAND VALLEY PROJECT

The Grand Valley project is also a point-source desalinization project on the Colorado River, east of Grand Junction in the Grand Valley. Construction is scheduled to begin on the project in the fall of 1978 and last for approximately ten years. Approximately 200 acres of marshes in the Grand Valley area would undergo significant reduction in water supply, causing existing vegetation to convert to greasewood. The USBR Environmental Assessment of the Grand Valley Unit Colorado River Salinity Control Project was published in December 1977.

DALLAS CREEK PROJECT

The purpose of the Dallas Creek project and the Ridgway Dam is to provide storage for 80,000 acre-feet of municipal and irrigation water; 25,000 acre-feet of the total is for recreational use. The project will be located approximately 16 road miles south of Montrose in Ouray County. Construction of the project, including realignment of Highway 550 around the reservoir, is scheduled to begin in 1978 and continue for a five-year period. No onsite housing will be provided by the USBR for construction employees. Ten full-time employees will be required for maintenance of the project. A total of 3,830 acres will be disturbed upon completion of the project. The Dallas Creek Project Final Environmental Statement was filed with the Council on Environmental Quality in September 1976.

DOMINGUEZ PROJECT

The Dominguez project is a multi-purpose project which could develop water from the Gunnison River for hydroelectric power, municipal and industrial use, recreation, and water quality control. Its proposed location will be at the confluence of the Gunnison and Colorado rivers, near the town of Whitewater in Mesa County. As currently planned, the dam would have a capacity of 300,000 acre-feet. This project is currently in the planning stages, with publication of a feasibility report scheduled for 1978. Acreage needed for the reservoir would be restricted to the Gunnison River Canyon from Whitewater to Escalante Creek (west of Delta). No estimation of the acreage to be removed from the current riparian status and converted to reservoir is available at this time. The Dominguez project feasibility report is scheduled for completion in 1979.

WEST DIVIDE PROJECT

The West Divide Project would be located in west-central Colorado in the Upper Colorado River Basin. It would provide water for irrigation and municipal uses, and recreational developments would be provided at all project reservoirs. Water for the project would be obtained mainly by pumping from the Colorado River near Silt, Colorado. This water, plus water from East and West Divide creeks would be distributed throughout the service area by a system of three project canal lines and the necessary lateral systems. Dry Hollow Reservoir would have a capacity of 23,000 acre-feet, and Kendig Reservoir a capacity of 18,000 acre-feet. A draft environmental statement is scheduled for completion in June 1979; the final environmental statement is to be completed by January 1980.

Projected Cumulative Development

The data contained in tables R1-1, R1-2, and R1-3, depict cumulative coal-related regional development. For a comparison, table R1-5 depicts total cumulative development, excluding the proposed actions, expected for other activities through 1990. Table R1-6 depicts total projected surface disturbance and reclamation for the ES area through 1990. As with the production schedule projections, this information is based on interviews with local representatives of companies, government agencies, and communities; on written information and plans submitted by the companies; and on USGS estimates of the necessary facilities required for the most probable production schedule.

Coal-Related Development Data

There were 15 coal mining operations in the ES area in 1977. At the most probable rate of development the number is expected to increase to 19 by 1980, 22 by 1985, and then decrease to 18 by 1990. No plans are known for the construction of coal

TABLE R1-5

ESTIMATED CUMULATIVE DEVELOPMENT FOR WEST-CENTRAL COLORADO
EXCLUDING THE PROPOSED FEDERAL ACTIONS

Projected Development	1977	1980	1985	1990
Coal:				
Coal mining operations (existing and projected private)	15	17	17	13
Coal production (million tons per year)	3.07	5.96	5.54	5.02
Power generation:				
Power plants	11	11	11	11
Power plant capacity (megawatts)	354	354	354	354
Uranium:				
Active DOE uranium lease tracts	22	NA	NA	NA
Inactive DOE uranium lease tracts	16	NA	NA	NA
Total tracts	38	38	38	38
Uranium mines (active lease)	31	NA	NA	NA
Uranium mills (nonlease)	2	2	2	2
Oil shale:				
Mines	2	2	4	4
Processing plants	2	2	4	4
Oil and gas:				
Wells drilled	-	95	265	440
Limestone-gypsum:				
Mines	1	1	2	2
Processing plants	2	2	3	3
Hardrock minerals:				
Mines	7	7	7	7
Mills	1	1	1	1
Smelters	0	0	0	0
Population:				
Population	149,850	196,850	235,900	237,600
Community expansion (acres)	-	3,997	7,321	7,851
Auxiliary development:				
New power and telephone lines (miles)	-	44	101	153
New roads (miles)	-	400	1,200	2,000
New pipelines (miles)	-	50	200	300

Note: DOE = Department of Energy; NA = not available.

TABLE R1-6

ESTIMATED REGIONAL SURFACE DISTURBANCE AND RECLAMATION FOR WEST-CENTRAL COLORADO

Activity	Cumulative Acreage a/					
	1978--1980		1978--1985		1978--1980	
	Disturbed	Reclaimed	Disturbed	Reclaimed	Disturbed	Reclaimed
Existing coal mines	1,104	0	1,265	180	1,393	265
Uranium mines/mills	780	NA	2,340	NA	3,900	NA
Power line/pipeline/ telephone line	0	0	2,000	0	2,000	0
Oil and gas exploration and drilling	285	NA	795	NA	1,320	NA
Community expansion	3,997	0	7,321	0	7,851	0
Road construction	2,000	0	6,000	0	10,000	0
Railroad construction	0	0	0	0	0	0
Oil shale mines/ refinery	60	NA	4,500	NA	4,500	NA
Subtotals	8,226	0	24,221	180	30,964	265
Six site-specific coal mines	349	0	1,133	0	1,175	0
Community expansion (assoc. with six site-specifics)	64	0	801	0	1,292	0
Subtotals	413	0	1,934	0	2,467	0
Total Regional Disturbance	8,639	0	26,155	180	33,431	265

Note: NA - Not available.

a/ Acreage in addition to that disturbed or reclaimed as of 1977.

conversion facilities in the ES area before 1990. Cumulative coal production would increase from the 3.07 million tons produced in 1977 to 7.49 million tons per year by 1980 and 13.17 million tons per year by 1985; by 1990, 15.56 million tons per year of coal would be produced from the ES region. Of these totals, the proposed actions would result in the production of 1.53, 7.63, and 10.54 million tons of coal per year by 1980, 1985, and 1990, respectively, or 20 percent, 58 percent, and 68 percent, respectively.

Cumulative population growth in the ES area would go from 149,850 people in 1977 to 197,600 by 1980; 245,300 by 1985; and 252,800 by 1990. Of the population growth, the proposed actions would be responsible for 750 (1.6 percent) people by 1980; 9,400 (9.8 percent) by 1985; and 15,200 (14.8 percent) by 1990.

This population increase would result in a need for 4,061; 8,122; and 9,143 acres by 1980, 1985, and 1990, respectively, for community expansion. Of these totals, the proposed actions would be responsible for 1.6 percent (64 acres) by 1980, 9.9 percent (801 acres) by 1985, and 14.1 percent (1,292 acres) by 1990.

For the purposes of this analysis, it is assumed that a total of 23 miles of new railroad would be built by 1980, with no additional miles through 1990. Additionally, it is assumed that the number of unit trains leaving the ES area annually would increase from 309 now to 661 by 1980; 1,276 by 1985; and 1,546 by 1990, based on 100 cars per unit train and 15.56 million tons of coal shipped out of the ES area annually by 1990. Approximately 30 percent of production would be shipped west and 70 percent would go east.

The bulk of annual coal production from the region would be hauled by unit trains over existing Denver and Rio Grande Western (D&RGW) railroad lines from Grand Junction to eastern Colorado and beyond. Additional trackage, spurs, and sidings would be needed, but no data are available on quantity. Centralized traffic control (CTC) of main-line capacity is already being planned for various branches by the D&RGW. It would obviate any need for double tracks and additional rights-of-way and would effectively upgrade the existing branch line to main-line capacity.

Implementation of the proposed and possible future federal coal actions would result in a considerable increase in worker, service, and industrial traffic over the road systems of the region. New roads would also have to be built. For the purposes of this analysis, it is assumed that a total of 5 miles of new road would be built by 1980, 76 miles by 1985, and 79 miles by 1990. (All miles of new road would be over and above existing road alignments.) These new roads would be haulage roads from projected new coal mines to rail-loading facilities or exploration trails and access roads. Other road requirements are included in the acreage calculations for increased population requirements.

In 1977 there were eleven power generating plants in the ES area. No plans have been confirmed for construction of additional coal-fired generating plants in the ES area before 1990. However, the development of the new mines would require new power and communication lines.

Delta-Montrose Electric Association has proposed to construct another 20-megawatt transmission line up the North Fork of the Gunnison River to service the population and mine expansions expected; the line is to be completed by 1984. The company has not yet applied for a right-of-way for this line.

Projected Acreage Requirements

The proposed mines would disturb a total of 413 acres by 1980; 1,934 acres by 1985; and 2,462 acres by 1990 (due to both site development and community expansion), with very small amounts of reclamation prior to mine abandonment at some point in the future (see table R1-2). Reclamation would be minimal due to the nature of underground mining. By comparison, table R1-6 indicates that regional cumulative disturbance and reclamation acreages for other development activities in the ES area would be much more substantial through 1990. Excluding the six proposed mines, regional surface disturbance would be 8,226 acres by 1980; 24,221 acres by 1985; and 30,964 acres by 1990. Reclamation would take place on 0, 180, and 265 acres by 1980, 1985, and 1990. Most of this disturbance would be due to oil shale development and associated community expansion in Mesa and Garfield counties. This information is used as the basis for describing the future environment without the proposal in chapter 2.

Projected Water and Sewage Treatment Requirements

A summary of estimated increased annual water and sewage treatment requirements in the ES area by 1990 is presented in table R1-7 for the most probable level of development. Similar requirements for coal-related development as a result of the proposed actions are given in table R1-8. These estimates indicate that increased consumptive use of water at the most probable level of development would be about 8,460 acre-feet per year (ac-ft/yr) by 1980; 44,120 ac-ft/yr by 1985; and 44,010 ac-ft/yr by 1990. Consumptive use attributable to the proposed actions would be about 120 ac-ft/yr by 1980; 3,130 ac-ft/yr by 1985; and 3,190 ac-ft/yr by 1990. Thus, the proposed actions would compose only about 1.4 percent of the total estimated in-

TABLE R1-7

PROJECTED INCREASED ANNUAL WATER AND SEWAGE TREATMENT REQUIREMENTS IN WEST-CENTRAL COLORADO BY 1990 AT THE MOST PROBABLE LEVEL OF DEVELOPMENT

1980 (acre-feet/ Facility	1985 (acre-feet/ year)	1990 (acre-feet/ year)	year)
1. Mining and coal-processing operations	420	1,920	1,710
2. Oil shale mining and processing operations	640	12,600	12,600
3. Other mining operations	200	300	400
4. Grand Valley project	+800 a/	+2,800 a/	+4,000 a/
5. Dallas Creek project (Ridgway Reservoir)	500	17,100	17,100
6. Population increase (treated water supply)	10,700	21,400	23,100
7. Population increase (sewage effluent)	+3,200 b/	+6,400 b/	+6,900 b/
8. Population increase (consumptive use- line 6 less line 7)	7,500	15,000	16,200
9. Total consumptive use of water	8,460	44,120	44,010

Note: Projections in this table are based on assumed values listed in table R1-9 when specific data are not available.

a/ Represents increased water yield to the Colorado River

b/ Sewage effluent returned to the Colorado River system.

TABLE R1-8

PROJECTED ANNUAL WATER AND SEWAGE TREATMENT REQUIREMENTS FOR COAL-RELATED DEVELOPMENT IN WEST-CENTRAL COLORADO BY 1990 AS A RESULT OF THE PROPOSED ACTION

Facility	1980 (ac-ft/yr)	1985 (ac-ft/yr)	1990 (ac-ft/yr)
Mining and coal-processing operations	0	1,660	1,530
Population increase (treated water supply)	170	2,100	3,400
Population increase (sewage effluent)	50	630	1,020
Consumptive use from population increase (initial water use less sewage effluent)	120	1,470	2,380
Total consumptive use as a result of the proposed action	120	3,130	3,910

Note: Data in this table are from site-specific analyses, volume 2.

creased consumptive use of water at the most probable level development by 1980, 7.1 percent by 1985, and 8.9 percent by 1990.

Estimated increased sewage treatment at the most probable level of development would be about 3,200 ac-ft/yr by 1980; 6,400 ac-ft/yr by 1985; and 6,900 ac-ft/yr by 1990. In contrast, sewage treatment required by the proposed actions would be about 50 ac-ft/yr by 1980; 630 ac-ft/yr by 1985; and 1,020 ac-ft/yr by 1990. Sewage treatment required by the proposed actions, therefore, would compose only about 1.6 percent of the total estimated increase at the most probable level of development by 1980, 9,8 percent by 1985, and 14.8 percent by 1990.

Analysis Assumptions

The following assumptions are used for analysis of regional impacts:

1. Mining and reclamation technology will not change significantly through 1990.
2. Labor and equipment shortages will not significantly distort the projected levels of development.
3. Although reclamation will be an ongoing process to be initiated when an area or portion of an area is no longer needed for underground mining operations, none of the disturbed acres will actually be available for post-mining land use until the end of the mine life.
4. Accelerated development of other energy minerals (including oil shale) will occur in addition to coal development in west-central Colorado.

Additional assumptions regarding employment, acreage, and water requirements for various elements of projected coal-related development are presented in tables R1-9 and R1-10.

TABLE R1-9

ASSUMED ACREAGE REQUIREMENT FOR DEVELOPMENT

Facility	Acres Required
Mine Buildings, shops, etc.	100 per mine
Roads (150-foot right-of-way)	18 per mile
Per 1,000 population increase	85
Railraods (100-foot right-of-way)	12 per mile

Note: These figures were used when specific data were not available.

TABLE R1-10

ASSUMED WATER AND SEWAGE TREATMENT REQUIREMENTS FOR DEVELOPMENT

Facility	Acre-feet/year
Consumptive use of water in power plants (water cooled) per megawatt	15
Consumptive use of water per 1,000 tons of coal produced	0.17
Consumptive use of water per 1,000 barrels of oil produced from oil shale	0.50
Additional treated water supply required per 1,000 population increase	230
Additional sewage treated per 1,000 population increase	70
Consumptive use of water per 1,000 population increase (initial use less sewage effluent)	160

CHAPTER 2

DESCRIPTION OF THE ENVIRONMENT

The following section describes the physical, biological, and cultural resources and the socioeconomic conditions of the west-central Colorado regional environmental statement area. The description focuses on the environmental elements which are most likely to be affected by the proposed actions and the alternatives. The concluding section of this chapter describes the anticipated future environment through 1990 if the proposed actions are not implemented.

EXISTING ENVIRONMENT

Climate

Introduction

The west-central Colorado region is one of geographical and meteorological complexity. Consequently, climatic conditions vary widely within short distances. Rugged mountains, deep valleys and canyons, and a few large plateaus or mesas characterize the terrain. The mountains of the Continental Divide provide an effective barrier to moisture-laden air that reaches into the plains from the Gulf of Mexico. The basic types of climate are (1) semiarid and (2) undifferentiated highlands (Trewartha 1961). Temperatures are cold in winter and, except for the higher elevations, warm in summer. Precipitation falls from air of Pacific origin and occurs most frequently in the winter half of the year. There is a winter maximum of precipitation over the higher elevations of the region, with summer maximums at most lower elevation locations.

Variations in weather are related to synoptic-scale high and low pressure systems that move with the mid-latitude westerlies. From fall to spring, considerable snowfall occasionally accompanies the low pressure storms. Occurrences of severe weather are infrequent.

Specific Climatic Factors

TEMPERATURE

Mean annual temperatures for observation stations with available data in west-central Colorado range from 54.1 degrees Fahrenheit at Palisade, in the Grand Valley, to 32.8 degrees Fahrenheit at Taylor Park, near the Continental Divide. Most of the high mountains (elevations about 12,000 feet) have mean annual temperatures below 30 degrees Fahrenheit. A diagram of the typical change in temperature with elevation along a slope in comparison to the change with elevation in the atmosphere is presented in figure R2-1.

The mean annual temperatures for stations in or near the study region are listed in table R2-1 (McKee 1972). An isotherm analysis based on these data is shown in map R2-1. Because the terrain is so complex, a topographic map was used to make topographic adjustments to the isotherms.

The warmest month is July, with the mean temperatures ranging from the upper 70s (degrees Fahrenheit) in the Grand Valley to the upper 50s in the higher mountains of the eastern portion of the study region. January is the coolest month with a range from the upper 20s in western locations to 10 degrees Fahrenheit or less in the mountains of the eastern portion. Table R2-2 contains temperature statistics for five stations that were selected as generally representative of certain areas in the region. Aspen and Crested Butte are in the mountainous areas in the east. Gunnison, in a deep valley in the west, is also in the eastern portion. Grand Junction characterizes the Grand Valley in the west, and Paradox is located in an area of strongly rolling terrain in the southwestern part of the region.

Daily, monthly, and annual mean temperatures are highest at lower elevations and lowest at higher elevations. However, on any given night, temperatures may be colder in valleys or basins than in the adjacent higher locations surrounding these lower areas. The cold temperatures in the valleys are caused by cold air drainage from the surrounding terrain during nighttime radiational cooling. Such cooling is most pronounced on clear, calm nights.

Extreme temperatures recorded at some of the stations in the region during the 20-year period 1951-1970 are presented in table R2-3 (Benci and McKee 1977). There is a difference of 166 Fahrenheit degrees between the lowest (-60 degrees Fahrenheit at Taylor Park) and the highest (106 degrees Fahrenheit at Gateway) temperatures recorded in the region during that period. The lowest and highest temperatures on record for the state of

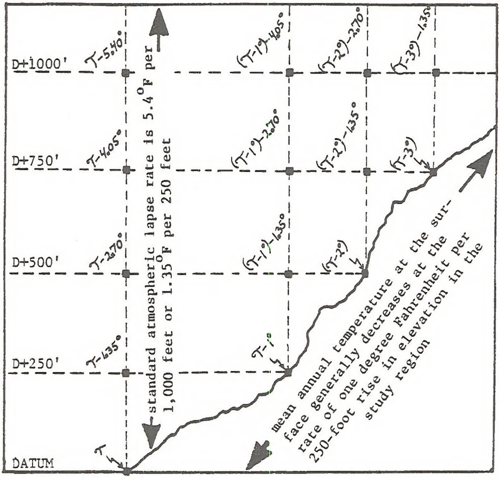


Figure R2-1. Generalized cross-sectional temperature structure of the atmosphere in the westcentral Colorado study region (in degrees Fahrenheit)

TABLE R2-1

MEAN ANNUAL TEMPERATURES FOR STATIONS
IN OR NEAR THE WESTCENTRAL
COLORADO STUDY REGION

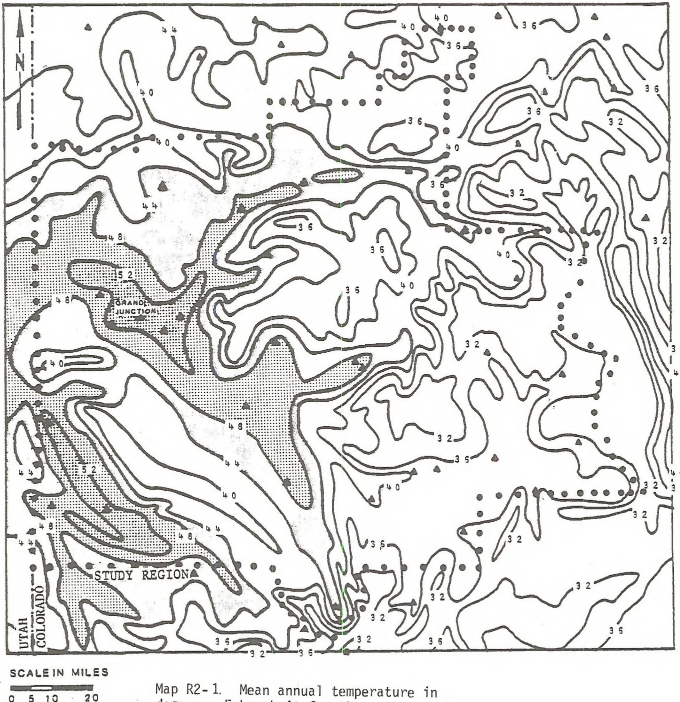
Station	Approximate Number of Years of Record	Mean Annual Temperature (°F)	Station	Approximate Number of Years of Record	Mean Annual Temperature (°F)
Altenbern	(14)	46.3	Little Hills*	(25)	42.8
Aspen	(43)	40.6	Marvine*	(12)	40.7
Basalt*	(6)	44.2	Meeker*	(29)	44.3
Bond*	(13)	43.9	Meeker 10NW* †	(20)	44.0
Cedaredge	(64)	48.6	Meredith	(6)	39.7
Cimarron 3SE †	(19)	41.2	Montrose No. 2	(80)	48.5
Climax 2NW *†	(20)	30.8	Norwood*	(39)	44.5
Cochetopa Creek	(25)	36.6	Ouray	(25)	45.0
Colibran	(67)	46.2	Palisade 1S †	(40)	54.1
Colorado National Monument	(31)	52.2	Paonia	(15)	49.4
Crested Butte	(61)	35.3	Paonia 3SE †	(50)	48.6
Delta	(42)	50.8	Paradox	(29)	50.3
Eagle*	(30)	42.1	Pitkin	(9)	33.5
Fruita	(42)	51.0	Powderhorn	(6)	35.2
Gateway	(15)	53.3	Rangely*	(20)	45.8
Glenwood Springs 1N †	(41)	47.7	Rifle	(41)	47.6
Gore Pass Ranch*	(5)	39.0	Sapinero 8E †	(11)	37.8
Grand Junction WBAP ††	(74)	52.7	Sapinero (near)	(23)	39.8
Grand Junction 6ESE †	(9)	54.1	Silverton 2NE* †	(65)	35.5
Grand Valley	(7)	50.5	Taylor Park	(32)	32.8
Green Mountain Dam*	(33)	40.4	Telluride*	(61)	39.4
Gunnison	(70)	37.4	Uravan	(11)	52.3
Kremmling*	(14)	37.7	Yampa*	(8)	39.0
Lake City*	(23)	38.6			

Source: McKee, 1972.

* Outside of study region.

† Denotes the distance in miles and direction away from the main Post Office in the respective city.

†† Station is located at the airport.



Map R2-1. Mean annual temperature in degreees Fahrenheit for the westcentral Colorado study region*

Source of Raw Data Used in Analysis: McKee, 1972.

*Contour interval is every four degrees. Shaded areas represent temperatures greater than 44°F. Triangles represent data points used.

TABLE R2- 2

SELECTED MONTHLY AND ANNUAL MEAN TEMPERATURE NORMALS FOR THE WESTCENTRAL COLORADO STUDY REGION (1951-1970)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Aspen	20.9	23.4	28.5	38.5	48.2	56.0	62.2	60.3	53.2	43.9	30.7	22.0	40.7
Crested Butte	13.7	16.3	22.4	33.0	44.5	52.6	58.6	56.8	49.8	40.6	26.1	16.0	35.8
Grand Junction WBAP†	26.7	33.9	41.2	51.4	62.3	71.9	78.8	75.3	66.9	54.9	39.9	28.6	52.7
Gunnison	10.4	14.8	24.6	38.0	47.9	56.0	62.2	59.7	52.4	42.1	27.8	14.2	37.3
Paradox	28.0	34.2	39.2	48.2	58.0	66.9	73.3	70.5	62.2	51.4	38.0	29.1	50.4

Source: Benci and McKee, 1977

†Station at airport.

TABLE R2-3

TEMPERATURE EXTREMES RECORDED WITHIN THE WESTCENTRAL COLORADO STUDY REGION DURING THE TWENTY-YEAR PERIOD OF 1951 TO 1970

Station	Highest (°F)	Date of Occurrence	Lowest (°F)	Date of Occurrence
Altenburn	101	July 1960	-32	January 1963
Aspen	93	June 1954	-37	January 1963
Cedaredge	103	June 1960	-24	January 1963
Cimarron 3SE†	98	July 1961	-43	January 1963
Cochetopa Creek	92	June 1954, July 1960	-39	January 1963
Colorado Nat. Mon.	103	June 1963	-18	January 1963
Crested Butte	90	June 1954	-47	January 1963
Fruita	103	August 1958, July 1960, June 1961	-34	January 1963
Gateway	106	August 1958, July 1959	-28	January 1963
Glenwood Springs	102	June 1954	-26	February 1951, January 1963
Grand Junction WBAP††	103	August 1969, June 1970	-23	January 1963
Gunnison	96	August 1958	-41	February 1955
Montrose No. 2	100	July 1960	-27	January 1963
Ouray	92	June 1954	-22	January 1963
Palisade 1S†	105	June 1954	-20	January 1963
Paradox	104	August 1958, July 1959	-21	January 1963
Pitkin	83	July 1966	-31	February 1965
Rifle	101	July 1954	-38	January 1963
Taylor Park	85	June 1954	-60	February 1951

Source: Benci and McKee, 1977.

†Denotes the distance in miles and direction away from the main Post Office in the respective city.

††Station is located at the airport.

Colorado are -60 degrees Fahrenheit at Taylor Park on February 1, 1951, and 118 degrees Fahrenheit at Bennett (northeast Colorado) on July 11, 1888 (National Oceanic and Atmospheric Administration 1974).

Growing Season

The length of the growing season varies considerably throughout the region. Locations in the Grand Valley tend to experience the longest growing seasons. Locations 13 or 14 thousand feet above mean sea level (MSL) may experience only a few days between occurrences of freezing temperatures. Palisade, at 4,780 feet MSL, has a growing season of 188 days between temperatures of 32 degrees Fahrenheit. Crested Butte, at 8,855 feet MSL, has only 29 consecutive days with minimum temperatures above 32 degrees Fahrenheit.

Some species of plants are vulnerable to light freezes while others are affected only by hard freezes. Therefore, average growing season data for temperatures of 32, 28, 24, 20, and 16 degrees Fahrenheit are shown in table R2-4. In a given year, the growing season may be shorter, longer, begin earlier, begin later, end earlier, end later, or be the same as the average. Examples are (1) a growing season of average length but later beginning and ending dates and (2) a shorter than average growing season that begins earlier but ends even earlier than the average dates.

The growing season at a given location may not be completely dependent on elevation. The mountainous terrain influences the strength and frequency of cold air drainage. If the drainage is strong and frequent at a given location, the growing season will be shorter than at another location with the same or somewhat higher elevation but weak and infrequent drainage events. Grand Junction and Fruita in the Grand Valley provide an example. Fruita, at 4,507 feet MSL, experiences 149 consecutive days without freezing temperatures. Grand Junction, at 4,849 feet MSL, experiences a longer growing season of 185 days. In general most stations at elevations higher than Grand Junction and Fruita experience shorter growing seasons.

Consideration of the date of the first fall freeze is particularly important when attempting to revegetate disturbed areas. The objective of revegetation is to establish a self-sustaining vegetative cover (Atlantic Richfield Company 1977). To ensure vegetation survival during the winter, seedlings of grass, shrubs, forbs, or trees that are used for revegetation may need to harden off before the first day with a freezing or subfreezing temperature. The date of the first occurrence of 32 degrees Fahrenheit at Palisade is October 23, while at Crested Butte the first freeze occurs on July 23. Detailed data on dates of first and last occurrences of 32, 28, 24, 20 and 16 degrees Fahrenheit are given in table R2-4.

Precipitation

Total Precipitation

The precipitation totals (rainfall plus the water equivalent of snowfall) in the west-central Colorado region are low compared with the totals in many other areas of the United States. The high elevation of the region is a major cause of these low totals. The water content of the atmosphere generally decreases with height. Therefore, elevated regions tend to have less precipitable water in the air than lower regions. However, the rise of moisture-laden air up mountain slopes (orographic lifting) may cause more precipitation on these slopes than at other locations within any given region. The low amounts of precipitation in much of west-central Colorado are also caused by the orographic removal of moisture as Pacific air masses are lifted over the high mountain ranges well to the west. Variation in precipitation amounts over the heterogeneous terrain of west-central Colorado is related not only to the variation of elevation but also to mountain range orientation with respect to the large-scale prevailing wind patterns (National Oceanic and Atmospheric Administration 1974).

Map R2-2 shows isohyets based on precipitation data for the study region. Since precipitation (as well as other parameters) is "profoundly affected" by the mountainous terrain (National Oceanic and Atmospheric Administration 1974), the isohyets were topographically adjusted. Table R2-5 shows the precipitation data that were used in the analysis and the corresponding lengths of record for each station (McKee 1972).

For the monthly variation of precipitation within the region, Aspen, Crested Butte, Grand Junction, Gunnison, and Paradox were selected as generally representative (see table R2-6). These are the same stations used for temperature in table R2-2. For most places, the greatest precipitation occurs in August, while the least precipitation occurs in June (Benci and McKee 1977). However, winter is the season with the greatest precipitation at most higher elevations, while summer is the peak season at most lower elevations. Table R2-7 shows the average number of days with measurable precipitation (0.01 inch or more).

Snowfall

Annual snowfall is highly dependent on terrain elevation and on the orientation of mountains and mountain ranges. Elevations in the region range from about 4,500 feet just west of Fruita to 14,431 feet at the summit of Mr. Elbert on the eastern

TABLE R2-4

GROWING SEASON DATA FOR STATIONS IN OR NEAR THE WESTCENTRAL COLORADO STUDY REGION

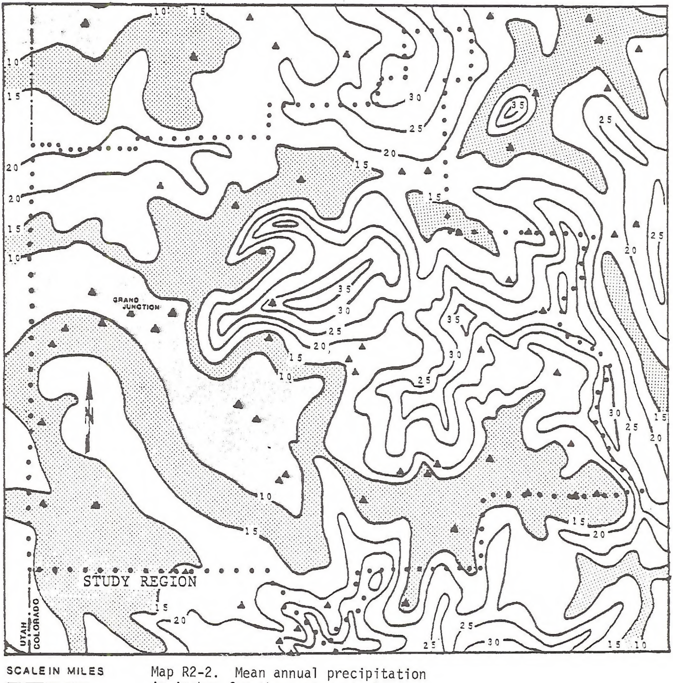
		Average Number of Days Between the Last Spring Occurrence and the First Fall Occurrence of Indicated Temperatures					Average Dates of First Occurrence In the Fall of the Indicated Temperatures					Average Dates of Last Occurrence In the Spring of the Indicated Temperatures				
STATION	ELEVATION (ft)	32°	28°	24°	20°	16°	32°	28°	24°	20°	16°	32°	28°	24°	20°	16°
Aspen	7928	76	116	140	165	185	8/28	9/24	10/6	10/16	10/25	6/13	5/31	5/19	5/4	4/23
Cedaredge	6180	143	178	192	221	235	10/7	10/18	10/28	11/10	11/14	5/17	4/23	4/19	4/3	3/24
Cochetopa Creek	8000	49	93	122	147	173	8/9	9/9	9/22	10/2	10/16	6/21	6/8	5/23	5/8	4/26
Collbran 1W**	6130	120	148	176	199	224	9/24	10/5	10/15	10/28	11/7	5/27	5/10	4/22	4/12	3/28
Col.Nat.Mon.	5280	156	179	204	223	236	10/9	10/20	10/31	11/9	11/16	5/6	4/24	4/10	3/31	3/25
Crested Butte	8855	29	84	113	144	171	7/23	9/4	9/21	10/1	10/15	6/24	6/12	5/31	5/10	4/27
Delta 1E**	5125	147	169	195	212	240	10/3	10/14	10/25	10/31	11/14	5/9	4/28	4/13	4/2	3/19
Eagle FAA AP*	6497	70	101	135	161	188	8/28	9/11	9/26	10/6	10/21	6/19	6/2	5/14	4/28	4/16
Fruita	4507	149	175	198	220	243	10/4	10/16	10/27	11/4	11/14	5/8	4/24	4/12	3/29	3/16
Glenwood Spgs 1N**	5823	138	170	195	220	239	10/2	10/15	10/27	11/5	11/13	5/17	4/28	4/15	3/30	3/19
Grand Junction WBAP ††	4849	185	209	230	242	272	10/22	11/4	11/10	11/14	11/27	4/20	4/9	3/25	3/17	2/28
Gunnison	7664	45	93	121	153	176	8/7	9/7	9/21	10/4	10/15	6/23	6/6	5/23	5/4	4/22
Montrose No. 1	5830	153	176	202	226	245	10/8	10/21	11/1	11/4	11/18	5/8	4/28	4/13	3/23	3/18
Montrose No. 2	5830	157	178	199	219	239	10/12	10/19	11/1	11/7	11/15	5/8	4/24	4/16	4/2	3/21
Norwood*	7017	109	130	164	189	204	9/24	10/6	10/18	10/27	11/2	6/7	5/29	5/7	4/21	4/12
Ouray	6203	129	157	181	201	215	10/2	10/13	10/21	11/1	11/10	5/26	5/9	4/23	4/14	4/9
Palisade	4780	188	215	234	260	275	10/23	11/3	11/11	11/21	11/30	4/18	4/2	3/22	3/6	2/28
Paonia 1S**	5900	138	171	197	216	241	10/4	10/17	10/29	11/6	11/14	5/19	4/29	4/15	4/4	3/18
Paradox	5309	129	152	182	205	228	9/27	10/10	10/22	10/30	11/7	5/21	5/11	4/23	4/8	3/24
Rifle	5400	109	143	173	195	223	9/14	9/29	10/14	10/23	11/5	5/28	5/9	4/24	4/11	3/27
Sapinero 8E**	7720	96	117	140	173	184	9/19	9/30	10/8	10/20	10/29	6/15	6/5	5/21	4/30	4/28
Taylor Park	9206	67	105	136	153	170	8/24	9/17	9/29	10/9	10/20	6/18	6/4	5/16	5/9	5/3
Telluride*	8800	40	80	122	150	178	8/2	8/31	9/26	10/10	10/24	6/23	6/12	5/27	5/13	4/29

SOURCE: National Oceanic and Atmospheric Administration, 1974.

*Outside of study region.

**Number of miles and direction that the station is located away from the main post office.

†Station at airport.



Map R2-2. Mean annual precipitation in inches for the west-central Colorado region*

Source of Raw Data Used in Analysis: McKee, 1972.

*Contour interval is 5 inches. Shaded areas represent amounts less than 15 inches. Triangles represent data points used. Periods of record used for analysis vary from 5 years to 84 years, most of them ending in 1972.

TABLE R2- 5
ANNUAL PRECIPITATION FOR STATIONS IN OR NEAR THE WESTCENTRAL COLORADO STUDY (NO DATA LATER THAN 1972)

Station	Years of Record (Generally ending in 1972)	Precipitation (inches)	Station	Years of Record (Generally ending in 1972)	Precipitation (inches)
Altenbern	(25)	15.93	*Meeker	(29)	17.06
*Ames	(58)	25.51	*Meeker 10NW †	(20)	16.79
Aspen	(44)	19.15	Meredith	(9)	17.77
Basalt	(6)	14.86	Montrose No. 1	(33)	9.35
Blue Mesa Lake	(5)	11.55	Montrose No. 2	(84)	9.72
*Bond	(14)	12.06	*Norwood	(40)	15.16
Bonham Reservoir	(9)	34.28	Olathe	(13)	7.05
Cedaredge	(62)	11.74	Ouray	(28)	21.04
Cimarron 3SE †	(20)	13.79	Palisade 1S †	(42)	9.12
*Climax 2NW †	(23)	23.71	Paonia	(15)	15.29
Cochetopa Creek	(25)	10.72	Paonia 3SE †	(51)	15.75
Collbran	(72)	14.89	Paradox	(30)	11.51
Colorado National Monument	(32)	10.99	Parshall	(20)	16.11
Crested Butte	(72)	26.83	Pitkin	(41)	16.86
Delta	(42)	7.73	*Placerville	(24)	15.23
Eagle	(30)	10.46	Powderhorn	(6)	11.53
Fruita	(42)	8.34	*Rangely	(21)	8.93
Gateway	(25)	10.97	Rifle	(42)	10.95
Glenwood Springs 1N †	(41)	17.49	Sapinero 8E †	(16)	19.22
*Gore Pass Ranch	(6)	11.40	Sapinero (near)	(23)	22.61
Grand Junction WBAP ††	(74)	8.54	*Sargents	(14)	12.02
Grand Junction 6ESE †	(9)	8.34	*Sargents 6W †	(11)	11.72
Grand Valley	(7)	13.37	Shoshone	(42)	19.23
*Green Mountain Dam	(33)	15.46	Silverton 2NE †	(66)	24.73
Gunnison	(80)	10.47	Taylor Park	(32)	16.40
Independence Pass 5SW†	(13)	28.35	*Telluride	(61)	23.30
*Kremmling	(15)	11.27	Tennessee Pass	(6)	18.70
*Lake City	(35)	14.49	*Trout Lake	(43)	28.66
Little Dolores 5NE †	(4)	10.79	Uravan	(12)	12.66
Little Delores	(9)	13.06	Wilcox Ranch	(12)	16.94
Little Hills	[illegible]	13.03	*Yampa	(26)	16.24
*Marvine	(23)	20.47			

Source: McKee, 1972.
* Outside of the study region.
† Denotes the distance in miles and direction away from the main Post Office in the respective city.
†† Station is located at the airport.

TABLE R2-6

SELECTED MONTHLY AND ANNUAL PRECIPITATION NORMALS FOR THE WESTCENTRAL COLORADO STUDY REGION (1951-1970)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Aspen	1.68	1.46	1.83	1.72	1.46	1.20	1.46	2.06	1.59	1.54	1.59	1.68	19.27
Crested Butte	3.34	2.41	2.68	1.91	1.39	1.30	1.97	2.22	1.81	1.60	1.93	2.97	25.53
Grand Junction WBAP	0.64	0.59	0.65	0.72	0.67	0.51	0.41	1.07	0.82	0.87	0.62	0.61	8.18
Gunnison	1.09	0.96	0.88	0.73	0.63	0.59	1.60	1.55	0.97	0.81	0.82	0.96	11.59
Paradox	0.98	0.90	0.76	0.88	0.75	0.48	1.18	1.72	1.05	1.23	0.97	1.06	11.96
Composite Precipitation for Study Region	1.55	1.26	1.36	1.19	0.98	0.82	1.32	1.72	1.25	1.21	1.19	1.46	15.31
Composite Monthly Precipitation as Percentages of the Annual Total	10	8	9	8	6	5	9	11	8	8	8	10	

Source: (Benci and McKee, 1977).

TABLE R2- 7

AVERAGE NUMBER OF DAYS WITH 0.01 INCH OR MORE OF PRECIPITATION IN THE WESTCENTRAL COLORADO STUDY REGION

January	10
February	9
March	10
April	9
May	9
June	7
July	9
August	11
September	7
October	9
November	7
December	9
Annual	106

Source: U. S. Department of Commerce, 1968.

border of the region. Annual snowfall at these locations ranges from less than 20 inches to more than 300 inches, respectively. The snowfall season in the lower elevations of the Grand Valley lasts approximately six months (November through April). The highest elevations, in the eastern part of the region, have a snowfall season of eleven months (September through July).

Annual snowfall data from stations in or near the region are shown in table R2-8 (McKee 1972). Snowfall isopleths, based on these data and topographically adjusted, are presented in map R2-3. The maximum monthly snowfall occurs in January, while July and August have the least. Snow has fallen at higher elevations in these summer months, but only in a few of the years on record. Table R2-9 shows monthly and annual snowfall averages for the same stations and period used to characterize temperature and precipitation in certain areas of the region.

In most of the region, blizzards rarely occur, especially at the lower elevations. On high plateaus and the upper slopes of the higher mountains, the occurrence of such conditions is more likely.

Heavy Rainfall Events

The heaviest theoretical rainfalls for the United States have been calculated using real data as input for mathematical rainfall models. These calculations indicate that a rainfall of 1.3 inches in 30 minutes has a mean recurrence interval of 100 years at a given location in west-central Colorado (see table R2-10). Therefore, rainfalls of this intensity can be expected once every 100 years. Similarly, 24-hour rainfalls of 3.3 inches can be expected once every 100 years (Hershfield 1961). The maximum 24-hour rainfall is most likely to occur during the month of August (Hansen 1977). Every 100 years a rainfall of 6.3 inches in ten days can be expected (Miller 1964). An analysis of climatological records shows that, within the region, maximum observed clock-hour rainfalls have ranged from 0.6 inch to slightly over 1 inch (Hansen 1977; see map R2-4). These observed rates are exceeded by the theoretical 1.2 inches of hourly rainfall that can be expected once every 25 years. However, the theoretical rate is not restricted to a clock hour (a one-hour period beginning on the hour).

Flooding and Streamflow

Most of the water that runs into the river systems comes from snowmelt at the higher elevations. During a year with normal snowfall and normal springtime temperatures, no general flooding occurs, although the river levels may become quite high (National Oceanic and Atmospheric Administration 1974). However, during years with heavy snow cover or sudden spring warming (or both), wide-spread flooding may occur. Local flash floods can occur in the summer because of heavy rains from intense thunderstorms (Irons 1965).

Most of the streamflow is regulated by snowmelt at the higher elevations. Rising temperatures during the late spring and early summer cause stream levels to reach their maximum. These high water levels persist until July when the annual snowpack has melted. Until the next spring, a base flow prevails, although a few small peaks in streamflow can occur during the July-October period as a result of thunderstorms.

Droughts

Data records indicate a 1-year drought period once every 7 years, a 2-year drought period once every 44 years, and a 3-year drought period once every 313 years. These drought frequencies were derived from statistical analysis of long-term data for Glenwood Springs, Grand Junction, Gunnison, and Montrose, Colorado (U.S. Department of Commerce 1896-1976). The probabilities and mean recurrence intervals (average frequencies) were calculated for the occurrence of one year, two consecutive years, and three consecutive years with 75 percent or less of normal annual precipitation. Drought conditions may develop if less than 75 percent of normal precipitation falls (A. H. Belo Corp. 1975).

The frequency of droughts is an important consideration in the determination of revegetation success. A drought is a period of abnormally dry weather sufficiently prolonged for the lack of water to cause a serious hydrologic imbalance that produces crop damage, water supply shortages, etc. (Huschke 1970). Since hydrologic imbalances denote drought conditions, subnormal precipitation totals can indicate probable drought conditions that may cause failures of revegetation attempts.

Thunderstorms, Hailstorms, and Tornadoes

Annually, there are approximately 40 days with thunderstorms in west-central Colorado (National Climatic Center 1976; Landsberg 1969). For comparison, general information on thunderstorm days for the contiguous United States is presented in figure R2-2. Thunderstorms occur predominantly in the spring, summer, and early fall. They are most frequent in the afternoon, and tend to be more extensive over the higher elevations in all parts of the region.

Although hail is not unusual in west-central Colorado, it is less frequent than in much of the nation (Changnon 1977). About 4 percent of the region's thunderstorms produce hail that reaches the ground (Flora 1956). The maximum frequencies, approximately three days a year, are in the Grand Junction area and in an area near the Conti-

TABLE R2-8

ANNUAL SNOWFALL FOR STATIONS IN OR NEAR THE WESTCENTRAL COLORADO STUDY REGION

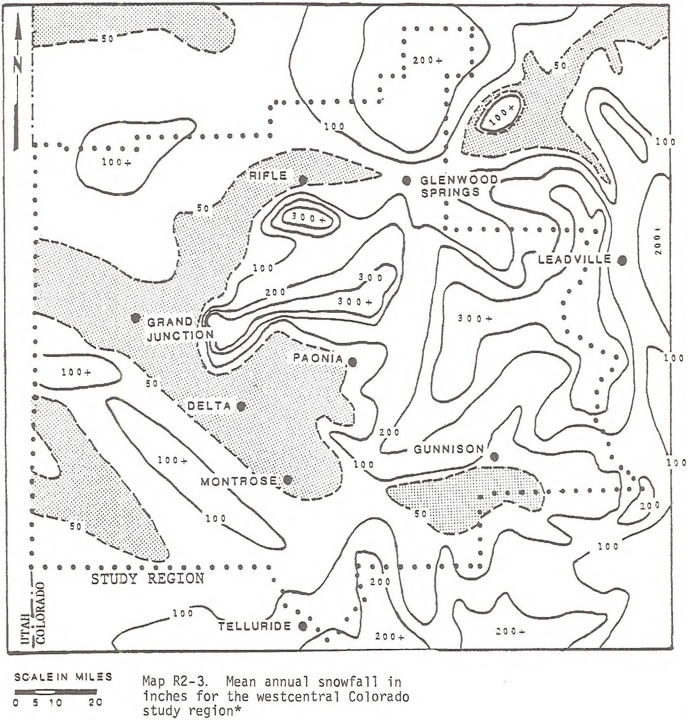
Station	Station Elevation (feet)	Approximate Number of Years of Record	Annual Snowfall (inches)
Altenbern	5690	(24)	70.0
Ames*	8701	(55)	173.3
Aspen	7928	(22)	138.0
Basalt*	6624	(6)	73.4
Bond*	6700	(11)	30.7
Bonham Reservoir	9835	(7)	343.9
Cedaredge	6180	(62)	40.1
Cimarron 3SE +	7096	(18)	65.4
Climax 2NW* +	11300	(22)	279.4
Cochetopa Creek	8000	(24)	49.0
Collbran	6137	(68)	69.8
Colorado National Monument	5280	(31)	40.4
Crested Butte	8855	(71)	208.6
Delta	5115	(40)	16.3
Dinosaur National Monument*	5921	(7)	43.8
Eagle (FAA)*	6497	(30)	46.8
Fruita	4507	(40)	17.4
Gateway	4562	(24)	20.1
Glenwood Springs 1N +	5823	(38)	67.2
Gore Pass Ranch*	7602	(6)	71.6
Grand Junction WBAP ++	4849	(73)	22.0
Grand Junction 6ESE +	4710	(8)	13.1
Grand Valley	5090	(6)	28.0
Green Mountain Dam*	7740	(24)	86.4
Gunnison	7664	(70)	54.3
Independence Pass 5SW +	10550	(12)	313.0
Kremmling*	7359	(5)	43.6
Lake City*	8880	(33)	91.5
Little Hills*	6140	(19)	57.1
Marvine*	7200	(22)	178.9
Meeker*	6242	(26)	80.3
Meeker 10NW *+	6425	(20)	80.5
Meredith	7825	(7)	123.1
Montrose No. 1	5830	(12)	20.9
Montrose No. 2	5830	(68)	31.0
Norwood*	7017	(38)	64.8
Olathe	5360	(12)	16.8
Ouray	6203	(28)	144.8
Palisade 1S +	4740	(31)	16.1
Paonia	5693	(14)	51.8
Paonia 3SE +	6200	(47)	54.6
Paradox	5309	(27)	22.4
Pitkin	9200	(41)	115.1
Placerville*	7322	(21)	67.8
Powderhorn	8087	(6)	47.2
Pyramid*	8009	(25)	194.9
Rangely*	5216	(14)	27.7
Rifle	5400	(34)	38.7
Sapinero 8E +	7720	(16)	175.1
Sapinero (near)	unknown	(24)	209.5
Sargents* +	8465	(12)	89.0
Sargents 6W*+	8125	(10)	81.9
Shoshone	5933	(35)	65.8
Taylor Park	9206	(31)	142.4
Telluride	8800	(58)	156.6
Tennessee Pass*	10245	(6)	132.6
Trout Lake*	9680	(42)	235.3
Uravan	5010	(7)	15.4
Yampa*	7892	(26)	113.9

Source: McKee, 1972.

* Outside of study region.

\+ Denotes the distance in miles and direction away from the main Post Office in the respective city.

++Station is located at the airport.



Map R2-3. Mean annual snowfall in inches for the westcentral Colorado study region*

Source of Raw Data Used in Analysis: McKee, 1972.

*Shaded areas represent amounts less than 50 inches. Otherwise, contour interval is every 100 inches.

TABLE R2- 9

SELECTED MONTHLY AND ANNUAL SNOWFALL
NORMALS FOR THE WESTCENTRAL COLORADO
STUDY REGION (1951-1970)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Aspen	25.4	22.1	23.0	13.6	3.2	0.2	0.0	0.0	2.7	8.0	19.2	23.2	140.6
Crested Butte	50.9	35.5	36.8	19.0	4.2	0.3	0.0	0.0	0.8	8.8	25.1	39.4	220.8
Grand Junction WBAP†	6.6	4.5	4.3	0.8	0.0	0.0	0.0	0.0	0.2	0.4	2.9	5.5	25.2
Gunnison	15.8	12.4	8.8	3.2	0.5	0.0	0.0	0.0	0.2	2.0	8.4	11.7	63.0
Paradox	6.1	5.7	3.1	1.0	0.0	0.0	0.0	0.0	0.1	0.3	1.7	5.8	23.8
Composite Snowfall for Study Region	21.0	16.0	15.2	7.5	1.6	0.1	0.0	0.0	0.8	3.9	11.5	17.1	94.7
Composite Monthly Snowfalls as Percentage of the Composite Annual Total	22	17	16	8	2	0	0	0	1	4	12	18	--

Source: Benci and McKee, 1977.

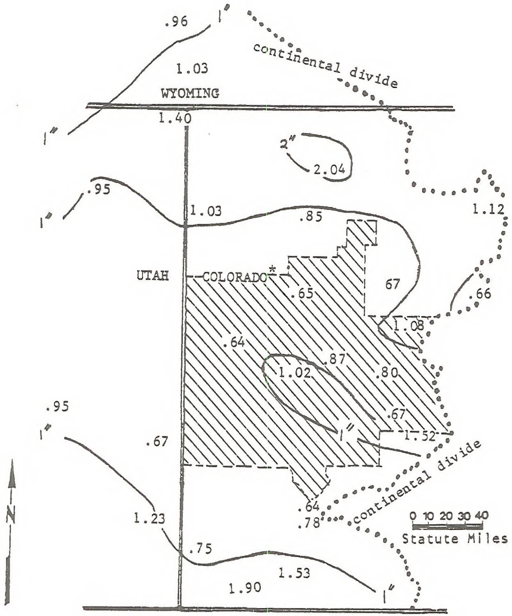
†Station at airport.

TABLE R2-10

MAXIMUM EXPECTED RAINFALL AMOUNTS (IN INCHES) PER DURATIONS FOR SELECTED RECURRENCE INTERVALS FOR THE WESTCENTRAL COLORADO STUDY REGION

Rainfall Duration (hours)	Rainfall Recurrence Interval (Years)						
	1	2	5	10	25	50	100
1/2	0.3	0.5	0.7	0.8	1.0	1.1	1.3
1	0.4	0.5	0.8	1.0	1.2	1.4	1.6
2	0.5	0.7	1.0	1.2	1.5	1.7	1.9
3	0.6	0.8	1.2	1.4	1.6	1.8	2.1
6	0.7	0.9	1.3	1.6	1.8	2.1	2.4
12	0.8	1.1	1.6	1.8	2.2	2.4	2.8
24 (1 day)	1.1	1.2	1.8	2.1	2.4	2.8	3.3
48 (2 days)	-	1.4	2.0	2.3	2.9	3.3	3.7
96 (4 days)	-	1.7	2.3	2.7	3.3	3.6	4.2
168 (7 days)	-	2.1	2.6	3.0	3.6	4.2	4.4
240 (10 days)	-	2.2	2.9	3.5	4.0	4.4	4.5

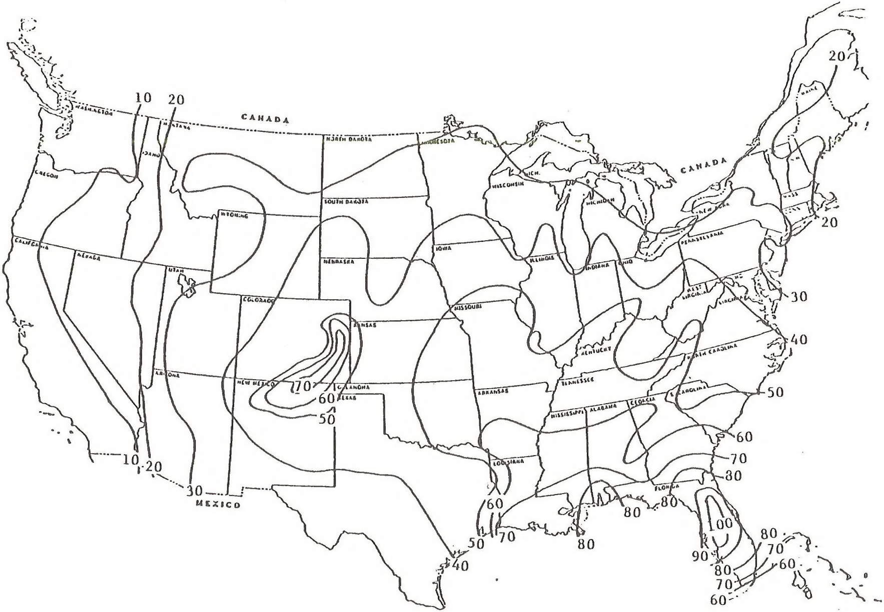
Sources: Hershfield, 1961; Miller, 1964.



*Shaded area represents the study region.

Map R2-4. Maximum clock-hour rainfalls at stations with records for period 1940-1972 (may through September)

Source: Hansen, 1977.



Source: Landsberg, 1969.

Figure R2-2. Mean annual number of days with thunderstorms in the United States nental Divide (see map R2-5). The rest of the region averages about one hail day per year. Hailstorms in Colorado are most numerous in June and July between 4:00 and 5:00 p.m. Mountain Standard Time (Flora 1956).

Tornadoes are rare in the region. They almost never occur in the Colorado mountains (National Oceanic and Atmospheric Administration 1974). In a thirteen-year period, 1955-1967, only one tornado was reported in the region (U.S. Department of Commerce 1969). Therefore, the likelihood of a tornado hitting a given location in west-central Colorado can be considered negligible.

AIR MOISTURE STATISTICS

The semiarid and mountain climates of west-central Colorado are reflected in the average moisture content of the air. The dew point temperature is main indicator of atmospheric moisture. Table R2-11 shows average dew point data for the semiarid Grand Junction area and the mountainous area in the region. These dew point values are low compared with most other areas in the contiguous United States. The annual averages range from 16 degrees Fahrenheit in the mountains to 30 degrees Fahrenheit in the Grand Junction area. The dew points are lowest in January and highest in August.

Annual relative humidities average 58 percent in the region. However, elevation differences are responsible for considerable variation of the relative humidity from one location to another. Table R2-12 shows averages for the region in comparison with averages for Grand Junction. Generally relative humidities are highest near sunrise, when the air is normally coolest, and lowest in the afternoon, when the temperatures are usually the highest.

Fogs occur infrequently in west-central Colorado because of the low amount of moisture normally available for condensation in the air near the ground. Therefore, fog does not often create visibility problems in the region. Available data indicate that heavy fog, which restricts visibility to 0.2 mile or less, occur on about eight days during the year (National Climatic Center 1976). Fogs occur most frequently during the winter and least frequently during the summer.

The mean annual lake evaporation in the region is about 35 inches, while the mean annual class-A pan evaporation is approximately 51 inches (U.S. Department of Commerce 1968).

SUNSHINE

The west-central Colorado region receives abundant sunshine (about 60 percent of the annual possible sunshine). The lower elevations in the western part of the region receive more than the higher elevations. Table R2-13 provides estimated averages of several parameters related to sunshine. Averages for the region are presented along with those for Grand Junction to illustrate the variability. More coudiness over the mountains allows fewer hours of sunshine than at locations like Grand Junction.

The most sunshine occurs in June and July and the least occurs in December and January. The winter is the cloudiest season, and the summer and fall are the least cloudy.

VISIBILITY

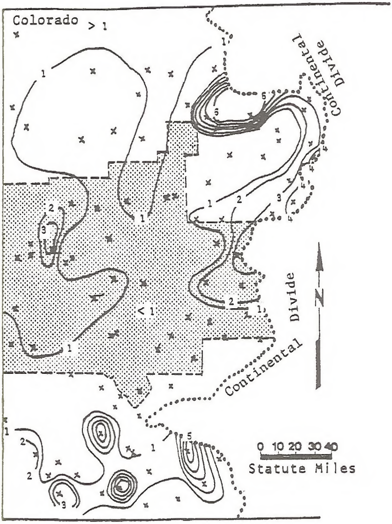
Visibility is normally excellent throughout the region. The average visibility is 47 miles and ranges from a winter average of 36 miles to a summer average of 55 miles (National Climatic Center 1959-1968). Low visibility (3 miles or less) occur about 4 percent of the time in the winter, more than five times as frequent as in any other season. However, most of the low visibility are caused by rain, snow, or fog. Restriction of visibility to 7 miles or less by dust, smoke, or haze is reported less than 0.1 percent of the time.

Compared with the remainder of the contiguous United States, the frequency of dusty conditions in the region is negligible. Dusty conditions in the western portion have been reported only 0.025 percent of the time (an average of two hours per year) from the 1940s to the 1960s (Orgill and Sehmel 1977). Dust in the air has almost never been reported in the eastern portion of the region.

WIND PATTERNS

The complex terrain of the region causes major local distortion of the large-scale wind pattern. At lower elevation, the large-scale pattern has very little influence. Instead, valley-induced circulations dominate the flow (see Topographic Influences for a more detailed description). Annual wind roses for Grand Junction and Eagle are presented in figures R2-3 and R2-4. Both wind roses show the predominance of downslope or downvalley flow, with a secondary maximum for upslope or upvalley winds. This pattern is charcteristic of most valley locations within the region.

At higher elevations, the wind patterns tend to resemble the wind rose at 700-millibar level (about 10,000 feet MSL). However, significant variations can occur at higher elevations because of channeling by mountain ridges and deflection around mountain peaks. Figure R2-5 shows that the winds at the 10,000-foot level are predominantly from the west-southwest. This annual wind direction pattern can be considered characteristic for that level of the atmosphere over most of the region, except over areas where the taller mountains may alter the pattern. However, compared with the annual average, wind speeds are lower in the summer and higher in the winter and spring.



Source of Raw Data Used in Analysis: McKee, 1972.

Map R2-5. Mean annual number of days with hail in Colorado west of the continental divide (study region is shaded)

TABLE R2-11

MONTHLY AND ANNUAL DEW-POINT AVERAGES (^oF) FOR THE WESTCENTRAL COLORADO STUDY REGION (BASED ON 1946-1965 RECORDS)

	Grand Junction Area	Mountainous Areas
January	17	4
February	20	5
March	21	8
April	25	14
May	29	18
June	31	23
July	39	28
August	43	30
September	35	25
October	29	18
November	24	10
December	19	5
Annual	30	16

Source: U. S. Department of Commerce, 1968.

TABLE R2-12

RELATIVE HUMIDITY DATA FOR THE WESTCENTRAL COLORADO STUDY REGION

Month	Monthly Averages for the Region (%)*	Monthly Averages for Grand Junction (%)**
January	73	70
February	72	57
March	60	45
April	51	40
May	50	34
June	48	31
July	51	33
August	53	35
September	48	38
October	54	45
November	67	56
December	72	67
Annual	58	46

* Source: U. S. Department of Commerce, 1968.
(Averages are based on long-term records through 1959.)

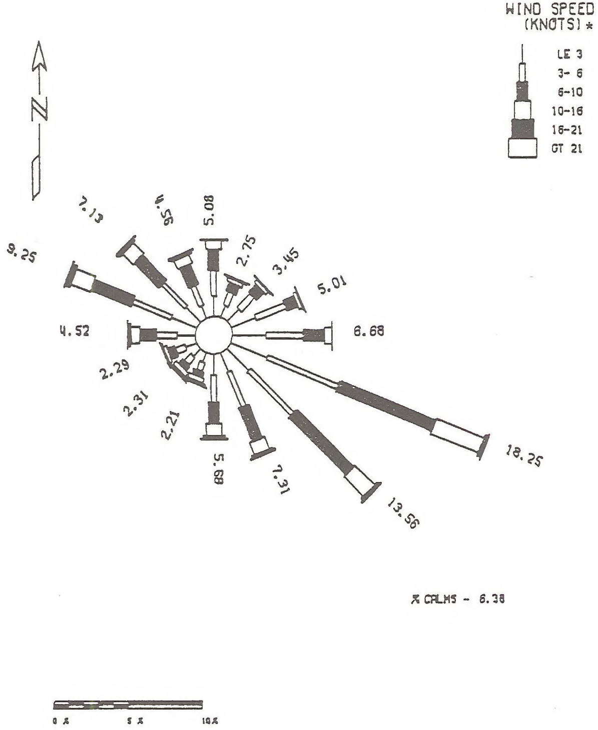
** Source: National Climatic Center, 1976.
(Averages are based on a 13-year period through 1976.)

TABLE R2-13

INSOLATION PARAMETERS FOR THE
WESTCENTRAL COLORADO STUDY REGION

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Percentage of Possible Sunshine	Grand Junction	58	62	64	67	71	79	76	72	77	74	67	58	69
	Study Region Average	50	55	55	55	60	70	70	70	70	65	55	50	60
Total Hours of Sunshine	Grand Junction	169	182	243	265	314	350	349	311	291	255	198	168	3095
	Study Region Average	160	175	220	250	285	320	320	290	270	235	175	150	2850
Mean Sky Cover Sunrise to Sunset (tenths)	Grand Junction	5.3	5.4	5.3	5.4	4.8	3.6	3.9	4.0	3.3	3.5	4.2	5.1	4.5
	Study Region Average	7.0	7.0	6.5	6.5	6.5	5.5	5.5	5.5	4.5	5.0	6.0	6.5	6.0
Mean Direct and Diffuse Daily Solar Radiation (Langleys)	Grand Junction	227	324	434	546	615	708	676	595	514	373	260	212	456
	Study Region Average	225	315	425	520	590	650	650	550	490	360	250	200	435

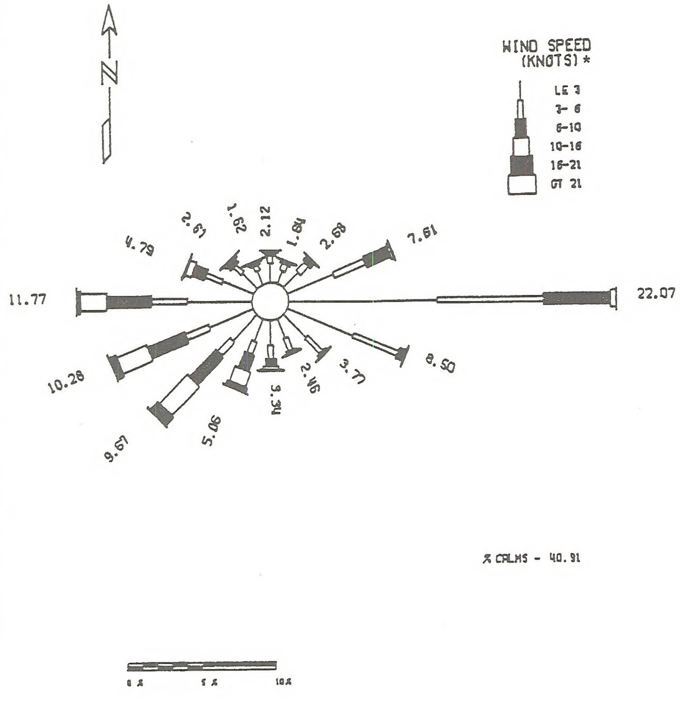
Source: U.S. Department of Commerce, 1968



Sources: National Climatic Center, 1959-1968.
National Climatic Center, 1968.

* (1 knot = 1.15 miles per hour)

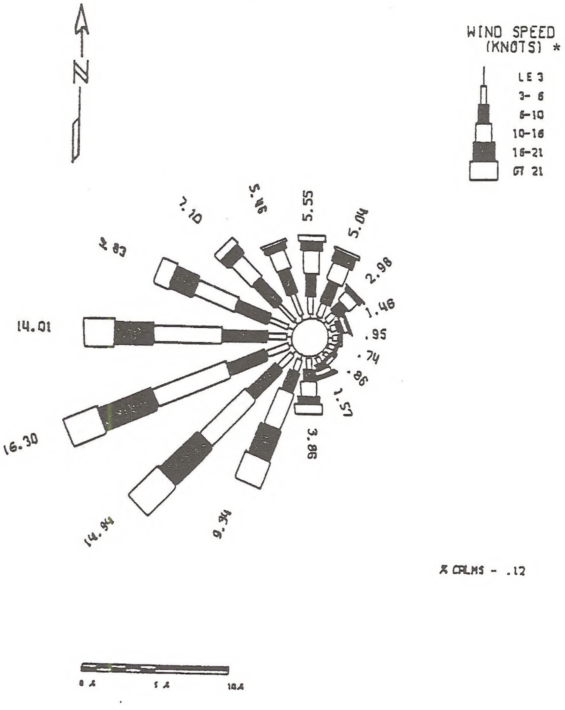
Figure R2-3. Annual wind rose - Grand Junction, Colorado, 1959-1968.



Sources: National Climatic Center, 1965-1974
National Climatic Center, 1968.

* (1 knot = 1.15 miles per hour)

Figure R2-4. Annual wind rose -
Eagle, Colorado, 1956-1974



Source: National Climatic Center, 1971-1976.

* (1 knot - 1.15 miles per hour)

Figure R2- 5. 700-millibar annual wind rose - Grand Juction, Colorado, 1971-1976

The seasonal surface wind roses for Grand Junction are presented in figure R2-6. There is little change from the annual wind direction frequencies because of the dominance of the valley-induced upslope and downslope flows. Light winds are most frequent during the winter as a result of cold air settling into the valley basins. The annual average wind speed of the period 1941-70 at Grand Junction is 8.2 miles per hour (mph). Monthly average wind speeds range from 5.6 mph for January to 9.9 mph for June (National Climatic Center 1976). Annual wind speeds are generally greater for the higher elevations because of more exposure to the strong large-scale wind patterns. Seasonal average wind speeds at high elevations are greatest during the winter and spring, when the large-scale circulation is strongest, and least during the summer.

Statistical analysis of wind speed data for the contiguous United States indicates that sustained winds of 75 miles per hour have a mean recurrence interval of 50 years in the region (Thom 1968). Therefore, theoretically, a 50-year interval can be expected between occurrences of 75 mph sustained winds (duration of about one minute) at locations in the region. Similarly, winds of 85 mph have a mean recurrence interval of 100 years. Relative to other states in the Rocky Mountain Region, Colorado ranks as one of the lowest for wind destruction potential.

At Grand Junction, Colorado, during the 78-year period of 1899-1976, the highest sustained wind was 66 mph, from a southerly direction, in June 1951 (National Climatic Center 1976; Hatch 1978). This observed wind speed is somewhat lower than the 50-year theoretical value of 75 mph. The sheltered location of Grand Junction within the Grand Valley of western Colorado may be the main reason for the difference.

Pollution Dispersion Potential

GENERAL CHARACTERISTICS

The air pollution dispersion potential is an indicator of the ability of the atmosphere to disperse or dilute air pollutants and is related to meteorological conditions. In general, a high pollution dispersion potential lowers the ground-level air pollution concentrations, while restricted or poor dispersion potential allows ground-level air pollution to reach high concentrations.

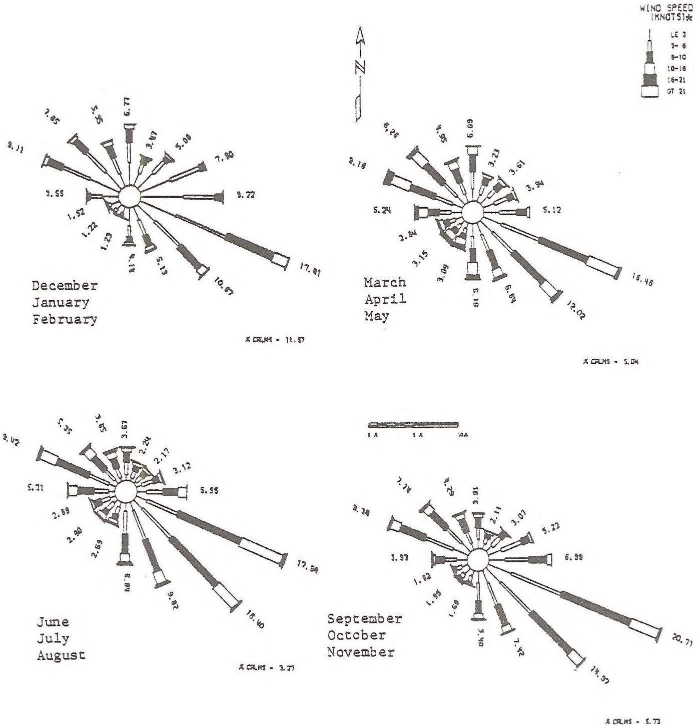
The pollution dispersion potential for the west-central Colorado region is quite dependent on elevation. Most of the lower elevations are valleys surrounded by mountains, while mountain tops and elevated plateaus constitute the higher elevations. The dispersion potential within the valleys is much less than it is at higher elevations because of both greatly reduced wind speeds and confining topography. Mountains surrounding the valleys block the large-scale wind patterns and inhibit the movement of air into and out of the valleys. The mountain tops and elevated plateaus have much greater dispersion potential than the valleys because of their exposure to stronger winds and general lack of topographic confinement of air movements. Most of the air pollutant emissions in the west-central Colorado area occur within valleys. Therefore, the dispersion conditions within valleys are of primary concern.

The pollution dispersion potential for an area can be estimated by calculating a ventilation value. The ventilation value is the product of two other factors: (1) height of the mixed layer above the earth's surface (mixing height), and (2) the average value of the wind speed (transport wind speed) through this mixed layer. The greater the ventilation value, the better the dispersion potential. The tabulation of data in table R2-14 shows that the pollution dispersion potential is best during the spring and summer when the ventilation values are largest. The values listed in table R2-14 are general values for the region. However, they are based on data collected at widely-spaced weather stations, only one of which (Grand Junction) is located in the region. Furthermore, these special weather stations are located in valleys or basins in the Rocky Mountains. Therefore, these values are not representative of the better dispersion conditions that prevail at the higher elevations.

TOPOGRAPHIC INFLUENCES

The strongest influence on prevailing wind patterns within valleys in west-central Colorado is the orientation of the valleys, which produce daytime upslope flow and nightime downslope flow. For higher elevations, the large-scale atmospheric circulation patterns are the strongest influence on prevailing winds. Transitions between these two flow patterns generally occur along the mountain slopes between the higher elevations and the valleys. Map R2-6 illustrates a typical example of the influence of upslope flow during the day and downslope during the night.

Valleys in the region form airsheds where dispersion is often limited. Major airsheds are shown in map R2-7. The largest airsheds are defined by the valley basins of the Colorado, Gunnison, and Dolores rivers. Most of the smaller airsheds drain into these basins at night. The areas outside of these airshed boundaries are mostly at higher elevations where large-scale weather patterns dominate the air flow. The valley-induced upslope and downslope flows are dominant within the airsheds.



Sources: National Climatic Center, 1959-1968.
National Climatic Center, 1968.

* (1 knot - 1.15 miles per hour)

Figure R2-6. Seasonal wind roses - Grand Junction, Colorado, 1959-1968

TABLE R2-14

AVERAGE MOUNTAIN VALLEY DISPERSION
CONDITIONS IN THE WESTCENTRAL COLORADO
STUDY REGION

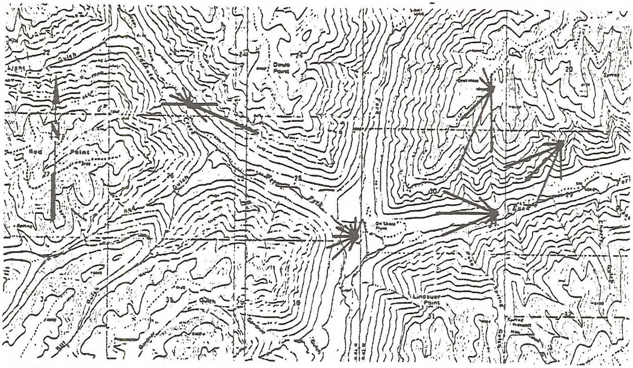
Season	Mixing Height* (Meters), (Feet)				Transport Wind Speed (Meters/Second) (Miles/Hour)				Ventilation** (Meters^2/Second) (Feet^2/Second)			
	Morning		Afternoon		Morning		Afternoon		Morning		Afternoon	
	Meters	Feet	Meters	Feet	Meters/Second	Miles/Hour	Meters/Second	Miles/Hour	Meters^2/Second	Feet^2/Second	Meters^2/Second	Feet^2/Second
Winter	350	1200	1150	3800	3.5	7.8	3.8	8.5	1100	12000	4400	47000
Spring	600	2000	3100	10200	5.2	11.6	6.8	15.2	3100	33000	21100	227000
Summer	350	1200	4000	13200	4.2	9.4	6.3	14.1	1300	14000	25200	271000
Fall	300	1000	2150	7000	3.8	8.5	4.7	10.5	1000	11000	10100	109000
Annual	400	1400	2600	8600	4.2	9.4	5.4	12.1	1600	17000	14000	151000

Source: Holzworth, 1972

Period of record: 1960-1964

* Mixing height is shown to the nearest 50 meters or 200 feet.

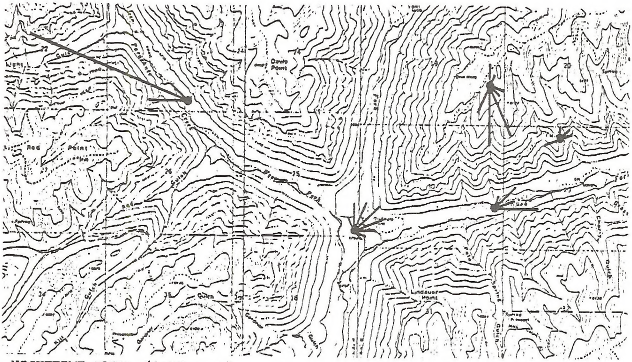
** Ventilation equals mixing height multiplied by transport wind speed and is presented to the nearest 100 meters^2/second or 1000 feet^2/second.



DAYTIME FLOW (1:00 p.m.)

SCALE IN MILES

0

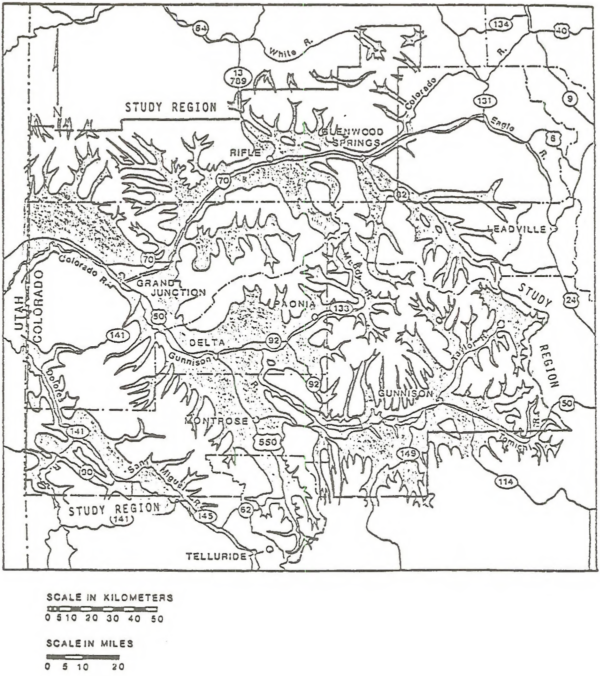


NIGHTTIME FLOW (1:00 a.m.)

Source: Stearns-Roger (1976).

Period of Record: 1974-1976

Elevation contours every 200 feet.
Map R2-6. Wind direction frequencies of 4% or greater at five sites near Parachute Creek, Colorado, in the daytime and the nighttime



Map R2-7. Major airsheds (shaded areas) in the westcentral Colorado study region

Air Quality

Federal and State Regulations

The 1970 Clean Air Act Amendments established primary and secondary national ambient air quality standards (NAAQS) for six pollutants: total suspended particulates (TSP), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide, photochemical oxidants (ozone), and hydrocarbons. These standards are shown in table R2-15. The primary standards were set to protect the public health, while the secondary standards were set to protect the public welfare (U.S. Congress 1971).

Colorado has adopted TSP and SO_2 regulations more stringent than the national standards. The Colorado 3-hour standard of 700 $\mu g/m^3$ is much lower than the 3-hour national secondary standard of 1,300 $\mu g/m^3$. Colorado's present TSP standards require all areas of the state to meet a 45 $\mu g/m^3$ annual standard and a 150 $\mu g/m^3$ 24-hour standard by 1980.

As required by the Clean Air Amendments of 1977, Colorado classified all areas as to their attainment status using existing air quality monitoring data. The west-central Colorado ES area has been designated as attaining (meeting) the national air quality standards for all criteria pollutants except TSP. The nonattainment area (designated by Colorado Air Pollution Control Commission) around Grand Junction exceeds the federal primary TSP standards. The remainder of Mesa County, and the towns of Delta and Aspen are classified as meeting national TSP standards because insufficient air quality monitoring data is available to classify them as nonattainment areas. The rest of the ES region has air quality better than the national TSP standards (U.S. Environmental Protection Agency 1978a).

The federal prevention of significant air quality deterioriation (PSD) regulations apply to all areas attaining the national ambient air quality standards. The 1977 Amendments to the Clean Air Act established "maximum allowable increases" which limit future increases of ambient concentrations of TSP and SO_2 above baseline concentrations. Ambient concentrations of TSP and SO_2 above baseline concentrations in calendar year 1974 are nominally the baseline concentrations. The "maximum allowable increases" (or increments) were established for three class areas as a function of the desired rise in ambient TSP and SO_2 concentrations. All "major" stationary sources contribute to the increments shown in table R2-16. The baseline concentration plus the increment cannot exceed the applicable national ambient air quality standard.

The maximum allowable increases (or increments) limit the amount of air pollutant emitting development in an area. The federal Class I area increments allow very little increase in ambient TSP and SO_2 levels. Very little energy-related development is possible in Class I areas. Class II area increments were designed to allow a moderate increase in ambient TSP and SO_2 levels. Class III area increments were designed to allow the maximum increases in ambient TSP and SO_2 concentrations. The highest level of energy-related development is possible in Class III area. Regulatory measures to prevent significant air quality deterioration for the other criteria pollutants are to be promulgated by the U.S. Environmental Protection Agency (EPA) in 1979.

The Region VIII office of the EPA in Denver, Colorado, has proposed a new PSD review procedure (Rachal 1978). Under the new procedure, the impact of fugitive emissions from surface coal mines would be excluded from the air quality analyses for the PSD increments and for the national air quality standards.

Colorado also has established maximum allowable increases for ambient SO_2 concentrations for prevention of significant air quality deterioration. The Colorado SO_2 increments were developed for three categories. The three Colorado categories have at least one increment that is lower than the increments of the corresponding federal PSD classes, as seen in table R2-16.

Under the 1977 federal Clean Air Act Amendments, all areas of the country were designated as Class II except for "mandatory" Class I areas. In mandatory Class I areas, visibility cannot be impaired. Five mandatory Class I areas are located in and near the region. These five wilderness areas have a total of 513,000 acres (see map R2-8). Besides the federal Class I areas, the Colorado National Monument near Grand Junction is a Colorado Category I area. The Colorado Category II and federal Class II areas can be reclassified by the state; however, mandatory Class I and Colorado Category I areas cannot be reclassified.

Existing Air Quality

The national standards for all pollutants except TSP are being attained within the region. The more restrictive Colorado TSP standards, however, are being exceeded in several areas. Six monitors in two undeveloped areas in the ES region measured low TSP, SO_2, CO, and NO_2 levels, well below the federal and state standards.

Relatively high hydrocarbon and oxidant levels, possibly caused by natural sources, were also measured at the monitors. The locations of the air monitors in the west-central Colorado region are shown in map R2-9.

TABLE R2-15

FEDERAL AND COLORADO AMBIENT AIR QUALITY STANDARDS APPLICABLE TO THE STUDY REGION

Pollutant	Averaging Period***	Federal Primary Standards		Federal Secondary Standards		Colorado State Standards
		$\mu g/m^3$	ppm	$\mu g/m^3$	ppm	$\mu g/m^3$
Sulfur Dioxide	Annual Mean (Arithmetic)	80	.03			
	24-hour	365	.14			
	3-hour			1300	.5	700
Total Suspended Particulate	Annual (Geometric)	75		60		45*
	24-hour	260		150		150*
Carbon Monoxide	8-hour	10,000	9	10,000	9	
	1-hour	40,000	35	40,000	35	
Photochemical Oxidant	1-hour	160	.08	160	.08	
Non-Methane Hydrocarbons**	3-hour (6-9 a.m.)	160	.24	160	.24	
Nitrogen Dioxide	Annual Mean (Arithmetic)	100	.05	100	.05	

Sources: U. S. Congress, 1970; Colorado, 1977.

* Effective in 1970 for non-designated areas and in 1980 state-wide. Effective in 1976 until 1980, the TSP standards for designated areas are 55 $\mu g/m^3$, annual and 180 $\mu g/m^3$, 24-hour. Grand Junction is the only designated area in the study region. The annual state standards are arithmetic means.

** Set as a guide to achieve the oxidants standard.

*** Standards for periods other than annual are not to be exceeded more than once per year.

TABLE R2-16

FEDERAL AND COLORADO MAXIMUM ALLOWABLE INCREASES (INCREMENTS) FOR THE PREVENTION OF SIGNIFICANT DETERIORATION OF AIR QUALITY

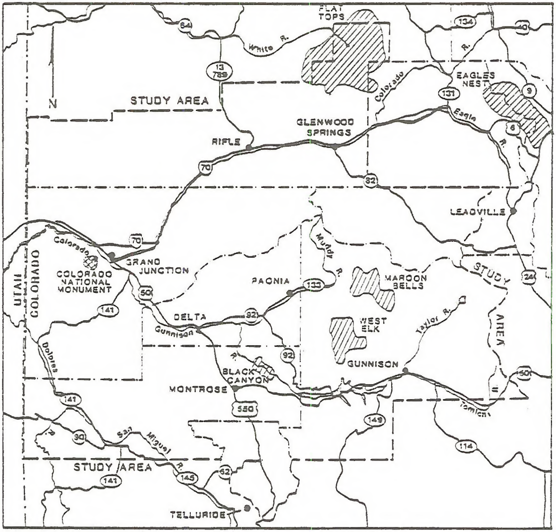
		Maximum Allowable Air Quality Increases ($\mu g/m^3$)		
Pollutant	Averaging Time	Category I	Category II	Category III
State*				
Sulfur Dioxide (SO_2)	Annual Mean	2	10	15
	24-hour***	5	50	100
	3-hour***	25	300	700
Federal**		Class I	Class II	Class III
Sulfur Dioxide (SO_2)	Annual Mean	2	20	40
	24-hour***	8	91	182
	3-hour***	25	512	700
Total Suspended Particulates (TSP)	Annual Mean	5	19	37
	24-hour***	10	37	75

Sources: Colorado, 1977b; U. S. Congress, 1977.

* All areas of the state were designated Category II except Colorado Category I areas. See Figure R2-

** All areas of the nation were designated Class II except Mandatory Class I areas. See Figure R2-

*** The increments for these averaging times are not to be exceeded more than once per year.



SCALE IN KILOMETERS

0 5 10 20 30 40 50

SCALE IN MILES

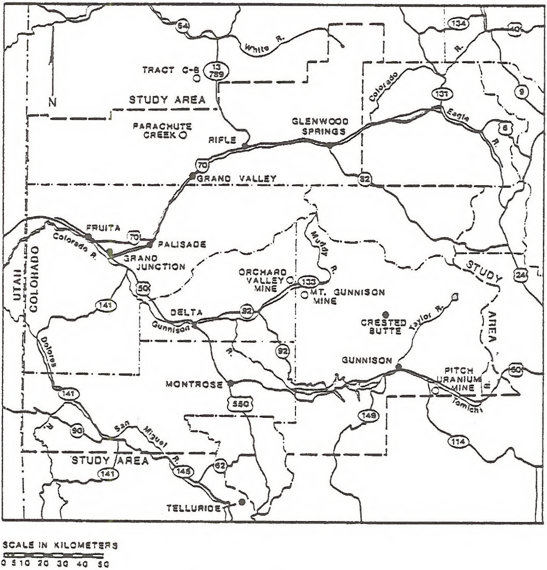
0 5 10 20

KEY:

Colorado Category I and PSD Mandatory Class I Areas

Colorado Category I Area Only

Map R2-8. Colorado Category I areas for sulfur dioxide and federal Mandatory Class I areas in the westcentral Colorado region



KEY:

- ● Monitoring Stations Operated by Colorado Air Control Division
- ○ Monitoring Stations Operated by Private Companies

Map R2-9. Air monitoring sites within and around the westcentral Colorado coal ES region

TOTAL SUSPENDED PARTICULATES

TSP concentrations at the future energy development projects in the region were generally lower than concentrations measured in the cities and towns. Concentrations monitored in 1975 at two sites on Union Oil Company's proposed oil shale development at Parachute Creek were above the Colorado TSP standards. Annual arithmetic mean concentrations of 47 and 62 $\mu g/m^3$ measured at Parachute Creek are higher than the 45 $\mu g/m^3$ Colorado standard. Other monitoring data from Parachute Creek and Tract Cb, the proposed Mt. Gunnison Mine, the Orchard Valley Mine, and the Pitch Uranium Mine generally exhibit lower TSP concentrations than would be expected in undeveloped areas. Annual geometric means for these sites range from 7 $\mu g/m^3$ at Tract Cb to 29 $\mu g/m^3$ at Mt. Gunnison.

In 1977 the TSP concentrations of all twelve state monitors at towns within or around the ES region were near or above the Colorado and federal standards. The annual geometric means of the measured TSP concentrations range from 43 $\mu g/m^3$ at Palisade to 107 $\mu g/M^3$ at Rifle. The federal secondary standard is 60 $\mu g/m^3$. The annual arithmetic mean concentration of 50 $\mu g/m^3$ measured at Palisade exceeds the Colorado standard of 45 $\mu g/m^3$. The TSP concentrations monitored at the site of future energy development projects and towns in and around the ES region are summarized in table R2-17.

GASEOUS POLLUTANTS

The gaseous pollutants of sulfur dioxide, nitrogen dioxide, carbon monoxide, photochemical oxidants, and non-methane hydrocarbons have been monitored at the sites of the proposed Parachute Creek and Tract Cb Shale Oil projects. Table R2-18 summarizes these gaseous pollutant monitoring data.

Sulfur dioxide concentrations at both sites were very low as compared with both federal and state standards. Tract Cb SO_2 concentrations averaged less than 1 $\mu g/m^3$ compared to 80 $\mu g/m^3$ federal standards. Concentrations at Parachute Creek averaged about 2 $\mu g/m^3$. Twenty-four-hour and 3-hour concentrations at both sites were also low.

Nitrogen dioxide concentrations at Tract Cb were very low, averaging less than 1 $\mu g/m^3$. Concentrations at Parachute Creek were much higher, averaging 40 $\mu g/m^3$, but still well below the 100 $\mu g/m^3$ annual federal standard.

Carbon monoxide concentrations at both sites were low, less than 10 percent of the federal standards.

Photochemical oxidant concentrations at both baseline sites were higher than would be expected for remote rural areas. Parachute Creek maximum concentrations were all less than 70 $\mu g/m^3$, which is well below the 160 $\mu g/m^3$ federal standard. However, maximum concentrations measured at Tract Cb were slightly above the federal standard.

Nonmethane hydrocarbon concentrations at Parachute Creek were less than the 160 $\mu g/m^3$ 6-9 a.m. 3-hour federal standard, but Tract Cb concentrations were consistently above the standard.

The EPA recognizes that high concentrations of photochemical oxidants and their precursors, nonmethane hydrocarbons, may occur in remote areas, such as the Tract Cb site. The EPA has determined that these areas should not be designated as nonattainment areas since the high hydrocarbon and oxidant measurements are most likely caused by natural sources and/or transport of the pollutants from major urban areas. (EPA 1978).

Geologic and Geographic Setting

Topography

The mountains of the Elk, West Elk, and western Sawatch ranges form the eastern half of the ES area. Peaks of these mountains lie at elevations of 9,000 to over 14,000 feet. Most peaks lie at elevations of 10,000 to 12,000 feet. Drainage is primarily north and south into either of the Colorado River or the Gunnison River. (Map 4 in the appendix shows the topography of the ES area.)

Grand Mesa, the largest flat-topped mountain in the world, lies at elevations from 6,000 to 11,000 feet. This east-west oriented highland stretches 50 miles from the junction of the Colorado and Gunnison Rivers, at Grand Junction, Colorado, in the west to the Elk Mountains on the east. Grand Mesa separates the broad valleys of the Uncompahgre and Gunnison rivers to the south and the narrow canyon of the Colorado River to the north. These lowlands have been eroded into soft shales to elevations of 4,500 to 6,000 feet.

The Colorado River occupies the Grand Valley west of Grand Junction. The steep cliffs of the Little Bookcliffs escarpment and the Roan Cliff escarpments form the northern edge of the valley. Elevations along the escarpments vary from 5,500 feet along the Little Bookcliffs to 8,000 feet farther north along the Roan Cliffs. The Grand Valley, the Gunnison Valley from Delta to Grand Junction, and the Uncompahgre Valley are bounded on their southwestern edges by the Uncompahgre Plateau. This broad, gentle upwarp of sedimentary rocks lies at elevations of 8,000 to 10,000 feet. It stretches 125 miles in a northwest/southeast direction from the Colorado-Utah border to the San Juan Mountains. Southwest of the Uncompahgre Plateau, the San Miguel Valley lies at elevations from 5,000 to 7,000 feet.

TABLE R2-17

A SUMMARY OF MONITORED TSP CONCENTRATIONS

Type of Area	Location	Sampling Period	Number of 24-Hour Samples	Geometric Mean	Arithmetic Mean	24-Hour Maximum	Second Highest 24-Hour Maximum
Undeveloped Rural	Tract C-b	Sept 76-Aug 77	360	7	NR	123	74
	Mt. Gunnison	Mar 77-Aug 77	24	29	34	94	69
	Parachute Creek, Site 2	Jul-74-Dec 74	21	7	17	53	NR
		Jan 75-Dec 75	38	31	47	276	166
		Jan 76-Sep 76	17	16	27	42	40
	Parachute Creek, Site 7	Jan 75-Dec 75	28	42	62	267	154
		Jan 75-Mar 75	7	14	29	63	NR
	Pitch Uranium Mine	Feb 76-Dec 76	NR	20	24	NR	NR
	Orchards Valley Mine	Oct 76-Jan 77	18	NR	NR	152	146
Towns (1977 data)							
	Palisade		87	43	50	158	132
	Grand Junction		91	78	84	176	159
	Fruida		90	66	73	188	143
	Glenwood Springs		74	65	73	194	166
	Rifle		91	107	121	377	281
	Grand Valley		85	52	75	334	217
	Delta		90	82	91	233	191
	Montrose		77	68	73	165	152
	Gunnison		49	45	49	131	101
	Crested Butte		75	71	81	173	171
	Telluride		76	87	100	289	240
	Aspen		82	71	88	307	288

Sources: PEDCo, 1978; Radian, 1978; Colorado, 1977.

NR - Not reported.

TABLE R2-18

SUMMARY OF GASEOUS POLLUTANT
CONCENTRATIONS MONITORED AT
PARACHUTE CREEK AND TRACT C-b*

Pollutant	Location	Annual Arithmetic Mean	Maximum 24-Hour	Maximum 8-Hour	Maximum 3-Hour	Maximum 1-Hour
Sulfur Dioxide (SO_2)	Parachute Creek	<2	33		65	
	Tract C-b	0.3	16		18	
Nitrogen Dioxide (NO_2)	Parachute Creek	40				
	Tract C-b	0.8				
Carbon Monoxide (CO)	Parachute Creek			–		800
	Tract C-b			1,005		1,530
Oxidants	Parachute Creek					69
	Tract C-b					164
Non-Methane Hydrocarbons	Parachute Creek				153	
	Tract C-b				1,026	

Sources: Radian, 1978; Stearns-Roger, 1975.

*The air monitoring data from Parachute Creek is for September 1974 through June 1975. The air monitoring data from Tract C-b is for November 1976 through August 1977.

Landforms

The ES area lies astride two major geomorphic provinces: the Colorado Plateau and the Eastern Rocky Mountains. Within each of these broad geomorphic provinces lies a wide variety of landforms.

The Colorado Plateau province is dominated by canyons, cliffs, plateaus or mesas, and broad valleys. It is a region of relatively flat-lying Paleozoic, Mesozoic, and Cenozoic sedimentary rocks. Because of the elevation of the area, the Colorado River and its tributaries, which drain the entire area, have become deeply entrenched in the strata. The entrenchment has created hundreds of youthful, isolated canyons and mesas.

A few simple folds disturb the generally flat-lying sediments. These folds have created major landforms such as the Grand Hogback, the Little Bookcliffs, the Uncompahgre uplift, and the Black Canyon of the Gunnison. In general these landforms are created by the erosion of softer, more easily eroded sediments around more resistant Cenozoic, Mesozoic, and Paleozoic sedimentary rocks.

The mountains which compose the Eastern Rocky Mountains in the ES area are complex and varied. The sharp, sawtoothed ridges which form most of the San Juan and West Elk mountains are characteristic of waterlaid volcanic rock interlayered with basalts and ash beds. The Elk Mountains are composed of a series of layers of Paleozoic sediments faulted over one another. These rocks are cut by numerous sills, dikes, and other intrusions, many of which have caused mineral enrichment locally. The Sawatch Mountains were formed by a great faulted anticline intruded by igneous rocks. Both the Sawatch and Mosquito ranges which lie to the east are one large dome with a sag in the middle.

Structure

The Colorado Plateau is a segment of broad, general structural stability lying between the Eastern and Central Rocky Mountains. The principal structural feature of the Colorado Plateau is monoclines. Most of the deformation which has occurred from the Laramide orogeny occurred along the monoclines.

Most of the monoclines are associated with uplifts, and many form lines of demarcation between basins and uplifts. Regionally, monoclines represent lines of great vertical shift; for example, the vertical shift along the Grand Hogback may approach 14,000 feet. Monoclines and uplifts in this area face west and south and they include the Grand Hogback, Gunnison uplift, and Uncompahgre Plateau. A few minor monoclines may face in the opposite direction to the major monoclines.

The mountain ranges of the Eastern Rockies which lie in the ES area are diverse structurally. The Sawatch Range is a faulted anticline which has been intruded by igneous rocks. The Elk Mountains are large thrusts of Paleozoic strata which have been thrust over one another. The San Juan Mountains, the most diverse mountain range in Colorado, are formed mostly of Tertiary volcanic rocks as the result of repeated outpourings of lava and ash from a cluster of volcanoes.

Stratigraphy

The stratigraphy of the coal fields in the ES area is shown in figure 1 in the appendix.

Paleontology

The principal fossil-bearing formations in the ES area, ages, number of known fossil localities, and general fossil types normally found in the formations are summarized in table R2-19. Due to the present lack of data and accepted criteria for determining significance, the importance of these paleontological resources to science, education, or other values, cannot presently be assessed.

Permits for excavation of fossils of scientific interest are issued under the Antiquities Act of 1906. Disposal of fossils for any other purpose is not permitted under the act. All vertebrate fossils are considered objects of scientific interest; specific invertebrate fossils are considered of scientific interest only if classified as such by a qualified paleontologist. The BLM is developing regulations on how to manage all paleontological resources under the Federal Land Policy and Management Act of 1976. Until the regulations are written, BLM will continue to manage paleontological resources based on their value to the scientific community and the immediacy of any threat to the specimen(s).

Mineral Resources

Coal

Landis (1959) describes the coal resources of the west-central Colorado area as being in the Colorado portions of the Uinta Basin. The area occupies the moderately to steeply dipping edges of the Piceance Creek Basin, a broad synclinal depression in the western part of Colorado. The simple regional structure, a syncline with low dips in the center and moderate to steep dips on the edges, is modified by faults, folds, and intrusions which have created local areas of structural complexities.

The coal of the region occurs mainly in the Cretaceous Mesaverde Group and ranges in rank from subbituminous in the Grand Mesa field to anthracitic in the Crested Butte and Carbondale fields. Approximately 94 percent of the coal is bituminous in rank. These bituminous coals are largely

TABLE R2-19

SUMMARY OF FOSSIL-BEARING FORMATIONS IN THE REGIONAL ES AREA

Formation	Period	Known Fossil Localities a/	Type of Fossils b/
Alluvium, gravel, landslides, talus, fanglomerates	Quarternary	General	V, I, P,
Uinta	Tertiary	General	V, I, P
Green River	Tertiary	3	V, I, P
Wasatch	Tertiary	4	V, I, P
Ohio Creek	Tertiary	General	V, I, P
Mesaverde (or Mt. Garfield and Hunter Canyon)	Cretaceous	1	V, I, P
Mancos Shale	Cretaceous	3	V, I
Dakota Sandstone and Burro Canyon	Cretaceous	1	V, I, P
Morrison	Jurassic	19	V, I, P
Summerville	Jurassic	General	V, I, P
Entrada	Jurassic	General	V, I, P
Carmel	Jurassic	General	V, I, P
Wanaka	Jurassic	General	V, I, P
Navajo	Jurassic	General	V, I, P
Kayenta	Jurassic	General	V, I, P
Wingate	Jurassic	General	V, I, P
Chinle	Triassic	General	V, I, P
Moenkopi	Triassic	General	V, I, P
Cutler-Rico	Permian	General	V, I, P
Hermosa	Pennsylvania	General	V, I, P

a/ General = formation contains fossils throughout; specific localities are not identified.

b/ I = invertebrate; V = vertebrate; P = paleobotanical high-volatile C coals (ranging from 11,000 to 13,000 BTUs). Coking coal is present in the Carbondale, Somerset, and Crested Butte fields.

Of the 81.8 billion tons of coal reserves in Colorado which lie under 3,000 feet of overburden, approximately 26.4 billion tons, or 32 percent, lie in the seven counties of the ES area (Landis 1959). Only 10.9 billion tons of these 26.4 billion tons lie in seams exceeding 28 inches in thickness and are, therefore, considered mineable with present mining technology.

Of the mineable coal, 0.3 billion tons are economically strippable (Speltz 1976), 10 billion tons are economically mineable by present underground mining methods, and 0.6 billion tons which are not presently economically mineable lie in seams from 28 to 42 inches thick. (Table R2-20 presents the coal reserves of the ES area by field.) Map 2 in the appendix shows occurrences of coal strata in the ES area. Underground mining methods commonly recover 50 percent of the inplace, mineable reserves. Therefore, of the 10 billion tons of coal which can be economically mined by underground methods, 5 billion tons are recoverable.

The following discussion of the coal fields of Colorado follows the description of Landis (1959). Landis is considered the most recent complete description available for the ES area. Currently the Office of the Area Geologist of the U.S. Geological Survey (USGS) is conducting geologic investigations in the Bookcliffs, Grand Mesa, and Somerset fields. The results of these investigations are not currently available. (Table R2-21 presents the current and projected mining activity in the fields. The locations of the mines listed are shown on map 1 in the appendix.)

LITTLE BOOKCLIFFS FIELD

The coal-bearing rocks of the Mesaverde Group outcrop from the Colorado-Utah state line almost continuously around the edge of the Piceance Creek Basin and the Colorado part of the Uinta Basin. Coal is found in the Mt. Garfield Formation of the Mesaverde Group and in the Anchor Mine tongue of the underlying Mancos Shale. The coal in the Mt. Garfield occurs in lenticular beds within three coal-bearing zones: the Palisade zone, which lies immediately above the Sego Sandstone; the Cameo coal zone, 200 to 230 feet above the Sego Sandstone; and the Carbonera zone, about 260 feet above the Sego Sandstone. The coal in the Anchor Mine tongue is of local importance only. The Palisade coal zone outcrops throughout the field but is of most importance in the eastern half. Nearly twice as much coal has been mined from the Cameo zone as from all other beds combined. The Carbonera zone outcrops in the western half of the field and has not been mined as extensively as the Cameo and Palisade zones. Recently, a possible fourth zone tentatively labelled the Loma, has been discovered in the Douglas Pass area.

The coal of the Little Bookcliffs field is mainly high-volatile C bituminous, but some high-volatile B is also present. There are a total of 1,906 million tons of coal present in the field at depths of less than 3,000 feet.

GRAND MESA FIELD

The Grand Mesa field lies along the western and southern edges of Grand Mesa, a high plateau in the southern part of the Piceance Creek Basin. The field consists of the coal-bearing members of the Mesaverde Formation, which outcrop from the Colorado River to just west of the town of Paonia in Delta County. The coal near the western edges of the field is mainly high-volatile C bituminous in rank. The remainder of the field is primarily subbituminous A (U.S. Bureau of Mines 1937).

The coal occurs in six to eight fairly persistent zones. The lowermost zone is the most persistent, or at least the most mined and prospected. Near the eastern edge of the field five mineable beds are present. However, in general only three mineable beds are present in any one locality.

A total of 1,452 million tons of coal is estimated to have been originally present at depths of less than 3,000 feet.

SOMERSET FIELD

The Somerset coal field extends from just west of the town of Paonia to Kebler Pass. In addition, there is some coal present in Coal Creek just east of Mt. Gunnison.

The coal occurs in the Paonia and Bowie shale members of the Mesaverde Formation. In the western part of the field, the Bowie Shale, the lower coal-bearing member, has three and locally four thick coal beds, and the Paonia Shale, the upper coal-bearing member, has two to four thick beds. The mineable coal beds have been labelled in ascending order, the A, B, C beds of the Bowie Shale Member; and the D, E, F seams of the Paonia Shale Member. In the eastern part of the field, the coal beds in the Paonia Shale are thin and bony, but the Bowie Shale has two persistent beds that are of mineable thickness and quality at almost all localities at which they have been prospected. In several small local areas in the southeastern part of the field, igneous intrusions have metamorphosed the coal to semianthracite.

The coal is high-volatile C and high-volatile B bituminous and in the eastern half it is moderately to strongly coking. A total of 3,115 million tons of bituminous coal is estimated to have been originally present in the field at depths of less than 3,000 feet.

TABLE R2- 20

COAL RESERVES IN BEDS GREATER THAN 42 INCHES IN THICKNESS
UNDER VARIOUS OVERBURDEN DEPTHS IN THE ES AREA (MILLION SHORT TONS)

		Overburden Depth (feet)			
Field Name	County	0-1000	1,000-2,000	2,000-3,000	Total
Little Bookcliffs	Garfield	547.62	229.91	27.95	805.48
	Mesa	461.67	466.68	172.24	1,100.59
	Subtotal:	1,009.29	696.59	200.19	1,906.07
Grand Mesa	Delta	686.88	466.95	48.01	1,201.84
	Mesa	102.08	82.26	65.37	249.71
	Subtotal:	788.96	549.21	113.38	1,451.55
Somerset	Delta	152.83	204.60	11.05	368.48
	Gunnison	1,096.21	1,219.77	430.24	2,746.22
	Subtotal:	1,249.04	1,424.37	441.29	3,114.70
Crested Butte	Gunnison	180.26			180.26
Carbondale	Gunnison	18.38	8.66	8.42	35.46
	Pitkin	97.62	100.88	98.16	296.66
	Subtotal:	116.00	109.54	106.58	332.12
Grand Hogback	Garfield	222.81	217.98	197.67	638.46
Tongue Mesa	Gunnison	170.19			170.19
	Montrose	1,029.26			1,029.26
	Ouray	1,018.80			1,018.80
	Subtotal:	2,218.25			2,218.25
Nucla	Montrose	181.32			181.32
	Total:	5,965.93	2,997.69	1,059.11	10,022.03

Note: Tonnages are presented by field and by county. These reserves are considered to be economically mineable with current mining technologies.

TABLE R2- 21

MINING ACTIVITY IN THE ES AREA BY COAL FIELD

			Mining to Occur in		
Coal Field	Mine Name	Status	Formation	Coal Zone	Rank or Quality
Little Bookcliffs	Cameo No. 1	E, SS, Ug	Mt. Garfield	Cameo B	B
	Cameo No. 2	SS, Ug	Mt. Garfield	Cameo B	B
	Coal Canyon	SS, Ug	Mt. Garfield	Cameo B	B
	Loma Mine	SS, Ug	Mt. Garfield	Cameo, Loma	B
	Farmers (Nearing)	E, Ug	Mt. Garfield	Cameo	B
Grand Mesa	Roadside (CMC)	E, Ug	Mesaverde	Cameo seam	B
	Cottonwood Creek No. 1	SS, Ug	Mesaverde	Carbonera seam	B
	Cottonwood Creek No. 2	SS, Ug	Mesaverde	Cameo seam	B
	Tomahawk Strip	E, St	Mesaverde	Paonia Shale (F seam)	SB
	Fairview	P, Ug	Mesaverde	Paonia Shale (B seam)	SB
	Coalby - Red Canyon	P, Ug	Mesaverde	Paonia Shale (D seam)	SB
	Red Canyon No. 1	E, Ug	Mesaverde	Paonia Shale (E seam)	SB
Somerset	Orchard Valley	E, Ug	Mesaverde	Paonia Shale (D seam)	B
	Bear	E, Ug	Mesaverde	Bowie Shale (C seam)	B
	Somerset	E, Ug	Mesaverde	Bowie Shale (B and C seams)	B
	Hawksnest No. 3	E, Ug	Mesaverde	Paonia Shale (E seam)	B
	Hawksnest East	E, Ug	Mesaverde	Paonia Shale (E seam)	B
	Blue Ribbon	E, Ug	Mesaverde	Paonia Shale (E seam)	B
	Mt. Gunnison No. 1	SS, Ug	Mesaverde	Paonia Shale (F seam)	B
	Edward's (Clark)	P, Ug	Mesaverde	Unknown	
Crested Butte	O. C. No. 2	E, Ug	Mesaverde	Paonia Shale (Kebler or B seam)	B
Carbondale	Sunlight	E, Ug	Mesaverde	Bowie Shale (D seam)	SB
	North Thompson Creek No. 1	E, SS, Ug	Mesaverde	Paonia Shale (Anderson seam)	B
	North Thompson Creek No. 3	E, SS, Ug	Mesaverde	Bowie Shale (A seam)	B
	Coal Basin (5 mines)	E, Ug	Mesaverde	Bowie Shale (B seams)	B
Grand Hogback	Eastside	E, Ug	Mesaverde	E seam	B
	NuGap No. 3	E, Ug	Mesaverde	Sunny Ridge	B
Tongue Mesa	NA				
Nucla	Nucla Strip	E, St	Dakota sandstone		B

Note: Map 1 in appendix A shows the locations of the operations listed. Tables R1-5, R1-6, and R1-7 provide more detailed information.

SYMBOLS: E = Existing, P = Projected, SS = Site specific proposed action, NA = No activity in the coal field. St = Strip mine, Ug = Underground, B = Bituminous Coal, SB = Subbituminous Coal

CRESTED BUTTE FIELD

The Crested Butte field, in north-central Gunnison County, is at the southeast end of the Piceance Creek Basin. Folding, faulting, and igneous intrusions of and in the coal-bearing rocks have made the area structurally complex. As expected, the coal ranges widely in rank. In general, coal north and west of the town of Crested Butte is high-volatile B and C bituminous; a small amount of subbituminous A is present in the southwestern part of the field. The bituminous coal has coking properties and was produced for such when the field was in operation.

Coal occurs throughout the field in the lower part of Paonia Member of the Mesaverde Formation, resting directly on the Rollins Sandstone in the northern and eastern sections of the field. The number of coal beds ranges from one in the Floresta area to a possible five in the Crested Butte area. Lateral correlation and the relationships of the beds are not fully known at present.

About 15 percent of the reserves assigned to the field are anthracite or semianthracite. The remaining mineable reserves are bituminous with good coking qualities. A total of 180 million tons of coal is present in the field at depths of less than 3,000 feet.

CARBONDALE FIELD

The Carbondale field extends along the Crystal River and upper Roaring Fork drainage from south of the town of Marble to as far north as Glenwood Springs, Colorado. Structurally, the Carbondale field is a transition zone between the complexly folded and faulted south end of the Elk Mountains and the simple monoclinal fold of the Grand Hogback.

The lower part of the Mesaverde Formation has the thickest and most persistent beds, but thin, bony coal beds and carbonaceous shale are present in the upper part. The coal ranges in rank from high-volatile C bituminous to anthracite. The coal in the northern part of the field is mainly high-volatile B. In the southern part, it is mainly high-volatile A and medium volatile bituminous. Most of the bituminous coal in the Pitkin and Gunnison County portion of the field has moderate to strong coking properties. The coal in the Garfield County portion is mainly noncoking.

From two to nine fairly persistent and mineable coal seams are present, with the lower seams being of higher rank and having more pronounced coking qualities. At least 50 percent of the estimated 332 million tons in the Carbondale field under less than 3,000 feet of overburden is bituminous coal with moderate to strong coking properties. About 7 percent of the total is anthracite or semianthracite.

GRAND HOGBACK FIELD

A monoclinal fold along the east border of the Piceance Creek Basin has the topographic expression of a prominent ridge known as the Grand Hogback. The ridge, formed by steeply dipping beds of the Mesaverde Group, extends from north of Rio Blanco, Colorado, southeast to Glenwood Springs, Colorado.

The Mesaverde Group of the Grand Hogback has been divided into the Iles Formation in the lower portion and the Williams Fork Formation in the upper portion. The coal seams of the Williams Fork Formation are the thickest and most persistent. The lower coal group lies in the Iles Formation and is of little importance. The middle group occurs in the lower 2,500 feet of the Williams Fork in nine or more seams. The upper coal seams are known as the Keystone coal group. This group occurs between 2,000 and 3,600 feet above the Iles and generally consisting of four or more seams.

In the southern part of the field, the coal is mainly high-volatile B bituminous in rank and is noncoking. In the northern part, the coal is mainly high-volatile C bituminous. It is possible that some of the upper seams in the northern part of the field may be subbituminous.

A total of 638 million tons of coal was originally present in the field at overburden depths of less than 3,000 feet.

TONGUE MESA FIELD

A fingerlike extension of the San Juan main mountain mass, known as Tongue Mesa, is underlain by Mesaverde coal-bearing strata. The strata, most likely an erosional outlier of the Mesaverde Group, are concealed by heavy vegetation, landslides, talus from overlying Tertiary volcanic rocks, and Quaternary glacial deposits.

Hills (1893) reports two coal beds have been worked; one is 15 to 20 feet thick, and the other (400 feet higher stratigraphically) is 5 feet thick. Evidence presented by the location of coal mines suggests there may be three coal beds present. Beds from 24 to 40 feet thick are reported to be present in some of the mines.

Analyses of coal samples indicate that the coal is subbituminous B. A total of 22.18 million tons of coal was originally present in the Tongue Mesa field.

NUCLA FIELD

The Nucla field is in a dissected plateau of moderate to strong relief on the eastern edge of the canyon lands section of the Colorado Plateau geomorphic province. The Cretaceous Dakota strata are almost horizontal with an essentially simple structure, although some local folding and faulting is present. At least three coal seams are present within about 45 feet stratigraphically. Most of the mining has been confined to the middle bed as it is usually the thickest. The coal seams usually contain many partings, but a bench in the middle bed is 4.5 feet thick with no partings at the Nucla Strip Mine. The coal in this area seems to be more persistent than that of other Dakota areas. Analyses indicates the coal to be high-volatile B bituminous.

A total of 181 million tons of coal was originally present in the Nucla field.

SUMMARY

There are eight coal fields in the ES area. A total of 10.3 billion tons of economically mineable coal are found in these fields at overburden depths of less than 3,000 feet. The rank of the coal varies from subbituminous to anthracite, with the large majority of the coal being bituminous.

Presently, coal is produced from seven of the eight coal fields in the ES area. No mining is now occurring in the Tongue Mesa coal field.

Of the six site-specific proposed actions three proposed operations are located in the Bookcliffs field, one proposed operation is located in the Carbondale field, one in the Somerset field, and one in the Grand Mesa field.

Oil and Gas

Many formations in the ES area contain oil and gas. Principally, these are the Entrada, Morrison, Dakota, Mancos Shale, Mesaverde Group, and the Wasatch. Of these, the Dakota, Mancos shale, and Mesaverde Group also contain coal-bearing rocks. The oil and gas section of Other Major Regional Development in chapter 1 presents the existing and projected activity in oil and gas in the ES area. The majority of the existing activity is associated with anticlinal structures.

Oil Shale

Oil shale reserves occur in the Parachute Creek Member of the Green River Formation. Map 3 in the appendix shows the distribution of the Green River Formation in the ES area in the Grand Mesa, Battlement Mesa, and Roan Cliffs-Piceance Creek Basin areas.

The section of Other Major Regional Development in chapter 1 presents the major existing and projected oil shale activity in and around the ES area. In brief, these activities are continued production from both the Occidental and Paraho operations in the Grand Valley; additional production in the Grand Valley from the anticipated operations of Colony Development and Union Oil; new production from the federal prototype oil shale tracts (Ca and Cb) and the Superior Oil Shale Project in the Piceance Creek Basin.

Uranium

The seven counties which constitute the ES area contain significant deposits of uranium minerals (see map 3 in the appendix). These vary from the highly productive sedimentary type deposits of the Uravan mineral belt to the vein type deposits fround in the Marshall Pass area of southeast Gunnison and Saquache counties.

The uranium section of Other Major Regional Development in chapter 1 discusses the existing and projected mining and exploration activity in the ES area. In brief, these activities are production of 600 tons per day at the Pitch Mine (Homestake Mining Company) in southern Gunnison County and intensive exploration in Gunnison, Saquache, and Chaffee counties; exploration in the area of the Black Canyon of the Gunnison; exploration and small amounts of production from the Grand Hogback area of Garfield County; and intensive exploration and production from the Uravan mineral belt in western Montrose and Mesa counties.

Lode Deposits of Metals

Lode deposits of metals are well known in several areas of the ES, particularly the Aspen district of Pitkin County, several districts in Gunnison County, and the Ouray district of Ouray County. Major metals of the districts are lead, zinc, and silver with minor amounts of copper and gold. Freeman (unpublished) discusses the Aspen area and the northern portions of Crested Butte area. Gaskill (1977) discusses the western portion of the Crested Butte area and portions of the Somerset area. Stevens (1976) discusses the Ouray area.

Considerable interest has been expressed by several companies in the possible occurrence of molybdenum in the Pitkin-Gunnison County area. American Metals Climax (AMAX) has released preliminary data on a molybdenum deposit in northern Gunnison County; other companies are continuing exploration and evaluation of several other occurrences.

Water Resources

Ground Water

Conditions of ground-water occurrence within the ES area range widely, depending on the local combination of climate, topography, geologic structure, and stratigraphy. Of these factors, climate is probably the most important because the annual precipitation in relation to evaporation losses determines the amount of moisture available for ground-water recharge. Potential aquifers are characteristically saturated at the higher elevations in the eastern part of the area where annual precipitation exceeds 25 inches and cooler temperatures minimize evaporation losses. Conversely, these same rock types are typically drained at the lower elevations in the western part of the area where annual precipitation is less than 15 inches and high temperatures result in evaporation losses in excess of 40 inches per year. Topography influences climate and is a controlling factor in determining stream-flow duration and thus the opportunity for ground-water recharge in arid and semiarid parts of the ES area. Also, topography in combination with geologic structure dictates the direction of ground-water movement and generally controls the location of springs and seeps. Finally, local stratigraphy determines aquifer characteristics, which, in turn, control the local quantity and quality of the ground-water resource.

Geologic units underlying the surface in the ES area and their water-yielding characteristics are given in table R2-22. The most widespread of these is recent alluvium, which bottoms virtually all stream valleys in the area and where saturated, holds water under unconfined (water-table) conditions. Although yields up to 500 gallons per minute (gpm) can be obtained from the alluvial aquifers in the principal river valleys, most wells tapping alluvium yield less than 25 gpm. Alluvial aquifers typically are in close hydraulic connection with the adjacent surface streams and periodically are recharged by or discharge to these streams, depending on whether stream levels are high or low. Water levels in wells tapping the alluvium, therefore, generally fluctuate seasonally, reflecting corresponding changes in nearby stream levels. Similarly, water quality in the alluvial aquifer generally reflects that of the adjacent stream, but commonly contains two or more times the dissolved-solids concentration of the surface water and correspondingly higher levels of sodium and sulfate ions. The poorer quality of water in the alluvium is attributed to increased leaching of salts by irrigation activities and to ground-water inflow from the underlying bedrock formations.

Terrace deposits in the larger river valleys, although of less areal extent than the alluvial aquifers, are currently the principal source of ground water in the ES area and yield as much as 1,000 gpm to wells under water-table conditions. The primary source of recharge to the terrace deposits, however, is generally irrigation water, and many wells dry up during the winter. Water in the terrace deposits commonly contains in excess of 1,000 milligrams per liter (mg/l) dissolved solids and is a calcium, magnesium, sodium, sulfate type, reflecting increased leaching by downward percolating irrigation waters. Ground-water movement in these deposits generally follows the direction of slope of the land surface toward the nearby streams or rivers.

On the dissected uplands bordering the principal stream and river valleys where the soil veneer is underlain by bedrock formations, ground-water recharge initially accumulates in the soil mantle. Movement is then downward to the first relatively impermeable bed, which acts as a "perching" layer. This perched water then tends to migrate downdip and also laterally toward discharge areas along the valley side slopes where the perching bed intersects the surface. In areas receiving adequate precipitation, this ground-water discharge gives rise to numerous springs and seeps. In the dryer areas, the comparatively small amount of ground water discharging on the valley side slopes is rapidly dissipated by evapotranspiration. Often, the only indication of supplemental moisture is a narrow band of more vigorous vegetation paralleling the bedding planes along a hillslope.

A comparatively small amount of ground water percolates downward through the perching layers, probably through small joints and fractures, to recharge underlying beds such as the coal seams that would be mined under the proposed actions. These deeper beds also tend to drain downdip and discharge to surface streams at their lowest point of outcrop. Again, in areas of high precipitation, all permeable beds tend to become saturated away from the outcrop areas and generally yield water to wells under confined (artesian) conditions. In the dryer parts of the ES area, the reduced recharge is not adequate to offset drainage, and permeable beds tend to be saturated only below the levels of nearby perennial streams. Emphasis is placed on the observation that bedrock formations in the ES area normally discharge ground water to the perennial streams, which represent the local base level of saturation below which all voids are filled with water. These formations are not normally recharged by the perennial streams and rivers unless artificial drawdown induced by local pumping of wells or by dewatering of mines has lowered ground-water levels in the bedrock aquifers to below nearby stream or river levels.

Most bedrock wells in the ES area obtain water from the Dakota Sandstone or from sandstone beds in the Mesaverde Group. Yields are generally less than 10 gpm, although yields of more than 100 gpm are obtained locally from porous or fractured zones. Water from shallow wells is generally a calcium, magnesium, sulfate type. With increasing depth, sodium tends to replace calcium and magnesium while bicarbonate often increases at the expense of sulfate. Dissolved-solids concentrations are generally less than 1,000 mg/l in discharge areas.

Comparatively few wells have been completed in coal beds for reasons that are not entirely clear. Where available, water from the coal tends to be a sodium bicarbonate type with less than 2,000 mg/l

TABLE R2-22

GENERALIZED HYDRO-STRATIGRAPHIC COLUMN

Geologic Period	Geologic Unit	Thickness (feet)	Hydrologic Character
Quaternary	Recent alluvium	0-50(?)	Source of water to stock and domestic wells in area. Yields up to 500 gallons per minute (gpm).
	Landslide debris	10-40	Generally low yield (20 gpm). Where derived from Mancos material, water is of poorer quality than that located in terrace gravel.
	Terrace deposits	20-100	Principal source of ground water in area. Yields up to 1,000 gpm. Source of water for stock and domestic purposes. Locally, primary source of recharge is irrigation water, and many wells dry up during the winter.
Cretaceous	Mesaverde Group	up to 5,300	Source of water to many springs and wells but locally unimportant.
	Mancos Shale	4,000-5,000	Not considered a source of water, although unconfined water is found in fractured or weathered zones. Water is of poor quality.
	Dakota Sandstone	60-250	Source of stock and domestic water supply, second to the alluvial aquifer in this area.
	Burro Canyon Formation	up to 60	Yields up to 40 gpm. Water is generally salty and under artesian head. Quality degrades with distance from outcrop.
Jurassic	Morrison Formation:		Sandstone lenses are potential sources of stock and domestic water locally. As yet, the Morrison is nearly untapped in the ES area as a source of water because water is under artesian head.
	Brushy Basin Member	250-400	
	Salt Wash Member	190-480	
	Summerville Formation	up to 200	Unknown. No wells completed into this unit in the ES area.
	Wanakah Formation	up to 80	Unknown. No wells completed into this unit in the ES area.
	Entrada Sandstone	80-250	Unknown. No wells completed into this unit in the ES area.

Source: Modified after Hydro-Search 1977.

dissolved solids, which is better suited for most domestic and livestock uses than the water obtained from overlying sandstone aquifers. Apparently, lower yields from coal seams and greater drilling depths at most locations have discouraged development of the coal aquifers. Available data also indicate that coal beds are often drained where they lie above the level of nearby perennial streams. Below that level, however, coal beds must be regarded as potential aquifers for development of low-yield wells, primarily for use by livestock and wildlife.

Price and Arnow (1974) in their appraisal of the potential for development of the ground-water resources in the Upper Colorado Region conclude that a tremendous amount of water is stored in just the upper 100 feet of saturated rocks. They emphasize that conjunctive use of the ground water with surface water or development of ground water as an independent supply could meet the demands imposed by coal mining while satisfying the requirements of the Colorado River Compact. Although such a statement may be valid for the Upper Colorado Region as a whole, the ground-water resources in the ES area hold out little immediate promise for significant additional development to meet the needs of either the coal-mining operations or the consequent increased population.

All of the coal seams currently being mined or that would be mined under the scenarios described in this report occur in the lower part of the Mesaverde Group, which is composed of an interbedded sequence of sandstone, shale, and coal. These rocks typically erode to form an irregular precipitous terrain characterized by elongate ridges separated by narrow steep-sided valleys that provide little space for housing and related facilities. In marked contrast, the underlying Mancos Shale is about 4,000 feet thick and typically erodes to form broad valleys with extensive alluvial fills and wide flood plains that are especially well suited for both agriculture and urbanization. Grand Junction, Palisade, Delta, Montrose, and Paonia are examples of urban centers located in valleys cut in Mancos Shale adjacent to the coal areas.

Increased populations from coal development would almost certainly live in or adjacent to these established urban centers and not in the confines of the narrow valleys adjacent to the proposed mines. The only practical source of ground water that could be tapped for individual household supplies on these valley floors are the alluvial aquifers. The underlying Mancos Shale is not normally water bearing, and any water obtained locally from the Mancos would probably be too saline for domestic use. Because water quality in alluvial aquifers overlying Mancos Shale degrades rapidly with increasing distance from a stream or river, residences depending on shallow wells for potable water supplies would tend to be located as close as possible to the principal water courses in areas where a close hydraulic connection exists between the streams and the alluvium. Pumping from shallow wells in these areas would have only slightly less protracted effect on total surface-water discharge from the ES area than pumping directly from the streams.

Although the great thickness of the Mancos Shale makes it uneconomical for individual home owners to drill to underlying formations for a water supply, the possibility exists for industrial and municipal development of these deep aquifers. Very probably, however, any water obtained from rocks underlying the Mancos Shale in most parts of the ES area would be unsuitable for municipal uses and may be too saline for most industrial uses.

The most promising undeveloped source of good-quality ground water in the ES area is the volcanic aquifer capping Grand Mesa which may hold as much as 640,000 acre-feet of water containing less than 150 mg/l dissolved solids. If approved, a proposed study by the U.S. Geological Survey will test this potential aquifer by 1980. It is emphasized, however, that development of the volcanic aquifer on Grand Mesa probably would not appreciably increase the total water yield of the Grand Mesa area. Any ground water removed from storage would be recharged by surface water, with a corresponding reduction in surface runoff to the Colorado River. Normally, utilization of a ground-water reservoir would largely eliminate evapotranspiration losses associated with the operation of a surface-water reservoir and thereby effect appreciable water savings. In this case, however, Grand Mesa is sufficiently high (10,000 feet above sea level) that evapotranspiration losses from surface-water bodies are minimal, and the higher costs associated with developing and operating a ground-water development system compared to a surface-water system may not be feasible.

The Leadville Limestone of Mississippian age may be an important source of ground water in the extreme northern and eastern parts of the ES area. Preliminary data suggest that large volumes of water of suitable quality for industrial, if not domestic, use may be obtained from wells along the Grand Hogback. Considerble work remains to be done to evaluate this possibility, however, and it appears unlikely that any significant development of this potential aquifer will occur within the time frames addressed in this report.

Variations in ground-water discharge within the coal areas described under Mineral Resources and the relative significance of that discharge to the total water yield of the report area are poorly defined. In general, however, greatest recharge and, consequently, greatest contribution of ground-water flow to streams occurs in coal fields in the eastern part of the ES area where precipitation is highest. Conversely, lowest ground-water contribution to stream flow occurs in the coal fields in the western part of the ES area where precipitation is lowest. For example, ground-water effluent indicated by base flow in the North Fork of the Gunnison River in the Somerset field and in North Thompson Creek in the Carbondale field, which lie in the eastern part of the ES area, averages about 50 acre-feet per square mile per year (ac-ft/sq-mi/yr). Most streams in the Little Bookcliffs and Grand Mesa fields in the western part of the ES area have no base flow.

Assuming an average annual base flow (ground-water effluent) from the overall coal areas of about 25 ac-ft/sq-mi and no evapotranspiration losses enroute to the principal rivers, total ground-water contribution from the 654 square miles of coal area (Landis 1959) would be about 16,000 acre-feet. That represents less than 0.4 percent of the annual water yield from the ES area. Actually, significant evapotranspiration losses are probably occurring. The above figures, therefore, should be high and, thus, further emphasize the relatively insignificant effect of ground-water effluent from the coal areas on the total water budget of the ES area.

Following the above logic dissolved solids contributed by ground-water effluent from the coal areas to the rivers in the ES area should average no more than about 45,000 tons annually. This is about 1.3 percent of the total dissolved solids yielded annually by rivers draining the ES area.

Surface Water

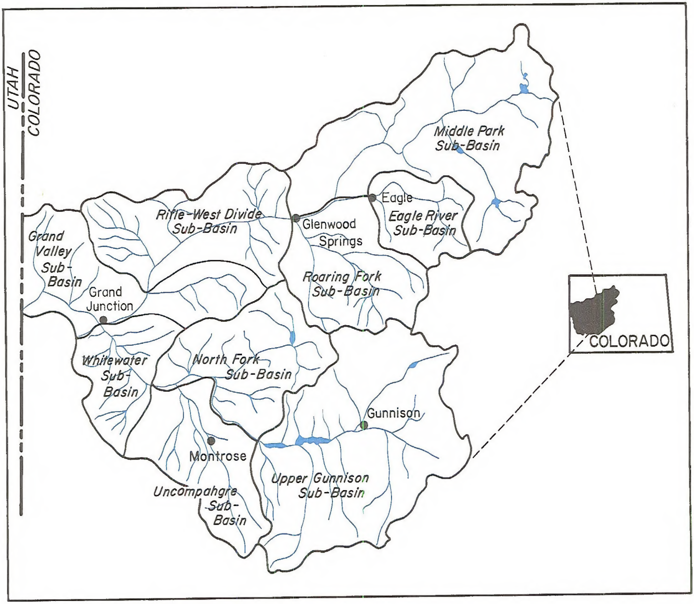
The ES area generally lies within the Upper Main Stem of the Upper Colorado Region in Colorado (map R2-10). The Upper Main Stem is composed of nine major subbasins: Middle Park, Eagle River, Roaring Fork, Rifle-West Divide, Grand Valley, Upper Gunnison, North Fork, Uncompahgre, and Whitewater. Altitudes range from about 4,300 feet on the Colorado River at the Colorado-Utah state line to over 14,000 feet on the Continental Divide, which follows the eastern margin of the watershed. The Upper Main Stem drains an area of 17,764 square miles upstream from U.S. Geological Survey gaging station No. 09163500, which is located 7.2 miles upstream from the Colorado-Utah state line. Average annual water yield (1951-1976) after all depletions is 4,200,000 acre-feet (5,800 cubic feet per second [cfs]). Discharge at the above station has ranged from a minimum daily of 960 cfs on September 7, 1956, to a maximum of 56,800 cfs on June 9, 1957.

High flows typically occur during May and June in response to melting snowpacks. Flow rates during this period increase five to ten times over those occurring during other months of the year, producing 60 to 65 percent of the total annual flow. Low flows normally occur during the winter months when surface runoff is minimal and most of the flow represents ground-water discharge from the watershed. Tributary streams supporting agricultural activities typically experience very low flows during late summer when irrigation demands are high.

Total annual runoff in the Upper Main Stem of the Colorado River in Colorado is about 5,389,700 acre-feet after adjustment for transbasin diversion (table R2-23). Total consumptive use within the Upper Main Stem watershed is about 1,189,700 acre-feet or about 22 percent of the available supply. Approximately 76 percent of the consumptive use is for irrigation; only 1.5 percent is used for industrial and commercial purposes, and only 4.4 percent is used for municipal and rural supplies. The remainder is dissipated primarily by evapotranspiration in conunction with nonbeneficial uses. Of the nine subbasins listed in table R2-23, only three, the Roaring Fork, Grand Valley, and North Fork, will be directly impacted by the expected coal development.

Future consumptive use of water in the ES area in conjunction with energy development is influenced by water apportionments set forth in compacts between the Colorado River Basin states and in treaties with Mexico. The Colorado River Basin Compact approved by Congress on August 19, 1921, is an agreement between the states of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming regarding the use and distribution of waters of the Colorado River. Article III of the Compact states that the "Upper Basin" (those parts of the states of Arizona, Colorado, New Mexico, Utah, and Wyoming within and from which waters naturally drain into the Colorado River System above Lees Ferry, Arizona) and the "Lower Basin" (those parts of the states of Arizona, California, Nevada, New Mexico, and Utah within and from which waters naturally drain into the Colorado River System below Lees Ferry) are each entitled to exclusive beneficial consumptive use of 7,500,000 acre-feet of water per year from the Colorado River System. In addition the states of the Upper Basin will not cause the flow of the river at Lees Ferry to be depleted below an aggregate of 75,000,000 acre-feet for any period of ten consecutive years (Radoesevich and Hamburg 1971).

The Upper Colorado River Basin Compact of 1948 provides for equitable apportionment of waters of the Colorado River System which have been allocated to the Upper Basin among the states of Arizona, Colorado, New Mexico, Utah, and



Map R2-10. Watersheds of the ES area

TABLE R2-23

SURFACE-WATER BALANCE FOR UPPER MAIN STEM OF THE COLORADO RIVER IN COLORADO BY SUBBASINS (ACRE-FEET/YEAR) a/

Item	Subbasin									Total
	Middle Park	Eagle River	Roaring Fork	Rifle-West Divide	Grand Valley	Upper Gunnison	North Fork	Un-compahgre	White-water	Upper Main Stem in Colorado
Total undepleted supply b/	1,555,000	435,600	959,700	367,500	128,900	1,404,000	716,000	168,700	112,000	5,847,400
Imported supply	2,800c/	0	2,500d/	2,200e/	6,100e/ 500f/ 7,000g/	0	0	361,500e/	0	3,300h/
Exported supply	345,400	34,400	81,800	0	0	369,700	2,000	0	7,000	461,000i/
Total available supply	1,212,400	401,200	880,400	369,700	142,500	1,034,300	714,000	530,200	105,000	5,389,700
Consumptive Use:										
Nonbeneficial use by reservoir evaporation, phreatophytes, riparian vegetation, seeped land, etc.	14,000	2,500	3,200	11,000	57,000	14,800	30,000	76,000	9,500	218,000
Irrigation	91,000	17,000	65,000	80,000	230,000	51,000	160,000	200,000	7,500	901,500
Industrial and Commercial	4,000	1,100	500	100	6,700	400	1,000	4,500	0	18,300
Municipal and rural	9,000	3,000	8,000	900	18,000	800	2,100	10,000	100	51,900
Total consumptive use	118,000	23,600	76,700	92,000	311,700	67,000	193,100	290,500	17,100	1,189,700
Total unused water supply	1,094,400	377,600	803,700	277,700	-169,200j/	967,300	520,900	239,700	87,900	4,200,000

a/ Data compiled from Irrigation Division No. 4 and No. 5 Annual Reports (1971-76), U.S. Department of Agriculture and Colorado Water Conservation Board (1962 and 1965) reports, U.S. Geological Survey Water Resources Data for Colorado (1967-77).
b/ Approximately 60 to 65 percent of this water supply occurs as runoff during May and June.
c/ Imported from Yampa River basin.
d/ Imported from Middle Park subbasin.
e/ Imported from Upper Gunnison subbasin.
f/ Imported from White River watershed.
g/ Imported from Kannah Creek watershed.
h/ Imported supply from outside upper Main Stem of Colorado River. Does not include imports from subbasins within the Upper Main Stem watershed.
i/ Water exported outside Upper Main Stem of Colorado River. Does not include exports from one subbasin to another within the Upper Main Stem watershed.
j/ Minus sign indicates consumptive use exceeded runoff plus imported supply to the subbasin. Difference was obtained from the Colorado River.

Wyoming as follows: (1) Arizona--50,000 acre-feet; then following deduction of Arizona's 50,000 acre-feet: (2) Colorado --51.75 percent, (3) New Mexico--11.25 percent, (4) Utah--23 percent, and (5) Wyoming--14 percent (Radoesevich and Hamburg 1971).

The Mexican Water Treaty of 1944 guarantees Mexico an annual quantity of 1,500,000 acre-feet of water from the Colorado River System (Radoesevich and Hamburg 1971).

Long-term records collected by the U.S. Geological Survey show that the computed annual virgin water yield from the Upper Basin for the period 1906-1973 was 14,952,000 acre-feet at Lees Ferry near the Utah-Arizona border. Yields ranged from a low of 5.6 million acre-feet in 1934 to over 24.0 million acre-feet in 1917. Since 1923, the average annual virgin flow at Lees Ferry has been about 13.8 million acre-feet.

The U.S. Bureau of Reclamation (USBR) estimates that the Upper Basin states could consume a total of as much as 5 million acre-feet annually under existing compacts and treaties, provided that adequate reservoir storage capacity is provided to carry water over from high water years to meet downstream commitments in years of drought. Experience has shown, however, that current development of Colorado River water by the Upper Basin states, which is considerably less than the maximum allowable, has significantly increased the salinity of the water delivered to the Lower Basin states, resulting in high treatment costs for municipal and industrial water and decreased agricultural yields. Pipe replacement because of corrosion, frequency of cleanup in boilers and other water-holding vessels, and soap and detergent use also have increased significantly as salinity levels have risen progressively in past years. Higher salinity levels downstream can be caused by increasing the total salt load through addition of municipal and industrial wastes, mine leachate, return irrigation flows, etc., or by transbasin diversion or consumptive use of good-quality water that previously diluted poorer-quality water entering the river system elsewhere.

Water-quality standards established for the Colorado River in 1975 include a call for maintenance of salinity levels at or below the 1972 level of 879 mg/l at Imperial Dam. Calculations made by the Colorado River salinity Control Forum indicate that the entire Colorado River Quality Improvement Program would be necessary to maintain this salinity level through the year 1990. An increase of 1 mg/l over this level is considered to result in added costs to Lower Basin water users in the amount of $230,000 annually in 1977 dollars (U.S. Department of the Interior, Bureau of Reclamation 1977).

The Northwest Colorado Coal Final Environmental Statement (U.S. Department of the Interior, Bureau of Land Management 1977d) chose to evaluate the effects of coal development on the salinity of the Colorado River below Hoover Dam rather than further downstream at Imperial Dam. For purposes of comparison, this study also uses the U.S. Geological Survey gaging station below Hoover Dam as a reference point in computing the effects of the proposed coal developments in west-central Colorado. Those records show an average annual water yield below Hoover Dam of 9,694,000 acre-feet, an annual dissolved-solids load of 8,975,800 tons, and a discharge weighted average dissolved-solids concentration of 681.00 mg/l. A summary of surface water availability, consumptive uses, polluting sources, and discharge-weighted average dissolved-solids concentrations in the Colorado River near the Colorado-Utah state line and below Hoover Dam are presented in table R2-24.

Surface runoff from the coal areas ranges widely in quantity from one part of the ES area to another. Observations indicate that highest annual runoff typically occurs in the coal fields in the eastern part of the area where precipitation is highest, whereas lowest annual runoff occurs from the Little Bookcliffs and Grand Mesa fields in the western part of the area where precipitation is lowest. Conversely, highest peak discharges per unit area of watershed apparently occur from the western tracts where runoff is generated largely by high-intensity convectional storms, whereas lowest peak discharges per unit area of watershed typically occur from the eastern tracts where runoff is generated largely by spring snowmelt. Unfortunately, however, no runoff records have been collected in the ES area that are specifically representative of the coal areas, although records for East and West Salt creeks near Mack are generally representative of the western coal fields. Data believed to be indicative of runoff from the eastern coal fields is currently being collected by the U.S. Geological Survey (1976, 1977) in cooperation with the BLM on seven small streams that drain coal areas in northwestern Colorado. These data are summarized in table R2-25, together with corresponding data for principal streams and rivers in the ES area.

Table R2-25 shows that differences in runoff from the various coal tracts are dwarfed in comparison to differences between the coal areas and the mountain areas. Annual runoff from the coal areas (based on two years of record) averages only about 0.64 inch, whereas the annual runoff from the mountain areas of 9.5 inches averages about 15 times that amount and is as high as 36 times that amount for runoff from the Crystal River watershed. Assuming an average annual runoff of 0.64

TABLE R2-24

SOURCES AND ESTIMATES OF ANNUAL CONSUMPTIVE USE AND POLLUTION IN THE ES AREA

Supply, Consumption, and Quality Categories	Present
1. Total undepleted surface-water supply (ac-ft)	5,847,400
2. Imported supply (from outside Upper Main Stem of Colorado River) (ac-ft)	3,300
3. Exported supply (to outside Upper Main Stem of Colorado River) (ac-ft)	461,000
4. Total available surface-water supply (lines 1 and 2 minus Line 3) (ac-ft)	5,389,700
5. Consumptive use:	
6. Nonbeneficial use by reservoir evaporation, phreatophytes, riparian vegetation, seeped land, etc. (ac-ft)	218,000
7. Irrigation (ac-ft)	901,500
8. Industrial and commercial (including coal mining) (ac-ft)	18,300
9. Municipal and rural (ac-ft)	51,900
10. Total consumptive use (lines 6 through 9) (ac-ft)	1,189,700
11. Net discharge without additional development (line 4 minus line 10)	4,200,000
12. Water quality (polluting sources):	
13. Natural sources (tons)	1,854,000
14. Irrigation (tons)	1,400,000
15. Industrial and commercial (including coal mining) (tons)	6,200
16. Municipal wastes (tons)	2,700
17. Less load due to power plants (tons)	-2,200
18. Total (dissolved solids in Colorado River near Colorado-Utah state line) (lines 13 through 16 minus line 17 (tons))	3,260,700
19. Discharge weighted average dissolved-solids concentration in the Colorado River near the Colorado-Utah state line without additional development (mg/l)	571.00 a/
20. Discharge weighted average dissolved-solids concentration in the Colorado River below Hoover Dam without additional development (mg/l)	681.00 a/

a/ Present dissolved-solids concentration is assumed to be the base level against which future changes as a result of development are compared.

TABLE R2-25

HYOROLOGIC OATA FOR STREAMS ORAINING MOUNTAIN ANO COAL AREAS IN WESTERN COLORAOO

	Station Number a/	Orainage Area (sq-mi)	Average Annual Runoff (ac-ft)	(ac-ft/sq-mi)	(inches)	Peak Oischarge (cfs)	(cfs/sq-mi)	Minimum Oaily Oischarge (cfs)	(cfs/sq-mi)	Annual Suspended Sediment Load (tons)	(tons/sq-mi)
Streams draining mountain areas:											
Colorado River near Kremmling	09058000	2,382	--	--	--	21,500	9.0	166	0.07	--	--
Colorado River near Ootsero	09070500	4,394	1,527,000	347	6.5	19,100	4.4	350	0.08	--	--
Colorado River below Glenwood Springs	09085100	6,013	2,473,000	411	7.7	20,500	3.4	924	0.15	672,500	112
Colorado River near Cameo	09095500	8,050	2,789,000	346	6.5	36,000	4.5	700	0.09	8,610,000	1,070
Colorado River near Colorado-Utah line	09163500	17,764	4,200,000	236	4.4	56,800	3.2	960	0.05	10,800,000	608
Eagle River below Gypsum	09070000	944	410,100	434	8.2	6,580	7.0	110	0.12	--	--
Crystal River near Redstone	09081600	167	209,400	1,250	23.5	3,980	23.8	22	0.13	--	--
North Thompson Creek near Carbondale	09082800	26.8	12,320	459	8.6	365	13.6	0.9	0.03	--	--
Roaring Fork River at Glenwood Springs	09085000	1,451	991,100	683	12.8	19,000	13.1	179	0.12	296,500	204
Gunnison River near Gunnison	09114500	1,012	553,500	547	10.3	11,400	11.3	80	0.08	79,000	78
Gunnison River near Lazear	09136200	5,241	--	--	--	14,800	2.8	115	0.02	--	--
Gunnison River near Grand Junction	09152500	7,928	1,848,000	233	4.4	35,700	4.5	106	0.01	2,025,000	255
North Fork Gunnison River near Somerset	09132500	531	315,200	594	11.1	7,860	14.8	17	0.03	--	--
Average		--	--	504	9.5	--	8.9	--	0.10	--	388
Streams draining coal areas: b/											
West Salt Creek near Mack	09153400	168	310	1.8	0.03	1,400	8.3	0	0	--	--
East Salt Creek near Mack	09163310	197	2,140	10.9	0.20	2,630	13.4	0.08	0.0004	--	--
Middle Creek near Oak Creek	09243700	23.5	1,550	66	1.2	20	0.8	0	0	--	--
Foidel Creek near Oak Creek	09243800	8.6	130	15	0.3	1	0.1	0	0	18E c/	2
Foidel Creek at mouth	09243900	17.5	1,670	95	1.8	69	3.9	0	0	--	--
Good Spring Creek at Axial	09250400	35	1,430	41	0.8	18	0.5	0.15	0.004	250E	7
Taylor Creek at mouth	09250510	7.2	23	3	0.1	7	1.0	0	0	167E	23
Wilson Creek near Axial	09250600	22	1,293	59	1.1	33	1.5	0.31	0.014	1,672d/	76
Jubb Creek near Axial	09250610	7.5	59	8	0.2	6	0.8	0	0	280E	38
Average		--	--	33.3	0.64	--	3.4	--	0.002	--	29

a/ U.S. Geological Survey number.
b/ Based on only two years of records.
c/ E = Estimated from random samples collected during 1976 water year.
d/ Based on 1976 water year.

inch, total runoff from the coal areas (654 square miles) would be about 22,300 acre-feet. This is only about 0.5 percent of the total runoff from the Upper Main Stem of the Colorado River at the Colorado-Utah state line.

Table R2-25 shows that measured peak discharges per unit area from the gaged coal areas are unusually low for small watersheds, which characteristically have much higher unit peak discharges than large watersheds, often exceeding 100 cfs/sq-mi. For example on July 18, 1974 a high-intensity thunderstorm caused Coal and Jerry creeks near Cameo in the Little Bookcliffs coal field to flow at bank-full stage. Subsequent measurements by the U.S. Geological Survey using indirect methods showed peak discharges of 3,440 cfs (287 cfs/sq-mi) in Coal Creek (12.0 sq-mi) and 12,000 cfs (175 cfs/sq-mi) in Jerry Creek (68.6 sq-mi). The low peak discharges shown in table R2-25 for the coal areas, therefore, are tentatively attributed largely to the short period of record, although they may be due in part to location of most of the gaged watersheds in the eastern coal fields where most runoff is generated by spring snowmelt rather than by convectional storms.

The Colorado Department of Health classifies all waters in the subbasins depicted on map R2-10 as Class B_1, except for the main stem of the Colorado River downstream from the mouth of Parachute Creek to the Colorado-Utah state line and the Gunnison River downstream from the mouth of the Uncompahgre River, both of which are classified as B_2 waters primarily because of their higher temperatures. Parameters and limits included in the Colorado Water Quality Classification System are listed in table R2-26.

Although municipal and industrial wastes, mine effluent, pesticides and herbicides used in agriculture, return flow of irrigation water, and natural radiological, heavy metal, and trace element discharges introduce local contaminants to the surface-water system in the ES area, the overriding problem is total salinity and its impact on downstream uses of the water as previously stated. It is important to note, therefore, that the Colorado Water Quality Classification System (table R2-26) does not include salinity as an element of classification.

Quality of water records published by the U.S. Geological Survey (1977) show that the headwaters of the Colorado River along the Continental Divide in Rocky Mountain National Park contain less than 50 mg/l dissolved solids. Dominant ions are calcium and bicarbonate. Downstream with increasing size of the watershed and inclusion of an increasing percentage of runoff and ground-water discharge from sedimentary rocks, dissolved-solids concentration increases to about 200 mg/l at Dotsero (table R2-27) and sulfate becomes an important constituent during low flow, primarily as a result of ground-water leaching of the thick gypsum beds in the lower reaches of the Eagle River Valley. Annual addition of about 214,000 tons of salts to the river by the springs at Glenwood Springs increases average salinity to about 300 mg/l and significantly increases the concentration of sodium and chloride ions. About 120 miles further downstream at Cameo, natural loading plus irrigation return flows have increased the dissolved-solids concentration to about 425 mg/l, and sodium and chloride are the dominant ions during low flow. Through Grand Valley the river picks up an additional estimated 650,000 to 850,000 tons per year (U.S. Department of the Interior, Bureau of Reclamation 1977), about 90 percent of which is attributable to agricultural activities. Calcium and sulfate become the dominant ions and dissolved-solids concentration increases to about 571 mg/l at the gaging station near the Colorado-Utah state line.

The Crystal River, into which streams traversing the Carbondale coal field drain, is a tributary of the Roaring Fork River, which enters the Colorado River at Glenwood Springs. The water is moderately hard to hard and contains about 100 mg/l dissolved solids during high flows. Dominant ions are calcium and bicarbonate as would be expected in runoff from mountain areas. At low flow dissolved-solids concentration increases to about 300 mg/l and the water changes to a calcium, sulfate, bicarbonate type, reflecting the leaching of gypsum from the adjacent sedimentary rocks by both natural processes and agricultural activities. Above Redstone, the river is generally clear and is better than the state's classification system would indicate. Below Redstone, Coal Creek carries sufficient sediment to color the river following summer storms and during spring snowmelt. The source of the sediment is from natural erosion of Cretaceous shales and coal mining to an unknown extent.

The North Fork of the Gunnison River, into which streams draining the Somerset coal field flow, is severely impacted by human activities, primarily agriculture. Coal mines in the area currently discharge little or no effluent into the river system. Near Somerset, the water is a calcium bicarbonate type, typical of runoff from mountain areas, and contains an average dissolved-solids concentration of 100 to 150 mg/l. Downstream, between Paonia and Hotchkiss, water quality changes only slightly during spring runoff, but degrades rapidly during the remainder of the water year in response to increased agricultural activities. After spring runoff is over the water changes to a calcium, magnesium, sodium, sulfate type, reflecting active leaching by irrigation return flows. Dissolved-solids concentra-

TABLE R2-26

COLORADO STATE WATER QUALITY CLASSIFICATION

STANDARD	CLASS A_1	CLASS A_2	CLASS B_1	CLASS B_2
Settleable Solids	Free From	Free From	Free From	Free From
Floating Solids	Free From	Free From	Free From	Free From
Taste, Odor, Color	Free From	Free From	Free From	Free From
Toxic Materials	Free From	Free From	Free From	Free From
Oil and Grease	Cause a film or other discoloration	Cause a film or other discoloration	Cause a film or other discoloration	Cause a film or other discoloration
Radioactive Material	Drinking Water Standards	Drinking Water Standards	Drinking Water Standards	Drinking Water Standards
Fecal Coliform Bacteria	Geometric Mean of less than 200/100 ml from five samples in 30-day period	Geometric Mean of less than 200/100 ml from five samples in 30-day period	Geometric Mean of less than 1000/100 ml from five samples in 30-day period	Geometric Mean of less than 1000/100 ml from five samples in 30-day period
Turbidity	No increase of more than 10 J.T.U.	No increase of more than 10 J.T.U.	No increase of more than 10 J.T.U.	No increase of more than 10 J.T.U.
Dissolved Oxygen	6 mg/l minimum	5 mg/l minimum	6 mg/l minimum	5 mg/l minimum
pH	6.5 - 8.5	6.5 - 8.5	6.0 - 9.0	6.0 - 9.0
Temperature	Maximum 68°F. Maximum Change 2°F.	Maximum 90°F. Maximum Change: Streams - 5°F. Lakes - 3°F.	Maximum 68°F. Maximum Change 2°F.	Maximum 90°F. Maximum Change: Streams - 5°F. Lakes - 3°F.
Fecal Streptococcus	Monthly average of less than 20/100 ml from five samples in 30-day period	Monthly average of less than 20/100 ml from five samples in 30-day period	-----	-----

Note: Adopted - March 19, 1974
Effective - June 19, 1974

TABLE R2-27

QUALITY OF WATER DATA FOR STREAMS DRAINING MOUNTAIN AND COAL AREAS IN WESTERN COLORADO

Station	Station Number a/	Drainage Area (sq-mi)	pH Range	pH Avg.	Specific Conductance b/ (micromhos/cm) Spring	Specific Conductance b/ (micromhos/cm) Fall	Water Type c/ Spring	Water Type c/ Fall
Streams draining mountain areas:								
Colorado River near Dotsero	09070500	4,394	7.8-8.3	8.1	300-400	400-500	$\underline{Ca}$, $\underline{HCO_3}$	$\underline{Ca}$, HCO_3, SO_4
Colorado River near Glenwood Springs	09071100	4,560	7.1-8.8	7.8	350-450	500-750	$\underline{Ca}$, $\underline{HCO_3}$	Ca, Na, Cl, HCO_3, SO_4
Colorado River near Cameo	09095500	8,050	7.6-8.5	8.0	350-600	1,000-1,200	Ca, Na, HCO_3, SO_4	$\underline{Na}$, Ca, $\underline{Cl}$, HCO_3 $\underline{SO_4}$
Colorado River below Colorado-Utah state line	09163530	18,034	7.2-8.1	7.7	500-800	1,000-1,900	$\underline{Ca}$, Na, $\underline{SO_4}$, $\underline{HCO_3}$	Ca, Na, $\underline{SO_4}$, HCO_3, Cl
Eagle River at Gypsum	09069000	944	7.2-8.5	8.0	150-350	800-1,200	$\underline{Ca}$, HCO_3, SO_4	$\underline{Ca}$, Na, SO_4, Cl, HCO_3
Gunnison River near Grand Junction	09152500	7,928	7.8-8.4	8.1	500-800	900-2,000	$\underline{Ca}$, $\underline{SO_4}$	$\underline{Ca}$, $\underline{SO_4}$
Streams draining coal areas:								
West Salt Creek near Mack	09153400	168	--	--	1,300-1,800	2,000-7,000	--	Na, Ca, SO_4, HCO_3
East Salt Creek near Mack	09163310	197	7.4-8.5	8.0	2,600-3,000	3,000-8,500	Na, Mg, SO_4	$\underline{Na}$, Ca, Mg, SO_4
Middle Creek near Oak Creek	09243700	23.5	7.6-8.8	8.2	400-500	600-850	$\underline{Ca}$, $\underline{HCO_3}$	$\underline{Ca}$, $\underline{HCO_3}$
Foidel Creek near Oak Creek	09243800	8.6	7.5-7.8	7.8	500-800	800-900	$\underline{Ca}$, $\underline{HCO_3}$	$\underline{Ca}$, $\underline{HCO_3}$
Foidel Creek at mouth	09243900	17.5	7.4-8.2	7.9	1,000-1,200	1,200-1,400	$\underline{Ca}$, $\underline{SO_4}$	--
Good Spring Creek at Axial	09250400	35	8.1-8.8	8.2	1,400-1,500	1,400-1,500	$\underline{Mg}$, $\underline{Ca}$, HCO_3, SO_4	Mg, Ca, SO_4, HCO_3
Taylor Creek at mouth	09250510	7.2	8.1-8.5	8.2	1,000-1,150	1,300-1,450	Mg, Ca, HCO_3	$\underline{Ca}$, $\underline{Mg}$, Na, HCO_3, SO_4
Wilson Creek near Axial	09250600	22	7.5-8.5	8.1	1,500-1,800	1,800-2,600	Na, Ca, Mg, $\underline{HCO_3}$, SO_4	$\underline{Na}$, Mg, Ca, $\underline{HCO_3}$, SO_4
Jubb Creek near Axial	09250610	7.5	7.8-8.4	8.1	1,500-1,600	1,500-2,100	$\underline{Mg}$, Ca, Na, $\underline{HCO_3}$, SO_4	$\underline{Mg}$, Ca, Na, HCO_3, SO_4

a/ U.S. Geological Survey number.
b/ Dissolved-solids concentrations in milligrams per liter (mg/l) can be approximated by multiplying specific conductance by 0.7.
c/ Ca, calcium; Mg, magnesium; Na, sodium; HCO_3, bicarbonate; SO_4, sulfate. Underline indicates dominant ions.

tions increase to more than 1,500 mg/l during middle and late summer and average about 500 mg/l through the fall and winter months. Analysis of irrigation return flow below Paonia by the Colorado Department of Health showed an increase in total hardness of 817 percent, calcium hardness of 998 percent, specific conductance of 630 percent, chlorides of 157 percent, and suspended solids of 1,200 percent (U.S. Department of Interior, Bureau of Land Management 1977b).

Data on water quality presented in table R2-27 show that streams draining the coal areas have significantly higher dissolved-solids concentrations than rivers draining the mountain areas. Assuming an average dissolved-solids concentration in runoff from the coal areas of about 1,800 mg/l (average of values listed in table R2-27) and an average annual runoff of 22,300 acre-feet, the total dissolved-solids load in runoff from the coal areas would be about 55,000 tons/yr. This is only about 1.7 percent of the total dissolved-solids load yielded by the Upper Main Stem of the Colorado River in Colorado (table R2-24).

Erosion and Sedimentation

A comparison of suspended sediment loads yielded by the coal areas with that yielded by the overall ES area is not warranted by the meager data in table R2-25. Those data show that the estimated annual unit suspended sediment yields from the coal watersheds were all substantially less than the corresponding value for the Colorado River near the state line. Normally, sediment yield per unit area of watershed decreases progressively with increasing size of a basin because of deposition of a part of the load as flows move downstream and bottom lands comprise a larger percentage of the watershed. For example, Hadley and Schumm (1961) report that annual sediment yields on Lance Creek in eastern Wyoming decreased from 1.10 ac-ft/sq-mi in the headwater areas to 0.33 ac-ft/sq-mi on the main stem, as the size of the watershed increased from about 0.5 to about 2,000 square miles. On that basis, long-term unit sediment yields from the small coal areas listed in table R2-25 would be expected to be three to four times as high as that from the Colorado River near the state line.

The apparent discrepancy is tentatively attributed to the short period of record for the coal areas, which include no large runoff events that would cause excessive erosion and high sediment yields, and to an absence of data for the Little Bookcliffs and Grand Mesa coal fields, both of which are comparatively arid and subject to locally high rates of channel and upland erosion. Studies by Lusby (1978) in small watersheds in Badger Wash near Fruita where runoff and erosion characteristics should be representative of the more arid western coal fields show an average annual sediment yield for the period 1953-73 of 1.80 ac-ft/sq-mi (approximately 2,750 tons/sq-mi/yr). On that basis, annual sediment yield from the Little Bookcliffs and Grand Mesa coal fields would probably average 0.5 to 1.0 ac-ft/sq-mi (750 to 1,500 tons/sq-mi). Observations in the eastern coal fields, however, show much less erosion because of a good protective plant cover, moderate grazing use, and generally stable soils. Sediment yield in this part of the ES area is estimated to be less than 50 tons/sq-mi/yr from the more stable areas and should not greatly exceed 250 tons/sq-mi/yr from the less stable disturbed areas. It is estimated, therefore, that total sediment yield from the coal areas is between 300,000 and 600,000 tons/yr. If so, the coal areas yield only 3 to 6 percent of the total suspended sediment load in the Colorado River at the state line.

Alluvial Valley Floors

Preservation of the hydrologic function of alluvial valley floors is required in the Surface Mining Control and Reclamation Act (SMCRA) of 1977 (see chapter 1, Related Reviews, Environmental Protection for identification of alluvial valley floors). The term alluvial valley floors refers to those unconsolidated stream-laid deposits holding streams where water availability is sufficient for subirrigation or flood irrigation agricultural activities. Not included in this category are those upland areas that are generally overlain by a thin veneer of colluvial deposits composed chiefly of debris from sheet erosion, deposits by unconcentrated runoff or slope wash, together with talus, other mass movement accumulation, and windblown deposits.

Technically, the identification of alluvial valley floors requires hydrologic data for both surface- and ground-water resources collected over a period sufficiently long to appraise the adequacy of the water supply for agricultural activities. These data are not currently available for most streams draining the coal areas. From a practical standpoint, however, the adequacy of the water supply for agricultural activities at any given location can be equated with ongoing farming operations. The perennial need for additional forage for livestock in the ES area, coupled with farming and ranching experience over many decades, have led to the development of virtually all those valley floors where agricultural activities are economically feasible.

On that basis, it is possible to approximate the location and significance of alluvial valley floors in relation to ongoing and proposed coal-mining operations in the ES area. Observations show that the flood plains of the rivers and lower reaches of most perennial and some intermittent stream valleys traversing the eastern coal areas undoubtedly qualify as alluvial valley floors. In contrast, most streams in the western coal areas are ephemeral and would not qualify. Identification of the alluvial valley floors that would be affected by the proposed mining operations can be found be found in the individual site-specific analyses of this ES.

The Office of Surface Mining (OSM) is currently developing criteria which will technically define alluvial valley floors. These criteria should be completed in early 1979.

Soils

General soil types for the region are shown in map 5 in the appendix; the three principal areas of anticipated coal development are delineated. Individual soil mapping units are based on a subgroup name (e.g., Typic Cryoboralf) along with other broad descriptive terms indicating texture, amount of rock fragments, and slope class. Each of these units is grouped into one of five orders (e.g., Alfisols), reflecting common soil features.

Aridisols and Entisols are the driest soils in the region; they occur in a zone with 8 to 15 inches of annual precipitation. Under natural conditions, moisture availability is a major limitation to cropping. With irrigation, however, certain of the Aridisols and Entisols may be quite productive. In Mesa County, much of map units 6 and 28 have been classified as either prime or unique farmlands. (Prime farmlands are those whose value derives from their general advantage as cropland due to soil and water conditions; unique farmlands are those whose value derives from their particular advantage for growing speciality crops such as orchards; see 7(CFR): 657.5 for specific selection criteria.) Units 10 and 28 in Delta County and unit 6 in both Delta and Montrose counties are also used for crop production, but these lands have not yet been evaluated for formal classification as prime or unique farmland.

Mollisols occur in the 15-to-25-inch precipitation zone. These soils have dark surface layers rich in organic matter. Reclamation potential is generally good due to the favorable surface qualities and the presence of sufficient moisture for revegetation. Principal limitations are the frequently steep slopes, stoniness, and the often heavy-textured subsoils which are subject to structural deterioration when disturbed.

Alfisols are represented by high elevation forested soils in the 20-to-40-inch precipitation zone. Alfisols, unlike Mollisols, lack the build-up of organic matter within the soil; instead, organic material accumulates on the surface, decomposing very slowly due to the cold temperatures. The frost-free period in this zone is generally less than 75 days, providing limited time for reclamation. Additional limitations are essentially the same as those listed for Mollisols.

Inceptisols are found under the highest moisture regime (30 to 50 inches) and the lowest temperature regime in the region. They generally occur above timberline, contain considerable rock fragments, and are highly susceptible to erosion. This soil unit is severely limited for all uses that in any way disturb the existing vegetative cover.

Vegetation

Vegetation Types

The distribution of vegetation types in western Colorado is limited chiefly by precipitation and moisture content of the soil, which in turn are affected by altitude, steepness, aspect, wind, vegetative cover, and the nature of the substrate. Annual precipitation levels increase with elevation, causing differences in soil moisture and vegetation. Aspect modifies the soil moisture in that north-facing slopes have a much lower evapotranspiration rate than south-facing slopes. This results in vegetation types growing at lower than normal elevations on the protected northern slopes. Also, vegetation types adapted to the relatively drier sites of lower elevations may extend higher by way of dry southern slopes. Variabilities such as this on the boundaries between one vegetation type to the next are rather common. They account for an overlap in the elevation and precipitation levels of the types. A list of the vegetation types and their extent (in acres) in the region as well as their approximate elevation and annual precipitation ranges are found in table R2-28. The scientific and common names of the dominant plants and characteristic plant associations within each vegetation type in the region are listed in the appendix. The vegetation types are shown on map 6 in the appendix. The following are descriptions of each of the vegetation types.

GREASEWOOD

The greasewood type overstory consists almost exclusively of black greasewood. It occurs where the annual precipitation is less than 10 inches and the water table is high, such as near rivers or irrigation ditches in low-lying valleys. Black greasewood favors soils that are high in salinity. The greasewood type is typically found at elevations below 6,200 feet.

Understory is very sparse to nonexistent in the greasewood type. When present, it consists of annual weeds such as belvedere summercyprus, Russian thistle, or in areas where there is water seepage to the surface, alkali sacaton or saltgrass.

TABLE R2-28

APPROXIMATE ANNUAL PRECIPITATION LEVELS, ELEVATION RANGES, AND EXTENT OF THE VEGETATION TYPES WITHIN THE ES AREA

Vegetation Type	Extent (acres)	Elevation (feet)	Annual Precipitation (inches)
Greasewood	103,950	less than 6,200	less than 10
Saltbush	277,200	less than 6,200	less than 10
Sagebrush	242,550	5,000 to 9,000	10 to 19
Pinyon-Juniper	966,250	6,000 to 7,500	12 to 15
Mountain Shrub	294,500	6,500 to 8,500	12 to 17
Ponderosa Pine-Douglas Fir	173,250	7,000 to 9,000	14 to 19
Aspen	346,500	7,000 to 11,000	14 to 35
Mountain Meadows	129,200	7,000 to 11,000	14 to 35
Lodgepole Pine	93,550	8,000 to 10,500	20 to 30
Spruce-fir	619,750	8,000 to 11,000	20 to 35
Alpine	242,550	greater than 11,000	greater than 35
Riparian	207,450	variable throughout region	
Annual weed	96,400	variable throughout region	
Barren type	48,500	variable throughout region	
Agricultural land	2,079,898	less than 10,000	7 to 30
Total	5,921,498		

Foxtail barley is also commonly found in black greasewood stands.

On soils which are not exceptionally high in salinity, big sagebrush, fourwing saltbush, and shadscale may be interspersed within the black greasewood stands.

SALTBUSH

The saltbush type occurs in valleys and on hills at low elevations. It is adapted to soils which are less saline than those of the greasewood type. Like the greasewood type, the saltbush type is restricted to elevations below 6,200 feet, where annual precipitation is 10 inches or less.

The dominant shrubs in the saltbush type are various species of saltbush. Shadscale, Gardner saltbush, and mat saltbush are most common. Fourwing saltbush and common winter fat are present to a lesser extent. The herbaceous species are chiefly galleta, blue grama, wildrye, scarlet coppermallow, eriogonum, and desert princes plume. Prickly pear also occurs in localized patches. In parts of the saltbush type, galleta, blue grama, or snakeweed may be extremely abundant, covering large areas. (Figures R2-7 and R2-8 are photographs of the saltbush type.)

SAGEBRUSH

The sagebrush type is present in two more or less distinct zones: sagebrush of the intermountains in the semidesert areas and sagebrush of the mountain parks and valleys. Big sagebrush is the main component of both zones, while black sagebrush and silver sagebrush are of lesser importance. The annual precipitation of the zones is 16 inches per year or less, and they differentiated chiefly by altitude and accompanying vegetation types.

The elevation range of the lower altitude sage zone is generally between 5,000 and 7,500 feet. At its lower limit, the sagebrush merges with the saltbush or greasewood types. Big sagebrush requires soil that is less saline than either of the previously discussed types. At the upper limit of the sagebrush type are the mountain shrub or pinyon-juniper types. The boundary between sagebrush and mountain shrub is distinct, but that between sagebrush and pinyon-juniper is variable, because both types occur in the same altitudinal and climatic range. Isolated sagebrush parks are often present in pinyon-juniper woodlands, or vice versa. Pinyon-juniper occurs on ridges and canyons with coarse, rocky, or shallow soil, while sagebrush occupies the valleys, mesas, or gentle slopes with fine, deep soil (Woodbury 1947). Pinyon and juniper have invaded and displaced sagebrush populations in many areas (see pinyon-juniper type). The understory of the semidesert sage type is sparse, consisting of western wheatgrass, Indian ricegrass, bottlebrush squirreltail, cheatgrass, Russian thistle, and hairy goldaster.

The sagebrush of the mountain parks and valleys is well represented in the Gunnison Basin, where it occurs mainly between 7,500 and 9,000 feet. It has been estimated that one-third of the Gunnison Basin is covered by big sagebrush (Barell 1969). The mountainous sagebrush type adjoins moist meadows of drainages at its lower limit and most commonly aspen at its upper limit, although it may occasionally contact ponderosa pine-Douglas fir, lodgepole pine, or spruce fir at the upper limits. The herbaceous understory is not as sparse as in the semidesert sage areas; it consists chiefly of Thurber's fescue, western yarrow, American vetch, and skyrocket gilia. Shrubs interspersed in the mountain sagebrush type are mountain snowberry, antelope bitterbrush, and Douglas rabbitbrush. (Figure R2-9 shows the sagebrush type.)

PINYON-JUNIPER

The pinyon-juniper type consists primarily of pinyon pine and Utah juniper in the regional ES area. It is most developed at an elevation range of between 6,000 and 7,500 feet. Shrubs interspersed within the pinyon-juniper type are big sagebrush, Douglas rabbitbrush, and antelope bitterbrush. At its upper limit, the pinyon-juniper type usually contacts the mountain shrub type, merging into Gambel oak, serviceberry, and mountain mahogany. At the lower limits of the pinyon-juniper type are the sagebrush or saltbush types.

The herbaceous understory of the pinyon-juniper type is sparse, consisting of Indian ricegrass, western wheatgrass, armored goldenweed, stemless hymenoxys, junegrass, galleta, and snakeweed. It is generally thought that the scarcity of grasses and forbs in the pinyon-juniper type is the result of severe overgrazing in the past and that historically much more herbaceous understory was present.

Both the range and density of the pinyon-juniper type have increased since the settling of the west. This is due to elimination of competition from herbaceous plants, resulting from severe overgrazing and from the prevention of fires which destroyed the woody pinyon-juniper overstory (West 1975). The removal of grass due to overgrazing creates a biotic vacuum which first sagebrush and later pinyon-juniper fill. It has been shown that the pinyon-juniper type spreads not only downward through the sagebrush in valleys, but also upward through sagebrush until it contacts the mountain shrub zone (Cottam and Steward 1940). Juniper colonizes an area first and is later followed by pinyon (Woodbury 1947). (Figure R2-10 shows pinyon-juniper woodlands.)

Figure R2-7. Saltbush type east of Palisade, showing shadscale and galleta grass in foreground.

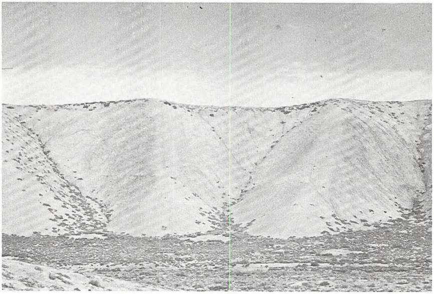


Figure R2-8. Saltbush type in Mancos shale hills near Montrose, showing Gardner saltbush (on bottomlands) and mat saltbush (on hills).

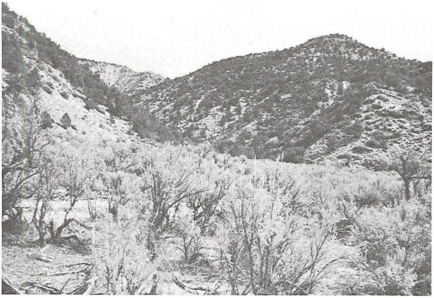


Figure R2-9. Sagebrush type. Pinyon-juniper is on the hills in the background.

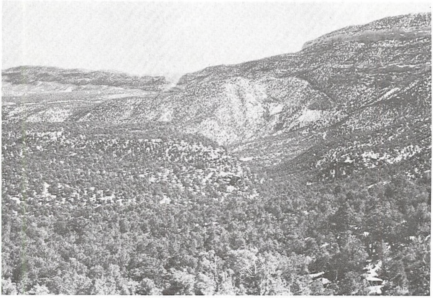


Figure R2-10. Pinyon-juniper woodlands in the ES area.

Mountain Shrub

The mountain shrub type occurs between 6,500 and 8,500 feet, in areas with annual precipitation between 12 and 17 inches. The vegetation is typically very dense in this zone, consisting mainly of Gambel oak associated with serviceberry and mountain mahogany. Other shrubs present are mountain snowberry, skunkbrush sumac, hawthorn, and chokecherry. Understory species in the mountain shrub type include slender wheatgrass, blue wildrye, junegrass, elk sedge, arrowleaf balsamroot, northern bedstraw, and lambstongue groundsel.

This vegetation type normally occurs as a narrow band between the pinyon-juniper or sagebrush types and the aspen or ponderosa pine-Douglas fir types. Occasionally the mountain shrub type expands and covers large areas, such as along Plateau Creek northeast of Palisade and along the Roaring Fork and Crystal rivers southeast of Glenwood Springs.

The mountain shrub type has historically occupied about the same area it does today in the regional ES area (Brown 1958), although the stands may now be more dense than in the past, due to fire and other disturbances caused by man. Brown (1958) showed that Gambel oak can withstand most disturbances, including fire, and will often increase as a result of them. Killing of the aboveground portion of Gambel oak will stimulate the plant to produce numerous suckers, which results in the thickening of open stands and the merging of scattered stands into continuous thickets. In contrast, Brown also showed that stands that age without any disturbance will tend to thin out into scattered clumps. Also, it is the nature of Gambel oak to be much more dense on steep slopes than on gradually sloping areas, possibly because of the easier spread of fire on steep slopes. (Figure R2-11 shows the mountain shrub type, and figure R2-12 shows Gambel oak.)

Ponderosa Pine-Douglas Fir

The ponderosa pine-Douglas fir type occurs at elevations between 6,500 feet and 8,500 feet. Ponderosa pine is present in the drier areas, particularly on southern aspects, while Douglas fir occurs on the more moist, northern aspects. The annual precipitation level for this type is approximately 16 to 26 inches. Chief understory species are Arizona fescue, mountain muhly, junegrass, Fremont geranium, and western yarrow. The understory is more developed under ponderosa pine because of the more open and discontinuous canopy layer; herbaceous understory plants are scarce beneath dense, closed Douglas fir stands (Costello 1954).

One of the two forest components in the ponderosa pine-Douglas fir type may be absent in localized areas. In the North Fork of the Gunnison River region, Douglas fir is present in extensive stands on north-facing slopes, but ponderosa pine is largely absent. In this area the south-facing slopes are inhabited by pinyon-juniper and mountain brush.

Colorado blue spruce is often present in moist soil along streams and in valleys within the ponderosa pine-Douglas fir type. (Figure R2-13 shows blue spruce, and figure R2-14 shows a spruce-fir forest.)

Aspen

Aspen occurs as a stable, rather continuous forest belt between 9,500 feet and 10,500 feet in the regional ES area, although it extends as low as 8,500 and as high as 11,200 feet. The mountain brush or Douglas fir zone borders the aspen type at its lower limit except in the Gunnison Basin where sagebrush parks occur below the aspen type. At the upper border of aspen is usually spruce-fir type.

The understory of the aspen type is very lush and contains a large diversity of grasses and forbs. The most common grasses are Thurber's fescue, nodding brome, fringed brome, Kentucky bluegrass, slender wheatgrass, needlegrass, alpine timothy, and spike trisetum. The main forbs are northern bedstraw, heartleaf arnica, Colorado blue columbine, wax flower pyrola, western yarrow, Barbey larkspur, meadowrue, and pseudomycopterus.

The aspen type is sometimes a successional stage, invading areas that have been burned or logged. In these cases it is usually replaced over years by a mature spruce-fir type. Aspen may also be found to occasionally invade mountain meadows dominated by Thurber's fescue. The prolific nature of its rootstalks and suckers enables aspen to invade a mature grass community. (Figure R2-15 shows aspen and spruce-fir types.)

Mountain Meadows

Mountain meadows are common in the woodlands of the lower mountains and the woodlands of subalpine areas. The plant composition of the meadows varies considerably, depending on the moisture content of the soil. Dry meadows are characterized in the lower mountains by Arizona fescue, Idaho fescue, mountain muhly, junegrass, pine dropseed, western yarrow, Fremont geranium, and harebell. In subalpine areas, they consist of Thurber's fescue, needlegrass, rough bentgrass, alpine timothy, spike trisetum, orange sneezeweed, and cinquefoil. In many areas on Grand Mesa and in the San Juans, extensive stands of Thurber's fescue have been replaced by other grasses and forbs, largely due to overgrazing (Costello 1954). Wet meadows consist of tufted hairgrass, blue joint

Figure R2-11. Mountain shrub type, in the North Fork valley near Paonia.

Figure R2-12. Gambel oak, the dominant plant of the mountain shrub type. Douglas fir is in the background.

Figure R2-13. Blue Spruce, a riparian plant along water courses in the mountains.

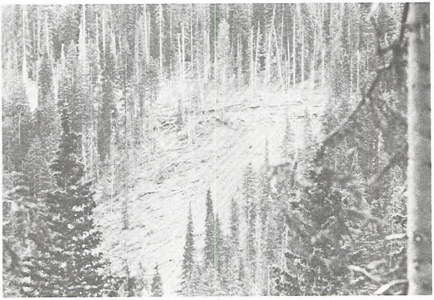


Figure R2-14. Spruce-fir forest.

reedgrass, buttercups, marsh marigolds, shrubby cinquefoil, and a variety of sedges and rushes. (Figure R2-16 shows mountain meadow.)

LODGEPOLE PINE

The regional ES area is near the southernmost geographical distribution of lodgepole pine, and consequently it is not very abundant (Langenheim n.d.). The lodgepole pine type is scattered throughout the woodlands and grasslands of subalpine areas, usually on north slopes, typically between 8,500 and 11,000 feet elevation. It is largely found on old burns, where it is a subclimax tree and may eventually be replaced by spruce-fir.

Where the lodgepole pines are very dense, there is little to no understory except for a thick mat of pine needles. In more open stands, the understory consists of elk sedge, heartleaf arnica, common juniper, grouse whortleberry, and russet buffaloberry. Lodgepole pine typically occurs between 8,500 and 11,000 feet.

SPRUCE-FIR

The spruce-fir type consists of Engelmann spruce and subalpine fir in rather dense stands. Engelmann spruce is the dominant tree of this type, with subalpine fir of lesser abundance (largely due to Engelmann spruce's longevity). The spruce-fir forest is characterized by an unevenness in the age of trees, along with numerous standing dead trees, and the forest floor littered with dead trunks of all sizes and in varying degrees of decomposition.

Spruce-fir is present at altitudes between 8,500 to 12,000 feet. It occupies only the north slopes at its lower altitudinal limit, and at the upper limit, which is timberline, the trees become dwarfed and contorted. Spruce-fir is the dominant vegetation type between 10,000 and 11,500 feet. The precipitation range of the spruce-fir type is approximately 20 to 35 inches.

The understory within the spruce fir type is rather uniform. It consists mainly of blueberries, heartleaf arnica, wild strawberry, sickletop pedicularis, Jacob's ladder, gooseberry currants, and pseudomycopterus. (Figure R2-15 shows spruce-fir and aspen types.)

ALPINE

The alpine type begins at timberline, where twisted, contorted Engelmann spruce and subalpine fir, collectively called Krummholz, are present. It extends from approximately 11,000 feet to the summits of the high peaks, above 14,000 feet. The vegetation is typically dense, usually with less than 5 percent bare ground. The annual precipitation level is near to above 40 inches in the alpine type.

The lower 1,000 to 2,000 feet of the alpine zone is characterized by tall grasses, sedges, and erect forbs. The most common species are thickleaf groundsel, porterligusticum, and lupine. Other abundant forbs are Barbey larkspur, American bistort, sulfur paintbrush, aspen sunflower, meadowrue, subalpine yarrow, thistle, and pseudomycopterus. The tall grasses of the lower part of the alpine zone are alpine timothy, spike trisetum, purple pinegrass, slender wheatgrass, tufted hairgrass, and timber oatgrass. In the higher portions of the alpine zone, above approximately 12,000 feet, is an abundance of cushion, rossete, mat, and low-tufted plants. The most common forbs are alpine avens, sibbaldia, alpine mouse-ear, moss silene, and Parry clover. Grasses present are alpine bluegrass, alpine timothy, alpine fescue, and spike trisetum. A number of sedges and rushes are also present.

Kobresia, a sedge-like plant, covers large areas above timberline, mainly on windswept ridges. A plant species may vary in size considerably from the lower edge of the alpine zone to the upper edge. An example is alpine timothy, which may be 35 to 40 centimeters tall near timberline, and just 10 to 15 centimeters tall at 13,000 feet elevation.

Boulder fields and talus slopes are common within the alpine zone. Vegetation is very sparse on these substrates, consisting of a specific association of plants: alpine springbeauty, Colorado blue columbine, alpine mountain sorrel, tiny hawksbeard, chaenactis, and ligularia. (Figure R2-17 shows the alpine type.)

RIPARIAN

The riparian vegetation type occurs along the many rivers and streams within the regional ES area. The typical trees and shrubs composing riparian vegetation are narrowleaf cottonwood, plains cottonwood, box elder, birch, alder, hawthorn, red osier dogwood, and many species of willows. Aspen may sometimes occur along streams as a riparian plant, mainly at elevations lower than that at which it is normally found. Colorado blue spruce is an important riparian component between 7,000 and 9,500 feet. Salt cedar occurs along rivers and streams at lower elevations, below 6,000 feet. Herbaceous species include many different grasses, forbs, and sedges. The specific composition of herbaceous species in riparian vegetetation varies considerably with altitude.

ANNUAL WEED TYPE

Disturbed areas exhibit a unique vegetation type of invader plants such as Russian thistle, bindweed, or cheatgrass. If no further disturbance occurs, the invader vegetation will succeed to a more stable vegetation type typical of the area. The appendix lists the common weed species found in the regional ES area.

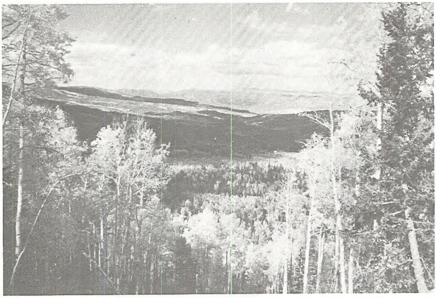


Figure R2-15. Aspen and spruce-fir vegetation types.

Figure R2-16. Mountain meadow consisting of Thurbers fescue, needlegrass, wheatgrass and bluegrass.

Figure R2-17. Alpine type, dominated by many species of grasses and forbs.

Barren Type

The barren type consists of any areas which have a vegetation cover of 2 percent or less. This may be on rock cliffs, talus slopes, or south-facing Mancos shale slopes.

Endangered and Threatened Species

There are fifteen plants in the ES area which are either proposed endangered or proposed threatened in the *Federal Register* (Vol. 40, No. 117, Tuesday, July 1, 1975; Vol. 41, No. 127, Wednesday, June 16, 1976). Table R2-29 is a list of the plants. The fifteen plants would receive legal protection if they are given a final endangered or threatened status in the *Federal Register*. To date there are no Colorado plants which have a final listed endangered or threatened status.

Eight of the proposed endangered or threatened plants are known to occur on public land in the ES area (*Echinocereus triglochidiatus* var. *inermis, Sclerocactus glaucus, Stellaria irrigua, Penstemon retrorsus, Cryptantha weberi, Cryptantha elata, Phacella submutica,* and *Astragalus linifolius*). Five are known to occur on national forest systems land (*Cryptantha weberi, Senecio porteri, Stellaria irrigua, Arabis oxylobula,* and *Sullivantia purpusi*). One occurs on private land (*Erigonum pelinophilum*). One has not been seen since the 1890s; consequently its actual range is not known (*Cryptantha aperta*).

Wildlife

The ES area lies within the Colorado Plateau and the southern Rocky Mountain physiographic regions (Kuchler 1964). Of the approximately 9 million acres of land in the ES area, most are available to wildlife in some manner. Some of the lands in agriculture and ranching are available for use by most species of wildlife. Secretive species such as bear and mountain lion will not use areas near human habitation except in extreme cases, while other species will make use of the areas either year-round (e.g., most small animals) or seasonally as winter range (e.g., deer and elk).

There are about 2,942,800 acres of deer winter range of which about 401,720 acres are considered crucial, and about 3,314,550 acres of elk range. Some of these acres are not in a usable condition for deer and elk due to human developments, topography such as cliffs, changes in microenvironments or vegetative patterns, and the fact that the distribution of animals is not as even as the figures might indicate.

The fauna is diverse, reflecting the variety of vegetation, soils, landforms, climate, and land uses in the region. Generally, ecological information is limited for the majority of the wildlife species found in the region, with the exception of species of recreational or economic value and unique species such as those classified as threatened or endangered. A list of species known to occur in the region, their relative abundance, and their most frequently used habitat sites is available for inspection at the Montrose District Office. Table R2-30 shows the number of wildlife species in various habitat types in the ES region.

Mammals

Carnivore (dogs, cats, bears, weasels, etc.)

Twenty-two species of carnivore currently inhabit, or until recently inhabited, the region. The Rocky Mountain wolf and the grizzly bear no longer inhabit this region, while the lynx, wolverine, and black-footed ferret may possibly still occur.

The carnivores are one of the higher trophic levels in the region. Although primarily meat eaters, some members of this order supplement their diets with nuts, berries, and other plant parts.

The economic value of this group is considerable. Mountain lion and black bear are both classified as big game animals. The distribution of mountain lion within the region is shown on map 8 in the appendix. Mountain lions are most abundant in rough, broken country with coniferous forest or riparian vegetation. The largest population within the region occurs in the Little Bookcliffs north of Grand Juntion. Black bear distribution can be determined from map 7 in the appendix areas above 7,000 feet in riparian, coniferous, or aspen types are considered occupied habitat.

The economic value of furbearers in this order has been increasing in recent years. Current pelt values for bobcat, coyote, red and gray fox, and raccoon are very good, and these species are taken throughout the region.

Artiodactyla (antelope, bighorn sheep, deer, elk)

There are four members of the order Artiodactyla in the region. They represent the most important wildlife resource in terms of economic value.

Antelope

Antelope are found in three distinct areas of the region, as shown on map 8 in the appendix. All three populations have been reintroduced since about 1950, through a Colorado Division of Wildlife (DOW) transplanting program. The current population in the region is about 430 to 500 animals. Only the population between Grand Junction and Delta has been opened to hunting since it was reestablished, and for the past two years this hunting has been restricted to archery only. Populations

TABLE R2-29

PROPOSED ENDANGERED AND PROPOSED THREATENED PLANTS IN THE ES AREA

Proposed Endangered	Proposed Threatened
Arabis gunnisoniana	Astragalus wetherillii
Arabis oxylobula	Cryptantha elata
Astragalus linifolius	Sullivantia purpusi
Astragalus lutosus	
Astragalus microcymbus	
Astragalus naturitensis	
Cryptantha aperta	
Festuca dasyclada	
Echinocereus triglochidiatus var. inermis	
Eriogonum pelinophilum	
Penstemon retrorsus	
Phacelia submutica	
Sclerocactus glaucus	
Senecio porteri	
Stellaria irrigua	

Source: Federal Register, vol. 40, no. 127, Tuesday, July 1, 1975; vol. 41, no. 117, Wednesday, June 16, 1976.

TABLE R2-30

WILDLIFE SPECIES AND HABITAT RELATIONSHIPS FOR
WEST CENTRAL COAL REGION

Habitat Type	Acres Habitat	Wildlife Group: Mammals					Reptiles/Amphibians				Birds					Species by type
		T/E a/	Ra	Und	Cmn	Total	Ra	Und	Cmn	Total	T/E a/	Ra	Unc	Cmn	Total	Total
Greasewood	103,950	1		1	18	20	1	8	6	15	1	2	2	13	18	53
Saltbush	277,200	1	2	6	19	28	1	8	5	14	2	1	2	15	20	62
Sagebrush	242,550	1		2	21	24	1	9	9	19	2	3	13	30	45	88
Pinyon/ Juniper	966,250		4	9	40	53		11	9	20	2	3	11	27	43	116
Mountain Shrub	294,500		1	4	28	33		7	6	13	1		24	35	60	106
Coniferous forest	886,500	1	2	4	33	40			3	3		1	29	42	71	114
Aspen	365,000				10	10			2	2			22	34	56	68
Mountain Meadow	129,200			2	25	27		5	12	17			13	18	31	75
Alpine	242,550	1		1	22	24				0			2	12	14	38
Riparian	207,450	1	2	4	23	30		8	14	22	2		30	53	85	137
Agriculture				1	13	14		4	2	6			20	39	59	79
Urban								1	3	4				12	12	16
Aquatic					15	15		2	9	11			54	49	103	129
Habitat Alteration					1	1				0				12	12	13

a/ T/E - Threatened/Endangered; Ra - Rare; Und - Undetermined; Cmn - Common; Unc - Uncommon.

b/ Includes ponderosa pine/Douglas fir 173,250; lodgepole pine 93,500; spruce fir 619,750 = 886,500.

Note: This table is designed to provide a quick overview of the importance of the various vegetative types in the ES region. As such it ignores, as in Birds, the importance of any one habitat type to a specific species; and what the use of the type is, i.e., breeding, migratory, or winter. For more information regarding a specific species the reader is referred to any competent field guide or the Colorado Division of Wildlife Latilong Distribution Studies for mammals, birds, amphibians, and reptiles.

are stable to decreasing, with water and forage resources considered below normal in most of the region.

Bighorn Sheep

Nine distinct populations of bighorn sheep occur in the region (Bear 1973), as depicted on map 7A in the appendix. Historically, bighorn sheep populations have periodically fluctuated throughout Colorado. Until very recently, populations have been on a downward trend, with five herds listed as decreasing and four herds listed as static (Bear 1973). In 1970, the population in the region was estimated at approximately 300 animals.

Mule Deer

Mule deer is the most abundant and economically important big game animal in the ES area. The vast majority of mule deer populations are migratory. Movements are generally from one elevation to another, brought about by seasonal changes and snow conditions. The portion of the region occupied by migratory populations of mule deer is shown on map 8 in the appendix. The major valley bottoms have been excluded, although sparse resident populations are found along major stream bottoms and throughout the irrigated farmland.

Based on DOW population estimates compiled by Data Analysis Units (DAUs), approximately 237,744 (table R2-31) deer occurred in the ES area in 1977. These estimates are made for late winter populations and represent the low point in yearly deer numbers. Although the DAUs and regional boundaries do not match exactly, the DAUs covering this region account for about 30 percent of the mule deer population in the state. Map 10 shows the DAUs. Deer numbers have been increasing for the past several years in the eastern portion of the region, while remaining static along the western portion.

Elk

The current distribution of elk is depicted on map 7 in the appendix. Elk are second only to mule deer in numbers and economic importance in the ES area. They are migratory throughout the region, moving from one elevation to another in response to seasonal changes and snow conditions. DAUs indicate a population of 42,416 (table R2-32) elk in the region in 1977. Map 11 shows DAUs.

PERISSODACTYLA (HORSE)

Wild horses occur in the ES area in the Little Bookcliffs Wild Horse Area (map 7A in the appendix). Established as a result of the Wild Horse and Burro Act of 1971, the area contins approximately 70 head of horses.

Wild horses occur in two additional areas in the southwest portion of the region, Dry Creek Canyon and Spring Creek Basin. Current populations are approximately 17 head in the Dry Creek area and 54 head in the Spring Creek Basin.

OTHER ORDERS

Rodentia (rodents) is by far the most abundant and diverse order in the region, with 36 species reported. Rodent populations tend to fluctuate widely, for reasons which are not well understood.

The requirements of individual species can be quite specific, e.g., beaver require an aquatic environment. On the other hand, some members, such as the deer mouse, are widespread, occurring throughout the region even in areas which have been severely disturbed. Rodent populations are a significant part of numerous food chains and the overall food web of the region. Numerous species of mammals, birds, and reptiles rely on rodents as their primary food source.

Six members of the order Lagomorpha (rabbits and hares) are present in the ES area, including two species of cottontail rabbits (one or the other of which can be found throughout the region). Since 1974, when populations were extremely low, an increase in cottontail populations has been evident. Snowshoe hares and pika are both found above 8,000 feet, the former in spruce-fir forest and the latter on talus slopes.

Fourteen species of Chiroptera (bats) are suspected to occur in the region, but information on local abundance and distribution is often sketchy at best.

One member of Didelphidae, the opossum, has been reported in the Grand Valley near Grand Junction. This species is not native to the area and remains very uncommon.

Four species of shrews (Insectivore) are present in the region, most commonly in riparian or meadow areas.

THREATENED AND ENDANGERED SPECIES

No official critical habitat for mammals has been designated by the U.S. Fish and Wildlife Service within the region under the Federal Endangered Species Act of 1973. The black-footed ferret, a species currently listed by the U.S. Fish and Wildlife Service (USFWS) on the federal endangered list and also listed by the state of Colorado as endangered, may occur in the region. Three unconfirmed sightings of the ferret near Hotchkiss have been reported in recent years, but no confirmed sightings or concrete evidence of ferret has been found in recent times. The DOW has identified no occupied range for this species in the region (DOW 1978). Nevertheless, the area was historic range for black-footed ferrets, which are closely associated with prairie dogs, and there is potential

TABLE R2-31

DEER DATA ANALYSIS UNITS, GAME MANAGEMENT UNITS IN EACH UNIT AND SIMULATED PROJECTION OF POPULATION

					Post-Hunt Population a/		
DAU	Identifier	Rank	Mean 10-Year Kill	DAU Name and Units Involved	1977	1980	1990
D7 b/	WR	1	7,428	White River (Units 11 12, 13, 131, 22,23, 24, 25, 26, 31, 32, 33, 34)	55,440	62,339 c/	NA
D8 b/	SB	8	487	State Bridge (Units 15, 35, 36)	2,797	3,317	NA
D11	BC	26	834	Little Bookcliffs (Unit 30)	8,533	9,744	NA
D12	GM	2	5,819	Grand Mesa (Units 41, 411, 42, 52, 521)	40,024	45,847	NA
D13	MB	18	1,640	Maroon Bells (Units 43, 47)	11,654	14,574	NA
D19	UP	3	4,027	Uncompahgre (Units 61, 62)	45,916	51,199	NA
D20	CR	9	2,496	Crawford (Units 53, 63, 64)	18,985	23,561	NA
D21	WE	25	885	West Elk (Unit 54)	10,545	12,818	NA
D22	TP	27	784	Taylor Park (Units 55, 551)	15,282	16,791	NA
D23	LA	33	422	LaSal (Unit 60)	5,144	6,481	NA
D24 b/	GH	4	626	Groundhog (Units 70,71)	6,368	8,040	NA
D25 b/	PL	12	1,510	Powderhorn Creek (Units 65, 66, 67)	17,056	18,345	NA
				Total	237,744	273,056	

Source: Colorado Division of Wildlife, Research Center, 1977, Fort Collins, Colorado

Note: Mean 10-Year Kill and Post-Hunting Population columns reflect the percentage of kill and population within the region. NA = Not available.

a/ Simulations reflect only changes due to hunting--does not factor in habitat changes.

b/ Forty-five percent of D7, 19 percent of D8, 18 percent of D24, and 66 percent of D25 are within the region.

c/ All mortality due to hunting is held constant at 1976, or earlier, figures.

TABLE R2- 32

ELK DATA ANALYSIS UNITS, GAME MANAGEMENT UNITS IN EACH UNIT AND SIMULATED PROJECTION OF POPULATION

					Post-Hunt Population a/		
DAU	Identifier	Rank	Mean 10-Year Kill	DAU Name and Units Involved	1977	1980	1990
E6 c/	WR	1	1,614	White River (Units 12, 13, 131, 23, 24, 25, 26, 33, 34)	9,100	9,118	NA
E11 c/	RB	29	53	Roan Bluffs (Units 31, 32)	329	451	NA
E14	GM	5	1,097	Grand Mesa (Units, 41, 411, 42, 52, 521)	11,270	11,281 b/	NA
E15	AC	14	320	Avalanche Creek (Units 43, 471)	3,245	3,991	NA
E16 c/	FP	10	267	Frying Pan (Units 44, 45, 47)	1,261	1,262	NA
E19	GL	31	37	Glade Park (Unit 40)	492	526	NA
E20	UN	20	183	Uncomphagre (Units 61, 62)	2,365	2,370	NA
E21	GR	4	1,124	Gunnison River (Units 63, 64, 53, 54, 55, 551)	7,621	7,254	NA
E24 c/	DC	8	156	Disappointment Creek (Units 70, 71)	1,764	2,485	NA
E25 c/	LF	7	577	Lake Fork (Units 65, 66, 67)	4,969	7,322	NA
				Total	42,416	46,060	

Source: Colorado Division of Wildlife, Research Center, 1977, Fort Collins, Colorado.

Note: Mean 10-Year Kill and Post-Hunt Population Columns reflect the percentage of kill and population within the region.
NA = Not available.

a/ Simulations reflect only changes due to hunting--does not factor in habitat changes.

b/ Simulation was that the population would be leveled at 1976 post-season level.

c/ Forty-seven percent of E6, 70 percent of E11, 50 percent of E16, 24 percent of E24, and 65 percent of E25 are within the region.

for ferrets to occur throughout the region where prairie dogs occur (see map 9 in the appendix).

The DOW also lists three additional species (river otter, wolverine, and lynx) as endangered. Historic range for both lynx and wolverine includes the high boreal forest in the eastern portion of the region. It is possible that lynx and, to a lesser extent, wolverines still occur in the region. Presently the DOW has not identified any occupied range for these species within the region.

The river otter was reintroduced into the Gunnison River through transplants in the fall of 1976 and again in 1977. Fifteen otters have been transplanted to date. Essential habitat is now considered the Gunnison River downstream from Black Canyon of the Gunnison National Monument to Highway 92 and 5 miles up all tributaries (map 9 in the appendix).

Birds

There are seven members of the orders Gaviiformes (loons), Podicipediformes (grebes), and Procellariiformes (tubenoses) that can be found at least occasionally within the region. All are closely associated with water, and their limited occurrence is primarily a result of the limited amount of suitable habitat in the region.

Fifty species from the three orders Ciconiiformes (herons), Gruiformes (cranes), and Charadriiformes (shorebirds) occur within the region. The majority are shorebirds. Members of these orders are heavily dependent on aquatic environments, although some members do make substantial use of upland areas or croplands for feeding and nesting. Many of these species are only present during spring and fall migrations and are closely associated with the major rivers.

The greatest concentration of Anseriformes (waterfowl) occurs in the region during the spring migration period, when virtually all bodies of water are used to some degree for resting and feeding. Of the 29 species of waterfowl occurring in the region, only three (mallard, cinnamon teal, and Canada goose) can be considered common nesters throughout the region. During the winter, there are two major waterfowl wintering areas in the region: the Grand Valley and the Delta-Montrose areas. Within these areas, waterfowl feed extensively on cropland during the morning and evening and rest during the day on the less accessible portions of the main rivers. The species goldeneye and merganser are found almost exclusively along the main rivers where they can find fish and crustaceans, which are the main items in their diet.

Sixteen species of the order Calconiformes (hawks, eagles, and falcons) occur in the region, including one vulture, one harrier, three accipiter, four buteo, two eagle, and four falcon species. The rough-legged hawk, osprey, and merlin occur only during the fall or winter months. The red-tailed hawk is the most common buteo in the region, although the rough-legged hawk is a common winter resident. The golden eagle is found throughout the region. Nest sites are predominantly on cliff faces although occasional tree nests do occur within the region. The kestrel is the most common of the falcons, occurring throughout the region in all habitat types. Prairie falcons are locally common within the region, occurring where cliff faces provide nesting sites adjacent to large green areas used for hunting. Members of this order are important predators, occupying positions at the top of the food chain. Rodents, rabbits, small birds, insects, and carrion are important items in the diet for one or more of these birds of prey.

There are nine members of the order Galliformes in the region. All are classified as upland game birds by the DOW. Five species (chukar, pheasant, Gambel's quail, mountain quail, and white tailed ptarmigan) have been introduced. There is some doubt whether mountain quail have ever become established from releases near Gateway, Colorado. Gambel's quail and ringnecked pheasant are both restricted to agricultural areas or riparian habitat in the lower valleys. Chukar were introduced in the 1950s and have become established in rough canyon lands throughout much of the region below 6,000 feet. White-tailed ptarmigan have been introduced in several alpine areas.

Most if not all wild turkey populations in the area are a result of transplants dating back as far as the 1930s. Populations are scattered throughout the region where mountain shrub and aspen types occur. The Uncompahgre Plateau, Plateau Valley, and North Fork Valley support the greatest populations.

Native grouse make up the last three members of this order. The blue grouse is the most common and widespread, occurring throughout the region above 7,000 feet. The sage grouse and sharp-tailed grouse have not fared as well as the blue grouse. Both species now occur in separated populations; their numbers and areas of occupation have been greatly reduced since European settlement in the region.

Three species from the order Columbiformes are present in the area. Two species (mourning dove and band-tailed pigeon) are classified as game birds, while the third (rock dove) is an introduced species. Mourning doves, summer residents, occur in all but the very highest areas in elevation. This bird is most abundant at lower elevations, nesting in trees or on the ground. Disturbed areas with an abundance of weed seeds or fine gravel will attract Doves. Band-tailed pigeon occur as migrants through the area in the spring and fall and as summer residents.

One member of the order Cuculiformes (the yellow-billed cuckoo), eight members of the order Stigiformes (owls), two members of Caprimulgiformes (goatsuckers), seven members of Aprodiformes (swifts and hummingbirds), and one species of Coraciiformes (belted kingfisher) are present in the area. Eight members of the order Piciformes (woodpeckers and sapsuckers) are present in the region. They are important in determining the presence of other species of birds in the area because they excavate nesting cavities, on which other orders of birds must rely for suitable nesting sites.

The order Passeriformes (perching birds) is a large complex group of 130 species occurring within the region. The order includes insectivorous groups such as flycatchers, swallows, wrens, bluebirds, warblers, and shrikes; herbivorous groups such as grosbeak, finches, and sparrows; and omnivorous groups such as blackbirds, jays, crows, and thrushes.

THREATENED AND ENDANGERED SPECIES

Three species of birds reported in the region, the peregrine falcon, whooping crane, and bald eagle are listed as endangered by both the DOW and USFWS.

Sandhill cranes stop over in the vicinity of Highline Lake and East Salt Wash and may be part of the Grey's Lake (Idaho) nesting population that are being used as foster parents for endangered whooping cranes. These birds migrate between their nesting habitat at Grey's Lake National Wildlife Refuge and their winter range at Bosque del Apache NWR (New Mexico) with intermediate stops at Ouray NWR (Utah) and Monte Vista NWR (Colorado). Foster whooping cranes have been observed at these, and other locations along this route. The region lies in a direct line between Ouray and Monte Vista NWRs.

The only report of whooping cranes came from the Crawford area in the fall of 1975. This bird was with its adopted family of sandhill cranes; it apparently originated from whooping crane eggs placed in a sandhill crane nest in Idaho. Whooping cranes can only be considered rare spring and fall migrants through the region.

The peregrine falcon is still known to nest in the region, although the present numbers and distribution of this bird are greatly diminishing. Two main habitat components are required to support a breeding pair of peregrines: (1) a nesting cliff 200 to 400 feet high, with ledges or potholes to serve as a nest site and (2) extensive hunting habitat. It is not uncommon for hunting areas to extend 10 miles from aeries. Small to medium-sized birds, such as blackbirds, doves, robins, finches, jays, meadowlarks, and pigeons, are common prey in Colorado. Since greatest concentrations of these birds often occur in riparian or aquatic habitat types, these areas are considered extremely important to peregrines. The DOW has classified a number of areas within the region as essential habitat. These areas are a combination of active, inactive, and potential sites which must be maintained to assure sufficient sites for reoccupation if recovery efforts are to be successful, DOW 1978; see map 9 in the appendix).

Bald eagles are quite common during the winter months along the major river bottoms (see map 9 in the appendix). Waterfowl, fish, and carrion are the primary food available to eagles.

Consultation with the USFWS under Section 7 of the Endangered Species Act of 1973 and the Bald and Golden Eagle Protection Act (16 USC 668-668d) will be initiated and completed prior to authorization of any action that may affect a listed species or a golden eagle.

Amphibian and Reptiles

One species of the order Caudata (the tiger salamander) and nine species of the order Salienta (toads and frogs) are found in the region. Twenty-two members of the order Iquamata (lizards and snakes) are present, including eleven snakes and eleven lizards. One subspecies, the midget faded rattlesnake, is also found in the region and is significant because of its limited distribution and scarcity in Colorado. Only two species of Cheloria (turtles) are thought to occur peripherally in the region: the common snapping turtle and the western box turtle.

Invertebrates

A wide variety of invertebrates is known to inhabit the region, although there is little published information on species classification. Major groups of insects found in the region include spiders, ticks, mites, grasshoppers, crickets, ants, gnats, beetles, true bugs, moths, flies, wasps, bees, earwigs, and butterflies.

One species of butterfly, the Nokomis Fritillar Butterfly (*Speyeria nokomis nokamis*), was proposed for study in April 1975 as a possible federally-listed threatened species under the Endangered Species Act. No action has been taken since that date. Colonies of this butterfly are located in Unaweep Canyon and along the Dolores River in Paradox Valley.

Aquatic Biology

There are a large number of rivers, streams, and lakes in the regional area that sustain fish populations and fisheries (see map 1 in the appendix, and map R2-10 in Water Resources). For this analysis, a brief, general description is given for drainages in the region where coal development is not taking place. Specific descriptions are given on those drainage systems whose aquatic life could be impacted by coal development.

Drainages Without Major Coal Developments

The Gunnison River drainage above the confluence with the North Fork of the Gunnison is an area of mountain streams supporting many excellent fisheries for rainbow, brown, brook, and cutthroat trout. The Lake Fork, Taylor River, East River, Tomichi Creek, Gunnison River, Cochetopa Creek, and Cimarron River are among the best trout streams in the state. Blue Mesa Reservoir and Taylor Park Reservoir provide heavily utilized fisheries for rainbows, browns, kokanee salmon, and lake trout. Many high mountain lakes and small streams in the upper Gunnison drainage support excellent brook and cutthroat trout fisheries.

The Uncompahgre River drainage has historically been subject to heavy metal concentrations from mining and from natural mineralization of the area. The trout population is poor, and rough fish dominate the drainage. The San Miguel River and its tributaries support rainbow, brown, and brook trout fisheries in the San Juan Mountains. Downstream from Nucla, irrigation diversions and natural factors change the river to a warm water environment, which supports suckers, dace, chubs, and catfish.

The Dolores River's aquatic environment is characterized by warm water, high turbidity, and high total dissolved solids. Fish populations consist of chubs, suckers, minnows, and channel catfish. Miramonte and Groundhog reservoirs at higher elevations support excellent rainbow trout fisheries.

On Grand Mesa, numerous small lakes and reservoirs hold populations of the major trout species. This area contains one of the largest concentrations of high quality small trout lakes in the state. Many of these are accessible only by trail.

The Roaring Fork River and its tributaries, beginning on Independence Pass above Aspen downstream to Glenwood Springs, is one of the best western trout streams. Excellent populations of large rainbow and brown trout are found in the Roaring Fork. This river is nationally known as an outstanding fly-fishing water. The river also supports a year-round fishery for mountain whitefish.

Drainages With Major Coal Developments

NORTH FORK OF THE GUNNISON RIVER

The North Fork of the Gunnison River from Paonia Reservoir to the confluence with the main stem of the Gunnison River, a length of 33 miles, could be heavily impacted by several major coal developments. The major tributaries forming the North Fork are Muddy and Anthracite creeks. Muddy Creek is a poor fishery characterized by high turbidity and supporting mainly a sucker population. Anthracite Creek is a high quality fishery with a population of about 60 percent rainbow, 12 percent brown, 21 percent brook, and 7 percent cutthroat trout. Anthracite Creek is stocked by DOW with catchable rainbow trout, and a portion of the stream is designated for fly-fishing only.

Water flows in the North Fork are strongly influenced by storage and release in Paonia Reservoir, diversion for irrigation, and irrigation return flow water. Water quality of the river is good in the section above Paonia, but it deteriorates rapidly below Paonia. Significant dewatering occurs below Paonia, and the total dissolved solid content of the water increases rapidly. Sulfate and dissolved iron are high in the lower section of the river also.

In general, the cobbled bottom of the North Fork provides a good substrate, and there is a fairly rich diversity of aquatic life. Major groups of insects are stoneflies, caddisflies, true flies, beetles, mayflies, dragon flies, and true bugs. Numerically, the most abundant groups are the flies, oligochaete worms, and caddisflies. Overall density of organisms averages 950 per square meter. In general the diversity of benthic organisms and densities found indicates relatively good quality of water. The main source of primary production in the North Fork is attached filimentous green algae (cladophora).

The North Fork in the upper part of the valley supports the best fishery habitat. This portion of the river is stocked with catchable-sized rainbow trout, which provide the bulk of the fishery. The fish are stocked during June and July of each year. Brown trout are also taken in the upper section of the North Fork. Downstream from Somerset, the fisheries decline due to poor habitat, and nongame species, including western white, bluehead, flannelmouth suckers, chubs, dace, and sculpins, become dominant. Below Hotchkiss, conditions improve somewhat, and rainbow and brown trout are again found in the river. The river above Somerset supports 140 pounds per acre of fish and is considered to be a good fishery.

CRYSTAL RIVER

The water quality in the Crystal River was historically good but development in the valley has caused the river to decline in quality. Upstream from Redstone, the river suffers due to siltation from periodic flooding and land slides from canyon walls. Road cuts, housing developments, and old mining areas have compounded this problem. Below Redstone, runoff from Coal Basin has damaged the fishery in the Crystal River and the Roaring Fork River farther downstream. In previous years, fugitive dust from the coal mining operations in Coal Basin has collected in the snow cover and in ponds in the basin. During runoff, this material entered Coal Creek and flowed to the Crystal River. Tests by the DOW have shown that rainbow trout were killed in the Crystal River by Coal Creek water. During some runoff periods Coal Creek has been heavily laden with coal dust and the stream water has been virtually black. This has been a recurring problem for many years.

The Crystal River is an important trout fishery. Summer flows range from 80 to 100 cubic feet per second (cfs). The river receives an average of 260 days per mile of fishing use. Fish populations consist of 5 percent whitefish, 10 percent brown trout, 55 percent rainbow trout, 10 percent cutthroat trout, and 20 percent brook trout. DOW stocks 20,000 catchable-sized rainbow trout from Crystal City to the confluence with the Roaring Fork River from June through August each year. The water temperature, fish food supply, and physical habitat limit the river to a moderate fish production.

COLORADO RIVER

The section of the Colorado River subject to impacts stretches from the Utah-Colorado border upstream to Glenwood Springs. It is the state's largest river, and it provides very important habitat for a variety of aquatic life. The habitat changes from cold, clear water around Glenwood Springs to warm, silt-laden water from Rifle to the state line. The main reason for the fairly quick change is the addition of irrigation return flow and the rapid change to a highly erosive landform below Glenwood Springs. During summer runoff, the river carries heavy sediment loads, which limit its use as a fishery.

Aquatic insects in the Colorado River are found at concentrations ranging from 100 to 1,500 insects per square foot. From 8 to 18 major kinds of insects can be found in various river segments. The upper section of river around Glenwood Springs has a bottom fauna made up of 96 percent clean-water species, such as mayflies, caddisflies, and stoneflies.

A cold-water sport fishery is located from Rifle upstream to the headwaters of the river. Rainbow and brown trout are the major species taken by anglers. DOW stocks 2,430 pounds of catchable-sized rainbow trout within the ES area above Rifle in the summer months. Approximately 200,000 2-to-4-inch brown trout were planted between Rifle and Glenwood in 1977. Other species found in the upper section of the river include mountain whitefish, roundtail chub, sand shiner, carp, flannelmouth sucker, bluehead sucker, white sucker, longnose sucker, channel catfish, bullhead, speckled dace, fathead minnow, redfin shiner, carp, green sunfish, and Rio Grande killifish.

As the river passes from Rifle to the confluence with Plateau Creek, the cold-water species gradually become less common and are replaced by warm-water species. Bass, bullhead, channel catfish, and sunfish become the major game fish species, while suckers, carp, and several minnow species become common.

THREATENED AND ENDANGERED SPECIES

Below the confluence with Plateau Creek, the section of the Colorado River extending west to Lake Powell in Utah has been recommended by the USFWS for designation as critical habitat for the Colorado squawfish, *Ptychocheilus lucius*. The squawfish and three other species of warm water fish endemic to this section of the Colorado River are presently considered to be threatened or endangered species. The survival of these species depends upon the Colorado River aquatic environment being maintained in a natural condition.

The Colorado squawfish has recently been collected within the river sections from Plateau to Palisade, from Palisade to Grand Junction, and from Grand Junction to Westwater, Utah (Kidd 1977). This fish has full federal protection under the Endangered Species Act of 1973. The USFWS has recently published the draft of a squawfish recovery plan, which describes procedures necessary to prevent the extinction of the squawfish. This plan includes biological studies, habitat protection, and artificial propagation as needed.

The USFWS has recommended two river segments in or near the ES area to the Secretary of the Interior as critical habitat for the Colorado squawfish. These segments are: (1) the Gunnison River from Whitewater, Colorado, to the confluence with the Colorado River; and (2) the Colorado River from the confluence with Plateau Creek to Lake Powell in Utah.

The significance of an area being designated as critical habitat by the Secretary of the Interior is described in Section 7 of the Endangered Species Act of 1973. This section states that no federal agency or department shall authorize, fund, engage in, or carry out any activity or program which will result in the destruction or adverse modification of a critical habitat. Modifications which diminish the value of critical habitat to a species are prohibited.

The bonytail chub, *Gila elegans*, is a state-listed endangered species that historically occupied the Gunnison River and the Colorado River. The habitat requirements of this species are similar to those of the Colorado squawfish. The known populations of this species have declined, and the species is near extinction.

The humpback chub, *Gila cypha*, is a state- and federally-listed endangered species. In August 1974, 32 humpback chubs were found in the Colorado River below and above Grand Junction. In 1977, they were found in the Black Rocks area of the Colorado River. This is the only known breeding population of this fish, and thus the Colorado River in the ES area is extremely important as habitat for this species.

The razorback sucker, *Xyraucher texanus*, is a state-listed endangered species and a federally-listed threatened species. Its historical range is similar to the previously mentioned species. Specimens have been taken recently in the Gunnison River near Delta and at the DOW Walker Wildlife area in the Colorado River below Grand Junction.

Cultural Resources

Archeological Resources

The archeological resources known to exist in the regional ES area are the result of occupation by various human groups over the past 10,000 years. There is some limited evidence that Folsom-type big game hunters may have used the area, pushing this date back further. The groups of people who occupied west-central Colorado on a continuous basis have been collectively termed the Uncompahgre Complex.

As an archaic stage of development, the Uncompahgre Complex has been defined as a continuous, localized manifestation of human adaptation to the various ecological zones in the area. The presumed level of organization was a band-level society that revolved around seasonal exploitation of the available resources by hunting and gathering.

The results of the west-central Colorado Coal Lease Survey have supported the hypothesis of a hunter-gather economic pattern in this area. Cultural remains were found representative of late Paleo-Indian (8000 B.C.) on through Historic times. Eleven time periods were defined (eight separate periods and three transitional ones) based on Wyoming projectile point typologies (Frison 1974, 1978). Buckles (1971) had previously identified twelve different phases within the Uncompahgre Complex encompassing the same time span. Each phase reflect specific responses and adaptations to outside influences and the changing environment although the hunter-gatherer lifestyle remained comparatively unchanged until the beginning of intensive contact with Europeans. The Uncompahgre Complex is thought by some authors to be the progenitor of the Ute Culture (Buckles 1971).

The physical expression of the various exploitation patterns results in the different types of archeological sites and artifacts found in the ES area. Sites are generally defined by five categories: lithic site, rock shelter, rock art, wickiups, and drylaid masonry. (Figure R2-18A shows a picture rock petroglyph; figure R2-18B shows a wickiup site.) Within these five categories are a number of subtypes which reflect the various activities taking place. Specific artifact types are used to determine the functional basis of a site to to differentiate among the different cultural phases and provide chronological sequences. Certain artifact categories, such as pottery and rock art, often indicate the presence of ideas and influences from outside cultures, e.g., the Anasazi to the south and the Fremont to the north and west.

Although evidence of Anasazi influence is sparse in the ES area (a Puebloan sherd was recovered in the WCCCL Survey) (Hibbets et al. 1978), sites of the Fremont culture have been identified in the northern portions of the region. The Fremont group appeared about A.D. 700 and have been associated with pithouse-like structures and above-ground masonry; they also grew crops, notably corn and squash, while still depending on hunting and gathering. This horticultural lifestyle continued through A.D. 1100, when they returned to an archaic hunting-gathering way of life. (With the data available at this point, it is not known why the Fremont people abandoned horticulture.)

As a part of the studies conducted for this ES, Archeological Associates, Inc., has conducted a sampling inventory on 28,466 acres (28,390 acres--16.20 percent was the contract sample size). The results of this survey include the identification of 90 sites, 158 isolated finds, and the basis with which to predict site occurrence. For a summary of the survey findings and the sampling procedures, see the appendix, volume 3.

Within the ES area there are 1,989 known archeological sites (29 of these are found within three of the site specific lease boundaries) which are the physical expression of the various described phases, as well as some Anglo-historic sites. Approximately 60 of the known sites have been tested or excavated by professional archeologists.

Of the presently known archeological sites in the ES area, 123 may be eligible for the National Register of Historic Places, (71 of which are recommened as part of an archeological district) based on the criteria developed by the Historic Preservation Act of 1966, as amended and 36(CFR): 800.10 (see table R2-33). These sites are under consideration for the Register because they have particular elements or characteristics that contain significant information on human use and adaptation in the area.

Historic Resources

The primary thrust of European settlement in west-central Colorado was along the main rivers, where merchandising and agriculture became the

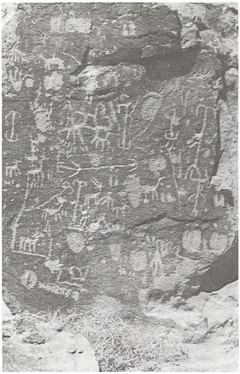


FIGURE R2- 18A "Picture Rock" Petroglyph.

FIGURE R2-18B Wickiup site.

TABLE R2-33

ARCHEOLOGICAL SITES CONSIDERED ELIGIBLE FOR INCLUSION IN THE NATIONAL REGISTER OF HISTORIC PLACES

Site Number	Site Name	Description
5 MN 41	Lee Ranch Wickiup Village	Wickiups
5 MN 43	Sandburg site	Rockshelter
5 MN 596		Lithic site
5 MN 716		Lithic site
5 MN 726		Lithic site
Moore site		Rockshelter/Petroglyph
5 DT 1	Dry Fork Petroglyphs	Petroglyph
5 DT 2	Christmas Rockshelter	Rockshelter
5 DT 216		Lithic site
Tabeguache	Cave II	Rockshelter
Tabeguache	Pueblo	Masonry habitation
5 ME 847		Lithic site
5 ME 848		Rockshelter
5 ME 81		Petroglyph
5 ME 852		Petroglyph
5 ME 854		Petroglyph
5 GF 445		Petroglyph
5 ME 855		Teepee poles
5 GF 452		Rockshelter
5 ME 241		Rockshelter/Petroglyph
5 ME 857		Rockshelter/Petroglyph
5 ME 858	Taylor site	Rockshelter
5 ME 236		Rockshelter
5 ME 227		Petroglyph/Rockshelter
5 ME 217		Rockshelter
5 ME 159		Petroglyph
5 ME 164		Rockshelter/Petroglyph
5 ME 82		Lithic site
5 ME 313		Rockshelter
5 ME 325		Handholes
5 ME 328		Petroglyph
5 ME 329		Petroglyph
5 ME 330		Handholes
5 ME 345		Petroglyph/handholes
5 ME 723		Petroglyph
5 ME 722		Pictograph/Rockshelter
5 GF 168		Petroglyph
5 ME 526		Petroglyph/Pictograph

Note: No archeological sites in the ES region are presently listed in the National Register.

TABLE R2-33

ARCHEOLOGICAL SITES CONSIDERED ELIGIBLE FOR INCLUSION IN THE NATIONAL REGISTER OF HISTORIC PLACES (continued)

Site Number	Site Name	Description
5 ME 535		Rockshelter/handholes
5 ME 306		Pictograph
5 ME 540		Rockshelter/Petroglyph/Pictograph
5 ME 711		Rockshelter
5 ME 710		Lithic site
5 ME 8		Lithic site
5 ME 10		Rockshelter
5 ME 13		Lithic site
5 ME 53		Rockshelter
5 EA 61		Lithic site
5 ME 699		Lithic site
5 GF 332		Pictograph/Petroglyph
5 ME 429		Lithic site
5 ME 430		Lithic site
5 ME 377		Lithic site
5 MN 531		Lithic site
5 ME 206		Historic*
5 ME 207		Lithic*
5 ME 208		Lithic*
5 ME 209		Lithic/Camp*
5 ME 210		Lithic*
5 ME 211		Historic*
5 ME 212		Historic*
5 ME 213		Rockshelter*
5 ME 214		Lithic/Camp*
5 ME 265		Historic*
5 ME 266		Lithic*
5 ME 267		Historic*
5 ME 268		Rockshelter*
5 ME 269		Lithic site*
5 ME 270		Lithic site*
5 ME 271		Lithic/Camp*
5 ME 272		Lithic site*
5 ME 273		Lithic site*
5 ME 275		Lithic site*
5 ME 276		Lithic site*
5 ME 277		Lithic site*
5 ME 278		Isolated Firehearth*

*Site recommended as part of an archaeological district.

TABLE R2- 33

ARCHEOLOGICAL SITES CONSIDERED ELIGIBLE
FOR INCLUSION IN THE NATIONAL REGISTER
OF HISTORIC PLACES
(continued)

Site Number	Site Name	Description
5 ME 279		Petroglyph*
5 ME 280		Rockshelter*
5 ME 281		Lithic site*
5 ME 282		Lithic site*
5 ME 283		Isolated Firehearth*
5 ME 284		Lithic site*
5 ME 285		Lithic/Camp*
5 ME 286		Lithic site*
5 ME 287		Game trap*
5 ME 288		Lithic/Camp*
5 ME 385		Lithic site*
5 ME 386		Historic*
5 ME 387		Lithic site*
5 ME 388		Historic*
5 ME 389		Lithic site*
5 ME 390		Lithic site*
5 ME 391		Lithic site*
5 ME 392		Lithic site*
5 ME 393		Lithic site*
5 ME 394		Lithic site*
5 ME 398		Petroglyph
5 ME 399		Lithic site*
5 ME 400		Lithic/Camp*
5 ME 401		Lithic/Camp*
5 ME 402		Lithic site*
5 ME 403		Lithic/Camp*
5 ME 404		Rockshelter*
5 ME 405		Lithic site*
5 ME 406		Lithic site*
5 ME 407		Rockshelter*
5 ME 408		Lithic site*
5 ME 409		Historic*
5 ME 410		Lithic site*
5 ME 411		Lithic site*
5 ME 412		Lithic site*
5 ME 413		Lithic site*
5 ME 414		Lithic/Camp*
5 ME 415		Lithic site*

TABLE R2- 33

ARCHEOLOGICAL SITES CONSIDERED ELIGIBLE
FOR INCLUSION IN THE NATIONAL REGISTER
OF HISTORIC PLACES
(continued)

Site Number	Site Name	Description
5 ME 416		Lithic site*
5 ME 417		Lithic site*
5 ME 418		Historic*
5 ME 419		Lithic site*
5 ME 420		Lithic site*
5 ME 470		Wickiup*
5 ME 471		Lithic site*
5 ME 472		Lithic/Camp*
5 ME 473		Lithic/Camp*
5 ME 474		Lithic site*
5 ME 482		Historic*

main occupations. In those areas that could not be irrigated, cattle and sheep grazing took place. Coal development and precious mineral extraction caused secondary settlements in the Central Rockies. The key to the rapid development within the ES area in the 1880s was the rail transportation systems that interlaced the entire region.

Mineral exploration moved westward from the front range of the Rocky Mountains during the 1860s. Although little gold was found, silver was discovered in large quantities in the late 1870s, and increasing pressures for mineral development caused settlers to move west over the Continental Divide. During the late 1870s and early 1880s, Crested Butte, which later became a coal mining town, and Aspen were formed. Other mining towns were established during the 1880s. A major consequence of this mining activity was the development of rail transportation into the mining regions.

One of the other major developments in the Roaring Fork and Crystal River valleys was discovery of coal. The first coal seams were developed at Thompson Creek, beginning around 1887. Near Redstone, coal fields were discovered and developed by Charles Osgood, a founder of Colorado Fuel and Iron Company. Farther west, reserves were developed near Newcastle. These coal fields were mined to serve the smelters of Leadville, Aspen, Denver, and Pueblo, as well as to provide fuel for the railroads and towns. The coal seams along the Little Bookcliffs were developed during the 1880s, and by 1890 several mines, including the Cameo Mine, were in production. Most of the major mining in the area died by the mid-1940s due to lack of demand, although several mines have continued limited production to the present.

The Denver and Rio Grande and the Colorado Midland railroads built a new line from Glenwood Springs to Grand Junction in 1892, opening the entire Grand Valley. Settlers moved into the valley and began to farm along the river bottoms of the Colorado River. They discovered that fruit trees grew well, and from Silt to Palisade fruit orchards abounded. Irrigation canals were constructed, and the valley boomed. Grand Junction, founded in 1885 by William Crawford, became the main city of the Grand Valley.

In compliance with Section 2b of Executive Order 11593 (1971), an inventory of historic places in the ES area has been prepared supplemental to the Colorado State Inventory. This inventory is not complete nor does it indicate all historic sites that may be on these lands. The inventory represents the following counties: Mesa, Delta, Pitkin, Garfield, Montrose, Ouray, and portions of Gunnison. (See table E-1 in appendix E for a list of the inventoried sites.) In consultation with the State Historic Preservation Officer, it was determined that the sites listed in table R2-33A are either listed on the National Register of Historic Places or have been determined eligible for the National Register.

Land Use

Of the 9.25 million acres in the ES area, 32 percent is public land administered by the Bureau of Land Management (BLM) and 37 percent is national forest systems land administered by the U.S. Forest Service (USFS). Most of the remaining 31 percent is in private ownership with relatively small areas in state ownership or administered by other federal agencies. Much of the land along the major roads and drainages is in private ownership. The desert lands, foothills, and lower mountains are generally where the public lands are found, while the high mountains and plateaus are national forest systems land. State lands and other federal lands can be found scattered throughout the region. (Table R2-34 contains a summary of land ownership for the ES area.) Most of the land in the ES area is also habitat for many kinds of wildlife.

Agriculture, primarily livestock production, is the traditional land use in the region. The ES area is predominantly rural; even in Mesa County, which has the largest urban population of the seven counties, Grand Junction and the other towns constitute less than 1 percent of the land area.

Over 60 percent of the total regional land area contributes to livestock production either as rangeland or as hay and pasture land. Generally, grazing takes place on public lands in spring and fall, on national forest system land in summer, and on private holdings in winter. During the spring and fall months of the year, the forage utilized on the public lands is essential for the economic survival of the grazing industry in most of the local counties.

Although commercial farming is not the traditional land use of most of the area, it is an important industry in the ES area, contributing more income than livestock production. Crop production is confined to the more level, privately owned portions of the ES area, which are generally in the valley floors. With an average annual precipitation of 8.5 inches for most of the cropland, natural snow and rainfall are inadequate for dryland farming. Crops grown in the area are irrigated by surface water from local runoff. The Colorado, Roaring Fork, Gunnison, and Uncompahgre rivers and their tributaries provide most of this irrigation water. The water is diverted from streams (some water is stored in reservoirs) and applied to fields mainly by gravity flow systems.

TABLE R2-33A

HISTORIC SITES IN THE ES AREA LISTED ON OR ELIGIBLE FOR THE NATIONAL REGISTER OF HISTORIC PLACES

County	Site	Location
Mesa	Convicts Bread Oven	near Molina, Colorado
Garfield	Hotel Colorado	Glenwood Springs
Montrose	D&RGW Trestle	near Montrose
	Ute Memorial	near Montrose
	Gunnison Tunnel (pending)	near Montrose
Gunnison	Crested Butte Townsite	Crested Butte
	Millsite (determined eligible)	Marble
Pitkin	Ashcroft	Ashcroft
	Millsite	Independence
	Pitkin County Courthouse	Aspen
	Aspen Community Church	Aspen
	Armory Hall	Aspen
	Stollard-Wheeler House	Aspen
	Wheeler Opera House	Aspen
	Osgood Castle	Redstone
	Historic District (determined eligible)	Emma
Ouray	Beaumont Hotel	Ouray
	Ouray City Hall	Ouray
Delta	No sites are currently on the Register nor have any been determined eligible to date.	

TABLE R2-34

LAND AREA AND OWNERSHIP

County	Total Acres	BLM		US Forest Service		Other Federal, State, and Private	
		Acres	Percent	Acres	Percent	Acres	Percent
Garfield	1,918,080	695,862	36	513,869	27	708,349	37
Pitkin	622,720	23,665	4	483,745	78	115,310	19
Mesa	2,113,920	981,904	46	545,681	26	586,335	28
Delta	738,561	205,718	28	191,651	26	341,192	46
Montrose	1,432,320	641,415	45	327,924	23	462,981	32
Gunnison	2,071,040	371,859	18	1,265,167	61	434,014	21
Ouray	345,600	38,936	11	126,692	37	179,972	52
TOTAL	9,242,241	2,959,359	32	3,454,729	37	2,828,153	31

Source: Montrose BLM Socioeconomic Data System, 1970 and Grand Junction, BLM Socioeconomic Data System.

Mining is a major industry in terms of employment and income for the ES area. It also produces considerable revenue for federal, state, and local governments under terms of the Mineral Leasing Act. Approximately 65 to 75 percent of production comes from mining claims or leased public land administered by the BLM. The public lands of the ES area are mined for coal, uranium, and vanadium. Common saleable building stone, sand, and gravel are also extracted from the public lands.

The ES area also contains economically significant deposits of natural gas and oil shale. Like coal, these energy minerals are leasable. A great deal of activity is beginning to take place, generally on public lands, in exploration and development of natural gas fields and in the conversion of oil shale to crude oil.

The ES area offers many opportunities for recreation, such as wildlife viewing and hunting, fishing, skiing, and ecologic or geologic interpretion. The management of these resources is mostly under the jurisdiction of three federal agencies, the National Park Service (NPS), USFS, and BLM. The private sector and the municipal, county, and state governments provide additional recreational opportunties and programs. Substantial portions of the region are either wilderness areas or wilderness study areas.

Transportation Networks

HIGHWAYS AND ROADS

The major traffic artery through the ES area is Interstate 70 running east-west through Grand Junction between Denver and Salt Lake City. The section of I-70 between the Utah border and Cameo is an upgraded, four-lane, divided highway. The section between Cameo and Rifle is a narrow, two-lane, paved highway, which is operating much above design capacities, creating bottlenecks along the entire stretch of road. The remaining span of I-70 between Rifle and Glenwood Springs is again an upgraded, four-lane, divided highway, which at the present time is operating below design capacity. Intersections on I-70 are also operating well below capacity. (Figures R2-19 and R2-20 show views of I-70; map R2-11 shows major road systems in the ES area.)

U.S. Highway 50 parallels I-70 from the Utah border to Grand Junction, then dips south through Delta and Montrose and continues east through Gunnison to Pueblo. With increased volumes of traffic, due primarily to both winter and summer recreation pressures, this highway operates above the design capacity during certain periods (e.g., summer holidays and weekends). On a yearly average, the highway does not operate above capacity. The worst section of road lies between Montrose and Gunnison. Although paved, this expanse of highway (approximately 65 miles) is narrow, steep, and winding; there are several fatalities each year.

Colorado 139 between Loma and Rangely, the main north-south route, is lightly traveled (approximately 500 vehicles per day, according to the State Division of Highways) and is currently being used by one coal company. Sheridan Enterprises is currently making 20 to 25 truck trips per day. The road, although somewhat narrow and winding in spots, is suitable for current levels of traffic.

Colorado 13 between Rifle and Meeker has a volume of traffic about one-third that of I-70 (1,850 cars per day). The highway is suitable for present traffic volumes.

Colorado 92 and 133 between Delta and Carbondale has a traffic volume ranging from 1,800 vehicles near Paonia-Somerset to 200 vehicles near the summit of McClure Pass. The section of road between Delta and the Hawksnest Mine (approximately 40 miles) is narrow, with the exception of a 4-mile expanse from Delta to the junction of Colorado 65, which is a four-lane divided highway. However, from that point east to the Hawksnest Mine, the road is two-lane, narrow, and somewhat winding. The next stretch between Hawksnest Mine and Muddy Creek is extremely narrow and winding, with approximately 2.5 miles of unpaved but improved gravel road. The remainder of Colorado 133 over McClure Pass to Carbondale is excellent road, although winding in spots. In the vicinity of Carbondale, Colorado 133 appears to be approaching design capacity.

Colorado 82 between Carbondale and Glenwood Springs is a four-lane, divided highway. It is heavily traveled, with increasing pressure from both winter and summer recreation activities. Anschutz is the only company that is using this highway at the present time.

Colorado 65 begins 4 miles east of Delta, traverses Grand Mesa and ends at the intersection with I-70 about 2 miles east of Cameo. The road receives medium use, about or slightly below its design capacity.

U.S. Highway 550 south of Montrose, Colorado 62, Colorado 145, and Colorado 141 constitute a loop through Ouray, San Miguel, western Montrose, and southwestern Mesa counties. The heaviest traffic occurs on this road between Montrose and Ridgway (approximately 2,700 cars per day). The remainder of the network is lightly travelled road in a sparsely populated area. Tourism accounts for part of the traffic between Montrose and Ridgway. On the rest of the loop most traffic is due to uranium and to oil and gas activity in the area, the expansion of which may increase traffic significantly.

Figure R2-19.

I-70 by Cameo is functioning below design capacity.

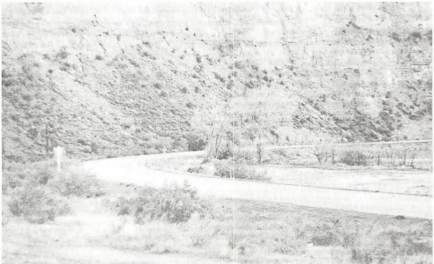
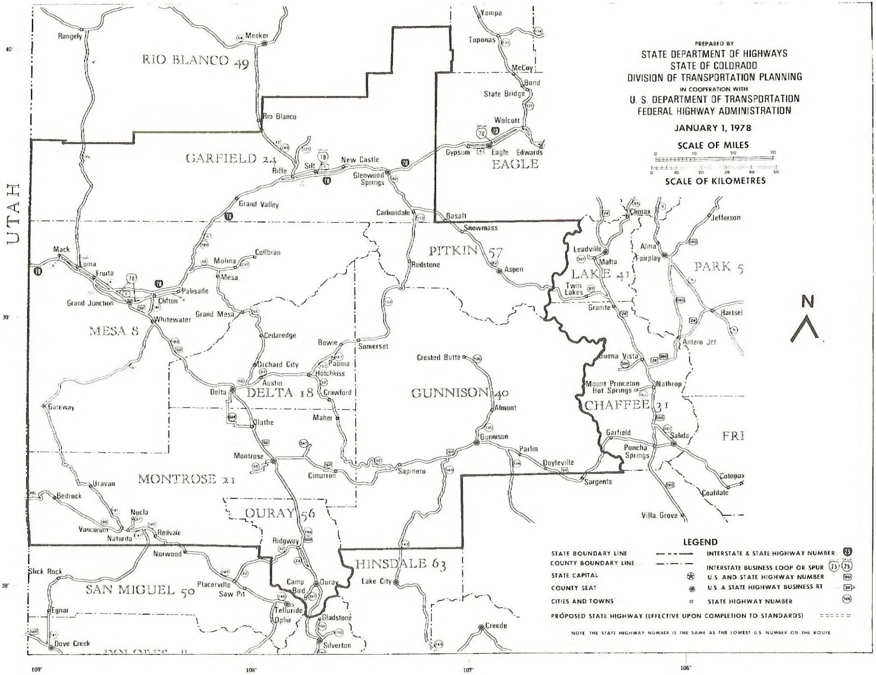


Figure R2-20.

I-70 east of Cameo is operating above design capacity.


PREPARED BY
STATE DEPARTMENT OF HIGHWAYS
STATE OF COLORADO
DIVISION OF TRANSPORTATION PLANNING
IN COOPERATION WITH
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
JANUARY 1, 1978
SCALE OF MILES
SCALE OF KILOMETRES
N
UTAH
RIO BLANCO 49
GARFIELD 24
EAGLE
MESA 8
PITKIN 57
LAKE 41
PARK 5
DELTA 18
GUNNISON 40
CHAFFEE 31
MONTROSE 21
OURAY 56
HINSDALE 63
SAN MIGUEL 50
Rangely
Meeker
Yampa
Toponas
McCoy
Bond
State Bridge
Wolcott
Rio Blanco
Gypsum
Eagle
Edwards
New Castle
Silt
Rifle
Glenwood Springs
Grand Valley
Carbondale
Basalt
Snowmass
Climax
Jefferson
Leadville
Malta
Alma
Fairplay
Mack
Loma
Fruita
Collbran
Molina
Mesa
Redstone
Aspen
Palisade
Clifton
Grand Junction
Twin Lakes
Granite
Hartsel
Whitewater
Grand Mesa
Cedaredge
Bowie
Somerset
Antero Jct
Crested Butte
Paonia
Orchard City
Hotchkiss
Buena Vista
Austin
Delta
Crawford
Mount Princeton Hot Springs
Nathrop
Gateway
Maher
Almont
Olathe
Garfield
Salida
Gunnison
Parlin
Poncha Springs
Montrose
Doyleville
Cimarron
Sapinero
Sargents
Cotopaxi
Coaldale
Uravan
Bedrock
Nucla
Vancorum
Naturita
Redvale
Villa Grove
Ridgway
Norwood
Slick Rock
Placerville
Saw Pit
Camp Bird
Ouray
Lake City
Telluride
Ophir
Gladstone
Creede
Egnar
Dove Creek
Silverton
FRI
LEGEND
STATE BOUNDARY LINE
COUNTY BOUNDARY LINE
STATE CAPITAL
COUNTY SEAT
CITIES AND TOWNS
INTERSTATE & STATE HIGHWAY NUMBER
INTERSTATE BUSINESS LOOP OR SPUR
U.S. AND STATE HIGHWAY NUMBER
U.S. & STATE HIGHWAY BUSINESS RT
STATE HIGHWAY NUMBER
PROPOSED STATE HIGHWAY (EFFECTIVE UPON COMPLETION TO STANDARDS)
NOTE THE STATE HIGHWAY NUMBER IS THE SAME AS THE LOWEST U.S. NUMBER ON THE ROUTE
109°
108°
107°
106°
40°
39°
38°

County roads in the seven-county area provide access from main highways to a major portion of the area. The primary county roads are only lightly used by local residents. These roads are gradually being upgraded from gravelled to paved roads. They serve as trunk lines for numerous branching, private, or undeveloped roads.

The major two-lane state highways in the area (Colorado 82, 92, 133, and 139) are also used as parts of school bus routes. The buses stop on the highways to pick up children, and in doing so stop both lanes of traffic. The routes are generally run between 6:45 and 8:30 a.m. and 3:15 and 4:30 p.m. The delay to other traffic caused by stopped school buses depends upon the timing of the bus run and the highway involved. Data are not available to quantify delays.

More detailed data on existing traffic levels and specific highway capacities in the region are available in the supporting data for the ES and from the Colorado State Highway Department.

RAILROADS

Rail service in the region is provided by the Denver and Rio Grande Western Railroad (D&RGW). The east-west main line of the D&RGW follows the course of the Colorado River through the region, passing through the communities of Dotsero in Eagle County, Glenwood Springs and Rifle in Garfield County, and Grand Junction in Mesa County. Two branch lines leave the main line in the region. One branch parallels State Highway 82 from the main line at Glenwood Springs to Woody Creek, a distance of 33 miles. The other branch parallels U.S. Highway 50 from Grand Junction through Delta to Montrose, a distance of 61 miles. Another line branches off this latter line at Delta. It parallels State Highway 92 to Hotchkiss and State Highway 135 through Somerset before terminating at Oliver. Its total length is 45 miles. (Map R2-12 shows major rail lines in the ES area.)

Rail traffic in the region is comparatively light. The main line averages approximately 10 trains per day in each direction while the Woody Creek branch averages 6 to 8 trains per week (of which 1 is coal). The Oliver branch averages 14 trains per week, which consist of a coal unit train round trip from Colorado Westmoreland to eastern markets and unit train round trips between the U.S. Steel coal mine at Somerset and Wellington, Utah. Only small quantities of general freight move on the line between Delta and Ridgway. These branch lines all operate below their capacity to handle traffic.

The main line which passes through the region is a major element in the D&RGW system. Beginning in Ogden, this line passes through Salt Lake City and Provo, crosses the Wasatch Plateau at Soldiers Summit, then parallels U.S. 6 to Grand Junction. At Dotsero, the east-west main line bifurcates. The northern main line continues to follow the course of the Colorado River and its tributary, Fraser River, to Winter Park. It then crosses the Continental Divide through the 6-mile-long Moffat Tunnel, and passes through at least three more smaller tunnels before entering Denver.

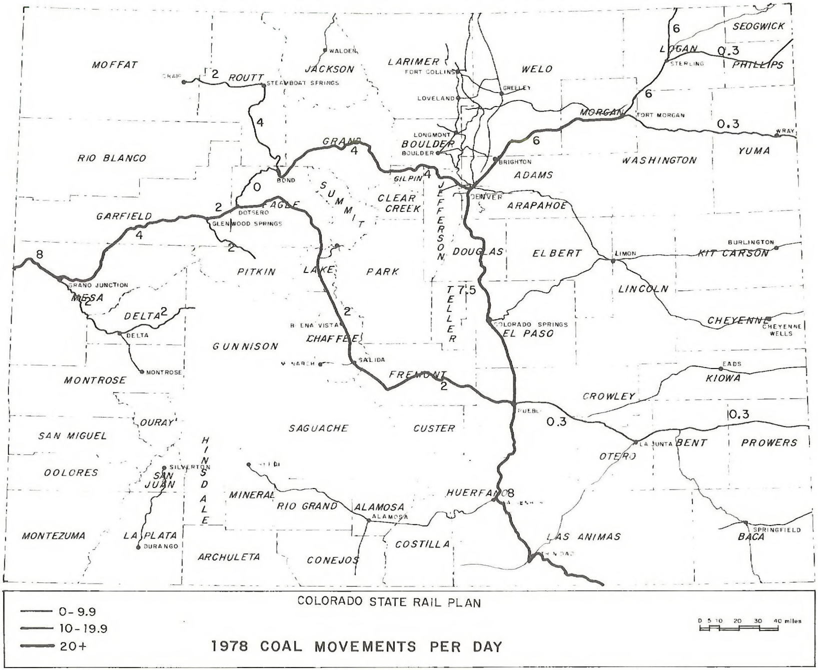
The southern main line follows the course of the Eagle River east from Dotsero, crosses over the Continental Divide in Tennessee Pass, then follows the course of the Arkansas River to Pueblo.

The other major element of the D&RGW system is its north-south oriented main line which is located on the front range of the Rockies between Denver and Walsenburg. Between these two points, this line provides rail service to all major front range cities, including Colorado Springs and Pueblo.

The main lines are generally single track, except for limited stretches at Soldiers Summit and on the front range where the D&RGW line is operated jointly with a parallel line of another railroad as a double track line. These lines operate under Centralized Traffic Control, which maximizes track capacity through efficient train scheduling. As with the branch lines in the region, the main lines operate well below their capacity to handle traffic.

There are certain aspects of the east-west main lines which influence their operation and their capacity to handle additional traffic. The line between Dotsero and Denver follows a rather serpentine course and has short stretches with grades as steep as 2 percent. In the 130 miles between Bond and Denver, there are 22 passing tracks, 15 of which are over a mile in length. Therefore, while trains of 100 cars in length can, and do, operate over this line with additional locomotives, most efficient operations would be restricted to trains about 80 cars in length. It is assumed that the 7 shorter passing tracks would be lengthened to accommodate 100-car trains if traffic demands warrant.

In passing over the Tennessee Pass, the line between Dotsero and Pueblo must surmount a 3 percent grade which is one of the steepest grades on a main line in the United States. Such grades severely limit the trailing load that a locomotive can handle. It has been estimated that a locomotive crossing the Tennessee Pass can haul only 60 percent of the load a locomotive can handle on the steepest grades of the Moffat Tunnel Route. While conceivably trains of 100 cars in length or greater could utilize this route, locomotive requirements tend to limit trains to about half this length. A unit train operation recently instituted from Utah over the Tennessee Pass to eastern destinations consists of 50 cars and 5 locomotives.



COLORADO STATE RAIL PLAN

1978 COAL MOVEMENTS PER DAY

The north-south main line has none of the gradient problems which exist on the east-west main lines. The movement of Wyoming coal to markets in Texas, however, is expected to greatly increase the traffic on this line, thereby limiting its ability to handle additional traffic.

The D&RGW main lines provide a connection between western and midwestern oriented rail operations. In Utah, the D&RGW interchanges with the Southern Pacific, Union Pacific, and Western Pacific. In Denver, it interchanges with the Burlington Northern, Union Pacific, and Rock Island; in Colorado Springs with the Rock Island; and in Pueblo with the Santa Fe and Missouri Pacific. The north-south main line, which is operated jointly with the Santa Fe between Denver and Pueblo, provides the only north-south rail link through this portion of the front range.

The D&RGW system provides the only rail service to many of the existing coal producing areas of Colorado and Utah; as a result coal traffic is a major element of D&RGW operations. The 6.5 million net tons of coal hauled over the D&RGW system west of Grand Junction in 1977 constituted 34 percent of the total net tons hauled in this area. This was accomplished despite the fact that coal only accounted for 22 percent of the total carloads.

Except for the railroad grade crossing of U.S. 50 at Delta, all other crossings in the region are rated at less than 1 accident/5 years. The Delta crossing is rated at 2.5 accidents/5 years (see table R2-35).

AIRLINES AND BUSES

Walker Field (Grand Junction) is presently served by three commercial carriers; United, Frontier, and Trans Western. United Airlines has four flights a day into Grand Junction while Frontier has nine and Trans Western has two . Key Airlines will begin service in January 1979, with one to two flights a day projected.

Walker Field has two runways; 11/29 is 10,500 feet long and 4/22 is 5,300 feet long. Runway 11/29 is used primarily for commercial flights, while Runway 4/22 is used for private airplanes.

The airport has a terminal building that houses the ticketing offices for the carriers as well as rent-a-car companies. A parking area for autos is also located at the airport.

Commercial service to the Montrose County Airport (Montrose), is supplied by Aspen Airways and Frontier. Frontier has four flights a day and Aspen has three. The runway is 8,500 feet long which is only adequate for prop-driven airplanes and smaller private jets. The terminal building contains areas for ticketing agencies and car rental agencies.

No commercial service to the Glenwood Springs Airport now exists. The runway is 3,300 feet long and built strictly for private aircraft.

The Garfield County Airport (Rifle) has no scheduled air service at this time; however, there is a charter service at the airport. The runway is 5,150 feet long and is capable of handling only small aircraft.

The Gunnison County Airport (Gunnison) is presently being served by Aspen Airways and Frontier Airlines. Aspen offers four flights a day and Frontier has three per day. The terminal houses the ticketing agencies, but offers no car rental services (although rentals are available in the downtown area). The existing runway is 7,200 feet long.

No scheduled commercial carriers presently service Blake Field; charter service is available. The existing runway is 4,500 feet. The terminal has car rental available.

Paonia has an airfield with scheduled flights to and from Denver.

Since air traffic in the area is projected to increase over the next twenty years, several airports in the area have either completed or are in the process of completing master plans for expansion.

Walker field has a plan which calls for three stages of development. The first stage would extend runway 4/22 from 5,300 feet to 7,300 feet; the second stage would extend runway 11/29 from 10,500 feet to 13,000 feet, and also construct a new terminal building; the third stage would expand the apron areas and rebuild portions of the taxiway networks. The three stages would be completed by 1990.

Montrose County Airport has completed a master plan that calls for extending the runway from 8,500 feet to 10,000 feet. A new north-south runway is being considered.

Garfield County Airport has plans to extend the present 5,100 foot runway to 8,500 feet and eventually to 10,000 feet. New terminal facilities are planned when commercial service comes into the airport.

The Gunnison County Airport has contracted for a master plan. No data on possible expansion are available.

The Delta County Airport is planning to expand its present runway from 4,500 feet to 6,000 feet. No expansion of the terminal facilities is planned.

Bus service is provided by Continental Trailways. It serves all areas except the North Fork Valley. The buses originate from either Denver or Pueblo.

Agriculture

Agriculture, including both livestock and crop production, provides about 9 percent of the person-

TABLE R2-35

RAILROAD CROSSING/PRESENT ACCIDENT RATES

Highway	Location	Average Daily Traffic	No. of Trains Per Day	Existing Hazard Rating
S.H. 90	Montrose-SW of Rio Grande Ave. (Montrose)	6,950	2	.31 acc./5 yrs.
S.H. 92	Hotchkiss-6.3 mi. W of S.H. 133 (Delta)	2,150	2	.63 acc./5 yrs.
S.H. 92	Hotchkiss-.75 mi. W of S.H. 133 (Delta)	2,600	2	.63 acc./5 yrs.
S.H. 133	Hotchkiss-.5 mi. NE of S.H. 92 (Delta)	1,800	2	.15 acc./5 yrs.
S.H. 133	Bowie-1.0 mi. NE of (Delta)	900	2	.63 acc./5 yrs.
S.H. 133	Bowie-1.5 mi. NE of (Delta)	900	2	.15 acc./5 yrs.
S.H. 133	Bowie-1.9 mi. NE of (Delta)	900	2	.15 acc./5 yrs.
S.H. 133	Somerset-1.0 mi. E of (Gunnison)	550	2	.15 acc./5 yrs.
S.H. 133	Carbondale-.4 mi. S of S.H. 82 (Garfield)	3,250	2	.63 acc./5 yrs.
S.H. 139	Loma-.03 mi. S of S.H. 6 (Mesa)	550	6	.15 acc./5 yrs.
I-70	Grand Valley-.55 mi. NE of R.R. Ave. (Garfield)	4,700	4	.15 acc./5 yrs.
U.S. 50	Delta-N of-.04 mi. N of S.H. 92	8,050	2	2.50 acc./5 yrs.
U.S. 6	Rifle-at 1st and West Ave.	4,000	4	1.25 acc./5 yrs.
S.H. 65	Delta-E of-.02 mi. N of S.H. 92	2,750	2	.15 acc./5 yrs.

Source: Colorado State Department of Highways.

al income and 12 percent of the total employment in the ES region (table R2-36). On an area basis, however, agriculture constitutes the major regional land use.

LIVESTOCK PRODUCTION

Over 60 percent of the total regional land area contributes to livestock production either as rangeland or as hay and pasture land. Based on the 1977 inventory of cattle, calves, and sheep, there are approximately 200,000 range livestock animal units in the ES area (one animal unit equals one mature cow with calf, five sheep, or the equivalent). This amounts to an annual forage requirement of about 2.5 million animal unit months or AUMs (one AUM is that amount of forage required to sustain one animal unit for one month). Most of this annual forage need comes from private land. Allotted grazing lands administered by the BLM and USFS, while amounting to nearly 5.4 million acres, provide only about 535,000 AUMs or about 20 percent of the annual requirement.

CROP PRODUCTION

Principal crops grown in the ES area are hay, field corn, wheat, barley, sorghum, vegetables, and fruit. Sugar beets, once an important crop, have decreased sharply in production due to the recent closing of the Holly Sugar Refinery in Delta.

As shown in table R2-37, hayland constitutes a substantial portion of the total cropland acreage, both by county and in the region as a whole. Nearly equal to hayland in total acreage is the reported cropland used only for pasture. The production of vegetables and grain crops accounts for about 25 percent of the regional cropland acreage and is concentrated in Delta, Mesa, and Montrose counties. Fruit orchards, lying almost entirely within Delta and Mesa counties, are a relatively small portion of the total regional cropland; however, they are a substantial part (over 90 percent) of the total orchard land in the state.

Compared with livestock production, the acres in cropland are small. Nevertheless, the market value of products sold in each category are more nearly comparable (table R2-38), particularly since the value of much of the hay produced along with some grain and silage is not reported as a cash crop, but rather appears as livestock and livestock products.

PRIME AND UNIQUE FARMLAND

Prime farmland has a certain combination of soil properties, growing season, and moisture supply which favors the production of agricultural crops. In the ES area, an adequate moisture supply generally requires supplemental irrigation. Unique farmland is land, other than prime farmland, which through a similar combination of factors is particularly important for the production of specialty crops such as orchard fruits. Specific criteria for both classifications are contained in 7(CFR): 657.

Prime farmland in Colorado is being identified by the U.S. Department of Agriculture's Soil Conservation Service and Colorado State University through the Important Farmlands Mapping Project. Although work within the ES area is not complete, specific soil mapping units which qualify as prime farmland if irrigated have been identified within certain formal soil survey areas. These survey areas are shown on map 21; general areas of irrigated cropland are indicated on maps 22 and 23 in volume 3. Table R2-39 summarizes the acreages which qualify as prime farmland based on soil properties. Irrigated cropland cannot be equated with prime farmland since not all irrigated land qualified in terms of soil properties. Similarly, the figures in table R2-39 are in error to the extent that some qualifying soil mapping units are not or cannot be irrigated. This error is thought to be significant only in the Mesa County Survey Area where 4 percent of the area has appropriate soil properties, yet only about 0.1 percent of the area is actually irrigated.

No acreage figures are yet available for unique farmland. However, much of the orchard land in the ES region qualifies as prime, thus preempting the unique classification. The rest of the orchard land would be classified as unique farmland. This is particularly true in the Grand Junction Soil Survey Area. Some orchard land in the Paonia Survey Area is probably too steep or stoney to qualify as prime farmland and would thus be classed unique.

Recreation

The ES area offers many opportunities for traditional activities, such as wildlife viewing and hunting, fishing, and skiing, as well as human-interest activities, such as ecologic or geologic interpretion. The management of these resources is mostly under the jurisdiction of three federal agencies, the NPS, USFS, and BLM. The private sector and the municipal, county, and state governments provide additional recreational opportunities and programs. (Map 15 shows recreational resources and map 16 shows recreational facilities; both maps can be found in the appendix.)

WILDERNESS AND PRIMITIVE VALUES

The region offers substantial acreage which is either designated or being studied for wilderness status. The USFS has three wilderness areas in the region. The Gunnison National Forest contains the West Elk Wilderness (61,412 acres); the White River National Forest contains the Maroon Bells-Snowmass Wilderness (71,060 acres) and the Flat

TABLE R2-36

AGRICULTURAL INCOME AND EMPLOYMENT

County	Agricultural Employment Percent of Total Employment	Agricultural Income Percent of Total Income
Delta	32	22
Garfield	13	1
Gunnison	10	4
Mesa	9	7
Montrose	18	18
Ouray	NA a/	8
Pitkin	6	-1
ES Area	12	9

a/ Not available

TABLE R2-37

CROPLAND ACREAGE

County	Orchards	Hay	Pasture	Other a/	Total Cropland	Irrigated Cropland
	(all figures in acres)					
Delta	6,728	24,388	23,967	25,581	80,664	68,994
Garfield	81	33,495	21,847	10,039	65,462	48,749
Gunnison	-	34,434	18,952	5,341	58,727	49,020
Mesa	4,027	34,828	40,942	29,106	108,903	83,642
Montrose	419	28,714	32,146	35,012	96,291	75,849
Ouray	-	12,698	14,110	1,020	27,828	15,218
Pitkin	1	5,656	10,944	165	16,766	9,113
7-County Region	11,256	174,213	162,908	106,264	454,641	350,585

Source: U.S. Department of Commerce, Bureau of the Census, 1977; 1974 Census of Agriculture.

a/ Includes those acreages used for production of corn, wheat, sorghum, barley, sugar beets, and vegetables.

TABLE R2-38

MARKET VALUE OF AGRICULTURAL PRODUCTS SOLD (1974)

County	Crops (Incl. Hay)	Livestock and Livestock Products	Total Agricultural Products
	(Thousands of dollars)		
Delta	9,221	9,788	19,082
Garfield	1,214	7,522	8,755
Gunnison	482	4,457	4,970
Mesa	11,761	14,695	27,007
Montrose	8,992	15,034	24,258
Ouray	370	1,172	1,554
Pitkin	69	764	948
7-County Region	32,109	53,432	86,574

Source: U.S. Department of Commerce, Bureau of the Census, 1977; 1974 Census of Agriculture.

TABLE R2-39

PRIME FARMLAND ACREAGE BY SOIL SURVEY AREA

Soil Survey Name	Prime Farmland a/ Acres	Percent of Soil Survey Area
Delta-Montrose Area	111,820	44
Grand Junction Area	79,216	65
Mesa County Area	45,000	4
Paonia Area	42,680	7
Delta Co. portion	36,810	
Gunnison Co. portion	910	
Montrose Co. portion	4,960	

a/ Corresponds to those soil mapping units which would qualify as prime farmland if irrigated; see text for further explanation.

Tops Wilderness (102,124 acres) which is about 80 percent within the ES area. The USFS, through its roadless area review and evaluation (RARE II) program, is currently inventorying all roadless areas over 5,000 acres on national forest system land for possible wilderness status. This program has identified about 2.5 million acres in the region, and determination of future status should be made in 1978. The Uncompahgre Primitive Area (69,253 acres), also on national forest land, is currently a primitive area but may be declassified when the RARE II studies are completed.

The Black Canyon of the Gunnison National Monument has had 11,000 acres, mostly between the canyon rims, designated as wilderness. The Colorado National Monument has had 10,400 acres of its land proposed for wilderness status and is awaiting congressional action. Both of these monuments are managed by the National Park Service.

The BLM also has several areas offering wilderness-primitive values, such as the Powderhorn Primitive Area in Gunnison County. The FLPMA (section 603) directs BLM to conduct an inventory of all roadless areas for wilderness potential; this inventory is currently taking place in the ES area.

Segments of the Gunnison, Colorado, and Dolores rivers within the region may be eligible for special designation according to the Wild and Scenic Rivers Act (PL 90-542, 82 Stat. 906), as amended by PL 93-621, January 1975. A 26-mile section of the Gunnison River, from the upstream boundary of the Black Canyon of the Gunnison to about 1 mile below the confluence with the Smith Fork, has been recommended for wild river status. A segment of the Colorado River, through Horsethief and Ruby canyons near Grand Junction, offers outstanding scenic values and is being studied for designation but no recommendations have yet been made.

There are three segments of the Dolores River within the region for which recommendations have been made. The segment from Little Gypsum Valley to Bedrock has been recommended for wild river status. Due to lack of outstanding values, the segment from the San Miguel River to Gateway was given no status. The segment from Gateway to the state line was also given no status due to its short length (8 miles); however, if combined with the Utah portion, it may be eligible. The U.S. Congress will determine the final classifications sometime in the future; the decision will affect the type of recreation allowed.

RECREATION DEVELOPMENTS AND VISITOR USE

National Park Service

The National Park Service manages three areas within the ES area: Colorado National Monument, Curecanti National Recreation Area, and Black Canyon of the Gunnison National Monument. In 1976, the areas had a combined visitor use of 1,814,442 people, accounting for 4,873,306 visitor hours. Table R2-40 summarizes visitor use.

U.S. Forest Service

The Grand Mesa National Forest is located within the ES area, as are portions of the Uncompahgre, Gunnison, and White River national forests. These areas are major recreation outlets for the region and provided 5,094,900 activity days (12 hours equals 1 activity day) in 1976. Visitor use in fifteen activities is provided in table R2-41 for the portions of the national forests within the ES area. Facilities for downhill skiing are usually privately owned, while the land is leased from the USFS (see Private Recreation below). The roads through the national forests are often the major access to the high country and provide excellent opportunities for driving for pleasure, in both passenger and four-wheel-drive vehicles.

Bureau of Land Management

The BLM provides land and developments for a variety of recreational activities in the region. The Gunnison Gorge Recreation Area (approximately 30,000 acres) straddles the Gunnison River between the Black Canyon of the Gunnison National Monument and its confluence with the North Fork. The area is managed for low intensity, dispersed recreation with developments limited to trail access improvements. The BLM also offers opportunities for camping and picnicking with four roadside parks and nine recreation sites providing 60 camp units and 28 picnic units. Through the special land use permit process, the BLM provides lands for moto-cross, snowmobile, and off-road vehicle activities.

Colorado Division of Parks and Outdoor Recreation

In the ES area, the Colorado Division of Parks and Outdoor Recreation manages seven recreation areas, totaling 7,201 acres of land and 2,272 acres of water: Crawford Reservoir, Highline Lake, Island Acres, Paonia Reservoir, Rifle Gap and Falls, Sweitzer Lake, and Vega Reservoir. The areas all provide camping and boating. Table R2-42 provides a breakdown of visitor use.

Colorado Division of Wildlife (DOW)

The DOW maintains nine wildlife areas, in the region, totaling 23,640 acres. The areas are managed for wildlife habitat; winter range for elk and mule deer is a major concern. The areas are open to the public and provide a variety of recreational opportunities including hunting, fishing, camping,

TABLE R2-40

NATIONAL PARK SERVICE
VISITOR USE 1976

	Black Canyon of the Gunnison National Monument	Colorado National Monument	Curecanti National Recreation Area
Visitors	373,853	704,114	736,475
Visitor Hours	1,020,120	1,519,481	2,333,705
Visitors by Activity:			
Campgrounds	27,233	24,826	102,000
Back-country camping	1,452	182	-
Picnicking	-	30,140	14,430
Boating	-	-	51,835
Fishing	-	-	82,655
Water-skiing	-	-	1,965
Snowmobiling	-	-	225
Hunting	-	-	105
Swimming	-	-	2,880
Miscellaneous (Sightseeing, etc.)	345,168	648,966	480,380

Source: National Park Service 1976.

TABLE R2-41

NATIONAL FOREST VISITOR USE IN 1976
(in thousands of visitor days)

Activity or Facility	Grand Mesa and Uncompahgre National Forests	Gunnison National Forest	White River National Forest a/	Totals
Camping	388.5	335.8	612.0	1,336.3
Picnicking	49.7	24.1	246.3	320.1
Winter Sports	102.1	173.0	575.3	850.4
Recreation on Roads	226.9	104.2	365.7	696.8
Trails	68.4	39.5	256.7	364.6
Water Sports	141.8	72.8	296.2	510.8
Observation Sites	12.9	1.6	16.4	30.9
Organized Sites	25.6	3.6	7.0	36.2
Information Sites	6.2	1.7	0.3	8.2
General Undeveloped	26.8	11.4	604.3	642.5
Hunting	63.4	94.0	-	157.4
Hotels and Lodges	40.8	9.9	46.1	96.8
Recreation Residences	7.5	4.0	22.5	34.0
Gathering Forest Products	3.5	1.5	-	5.0
Mountain Climbing	4.3	0.5	-	4.8
Total	1,168.4	877.6	3,048.8	5,094.8

Source: U.S. Forest Service Resources Inventory Management data.

Note: visitor day = twelve hours of use.

a/ Includes only that portion of White River National Forest in the ES area (i.e., in Mesa, Garfield, Pitkin, and Gunnison counties).

TABLE R2-42

FACILITIES, ACTIVITIES, AND VISITOR USE FOR COLORADO STATE PARKS AND RECREATION AREAS (1976-77)

Facilities, Activities and Visitor Use	Crawford	Highline	Island Acres	Rifle Gap-Falls	Sweitzer Lake	Vega	Paonia	Totals
Park pass required	X	X	X	X	X	X	X	
Camping fee	X	X	X	X	X	X	X	
Dump station	X	X	X	X	X	X	-	
No. of campsites	20	15	32	25	5	110	5	212
Flush or vault toilets	F	F	V	V	V	V	V	
Showers	-	X	-	-	-	X	-	
Group picnic shelters	-	X	X	-	X	-	X	
Picnic shelters	5	2	3	10	15	1	-	36
Nature trail	-	X	-	-	-	X	-	
Hiking	-	-	-	X	-	X	-	
Rock-climbing	-	-	X	X	-	-	-	
Snowmobiling/ski-touring	-	-	-	*	-	X	-	
Motorized trails	-	-	-	-	-	-	-	
Primitive/back-country	-	-	*	*	-	*	*	
Bathhouse	-	X	-	-	-	-	-	
Swimming	-	X	X	-	X	-	-	
Boat ramps	X	X	-	X	X	X	X	
Water-skiing	X	X	-	X	X	X	X	
Boating	X	**	***	X	X	X	X	
Electrical hookups	-	-	-	-	-	-	-	
Land acreage	821	650	135	2,185	73	1,830	1,507	7,201
Water acreage	397	174	4	350	137	900	309	2,271
Elevation (feet)	6,600	4,700	5,000	6,000	5,000	8,000	6,400	
Visitors (July 1976 to June 1977)	65,583	189,826	102,578	109,203	75,064	77,725	15,225	635,204
Percent change (from July 1976 to June 1976)	- 8.1	+ 16.5	+ 4.4	+ 7.2	- 21.2	- 14.8	+ 4.9	

* Facility nearby.
** Boats allowed on Highline Lake; hand-propelled craft only on Mack Mesa Lake.
*** Hand-propelled craft only.

and wildlife observation. The DOW estimated that the areas provide 20,000 hunter days and 15,000 recreation days for nonconsumptive uses.

Colorado Division of Highways

The Colorado Division of Highways maintains five rest stops within the region: Hanging Lake, 8 miles east of Glenwood Springs on I-70; French Creek, 10 miles east of Glenwood Springs on I-70; Glenwood Springs, 1.4 miles west of Glenwood Springs on I-70; Delta-Antelope, 17 miles west of Delta on U.S. 50; and Rifle, at the junction of I-70 and Colorado 13.

Municipal-County Facilities

The facilities most often provided by municipal-county governments are game fields and tennis courts, often within city parks. City parks are located in twenty communities. Cities which provide league activities report that they are well used, e.g., presently Grand Junction must turn people away from its leagues. Many communities use school facilities during off-hours for their recreation programs. See table R2-43 for a listing of municipal-county facilities.

Private Recreation

The region has numerous private recreation areas; most are hunting and fishing areas, campgrounds, or recreation resorts. Downhill skiing is a major industry in portions of the region; the seven ski areas accommodated 2,584,600 skiers in the 1975-76 ski season. (See table R2-44.)

The American (ASC) and the International (ISC) sportsmen's clubs each have a lease site in the region. The Volk Ranch (ASC) contains 2,000 acres and is used primarily for deer and elk hunting. The Peterson Ranch (ISC), 2 miles east of Parlin, contains approximately 1,000 acres along Tomichi Creek and is used for fishing.

Small Game Hunting and Trapping

The region provides opportunities to hunt and trap a wide variety of species. Small Game Management Units (SGMUs) in the region provided hunters and trappers with 264,955 recreation days in 1975. Residents of the state accounted for 97 percent of the small game licenses sold.

Small game hunting in the region provided 228,114 recreation days in 1975. Pheasant and rabbit hunters constituted the largest groups with 8,209 and 11,748 hunters, respectively. The rabbit hunters spent 74,829 recreation days in 1975, over twice the 29,936 recreation days spent by pheasant hunters that year. Duck hunting provided the third largest group of hunters (3,615) and recreation days (27,133).

Trapping in the region provided trappers with 36,841 recreation days in 1975. Coyotes provided the most trapping recreation days (7,593), followed by bobcats, muskrats, and raccoons.

Table R2-45 summarizes small game hunting statistics, and table R2-46 summarizes small game trapping statistics; both are broken down by SGMUs. The locations of SGMUs can be found on map 12 in the appendix. (This information has been summarized from DOW 1975).

Big Game Hunting

Big game hunting for elk, deer, black bear, mountain lion, and big horn sheep in the ES area provided 75,748 license holders with 340,000 recreation days in 1976. Deer and elk were the most hunted species; this combination accounted for over 300,000 recreation days. Big game managements units (GMUs) 42 and 62 were the most used, with 47,252 and 27,859 recreation days, respectively.

The locations of the GMUs are shown on maps 13 and 14 in the appendix. Table R2-47 provides information on hunter numbers and recreation days, broken down by GMU and game type (DOW 1976).

Fishing

The DOW used the 1974 fishing questionnaire to project fishing activity days by county; the projects relevant to the ES area are summarized in table R2-48. This survey indicates that 1,473,039 fishing days (fishing for all or part of a day) occurred in the ES area in 1974. Residents of the state accounted for 78.5 percent of the fishing days. Lakes and streams split the fishing days, with lakes accounting for 50.8 percent of the activity. Gunnison County provided the most fishing days (589,138); Mesa County (265,658) and Garfield County (210,524) followed (DOW 1974).

RECREATION SUPPLY AND DEMAND

The 1974 Colorado Interim Statewide Comprehensive Outdoor Recreation Plan--SCORP (Colorado Division of Parks and Outdoor Recreation 1974) contains a statewide assessment of outdoor recreation and analyses of recreation supply and demand at the state planning region level. The Colorado Division of Parks and Outdoor Recreation (DOP) recommends that the information be used as an indication of recreation trends rather than as an exact description of existing facilities and programs. This recommendation is particularly relevant when the state planning region does not fall completely within the ES area. Information developed for Planning Regions 10 and 11 can be considered representive of those areas within the ES area, while information for Region 12 (with

TABLE R2- 43

MUNICIPAL AND COUNTY FACILITIES

Community	Parks	Recreation Leagues	Swimming Pools	Tennis Courts	Basketball Courts	Game Fields	Golf Course	Fairgrounds Rodeo	Bowling Lanes	Theaters	Other
Aspen	7	X	1	9	-	3	X	-	-	X	Racquetball Club
Carbondale	1	X	-	2	2	2	X	-	-	-	
Cedaredge	1	-	-	1	-	S	-	X	-	-	
Collbran	2	-	-	1	-	S	-	X	-	-	
Crawford	-	-	-	-	-	S	-	-	-	-	
Debeque	1	-	-	-	-	-	-	-	-	-	
Delta	1	X	1	6	S	2	X	X	X	X	Trap Club
Fruita	3	X	1	S	-	4	-	-	-	-	Trap Club
Glenwood Springs	1	X	1	10	-	X	X	-	X	X	Racquetball Club
Grand Junction	11	X	2	14	21	20	X	X	X	X	Go-Cart Track Ski Area Roller Skating
Grand Valley	-	-	-	-	-	S	-	X	-	-	
Gunnison	3	-	-	2	S	S	X	X	X	X	Ski Area
Hotchkiss	1	-	-	S	-	S	-	X	-	-	Roller Skating

TABLE R2-43

MUNICIPAL AND COUNTY FACILITIES
(continued)

Community	Parks	Recreation Leagues	Swimming Pools	Tennis Courts	Basketball Courts	Game Fields	Golf Course	Fairgrounds Rodeo	Bowling Lanes	Theaters	Other
Loma	-	-	-	-	-	-	-	-	-	-	
Montrose	10	X	1	8	S	9	X	X	X	X	Shooting Range Roller Skating
New Castle	-	-	-	1	-	1	-	-	-	-	
Olathe	1	-	-	S	-	S	-	-	-	-	
Orchard City	-	-	-	-	-	-	-	-	-	-	
Palisade	1	-	-	2	1	S	-	-	-	-	
Paonia	1	-	-	2	1	S	-	-	-	X	
Ridgeway	1	-	-	-	-	S	-	X	-	-	
Rifle	4	-	1	-	-	-	X	-	-	-	
Silt	1	-	-	1	-	S	-	-	-	-	
Somerset	1	-	-	-	-	-	-	-	-	-	Community Center
Ouray	1	-	1	2	1	1	-	-	-	X	Handball Court Ski Area (children)

X = Facilities available
S = Public school provides facilities

TABLE R2-44

SKI VISITS TO WINTER SPORTS AREAS IN ES AREA (1974-77)

	1974-75 Skiers	1975-76 Skiers	1976-77 Skiers
White River National Forest:			
1. Aspen Highlands	299,200	320,800	121,400
2. Aspen Mountain	274,400	240,800	106,658
3. Buttermilk	214,400	215,500	92,974
4. Snowmass	568,700	636,800	245,092
5. Sunlight	34,300	44,900	11,143
Grand Mesa-Uncompahgre National Forest:			
6. Powderhorn	43,700	47,200	19,386
Gunnison National Forest:			
7. Crested Butte	231,000	279,000	108,542
Totals	1,665,700	1,785,000	705,195

TABLE R2-45

1975 SMALL GAME HUNTING STATISTICS

	24	54	56	58	60	62	64	66	Totals
Ducks									
Hunters	54	475	171	1,166	111	103	1,286	249	3,615
Rec. Days*	127	2,078	2,111	9,794	589	337	11,120	977	27,133
Geese									
Hunters	-	29	39	423	75	-	180	-	746
Rec. Days	-	142	545	1,950	295	-	1,163	-	4,095
Dove and Pigeon									
Hunters	96	132	36	1,106	160	139	1,155	-	3,190
Rec. Days	215	433	36	6,251	512	537	5,271	1,093	14,348
Turkey									
Hunters	-	38	34	-	-	16	36	-	124
Pheasant									
Hunters	16	-	36	2,021	317	247	5,470	102	8,209
Rec. Days	152	-	181	7,203	1,297	537	19,963	603	29,936
Quail									
Hunters	-	-	-	-	78	-	333	-	411
Rec. Days	-	-	-	-	190	-	960	-	1,150
Chukar									
Hunters	-	-	70	500	98	-	-	-	668
Rec. Days	-	-	350	1,123	312	-	-	-	1,785
Grouse									
Hunters	416	1,516	181	261	104	434	460	830	4,202
Rec. Days	1,132	4,971	436	814	240	1,380	1,209	1,890	12,072
Ptarmigan									
Hunters	-	171	-	7	-	70	28	131	407
Rec. Days	-	303	-	-	-	175	83	349	910
Rabbits									
Hunters	387	1,295	538	3,952	488	1,040	2,861	1,187	11,748
Rec. Days	4,080	6,333	2,516	28,789	2,822	8,815	17,852	3,622	74,829
Squirrels									
Hunters	37	169	37	53	-	68	60	131	555
Rec. Days	73	468	73	225	-	221	563	662	2,285
Fox									
Hunters	-	-	38	38	-	-	101	-	177
Rec. Days	-	-	358	72	-	-	267	-	697
Coyote									
Hunters	63	269	148	386	77	184	352	487	1,966
Rec. Days	277	1,576	676	4,529	268	862	854	3,671	12,713
Marmot									
Hunters	35	367	73	98	-	100	124	346	1,143
Rec Days	105	1,095	219	299	-	513	709	649	3,589

TABLE R2-45

1975 SMALL GAME HUNTING STATISTICS
(CONTINUED)

	24	54	56	58	60	62	64	66	Totals
Porcupine									
Hunters	122	160	140	-	-	98	230	198	948
Rec. Days	887	278	280	-	-	125	1,040	1,450	4,060
Raccoon									
Hunters	-	29	-	-	-	-	64	-	93
Rec. Days	-	119	-	-	-	-	129	-	248
Prairie Dog									
Hunters	100	29	109	550	36	419	814	267	2,324
Rec. Days	570	168	534	4,140	70	3,741	8,454	1,527	19,204
Magpie									
Hunters	-	176	37	352	-	37	348	213	1,163
Rec. Days	-	474	142	5,283	-	4,382	2,075	1,501	13,857
Crow									
Hunters	-	37	-	-	-	103	131	169	440
Rec. Days	-	73	-	-	-	3,383	156	1,591	5,203
Total Rec. Days	7,618	18,511	8,457	70,472	6,595	25,008	71,868	19,585	228,114

Total Hunters: Not provided as hunters may hunt more than one species.

Source: 1975 Colorado Small Game, Furbearer, Varmit Harvest; Colorado Division of Wildlife.

*All or part of a day.

TABLE R2-46

1975 SMALL GAME TRAPPING STATISTICS

	Small Game Management Units 24	54	56	58	60	62	64	66	Totals
Badger									
Trappers	3	10	2	9	3	5	12	2	46
Rec. Days	260	289	103	757	246	310	578	2	2,545
Beaver									
Trappers	21	17	5	17	2	9	30	12	113
Rec. Days	483	394	170	426	43	152	801	747	3,216
Bobcat									
Trappers	9	12	5	30	7	19	25	14	121
Rec. Days	479	619	134	1,918	202	864	1,267	648	6,131
Ringtailed Cat									
Trappers	-	-	-	3	2	-	3	-	8
Rec. Days	-	-	-	310	189	-	120	-	619
Coyote									
Trappers	11	25	7	21	9	16	34	25	148
Rec. Days	320	732	469	2,086	375	530	2,195	886	7,593
Fox									
Trappers	2	5	2	29	-	11	21	7	77
Rec. Days	158	314	25	1,235	-	707	1,134	112	3,685
Marten									
Trappers	-	2	-	-	-	-	2	2	6
Rec. Days	-	68	-	-	-	-	5	2	75
Mink									
Trappers	5	2	-	-	-	-	7	-	14
Rec. Days	155	14	-	-	-	-	468	-	637
Muskrat									
Trappers	25	14	5	32	5	5	4343	30	159
Rec. Days	653	377	73	1,203	157	269	1,723	1,114	5,569
Raccoon									
Trappers	18	12	5	20	5	4	37	9	110
Rec. Days	852	388	128	509	203	167	1,739	180	4,166
Skunk									
Trappers	5	7	2	7	7	7	15	15	55
Rec. Days	156	206	12	144	519	487	636	146	2,306
Weasel									
Trappers	3	2	-	-	-	3	3	-	11
Rec. Days	21	2	-	-	-	156	120	-	299
Trappers (1)									
Total Rec. Days	3,537	3,403	1,114	8,588	1,934	3,642	10,786	3,837	36,841

Source: 1975 Colorado Small Game, Furbearer, Varmit Harvest; Colorado Division of Wildlife.

(1) GMU Trapper totals not provided as trappers may trap more than one species.

* All or part of a day.

TABLE R2-47

COLORADO 1976 BIG GAME HARVEST
FROM: 1976 COLORADO BIG GAME HARVEST, COLORADO DIVISION OF WILDLIFE

Unit	Deer		Elk		Bear		Mountain Lion		Total
	Hunters	Recreation a/ Days	Hunters	Recreation a/ Days	Hunters	Recreation a/ Days	Hunters	Recreation a/ Days	Recreation a/ Days
30	854	3,122	--	--	20	151	9	91	3,364
31	1,413	5,850	98	632	20	135	1	15	6,632
32	1,814	6,492	337	1,616	17	110	1	14	8,232
33	1,699	6,957	2,859	14,347	139	961	7	19	22,284
34	829	3,115	1,895	9,040	79	490	1	7	12,652
40	2,516	9,995	94	204	72	457	3	14	10,670
41	894	3,803	818	4,091	31	176	--	3	8,073
411	325	1,517	415	1,945	6	38	--	--	3,500
42	3,549	14,223	6,468	31,250	224	1,768	1	11	47,252
43	1,237	4,878	1,904	8,508	127	866	--	--	14,252
47	255	1,066	849	4,459	26	203	--	--	5,728
471	108	501	280	1,406	11	73	--	--	1,980
52	903	3,185	867	4,179	19	127	--	--	7,491
521	1,249	4,903	2,845	12,952	129	903	--	--	18,758
53	1,926	7,801	1,501	7,422	190	1,525	--	--	16,748
54	1,091	4,598	2,763	13,646	153	1,173	--	--	19,417
55	833	3,494	3,711	18,239	175	1,120	1	7	22,853
551	347	1,477	1,757	8,636	55	405	--	--	10,518
60	181	938	46	133	15	91	1	6	1,168
61	2,366	10,516	1,047	5,496	154	1,058	--	--	17,070
62	4,239	18,213	1,544	8,543	148	1,103	--	--	27,859
63	615	2,300	278	1,348	30	346	--	--	3,994
64	406	1,878	267	1,419	18	139	--	--	3,436
65	1,901	7,743	2,284	12,039	107	709	--	--	20,491
66	590	2,152	2,109	10,283	67	433	--	--	12,868
67	356	1,239	2,156	13,121	61	506	--	--	14,866
Total	32,496	131,956	38,192	194,954	2,093	15,066	25	187	342,156

Note: Hunter totals for region not provided as hunters may hunt more than one species.

a/ All or part of a day.

TABLE R2-48

FISHING ACTIVITY IN USER DAYS
(1974)

County	Resident Stream	Resident Lake	Total Resident	Nonresident Stream	Nonresident Lake	Total Nonresident	Total Stream	Total Lake	Total Fishing Days
Delta	31,182	106,101	137,283	4,530	22,699	27,229	35,712	128,800	164,512
Garfield	126,416	60,800	187,216	13,975	9,333	23,308	140,391	70,133	210,524
Gunnison	184,567	224,919	409,486	108,725	70,927	179,652	293,292	295,846	589,138
Mesa	76,411	154,185	230,596	8,446	26,616	35,062	84,857	180,801	265,658
Montrose	20,226	17,882	38,108	5,682	3,284	8,966	25,908	21,166	47,074
Ouray	7,304	5,166	12,470	4,530	2,880	7,410	11,834	8,046	19,880
Pitkin	105,908	35,367	141,275	27,258	7,720	34,978	133,166	43,087	176,253
Total	552,014	604,420	1,156,434	173,146	143,459	316,605	725,160	747,879	1,473,039

only Pitkin County within the ES area) may be somewhat less representative.

Demand was determined by conducting random sampling during the 1973-74 season. Telephone interviews provided information for the random resident surveys, while questionnaires and roadside interviews were used to sample nonresident visitors traveling by air and auto. Table R2-49 indicates the demand for 21 types of recreation.

Subsequent to this 1974 SCORP report, the DOP met with county and local officials and planners to revise the supply analysis to reflect what they feel are current needs. The residents of Regions 10 and 11 engaged in bicycling, hiking, game playing, and driving for pleasure as major recreation activities. The local planners feel that there are enough trails and roads for hiking and driving for pleasure, but that the hiking trails are too concentrated, mostly in the national forests and away from population centers. They feel that bicycle trails are needed to get riders off the roads. Additional playgrounds and marked-off fields for games are also needed; such areas are often located within population centers and should provide a convenient recreation resource. Nonresidents most often enjoyed driving for pleasure, camping, picnicking, and hiking in Regions 10 and 11. A need for trailer camp sites and picnic areas closer to main routes was identified. Region 10 planners again identified a need for more dispersed hiking trails.

The most popular activity for residents of Region 12 was downhill skiing, followed by hiking, bicycling, and crosscountry skiing. This perhaps indicates the concentration of ski resorts in the Aspen area. Local planners in the region see a need for additional downhill and crosscountry skiing facilities as well as trails for hiking and bicycling. Wide shoulders are needed on roads to allow for safer bicycling.

The downhill ski industry provided the major recreation outlet for nonresidents in Region 12, followed by driving for pleasure, hiking, camping, and picnicking. The need to maintain existing hiking trails was identified; more trailer sites for camping and accessible areas off main routes for picnicking are also needed.

The information on hunting and fishing in the SCORP report was not used as it is felt that the figures provided by the Colorado Division of Wildlife would be more informative.

Visual Resources

The ES area contains a wide variety of landscape types, each of which displays unique visual attributes. The landscapes of the ES area can be grouped into three major types: river valleys, plateaus, and mountain ranges (see figure 2 in the appendix for an aerial view of these landscape types). Each landscape type has a unique visual character, but all three are composed of subtype landscapes with additional characteristics whose visual attributes can be assessed through the BLM's visual resource management system (see the appendix volume). Based on the criteria land/water forms, vegetation, color, adjacent scenery, and cultural modifications, a landscape is assigned to one of three scenic quality classes: A--outstanding; B--characteristic; C--minimal. The combination of landscape qualities within a region would establish the overall scenic quality of that larger land area.

LANDSCAPE TYPE NO. 1: RIVER VALLEYS

The wide alluvial valleys that border the Colorado, Gunnison, and Uncompahgre rivers are the landscapes primarily affected by the area's 152,000 residents. Roads and railroads follow the rivers, so these valleys are visual foregrounds for the majority of people traveling in west-central Colorado. The mixture of land uses in each valley, combined with adjacent scenery, determines the scenic quality of this landscape type.

Sublandscape Type 1A: Grand Valley

The Grand Valley of the Colorado River runs 100 miles from Glenwood Springs to the Utah border. The valley landscapes, which are bounded by the White River, Roan, and Uncompahgre plateaus and by Grand Mesa, are predominantly wide expanses, narrowing only at DeBeque Canyon, where 500 foot cliffs confine the Colorado River and adjacent I-70.

From Glenwood Springs down through DeBeque Canyon, large cottonwood trees along the water course add green and gold colors to the canyon environment. Other vegetation is scattered among the rock cliffs on taluses or in adjoining canyon lands and adds more shades of green or russet, depending on the season.

DeBeque Canyon itself has been altered by the D&RGW Railroad, water control dams, traffic interchanges, the Cameo power plant, and the nearby Roadside Coal Mine. However, the visual quality of the canyon is primarily determined by the immense rock cliffs and presence of the Colorado River, which have earned the canyon's scenic quality B rating.

West of DeBeque Canyon, the lands around Grand Junction (1977 population of 25,398), Clifton, and Palisade are predominantly urban and residential. The resultant scenic quality class C reflects the extensive cultural modification of the natural landscape. The Little Bookcliffs form the northern edge of the valley and sharply define the horizon line.

Westward toward Fruita, Loma, and Mack, the landscape has a pastoral character that derives

TABLE R2-49

RECREATION PARTICIPATION IN REGIONS 10, 11, AND 12 (1976)

Activity	Recreation Participation in Region 10 (in activity days a/)				Recreation Participation in Region 11 (in activity days a/)				Recreation Participation in Region 12 (in activity days a/)			
	Region	Region per 100 Residents	Nonregion	Total	Region	Region per 100 Residents	Nonregion	Total	Region	Region per 100 Residents	Nonregion	Total
Hiking	1,208,965	2,498	3,403,005	4,611,970	2,234,427	2,565	895,547	3,129,974	3,151,944	8,683	5,025,586	8,177,530
Horseback riding	528,922	1,093	334,983	863,905	205,092	235	626,072	831,164	604,483	1,665	529,116	1,133,599
Bicycling	2,882,086	5,955	81,945	2,964,031	4,047,874	4,647	118,507	4,166,381	2,288,398	6,304	265,853	2,554,251
Motorcycling	237,475	491	354,190	591,665	593,688	682	153,095	746,783	172,709	476	161,570	334,279
Sightseeing	712,426	1,472	4,166,330	4,878,756	939,107	1,078	2,722,667	3,661,774	183,504	506	7,679,417	7,862,921
Off-road vehicles	269,858	558	1,270,663	1,540,521	237,475	273	439,902	677,377	151,120	416	1,462,798	1,613,918
Swimming	345,419	714	187,336	532,755	1,133,405	1,301	597,663	1,731,068	582,984	1,606	1,333,326	1,916,310
Picnicking	367,007	758	1,939,547	2,306,554	593,588	692	925,315	1,518,903	151,120	416	2,683,942	2,835,062
Camping	323,830	669	2,138,980	2,462,810	302,241	347	1,508,283	1,810,524	151,121	416	4,166,504	4,317,625
Boating and rafting	0	0	274,666	274,666	356,213	409	137,776	493,989	280,652	773	386,173	666,825
Game playing	680,043	1,405	55,831	735,874	1,349,292	1,549	107,546	1,456,888	302,242	833	515,272	817,514
Tennis	32,383	67	30,350	62,733	194,298	223	8,589	202,887	205,092	565	375,673	580,765
Golf	149,326	290	21,473	161,799	356,213	409	60,356	416,569	53,972	149	369,330	423,302
Target shooting	21,589	45	0	21,589	21,589	25	0	21,589	0	0	91,078	91,078
Downhill skiing	129,532	268	148,982	278,514	248,270	285	192,951	441,221	3,173,533	8,743	11,033,324	14,206,857
Cross-country skiing	183,504	379	51,832	235,336	0	0	10,794	10,794	669,249	1,844	751,218	1,420,467
Snowmobiling	129,532	268	12,884	142,416	151,121	174	43,177	194,298	183,504	506	207,561	391,065
Sledding and tubing	183,504	379	337,930	521,434	356,213	409	0	356,213	273,475	753	143,457	416,932
Ice skating	75,560	156	0	75,560	53,972	62	0	53,972	485,745	1,338	122,433	608,178
Other	237,475	491	643,494	880,969	442,568	508	395,224	837,792	863,355	238	448,965	535,320
Total	8,689,436	-	15,454,421	24,143,857	13,816,646	-	8,943,514	22,760,160	13,151,202	-	37,752,596	50,903,798

Source: Colorado Division of Parks and Outdoor Recreation, 1976 Colorado Comprehensive Outdoor Recreation Plan.

a/ All or part of a day.

from a mixture of open rangeland, cultivated fields, irrigation ditches, and dispersed residential areas. The fields, fences, roads, ditches, and power lines overlay the historic grid pattern of land ownership, creating a strong linear pattern on the valley landscape. The southern boundary of the valley is defined by the cliff faces of the Uncompahgre Plateau.

Sublandscape Type 1B: North Fork Valley

The North Fork of the Gunnison River has cut a valley along the southern edge of Grand Mesa from Somerset to Delta. At its eastern end, which is predominantly scenic quality class B, the valley is narrow, winding, and V-shaped, with only small pockets of development on the intermittent flatlands. Townsites at Somerset, Bowie, and Paonia alternate with old and new mine sites, such as the Bear Mine and the Orchard Valley Mine, dominating the landscape character with residential, commercial, and industrial zones, power lines, and road networks.

The valley opens up as it progresses west. Orchards and cultivated croplands spread through an angular grid of trees, fields, ditches, and fence lines on the lands adjoining the river. The landform becomes a wide, open area as it nears Delta, where to the north a band of adobe badlands separates the valley from the base of Grand Mesa.

All along the valley, among the urban, industrial, and agricultural land uses, there are mountain landscapes bordering on Highway 133 and the North Fork River. These interruptions of the valley's development pattern create a natural landscape along certain highway segments, which is emphasized by marked vegetation transitions. The sages and grasses of the lower elevations are replaced by pinyon-juniper cover at higher elevations by fir, spruce, and mountain shrub at the highest, wettest elevation. The variety of vegetation creates strong edge lines between plant communities which help establish landscape diversity.

LANDSCAPE TYPE NO. 2: PLATEAUS

Much of the landscape in the ES area is dominated by plateaus: the Roan and White River plateaus to the north, the Uncompahgre Plateau to the southwest, and Grand Mesa in approximately the center of the region. These large land masses along the valley corridors establish horizon lines and delimit the valley spaces for viewers in the valleys. The abrupt cliff faces of the plateaus also mark the boundaries of vegetation zones. The higher elevations of the plateaus receive more rainfall and therefore have a heavier vegetation cover.

Land uses on the plateaus include varied forms of agriculture and recreation. Roads and fencing are extensive, and there are modifications from older mines, residences, and ranching operations. Nevertheless, the plateau landscapes remain essentially unaltered with dense vegetative cover and expanses of natural landscapes.

LANDSCAPE TYPE NO. 3: MOUNTAIN RANGES

The eastern boundaries of the ES area are the Sawatch Mountain Range and the West Elk Mountains. The high elevations receive sufficient moisture to provide runoff for streams and lakes and to support the denser forests on the mountain slopes. The topographic extremes of the valleys and peaks and the presence of water create a landscape character that contrasts strikingly with the nearby plateaus and river valleys.

REGIONAL VISUAL QUALITY

The diversity of three major landscape types: river valleys, plateaus, and mountains, found within a few hours drive, establishes a high level of visual stimulation and scenic quality. The predominance of natural landscapes is the key to the general appeal of these west-slope landscapes for recreation and as a daily, residential environment. The restricted landscape disruption of the natural environment also adds to the local quality of life, which is primarily rural; urban developments are modest in scale and widely separated, which supports the nautral character of the regional landscapes.

Socioeconomic Conditions

The following information was gathered to provide a base from which to analyze the impacts on the economic and social institutions within the ES area. It was gathered through a series of interviews with public officials and planning officers of the various governments involved. Emphasis will be given to the areas that will receive the majority of the impacts from the proposed action or from the scenarios and alternatives in chapter 8.

Demography

The seven counties in the ES area contain 30 incorporated towns. The principal population centers are Grand Junction, Montrose, Gunnison, Glenwood Springs, and Delta. Table R2-50 lists the population of each county, town, and county census area; table R2-51 provides other population figures for the ES area. Map 17 in the appendix outlines the county census areas for which population census information is available. Figure R2-21 shows the population by age group (1970).

Mesa County and the Grand Junction area are the commercial center for most of western Colorado and parts of eastern Utah. Grand Junction has become the regional headquarters for industry and government agencies involved in the development of the area's energy resources, including oil, natu-

TABLE R2-50

TOTAL POPULATION
(By County, Incorporated Place, and Census Divisions)

	1970	1975	Percent Change (1970 to 1975)	1977	Percent Change (1970 to 1977)
Delta County:	15,286	17,484	14	18,949	24
Cedaredge	581	782	37	966	66
Cedaredge Area	2,992			4,347	45
Crawford	171	198	16	261	53
Delta	3,694	3,632	-2	3,705	0
Delta Area	7,201			8,290	15
Hotchkiss	507	554	9	728	43
Hotchkiss Area	2,684			3,499	30
Orchard City	1,163	1,327	14	1,815	56
Paonia	1,161	1,331	15	1,276	10
Paonia Area	2,409			2,813	17
Garfield County:	14,821	17,906	21	18,800	27
Carbondale	726	1,128	55	1,644	46
Glenwood Springs	4,106	5,351	30	4,091	0
Glenwood Springs Area	8,729			11,109	27
Grand Valley	270	304	13	377	40
Grand Valley Area	819			858	5
New Castle	499	740	48	543	9
New Castle Area	1,976			3,278	66
Rifle	2,150	2,016	-6	2,244	44
Rifle Area	3,297			3,555	8
Silt	434	602	38	859	98

Source: U.S. Bureau of the Census, 1970 Population Census, 1975 Population Estimates for Counties and Incorporated Places, and 1977 Special Census for Delta, Garfield, and Mesa Counties.

TABLE R2-50

TOTAL POPULATION
(By County, Incorporated Place, and Census Divisions)
(continued)

	1970	1975	Percent Change (1970 to 1975)	1977	Percent Change (1970 to 1977)
Gunnison County:	7,578	9,105	20		
Crested Butte	372	868	133		
Crested Butte Area	463				
Gunnison	5,111	5,639	10		
Gunnison Area	6,735				
Marble	13	16	23		
Mt. Crested Butte	13	112	761		
Pitkin	44	69	56		
Sapinero Area	116				
Somerset	264				
Mesa County:	54,374	62,474	15	66,848	70
Clifton Area	3,554			5,913	66
Collbran	225	211	-6	293	39
Collbran Area	1,428			1,364	-4
De Beque	155	276	78	264	70
De Beque Area	306			427	40
Fruita	1,822	2,145	18	2,328	28
Fruita Area	5,837			7,709	32
Gateway Area	817			797	-2
Grand Junction	24,043	27,729	15	25,398	6
Grand Junction Area	28,527			35,871	26
Orchard Mesa Area	6,890			5,012	-27
Palisade	874	883	1	1,038	19
Palisade Area	1,964			2,178	10
Redlands Area	4,446			6,826	53
Whitewater Area	605			751	24

TABLE R2-50

TOTAL POPULATION
(By County, Incorporated Place, and Census Divisions)
(continued)

	1970	1975	Percent Change (1970 to 1975)	1977	Percent Change (1970 to 1977)
Montrose County:	18,366	20,651	12		
Montrose	6,496	7,694	18		
Montrose Area	11,353				
Naturita	820	965	18		
Nucla	949	891	-6		
Naturita/Nucla Area	3,960				
Olathe	756	796	5		
Olathe Area	3,053				
Ouray County:	1,546	1,810	17		
Ouray	741	844	14		
Ridgway	262	302	15		
Pitkin County:	6,185	8,765	42		
Aspen	2,437	3,346	37		
Study Area	118,156	138,195	17		
State of Colorado	2,209,596	2,541,000	13		

TABLE R2-51

POPULATION STATISTICS FOR THE ES AREA

Area	Population Density (persons per square mile)		Median Age		Births and Deaths (1970-1976) d/			Net In-Migration (1970-1976) d/		Median School Years Completed (1970)
	1970 a/	1975 b/	1970 a/	1977 c/	Births	Deaths	Net Change	Total Persons	Percent of Total Population	
Delta	13	15	39.6	35.2	1,400	1,300	+ 100	3,800	24.6	11.9
Garfield	5	6	30.0	28.4	1,700	900	+ 800	3,400	22.7	12.2
Gunnison	2	3	35.5	-	700	200	+ 500	700	9.8	12.7
Mesa	16	19	30.2	29.4	5,500	3,600	+ 1,900	9,200	16.9	12.3
Montrose	8	9	29.1	-	1,800	1,100	+ 700	2,200	12.1	12.1
Ouray	3	3	31.2	-	200	100	+ 100	400	24.8	12.2
Pitkin	6	9	27.0	-	700	200	+ 500	2,900	46.1	14.4
Study Area	-	-	28.7	-	12,000	7,400	+ 4,600	22,600	19.1	-
Colorado	21	24	26.2	-	248,000	111,000	+ 137,000	237,000	10.7	12.4

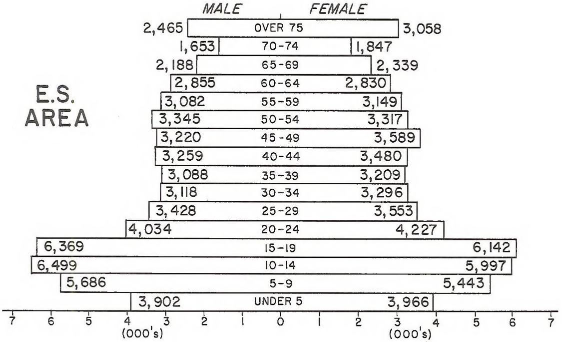
Sources:

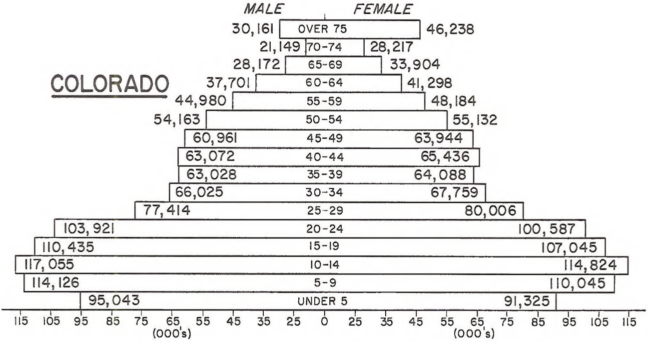
a/ U.S. Bureau of the Census, General Population Characteristics, 1970 Population Census.

b/ U.S. Bureau of the Census, Population Estimates and Projections (May 1977).

c/ U.S. Bureau of the Census, Special Census (April 1977).

d/ U.S. Bureau of the Census, Population Estimates (July 1977).





(SOURCE: US BUREAU OF THE CENSUS, 1970, POPULATION CENSUS)

Figure R2-21 Population by age group in Colorado and the ES area ral gas, coal, uranium, and oil shale. The eastern portion of Mesa County, in the vicinity of DeBeque, has experienced growth due to the location of the Occidental oil shale test retort on a site along Roan Creek.

The eastern portion of the Grand Valley in Garfield County has also felt some growth pressure from the oil shale industry. The towns of Grand Valley, Rifle, Silt, and New Castle have traditionally served as commercial centers for the agriculture community in the area. Some of their recent growth can be attributed to the construction activity on Interstate 70 through the Grand Valley area. Glenwood Springs serves as a commercial center for Garfield, Pitkin, and a portion of Eagle counties, as well as a year-round recreational center. The town of Carbondale in Garfield County has been one of the fastest growing towns in western Colorado over the past five years. Its growth has stemmed from the expansion of coal mining in the Crystal River Valley and from ski industry growth in Pitkin County. Carbondale has been designated by the state government as one of five communities in the state experiencing significant population increases due to the expansion of the energy resource industry.

The only urbanized area in Pitkin County, Aspen, is recognized internationally as a ski resort. The boom in the ski industry has transformed Aspen from a mining town to an area centered almost entirely on a recreational economy.

In Gunnison County, the towns of Crested Butte and Mt. Crested Butte are also very much involved in the ski industry. Crested Butte is a historic mining town, which has preserved its Victorian setting through a strict architectural code. The town of Gunnison, the county seat, is a commercial center for the agricultural and recreational industries in the Gunnison River Valley. Gunnison is also the home of Western State College, which has contributed some growth to the area in recent years.

Ouray County continues to attract large numbers of summer tourists to its scenic mountain environment. The metals mining industry, which was the original impetus for development in the area, continues to decline.

Montrose County has experienced population growth primarily because the city of Montrose has continued to expand as a commercial center for much of Montrose, San Miguel, and Ouray counties. Montrose has attracted a relatively high number of professionals, especially doctors and attorneys, and it has experienced significant growth in government employment. The western part of Montrose County, including the communities of Uravan, Nucla, and Naturita, is experiencing a resurgence in the uranium industry, triggered by higher prices for uranium. After a postwar boom, this area experienced a decline due to the decline in the market for uranium.

Delta County has the strongest agricultural orientation in the ES area, although its agricultural base has been declining in recent years. However, it seems that any agricultural population loss has been more than supplemented by an increase in coal mining and an in-migration of retired and other persons who are attracted by the area's climate and lifestyle.

The concentration of persons in the older age groups in the ES area is reflected by the median age of 28.7 years compared with a statewide median age of 26.2 years at the time of the 1970 census. It should be noted that the median age was lower in 1977 than in 1970 for all three counties included in the special population census. The low percentage of persons in the 20 to 30 age group implies an out-migration of young adults upon completion of high school. However, indications are that young, well-educated people are migrating into the area, often taking significant decreases in personal income to enjoy the area's climate, scenery, and casual lifestyle. Tables R2-50 and R2-51 show that most of the growth in the area since 1970 has resulted from people migrating into the area.

Family stability, as measured by marriage and divorce rates, varies greatly among the counties in the region. All of the counties but Ouray have more marriages per thousand than the state average. Garfield, Mesa, Montrose, and Pitkin counties all have dissolution rates higher than the state while Delta, Gunnison, and Ouray rates are all lower. The regional average is higher than the state in both respects. This indicates that there are more people in the area marrying but that more people are separating than in the state as a whole. The agricultural counties in the region tend to have lower dissolution rates than the more urbanized counties. Numbers of marriages, dissolutions, and rates per 1,000 total population for 1975 are shown in table R2-52.

Community Attitudes

Most of the research which has been done in recent years concerning the attitudes of residents in the ES area towards their community has reached similar conclusions. Most residents consider the environmental quality and the rural lifestyle of the area to be its principal assets. Many of the residents have indicated that these factors were the main stimulus for their migrating to the area and that job opportunities and economic gain were secondary.

A number of opinion surveys and attitude research studies have been performed over the past few years in the area. Most of these have been

TABLE R2-52

REGIONAL MARRIAGE AND DISSOLUTON RATES
PER 1,000 POPULATION (1975)

County	Marriages		Dissolutions	
	Number	Rate	Number	Rate
Colorado	27,565	10.6	15,733	6.0
Region	1,578	11.6	941	6.9
Delta	179	10.9	94	5.7
Garfield	210	11.8	124	7.0
Gunnison	101	11.6	37	4.3
Mesa	698	11.1	475	7.6
Montrose	191	10.2	122	6.5
Ouray	16	8.9	7	3.9
Pitkin	183	17.8	82	8.0

Source: Colorado Department of Health, Statistics Unit.

attempts to determine residents' concerns about development of the area in general, and specifically the development of the oil shale and coal resources.

One study (Bickert, Browne, Coddington and Associates, Inc. 1973) assessed the opinions of Mesa, Garfield, and Rio Blanco county residents about oil shale development. This survey sampled 200 residents from each of the three counties and 110 public officials from four counties, including Moffat County. The survey showed that residents in Mesa and Garfield counties felt that the environment was an outstanding feature of life in the area. The casual atmosphere, lack of congestion, scenery, and recreational resources were all considered important positive factors by residents and public officials alike. The high cost of living, low wage rates, the shortage of job opportunities, and the quality of education were all thought to be major disadvantages of living in Mesa and Garfield counties. The dissatisfaction with job opportunities was highest in Mesa County where one-third of respondents felt that the head of the household possessed nonutilized occupational skills, and one-fifth of the respondents reported that a member of their family had been forced to leave the area to find employment. As far as education, residents felt that teachers were well-qualified and that there were a sufficient number of teachers, but that the schools were deficient in preparing students for college and jobs. Residents of Garfield and Mesa counties also expressed a need for more low and middle income housing to be built in the area.

The Bickert, Browne, Coddington and Associates survey indicated that 80 percent of Mesa County residents agreed that additional industry should be encouraged to move into the area. However, the Garfield County residents were divided on the issue, with 43 percent in favor and 39 percent opposed to industrial growth. More than 75 percent of the public officials in both counties favored additional industrial development. When asked specifically about oil shale development, over half the residents in Garfield and two-thirds of the residents in Mesa County expressed their support.

In Delta County, a public opinion survey was conducted in 1974 by the county. A questionnaire was delivered to 8,551 residents, and 4,451 responses were received. (A copy of the survey form is available at the Montrose District Office.) This survey provided some insight into residents' opinions about future development in Delta County.

Residents felt that the order of priority for the use of public lands in the county ought to be as follows (highest to lowest): livestock grazing, wildlife habitat, recreation, timber development, mineral development, wilderness, industrial development, and residential development. There was also a strong feeling that access to public lands should remain unchanged, without increasing or decreasing access routes.

Delta County residents expressed a very strong preference for protecting prime agricultural land from any residential, commercial, or industrial development. They felt that persons moving into the area for reasons other than agriculture should be encouraged to live in or around the developed areas of the county.

More than 90 percent of those surveyed favored preserving the present rural atmosphere of Delta County. Agriculture was considered the economic activity which should be encouraged most to improve the area's economic base. Coal mine development and light industry development ranked second behind agriculture, with recreation and tourism less favored and heavy industry development least favored as activities to improve the economic base.

The western pride in individualism and self-destiny is present throughout the area and is reflected in the strong preferences for minimum government regulation and control. Most people agree that some controls are necessary to preserve environmental quality and to promote orderly growth and development, but they also feel strongly that those controls should be exercised primarily at the local level.

Lifestyles

The dominant lifestyle in most of the region is that found in many rural areas around the country. Low per capita incomes and remoteness from urban areas foster a simplified existence. Daily life is centered around the family, jobs or farms, civic organizations, church activities, or school activities. Recreational activities for most people consist of hunting, fishing, hiking, four-wheeling, skiing, snowmobiling, attending high school sports events, T.V. viewing, and attending movies.

The lifestyle is somewhat different in the more urbanized area of Grand Junction where employment and educational opportunities are somewhat greater than in the smaller communities. Grand Junction, in its role as a regional center for commercial and industrial activity, is more exposed to national trends, and offers more variety in lifestyle.

Noise

The low population density and lack of major heavy industry in the ES area contribute to a quiet environment. For example, over a 24-hour period the equivalent noise level (L_{eq}) measured on the east edge of Palisade was 50 decibels (dBA); some of this noise came from trains and traffic on I-70. The community of Somerset had an L_{eq} of 55 dBA;

most of this noise was contributed by coal mining activities. On the western edge of Grand Junction the L_{eq} rose to 68 dBA during daylight hours; most of this noise was caused by heavy truck traffic on Highway 50. In Paonia the L_{eq} was 52 dBA; most of the noise came from vehicular traffic. (For comparison, table R2-53 presents various sound levels and their effect on people.)

Relatively higher noise levels can be found along the two major highways, U.S. 50 and I-70. For example, in Montrose the L_{eq} measured 25 feet from Highway 50 was 66 dBA. On I-70 east of Palisade, an L_{eq} of 65 dBA during daylight hours was recorded 50 feet from the edge of the highway. The main east-west rail line through the ES area parallels I-70 and the Colorado River and contributes to the main noise corridor through the ES area. Grand Junction has noise levels associated with an actively growing city.

Other major sources of noise are mining operations, farm and ranch machinery, construction, and vehicles (including off-road vehicles, motorcycles, and snowmobiles). In general, except along railroads and highways, the ES area is a relatively quiet region.

Community Facilities

DELTA COUNTY

As the recent special census indicates, the unincorporated areas in Delta County have absorbed much of the recent population growth. Much of this new development, because it is located in the rural areas of the county, is provided with only minimum urban services. The desire of many inmigrants to the county to live in a rural setting seems to be the primary reason for this type of development. The lack of county zoning regulations and the encouragement of large lot subdividing have made it possible to continue development of rural areas.

Many of the developed areas of the county receive domestic water through one of the numerous independent water companies. These companies are generally a small group of neighbors who either develop their own wells or purchase water in quantity from a municipal system. This arrangement relieves any responsibility on the part of the municipalities to maintain transmission lines to individual residences. Most of the residences in outlying areas maintain individual septic systems for the treatment of sewage.

The county government provides jail facilities to most of the towns. These facilities are located in Delta and are antiquated and in need of replacement.

Delta County was instructed to abandon its trash dumps by the State Health Department last year. The county has contracted with private firms to operate three land fills to replace the trash dumps.

The county has combined what were three separate road departments operating out of the three county districts, enabling them to operate one gravel plant instead of three.

Delta

The present raw water source for Delta is on Grand Mesa, about 20 miles from the treatment plant. Raw water is transported from the main source to the treatment plant through a clay tile pipe, installed in 1903. Climatic conditions and landslides have occasionally interrupted the raw water supply. Delta also has a very inadequate raw water storage reservoir. With a capacity of only 34 acre-feet, it would last less than five days at Delta's average daily demand for water. Presently, the maximum daily demand for treated water in Delta, 4.6 million gallons per day (mgd), exceeds the capacity of the treatment plant (3.5 mgd). Delta is currently replacing much of its antiquated water transmission system and installing water meters. The city has obtained nearly \$1.5 million in financial assistance from federal and state sources for this project.

In addition the city of Delta has joined with the cities of Montrose and Olathe and other water companies and districts in the area to build and operate a regional water system (see figure R2-22). Project 7 is intended to increase greatly the capacity to supply treated water to the Delta-Montrose area, from 12.3 mgd to approximately 25 mgd. This level should be sufficient to support the average maximum daily water demands for more than 92,000 persons, which is the projected population level of the area for the year 2000.

Project 7 will use the water diversion point on the Gunnison River now used by the city of Montrose. Existing water rights held by all of the participants will be pooled for use in the project. Additional water resources, developed through the Dallas Creek project, are expected to supplement existing rights.

The present treatment plant for the city of Montrose, located east of town, will be expanded by 20 mgd and will serve as the primary treatment facility for the project. Treated water will be transported to much of the project area through a 24-inch main line along a route paralleling the Uncompahgre River between Montrose and Delta.

Construction costs for the project are estimated to be \$14 million. Financing is expected to be obtained from the Farmers Home Administration (FHMA) in the form of an \$8.5 million loan and a \$5.5 million grant. Operating expenses have been estimated at \$100,000 per year. Financing this project is expected to add about 33.5 cents per 1,000

TABLE R2-53

SOUND LEVELS AND HUMAN RESPONSE

	Noise Level (dBA)	Response	Conversational Relationships
Carrier deck jet operation	140		
	130	Limit amplified speech	
Jet takeoff (200 feet)			
Discotheque	120		
Auto horn (3 feet)		Maximum vocal effort	
Riveting machine	110		
Jet takeoff (2,000 feet)			Shouting in ear
Garbage truck	100		
New York subway station		Very annoying	
Heavy truck (50 feet)	90		Shouting at 2 feet
Pneumatic drill (50 feet)			
	80	Annoying	Very loud conversation, 2 feet
Alarm clock			
Freight train (50 feet)			Loud conversation, 2 feet
Freeway traffic (50 feet)	70	Telephone use difficult	
		Intrusive	Loud conversation, 4 feet
Air conditioning unit (20 feet)	60		
			Normal conversation, 12 feet
Light auto traffic (100 feet)	50	Quiet	
Living room			
Bedroom	40		
Library			
Soft whisper (15 feet)	30	Very quiet	
Broadcasting studio	20		
	10	Just audible	
	0	Threshold of hearing	

Source: U.S. Department of Agriculture. Environmental Protection Agency, 1974a.

Note: dBA = decibels; measured on the A-scale. Contributions to hearing impairment begin at about 70 dBA.

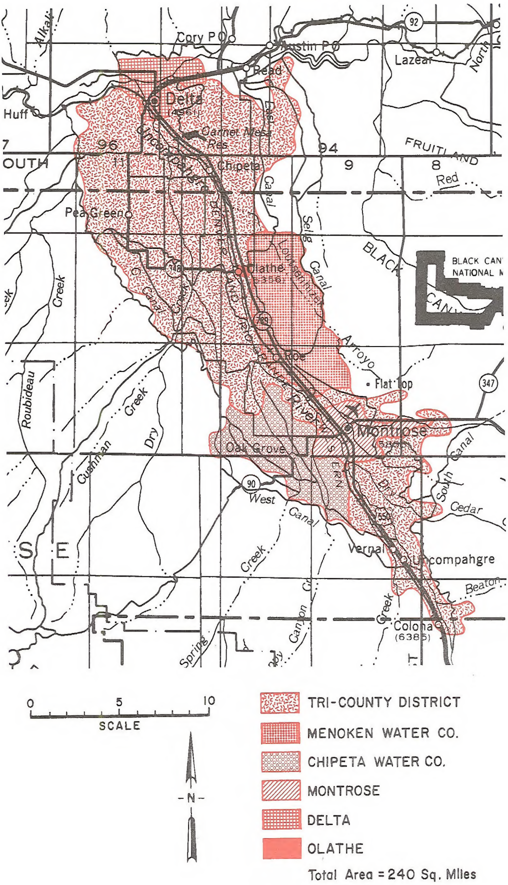


Figure R2-22. Project 7 service area

gallons of water used to the present water bills of residential customers in the area.

The Federal Water Pollution Control Act, as amended, requires that a community, in order to be eligible for 75 percent federal funding, proceed with upgrading waste-water facilities in a three-step process. Step 1 requires that a facilities plan be prepared from which a decision is made to proceed to step 2 (final engineering and architectural design) and step 3 (construction). The city of Delta has recently completed a step 1 feasibility study to determine its sewer treatment needs. That study has recommended that new sewage collector lines be installed in North Delta and on a portion of Garnet Mesa southeast of town, and that a mechanical treatment plant be built to replace the existing lagoon system. The plant would have an initial treatment capacity of 2.5 mgd with the ability to expand to 4 mgd as needed. The treatment plant has been designed to serve about a 19-square-mile area consisting of Delta and vicinity. A design capacity of 2.5 mgd should provide for a maximum population of 16,000 persons within the service area, which is more than double the population presently served.

The cost of this sewer expansion program is estimated to be $5 million. If a grant is obtained from the Environmental Protection Agency (EPA) for 75 percent of the project cost, the local share could be financed through a doubling of the present $4 per month sewer rate.

Delta is experiencing increasing truck traffic through the center of town (U.S. 50) and has initiated plans for a highway by-pass. Delta's current 1 percent sales tax has been earmarked for road construction and maintenance.

Delta operates its own power utility. Revenues from the power utility have traditionally been available for general operating purposes, but the costs of maintaining the utility have increased rapidly in recent years and the surplus revenues are being eliminated.

Fire protection in Delta and the surrounding area is provided by a municipal fire department and a rural fire district, both run by volunteers. Some consideration is now being given to merging the two departments. Delta has twelve full-time police officers and maintains five police vehicles.

Cedaredge

Cedaredge has recently received a $483,000 grant and a $573,000 loan from the FHMA to build a new water treatment plant, install water meters, and add a 1-million-gallon treated water storage tank to the existing storage capacity of 330,000 gallons. These improvements should allow the city sufficient capacity to serve approximately 2,000 persons with potable water. The pristine quality of the town's raw water source means that only a minimum amount of water treatment is needed. The Cedaredge water system serves all residents within the town boundaries and a small area outside of town.

Present outstanding water debt is due to be retired by the fall of 1979. The new FHMA loan is scheduled to be retired in forty years.

The present sewer treatment facility in Cedaredge was constructed in 1976. It is designed to serve a population of 2,800 persons and is presently serving about 1,000 persons. Most of the developed areas around the town of Cedaredge, including Orchard Mesa, use individual septic systems.

Cedaredge has two full-time and three part-time police officers and three operative patrol cars. One of the three ambulance services in the county is operated out of Cedaredge. Fire protection is provided by a volunteer department.

Orchard City

Orchard City includes the three small settlements of Austin, Cory, and Eckert, or an area of about 11 square miles. The town has operated as a water district up until now, providing no other urban services.

Hotchkiss

Hotchkiss is currently replacing many of the antiquated water transmission lines, installing water meters throughout the town, and providing a new water treatment plant. These improvements will allow the town to provide up to 2.0 mgd of treated water to its customers, which include the incorporated town and three water districts outside of town. Enough treated water should be available to support 3,000 additional persons in the service area. The water system improvements are being financed through FHMA. The total project cost is $1,175,000, of which $900,000 is debt financed and $275,000 has been provided as a grant.

The Hotchkiss sewer system consists of a one-cell lagoon system and polishing pond. About one-half of the collection system is relatively new, constructed in 1971. The sewer system is designed for a capacity of 750 persons. Outstanding debt for the sewer system is $171,000.

Hotchkiss has two full-time and two part-time police officers. Jail facilities are located in Delta, twenty miles away.

Paonia

In Paonia peak water demand is in excess of treated water supply. The town had to impose restrictions on water usage beginning in the spring of 1977. Through FHMA, they have recently received a $783,000 grant and a $767,000 loan for water system improvements.

Paonia plans to use this financial assistance for the development of the German Creek Springs, south of town, as a water source. They also plan to acquire an additional 2 million gallons of treated water storage, to replace 20,000 linear feet of existing water mains, and to construct a small water filtration plant. These improvements to the water system should supply enough water for an additional 2,900 persons in the area to which Paonia provides water. This area includes nine private water companies and most of the developed but unincorporated areas west of Somerset and east of Hotchkiss.

Due to the high quality of its raw water source, the town presently does not have any treatment for its water other than chlorination. This has eliminated the need for constructing and operating expensive water treatment facilities. Paonia is in the minority in Delta County in that the city has a fully metered water system.

Paonia has recently added a new sewer outfall line to its existing system. The new line serves the Pan American subdivision, as well as other lots which were previously on septic systems. Paonia's present single-cell lagoon system is plagued by inflow problems because the system was originally built to collect mostly surface drainage. The town is now beginning to study its future sewer system needs through a step 1 facilities study.

Paonia has four police officers supplemented by a voluntary police auxiliary. They have two operative patrol cars. The 1978 budget calls for the addition of another police officer and another patrol car.

The town operates a volunteer fire department, which is supplemented by a rural fire district. It is not practical to draw upon the antiquated municipal water system for firefighting.

Most of Paonia has paved streets. No road or street construction is planned until after water and sewer improvements are made.

GARFIELD COUNTY

Most of the urbanized areas in Garfield County are spread out along the Colorado River and Interstate Highway 70 from Grand Valley on the west to Glenwood Springs on the east. Because this is the main east-to-west transportation corridor through Colorado, these communities serve the highway business as well as the surrounding agricultural areas. They also support the many tourists who visit the area each year to enjoy its recreational opportunities.

Grand Valley

The town of Grand Valley owns and operates its water system, while the sewage disposal system is owned and operated by the Grand Valley Sanitation District. There are approximately 160 water taps and 130 sewer taps served by the town and the district. The town obtains its water from springs on the south side of the Colorado River, where it has diversion rights of 2.0 cubic feet per second (cfs) under absolute decree and 20.0 cfs under conditional decree. The town has water storage facilities for only 180,000 gallons, which, combined with the limited raw water supply, restricts the town's ability to meet existing water demand.

The sewage treatment system is operating at about capacity. The two lift stations are in poor condition and in need of renovation. The town is not presently upgrading either the water or the sewer system.

Police protection in Grand Valley is provided by a single officer. The volunteer fire department serves the town and the surrounding rural area, which includes all of School District No. 16. Fire department equipment consists of two conventional pumper trucks, both over 30 years old, and one four-wheel-drive vehicle with an auxiliary pump.

The town owns a 7-acre sanitary landfill, but no trash collection is provided.

Rifle

The city of Rifle has recently completed a settling pond, pump house, and filter improvements to its water treatment plant, as part of an ongoing program to replace water system transmission lines and equipment. In addition, the city plans to construct a 3 million gallon water storage tank at an estimated total cost of $1 million. Once all of these improvements are completed, the water system should meet the needs of about 5,000 persons. It is estimated that this population level will be achieved by 1980, primarily due to growth from the development of nearby oil shale resources.

Rifle is planning to improve its sewage treatment plant and sewage collection system. The first phase of the improvement program will consist of upgrading the existing sewage treatment plant with funds provided by the state oil shale trust fund. The second phase will involve constructing a new lift station and extending interceptor sewer lines at a cost of $233,000. These improvements should provide for a future population of 10,000 persons. A separate sewer district, the Rifle Village South Metropolitan District, has been established to serve presently undeveloped land south of town along I-70. However, it may be decided to build a completely new treatment plant to serve both the town and the district.

Financing requirements for these water and sewer system improvements will absorb most of Rifle's debt financing capabilities for many years to come.

A 1975 survey of street and road conditions in Rifle identified the need for $1.4 million worth of improvements. The city is working on a capital improvements program designed to provide most of these improvements over the next ten years. Rifle has also identified the need for a north-south bypass route to relieve traffic on Highway 13, which runs through the center of town.

The Rifle Police Department consists of five police officers and two patrol cars. Fire protection is a joint effort between the town and the rural fire district. Rifle has also determined the need for expanding or relocating the fire station and the police headquarters, relocating its library, and either remodeling the existing City Hall or constructing a new facility.

Silt

Both the water and sewer systems are owned and operated by Silt, which is planning to improve both systems to provide up to 1,600 persons with adequate water and sewer service. They have completed a step 1 feasibility study for sewer improvements, which calls for upgrading the existing lagoon system and improving collection lines. An application has been submitted to the state for financial assistance for engineering design work in connection with water system improvements.

Silt has one police officer and a volunteer fire department. Silt operates a sanitary landfill on leased land about 0.5 mile west of town.

New Castle

Like Silt, New Castle is planning to expand both its water distribution and sewage treatment system. Needed water system improvements include upgrading the water treatment plant, installing additional storage facilities, and replacing the raw water transmission line. It is hoped that financing for this project can be acquired from the state Oil Shale Trust Fund.

New Castle has done a step 1 feasibility study in connection with sewer system improvements, which recommends upgrading the existing lagoons and collection system to accommodate a town population of 1,000 persons.

New Castle has one police officer and a volunteer fire department.

Glenwood Springs

The city of Glenwood Springs provides treated water to residences and businesses in most of the Glenwood Springs area including the West Glenwood Water District. The city has recently constructed a new water treatment plant which is designed to provide 3.25 mgd of water, enough to provide for about 10,000 people.

Glenwood Springs is about to begin construction on an addition to their sewage treatment plant. The new secondary treatment facility is designed to treat up to 2.3 mgd of effluent, which should accommodate up to 14,500 persons. The total cost of sewer system improvements is estimated to be $2.4 million of which about $600,000 must be financed from local sources. The area served by the city does not include West Glenwood, which is served by a separate sanitation district.

The Glenwood Springs police force is staffed with fourteen police officers, who use four patrol cars.

The city government provides solid waste collection to its residents and operates a sanitary landfill jointly with Garfield County.

Carbondale

Carbondale has recently improved its municipal water system by constructing a new filtration plant, adding a 2-million-gallon treated water reservoir, new wells, and distribution system improvements, and installing water meters. The total project cost was $1.5 million, which the town financed through two long-term, low-interest loans. The new system has the capacity to serve a population of about 8,000 people.

Sewer service in the Carbondale area is provided by the Carbondale Sanitation District. A new sewer plant was installed in 1975, but due to growth pressures, plans are under way to expand its capacity. Carbondale has recently received a $479,000 grant from the state Oil Shale Trust Fund, which will cover about 50 percent of the cost of planned sewer system improvements. Once those improvements are complete, the system should be capable of providing for almost twice the present capacity, or about 6,000 persons.

The Carbondale police force has three full-time police officers and two patrol cars.

Carbondale plans to build a permanent town hall, financed partially by a $75,000 state grant. Town hall facilities are presently located in a double-wide trailer.

GUNNISON COUNTY

Most of the urbanized population in Gunnison County resides in or around the city of Gunnison or the smaller town of Crested Butte. The town of Somerset, in the western end of the county, is a small, close-knit community, which for geographic reasons is more closely tied with communities in Delta County.

Gunnison

Gunnison obtains all of its raw water from wells in the Gunnison River channel. The existing wells are only 60 to 80 feet deep, which limits the reliability of the water source because the water table in the channel fluctuates. The town is considering a new well system which should provide a more reliable source of raw water. Gunnison does not need to treat its water beyond chlorination because of the high quality of its raw water source.

The town operates a sanitary sewer system which is capable of treating 1.5 mgd of effluent. This system will allow for some growth before capacity is reached. Additional sewage treatment capacity could be obtained by eliminating the infiltration of ground water into the system, which occurs because of the high water table and the poor condition of the collection system.

Gunnison employs ten full-time police officers and has four police vehicles. The county is considering replacing existing jail facilities, which are no longer useable due to age and poor condition. Gunnison, like most other small towns in the area, has a volunteer fire department, which also serves the rural fire district outside the town limits.

Crested Butte

Crested Butte has recently completed a $150,000 project to replace its raw water transmission line, which runs 9,500 feet from the point of diversion to the raw water reservoir. Crested Butte diverts water from Coal Creek, just above the point at which mine water runoff enters and pollutes the creek.

The town's raw water reservoir is capable of storing 6 million gallons of water. The water treatment plant can treat approximately 0.5 mgd. Presently, the water system is operating at about 40 percent of design capacity. The town has outstanding debt totalling $242,000 associated with the water system.

Crested Butte has a sewage treatment facility which provides tertiary treatment to effluent. A $250,000 expansion to that facility has recently been completed, allowing it to provide for approximately 1,600 persons at capacity.

Only about 70 percent of the town population, estimated now at 1,200 persons, is served by the municipal water and sewer systems. Work is under way to extend these services to those not presently receiving them.

The town of Crested Butte provides its own police protection with a staff of three officers who share a single vehicle. The police department also serves as an extension of the county sheriff's department serving the surrounding rural areas. Fire protection is provided by a rural fire district serving Crested Butte and the ski area of Mt. Crested Butte.

OURAY COUNTY

The small communities of Ouray and Ridgway account for about 65 percent of the population in Ouray County. Ridgway is anticipating population growth from the construction of the Dallas Creek Dam and Reservoir. Development in Ridgway depends somewhat upon the municipal water supply system being improved; it is now in a state of "advanced deterioration", according to the town engineer. Water problems are such that an entire new water system is needed, a project which will cost in the neighborhood of $800,000, most of which will have to be advanced in the form of a grant from the federal or state government. Ridgway's sewer system was built only a few years ago and it is adequate to provide for the town's needs.

The water system in Ouray is capable of supplying an additional 40 percent of current peak loads. The sewer system is designed to serve about 1,200 persons and is now serving close to 900 people.

Police protection in Ridgway and Ouray is supplied by town marshalls supplemented by the county sheriffs' office. Fire protection is on an all-volunteer basis.

MESA COUNTY

The urbanized area in the vicinity of the city of Grand Junction accounts for all but a small portion of Mesa County's population and urban service systems. Most of the developed areas of the county around Grand Junction receive treated water from the Ute Water Conservancy District. The district maintains a treatment plant east of Palisade and provides water to other districts and to individual water users. It has water diversion rights from the Colorado River for 640 cfs. The city of Grand Junction is surrounded by the district, so that any development beyond the city limits will obtain water from the district.

The Ute District's water treatment plant has a design capacity of 12 mgd. The present demand for the districts water averages only 6 mgd during the peak water usage periods. The Ute Water District was forced to place a moratorium on new water taps between June and September of 1977 due to drought conditions. As a result, the district is developing additional water resources to add to its existing supply and is building a second raw water reservoir.

Areas such as the Redlands, Clifton, and the unincorporated areas outside of Fruita and Palisade are expanding rapidly, and many single-purpose special districts exist in the area. These special districts provide water and sewer services, fire protection, pest control, hospital services, cemetery services, and flood control.

Sanitary sewer service is available to most of the populated areas of the county through sanitation districts. Most sanitation districts function on lagoon systems.

There are two sanitary landfills in the county. A 120-acre site is located south of Orchard Mesa. It is administered jointly by the city and the county. The county operates another 40-acre landfill northeast of Grand Junction.

The Mesa County Sheriff's Department provides police protection to the county outside the jurisdictions of the towns of Fruita, Grand Junction, and Palisade. The Sheriff's Department employs 41 full time employees of which 21 are uniformed police officers. It is outfitted with 14 patrol cars and other specialized equipment. A volunteer rescue group also operates in the county.

Fire protection is provided by seven volunteer rural fire districts. The northwestern portion of the county, including Loma and Mack, are not served by any rural fire district.

Grand Junction

The city of Grand Junction obtains its water supply from surface sources on Grand Mesa. The city maintains two raw water storage reservoirs and a treatment plant which is capable of treating 16 mgd. The city's five-year capital improvements plan calls for $5 million to be spent for water system improvements, which will include expanding the capacity of the treatment facility to 24 mgd, constructing new raw water transmission lines, and replacing portions of the water distribution system. It is expected that most growth in the area will take place within the Ute Water Conservancy District service area rather than the area served by the municipal water system.

Grand Junction has recently completed a step 1 facilities study under provisions of Section 201 of the Federal Water Pollution Control Act for a new regional waste water treatment facility. This facility will serve Grand Junction and the surrounding areas of Orchard Mesa, Fruitvale, and Redlands. The new facilities have a design capacity for a population of approximately 140,000 persons to be realized in the next twenty years. The treatment facilities will have the capacity to treat 12.5 mgd of effluent. The total cost of the project is estimated to be $14 million, of which $3.6 million must be paid from local sources.

The Grand Junction Police Department maintains a staff of 75 full-time employees, of which 40 are uniformed police officers. The department has fourteen police vehicles. Grand Junction has a full-time fire department, which employs 54 trained fire fighters.

Fruita

The town of Fruita obtains most of its raw water from Pinon Mesa, south of town. Presently, water must be piped about 17 miles from the source to the treatment plant. The demand for water in Fruita now exceeds the treatment plant capacity, the raw water transmission capacity, and the watershed yield. As a result, Fruita has had to purchase additional treated water from the Ute Water Conservancy District, which already serves the rural areas outside of town.

Fruita has recently completed a study to determine its water needs over the next twenty years. The study recommends that Fruita discontinue use of its raw water source and treatment plant in favor of buying all of its treated water from the Ute Water Conservancy District. It also recommends that the town retain its distribution system and add a 750,000 gallon treated water storage tank. This alternative should allow the town to serve the needs of at least 4,000 people, with the ability to serve 6,000 persons after construction of additional water storage facilities. This alternative would make it necessary for Fruita to increase its average monthly water charge to residential users to over $12.

Fruita operates a sanitary sewer system consisting of several miles of collector sewers and a two-cell lagoon treatment facility. The treatment facility is currently operating at design capacity and, on occasion, is in violation of its discharge permit. A step 1 facilities study has recently been completed to evaluate the needs for upgrading sewer facilities. That study recommends that Fruita modify its existing system to a three-cell, aerated lagoon system capable of treating 1.25 mgd of effluent. This system is designed to provide sufficient sewage treatment capacity for an area population of 10,600 persons. The study also recommends that interceptor sewer lines be extended to outlying areas over a three-phase construction period. The total cost of the first phase of construction is $796,600. It is estimated that construction and increased operating costs can be financed by raising the monthly sewer charge from $3.00 to $7.40.

Fruita has five police officers and two patrol cars. The town has budgeted for an additional patrol car. The town also operates a volunteer fire department, which has contracted to provide fire protection to the surrounding rural areas in cooperation with the rural fire district. Because most of the fire hydrants in town draw on 4-inch water mains, the water supply for firefighting is limited.

Palisade

Palisade is presently in the first phase of a three-phase, $1.9 million construction program to improve its water system. The first phase involves the construction of additional raw water transmission lines, the addition of a 5-million gallon treated water storage facility, and installation of water meters. The second and third phases call for increasing the town's raw water storage capacity from 215 acre-feet to 750 acre-feet and replacing most of the existing transmission lines in town.

Palisade has placed a moratorium on new water taps outside the town limits. Currently, the water system serves more taps outside town than within town.

Improvements to the water system should provide sufficient water to serve an additional 1,500 persons in the area. Palisade has financed the first phase of improvements by issuing revenue bonds. Outstanding water revenue bonds now total $999,000.

Palisade is also developing a step 1 facilities study on the improvement and expansion of its sanitary sewer system. Recommendations for sewer system improvements are being based on a projected population of approximately 2,400 persons by the year 2000 within a 13-square-mile area of Palisade and vicinity. Because sanitary sewer service is presently limited to the town boundaries of Palisade, additional interceptor sewers need to be constructed to serve outlying areas.

The newly created Palisade police force consists of two police officers and one patrol car. There are plans to hire another officer. Palisade, like most other areas in the county, relies on the Mesa County jail facilities in Grand Junction. Fire protection is provided by a volunteer fire department. The town also provides ambulance service to Grand Junction.

Collbran

The town of Collbran owns and operates both the water supply and the sewage treatment systems. The principal problems appear to be an old and inadequate water distribution system and very high infiltration in the sewage collection system. Collbran has recently raised its water and sewer tap fees to a total of $2,000, which is the highest in the ES area. An engineering evaluation has recently been completed on the need for water system improvements. This study recommends that an improvement program be undertaken which would replace much of the existing water distribution system and add more treated water storage. Once these improvements are made, the town should be capable of providing water for up to 800 people. No plans to improve the sewer system are now under way.

Mesa County operates a sanitary landfill about 1 mile west of town. No trash collection service is available to residents.

DeBeque

DeBeque is reconditioning its water treatment plant and improving water distribution lines. The town recently received a $608,000 grant from the state Oil Shale Trust Fund for the water system improvements. Once work is completed, the town water system should be adequate to serve the needs of about 1,000 persons.

DeBeque is also considering improvements in its sewage treatment system, which is presently operating at capacity. A step 1 feasibility study is being prepared to determine what improvements are needed so that the town can provide sewer service to 1,000 people over the next twenty years.

DeBeque has one police officer and a volunteer fire department. There is very limited space available for police and fire department equipment.

DeBeque's city staff consists of a part-time clerk, who works out of a one-room city hall. A branch of the county library, containing about 500 volumes, is also located in the city hall.

Montrose County

Montrose

Montrose is working with the towns of Delta and Olathe to develop Project 7, a regional domestic water treatment and distribution system (see section on Delta).

Most of the sewage collection system operated by the city of Montrose was constructed around 1930. The remainder of the collection system and the treatment plant were constructed in the early 1960s. These facilities are presently operating at levels above their original design capacity. The West Montrose Sanitation District was formed in 1975 to serve the developed but unincorporated area west of the city. The district owns and operates separate waste water collection and treatment facilities.

The city of Montrose has recently completed a step 1 facilities plan, which recommends that a new sewage treatment facility, and additions to the collection system be installed to provide service to a 38-square-mile area, including Montrose and vicinity. The new facility is intended to have a design flow capacity of 3.75 mgd of effluent, which will serve the needs of 31,000 people, the projected population for the area in the year 2000. The estimated cost of this regional system is $8.4 million. If 75 percent of the cost is assumed by the federal government, the local share would be $2.9 million, or about $532,000 per year for debt service and operating costs.

The Montrose Police Department has seventeen police officers and is equipped with twelve police cars. Montrose police officers are trained in various special skills such as cardiopulmonary resuscitation, emergency medical techniques, crime prevention, and community relations.

The Montrose Fire Department has recently merged with the Montrose Rural Fire District to form one agency that provides fire protection to the city and the surrounding area. The fire department has six paid employees who are supplemented by 21 volunteers. The department is equipped with five trucks, four of which are four-wheel drive vehicles.

Montrose has over 80 miles of paved streets. Major street improvement projects in the future include the proposed construction of two bypass routes, circling the northeast and southeast quadrants of the city. These bypass routes should eliminate some of the traffic on those sections of U.S. 550 and U.S. 50 which pass through the center of town.

Naturita

Naturita built a water treatment plant and treated water storage facilities in 1969 and is now in the process of replacing its entire water distribution system and installing water meters. Once construction is completed, the system will be capable of serving an estimated 1,200 water taps, or four times the number of taps now served in town. Total cost of the water project is $505,500, some of which is being financed by the Economic Development Administration (EDA) and the FHMA through grants, the balance being financed through an FHMA long-term loan.

Naturita is also planning to improve its sewage treatment and collection system. The present system has a design flow capacity of 100,000 gpd, but the total volume of effluent averages more than double that. The town's engineer estimates that much of the problem is due to infiltration caused by the leaky water system, which should be eliminated once water lines are replaced. However, the existing treatment facilities will still need to be upgraded and possibly moved further downstream to allow for expansion of the town in that direction.

The Naturita police force consists of one full-time marshall. Fire protection is provided by a rural fire district, which includes both Naturita and Nucla as well as the surrounding rural areas. Fire protection is considered to be more than adequate at the present time.

Olathe

Olathe is involved with the towns of Delta and Montrose in developing Project 7 to meet its future demands for treated water (see section on Delta). The existing water distribution system in Olathe needs substantial repairs due to its deteriorated condition.

Olathe is planning improvements to its sanitary sewer system, which now serves approximately 1,200 residents. The improvements will consist of replacing some existing collector sewers and upgrading the existing lagoon system to provide service for up to 2,500 people in Olathe and vicinity. The cost of improvements is approximately $200,000, and financing will not involve raising either the sewer tap fee or the monthly service charge.

Olathe employs two full-time police officers and one part-time. They are equipped with a single police car. The town is included in a rural fire district, which has a twelve-person volunteer force and two fire trucks.

Nucla

Nucla obtains its water supply from the San Miguel River via a long, open ditch. The treatment and distribution system is old and in need of major renovation. An additional 500,000 gallons of treated water storage is needed. The town is attempting to acquire adequate financing from FHMA for necessary improvements to its water supply system.

The Nucla sewage treatment system is relatively new and in good condition. About 95 percent of the town is served by central sewers.

Nucla's police protection is provided by one full-time town marshall, supplemented by a county sheriff.

SUMMARY

The availability of water and sewer service is a primary factor in determining the ability of many small towns to accommodate rapid growth. Since most of the communities in the area are now experiencing modest growth and the expectations for energy resource-related growth are high, much effort has already gone into upgrading water and sewer facilities.

It should be noted that many towns are incurring relatively large debts from water and sewer projects, which will limit their ability to borrow for other projects for some time. Many of these towns are placing themselves in somewhat precarious positions by taking steps to increase the capacity of their facilities. Their ability to pay for these facilities is based on maintaining at least a steady rate of growth for 20 or 30 years. If growth does not occur, the expected revenues from future tap fees and increased service charges will not materialize. On the other hand, if growth occurs much faster than anticipated, the town is left with little ability to raise additional capital for further system expansions.

Tables R2-54 and R2-55 present an overview of the capabilities of the counties and the municipal jurisdictions to generate revenue locally. The primary sources of revenue for local governments are ad valorem property taxes, sales taxes, and utility

TABLE R2-54

COUNTY REVENUE CAPABILITIES

County	1976 County Assessed Valuation	1976 County Mill Levy	Total Average County Levy	1975-76 Retail Sales	Sales Tax Rate (percent)	General Obligation Debt Limit a/	General Obligation Debt
Delta	43,750,390	11.41	62.96	68,474,897	1	2,187,519	0
Garfield	70,255,900	21.19	80.95	145,889,121	None	3,512,795	0
Gunnison	47,358,360	10.43	53.30	42,851,540	None	2,367,918	0
Mesa	167,251,920	16.42	77.98	391,455,353	None	8,362,596	0
Montrose	53,979,730	19.93	80.83	99,369,475	None	2,698,986	0
Ouray	10,900,660	15.00	66.97	4,316,539	None	545,033	0
Pitkin	132,240,800	10.29	51.53	112,037,460	2	6,612,040	220,000

Source: State of Colorado, Division of Property Taxation, Department of Revenue.

a/ Set by state law at 1.5 percent of actual valuation.

TABLE R2-55

MUNICIPAL REVENUE CAPABILITIES

	1976 Municipal Assessed Valuation (dollars)	1976 Municipal Mill Levy	1975-76 Retail Sales (dollars)	Municipal Sales Tax Rate (percent)	General Obligation Debt Limit a/ (dollars)	Minimum Residential Water Tap fee (dollars)	Minimum Residential Water Service Charges (dollars)	Minimum Residential Sewer Tap Fee (dollars)	Minimum Residential Sewer Service Charges (dollars)
Delta County									
Cedaredge	2,314,580	8.60	3,435,885	None	231,458	500	5.00	1,000	5.00
Crawford	288,410	5.66	767,220	None	28,841	832	7.00	None	None
Delta	8,946,020	10.45	41,552,845	1	894,602	500	7.50	500	4.00
Hotchkiss	1,214,480	9.59	2,685,974	1	121,448	400		125	
Paonia	2,412,100	10.78	5,870,773	None	241,210	600	5.50	600	1.75
Garfield County									
Carbondale	3,661,500	8.72	7,586,751	2	366,150	1,000	5.26	500	3.50
Glenwood Springs	16,497,270	4.52	101,825,086	2	1,649,727	775	10.00	775	5.00
Grand Valley	470,110	11.89	911,837	None	47,011	300	5.00	300	3.50
New Castle	689,640	9.87	796,500	None	68,964	400	4.00	400	4.00
Rifle	5,220,410	9.87	18,220,122	2	522,041	985	4.00	425	3.00
Silt	790,110	23.60	3,072,471	2	79,011	300	5.00	400	2.50
Gunnison County									
Crested Butte	4,105,040	8.10	2,687,895	3	410,504	600	7.50	600	7.50
Gunnison	12,245,950	7.80	34,156,487	1	1,224,595	300	4.20	300	3.50
Mesa County									
Collbran	394,820	23.85	978,753	1	39,482	1,000	10.50	1,000	4.50
DeBeque	306,220	21.72	361,409	2	30,622	500	7.00	500	6.00
Fruita	3,607,060	18.75	11,637,509	2	360,706	900	7.00	800	3.00
Grand Junction	74,786,990	14.00	303,390,198	2	7,478,499	250	3.00	1,200	2.05
Palisade	1,806,880	21.19	4,520,567	1	180,688	800	12.50	800	2.00
Montrose County									
Montrose	20,662,770	9.85	62,530,695	2	2,066,277	710	10.60	1,160	3.75
Naturita	613,830	9.60	5,359,419	1	61,383	200	8.50	200	2.50
Nucla	763,960	19.44	5,160,125	1	76,396	300	8.50	100	10.50
Olathe	1,319,770	11.80	4,449,273	1	131,977	300	8.00	500	5.00
Ouray County									
Ouray	3,337,110	10.94	3,514,453	2	333,711	600	6.00	450	None
Ridgway	615,220	14.41	613,738	2	61,522	450	3.50		

Sources: State of Colorado, Division of Property Taxation, Department of Revenue, Socioeconomic Impact Office, Region 10 Overall Economic Development Program.

a/ Set by Colorado law at 3 percent of actual valuation; revenue bonds and any water bonds are exempt from limits.

fees. Those jurisdictions with large assessed valuations and retail sales are generally in better positions to raise revenues locally. The state government imposes limits on local government bonded debt to prevent it from exceeding reasonable revenue generating capabilities.

Law enforcement services in the area, with the exception of some of the larger towns, are at minimum levels. Table R2-56 shows the increases in reported crimes throughout the area since 1970.

Fire protection is primarily provided by volunteer departments with outdated equipment. Many of the town water systems do not have sufficient capacity to provide the water volumes needed in fighting fires.

Most towns have small administrative staffs which are kept busy with daily matters; they do not have the time or the resources to devote to planning for future developments. Many communities do not have land use control mechanisms, which would allow them to manage growth as it occurs.

Housing

According to the Colorado Division of Housing (see table R2-57), the rate of increase in total housing units in the area since 1970 has exceeded the rate of population increase. The total housing stock grew by 36 percent during that period while the total population grew by only 24 percent. Part of this growth can be attributed to the building of vacation homes, such as in Pitkin County, where the total number of units has increased more than twice as fast as the permanent population. Also, the addition of many mobile homes, averaging fewer occupants than conventional housing, has contributed significantly to the increase in housing units.

Almost one-third of the increase in housing units in the area since 1970 has been mobile homes. This percentage is even greater in Delta, Montrose, and Ouray counties, where mobile homes are being brought in faster than conventional houses are being added (see table R2-57). One reason for the increase in mobile homes is the unavailability of low-cost conventional housing. Except for the Grand Junction area, the ES area has many fewer subsidized housing units for its population size than the state as a whole. People in lower income groups are not able to afford new conventional houses, and mobile homes are an acceptable alternative.

About 33 percent of the total housing in the ES area is rental housing, compared with 37 percent statewide. Data are not available on the vacancy rates for rental housing, but as in most growing areas, newcomers can expect difficulty in finding rental housing.

Table R2-58 indicates the number of new housing starts in each county between 1970 and 1975. The greatest number of new housing units were built during 1972-73, when the ski industry boom reached a peak in Garfield, Gunnison, and Pitkin counties, and before the rapid escalation of housing construction costs. Those counties not as directly associated with the skiing industry have had fairly steady growth in new home construction. The new housing starts are indicators of the ability of the area's construction and financial sectors to meet demands for new housing.

Education

Most of the ES area is included within the limits of thirteen independent public school systems (see map 18 in the appendix). These districts range in size from Mesa County Valley, in the Grand Junction area, which supports 34 schools and over 13,200 students, to the DeBeque district, in eastern Mesa County, which has only 2 schools and 150 students. Student numbers increased in seven districts and decreased in six districts between 1970 and 1976 (see table R2-59). Overall, the public school population in the ES area increased 2.4 percent between 1970 and 1976. That increase is slightly higher than the 2.2 percent increase for the state as a whole during the same period.

Table R2-60 indicates the relative financial position of all the school districts in the ES area. Evaluating the financial capabilities of school districts is complicated by the regulations placed upon them by the state government. The Public School Finance Act limits the amount any district can increase its revenue for operating purposes each year. That revenue is measured in terms of dollars per pupil (authorized revenue base per attendance entitlement), and it is provided basically by two sources, local property taxes and state equalization payments. Last year, state law limited to $120 per pupil the amount each district could raise its authorized revenue base. State equalization payments are made to each district to increase the amount available per pupil for operating expenses to at least $35 for each mill which the district levies for its operating purposes. The state also imposes a maximum limit of 4 mills which a school district can levy for its capital reserve fund. Capital reserve fund revenues are used primarily to maintain existing capital facilities.

Most new facilities construction is financed through bond issues. Each district has a bond redemption fund which is earmarked for retiring outstanding bond issues. The state also imposes a limit of 20 percent of the assessed valuation as a maximum amount of bonded debt any district can incur. As indicated by table R2-60, the Garfield District is spending about 20 percent of its local revenues

TABLE R2-56

CRIME TRENDS

		Murder	Rape	Robbery	Aggravated Assault	Burglary	Total Larceny	Auto Theft	Total Crimes
Delta County	1970	0	0	0	0	36	85	13	134
	1975	1	5	3	42	96	180	18	345
	% Change	-	-	-	-	-	-	-	157%
Garfield County	1970	1	2	0	11	70	194	28	306
	1975	2	3	6	35	157	735	64	1,002
	% Change	-	-	-	-	-	-	-	227%
Gunnison County	1970	0	1	0	9	70	188	4	272
	1975	1	1	1	7	101	365	13	489
	% Change	-	-	-	-	-	-	-	79%
Mesa County	1970	1	9	14	54	442	1,395	86	2,001
	1975	6	9	27	85	684	1,853	118	2,782
	% Change	-	-	-	-	-	-	-	39%
Montrose County	1970	1	3	1	37	86	378	27	533
	1975	0	5	4	33	182	667	48	939
	% Change	-	-	-	-	-	-	-	76%
Ouray County	1970	0	0	0	0	6	0	0	6
	1975	0	0	0	2	14	22	2	40
	% Change	-	-	-	-	-	-	-	560%
Pitkin County	1970	0	2	0	21	82	449	46	600
	1975	1	4	9	52	316	1,016	103	1,501
	% Change	-	-	-	-	-	-	-	150%

Source: Colorado Bureau of Investigations, "Crime in Colorado", Uniform Crime Reports, 1970-1975.

TABLE R2-57

AREA HOUSING STOCK BY COUNTY

County	Estimated Year-Round Housing Inventory (1970)		Estimated Year-Round Housing Inventory (1976)		Net Additions a/	
	Total Conventional Units	Mobile Homes	Total Conventional Units	Mobile Homes	Total Conventional Units	Mobile Homes
Delta	5,524	351	5,775	835	251	484
Garfield	4,733	712	5,687	1,333	954	621
Gunnison	2,604	250	3,618	589	1,014	339
Mesa	17,445	1,353	21,360	3,554	3,915	2,201
Montrose	5,501	646	6,151	1,371	650	725
Ouray	621	61	662	158	41	97
Pitkin	2,364	294	4,956	494	2,592	200
ES Area	38,792	3,667	48,209	8,334	9,417	4,667

Source: State of Colorado, Division of Housing, Housing in Colorado (April 1, 1976).

a/ Units constructed minus units deleted.

TABLE R2-58

HOUSING STARTS BY COUNTY

County	1970	1971	1972	1973	1974	1975	Yearly Average
Delta	20	27	47	25	124	48	49
Garfield	106	41	377	244	105	142	154
Gunnison	18	60	339	436	123	112	181
Mesa	281	561	667	748	848	1,089	699
Montrose	32	54	115	192	124	193	118
Ouray	4	3	15	3	4	18	8
Pitkin	544	301	564	554	259	223	407
Total Study Area	1,005	1,047	2,124	2,202	1,587	1,825	

Source: Housing in Colorado, April 1, 1976, Division of Housing, State of Colorado.

TABLE R2-59

AVERAGE DAILY MEMBERSHIP BY SCHOOL DISTRICT

District	1970-71	1975-76	Percent Change	Pupil-Teacher Ratio
50(J) Delta County	3,787	4,129	+ 9.0	21:1
RE-1(J) Roaring Fork	3,040	3,206	+ 5.4	21:1
RE-2 Garfield	1,387	1,549	+ 11.6	18:1
16 Grand Valley	181	180	- 0.5	10:1
RE-1(J) Gunnison	1,460	1,399	- 4.1	18:1
49(JT) De Beque	122	153	+ 25.4	11:1
50 Plateau Valley	297	284	- 4.3	20:1
51 Mesa County Valley	13,373	13,233	- 1.0	20:1
RE-1(J) Montrose	4,121	4,378	+ 6.2	20:1
RE-2 West End	1,117	904	- 19.0	17:1
R-1 Ouray	211	205	- 2.8	13:1
R-2 Ridgway	147	165	+ 12.2	12:1
1 Aspen	1,230	1,419	+ 15.3	18:1
TOTAL STUDY AREA	30,473	31,204	+ 2.4	

Source: Colorado Department of Education, Pupil Membership and Related Information, Fall 1976.

TABLE R2-60

SCHOOL DISTRICT FINANCIAL CAPABILITIES (1977)

District	Assessed Valuation (Dollars)	Total Mill Levy a/	Bond Redemption Mill Levy b/	Local Dollars per Attendance Entitlement c/	Authorized Revenue Base per Attendance Entitlement (Dollars) d/
50(J) Delta County	48,440,660	38.84	0.79	410	1,087
RE-1(J) Roaring Fork	63,389,540	43.80	7.01	688	1,045
RE-2 Garfield	18,554,630	56.41	11.53	510	1,305
16 Grand Valley	3,917,370	66.34	4.00	1,325	1,959
RE-1(J) Gunnison	43,818,280	35.42	1.74	968	1,273
49(JT) DeBeque	1,296,430	44.78	2.30	1,613	2,036
50 Plateau Valley	5,688,460	38.83	3.00	730	1,128
51 Mesa County Valley	160,218,650	45.68	4.00	475	1,203
RE-1(J) Montrose	45,528,890	49.50	4.50	461	1,220
RE-2 West End	8,262,610	47.44	--	417	1,281
R-1 Ouray	6,769,030	36.63	2.00	1,060	1,392
R-2 Ridgway	3,434,790	52.19	8.00	763	1,283
1 Aspen	117,380,570	23.83	2.89	1,468	1,652
Statewide	--	40.94	5.73	768	1,409

a/ Combined mill levy for General Fund, Capital Reserve Fund, and Bond Redemption Fund.

b/ Those mills levied for the purpose of retiring outstanding debt.

c/ Those dollars spent per pupil on operating expenses which are collected from the local tax base.

d/ Those dollars available from the local tax base and state equalization payments for operating expenses per pupil.

to retire existing debt, the most of any district in the ES area. (Figures R2-23 and R2-24 are photos showing two of the schools in the ES area.)

As might be expected, the districts with the largest increases in enrollment since 1970 are the most overcrowded (see table R2-61). Delta County schools are some of the most overcrowded in the area. The Delta County district has difficulty getting the required approval from voters before it can issue any bonds to finance new facilities construction. Even though the district now has a relatively low mill levy, voters have defeated three bond issues. The most recent was a proposed $8 million issue in the spring of 1976.

The reluctance of the public to incur debt, with the related increase in property taxes, is a dilemma faced by most school districts in the area. After five previous voter rejections, the Garfield District recently had a $2 million issue approved after the state granted the district $1 million contingent on passage of the issue. The state, from the Oil Shale Trust Fund, has granted school districts in Mesa and Garfield counties a total of $2,598,038 since 1975 for school facility expansions and improvements. These expenditures have been made primarily to accommodate growth from oil shale development.

There are three institutions of higher education located in the ES area. Mesa College in Grand Junction offers four-year degrees in a variety of subjects. Its current enrollment is approximately 3,000 students. Western State College in Gunnison was originally organized as a teachers college but now offers degrees in liberal arts, sciences, and business administration. Western State has an enrollment of about 3,300 students. Colorado Mountain College operates a campus at Glenwood Springs for about 600 students, many of whom are from outside Colorado.

Vocational training is being provided by the Delta-Montrose Area Vocational-Technical School, newly opened in 1976. The facility provides area residents with training in mining, construction, mechanics, office skills, and other fields.

Health Care Facilities

There are ten licensed hospitals operating within the area, which provide primary health care services to residents. These hospital facilities are located, for the most part, in the larger towns and urbanized areas (see table R2-62). Communities which do not have their own health care facilities rely on the ambulance-emergency medical services which link most of the area with hospital facilities. Table R2-63 lists those communities which have volunteer ambulance service and the main hospital to which service is provided. Figures R2-25 and R2-26 show two hospital facilities in the ES area.

Physicians in the area are concentrated in the communities which have major hospitals. Grand Junction presently has 120 resident doctors, of whom about 65 are specialists. The hospitals and doctors in Grand Junction offer specialized health services to communities throughout the ES area. There are 27 doctors in Montrose, 10 in Delta, 25 in Glenwood Springs, 6 in Rifle, and 24 in Aspen. Many of the smaller towns do have doctors residing in the community who are available for emergencies and some out-patient services.

There are also numerous nursing home and other long-term care facilities in the area, many of them in Grand Junction, Montrose, and Delta. These facilities provide almost 1,200 licensed beds for long-term care, reflecting the large number of elderly persons residing in nursing homes.

Mental health services are provided to the area by the Colorado West Regional Mental Health Center with offices in Glenwood Springs and Grand Junction and by the Midwestern Colorado Mental Health Center in Montrose. The Colorado West Center serves Mesa, Garfield, and Pitkin counties. The Midwestern Colorado Center serves Montrose, Delta, Gunnison, and Ouray counties, with branch offices in Crested Butte, Ouray, Telluride, Nucla, and Paonia. Both centers provide psychiatric counseling for almost all forms of mental disorders, including alcoholism treatment programs.

The centers are currently receiving almost 50 percent of their revenues from federal aid, but that subsidy is due to be cut back to about 10 percent in the next few years. Unless state revenues can replace the lost federal revenues, mental health services may have to be substantially curtailed.

Employment

The labor force in the region has grown very rapidly during the 1970s. In 1973, the total labor force in the ES area was 56,409 persons. By 1976, it had grown to 64,577, an annual growth rate of 4.5 percent. During this same period, changes in the labor force in individual counties varied considerably, ranging from a loss of 6.2 percent in Ouray County to a gain of 9.1 percent in Pitkin County. Ouray County was the only county in the region with a declining labor force during this period.

Total employment in the region also grew at an annual rate of 4.5 percent between 1973 and 1976. Variation among the individual counties ranged from Ouray County's loss of 7.5 percent to Pitkin County's gain of 9.1 percent. Table R2-64 shows the percentage changes in total labor force and total employment for each county in the region.

Within the region, the agriculture, wholesale and retail trade, services, and government sectors tend to be the largest employers. County data could not

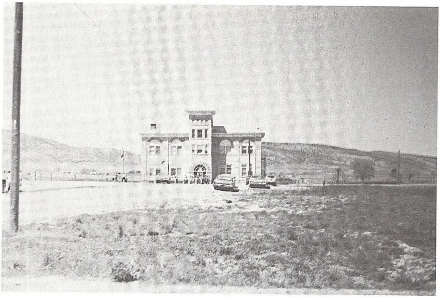


Figure R2-23.

Figure R2-24.

Loma School and Grand Junction High School: school facilities in the region vary considerably in age and capacity.

TABLE R2-61

SCHOOL DISTRICT FACILITIES

District	Number of Schools	Percent of Design Capacity Now in Use
50(J) Delta County	7 Elementary 2 Jr. High 2 Jr./Sr. High 2 Sr. High	11 out of the 13 schools have enrollments which exceed the design capacity of the building. The average age of the buildings is 41 years.
RE-1(J) Roaring Fork	4 Elementary 3 Jr. High 3 Sr. High	80 percent.
RE-2 Garfield	3 Elementary 2 Jr. High 1 Sr. High	90 percent (once new school construction is is completed).
16 Grand Valley	1 School (Grades K-12)	70 percent.
RE-1(J) Gunnison	4 Elementary 1 Jr. High 1 Sr. High	Decreasing enrollment
49(JT) DeBeque	1 Elementary 1 Jr./Sr. High	85 percent -- Both buildings are 16 years old.
50 Plateau Valley	1 Elementary 1 Jr. High 1 Sr. High	80 to 90 percent -- Buildings are 19 years old and in good condition.
51 Mesa County Valley	24 Elementary 6 Jr. High 4 Sr. High	80 to 85 percent.
RE-1(J) Montrose	11 Elementary 3 Jr. High 2 Sr. High	Elementary and Sr. High near capacity, additional capacity in Jr. High.
RE-2 West End	3 Elementary 1 Jr. High 1 Sr. High	80 to 85 percent.

TABLE R2-61 -- Continued

R-1 Ouray	1	Elementary	Decreasing enrollment; 1976 enrollment 87 percent of 1966.
	1	Jr./Sr. High	
R-2 Ridgway	1	Elementary	Increasing enrollments.
	1	Jr./Sr. High	
1 Aspen	1	Elementary	Increasing enrollments.
	1	Jr. High	
	1	Sr. High	

TABLE R2-62

GENERAL HOSPITAL FACILITIES

Hospital	Location	Licensed Hospital Bed Capacity	Present Occupancy Rate (1976)
Aspen Valley Hospital	Aspen	30	77.2
Delta Memorial Hospital	Delta	32	66.4
Valley View Hospital	Glenwood Springs	39	80.3
Clagett Memorial Hospital	Rifle	32	40.7
Gunnison County Public Hospital	Gunnison	24	36.0
Plateau Valley Hospital	Collbran	6	51.9
Lower Valley Hospital	Fruita	20	38.8
Grand Junction Osteopathic Hospital	Grand Junction	78	51.2
Mesa Memorial Hospital	Grand Junction	42	54.1
St. Mary's Hospital	Grand Junction	222	73.1
Montrose Memorial Hospital	Montrose	75	67.6

Source: Western Colorado Health Systems Agency

TABLE R2- 63

EMERGENCY MEDICAL SERVICES FOR COMMUNITIES WITHOUT HOSPITAL FACILITIES

Town	Type of Emergency Medical Service	Distance to Nearest Hospital (miles)	Resident Physicians
Paonia	Ambulance	35-Delta	Two physicians and small clinic
Cedaredge	Ambulance	15-Delta	Three physicians and two small clinics
Hotchkiss	Ambulance	16-Delta	Two physicians and small clinic
Nucla/Naturita	Ambulance	95-Montrose 105-Grand Junction	One physician
Olathe	Ambulance	10-Montrose	None
Ouray	Ambulance	37-Montrose	One physician
Ridgway	Ambulance	26-Montrose	None
Crested Butte	Ambulance	38-Gunnison	One physician
Palisade	Ambulance	13-Grand Junction	One physician
DeBeque	Ambulance	30-Grand Junction	None
Silt	Ambulance	7-Rifle	None
New Castle	Ambulance	11-Glenwood Springs	None
Carbondale	Ambulance	13-Glenwood Springs	Three physicians

Source: Western Colorado Health Systems Agency

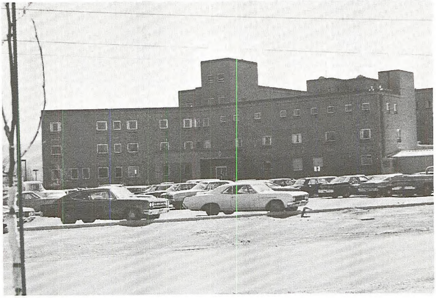


Figure R2-25

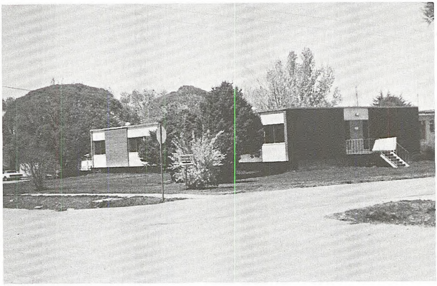


Figure R2-26

St. Mary's Hospital and Fruita Hospital: health care facilities vary considerably within the region.

TABLE R2-64

ANNUAL PERCENTAGE CHANGE IN LABOR FORCE AND EMPLOYMENT
(1973-1976)

County	Total Labor Force (percent change)	Total Employment (percent change)
Delta	+2.2	+1.6
Garfield	+2.2	+1.9
Gunnison	+5.6	+5.1
Mesa	+5.7	+6.1
Montrose	+3.1	+2.8
Ouray	-6.2	-7.5
Pitkin	+9.1	+9.1
Region	+4.5	+4.5
State	+3.6	+3.0

Source: Colorado Division of Employment, County Labor Force Estimates.

be aggregated to regional totals because of data withheld under the Employment Security Act; the act restricts information where there are only one or two firms of an industry in a county. Table R2-65 summarizes what data are available. It shows that agriculture has been declining in relative and absolute importance, while the other sectors have grown, particularly the mining, construction, wholesale and retail trade, and service sectors. This shift indicates that people are still willing to leave agriculture for better jobs in other sectors.

In spite of the growth in the area, unemployment remains a problem. Table R2-66 shows the percent of the labor force that was unemployed in each county in 1973, 1975, and 1976. Unemployment rates in the region tended to rise during the period 1973 to 1975, but dropped during 1976. The state average followed this same pattern. However, unemployment was higher in most of the counties than in the state as a whole. In 1976, only Mesa County had unemployment rates lower than the state average; Garfield County's rates were the same as the state's. The regional average was the same as the state average in 1976, but was considerably higher in 1973 and 1975.

Income

Per capita income often indicates standard of living, that is, the amount of income that is available for food, shelter, clothing, and luxuries. Table R2-67 shows per capita income for the counties, region, state, and nation for 1970 and 1974, as well as the percentage increase.

Per capita income in the ES area is low in comparison with income in the state of Colorado and the United States. In 1974, it varied from $3,483 in Gunnison County to $7,896 in Pitkin County. Only Pitkin County had an income level higher than state or national incomes. However, table R2-67 also shows that, during the period 1970 to 1974, per capita income increased at a faster rate in the region than in either Colorado or the United States, which indicates a strengthening of the regional economy and implies an improving standard of living.

A second indicator of standard of living is median family income, which also shows the region as being a relatively low income area. Table R2-68 shows median family income for each county.

Another indication that incomes in the region are low is the percentage of the population with incomes below the poverty level. As shown in table R2-69, most counties in the region have a larger proportion of families living below the poverty level than does the state as a whole. Only Garfield and Pitkin counties have a smaller percentage of families below the proverty level than the state average.

Income is also useful in showing the importance of the various sectors in a region's economy, with the more important sectors providing the largest portions of regional income. Table R2-70 summarizes dependence upon various sectors of the regional economy. Federal, state, and local government accounts for the largest share of personal income (21.81 percent). Second is wholesale and retail trade (19.22 percent), followed by services (16.36 percent), contract construction (10.11 percent), transportation, communication, and public utilities (8.17 percent), agriculture (8.03 percent), mining (7.25 percent), manufacturing (6.53 percent), finance, insurance, and real estate (4.55 percent), and other industries (0.30 percent).

The region is significantly more dependent upon agriculture and mining to provide income than are the state of Colorado and the nation. Manufacturing, which provides the largest portion of income in the United States and the second largest in Colorado, is relatively insignificant in the region, providing only 6.53 percent of the income. Other sectors of the regional economy are not significantly different from the state or nation.

FUTURE ENVIRONMENT WITHOUT THE PROPOSAL

Extensive development of the ES area's mineral resources is expected by 1990, particularly oil shale, molybdenum, and uranium, as well as some coal. Four oil shale mines, 4 oil shale processing plants, 440 oil and gas wells, 2 limestone-gypsum mines, 3 limeston-gypsum processing plants, 7 hardrock mineral mines, and 1 hardrock mill are projected to be in operation through 1990 in the ES area. In addition, demand for uranium is expected to increase at an annual rate of about 15 percent through 1985, which will increase exploration activity and development of new mine and mill capacity at least through 1990. The 38 existing tracts are expected to be still in operation by 1990, but information on other possible proposed tracts is not available from the Department of Energy at this time. Approximately 5.02 million tons of coal will also be produced annually from thirteen mines by 1990.

If the area's oil shale, molybdenum, and uranium resources are developed as projected, parts of the Es area are expected to experience rapid population growth over the next ten years. By 1980, the regional population is estimated to be 196,850; by 1985 it would climb to 234,000; and by 1990 reach 234,450. Community expansion will require conversion of 4,010 acres by 1980 from present uses; by 1985 this would be 7,160 acres and by 1990, 7,200

TABLE R2- 65

EMPLOYMENT BY MAJOR OIVISION (JUNE 1970, 1975, and 1977)

Sector	Oelta			Garfield			Gunnison			Mesa			Montrose			Ouray			Pitkin		
	1970	1975	1977	1970	1975	1977	1970	1975	1977	1970	1975	1977	1970	1975	1977	1970	1975	1977	1970	1975	1977
Agriculture	2,157	1,759	1,679	1,087	941	899	483	385	70	3,120	2,500	2,310	1,870	1,467	1,382	269	215	200	345	356	335
Mining	*	*	*	413	469	*	319	406	475	420	850	940	631	406	617	*	*	*	*	*	*
Contract Construction	34	143	350	301	573	658	43	90	182	830	1,740	1,990	267	551	451	*	*	*	351	353	520
Manufacturing	312	272	327	75	174	179	27	53	92	1,950	2,230	2,540	238	551	717	*	*	*	49	123	181
Transportation	105	202	223	261	583	625	23	64	67	1,370	1,780	1,750	360	596	736	*	*	*	219	149	226
Wholesale and Retail Trade	403	821	954	979	1,475	1,857	344	730	745	4,260	5,910	6,000	724	1,258	1,490	*	*	*	817	1,644	1,816
Finance, Insurance, and Real Estate	95	156	189	124	228	265	56	162	175	530	750	880	96	187	244	*	20	*	148	603	664
Services	401	501	574	665	1,492	1,282	176	760	631	3,120	4,010	4,700	410	659	697	*	53	62	602	1,833	1,902
Nonclassifiable	0	4	0	0	6	0	0	0	0				0	9	0	*	0	0	0	11	0
Government	756	797	1,006	955	1,251	1,334	1,170	1,233	1,371	3,530	4,230	4,500	1,299	1,379	1,358	129	150	132	194	540	441

Source: Colorado Oivision of Employment, Research and Analysis Section, UI Reports.

Note: Self-emoloyed, other than in agriculture, unpaid family workers, and domestics are not included.

* Confidential data as defined by the Employment Security Act.

TABLE R2-66

UNEMPLOYMENT AS PERCENTAGE OF LABOR FORCE
(1973, 1975, and 1976)

County	Year	Percent Unemployment
Delta	1973	5.4
	1975	7.7
	1976	7.1
Garfield	1973	5.1
	1975	6.0
	1976	5.9
Gunnison	1973	4.6
	1975	7.1
	1976	6.0
Mesa	1973	5.9
	1975	5.7
	1976	5.1
Montrose	1973	5.9
	1975	6.9
	1976	6.9
Ouray	1973	3.2
	1975	4.9
	1976	7.2
Pitkin	1973	7.2
	1975	10.5
	1976	7.4
Region	1973	5.7
	1975	6.5
	1976	5.9
State	1973	4.1
	1975	6.9
	1976	5.9

Source: Colorado Division of Employment, County Labor Force Estimates.

TABLE R2-67

PER CAPITA INCOME

County	1970	1974	Percent Change
Delta	2,484	3,813	53.5
Garfield	3,270	5,106	56.2
Gunnison	2,489	3,483	39.9
Mesa	3,190	4,799	50.4
Montrose	3,031	4,308	42.1
Ouray	3,351	4,876	45.5
Pitkin	5,165	7,896	52.9
Region	3,144	4,744	50.9
Colorado	3,855	5,514	43.0
United States	3,966	5,449	37.4

Source: U.S. Dept of Commerce, Bureau of Economic Analysis, Local Area Personal Income: 1969-74.

TABLE R2-68

MEDIAN FAMILY INCOME

County	1960	1970	1974
Delta	$3,623	$5,943	$ 7,550
Garfield		8,065	11,565*
Gunnison	5,014	7,504	9,530
Mesa		8,380	11,130*
Montrose	4,451	7,362	9,350
Ouray	4,133	7,245	9,200
Pitkin		8,637	15,643*
Colorado	5,663	9,555	12,330 (12,990*)

Source: Big Country Comprehensive Health Planning Council, Inc., 1975. Gunnison, Mesa, and Pitkin County information from Colorado Dept. of Health, Records and Statistics Section.
* 1975 estimate

TABLE R2-69

INCOME DISTRIBUTION IN THE REGION

Income Group	Counties							
	Delta	Garfield	Gunnison	Mesa	Montrose	Ouray	Pitkin	State
Less than $3,000	14.2%		8.4%		9.7%	8.0%		6.6%
$3,000 to $4,999	17.4%	10.3%	9.3%	15.1%	12.0%	6.1%	7.3%	5.2%
$5,000 to $7,999	21.7%	17.5%	22.1%	18.2%	19.0%	20.1%	7.3%	17.0%
$8,000 to $9,999	12.2%	12.1%	12.8%	10.7%	13.5%	22.8%	8.8%	11.2%
$10,000 and Over	34.5%	60.2%	47.4%	56.0%	45.8%	43.1%	76.7%	60.0%
Families below poverty level	19.4%	8.4%	10.7%	11.4%	15.5%	11.4%	5.7%	9.1%

Source: Colorado Department of Health Records, and Statistics Section, Demographic Profile: Colorado Planning and Management District 10, 1975. Garfield, Mesa, and Pitkin county data from Colorado State Housing Board and Division of Housing, Department of Local Affairs.

Note: Garfield, Mesa, and Pitkin are 1975 data; others are 1974.

TABLE R2-70

1974 PERSONAL INCOME BY SECTOR IN THE STUDY REGION
(Thousands of Dollars)

	Delta	Garfield	Gunnison	Mesa	Montrose	Ouray	Pitkin	Region	Percent of Total Region	Percent of Total State	Percent of Total Nation
Total Labor and Proprietors Income	33,024	54,042	24,256	200,990	59,915	8,587	47,883	428,697	100.00	100.00	100.00
Agriculture	7,276	758	995	13,702	10,832	699	164	34,426	8.03	5.33	3.69
Mining	681	8,371	5,801	6,547	3,652	5,380	191	30,623	7.15	2.12	1.09
Manufacturing	3,291	1,243	481	17,789	3,700	563	910	27,977	6.53	16.01	26.78
Contract Construction	1,868	6,709	1,067	20,461	6,558	77	6,565	43,305	10.11	8.48	6.23
Wholesale and Retail Trade	5,661	11,218	4,044	41,320	7,894	363	11,895	82,395	19.22	17.75	16.51
Finance, Insurance, and Real Estate	1,510	2,198	1,049	7,140	1,996	187	5,410	19,490	4.55	5.68	5.23
Transportation, Communication, and Public Utilities	1,166	5,072	548	19,729	6,124	143	2,217	34,999	8.17	7.61	7.23
Services	3,821	9,864	2,862	31,434	5,744	225	16,172	70,122	16.36	14.97	15.38
Other Industries	99	334	73	681	180	26	144	1,537	0.36	0.30	0.32
Government	7,651	8,275	7,336	42,187	13,235	924	4,215	83,823	19.56	21.81	17.58

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Local Area Personal Income: 1969-1974.

acres. Projected population and land required for community expansion for each county in the ES area are shown in table R2-71. Mesa, Garfield, and Gunnison counties will be most directly affected by the development of these mineral resources, and they will require much expansion of housing, schools, health care facilities, and government services to serve a growing population.

Total employment in the ES area is expected to increase dramatically due to mineral developments (other than coal). However, employment rates are expected to fluctuate in many counties as the various construction projects related to mineral development are completed. Agriculture will probably decline in importance in the ES area as alternate sources of employment become available.

The influx of large construction work forces is likely to cause some change to the lifestyles in Mesa, Garfield, and Gunnison counties. The influx of similar large work forces in other rural areas of the west has led to what is commonly referred to as the "boom town syndrom." The more commonly documented changes include rising rates of divorce, increased cases of alcoholism and mental illness, and decreased levels of job productivity. Also, and probably more importantly, there tends to be a polarization in small communities between the long-time residents and the more transient newcomers, which causes difficulty in accomplishing needed reforms.

Significant increases in traffic are anticipated (see table R2-72). Approximately 2,000 miles of new roads will be developed, and many highways in the ES area will need improvements. The section of I-70 bewteen Cameo and Rifle will need to be upgraded to a four-lane divided highway to accommodate the increased traffic from oil shale development in the area. The Colorado Division of Highways has plans to widen and realign State Highway 133 from Hotchkiss to Paonia Dam. U.S. Highway 50 will need to be widened to accommodate increased local and through traffic. Smaller state, county, and private roads may also continue to be upgraded to meet needs.

Maximum future ambient levels of TSP, SO_{2G1} and NO_2 will result from contributions from the rural baseline and from emissions from towns and highways. Highest pollutant levels will be centered in the major towns in the region (Fruita, Grand Junction, Delta, and Montrose); however, concentrations will drop almost to rural baseline levels within 5 to 15 miles from the towns. Pollutant emissions will also increase slightly due to ongoing coal mining and its associated train traffic and increased oil shale and uranium development. However, the increases are expected to be small and localized in comparison with increases due to urban growth.

Increased mineral development, population, and recreational activity will increase noise levels in the ES area. The EPA's scheduled reductions in maximum permissable noise levels for machinery, locomotives, motor vehicles, trucks, and forms of recreational transportation should assist in minimizing noise problems.

Subtantial development and consequent hydrologic impacts are expected in the ES area by 1990 without the proposed mines. Approximately 3,730 acres of coal beds, about half of which will be saturated and thus potential aquifers, will be removed by 1990. The overlying rocks will be subject to possible subsidence and consequent cracking with loss of springs and diversion of surface water into the mines in affected areas. Since only 0.04 percent of the ES area will be disturbed by projected coal-mining operations by 1990, any impacts on ground water should be very local and should not measurably alter the regional ground-water system.

Stream channels will be removed, relocated or altered on an area of about 30,960 acres by 1990, which is about 0.33 percent of the ES area. Impacts should be very local and generally short term.

Consumptive use of water will increase by about 40,090 acre-feet annually by 1990, reducing water yield from the Upper Main Stem of the Colorado River by about 1 percent. Because of the Grand Valley Project, which will remove an estimated 410,000 tons of salt annually from the Colorado River by 1990, the dissolved-solids concentration in the Colorado River will be reduced about 66.05 milligrams per liter (mg/l) (11.6 percent) at the Colorado-Utah state line and 27.99 mg/l (4.1 percent) below Hoover Dam.

Local increases in sediment yield to receiving streams will occur during construction phases of the expected development, but these increases should be approximately offset by reduced sediment yield below current rates in areas that are stabilized by urbanization and that are subject to effluent limitations as a result of coal-mining operations. Computations indicate that net sediment yield from the ES area will decrease about 2,300 ton/year by 1990.

Land use changes are anticipated on approximately 30,964 acres by 1990. Of the total acreage disturbed, 1,393 acres would be due to coal mining; 3,900 acres due to uranium mines and mills; 1,320 acres due to oil and gas development; 4,500 acres due to oil shale development; 7,851 acres due to community expansion; and 12,000 due to road, power line, pipeline, and telephone line construction. The exact location of this disturbance cannot be predicted, but it is likely that at least some of it

TABLE R2-71

FUTURE WITHOUT PROPOSED ACTION: PROJECTED POPULATION AND COMMUNITY EXPANSION

County	1980		1985		1990	
	Population	Land Use (acres	Population	Land Use (acres)	Population	Land Use (acres)
Delta	20,600	140	19,100	340	24,900	510
Garfield	33,000	1,210	38,650	1,690	45,600	2,240
Gunnison	9,350	60	23,000	880	18,400	820
Mesa	91,750	2,120	106,000	3,330	94,800	2,380
Montrose	22,900	130	24,150	230	24,600	270
Ouray	2,200	30	2,100	20	2,400	40
Pitkin	17,050	320	21,100	670	24,250	940
Total	196,850	4,010	234,100	7,160	234,950	7,200

TABLE R2-72

PROJECTED VEHICLE TRAFFIC BY 1990 WITHOUT THE PROPOSED ACTIONS

Road a/	Location b/	Average Daily Traffic	Average Peak-Hour Volume	Design-Hour Volume	Vsl_C (Capacity) c/	Peak-Hour Vsl_C / $\frac{DHV}{Vsl_C}$	Vehicle Miles Travelled
I-70	W/o Grand Valley	8,200	570	1,230	4,980 d/	0.11/0.25	112,914
I-70	Rifle	6,190	430	930	4,980	0.09/0.19	8,233
I-70	W/o Glenwood Springs	11,400	800	1,710	4,980	0.16/0.34	5,586
I-70	E/o Glenwood Springs	9,460	660	1,420	4,980 d/	0.13/0.29	16,650
I-70	E/o Grand Junction	9,400	760	1,410	5,000	0.15/0.28	6,712
I-70	E/o Grand Junction	4,640	370	700	4,980	0.07/0.14	18,374
I-70	Junction 139	4,560	360	690	5,000	0.07/0.14	18,012
US-50	N/o Delta	14,410	1,110	2,160	5,100	0.22/0.42	288
US-50	S/o Delta	8,660	780	1,390	1,180	0.66/1.18	30,743
US-50	N/o Montrose	16,880	1,180	2,700	5,100	0.23/0.53	148,713
US-50	E/o Montrose	6,360	570	1,080	510	1.12/2.12	198,686
US-550	S/o Montrose	8,750	790	960	1,050	0.75/0.91	27,825
US-550	S/o Ridgway	3,090	280	490	1,050	0.27/0.47	32,136
US-550	N/o Ridgway	3,710	330	590	1,050	0.31/0.56	20,219
SH-82	S/o Glenwood Springs	19,780	1,780	2,180	5,260	0.34/0.41	149,298
SH-82	W/o junction with SH-133	14,870	1,340	1,640	5,260	0.25/0.31	16,531
SH-82	E/o junction with SH-133	10,710	1,070	2,140	1,130	0.95/1.89	108,064
SH-133	N/o Carbondale	8,190	820	1,640	460	1.78/3.57	4,259
SH-133	S/o Carbondale	5,670	570	1,140	460	1.24/2.48	4,366
SH-133	E/o McClure Pass	330	30	70	460	0.07/0.15	858
SH-133	W/o McClure Pass	1,200	140	240	500	0.28/0.48	11,676
SH-133	E/o Somerset	900	110	180	500	0.22/0.36	11,340
SH-133	W/o Somerset	1,480	180	300	500	0.36/0.60	5,328
SH-133	E/o junction with SH-187	2,460	300	500	500	0.60/1.00	41,820
SH-133	W/o junction with SH-187	2,960	360	600	500	0.72/1.20	1,776
SH-133	E/o Hotchkiss	2,960	360	600	500	0.72/1.20	592
SH-92	E/o Delta	9,770	880	1,170	1,860	0.47/0.63	72,298
SH-92	W/o junction with SH-65	7,880	630	950	860	0.73/1.10	51,456
SH-92	E/o junction with SH-65	3,690	300	440	860	0.35/0.51	22,361
SH-65	N/o junction with SH-92	4,520	360	540	1,100	0.33/0.49	7,232
SH-139	Junction road N/o Junction 6	1,130	90	230	740	0.12/0.31	1,379
SH-139	Junction road at Mesa-Garfield County line	710	60	140	740	0.08/0.19	9,464

Source: All figures except projected average daily traffic supplied by Colorado Department of Highways.

a/ I = Interstate; US - United States; SH = State Highway.

b/ N/o = north of; S/o = south of; E/o = east of; W/o = west of.

c/ Vsl_C = volume service level C, which indicates an efficient flow of traffic at 55 miles per hour with adequate opportunities to pass.

d/ Assumes completion of I-70 to four lanes.

will affect farmland, livestock range, and wildlife habitat.

With the final approval of the Uncompahgre Basin grazing ES (U.S. Department of the Interior, BLM 1978) and Grand Junction grazing ES (draft ES scheduled for publication in the spring of 1979), the grazing system on public lands within the region may be converted to a rest-rotation system of livestock production, seed trampling, and rest, where such a system is not already in use. This change will increase AUMs available for livestock and also benefit wildlife.

Locally heavy losses and displacement of wildlife could occur because of interference in microenvironments and certain habitat types, and because the distribution of wildlife species is not even and locally heavy populations could be impacted. Oil shale development and urban expansion would be the major factors causing decreases in wildlife habitat. Increased population would also cause increased road kills due to increased vehicular traffic; increased poaching and indiscriminate shooting of wildlife; increased harassment of wildlife during stress periods, especially winter and reproductive periods; and increased recreation use of wildlife.

Aquatic habitats in the regions will remain closer to their present condition through 1990. Lower population growth will facilitate construction and improvement of sewage treatment systems to meet demands. Solutions to water pollution problems from sewage will be easier to obtain. Fishing pressure in the region will be approximately 5 percent less. Less consumptive use of water will slightly decrease the possibility of dewatering streams. Lower sediment loads will lessen degradation trout streams. Tailing pond spills or leaks should constitute less of a hazard to fisheries in the region.

The 1976 Statewide Comprehensive Outdoor Recreation Plan (SCORP) projected recreation participation in the state planning regions through 1990. This information is presented in table R2-73. Most of the 21 activity classes showed increased use in proportion to population increases; however, several activities, including tennis, boating, camping, picnicking, and skiing, showed higher rates of increase. Tennis in particular showed very high increases in Regions 11, and 12, as it had throughout Colorado. The growth of the ski industry should remain steady and account for much of the increase in the region.

The USBR has two projects in the region which will help provide facilities for increased boating, camping, and picnicking. The Dallas project will be a major reservoir (approximately 1,000 surface acres) on the Uncompahgre River. Construction has been authorized, and initial phases of construction are scheduled for 1978. The USBR has estimated visitor use would be 348,000 recreation days in the first year after completion.

The USBR Dominguez Dam project will be located between Escalante Canyon and Whitewater on the Gunnison River. Preliminary planning indicates potential for a 2-million-acre impoundment, which would provide 300,000 to 500,000 recreation days during its first year of use. This proposal is still being formulated, and a starting date has not yet been set.

The National Park Service has indicated that they intend to upgrade the visitor center and sanitary facilities at the Black Canyon of the Gunnison but do not plan any significant expansion or major developments for the monument in the future.

For the Curecanti National Recreation Area, the NPS has indicated an intention to expand the Elk Creek campground and develop a picnic area near Iola. Long-term planning for the recreation area includes possible campground development on Soap Creek at Ponderosa and at the east end of the reservoir, probably near North Willow Creek.

At the present time the NPS has no plans for new developments at the Colorado National Monument. A private development just outside the west entrance will provide 50 (and later 150) campsites for recreational vehicles.

The USFS and BLM are currently identifying all roadless areas over 5,000 acres for study as wilderness areas. Total acreages are not known at the present time but are substantial. Recreation use in these areas would be affected by the management objectives determined for them. Similarly, segments of the Colorado, Gunnison, and Dolores rivers are being studied for possible inclusion in the wild and scenic rivers system, and recreation use on portions of these rivers could be limited if they are designated as wild rivers.

The visual quality of the ES area's landscapes would continue to be affected by regional growth patterns, which would be most noticeable in Mesa and Garfield counties. The expansion of urban land use patterns in the Grand Valley landscapes would reduce the influence of the pastoral landscape character; development in the valley corridors could create an urban landscape image in many parts of the ES area.

Through the year 1990, vandalism and weathering would be the two major factors causing the loss of cultural values. It is doubtful that additional monies or employees would be available to retard this loss, although the Federal Land Policy and Management Act of 1976 will provide BLM with more protective enforcement authority. By 1990, certain delicate historic sites could be expected to be lost, while some sites (such as the Ashcroft, Colorado townsite) would remain in good condition due to patrols and ongoing restoration work.

TABLE R2-73

FIFTEEN-YEAR RECREATION PARTICIPATION PROJECTIONS IN COLORADO PLANNING REGIONS 10, 11, AND 12
(In Thousands of Activity Days)

Activity	Region 10 1990	Region 11 1990	Region 12 1990
Hiking	7,038.0	3,429.2	11,799.6
Horseback riding	1,280.6	1,073.4	1,649.0
Bicycling	4,073.4	5,645.2	3,435.9
Motorcycling	816.7	1,020.3	466.8
Sightseeing	7,592.7	5,695.0	12,317.9
Off-road vehicles	2,452.2	945.7	2,407.2
Technical mountain climbing	130.6	0	249.0
Swimming	760.3	2,445.7	2,876.0
Picnicking	3,522.3	2,271.2	4,450.1
Camping	3,834.7	2,703.5	6,396.5
Boating and rafting	425.8	741.2	926.6
Game playing	1,026.7	1,989.8	1,155.1
Tennis	94.3	277.3	876.7
Golfing	228.5	568.5	683.9
Target shooting	28.9	29.2	138.6
Downhill skiing	397.8	649.4	33,547.1
Cross-country skiing	337.6	14.6	1,574.1
Snowmobiling	199.3	262.6	546.7
Snowshoeing	0	0	469.9
Sledding and tubing	881.9	485.1	567.3
Ice skating	103.7	73.0	884.1
Other activities	1,409.2	1,250.8	946.5
Totals	36,635.2	31,570.7	88,364.6

Source: Colorado Division of Parks and Outdoor Recreation, 1976 Colorado Comprehensive Outdoor Recreation Plan.

CHAPTER 3

PLANNING AND ENVIRONMENTAL CONTROLS

This chapter discusses planning and environmental controls under which the proposed coal mines would be required to operate if they are approved. The chapter is in three sections: (1) legal, regulatory, and policy framework; (2) land use plans, controls, and constraints; and (3) interrelationships.

Legal, Regulatory, and Policy Framework

Coal Resource

Federal coal leasing is conducted in a manner to assure environmental protection to the maximum extent practicable, in addition to achieving orderly and timely mineral resource development and assuring a fair return for the mineral resource. The two laws that provide the basic authorities for leasing and management of federal minerals, including coal, are the Mineral Leasing Act of 1920 (41 Stat. 437, as amended; 30 USC 181 et seq.) and the Mineral Leasing Act for Acquired Lands (61 Stat. 913; 30 USC 351-359).

The Federal Land Policy and Management Act of 1976 (90 Stat. 2743; 43 USC 1701-1771) authorizes the Bureau of Land Management (BLM) to retain public lands for multiple-use resource management (e.g., for mining claims, for public hunting, fishing, camping, and other outdoor recreation, for wilderness, and for production of natural resource products). In addition, the act has given BLM the authority to carry out comprehensive land use planning, has abolished or consolidated a number of old public land laws, and has authorized BLM to promulgate regulations and policy governing all aspects of public land management.

With respect to coal leasing and development, these laws are implemented by the BLM and the U.S. Geological Survey (USGS) under the following regulations.

Title 43(CFR): 3041 sets forth the regulations governing reclamation; use of surface; bond requirements; and environmental assessment and technical reports relating to leases, permits, and licenses issued by the BLM with respect to federal coal deposits located on public and acquired lands of the United States and reserved deposits underlying lands with privately owned surface. The regulations require that adequate measures be taken during exploration or mining of federal coal to avoid, minimize, or correct damages to the environment (land, water, and air) and hazards to public health and safety, while ensuring orderly development of the federal coal deposits.

Title 43(CFR): 3500 provides procedures for leasing and subsequent management of federal coal deposits (among other minerals).

Title 43(CFR): 2800 establishes procedures for issuing rights-of-way to private individuals or companies on public lands and for identifying and protecting environmental resources that could be affected by right-of-way construction for coal-related projects.

Title 30(CFR): 211 governs operations for discovery, testing, development, mining, and preparation of federal coal under leases, licenses, and permits pursuant to 43(CFR): 3500. The regulations in Part 211 are intended to promote orderly and efficient operations and production practices without waste or avoidable loss of coal or other mineral-bearing formation; to encourage maximum recovery and use of coal resources; to promote operating practices which will avoid, minimize, or correct damage to the environment (including land, water, and air) and hazards to public health and safety; and to obtain a proper record of all coal produced.

The Surface Mining Control and Reclamation Act of 1977 (30 USC 1201 et seq.) regulates surface mining and the surface effects of underground mining of all coal deposits and is implemented by the Office of Surface Mining (OSM) under the interim regulations in Title 30(CFR): 700. The act and regulations provide for environmental performance standards for surface coal mining and reclamation operations; requirements and standards for surface operations associated with underground mining; inspection and enforcement procedures, including the assessment of civil penalties; requirements and approval procedures for state programs; requirements for surface coal mining and reclamation operations on public lands; procedures for state and federal designation of areas unsuitable for surface or underground coal mining operations; special performance standards for steep slope mining, mountain top removal, prime farmland, and standards for mining in alluvial valley floors; requirements and procedures for approval of state mining permits; and requirements for posting, release, and forfeiture of performance bonds.

The Division of Mines of the Colorado Department of Natural Resources requires the filing of a notice of activity for any proposed exploration or mining in the state. The division also monitors mine safety practices in concert with the Mine Safety and Health Administration (MSHA); common procedure is for the state to conduct the monitoring with MSHA overview.

The Colorado Mined Land Reclamation Board (Colorado Department of Natural Resources) issues a permit based on an acceptable M&R plan, and performance bond. The plan must comply with the Colorado Mined Land Reclamation Act of 1976, which set standards, practices, time factors, and reporting proedures. Under cooperative agreement, pursuant to Section 523(c) of SMCRA and effective July 1, 1977, between the state of Colorado and the Department of the Interior, the Colorado Mined Land Reclamation Board of the Colorado Department of Natural Resources is responsible for administering and enforcing federal reclamation requirements on federal coal leases in Colorado.

Protection of Other Resources

The regulations in 43(CFR): 3041 and 30(CFR): 211 and 700 are used as the primary guidelines to ensure environmental protection in the coal development process. However, other authorities specifically emphasize protection of certain resources.

AIR QUALITY

The proposed federal action would be constrained by provisions of the federal Clean Air Act, as amended (42 USC 7401 et seq.). The 1977 Clean Air Act amendments revised portions of the 1970 amendments and added several new sections to the Clean Air Act. Regulations implementing the act are primarily developed and enforced by the U.S. Environmental Protection Agency (EPA) through 40(CFR): 50-54 and 60. In addition, Colorado has responsibility for developing and enforcing a state implementation plan (SIP) to meet the requirements of the EPA regulations. The SIP is administered by the Air Pollution Control Commission of the Colorado Department of Health. The state also has passed rules which set ambient standards and increments more stringent than required by the federal Clean Air Act. A further description of the federal and state ambient standards and increments is presented in chapter 2, Air Quality.

The 1977 Clean Air Act amendments set forth requirements for the prevention of significant air quality deterioration (PSD) for total suspended particulates and sulfur dioxide. These requirements have just recently been implemented by the EPA through revisions to 40(CFR): 52. The regulations will be enforced by the EPA until the state of Colorado includes them in its SIP.

Fugitive dust emissions are the most significant emissions from coal mines. However, fugitive dust will generally not be considered in determining PSD compliance of surface and underground coal mines.

Any coal mine with potential (uncontrolled) fugitive dust emissions of 250 tons per year or more will be subject to the requirements for PSD. Mines with uncontrolled emissions of less than 250 tons per year will not require a PSD permit.

Not all mines with uncontrolled emissions of at least 250 tons per year will receive full PSD review. Mines with allowable (controlled) fugitive dust emissions less than 50 tons per year or 1,000 pounds per day will not be required to apply best available control technology (BACT) in order to get a PSD permit, nor will it be necessary to demonstrate that the mine will not cause a violation of a PSD increment or a National Ambient Air Quality Standard (NAAQS). Monitoring data will not be required, unless the mine will impact a Class I area, nor will impacts on visibility have to be determined.

Coal mines with controlled fugitive dust emissions of at least 50 tons per year or 1,000 pounds per day will receive a full PSD review. This includes a case-by-case determination of BACT, an ambient impact analysis of whether the mine will cause a violation of the PSD increment or NAAQS, and a determination of the impact of the mine on visibility. Air quality monitoring data may also be required. However, in determining the air quality impact of the mine, fugitive dust emissions as defined by EPA will not be included. This will exclude most coal mine particulate emissions with the exception of those caused directly by removing and processing coal.

In addition to PSD permit requirements, all mining operations will be required to obtain permits from the state based on Colorado Air Pollution Control Commission Regulation No. 1.

WATER QUALITY

Legislation and regulations which apply to water quality include the following:

- Federal Water Pollution Control Act, as amended (33 USC 466)
- Water Quality Act of 1965 (33 USC 1151)
- Water Resources Planning Act (42 USC 1462)
- Colorado Water Quality Control Act of 1970 (CRS 25-8-101 et seq.)

National standards to restore and maintain the chemical, physical, and biological integrity of the nation's waters were promulgated by the Federal Water Pollution Control Act, as amended in 1972.

The Colorado Department of Health has primary responsibility for water pollution control in the ES area. The department published a booklet (1974) describing water quality standards for Colorado as defined in the Water Quality Control Act of 1973. These standards are intended to be consistent with the goals and policies of the Federal Water Pollution Control Act amendments of 1972. The basic water quality standards applicable to all Colorado waters follow (Colorado Department of Health 1974).

Municipal, industrial, or agricultural discharges are forbidden to pollute state waters with objectionable sludge deposits, unsightly or harmful floating debris or scum, undesirable color or taste, toxic substances, oil films or grease globules, or substances or conditions that produce undesirable aquatic life. Furthermore, both radioactivity and salinity are to be maintained at the lowest possible levels.

With regard to the Colorado River system and its tributaries, the state of Colorado will cooperate with other Colorado River Basin states and the federal government to support and implement conclusions and recommendations adopted April 27, 1972, by the reconvened Seventh Session of the Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries.

The Colorado Department of Health, Water Quality Control Commission, has adopted rules that became effective August 21, 1975. Regulations for effluent limitations, codified in Colorado Revised Statutes (CRS) 25-8-205, as amended, outline the authority of the Water Quality Control Commission, regulations, technical data, the specific limiting parameters for the discharge of water which are summarized in table R3-1, sampling and analytical techniques, and requirements for discharge permits. Sections 25-8-202(2), 25-8-205, 25-8-207(1), and 25-8-704, CRS, 1973, require site review and approval by the Water Quality Control Commission and the issuance of any necessary discharge permits before any sewage treatment works begins operating. Section 25-8-205, CRS, 1973, forbids the discharge of waste from industrial, commercial, or sanitary sources into a storm sewer without an appropriate permit, and does not allow connection of a drainage system for other than storm water to a storm sewer.

State of Colorado statutes CFR 37-87-122 establish state criteria for erosion control dams. The use of ground water in Colorado is controlled by CRS 37-90-107, which requires people wanting to appropriate ground water for a beneficial use to make application to the commission.

NOISE CONTROL

The Federal Noise Cntrol Act of 1972 states that "primary responsibility for control of noise rests with State and local governments." The EPA establishes noise emission standards for new equipment. In conjunction with the Federal Aviation Administration (FAA), the EPA establishes regulations to control aircraft noise. Railroad noise emission standards are established by the EPA after consultation with the Secretary of Transportation. Standards for vehicles engaged in interstate commerce are established in a similar manner. Enforcement of these regulations is the responsibility of the Department of Transportation through the Bureau of Motor Carrier Safety.

For motor vehicles not engaged in interstate commerce the state of Colorado has established noise emission standards. Enforcement of these standards has been delegated to county and municipal governments and to regional health departments.

Under the Colorado noise abatement statute (CRS Title 25, Article 12), sound levels measured 25 feet within property zones are considered public nuisances if they exceed the values listed in table R3-2. In daytime hours the levels indicated in table R3-2 may be increased 10 decibels (dBA) for a period not to exceed 15 minutes in a one-hour period. Periodic, impulsive, or shrill noises are penalized 5 dBA. Construction projects and railroad rights-of-way are considered as industrial zones.

Counties or municipalities may adopt ordinances prohibiting the operation of motor vehicles which exceed the standards presented in table R3-3. Municipal standards must be at least as restrictive as those in the table. Measurements will be made 50 feet or more from the center of lane of travel. The standards listed in table R3-3 for vehicles with gross weight of 6,000 pounds or more correspond to the federal standard for motor carriers engaged in interstate commerce (40[CFR]: 202).

Noise analyses contained in this ES do not take into consideration proposed changes in federal noise standards for construction and earth moving equipment, motor vehicles, and railroad rolling stock.

CULTURAL RESOURCES

Authorities which apply to cultural resources include the following:

Antiquities Act of 1906 (34 Stat. 225; 16 USC 431-433)

Historic Site Act of 1935 (49 Stat. 666)

Historic Preservation Act of 1966 (80 Stat. 915; 16 USC 470)

National Environmental Policy Act of 1969 (33 Stat. 852; 42 USC 4321 et seq.)

TABLE R3-1

STATE OF COLORADO
PARAMETERS LIMITING DISCHARGE OF WATER

Parameter	7-Day Average	30-Day Average
BOD_5	45 mg/l	30 mg/l
Suspended solids	45 mg/l	30 mg/l
Fecal coliform	(As determined by the Colorado State Health Department)	
Residual chlorine	0.5 mg/l	0.5 mg/l
pH	6.0-9.0	9.0-9.0
Oil and grease	10 mg/l (no visible sheen)	10 mg/l

Note: mg/l = milligrams per liter; BOD_5 = five-day biological oxygen demand.

TABLE R3-2

PARAMETERS LIMITING NOISE LEVELS WITHIN 25 FEET OF PRIVATE PROPERTY

Zone	Daytime (7:00 a.m.-7:00 p.m.) (dBA)	Night (7:00 p.m.-7:00 a.m.) (dBA)
Residential	55	50
Commercial	60	55
Light Industrial	70	65
Industrial	80	70

Note: Sound levels which exceed these levels are considered public nuisances (CRS, Title 25, Article 12). dBA = decibels; measured on the A-scale.

TABLE R3-3

PARAMETERS LIMITING MOTOR VEHICLE NOISE IN COLORADO COUNTIES AND MUNICIPALITIES

	Speed Limit	
	35 mph or Less	Over 35 mph
Vehicles with gross weight of 6,000 lbs. or more	86 dBA	90 dBA
Vehicles designed primarily for off-road use	82 dBA	86 dBA

Note: Measurements must be made 50 feet or more from the center of the lane of traffic. dBA = decibels; measured on the A-scale.

Archeological and Historical Data Conservation Act of 1974

Executive Order 11593

Procedures for the Protection of Historic and Cultural Resources (36[CFR]: 800)

Colorado Antiquities Act of 1973

Colorado Land Use Act of 1974 (House Bill 1041)

Federal and state legislation has been established to protect and manage cultural resources. The 1906 Antiquities Act and the 1973 Colorado Antiquities Act declare it illegal to appropriate or damage historic and archeological values on federal and state lands. Any person collecting or excavating without the proper permit is subject to fine or imprisonment. The Historic Preservation Act of 1966 created the National Register of Historic Places and the National Advisory Council on Historic Preservation. Federal actions affecting properties eligible for the National Register must be submitted to the council for review prior to approval. Impacts to sites that fall outside National Register criteria will be mitigated according to the professional judgment of the contracting archeologist, pending review and approal of the surface managing agency.

Executive Order 11593 requires all federal agencies to cooperate with nonfederal agencies, groups, and individuals to ensure that federal plans and programs contribute to the preservation and enhancement of nonfederally owned historic and cultural values. Section 2a requires that federal agencies locate and inventory cultural resources and nominate eligible sites to the National Register of Historic Sites.

No mining plans or rights-of-way will be approved without the identification and mitigation of existing cultural values (in accordance with 30[CFR]: 800 and Executive Order 11593), pending review by the Colorado State Preservation Officer and the National Advisory Council on Historic Preservation. Approvals will require that the USGS Area Mining Supervisor be notified, of any archeological sites discovered during mining and that the appropriate officer of the surface management agency be notified of sites discovered during right-of-way construction.

PALEONTOLOGICAL RESOURCES

The BLM and USGS are currently developing a memorandum of understanding for the protection of paleontological resources on federal lands. The agencies are also developing technical guidelines to define the resource and provide criteria for evaluation and measures for protection. When completed, the provisions of these documents will serve as a basis for management and protection of paleontological resources and appropriate protection program.

WATER IMPOUNDMENTS

Requests can be granted for water impoundments on public lands containing important cultural and recreational values, pending decisions by the State Engineer, through the Reservoir Salvage Act of 1960 (74 Stat. 220) and the National Environmental Policy Act of 1969 (83 Stat. 852, 42 USC 4321 et seq.). If a planned reservoir covers public land surface or mineral estate and its water is designated for another federally approved project, it will first be assessed under the requirements of the National Environmental Policy Act and the salvage requirements of the Archeological and Historical Data Conservation Act of 1974. If cultural values are located, they will be evaluated according to the provisions of Section 106 of the National Historic Preservation Act and Section 2(b) of Executive Order 11593 (see Cultural Resources above).

RAILROADS

The Interstate Commerce Act (49 Stat. 543, 49 USC 1(18)) requires prior approval by the Interstate Commerce Commission for extension or new construction of a line of railroad or for abandonment of a line of railroad. Spur, industrial team, switching, or side tracks located wholly within one state are exempted from this authority.

In Colorado the Public Utilities Commission and the Colorado Department of Highways are concerned with railroad construction and abandonment especially where crossings of public roads by a railroad are necessary.

MINERAL PROTECTION

Priorities for mining coal or drilling for oil and gas on public lands are established by the Conservation Division of the U.S. Geological Survey (USGS). Mining operations approaching wells or bore holes that may liberate oil, gas, water, or other fluid substances must be approved in accordance with 30(CFR): 211.17 and 211.63.

MINERAL RESOURCES

Section 317(a) of the Federal Land Policy and Management Act of 1976 (FLPMA) provides that all money received from sales, bonuses, royalties and rentals of the public lands under the provisions of the Mineral Leasing Act of 1920 shall be paid into the Treasury of the United States. Fifty percent of this money shall be paid by the Secretary of the Treasury as soon as practicable after March 31 and September 30 of each year to the state other than Alaska within the boundaries of which the leased lands or deposits are or were located.

Such money paid to any state on or after January 1, 1976 is to be used by the state and its subdivisions, as the legislature of the state may direct, giving priority to those subdivisions of the state socially or economically impacted by development of minerals leased under the Mineral Leasing Act of 1920, for (1) planning, (2) construction and maintenance of public facilities, and (3) provision of public service.

Section 317(c) of FLPMA authorizes the Secretary of the Interior to make loans to states and their political subdivisions in order to relieve social or economic impacts occasioned by the development of minerals leased in such states pursuant to the Mineral Leasing Act of 1920. Such loans shall be confined to the uses specified for the 50 per cent of the act. All loans shall bear interest at a rate not to exceed 3 percent and shall be for such amounts and durations as the Secretary shall determine. The Secretary shall limit the amounts of such loans to all states except Alaska to the anticipated mineral revenues to be received by the recipients of the loans. Such loans shall be repaid by the loan recipients from mineral revenues to be derived from section 35 of the Act by such recipients as the Secretary determines.

ENDANGERED SPECIES

The Endanger Species Act of 1973 (87 Stat. 844; 16 USC 1531-1543) protects listed species (both vegetation and animals) and their critical habitat. Before authorizing any significant disturbance of lands under lease or permit, The Department of the Interior will make a survey to determine if listed species or their habitat may be present. If it is determined that listed wildlife species or their habitat may be present and could be affected by the proposed activities, no activities will be authorized until the U.S. Fish and Wildlife Service has been consulted and given clearance for the project as required by the 50(CFR): 402 regulations. No actions will be authorized until this mandatory consultation is completed. Under the Bald Eagle Protection Act of 1969 (16 USC 668-668c), mining operations are not permitted in any area where such activities would harm or disturb bald or golden eagles or their nests.

FISH AND WILDLIFE RESOURCES

Under the Fish and Wildlife Coordination Act of 1958 (16 USC 470), the U.S. Fish and Wildlife Service is to be consulted about any action which would affect the habitat of any fish or associated wildlife resource.

Other Authorities

With respect to impacts of coal mining, the BLM and U.S. Forest Service (USFS) are also dependent upon the following authorities, directives, and guidelines to ensure enhancement and protection of the quality of the environment on the public lands:

Statutes:

National Environmental Policy Act of 1969 (PL 91-190, 42 USC 4321, January 1, 1970)

Solid Waste Disposal Act, as amended (42 USC 3254)

Noise Pollution and Abatement Act of 1970 (42 USC 1858)

Department of Transportation Act of 1966 (49 USC 1651)

Wild and Scenic Rivers Act of 1968

Intergovernmental Cooperation Act (40 USC 531 and 42 USC 4201)

Material Sales Act of July 31, 1947 (43 USC 1185)

Wild Free Roaming Horse and Burros Act of 1971 (16 USC 1331)

Wilderness Act (16 USC 1131 A, C; 1132 A, B, C)

Sikes Act Extension for Wildlife, October 18, 1974 (PL 93452, 16 USC 670)

Executive Orders:

Executive Order 11988, Flood Plain Management (May 24, 1977)

Executive Order 11514, Protection and Enhancement of Environmental Quality (35 FR 4247, March 5, 1970)

Executive Order 11991, Protection and Enhancement of Environmental Quality (May 24, 1977)

Others:

Intensity of Use and Management of Lands Retained for Multiple Use Management, 43(CFR): 1725.3-2

Guidelines of the Council on Environmental Quality, 40(CFR): 150

Noise Emission Standards, 40(CFR): 202

Table R3-4 lists federal and state permit requirements. Table R3-5 lists local statutes and regulations.

Land Use Plans, Controls, and Constraints

BLM Planning System

The BLM's land use planning system is based upon the concept of multiple resources management. The Federal Land Policy and Management Act of 1976 (43 USC 1701-1771) requires comprehensive land use planning for public lands. The Federal Coal Lease Amendments Act of 1975 (30

TABLE R3-4

FEDERAL AND STATE REGULATIONS GOVERNING AND REQUIRING PERMITS

Action	Regulations
Federal:	
Lease Issue	43(CFR): 3500
Exploration License	43(CFR): 3507
Major Drainage Effects	33(CFR): 209
Explosives License	18(USC): 40
Air and Water Quality	40(CFR): 52
State Notification	PL 92-500
Lease Identity	30(CFR): 82
Ventilation and Roof Support Approval	30(CFR): 77
Mining and Reclamation Plan Approval	43(CFR): 3041
	30(CFR): 211
Preparation Plant	40(CFR): 60
Clearance of Sale of Variety Mineral	43(CFR): 3610
	36(CFR): 251
Radio Use	Communication Act of 1934
Railroad Spur	ICC
Pollution Discharge	PL 92-500
Right-of-Way Permit	PL 94-579
Noise Emission Standards	40(CFR): 202
Medium and Heavy Truck Noise Emission Standards	40(CFR): 205
Dredge and Fill Permit	Section 404, Clean Water Act
State:	
Air Pollution	CRS 25-7-101, 1970
Water Discharge	CRS 25-8-501, 1973
Solid Waste	CRS 30-20-103 and 104, 1973
Sewage Disposal	CRS 20-10-104, 1973
	CRS 25-20-107, 1973
Site Application	CRS 25-8-101
Waste Water Treatment	CRS 25-9-101
Potable Water Supply	CRS 25-1-107
Radioactivity License	CRS 25-11-101
Erosion Control Dams	CRS 37-87-122
Diesel Permit	Bulletin 20, Colorado Division of Mines Memorandum CMI-52
Booster Fans	CRS 1973, Title 34, Article 25, Section 102
Roof Control	CRS 1973, Title 34, Article 26,
Major Drainage Effect	CRS 25-8-202 and 205
Exempt Well	CRS 37-92-602
Small Capacity Well	CRS 37-90-137
Well Construction	CRS 1973, Title 37, Article 91
Use of Ground Water	CRS 1973, 34-90-137
Explosives License	CRS 1973, Title 34, Article 27, Section 101-110
	CRS 1973, Title 34, Article 47, Section 103-104
	CRS 1973, Title 9, Article 7
Coal Mine License	CRS 1973, Title 34, Article 23, Section 101
Prospecting Permit	CRS 1973, Title 34, Article 32, (as amended)
Development and Extraction	CRS 1973, Title 24, Article 32, (as amended)
State Interest Areas	House Bill 1041
Noise Abatement	CRS 25-12-101, 1971
Application and Approval for Safety, Need, and Point of Crossing Public Right-of-Way	CRS 40-4-106

TABLE R3- 5

COUNTY REGULATIONS GOVERNING
AND REQUIRING PERMITS

County	Zoning Ordinance Section or Regulations
Delta	None
Garfield:	
Special Use Permit	7.03
Industrial Operation	4.03.07
	4.03.08
Gunnison:	
Guidelines	Section 3-6
Permit	Section 4-1
Review Procedure	Section 4-2
Impact Development	Section 4-9
Mineral Resource Area	Section 5-4
Mesa:	
Conditional Use Permit	AF-T Section XV, B, 5
Conditional Use	Supplementary Regulations (T)
Montrose:	
Mineral Resource Resolution	Article 28, Title 30, CRS 1973, amended
Ouray:	
Mineral Resource Regulations	Section 3A
Proven Mineral Resource Area	Section 3A.2, 1, B
Probable Mineral Resource Area	Section 3A.3, 1, B
	Section 3A.3, 2, D
Supplementary Regulations	7.2, A
	7.2, D
Pitkin:	
Special Use	1.02.02
Procedure	1.02.03 and 6.0
Geologic Conditions	2.04
Drainage	2.05 and 5.03
Sewage Treatment	2.07
Road	2.08; 2.09; and 5.21
Water Resources	2.22 and 5.09
Use Requirements	3.03, 36
	3.03, 40
Soil and Geologic Conditions	5.02
Erosion	5.04
Historic and Archeological	5.05
Air Quality	5.08
Road Construction	5.22
State Interest	5.40

USC 181 et seq.) requires that coal leasing and mining must be compatible with land use planning within any public land areas and directs that coal leases cannot be issued unless compatible with such plans.

BLM's planning process is guided by the basic resource inventory data called unit resource analyses (URAs) and by management decisions developed in the management framework plans (MFPs). The URA is a summarized and coordinated resource inventory prepared on planning units, which are the basic geographic units used by BLM to aggregate resource data. The MFP is the planning document which establishes objectives and constraints for each resource and support activity. The overlaps and conflicts are reconciled through extensive study and discussion, including public response.

There are fifteen planning units within the environmental statement (ES) area. All but three of the URAs were updated during fiscal years 1976 and 1977, when inventory data necessary to evaluate coal-related development in the region were accumulated. The other planning units have recently completed URAs and were not updated because they are unlikely to have coal development. The URAs that were updated indicate present and potential coal development within the ES area. Recommendations and decisions necessary to develop such proposals were subsequently worked out in the MFPs, which provide a set of management guidelines for the key resource values of the ES area. Table R3-6 lists the planning units and completion dates of URAs and MFPs for the ES area.

The major resource objectives related to coal development, established by the MFPs for the ES area, may be summarized as follows:

1. Establish corridors to provide utility and transportation systems to leased coal tracts. Applications must be consistent with criteria in the Federal Land Policy and Management Act of 1976 and regulations developed from the act.
2. Applications for future utility and transportation rights-of-way to leased coal tracts will be considered case-by-case. The rights-of-way should be routed so that they fall within approved corridors. Temporary use permits issued in connection with rights-of-way will be evaluated case by case and confined to corridor areas where possible.
3. Assist energy impacted communities by identifying and providing tracts of public lands to qualified applicants for recreation or other public uses.
4. Designate areas of potential interest for coal development.
5. Review exploration, mining, and reclamation plans accepted by USGS and assess environmental impacts prior to any development.
6. Locate exploration and mining roads to minimize damage to valuable watershed, wildlife, recreation, and natural areas and management facilities.
7. Allow for the construction of mining-associated facilities (i.e., access roads, transmission lines, water lines, waste disposal sites, etc.) in appropriate locations on public lands.
8. Include in all permits stipulations requiring reclamation of all disturbed areas.
9. Maintain the Little Bookcliffs Wild Horse Area in a primitive condition, allowing only minimal development that would be compatible with the maintenance of suitable habitat for the wild horse herd.
10. Designate the Little Bookcliffs Wild Horse Area as a wildland study area for possible designation as wilderness. Until the study is completed, an interim management policy is adopted, restricting motorized transportation, facilities construction, and surface occupancy on mineral leases, and imposing strict stipulations on development of existing mineral leases.
11. Apply watershed protection guidelines to all surface disturbing activities on public lands (i.e., mining exploration and development, timber sales, road construction, etc.).
12. Protect critical wildlife habitat by restricting vehicular and development activity (e.g., mineral exploration and construction or off-road vehicle use) during winter periods when animals are concentrated (December 1 to April 15) or during calving and fawning periods (May 1 to June 20).
13. Provide buffer areas (0.25 mile) around raptor nests, restricting human activity seasonally (April 1 to June 1) and prohibiting physical disturbance of nesting areas.
14. Do not construct fences which would impede big game movement (16-inch bottom height and 42-inch top height).

It should be noted that the MFP by definition provides fairly broad guidance concerning management direction and constraints from which to develop more detailed plans of action for resource management, involving programs such as range, wildlife, soils, watershed, minerals, cultural resources, and realty management on public lands.

BLM Wilderness Review

The Federal Land Policy and Management Act of 1976 (FLPMA) directs the BLM to inventory public lands and identify those lands having wilderness characteristics as defined in the Wilderness Act of September 3, 1964. In the FLPMA man-

TABLE R3-6

BLM PLANNING SCHEDULE

Resource Area	Planning Unit	MFP	MFP Completion Date
Grand Junction District:			
Glenwood Springs	Battlement	Garfield*	6/75
	Cliff	Garfield*	6/75
	Grand Hogback	Garfield*	6/75
	Roaring Fork	Roaring Fork-Newcastle*	9/73
	Newcastle	Roaring Fork-Newcastle*	9/73
Grand Junction	Baxter-Douglas	Baxter-Douglas/Glade Park*	4/74
	Glade Park	Baxter-Douglas/Glade Park*	4/74
	Mt. Garfield	Mt. Garfield*	1/70
	DeBeque	Roan Creek-Winter Flats*	1/71
	Collbran	Whitewater*	4/77
	Kannah Creek	Whitewater*	4/77
	Dominguez	Whitewater*	4/77
	Gateway	Whitewater*	4/77
Montrose District:			
Uncompahgre Basin	Alkali	Alkali-North Fork*	6/76
	North Fork	Alkali-North Fork*	6/76
	Escalante	Escalante	6/71
	Cimarron	Cimarron	6/76
	Gunnison Gorge	Gunnison Gorge	6/76

* Each of these MFPs was updated during the last quarter of fiscal year 1977 to develop URA information and MFP decisions concerning coal development and other resource activities in the ES area. Public meetings were held, and MFP decisions were approved by the State Director of Colorado in September 1977.

date, Congress set several specific requirements including: (1) recommendations on all natural or primitive areas formally identified prior to November 1, 1975, must be reported to the President by July 1, 1980; and (2) within 15 years of the date of approval of the act (October 21, 1976), all roadless areas of 5,000 acres or more and all roadless islands of public land with wilderness characteristics must be reported to the President, and each must be accompanied by a suitability or nonsuitability recommendation.

The proposed Wilderness Review Process consists of three phases:

1. Wilderness Inventory: preliminary identification of roadless areas and islands with wilderness characteristics (referred to as "Wilderness Study Areas").
2. Wilderness Study: applied to all wilderness study areas resulting in a finding as to whether the area, or part of it, is suitable or not suitable for wilderness; it involves the identification and consideration of all resource opportunities in the area.
3. Wilderness Reporting: recommending further study and reporting results on wilderness study areas to the President, along with statements as to the suitability of wilderness designations; based on the President's decisions, recommendations will be sent to Congress.

In each of these phases, the public will be invited to participate. From the time an area is identified as a wilderness study area to the final recommendation, it will be managed so that multiple use activities will continue under interim management, which will allow maximum use while protecting the wilderness values.

Wilderness areas are discussed throughout the ES under Recreation in the Land Use Section.

U.S. Forest Service Planning

The USFS provides requirements to BLM to be incorporated into the mineral leasing process for administration of the surface activities. Basic management direction is established principally under the Federal Land Policy and Management Act of 1976, the Multiple Use Act, the Wilderness Act, the National Environmental Policy Act of 1969, and the National Forest Management Act. From this basic direction, local management is developed through land use planning.

As a part of the basic direction of the Wilderness Act, a roadless area review and evaluation (RARE II) is being conducted by the USFS to inventory all roadless areas that meet certain criteria. Management is constrained on each of the inventoried areas pending final determination to place it in the wilderness system or to use it for nonwilderness purposes. In the interim, these inventoried areas will be managed in a way that will not prejudice the purpose of RARE II or degrade the physical characteristics of the area which permitted it to be placed on the inventory.

RARE II areas are discussed throughout the ES under Recreation in the Land Use section.

State and Local Controls and Land Use Plans

The state of Colorado has the authority and administrative ability to control the use of land owned by the state, although the state's constitution places an emphasis on maximizing revenue production from such lands. In addition, a few state agencies have regulatory authority over certain activities on both public and private lands. For example, the Mined Land Reclamation Board requires permits for mining reclamation, the Water Quality Control Commission reviews any application to discharge into the state's waters, the State Engineer licenses wells and administers the state's water laws, etc.

Section 208 of the Clean Water Act (PL 92-500) provides authority and funding for planning to identify and control point and nonpoint sources of water pollution from public and private land. In the ES area, the Region 11 and 12 Councils of Government have been designated as responsible agencies for those planning regions. In region 10, the state has maintained responsibility for 208 planning, although it has delegated the ongoing planning function to the District 10 Regional Planning Commission.

However, overall state involvement in land use planning and control in Colorado is very restricted. State enabling legislation allows units of local government to adopt and enforce such basic land use tools as zoning ordinances, subdivision regulations, and comprehensive plans. The State Land Use Act (HB 1041) establishes the only means by which the state government has direct involvement in general land-use decision-making.

HB 1041 maintains the philosophy, which is predominant in Colorado, that land use control should be preserved at the local level. It does require all local governments to identify and designate specific "areas and/or activities of state interest" within their jurisdictions. Areas that may be designated as "areas of state interest" include the following:

1. Mineral resource areas
2. Natural hazard areas
3. Areas containing or having significant impact upon historical, natural, or archeological resources of statewide significance
4. Areas around key facilities (airports, major public utility facilities, arterial highway interchanges, etc.) in which development may have a material effect upon the facility or the surrounding community

Activities deemed to be eligible for designation as "activities of state interest" include the following:

1. Site selection and construction of major new domestic water and sewage treatment systems and major extensions of existing domestic water and sewage treatment systems
2. Site selection and development of solid waste disposal sites
3. Site selection of airports
4. Site selection of rapid or mass transit terminal, stations, and fixed guideways
5. Site selection of arterial highways and interchanges and collector highways
6. Site selection of major facilities of a public utility
7. Site selection and development of new communities
8. Efficient utilization of municipal and industrial water projects
9. Nuclear detonations

A deadline of June 30, 1976, was established for all counties to adopt regulations concerning the management of floodplains, geological hazards, wildfire hazards and mineral resource areas in order to remain in the program.

Once any of these areas or activities is designated by local government under the HB 1041 process, the Colorado Land Use Commission reviews any proposed land-use changes in designated areas or any proposed designated activities. The ultimate control over land use, even in designated areas, still rests with the local jurisdiction, despite any recommendations forwarded from the state level. A provision of HB 1041 allows the State Land Use Commission to impose temporary emergency power, staying a decision on a change of land use for a short period of time. This power has been used only in extreme cases where a local government has clearly ignored its responsibility.

Local comprehensive planning and land use regulations vary widely among the local jurisdictions in the ES area. Gunnison, Pitkin, Mesa, Montrose, and Ouray counties have adopted regulations concerning the management of floodplains, geological hazards, wildfire hazards, and mineral resource areas pursuant to HB 1041. Delta County has adopted a resolution to participate in the HB 1041 program and is in the process of mapping, conducting studies and preparing guidelines for land use administration of some areas or activities addressed in the legislation. Garfield County has not to date participated in the HB 1041 program.

In addition, Pitkin, Garfield, Mesa, and Ouray counties have adopted zoning resolutions for their entire unincorporated areas, and Montrose and Gunnison counties have similar controls over portions of its areas. Delta County has no zoning or similar regulatory control. All of the counties have subdivision regulations as required by law although a significant amount of subdivision (especially in Delta County) is exempted from the application of these requirements.

While local governments have ample authority over land use concerns, problems remain with respect to intergovernmental coordination and funding for planning. Some programmatic plans are prepared at the state or regional level (state highway plans, 208 water quality plans, economic development plans, for example). All of the local government planning staffs in the ES area cite budgetary restraints as a prime reason for the lag in comprehensive planning. HUD's 701 program has been reduced to the point where virtually no federal money is available to local planning efforts. In the 1978 session, the Colorado General Assembly eliminated a state program that had awarded $25,000 annually to each county planning office since 1974. A limited amount of state planning subsidies remain available to local government on an equal matching basis.

GUNNISON COUNTY

Gunnison County has adopted a county comprehensive plan and land use resolution, made up of four main parts: policies, impact classifications, hazard/constraint zones, and design criteria. Major policy items include strengthening basic industries, broadening employment opportunities, protecting agricultural productivity, discouraging overbuilding of housing, discouraging development outside existing urbanized areas, eliminating the degradation of air or water quality, and minimizing the loss of wildlife habitat. It is established in the land use resolution that "no permit shall be issued for any land use changes which substantially conflict" with these policies.

The Gunnison County land use resolution requires detailed information to be provided on any proposed development within hazard/constraint zones. These areas are identified as avalanche hazard areas, landslide-earthflow hazard areas, rockfall hazard areas, mudflow-debris fan areas, unstable or potentially unstable slope area, floodplain hazard zones, wildfire hazard zones, and wildlife resource areas. The resolution contains specific design criteria with which a development in any of the ES areas must comply before it can be approved. In addition, the resolution identifies mineral resource areas, where no development would be allowed which would prevent the exploration for and extraction of economic mineral resource deposits.

The land use resolution also provides that each proposed development be classified in terms of its potential impacts. A proposed development can be placed in one of four impact classifications: no impact, minor impact, moderate impact, or major impact. If the development falls within either the moderate or major impact classification, as would Atlantic Richfield Corporations's proposal for the Mt. Gunnison No. 1 Mine, information is required to be provided to the county on the effects of that development upon adjoining lands; on the economic, social, government, and environmental systems; and its compatability with the policy, guidelines, and decision criteria of the county. The availability of water and sewage service, the adequacy of storm drainage, and the capability of financing these systems must be considered, in addition to all other hazard/constraint factors before that type of development can be approved.

PITKIN COUNTY

Pitkin County has adopted a growth-management policy plan, the primary element of which is a 3.47 percent ceiling on the annual growth rate of total residential housing units. This rate was arrived at through consideration of the rate of growth which could be sustained by local services and the capacities of existing zoning over a fifteen-year period. The county has been divided into four separate growth management areas, with each assigned a specific maximum annual growth rate. These rates of growth are expected to be maintained from growth in the recreation industry, with additional coal mining not expected to contribute to population growth in Pitkin County.

Along with a ceiling on residential growth, Pitkin County has adopted other policies which should affect its development process. It is county policy to prevent development which would be subject to natural or human hazards; to preserve natural drainages and prevent excessive run-off; to ensure that adequate potable water and sewage treatment is available; to prevent excessive traffic volume creating traffic hazards; to protect historical or archeological sites; to preserve the economic viability of agricultural lands; to prevent any reduction in the quality of public services or facilities; to maintain an adequate number of low- and moderate-income housing units; to preserve the scenic quality of the county; to preserve the air quality and water resources of the county; and to preserve compatability with existing land uses.

In order to implement these policies, the county has adopted a land use code, which combines the elements of zoning, subdivision regulation, and impact analysis. The land use code also identifies six areas and nine activities of local and state interest, most of which are similar to those identified by HB 1041. A special review is required before any development is permitted in areas of local or state interest or any of the activities of local or state interest are approved.

A mining operation such as Anschutz Coal Corporation's North Thompson Creek mines, is permitted within Pitkin County only after complying with special review procedures. These procedures require the applicant to submit detailed information on the effects of the proposal upon the physical environment, fiscal and design aspects of public facilities and services, and the social environment. The proposal is then evaluated in terms of its conformity with stated policies in each of these areas.

MESA COUNTY

Mesa County adopted a comprehensive plan in 1967. The county also has subdivision regulations and zoning regulations and zoning resolutions. The communities of Grand Junction, Palisade, and Fruita each have their own zoning resolutions and subdivision ordinances, but only Grand Junction has adopted a comprehensive plan. Mesa County and the city of Grand Junction are attempting to rewrite and integrate their two sets of regulations into one nonconflicting manual.

The Mesa County zoning resolution identifies seventeen zoning classifications within the central Grand Valley area, including eight residential districts, one planned development district, six commercial districts, and two industrial districts. Mobile home parks are permitted only within specific mobile home zones. The remainder of the county is included in an agriculture and forestry district. Mining and extra-active industries are permitted in this district by conditional use. GEX Colorado Company's Cameo mines and Mid-Continent Coal and Cokes Coal Canyon and Cottonwood Creek mines would be located in this district.

The conditional-use review process in Mesa County requires that two public hearings be held, that the county planning commission review the proposal, and that the county commissioners approve or deny the proposal. The county has no specific regulations which address mining activities, but it is drafting mineral resource regulations which would comply with state HB 1041 guidelines. These regulations are expected to be adopted by early 1979.

Mineral resource mapping for the county is approximately 85 percent complete, with full completion of the mapping program scheduled for late in 1978. Geologic hazard areas are being mapped but have not been designated as yet. Floodplain areas have been mapped and designated, and regulations concerning them have been adopted.

MONTROSE COUNTY

Montrose County is currently updating and revising the comprehensive plan for the immediate vicinity of the city of Montrose. No comprehensive plan exists for the remainder of the county, although the county is preparing a series of base maps and land use maps for the developed areas of the county.

The entire county is covered by subdivision regulations, which the county planning department has recently updated. The county zoning resolution is concerned solely with the developed areas surrounding the city of Montrose.

As a result of the HB 1041 program, Montrose County has adopted specific ordinances to regulate development in floodplain hazard areas, wildfire hazard areas, geological hazard areas, and mineral resource areas. The county requires that permits be obtained for development within any of these areas. In order to develop or explore within a mineral resource area, a company must submit maps and plans for the area to be developed and a general schedule for exploration or development.

OURAY COUNTY

Ouray County is developing a county-wide master plan and updating zoning and subdivision regulations for all jurisdictions within the county. The county has also developed specific regulations for geologic hazard areas, wildfire hazard areas, mineral resource areas, and wildlife resource areas, pursuant to HB 1041 guidelines.

GARFIELD COUNTY

Garfield County is updating the county's master plan, which was developed in 1968. The county has implemented subdivision regulations and a county zoning resolution, which it is also updating. All lands owned by the U.S. Government are included in an open-space zone. Extraction, processing, fabrication, and storage of natural resources is allowed within this zone subject to special-use permit.

In order to obtain a special use permit for a mining operation, the applicant must prepare and submit an impact statement to the county which describes the location, slope, design and construction schedule. It must be shown in the impact statement that the project would not have a significant adverse effect upon existing water sources through depletion or pollution; adjacent land use through generation of vapor, dust, noise, glare, or vibration; wildlife or domestic animals through the creation of hazardous attractions, alteration of vegetation, or blocking of migration routes. In addition, truck or automobile traffic generated by the operation should not cause hazards or nuisances to any areas of the county. All of these conditions would apply to Sheridan Enterprises, Loma project in western Garfield County.

Garfield County has not participated in the HB 1041 program in recent years; consequently, it does not have the regulations governing hazard or constraint areas that many of the other counties within the ES area have. The county does have a floodplain ordinance, but it feels that existing floodplain mapping is inadequate for the proper management of floodplain areas.

DELTA COUNTY

Delta County does not presently have a county zoning resolution or a county comprehensive plan. Since most growth and development are occurring within unincorporated areas of county jurisdiction, they are essentially unregulated at the present time.

However, the county has requested a grant from the Farm Home Administration to establish a development-permit system which would take the place of a conventional comprehensive plan. Under this system, community groups for each incorporated area and surrounding unincorporated areas would establish goals and objectives for an area would be used as criteria to evaluate a proposed development in that area. If a proposed project would be likely to have a major impact, it would be subject to a thorough review, public hearings, and perhaps an environmental analysis.

In addition, the county is carrying out a study of water systems in the area to determine the capacity of various communities and agricultural areas to accommodate growth. A flood plain study is also under way. When it is completed, possibly by early 1979, the county will adopt appropriate floodplain regulations.

Interrelationships

On September 27, 1977, the U.S. District Court for the District of Columbia ruled in NRDC vs. Hughes that the 1975 final coal leasing programmatic environmental impact statement was inadequate and enjoined the Department of the Interior from "taking any steps whatsoever directly or indirectly to implement the new coal leasing program included calling for the nominations of tracts for Federal coal leasing and issuing any leases, except when the proposed lease is required to maintain an existing mining operation at the present levels of production or is necessary to provide reserves needed to meet existing contracts and the extent of the proposed lease is not greater than is required to meet these two criteria for more than three years in the future." The court stated that the standard should be applied to both noncompetitive preference right lease applications (PRLAs) and competitive leases.

In addition, the court ordered the Department to issue an official press release, publish a notice in the *Federal Register*, and take other steps appropriate to receive additional comments on the 1975 statement. The Department was further ordered to prepare a draft supplement to the 1975 statement, receive comments on the supplement, and prepare a new final statement. These documents were to discuss the issues which the court identified as being deficient.

Although the Department initially filed a notice of appeal of the Court's decision, the District Court approved a settlement of the case on June 14, 1978. The modified order permits substantially more leasing before the final new programmatic environmental impact statement is ussued than would have been allowed under the Court's initial standards. The agreement will remain in effect until the injunction is lifted. Utah Power and Light Company has appealed the settlement to the Court of Appeals for the District of Columbia.

The agreement embodied in the amended order permits leasing under any of the following six standards:

1. Short-term by-pass leases are permitted where federal coal may be otherwise lost if it is not developed by an existing mine because subsequent costs (either economic or environmental) would be much higher. Up to five years of reserves may be included in a lease issued under this provision. To qualify for a lease, mining operations must have been in existence on September 27, 1977.

2. Short-term employment leases may be issued in order to maintain production and employment in mines existing on September 27, 1977, which are running short of reserves needed to maintain past production or where additional reserves are needed to meet existing contracts. Up to eight years of reserves may be included in a lease under this provision.

3. ERDA project leases of no more than 500,000 tons annual production may be issued to support Energy Research and Development Administration (ERDA) projects authorized under section 908 of SMCRA. Leasing is allowed if the technology assessed cannot be demonstrated on existing leases or private coal holdings.

4. Lease exchanges are permitted to implement exchanges for federal leases in alluvial valley floors under section 510(b)(5) of SMCRA.

5. Hardship leases involve seven particular lease applications specified in the agreement as being not subject to the injunction regardless of any other particular standard. The basis for these leases varies, but each has some special circumstance or hardship which justified proceeding with lease issuance in advance of the completion of the final version of this statement.

6. Noncompetetive (preference right) lease applications may be processed but not issued for the twenty PRLAs having the least environmental impact. Preference is to be given to PRLAs for tracts containing 90 percent of reserves which can be mined by deep mining and PRLAs for tracts which would not require substantial additional transportation facilities or water storage or supply systems in the regions. All activities, including completion of the commercial quantities test and necessary environmental analyses, are permitted under this standard.

The modified order enables the Department to achieve production in areas where needs are critical and to avoid unnecessary loss of federal coal resources in by-pass situations. In addition, the settlement allows the Department to continue with the overview portion of its regional environmental impact statements. Although only lease proposals meeting the revised short-term standards will be studied on a site-specific basis, the regional environmental impact statements will address the social economic, and environmental effects of increased coal production in particualr areas, including impacts which could occur under various leasing levels. This information will be useful both to the programmatic environmental impact statement and to subsequent program decisions.

The Department is currently preparing comprehensive coal environmental impact statements on activities occurring in eight geographic areas, including west-central Colorado. Under a policy formally adopted in 1976, these comprehensive analyses are called for whenever the Department is faced with multiple coal-related actions in a broad geographic area. These actions could involve issuing coal leases, approving mining and reclamation plans on existing leases, and right-of-way permit requests for coal-haul roads, railroads, access roads, or transmission lines.

The areas covered by these statements were chosen after consideration of coal basin boundaries, drainage areas, areas of common reclamation characteristics, administrative boundaries, areas of economic interdependence, and other relevant factors. The regional statements include a broad, overview analysis of environmental impacts associated with current and potential coal development activities, as well as site-specific analyses of mine plans, and right-of-way permits for which administrative action is proposed.

The Department is also preparing a supplemental programmatic coal statement pursuant to the 1977 District Court order in NRDC vs. Hughes. The Draft Environmental Statement: Federal Coal Management Program was published in December 1978. The final draft is scheduled for publication in the spring of 1979. This programmatic statement assesses the national impacts of the federal coal management program and related federal coal policies. The statement covers all major national aspects of the management program and alternatives, and assesses impacts of alternative programs in twelve specific coal regions.

Institutional Relationships

In the ES area a large number of separate jurisdictional entities exercise certain types of land and resource use controls.

FEDERAL JURISDICTION

The federal sector includes the BLM (public lands and mineral estate under other federal and certain private lands); the USFS (White River, Grand Mesa, Uncompahgre, and Gunnison national forests); the National Park Service (Colorado National Monument, Black Canyon of the Gunnison National Monument, and Curecanti National Recreation Area); and the Bureau of Reclamation (certain withdrawn lands in various counties).

Development, management, use, and control of use on federal lands has been delegated to these agencies. Controls are effected through issuance or nonissuance of a variety of leases, permits, licenses, etc. Each authorization to use federal lands contains provisions to control that use. Controls exercised by the federal government for the subsurface estate are governed by the statutes authorizing the disposition and use of that estate. Management policy has been extended in greater detail by the National Environmental Policy Act of 1969 and the Federal Land Policy and Management Act of 1976.

Office of Surface Mining

OSM, in consultation with Surface Managing Agency (BLM and USFS), USGS, or (where applicable) the state regulatory authority, recommends approval or denial of surface coal mining permit applications to the Assistant Secretary of Energy and Minerals. OSM (as lead agency) is the federal regulatory authority responsible for reviewing coal M&R plans (permit application), enforcement of all environmental protection and reclamation standards included in an approved mining permit, the monitoring of both on- and off-site effects of the mining operation, and abandonment operations within the area of operation of a federal lease.

OSM is the principal contact for all coal mining activities within the area of operation. OSM will conduct as many inspections as are deemed necessary but no less than one partial inspection quarterly and at least one complete inspection every six months (30[CFR]: 721.14[c]).

OSM, after consultation with BLM, USGS, and the operator establishes the boundaries of the permit area for the proposed mine and approves the locations of all the mine facilities located within this boundary.

Section 523 of SMCRA requires the Federal Lands Program to adopt those state performance standards which the Secretary determines are more stringent than the federal standards. The Federal Lands Program means a program established by the Secretary pursuant to Section 523, SMCRA, to regulate surface coal mining and reclamation operations on federal lands. Therefore, the performance standards enforced by OSM on a federal leasehold should be at least as stringent as those required under state law or regulations. The Department of the Interior is negotiating a cooperative agreement pursuant to Section 523(c) of SMRCA with the state of Colorado and other states.

Whenever this agreement is consummated with the state, the OSM's functions and responsibilities specified in this agreement will be delegated to the state regulatory authority. Under this agreement, OSM and the state regulatory authority will jointly review and act on mining permiot applications and recommend approval or disapproval to the officials authorized to take final action on the application. The Secretary is prohibited by law from delegating his authority to approve mining plans on federal lands.

U.S. Geological Survey

The USGS is responsible for reviewing M&R plans for development, production, and coal resource recovery requirements on a federal leasehold. USGS is responsible for the maximum economic recovery of the federal coal resource and for the federal government receiving fair market value for the coal resource.

Bureau of Land Management

The BLM formulates special requirements to be included in a lease or mining permit application related to the management and protection of all resources (other than coal) and the post-mining land use of public lands.

The BLM, after consultation with USGS and OSM, is responsible for the authorization of various ancillary facilities such as access roads, power lines, communication lines, and railroad spurs proposed by a mining company on federal lands outside of the permit area. Rights-of-way can only be granted pursuant to Title V of the Federal Land Policy and Management Act of 1976 (PL 579, 90 Stat. 2743). The rights-of-way would be approved after consultation with OSM and USGS subject to standard requirements for duration of the grant, rights-of-way widths, fees or costs, and bonding to secure obligations imposed by the terms and conditions of the right-of-way grants. The terms and conditions applicable to the rights-of-way are determined by 43(CFR): 2800, the Land Use Plan, and by an on-the-ground evaluation.

The BLM is the lead agency, in coordination with USGS and OSM, for all proposed uses other than coal mining on public lands within a leasehold.

U.S. Forest Service

The USFS formulates special requirements to be included in a lease or mining permit application related to the management and protection of all resources other than coal and the post-mining land use of national forest systems land.

The USFS, after consultation with USGS and OSM, is responsible for the authorization of various ancillary facilities such as access roads, power lines, communication lines, railroad spurs proposed by a mining company on federal lands outside of the permit area. Rights-of-way can only be granted pursuant to Title V of the Federal Land Policy and Management Act of 1976 (PL 579, 90 Stat. 2743). The rights-of-way would be approved after consultation with OSM and USGS subject to standard requirements for duration of the grant, rights-of-way widths, fees or costs, and bonding to secure obligations imposed by the terms and conditions of the right-of-way grants. The terms and conditions applicable to the rights-of-way are determined by 43(CFR): 2800, the Land Use Plan, and by an on-the-ground evaluation.

The USFS is the lead agency, in coordination with USGS and OSM, for all proposed uses other than coal mining on forest lands within a leasehold.

STATE AND LOCAL JURISDICTIONS

A number of state of Colorado agencies have development and administrative authority over lands owned by the state, and some have authority over some uses of public lands through issuance of state required permits, etc. Except where controls have specifically been delegated by statute to counties or municipalities, Colorado retains total jurisdiction over nonpublic and privately owned lands. Certain of these lands were conveyed to the state as part of the act admitting Colorado to the Union. This legislation granted Sections 16 and 36 of every township to the state for educational purposes. Use and control of these lands (including mineral leasing, rights-of-way, etc.) is governed by Colorado law.

Under Colorado statutes, counties have a wide variety of controls in matters not specifically reserved to the state. The authority applies only to those portions of the county that are unincorporated. A county may regulate and restrict the location and use of buildings and structures and the use, condition of use, or occupancy of lands for residency, recreation, agriculture, industry, commerce, public use, and other purposes. Cities have authority to implement a master plan, zoning, and other regulatory controls.

State government has little enacted authority to impelement general land use planning, although some of its agencies have ultimate quality, air quality, mining reclamation) or may halt projects in cases of extreme consequences. Local government has sufficient authority to impose effective land use controls, but may lack the financial resources necessary to develop them effectively. Perhaps the greatest deficiency exists in coordination between the various jurisdictions.

MULTIAGENCY JURISDICTION

In certain situations, there is a joint or multiagency sharing of particular management and control functions and responsibilities, such as the cooperative agreement between the Department of the Interior and the state of Coloraeo that allows the state to administer and enforce reclamation operation on federal leases in Colorado. The subsurface estate vested in private or state ownership would normally be governed by applicable state of Colorado statutes.

CHAPTER 4

ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

Impacts are analyzed at two levels in this chapter: (1) aggregate impacts of the six proposed federal site-specific coal actions (which are also analyzed individually in the site-specific volume) and (2) cumulative impacts on the region of the six proposed federal coal actions together with other existing and possible future activities (oil and gas development, uranium development, water developments, etc., as described in chapter 1) at the most probable level of development. Impacts are analyzed at three time points: 1980, 1985, and 1990.

Mining and reclamation (M&R) plans for the six proposed coal mines have been accepted by the Area Mining Supervisor of U.S. Geological Survey (USGS) as suitable for analysis of environmental impacts in this environmental statement (ES). Four of the M&R plans included in this ES were submitted for review before promulgation and two after promulgation of the interim regulations, 30(CFR): 700, required under Sections 502 and 523 of the Surface Mining Control and Reclamation Act (SMCRA) of 1977 (PL 95-87). None of the M&R plans has been officially reviewed for compliance with that act, and the applicants' plans may not fully reflect the requirements of the interim regulations. However, in this ES the interim regulations are considered as federal requirements with which the M&R plans must comply, just as they must comply with all other applicable regulations.

The M&R plans will be returned to the operators for revision in accordance with the applicable federal regulations. As soon as the applicants' plans are revised and returned to the Office of Surface Mining (OSM), they will be evaluated by OSM in conjunction with the U.S. Geological Survey (USGS) to determine compliance with the requirements of federal regulations 30(CFR): 211 and 30(CFR): 700. The M&R plans cannot be considered for approval by the Department of the Interior until they conform with all applicable federal requirements.

Air Quality

Introduction

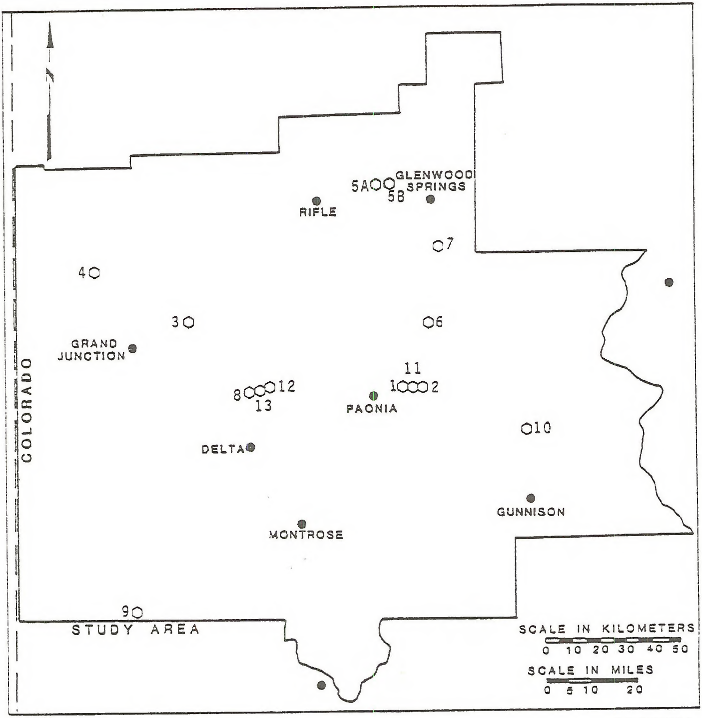
Air quality impacts caused by coal developments and related activities in west-central Colorado are addressed assuming a normal (or average) level of control. These controls include a normal precipitation pattern over the region as well as no new coal fires. Some existing fires may contribute to ambient concentrations of total suspended particulates (TSP), but they are already accounted for in the baseline TSP concentrations.

The impacts on the ambient TSP, sodium dioxide (SO_2), and nitrogen dioxide (NO_2) concentrations, which are a consequence of the proposed actions alone, are examined for the years 1980, 1985, and 1990. Next, the total impact of the proposed actions and all other activities in the region is assessed for the same years. The pollutant concentrations are compared to the national and Colorado ambient air quality standards and to the increments for prevention of significant deterioration of air quality (PSD).

Emissions

Air quality modeling requires as input the pollutant emissions for each source modeled. These emissions are the quantity of each pollutant emitted to the atmosphere by a given source. Emissions were estimated for four different types of sources: surface and underground coal mines, towns, transportation, and major point sources in the region.

Underground coal mines are contributors of particulate emissions in the region. The location of the mines (underground and surface) modeled in this study are shown in maps R4-1 and R4-2. Fugitive emissions result from a number of activities within the underground mining areas, including coal loading, conveying, transferring, crushing, and hauling. For these operations emission factors from the documents prepared by PEDCo Environmental, Inc. (1978b), the Colorado Air Pollution Control Division (1978), and Midwest Research Institute (1977) were used to relate the level of activity of an operation to fugitive dust emissions. Operating information was extracted from individual M&R plans when this information was available. Where limited operating information was provided, certain mining operations were assumed. Chapters 3 and 4 (Air Quality) of the site-specific volume discuss the use of these factors in quantifying fugitive dust emissions from the proposed actions. The annual emissions of particulates from the existing and pro-



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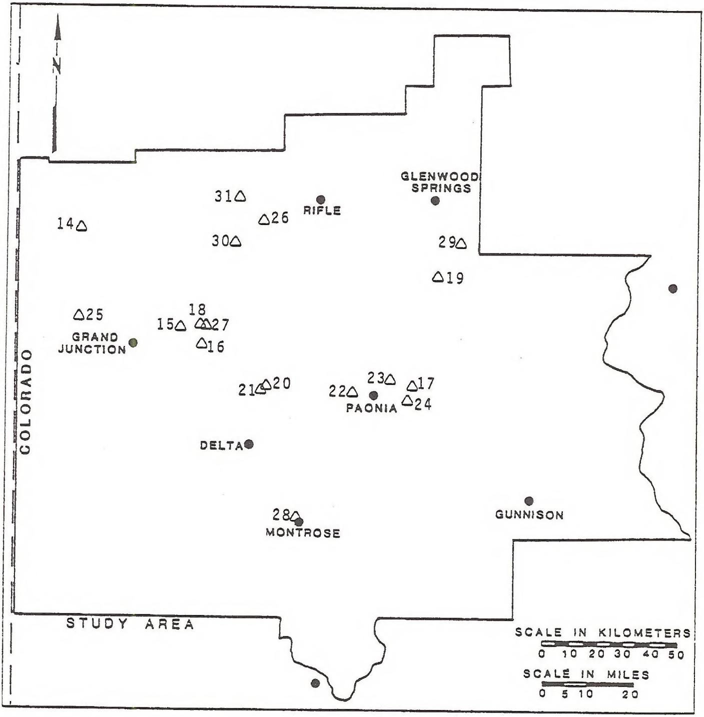
LEGEND

EXISTING

1	SOMERSET	7	SUNLIGHT
2	HAWKSNEST EAST & NO. 3	8	FAIRVIEW
3	ROADSIDE	9	NUCLA STRIP MINE
4	BOOKCLIFFS FARMERS	10	OHIO CREEK NO. 2
5A	EASTSIDE	11	BEAR MINE
5B	NU GAP NO. 3	12	RED CANYON NO. 1
6	COAL BASIN	13	TOMAHAWK STRIP MINE

Map R4- 1 Locations of existing coal mines in the study region



LEGEND

MAJOR FEDERAL ACTION

14 LOMA
15 COAL CANYON
16 COTTONWOOD CREEK NO. 1 & NO. 2
17 MT. GUNNISON NO. 1
18 CAMEO NO. 1 & NO. 2
19 NORTH THOMPSON CREEK NO. 1 & NO. 3

EXISTING

20 COALBY-RED CANYON
21 TOMAHAWK UNDERGROUND
22 ORCHARD VALLEY
23 BLUE RIBBON
24 EDWARDS

OTHER

25 WESTERN REFINERY
26 ANVIL POINTS OIL SHALE
27 CAMEO POWER PLANT
28 BULLOCK POWER PLANT
29 MID-CONTINENT COAL & COKE LOADING FACILIT
30 OCCIDENTAL OIL SHALE
31 COLONY OIL SHALE

Map R4- 2. Location of highway segments for which emissions are calculated posed coal mines for 1980, 1985, and 1990 are shown in tables R4-1, R4-2, and R4-3.

Small amounts of pollutants are released from vehicles, steam generators, and other combustion sources operating within the coal mines. Because small quantities are emitted, the effects on surrounding air quality are expected to be insignificant (U.S. Department of the Interior 1976).

Major towns in the region are anticipated to have a significant effect on the regional air quality for TSP, SO_2, and NO_2. Current emissions data for these pollutants were taken from the National Emissions Data System (NEDS) Inventory for 1977 (U.S. Environmental Protection Agency 1978b). The total pollutant emissions for each county in the ES region were apportioned to the towns based on the percentage of the county population in each town. The 1980, 1985, and 1990 emissions from the towns were predicted to increase in direct proportion to projected growth in the population of the towns between the base population year (1975 or 1977) and the study year. The TSP, SO_x, and NO_x emissions from the towns are listed in tables R4-4 and R4-5.

Traffic on major highways within the region contributes emissions of NO_x and particulates. Although no significant increases in emissions of these pollutants would occur as a result of the proposed actions, emissions from vehicles using major highways will contribute slightly to ambient pollutant levels in 1980, 1985, and 1990. The emissions from vehicles, as summarized in table R4-6, were predicted for each study year. Major highway segments examined in the analysis are depicted on map R4-3.

A number of major point sources of particulates, SO_x, and NO_x are located in the ES region. Those sources emitting significant pollutants which could possibly interact with emissions resulting from the proposed actions and associated population growth were identified. These emissions were obtained primarily from point source emissions inventories for west-central Colorado counties (Colorado Air Pollution Control Division 1978) and were quantified for input to the dispersion models. Locations of these sources are presented in map R4-1. Emissions from these sources are summarized in table R4-7.

Several major pollutant sources were not modeled because their emissions would not interact with emissions related to the proposed actions. A large area of existing uranium and vanadium mines is located in and near the Paradox Valley. Also, the Colorado Ute Nucla Power Plant is located in this area. Emissions from sources in this region, approximately 30 to 40 miles southwest of the Grand Valley, would not interact with emissions from the proposed coal mines in the ES area. This is because of the great separation distance and because the Paradox Valley sources are located in a dispersion sub-area which is not connected to the part of the region containing the proposed actions.

Oil shale Tracts Ca and Cb are located in the White River Valley dispersion sub-area and emissions from these major pollutant sources would not interact with emissions from coal-related developments to the south.

Railroads serve existing coal mines in west-central Colorado primarily transporting coal to eastern Colorado and beyond. The number of unit trains is expected to increase by 1980, 1985, and 1990 in order to move coal from the mines of the proposed actions to the expected markets. Construction of railroad lines and operation of unit trains along existing and proposed tracks will continue to be a source of fugitive dust emissions. However, fugitive dust emissions from the construction of these lines should be small and have no significant affect on regional TSP concentrations. In addition, emissions from trains would be intermittent and their impact is expected to be site-specific. Hence, significant regional impact is unlikely.

Modeling Procedures

The annual average SO_2, NO_2, and TSP concentrations were predicted with a model based on the steady-state Gaussian dispersion equation (Busse and Zimmerman 1973). Statistical meterological data constructed from observations taken at the National Weather Service Stations in Grand Junction, Colorado for 1959-68 and Eagle, Colorado, for 1965-74 were meteorological data sets used for annual average modeling. The Grand Junction data were adjusted for other dispersion sub-areas in west-central Colorado to account for changes in the directional alignment of canyons and valleys in the region. As a result, ten different sets of statistical meteorological data were generated for performing the annual average modeling analyses. The pollutant concentrations were computed for grid points (receptors) overlying the affected areas of the region.

The 24-hour TSP and 3-hour SO_2 concentrations around towns and along highways were estimated from predicted annual concentrations using Larsen statistics (Larsen 1971). All sulfur oxides emissions were assumed to be SO_2. All nitrogen oxides emitted to the atmosphere were assumed to be converted to NO_2.

A short-term model which accounts for the retention of pollutants within narrow valleys was used to predict maximum 24-hour TSP concentrations around mines having significant particulate emissions. This model, based on the steady-state Gaussian dispersion equation (Turner 1972), requires as input actual hourly meteorological conditions (wind speed, wind direction, and stability

TABLE R4-1

TOTAL SUSPENDED PARTICULATE EMISSIONS FROM COAL MINES IN WEST-CENTRAL COLORADO (TONS/YEAR) - 1980

Mine	With Proposed Actions	Without Proposed Actions
Existing		
Hawksnest	42.7	42.7
Bear	15.0	15.0
Sommerset	148.6	148.5
Blue Ribbon	58.8	58.8
Orchard Valley	11.5	11.5
Coal Basin	609.0	609.0
Sunlight	3.8	3.8
Ohio Creek No. 2	0.5	0.5
Eastside	0.3	0.3
Nu Gap No. 3	0.3	0.3
Nucla Strip	46.0	46.0
Roadside	34.5	34.5
Tomahawk Strip	92.5	92.5
Bookcliffs Farmers	461.0	461.0
Major Proposed Federal Actions		
North Thompson Creek Nos. 1, 3	3,647.7	0
Loma	1,388.8	0
Cameo	51.7	0
Minor Possible Federal Actions		
Coalby Red Canyon	1.5	0

TABLE R4-2

TOTAL SUSPENDED PARTICULATE EMISSIONS FROM COAL MINES IN WEST-CENTRAL COLORADO (TONS/YEAR) - 1985

Mine	With Proposed Actions	Without Proposed Actions
Existing		
Hawksnest	97.7	97.7
Bear	0	15.0
Sommerset	148.5	148.5
Coal Basin	609.0	609.0
Sunlight	6.3	6.3
Ohio Creek No. 2	0.5	0.5
Eastside	0.3	0.3
Nu Gap No. 3	0.3	0.3
Nucla Strip	46.0	46.0
Roadside	12.1	12.1
Fairview	168.5	168.5
Tomahawk Strip	91.6	91.6
Bookcliffs Farmers	461.0	461.0
Major Proposed Federal Actions		
North Thompson Creek Nos. 1, 3	3,647.7	0
Mt. Gunnison	62.5	0
Loma	920.7	0
Cameo 1 & 2	60.1	0
Coal Canyon	180.9	0
Cottonwood Creek 1 & 2	187.4	0
Minor Possible Federal Actions		
Edwards	7.0	0
Blue Ribbon	58.8	0
Orchard Valley	19.6	0
Coalby Red Canyon	1.5	0

TABLE R4-3

TOTAL SUSPENDED PARTICULATE EMISSIONS FROM COAL MINES IN WEST-CENTRAL COLORADO (TONS/YEAR) - 1990

Mine	With Proposed Actions	Without Proposed Actions
Existing		
Hawksnest	97.7	97.7
Bear	0	15.0
Sommerset	148.5	148.5
Coal Basin	609.0	609.0
Sunlight	6.3	6.3
Eastside	0.3	0.3
Nu Gap No. 3	0.3	0.3
Nucla Strip	46.0	46.0
Roadside	7.1	7.1
Fairview	168.5	168.5
Bookcliffs Farmers	461.0	461.0
Major Proposed Federal Actions		
North Thompson Creek Nos. 1, 3	3,647.7	0
Mt. Gunnison	73.8	0
Loma	1,161.2	0
Cameo 1 & 2	82.1	0
Coal Canyon	311.7	0
Cottonwood Creek 1 & 2	417.3	0
Minor Possible Federal Actions		
Edwards	7.0	0
Orchard Valley	19.6	0
Coalby Red Canyon	1.5	0

TABLE R4-4

EMISSIONS OF PARTICULATES, SO_x AND NO_x (TONS/YEAR) FROM TOWNS WITH THE PROPOSED FEDERAL ACTION

AREA	1980 TSP	1980 SO_x	1980 NO_x	1985 TSP	1985 SO_x	1985 NO_x	1990 TSP	1990 SO_x	1990 NO_x
Delta	18.3	8.5	95.0	20.8	9.6	106.8	21.5	10.0	111.1
Paonia	8.2	3.7	42.1	9.6	4.7	50.0	10.4	4.7	53.5
Montrose	27.4	11.1	126.9	27.3	11.0	127.0	26.7	10.7	125.0
Grand Junction	41.8	18.2	272.6	42.6	18.9	285.5	39.8	17.7	266.6
Glenwood Springs	37.5	11.0	160.3	40.3	12.1	172.2	46.4	13.8	197.3
Cedar Edge	4.7	2.0	24.1	5.6	2.8	40.0	6.2	2.9	31.7
Gunnison	45.1	9.5	106.6	57.0	12.1	134.5	58.5	12.4	138.1
Fruita	11.0	4.9	73.2	12.9	5.7	85.4	12.0	5.3	80.0
Orchard Mesa	25.1	11.0	163.2	27.7	12.2	182.2	26.2	11.3	170.6
Rifle	24.8	7.5	105.5	27.5	8.1	118.2	32.2	9.3	136.6

TABLE R4- 5

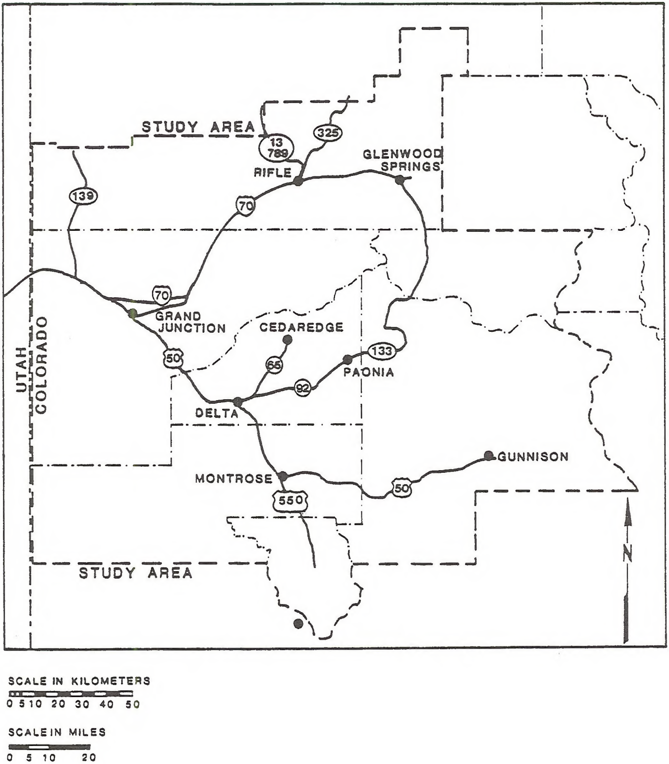
EMISSIONS OF PARTICULATES, SO_x AND NO_x (TONS/YEAR)
FROM MAJOR URBAN AREAS WITHOUT THE PROPOSED FEDERAL ACTION

AREA	1980 TSP	1980 SO_x	1980 NO_x	1985 TSP	1985 SO_x	1985 NO_x	1990 TSP	1990 SO_x	1990 NO_x
Delta	18.6	8.6	94.8	19.5	9.1	100.4	20.1	141.4	92.1
Paonia	8.2	3.6	41.5	8.7	4.0	45.0	9.4	4.3	47.8
Montrose	27.4	11.1	126.9	27.6	11.3	128.9	26.9	10.7	125.7
Grand Junction	42.6	18.7	279.6	42.4	18.8	279.7	38.3	16.6	252.2
Glenwood Springs	37.5	11.0	160.0	39.9	11.8	170.2	44.8	13.4	190.5
Cedar Edge	4.6	2.2	23.6	5.1	2.4	26.2	5.3	2.5	28.0
Gunnison	45.1	9.5	106.6	57.8	12.3	136.4	58.5	12.4	138.1
Fruita	11.3	5.0	73.8	12.4	5.3	81.2	11.2	4.7	73.0
Orchard Mesa	25.4	10.9	167.1	27.4	12.1	179.7	24.1	10.6	158.6
Rifle	24.8	7.5	105.5	27.2	8.1	116.6	31.1	9.0	131.9

TABLE R4-6

TOTAL VEHICULAR EMISSIONS FROM MAJOR HIGHWAYS IN WEST-CENTRAL COLORADO

YEAR	EMISSION RATE (TONS/YEAR)			
	Without Proposed Action		With Proposed Action	
	Particulate	NO_x	Particulate	NO_x
1980	1,310	1,090	1,315	1,097
1985	1,535	858	1,605	896
1990	1,552	720	1.668	778



Map R4- 3 Locations of major and minor federal action mines and major pollutant point sources in the study region

TABLE R4- 7

EMISSIONS FROM MAJOR POINT SOURCES IN WESTCENTRAL COLORADO

	Emission Rate (Tons/Year)								
	1980			1985			1990		
SOURCE	PART	SO_x	NO_x	PART	SO_x	NO_x	PART	SO_x	NO_x
Western Refinery	8,782	1,256	4,127	8,782	1,256	4,127	8,782	1,256	4,127
Anvil Pts. Oil Shale (Existing)		28	15		28	15		28	15
Anvil Pts. Oil Shale (Proposed)				548	5,380	1,655	548	5,380	1,655
Cameo Power Plant	180	1,564	2,164	180	1,564	2,164	180	1,564	2,164
Bullock Power Plant	1,472	428	406	1,472	428	406	1,472	428	406
Mid Continent Coal & Coke Loading Facility	140			140			140		
Occidental Oil Shale	7	36	12	7	36	12	7	36	12
Colony Oil Shale	3,951	1,495	8,540	3,951	1,495	8,540	3,951	1,495	8,540
Total	14,532	4,807	15,264	14,532	4,807	15,264	14,532	4,807	15,264

class). Pollutant concentrations are computed for lines of receptors in specified downwind directions from the source or sources. Each of the models used in this study accounts for the deposition of large particles in the prediction of annual and 24-hour average TSP concentrations.

Baseline pollutant concentrations obtained from air quality measurements in west-central Colorado were added to model predictions to obtain total ambient pollutant concentrations. Baseline TSP concentrations of 40 micrograms per cubic meter ($\mu g/m^3$ for the Grand Valley and 24 $\mu g/m^3$ for the remainder of the region were estimated from the measurements. Estimated baseline levels of SO_2 and NO_2 were approximately 1 $\mu g/m^3$ for each pollutant.

The regional visibilities in the region, resulting from increased ambient total suspended particulate concentrations, were determined from a simple equation relating visual range and particulate levels (Ettinger et al. 1972).

The modeling procedures for predicting annual and short-term pollutant concentrations and for predicting visibility are described in detail in the technical report for chapter 4 of the regional ES, available at the Montrose District Office of BLM.

Resultant Air Quality

INTRODUCTION

The impact of the proposed actions alone on ambient TSP, SO_2, and NO_2 concentrations is first assessed for the case study years of 1980, 1985, and 1990. Then the impact of proposed actions and all other activities in the region are assessed for the same years. The pollutant concentrations for the two cases are compared to the national and Colorado ambient air quality standards and to the increments for prevention of significant deterioration of air quality.

PROPOSED ACTIONS ALONE

Air quality impacts analyzed in this section are the result of emissions from the proposed actions and from growth of emission sources induced by the proposed actions. These concentrations do not include baseline levels or contributions from other activities. The area effected by the particulate emissions from the major proposed mining actions would be limited to a few square miles around the individual mines. The increase of annual TSP concentrations are predicted to be less than 1 $\mu g/m^3$ beyond a five-mile radius from the mines and their haul roads for the three study years (maps R4-4 and R4-5).

Since most of the fugitive dust generated by mining operations consists of relatively large diameter particles, considerable particulate deposition would occur before the particles are transported far. Thus, the area affected by particulate emission from mines is expected to be limited to within a few miles of the individual mines.

The annual Colorado ambient air quality standards for TSP may be exceeded very near specific mining operations within or very near the mine boundaries. However, TSP concentrations would drop below standard levels at very short distances from the individual sources. At and slightly beyond the mine boundaries of most of the proposed mines, the total particulate emissions from the mines would cause the Class II increments for PSD to be exceeded. However, the proposed mines would have no impact on the air quality of nearby PSD Class I areas within the region.

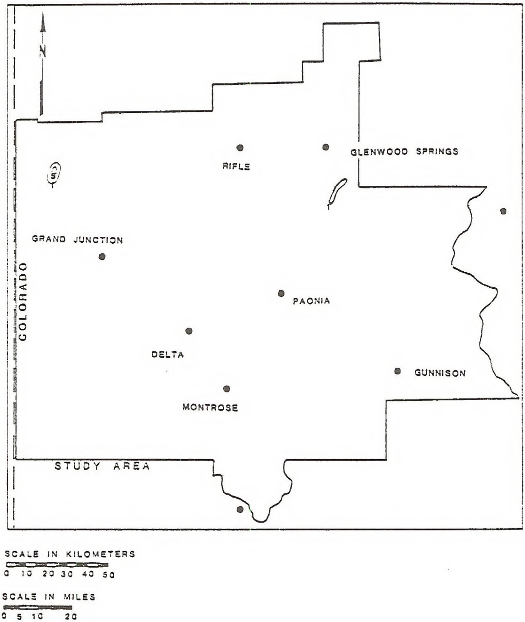
Under the new PSD review procedure promulgated by the U.S. Environmental Protection Agency in June 1978 (*Federal Register,* June 19, 1978), the impact of fugitive dust emissions from coal mines would not be included in the analysis of the impact of the mines on either the PSD increments or the national ambient air quality standards. However, any coal mine with potential (uncontrolled) particulate emissions of at least 250 tons per year would be required to obtain a PSD permit for construction and operation. A full PSD review would be required only for mines with actual (controlled) emissions of at least 50 tons per year or 1,000 pounds per day. Mines with particulate emissions less than these limits would not be required to apply Best Available Control Technology (BACT) or to make an analysis of the impact of the mine on the ambient air quality of the area in order to get a PSD permit.

Because the new PSD review procedures have neither been implemented by EPA nor reviewed by parties of interest, the regional air quality analysis has been prepared using the previous PSD regulations. The previous regulations require the air quality impact of all particulate emissions from surface mines be analyzed for PSD review.

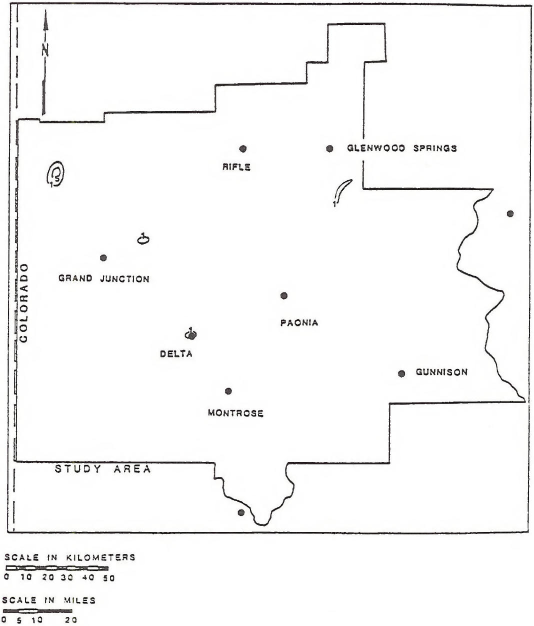
The mines of the proposed actions are located in predominantly rural areas of the ES area. Because the areas of impact are confined to a few square miles around each mine, no noticeable impacts on the major towns of the region would be caused by emissions from the mines.

Increments for PSD for Class II areas would be exceeded outside the boundaries of the Loma, Cottonwood Creek, and North Thompson Creek mines. In 1990, the maximum 24-hour concentrations of 65 $\mu g/m^3$ would occur over a small area just south of the surface facilities of the Loma Project. Slightly lower maximum levels would occur in 1980 and 1985 in the same area.

Maximum 24-hour TSP concentrations would reach 88 $\mu g/m^3$ over a small area around the Cot-



Map R4-4 Increase of annual average TSP concentrations in 1980 from the proposed actions alone



Map R4- 5 Increase of annual average TSP concentrations in 1985 and 1990 from the proposed federal action alone tonwood Creek Mine in 1990 exceeding the Class II PSD increment. In 1985, much lower emissions would result in maximum 24-hour levels of about 42 $\mu g/m^3$ over the same area. However, these concentrations would still slightly exceed the Class II increment.

Particulate emissions from the North Thompson Creek mines in 1980, 1985, and 1990 would cause maximum 24-hour TSP levels to reach 53 $\mu g/m^3$ along the haul road northeast of the mine.

The increase in TSP, SO_2, and NO_2 concentrations from urban population growth and from increased roadway traffic created by the proposed actions are expected to be small. Map R4-5 shows that the only noticeable increase in annual TSP levels would occur around the town of Delta in 1985 and 1990. These increases would be about 1 $\mu g/m^3$ within five miles from the town. Increases in 24-hour TSP levels would reach only about 3 to 4 $\mu g/m^3$ over the same area. Similarly, small increases in NO_2 levels should occur in 1990 in Delta (map R4-6). NO_2 concentration of 5 $\mu g/m^3$ would occur over the same area containing the 1 $\mu g/m^3$ TSP concentration increase.

No noticeable increase in SO_2 levels would occur in the region resulting from growth induced by the proposed actions.

The commuter traffic to the proposed mines and increased travel on all highways in the region as a result of the proposed actions are not expected to significantly increase TSP, NO_2, and SO_2 concentrations in the region.

INTERACTION OF THE PROPOSED ACTIONS AND OTHER ACTIVITIES

Concentrations discussed in this section refer to contributions from all significant sources in ES area which would emit pollutants for the most probable level of development. These sources include towns, highways, mines, major point sources, and contributions from the rural baseline pollutant concentrations.

Maximum ambient levels of TSP, SO_2, and NO_2 for the most probable level of development would result from the contributions from baseline levels and from the emissions caused in the towns by activities other than proposed actions. In addition, relatively high TSP concentrations would occur near the Loma Project and the group of existing and proposed mines in DeBeque Canyon. TSP concentrations near major towns and near several of the mines would exceed state and national ambient air quality standards over relatively small areas centered about the sources.

Highest annual average TSP concentrations in 1980, 1985, and 1990 would occur in the vicinity of Grand Junction, Montrose, Delta, and in the area of the Western Oil Refinery northwest of Fruita with annual average TSP levels exceeding 55 $\mu g/m^3$ over small areas about five to ten miles in diameter or less at these locations (maps R4-7, R4-8, and R4-9). These concentrations represent increases of approximately 15 $\mu g/m^3$ above the estimated background TSP levels of 40 $\mu g/m^3$ in the Grand Valley. The predicted ambient concentrations would exceed the Colorado TSP standards of 45 $\mu g/m^3$ for an annual average.

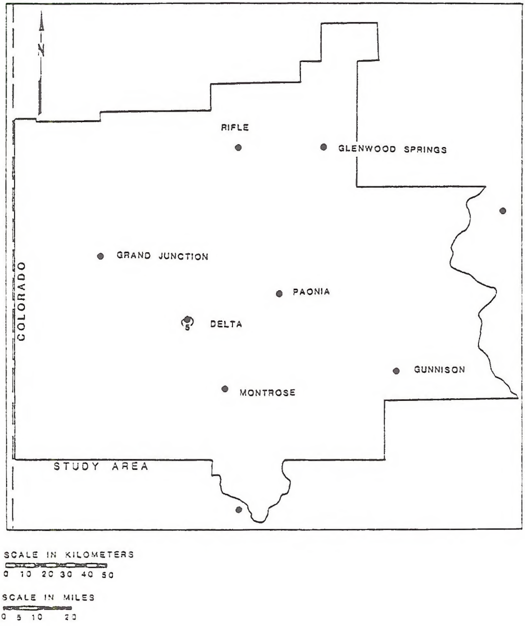
In 1980, concentrations in excess of 60 $\mu g/m^3$ would occur over a small area in the Fruita/Western Refinery region and by 1985 and 1990 concentrations of 60 $\mu g/m^3$ would occur over a small area around Grand Junction. These levels would equal the federal secondary standard for TSP.

Fruita, Grand Junction, and Paonia are in an area designated by the Environmental Protection Agency (EPA) as not attaining the National Ambient Air Quality Standards (NAAQS) for TSP. A regional level of analysis of air quality impacts does not show these violations except for the small areas in the vicinity of Fruita and Grand Junction. However, as existing monitoring data indicates, numerous violations of state and federal annual average and 24-hour ambient air quality standards for TSP occur in this non-attainment area and near other major urban particulate sources in the ES region (chapter 2 of the regional air quality technical report). These local violations should continue during the study period unless reduction in particulate emissions occur in the major towns in the ES region.

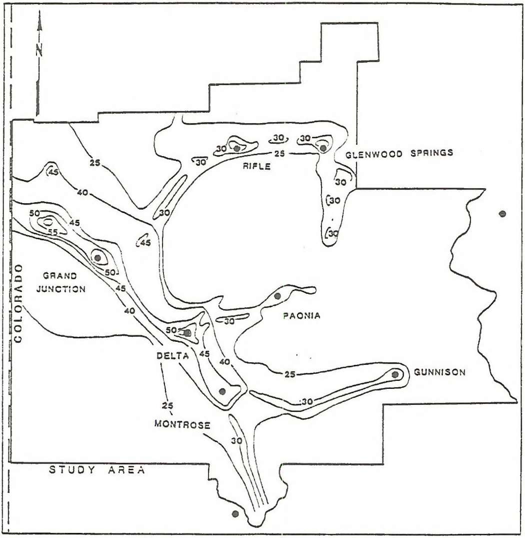
Maximum 24-hour TSP levels would exceed the national secondary and the state ambient air quality standards with predicted concentrations of 190 to 200 $\mu g/m^3$ over small areas around Grand Junction, Fruita, and Delta during all three study years. These standards would also be exceeded in the Montrose area in 1985 and 1990. These concentration levels would only slightly exceed the Colorado standard of 180 $\mu g/m^3$ around Grand Junction, but would exceed by a larger margin the 150 $\mu g/m^3$ 24-hour TSP standard applicable in all other parts of the region.

The primary contributor to the relatively high 24-hour ambient TSP levels around towns in the Grand Valley would be baseline TSP concentrations and not particulate emissions from towns and highways. The baseline TSP levels are primarily caused by fugitive dust from agricultural activities in the Grand Valley.

Annual average TSP concentrations along roadways and around towns in the remainder of the region would be well below Colorado and National Ambient Air Quality Standards except for areas very near the roads and near local pollutant sources in the towns. Maps R4-7, R4-8, R4-9 show ambient TSP concentrations of about 5 to 10 $\mu g/$



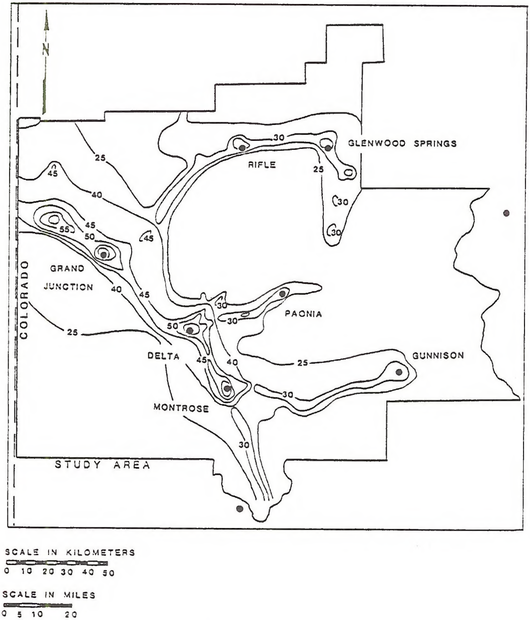
Map R4-6 Increase of annual average NO_2 concentrations in 1990 from the proposed federal actions



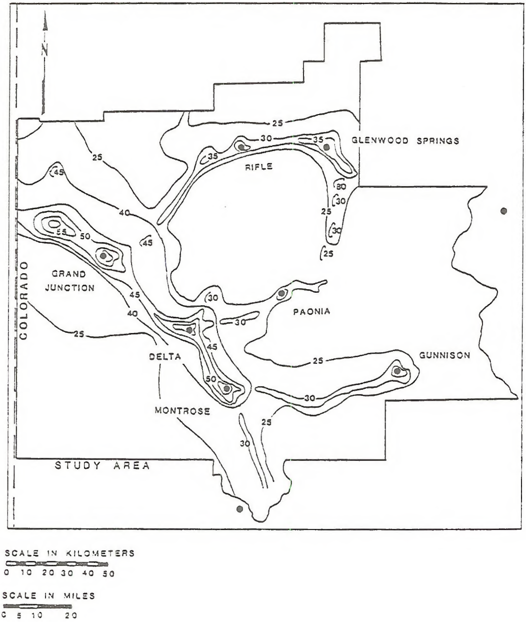
SCALE IN KILOMETERS
0 10 20 30 40 50

SCALE IN MILES
0 5 10 20

Map R4- 7 Annual average TSP concentrations in 1980 for the most probable level of development



Map R4-8 Annual average TSP concentrations in 1985 for the most probable level of development



Map R4- 9 Annual average TSP concentrations in 1990 for the most probable level of development m^3 above the rural baseline of 24 $\mu g/m^3$ for small areas around Rifle, Glenwood Springs, and Gunnison. Maximum 24-hour average TSP levels would reach 120 $\mu g/m^3$ over small areas around Rifle and Glenwood Springs in 1980 and 1985. By 1990, these levels should increase to 140 $\mu g/m^3$ around Glenwood Springs but remain at 120 $\mu g/m^3$ around Rifle. Therefore, no violations of Colorado or National Ambient Air Quality Standards are predicted.

Annual average TSP concentrations about 5 $\mu g/m^3$ above the baseline levels are predicted to occur over small areas around the Loma Project north of Fruita, around mines in the DeBeque Canyon area, around mines south of Glenwood Springs, and around mines on the slopes of Grand Mesa north of Delta. The areas of highest concentrations around the mines are smaller in extent than those predicted around the towns and do not add to TSP concentrations around the towns. However, relatively high annual average and 24-hour average concentrations occur over very small areas near several mines in the region.

By 1990 interactions of particulate emissions from existing and proposed mines in DeBeque Canyon would result in annual average TSP concentrations in excess of 65 $\mu g/m^3$ over about a one-quarter mile area near the bridge over the Colorado River. Hence, this area would have concentrations in excess of the national secondary and the Colorado standards. Slightly lower annual average concentrations would occur in this area for the other two study years. Also, maximum 24-hour TSP concentrations would reach 150 $\mu g/m^3$ in 1990 equalling the federal secondary and the Colorado 24-hour ambient air quality standards.

Particulate emissions from existing and proposed mines in the North Fork Valley would also interact although maximum annual and 24-hour TSP concentrations would be lower than those in DeBeque Canyon and would not cause any ambient air quality standards to be exceeded. Maximum annual average and 24-hour average concentrations of 38 $\mu g/m^3$ and 111 $\mu g/m^3$ would occur in 1990 with slightly lower concentrations for other study years. These maximum concentrations would occur over a very small area near Somerset, Colorado.

Emissions from the Loma Project would contribute to annual average TSP concentrations of 55 $\mu g/m^3$ in 1980 and would cause ambient levels to reach 60 $\mu g/m^3$ by 1990, exceeding both the federal secondary and the Colorado ambient air quality standards. These concentrations would be limited to areas of less than about one-half of a square mile. Maximum 24-hour TSP levels in the same area would reach 105 $\mu g/m^3$ by 1990, but would not exceed state or federal ambient air quality standards.

Emissions from the North Thompson Creek mines would contribute to maximum annual average and 24-hour average TSP concentrations of 40 $\mu g/m^3$ and 77 $\mu g/m^3$, respectively. Neither of these levels, occurring in a very small area in the vicinity of the mines, would result in violations of any state or federal ambient air quality standards.

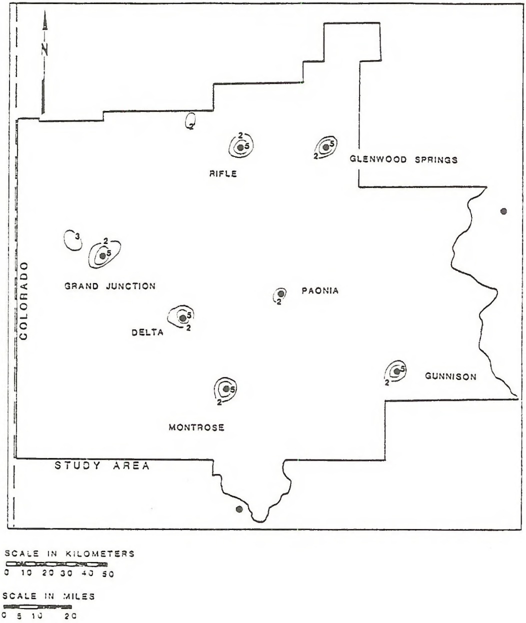
Other mines and groups of mines in the area would cause increased TSP concentrations during the study years. However, maximum concentrations would be localized and would be lower than the maximum impact reported for the four mine groups discussed here.

Highest concentrations of gaseous pollutants (SO_2 and NO_2) would occur around towns and along highways in the ES region. Mining activities in 1980, 1985, and 1990 would have no noticeable impact on the levels of these pollutants, with annual average concentration increases of less than 1 $\mu g/m^3$.

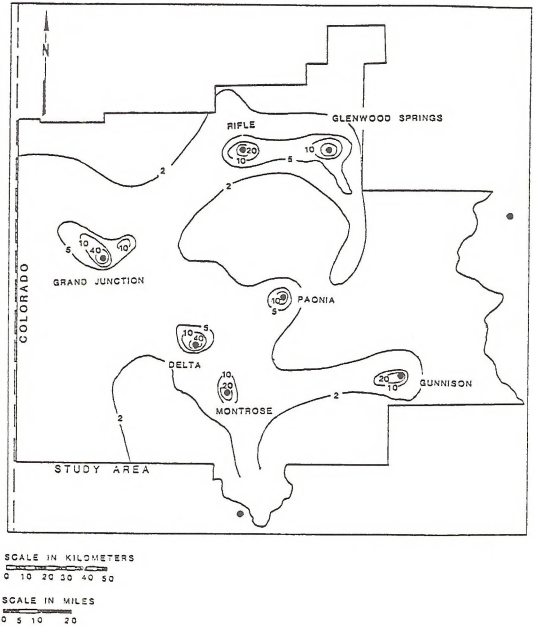
Map R4-10 shows that regional annual average SO_2 levels exceed 5 $\mu g/m^3$ over only very small areas around Grand Junction, Delta, Montrose, Gunnison, Rifle, and Glenwood Springs. Still lower concentrations would occur around Fruita, Paonia, and the Occidental Oil Shale facility in the Parachute Creek area. Maximum 24-hour and 3-hour SO_2 levels for all study years should not exceed 8 $\mu g/m^3$ and 28 $\mu g/m^3$, respectively, outside areas about five miles in diameter around the towns. Therefore, no regional violations of Colorado or national ambient air quality standards are predicted to occur.

Similarly, NO_2 levels should remain relatively low during the study period; maps R4-11 and R4-12 show that highest annual average NO_2 concentrations would reach 40 to 45 $\mu g/m^3$ within small areas around Grand Junction and Delta. Maximum ambient levels of 10 to 20 $\mu g/m^3$ are predicted within small areas around other major towns. Annual average NO_2 levels would be well below the NAAQS of 100 $\mu g/m^3$ for all three study years.

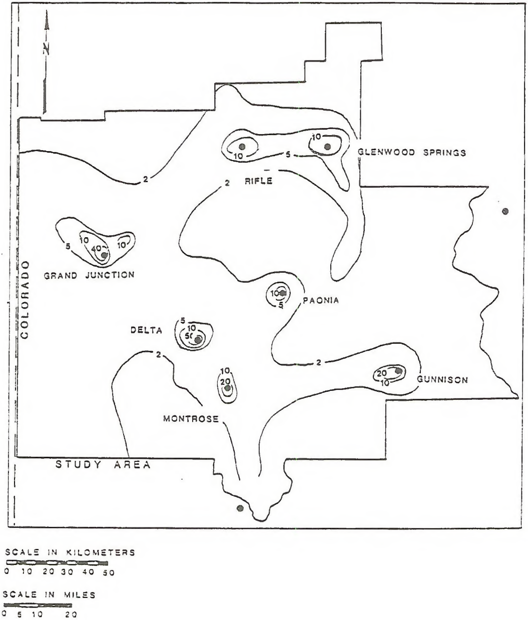
Away from towns, mines, and other major pollutant sources, the annual horizontal visibilities related to atmospheric particulates are expected to exceed 60 miles almost 50 percent of the time. During 1980, 1985, and 1990, average regional visibilities will be reduced to around 53 miles over areas 5 miles in diameter or less around individual mines and groups of mines of the proposed actions. These include areas around the Loma, Sunlight, Coal Basin, North Thompson Creek, Fairview, Tomahawk, and Red Canyon No. 1 mines and around the mines in DeBeque Canyon. Much higher short-term visibility reductions would occur very close to the individual mines; however, these reductions would be highly localized. In many



Map R4- 10 Annual average SO_2 concentrations in 1980, 1985, and 1990 for the most probable level of development



Map R4-11 Annual average NO_2 concentrations in 1980 and 1985 for the most probable level of development



Map R4-12 Annual average NO_2 concentrations in 1990 for the most probable level of development cases, the slight reductions in atmospheric clarity around mines in the region would not be apparent as actual visibility reductions because lines of sight would be obstructed by canyons, mountains, and other complex terrain features.

Regional visibilities (related to atmospheric particulates) would be reduced to 40 to 52 miles over small areas around major towns in the region for the three study years. These reduced visibilities would not extend beyond about 10 to 15 miles from the towns. Much lower visibilities may occur near specific sources within the towns, however, these visibility reductions would be very localized.

Resultant Climate

The proposed mines would not significantly modify the climate and meteorology of the region. The redistribution of soils and other materials at the mines, railroad, and transmission lines proposed for the region may cause small changes in the local climate. The modification of surface contours and albedo may result in local changes in wind speeds and directions, temperatures, and relative humidities.

Geologic and Geographic Setting

Topography

The number of surface acres which would be modified permanently for various facilities related to mining of the six site-specific proposed actions is 349 acres by 1980; 1,133 acres by 1985; and 1,175 acres by 1990. This constitutes 4 percent of the total projected regional disturbance of 8,639 acres by 1980; 4.3 percent of 26,155 acres by 1985; and 3.5 percent of 33,431 acres by 1990. These changes would alter natural erosion processes, which in turn could modify rates of gully cutting and sediment yield, depending on the effectiveness of mitigating measures.

Surface subsidence due to the proposed actions would cause some alteration of the existing topography of approximately 90 acres by 1980; 1,370 acres by 1985; and 3,920 acres by 1990. These acreages would constitute 15 percent of the area (600 acres) to be disturbed by subsidence from the cumulative level of mining in the ES area by 1980, 39 percent (3,550 acres) by 1985; and 51 percent (7,650 acres) by 1990. In general, subsidence in the ES area would be less than 12 vertical feet whether caused by the proposed actions or other mining activity. The following discussion is a general description of the impacts of subsidence. Specific impacts to areas covered by site-specific ESs are discussed in the site-specific volume.

The effects of subsidence are well understood and can be accurately predicted for relatively flat-lying areas underlain by flat-lying coal seams. The most common effect under these conditons is the formation of a trough or basin at the surface overlying the seam. The size of the area affected may be either larger or smaller than the underlying mine workings depending upon the specific mining and geologic conditions of the area and the curvature and strain which are distributed over the affected area in a predictable manner. However, the effects that rugged and uneven topography, such as that found in the ES area, have on the shape of the subsidence profile and the magnitude of surface movements are more complex and not as well understood.

Subsidence impacts can occur in the coal seam, through the overburden, and on the surface. Potential subsidence impacts in the ES area include the rubbilization of the beds overlying the coal seam, the fracturing of overlying strata, and the appearance of tension cracks and compression features at the surface. For the most part, subsidence features would develop over the period of several months to several years following the completion of mining in an area. However, these features, which would probably be permanent, could continue to develop for a period of decades after mining is completed.

The most significant surface subsidence feature would be the formation of tension cracks. These cracks would extend upward from a mined area to the surface above barrier pillars or where coal has been left during the mining operation. Cracks occur because the pillars are not strong enough to support the weight of the overburden completely. They tend to orient either parallel or perpendicular to the length of the barrier pillar. Studies of the Somerset area show the existence of cracks up to a maximum of 1.5 feet wide and several thousand feet long. Similar features in the surface overlying the Sunnyside Mine in Utah are 3.5 feet wide. Tension cracks can appear above both longwall and room-and-pillar mining, although greater numbers of cracks would be expected to occur above room-and-pillar mining. These cracks could begin forming a few months after the onset of mining and continue for several years after mining has been completed. They can cause severe impact to water courses or drainage basins and to human facilities and structures in the area.

In areas which have several feet of soil or colluvium, subsidence cracks may be rapidly erased by erosion of these materials. In some cases, the cracks may never appear at the surface because of the bridging effect of overlying materials. However, in time depression pits may form by collapse of soil into underlying cracks. Depression pits are usually circular in form and as deep as overlying soil. Studies in the Somerset area indicate that they commonly appear a year or two after mining, but may take much longer. The actual formation of a subsidence pit may be very rapid and may occur without warning.

Surface streams flowing across an area to be undermined may be diverted into open fractures or disrupted or rerouted by changes in their gradients. Lakes and reservoirs may be drained directly or by changes affecting their upper reaches. Changes in jointing and fracturing caused by subsidence may affect ground-water flow and the locations of springs may change. The results affect not only surface water but also wildlife, vegetation, and subsequent land use and productivity of the area.

The most common structures overlying areas to be mined are pipelines, ditches, and roads. Pipelines which are buried or attached to the surface will rupture and break unless they have been constructed with telescoping joints and flexible pipe. Fracturing along its length may destroy a ditch. As with streams, the rate of flow along the pipeline or ditch may be changed as the slope of the underlying ground changes. If the change in gradient is severe, flow may be completely disrupted. Although the impact is usually less important, the slopes of roads may also be changed.

Subsidence of the ground surface and the increased local seismic activity that usually accompanies it may increase the rate of downhill movement of soils and sediments, particularly those lying on steep slopes. Under moist conditions a hazard potential for landslides and rockslides will exist. It should be noted that the same hazard potential exists for refuse disposal areas placed in areas of shallow overburden.

In the subsurface, the effects of subsidence may endanger the recovery of coal lying in adjacent seams. Elevated stresses may cause bumps and roof falls, endangering employees and equipment. This is particularly true if mining occurs in overlying seams. Later mining in underlying seams may be endangered if water and methane have accumulated in seams already mined and escape due to subsidence fractures. Valuable reserves of coal may be abandoned or the extraction ratio reduced if the hazard becomes great enough.

In addition, subsidence induced by mining could increase air circulation at depth through fracturing. Increased circulation of the air at depth would allow spontaneous heating and combustion of the coal beds including the seam being mined and all of the overlying seam. The burning of coal beds in the Bowie area has been found to have occurred naturally under overburden depths as great as 600 feet (Louis Gaspar, Coors Beer Company, oral communication). Dunrud and Osterwald (1978) have noted that these fires are common in operational coal mines in Colorado and Utah. Once begun, fires frequently continue to burn for years after the mines have been sealed. In some cases danger may exist that the fire will reach the surface and cause wildfires there. A danger also exists that any fire in an underground mine may spread and consume large areas of adjacent coal reserves.

Paleontology

Plant, invertebrate, and vertebrate fossil materials would be destroyed, disturbed, or removed as a result of coal mining activities, unauthorized collection, and vandalism. The primary impact would probably result directly from mining operations. Given the overall character of the stratigraphic columns, it is probable that some fossils would be destroyed. However, these stratigraphic sections are only moderately likely to yield significant fossils when compared with other parts of the ES area.

All exposed fossil-bearing formations within the region could also be affected by increased vandalism and unathorized fossil collecting as a result of increased regional population. The extent of this impact cannot presently be assessed due to a lack of information on such activities.

As a result of the above impacts, an undetermined number of fossils would be lost for scientific research, public education (interpretive programs), etc. On the other hand, as a result of development, some fossil materials would also be exposed for scientific examination and collection. Due to the present lack of data and accepted criteria for determining significance, the importance of these impacts cannot presently be assessed.

Mineral Resources

Coal

As a result of the six site-specific proposed actions, 4.28 million short tons of coal would be produced by 1980, 34.24 million tons by 1985, and 87.94 million tons by 1990. Production from the six site-specific actions would total 22 percent of the 19.79 million tons to be produced by the cumulative level of mining activity by 1980, 43 percent of 79.16 million by 1985, and 55 percent of 160.54 million by 1990. Table R4-8 presents the impacts to the coal reserve from production for the years 1980, 1985, and 1990.

The companies which have submitted site-specific M&R plans have indicated that their production would be used to supply metallurgical and steam-generating coal markets which lie primarily outside of the ES area and outside the state of Colorado. In contrast, production from the cumulative level of mining activity would be used to supply a much broader spectrum of local, state, national, and international demands for metallurgical, steam-generating, industrial, and domestic home heating markets.

The production and consumption of the tonnages listed above would entail the permanent loss of a nonrenewable resource. In addition to the loss of the coal resource through consumption, the limitations of existing underground mining technologies can only recover about 50 percent of the coal resource. Although today the remaining coal is considered to be unrecoverable, advances in mining may make it available at some future date. Table R4-9 presents the impacts of mining, including both the coal which would be consumed and the coal which must be left in place during mining. The impact to the regional coal reserve due to the six site-specific proposed actions would be to reduce the reserve by 0.09 percent by 1980, 0.70 percent by 1985, and 1.75 percent by 1990. The most substantial reduction of reserves to result from the site-specific actions would occur to the Bookcliffs and Carbondale coal fields. Coal production from the cumulative mining level would create a larger impact on the reserves, reducing them by 0.4 percent by 1980, 1.6 percent by 1985, and 3.2 percent by 1990.

Because of the lack of specific and detailed geologic information no attempt has been made to quantitatively assess the level of impact which would result to particular coal fields, coal beds or zones, or to coal reserves of specific rank or quality. In general, the production of coal from the site-specific proposed actions and the cumulative level of mining would be largely from coking and noncoking bituminous reserves that constitute the major part of the reserves of the ES area. The shallow depth of overburden, large quantity of reserves, accessibility to existing transportation facilities, and high BTU content of the Bookcliffs, Grand Mesa, and Somerset fields would mean that their reserves would be depleted faster than those of other fields.

Oil and Gas

Oil and gas operations can at times conflict with coal mining operations. In west-central Colorado, oil or gas deposits may occur below, on the same horizon, or above a mineable coal bed of the Mesaverde Group. In general, simultaneous operation of a coal mine and a producing oil or gas field is potentially difficult for the following reasons:

1. Drill holes may interfere with underground operations where the holes intersect the coal bed.
2. Wells drilled through coal seams may be sheared, allowing hydrocarbon vapors to penetrate the coal seam, creating a safety problem which could preclude further mining in the affected areas.

Resolution of these resource conflicts must be settled on a case-by-case basis. Often it becomes necessary to extract one resource prior to extracting the other. However, even sequential extraction of the two resources can create potential problems for the second resource extractor.

Drilling for oil and gas resources in an area of abandoned underground mine workings may be difficult due to loss of drilling media and circulation if the abandoned workings are encountered. Maps of abandoned underground mines would have to be obtained and thoroughly studied to prevent inadvertent drilling into the underground workings.

In the reverse case, where a mining operation is to follow extraction of petroleum products, the location of oil and gas wells would have to be determined by the mining company in order to leave safety pillars around the wells. (Refer to 30(CFR): 211.11 for further discussion.) It should be noted that in cases requiring sequential extraction, it is generally more prudent for technological reasons to extract the coal resource before the oil and gas resource.

Finally, methods do exist for mitigating the conflicts of simultaneous development. Oil and gas wells can be confined to "islands" on the surface where their effect on the coal reserves can be minimized. Then by means of off-set or directional drilling, the petroleum reserves can be tapped while allowing continued orderly operation of a coal mine. The additional cost of this type of drilling is usually very small in comparison with the potential loss of coal reserves. (Colorado Revised States [e.g., Article 61--34-61-101 to 34-61-104, revised 1977] deal with boreholes penetrating coal seams, etc.)

Water Resources

Ground Water

Cumulative development at the most probable level would affect coal and overlying sandstone aquifers in somewhat less than 0.08 percent of the ES area. No significant impacts, therefore, are expected to occur to the regional ground-water system in west-central Colorado. Local impacts, however, could occur from (1) removal of parts of the coal aquifers, (2) interruption of pre-mining ground-water flow through the mined areas, (3) changes in water quality caused by leaching of refuse materials placed in disposal areas, and (4) the effects of subsidence from underground mining. An appraisal of these impacts is based on the quantitative and qualitative hydrologic relationships described in chapter 2, Water Resources.

Removal of Parts of the Coal Aquifers

The approximate areal extent of coal beds that would be removed during the time frames addressed in this statement and the relationship of the

TABLE R4-8

CUMULATIVE IMPACT OF PRODUCTION OF COAL IN SIX SITE-SPECIFIC PROPOSED ACTIONS AND ALL COAL MINING ON THE MINEABLE COAL RESERVES OF THE ES AREA

	Field	Amount of Mineable Coal Reserves (Million Short Tons)	Cumulative Impact of Production to the Mineable Coal Reserve By 1980: Million Short Tons Produced	By 1980: Percent of Mineable Reserves Produced	by 1985: Million Short Tons Produced	by 1985: Percent of Mineable Reserve Produced	by 1990: Million Short Tons Produced	by 1990: Percent of Mineable Reserve Produced
Site-Specific Proposed Actions	Bookcliffs	1,906	2.97	0.15	21.67	1.13	53.85	2.83
	Grand Mesa	1,452	0	0	0.70	0.05	4.80	0.33
	Somerset	3,115	0	0	5.48	0.18	17.68	0.57
	Carbondale	332	1.31	0.39	6.46	1.95	11.61	3.50
	All Other Fields	3,217	0	0	0	0	0	0
	Subtotal	10,022	4.28	0.04	34.24	0.34	87.94	0.88
Existing and Projected Mining Activity	Includes all Fields	10,022	15.51	0.15	44.85	0.45	72.60	0.70
	Total	10,022	19.79	0.20	79.16	0.79	160.54	1.60

Residual mineable coal reserves as of 1990: 9,861 million short tons, or 98.4 percent of original mineable reserve.

TABLE R4-9

CUMULATIVE IMPACT OF MINING ON THE COAL RESERVES OF THE ES AREA

			Cumulative Impact of Mining to the Mineable Coal Reserve (Tons Produced Plus Tons Left in Place)					
			By 1980		by 1985		by 1990	
	Field	Amount of Mineable Coal Reserves (Million Short Tons)	Million Short Tons Mined	Percent of Mineable Reserves Mined	Million Short Tons Mined	Percent of Mineable Reserve Mined	Million Short Tons Mined	Percent of Mineable Reserve Mined
Site-Specific Proposed Actions	Bookcliffs	1,906	5.94	0.31	43.34	2.27	107.70	5.65
	Grand Mesa	1,452	0	0	1.4	0.09	9.60	0.66
	Somerset	3,115	0	0	10.96	0.35	35.36	1.14
	Carbondale	332	2.62	0.79	12.92	3.89	23.22	6.99
	All Other Fields	3,217	0	0	0	0	0	0
	Subtotal	10,022	8.56	0.09	68.62	0.69	175.88	1.75
Existing and Projected Mining Activity	Includes all Fields	10,022	31.02	0.31	89.70	0.89	145.20	1.45
	Total	10,022	39.58	0.39	158.32	1.60	321.08	3.20

Residual mineable coal reserves as of 1990: 9,701 million short tons, or 96.8 percent of original mineable reserve.

affected areas to the total coal area and to the ES area are summarized in table R4-10. Data are not available from which to appraise the occurrence of ground water in the coal beds being mined by ongoing operations, but based on the evaluation of the six site specifics presented in volume 2 and the relative location of existing mines, the coal beds in only about half the area listed in table R4-10 can be regarded as potential aquifers. Most of the coal beds in the eastern coal fields should be saturated in all but the outcrop areas, whereas most of the coal beds in the comparatively arid western fields are drained and yield little or no water to wells and springs. On that basis, mining of the coal beds at cumulative mid-level production would impact coal aquifers in only about 0.9 percent of the coal areas by 1990 and in about 0.04 percent of the total ES area by that date. Coal mining attributable to the proposed actions by 1990 would remove the coal aquifers in only about 0.5 and 0.02 percent, respectively, of the coal areas and the ES area.

Removal of most of the coal in the mined areas, followed by eventual collapse of the remaining pillars, would leave behind a rubble zone within the mined interval that probably would include interconnected voids for a period of many decades. Very probably, this rubble zone would be far more permeable than the removed coal beds. Where they lie above the top of the saturated zone, these permeable rubble zones would tend to be drained; below that level, they 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.

Thus, underground coal mining at cumulative development at the most probable level should have no appreciable local or regional adverse impacts on most coal aquifers or areal ground-water recharge-discharge relationships, except as described later in relation to the effects of subsidence induced by mining. Areas in which coal beds were not water bearing prior to mining would be virtually unaffected by mining. Areas in which coal beds were saturated prior to mining should be generally amenable to ground-water development after mining and reclamation with the exception of that part of the Somerset coal field that lies south of the North Fork of the Gunnison River. The coal beds in that area dip generally northward toward the river and crop out in the steep valley sideslopes above the river level. Normally these beds would be naturally drained, but because of the high precipitation and recharge occurring on the northwest slopes of Mt. Gunnison, they are saturated in all but the outcrop areas. The permeable rubble zone left in the wake of mining would tend to drain downslope with probable occurrence of springs at points of discharge. The impacts of mining on the ground-water system in this area are described in detail in volume 2 in conjunction with Atlantic-Richfield Company's proposal to operate the Mt. Gunnison No. 1 Mine.

Interruption of Pre-mining Ground-water Flow Through the Mined Areas

Water pumped from underground mines that extend below the saturated zone would create a new sink or low point in the ground-water flow system. The effect would be to interrupt ground-water movement through the mined areas toward points of natural ground-water discharge, 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 are pumped to supply water for mining operations.

The magnitude of water-level declines in the vicinity of mines would depend on the depth of mining, aquifer properties, recharge potential, and the rate and duration of pumping of any wells used as a source of water for mining operations. Declines should be very local, however, and probably would not exceed a few tens of feet at a distance of more than a mile from the mined areas. So far as could be determined, no existing wells would be adversely affected by the six proposed mines described in volume 2. Should any nearby domestic or stockwater wells be significantly impacted, the responsible mining company must replace the interrupted supplies (30[CFR]: 717.17[i]).

Dewatering of those mines that extend below the level of nearby perennial or intermittent streams would 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 mined areas toward the streams. A reduction in stream flow could result, but the magnitude should be small and should not significantly impact any of the principal streams in the ES area.

Discharge of effluent from coal mines into surface streams in conjunction with dewatering of the mines would tend to increase sodium and sulfate concentrations as well as total salinity of the receiving streams, especially during periods of low flow. North Thompson Creek could be severely impacted by Anschutz' ongoing operations as described in volume 2, but other streams and rivers in the ES area should be only minimally affected with no serious impacts on aquatic biology or downstream uses of the water. The impact of mine effluent on the salinity of the Colorado River is discussed under Surface Water.

TABLE R4-10

AREA OF COAL BEDS REMOVED BY MINING

Activity	1978-80	1981-85	1986-90	1978-90
Approximate total area of coal beds removed by cumulative development at mid-level (acres)	600	2,950	4,100	7,650
Percent of total coal area disturbed	0.15	0.70	0.98	1.8
Percent of ES area disturbed	0.01	0.03	0.04	0.08
Approximate total area of coal beds removed as a result of the six proposed mines (acres)	90	1,280	2,550	3,920
Percent of total coal area disturbed	0.02	0.31	0.61	0.94
Percent of ES area disturbed	0.001	0.01	0.03	0.04

CHANGES IN WATER QUALITY CAUSED BY LEACHING OF REFUSE MATERIAL

As water moves through refuse materials consisting largely of coal-processing wastes placed in disposal areas adjacent to the mines, solution and interaction with soluble minerals can be expected to significantly increase the concentrations of sodium, magnesium, sulfate, and total dissolved solids. Although analytical data are lacking from which to quantitatively predict the effect of this leaching on the local ground-water and surface-water resources, some inferences can be drawn from observed ground-water quality in spoils materials elsewhere in Colorado and from the standards set forth in 30(CFR): 715.15 for the disposal of spoil and waste materials in refuse areas.

On that basis, leachate from refuse areas can be expected to be a sodium, magnesium, calcium, sulfate type water containing 2,000 to 3,000 milligrams per liter (mg/l) dissolved solids, which is not significantly different from ground water occurring in siltstones and shales in the Mesaverde Group. The affinity of carbonaceous materials in the refuse areas for heavy metals and trace elements should trap and hold most of these minor constituents, thereby preventing them from reaching toxic levels in the effluent. Also, ground-water recharge in refuse areas, and thus, effluent discharge should be minimized by (1) compaction of the waste materials during placement to insure mass stability, (2) reclamation of the final graded surface, and (3) diversion of all surface drainage from undeveloped areas above such fills away from those fills as required by 30(CFR): 715.15. For these reasons, leaching of refuse materials in approved disposal areas should present no significant impacts to either the ground-water or surface-water resources in the ES area.

EFFECTS OF SUBSIDENCE FROM UNDERGROUND MINING

Subsidence both during and following the completion of underground mining in an area can introduce compression and tension stresses in the overlying rocks that eventually may cause local rupture in many, if not most, of the mined areas. Cracks thus formed commonly extend upward to the surface and would open all intersected aquifers to intercirculation of ground water and equilization of hydraulic pressures. Surface streams could be intercepted by these elongate fractures and their flows at least temporarily diverted into the mine (see discussion of impacts on surface water).

Studies by Dunrud (1976) show that subsidence, accompanied by open fractures and compression bulges at the surface, is presently occurring in the Somerset coal field as a result of conventional room-and-pillar mining. Little or no subsidence-related fracturing in response to conventional mining is apparent, however, in other coal fields in the ES area. Unfortunately, longwall mining is too new in the ES area to permit direct assessment of the probable extent of subsidence and fracturing that can be expected from the use of this method. Experience, elsewhere, however, indicates that longwall mining would almost certainly cause extensive fracturing wherever used in the ES area (see Topography), with possible local impacts on the ground-water system.

It follows, therefore, that the severity of the impacts on ground water caused by subsidence can be expected to range widely, depending primarily on the mining method used and the extent of saturation in rocks overlying the coal beds to be mined. For example, the coal beds and overlying strata in the Little Bookcliffs and Grand Mesa coal fields are largely drained in both the active and proposed mine areas. Few or no springs discharge at the mine surface. Subsidence and related fracturing, therefore, should have virtually no impact on ground water in these areas, regardless of the mining method used. In marked contrast, the proposed Mt. Gunnison No. 1 Mine in the Somerset coal field in the eastern part of the ES area would mine a saturated coal bed using longwall methods. Strata overlying the coal are also largely saturated, and approximately 114 springs and seeps having a combined discharge of as much as 500 gallons per minute (gpm) have been identified on or adjacent to the mine area. The proposed mining operations would probably extensively fracture the strata overlying the mined coal bed and divert most of the ground water in the overlying aquifers into the mine, thereby drying up most of the springs and seeps. In this case, the impacts would be long-term. An assessment of the effects of subsidence on the ground-water resource for each of the six proposed mines is presented in volume 2.

Surface Water

Impacts on the surface-water system as a result of cumulative development at the most probable level include (1) removal, relocation, or alteration of existing stream channels within disturbed areas; (2) effects of subsidence from underground mining on streams; (3) interception and diversion of runoff in disturbed areas and consequent reduction in discharge downstream; (4) consumptive use of water; and (5) degradation in water quality.

ALTERATION OF EXISTING STREAM CHANNELS

Surface disturbances in conjunction with cumulative development at mid-level would require the removal, relocation, or alteration of natural stream channels within the disturbed area. Regulations 30(CFR): 715(j) and 717.17(d) protect the essential hydraulic functions of alluvial valley floors from disruption by coal-mining operations and require that new or altered channels in mined areas must maintain average stream gradients and remain stable to the extent possible using the best technology currently available. This wording, however, recognizes that current technology is not adequate to permit reestablishment of channels as stable as those draining the pre-mining surface. Properly reconstructed channels, however, can be expected to reach quasi-equilibrium with post-mining flow conditions through natural processes of geomorphic readjustment much more rapidly than those that are not properly engineered. Thus, impacts stemming from alteration of stream channels should be minimal for coal-related disturbances and probably would be largely unmitigated for other channel disturbances at cumulative mid-level development.

Assuming that disturbed areas have approximately the same average drainage density as the overall ES area, the total length of channels removed, relocated, or altered should be proportional to the areas disturbed. Accordingly, the percentage of stream channels affected during the time frames addressed in this statement are summarized in table R4-11.

Clearly, the disturbance of stream channels on only 0.03 percent of the ES area by 1990 as a result of the six proposed mines described in volume 2 should not constitute a significant impact on the regional surface-water system, especially given the protection required by regulation 30(CFR): 717.17(d). Combined disturbance of channels on only 0.36 percent of the ES area by 1990 as a result of cumulative development at the most probable level also should have only a very minor impact on the regional system. Any impacts incurred from possible failure to reconstruct stable channels should be primarily local in nature.

Effects on streams of Subsidence From Underground Mining

Some subsidence, accompanied by open fractures and compression bulges at the surface as described under the sections on Topography and Ground Water, is currently occurring in the Somerset coal field in response to mining by conventional room-and-pillar methods. Impacts are very local to date and have little or no effect on the surface-water resource. With the onset of mining using longwall methods, however, whereby caving is induced following the removal of all coal from panels as much as 600 feet wide and several thousand feet long, appreciable subsidence over large areas can be expected, together with the formation of elongate cracks at the surface that may reach a foot or more in width and several thousand feet in length. Where these cracks cross stream channels, flows can be temporarily intercepted and diverted into the mines. The consequent reduction in surface flow may be dramatic, if short lived. Sediment transported by the streams would tend to seal the cracks effectively, possibly in a single flow event in areas of high sediment yield, with correspondingly longer periods required in areas of low sediment yield. Changes in channel geometry should be only minor in most areas inasmuch as streams are continuously readjusting their size, shape, gradient, etc., to maintain approximate equilibrium with changing flow conditions.

Although any reduction in surface runoff attributable to subsidence should be insignificant, compared with total runoff from the ES area, the immediate impact on local water systems could be severe. Atlantic Richfield Company's proposed Mt. Gunnison No. 1 Mine, for example, would almost certainly impact existing irrigation water rights, whereas Mid-Continent's proposed Cottonwood Creek No. 1 and No. 2 mines would very probably disrupt Palisade's municipal water supply. Details of those impacts are presented in the site-specific appraisals in volume 2. No significant subsidence-related impacts to streams are expected in the other four proposed mine areas described in volume 2.

Interception and Diversion of Runoff in Disturbed Areas

Unless the total disturbed area is small and the permittee can show that sedimentation ponds are not necessary to meet effluent limitations, regulations require that all surface drainage from areas disturbed by coal mining (including reclaimed areas) must be passed through a sedimentation pond or a series of ponds before leaving the permit area (30[CFR]: 717.17[a]). Although this regulation mitigates increased sediment yield downstream, the sedimentation ponds and other temporary and permanent impoundments constructed in conjunction with coal-mining operations also store water and thereby increase evapotranspiration losses. The effect would be to reduce runoff downstream during the life of the structures.

Data are not available to calculate the magnitude of these losses, but they should be so small as to be generally insignificant compared with water yield from the ES area. For example, if all runoff from areas disturbed directly by coal mining activities were retained in reservoirs, the loss to downstream flow should average only about 0.64 inch from the disturbed areas (chapter 2, Water Resources). This represents an annual loss of only 21 acre-feet (ac-ft) by 1980, 41 ac-ft by 1985, and 49 ac-ft by 1990. Losses this small should have no measurable effect on the low flow of streams in the vicinity of the mining operations.

Offsetting the small adverse impact of this water loss to the Colorado River system would be the

TABLE R4-11

STREAM CHANNELS AFFECTED BY DEVELOPMENT

Activity	1978-80	1981-85	1986-90	1978-90
Approximate total surface area disturbed at cumulative mid-level development (from table R1-6) (acres)	8,639	17,516	7,276	33,431
Percent of ES area in which stream channels would be affected	0.09	0.19	0.08	0.36
Approximate total surface area disturbed by the six proposed mines (acres)	413	1,521	533	2,467
Percent of total coal area disturbed	0.10	0.36	0.13	0.59
Percent of ES area disturbed	0.004	0.02	0.006	0.03

added source of water provided by the impoundments for wildlife and for livestock in those areas where grazing is permitted.

CONSUMPTIVE USE OF WATER

Any additional development in west-central Colorado would tend to increase the consumptive use of water and, consequently, reduce discharge downstream to the Colorado River system. Estimates presented in table R4-12 indicate that cumulative development at the most probable level would decrease annual water yield from the Upper Main Stem of the Colorado River by almost 8,460 ac-ft (0.2 percent) by 1980; 44,120 ac-ft (1.1 percent) by 1985; and 44,010 ac-ft (1.0 percent) by 1990. In comparison, consumptive use of water attributable to the proposed mining operations described as site specifics in volume 2 (table R4-13) would reduce the annual water yield by only 120 ac-ft (0.003 percent) by 1980; 3,140 ac-ft (0.07 percent) by 1985; and 3,920 ac-ft (0.09 percent) by 1990.

Consumptive use of this small amount of additional water at cumulative mid-level development would not violate the terms of the Colorado River Basin Compact inasmuch as the Upper Basin States are not yet using their alloted amount of river water. Nevertheless, this additional use would reduce the amount of water available for other beneficial uses downstream and, therefore, could adversely affect those activities.

Most parts of the ES area where coal development is expected should not be locally impacted by the projected increase in water consumption inasmuch as flow in the nearby streams or rivers should be more than adequate, provided that appropriate storage is developed to provide carry over during periods of low flow. The exception may be the Somerset coal field in the drainage of the North Fork of the Gunnison River where virtually all runoff is currently used during the summer months. Additional development in this area could utilize water diverted and stored during periods of high flow in the spring, but that source may not be dependable during periods of protracted drouth. Inevitable pressures would be placed on existing water rights with possible local short-term violations despite the protections offered by existing rules and regulations. That possibility should be minimized, however, by Colorado Rule 7 c, d, and f, which require that the operator (of a coal mine in this case) must provide an estimate of project water requirements and indicate the water rights or sources of water to supply these project water requirements. If the development, mining, and reclamation phases of the project are expected to cause measurable material injury to senior water rights, the operator must describe the steps to be taken to resolve the injury to such water rights. Under regulation 30(CFR): 727.17(i) a permittee must replace the water supply of an owner of interest in real property who obtains all or part of his supply of water for domestic, agricultural, industrial, or other legitimate use from an underground or surface source where that supply has been affected by contamination, diminution, or interruption proximately resulting from surface or underground coal mine operations by the permittee.

It should be noted that mining operators must file for the necessary permits and obtain rights from the state of Colorado before they can use any water intercepted in their mining operations. Accordingly, the operators of the six proposed mines described as site specifics in volume 2 have all indicated an intent to obtain all necessary permits and water rights before consumptively using any such intercepted waters.

DEGRADATION IN WATER QUALITY

Additional development within the ES area normally can be expected to degrade the quality of the receiving waters by (1) increased salt loading from municipal and industrial wastes, irrigation activities, mine effluent, etc.; (2) the salt concentrating effects of the consumptive use of good-quality water that formerly diluted poorer-quality entering the surface-water system downstream; and (3) increased erosion and sediment yield from disturbed areas (see Erosion and Sedimentation).

Solid pollutants in wastes are minimized by effluent standards enforced by the Colorado Department of Health (table R2-14), which must issue National Pollutant Discharge Elimination System (NPDES) permits for all unnatural polluting sources. Municipal effluents, however, typically are characterized by downstream increases in biological oxygen demand, fecal coliforms, suspended solids, nitrates, nitrites, chlorine, ammonia, and orthophosphates. Coal mine effluents tend to increase concentrations of dissolved solids, alkalinity, sodium, and sulfate and may decrease pH, although acid conditions are not characteristic of effluent from coal mines in the ES area. Metal mines commonly discharge effluent that is low in total dissolved-solids concentration, but exceeds desirable limits of some heavy metals and trace elements. Similarly, industrial wastes may contain dissolved solids pollutants in excess of recommended limits. In most cases, impacts stemming from pollutants in effluent discharged to receiving waters occur largely to the aquatic biology in the reach immediately downstream from the polluting sources. The effects tend to diminish progressively downstream until the next polluting source is encountered.

The principal impact of additional development of water quality would be the effect on the total

TABLE R4-12

ESTIMATED ANNUAL CONSUMPTIVE USE OF WATER AND DECREASED SALINITY IN THE COLORADO RIVER AS A RESULT OF CUMULATIVE DEVELOPMENT AT THE MOST PROBABLE LEVEL

No.	Item	1980 a/	1985 a/	1990 a/
	Water yield:			
1.	Net discharge without additional development (see (table R2-24) (ac-ft)	4,200,000	4,200,000	4,200,000
2.	Additional consumptive use:			
3.	Irrigation (Dallas Creek Project) (ac-ft)	-500	-17,100	-17,100
4.	Coal mining operations (ac-ft)	-420	-1,920	-1,710
5.	Other mining operations (ac-ft)	-200	-300	-400
6.	Oil shale development (ac-ft)	-640	-12,600	-12,600
7.	Grand Valley Project (ac-ft)	+800	+2,800	+4,000
8.	Municipal and rural (ac-ft)	-7,500	-15,000	-16,200
9.	Total additional consumptive use (lines 3 through 8) (ac-ft)	-8,460	-44,120	-44,010
10.	Net discharge (line 1 plus line 9) (ac-ft)	4,191,540	4,155,880	4,155,990
	Salinity:			
11.	Total dissolved solids load in Colorado River near Colorado-Utah state line without additional development (see table R2-24) (tons)	3,260,700	3,260,700	3,260,700
12.	Additonal dissolved-solids load:			
13.	Irrigation (Dallas Creek Project) (tons)	+300	+9,800	+9,800
14.	Coal mining operations (tons)	-70	-410	-570
15.	Other mining operations (tons)	-80	-120	-160
16.	Oil shale development (tons)	-480	-9,420	-9,420
17.	Grand Valley Project (tons)	-81,500	-285,300	-407,500
18.	Municipal and rural (tons)	+870	+390	+1,880
19.	Total additional dissolved-solids load (lines 13 through 18) (tons)	-80,960	-285,060	-405,970
20.	Total dissolved solids load in Colorado River near Colorado-Utah state line (line 11 plus line 19) (tons)	3,179,740	2,975,640	2,854,730
21.	Change in discharge-weighted average dissolved-solids concentration in Colorado River near Colorado-Utah state line (mg/l)	-13.05	-44.38	-65.79
22.	Percent change	-2.3	-7.8	-11.5
23.	Change in discharge-weighted average dissolved-solids concentration in Colorado River below Hoover Dam (mg/l)	-5.55	-18.61	-27.83
24.	Percent change	-0.81	-2.7	-4.1

a/ Increase (+) or decrease (-) in indicated items.

TABLE R4-13

ESTIMATED ANNUAL CONSUMPTIVE USE OF WATER AND INCREASED SALINITY IN THE COLORADO RIVER AS A RESULT OF THE PROPOSED COAL-MINING OPERATIONS

No.	Item	1980 a/	1985 a/	1990 a/
	Water yield:			
1.	Net discharge without additional development (see (table R2-24) (ac-ft)	4,200,000	4,200,000	4,200,000
2.	Additional consumptive use:			
3.	Coal mining operations (ac-ft)	0	-1,660	-1,530
4.	Municipal and rural (ac-ft)	-120	-1,480	-2,390
5.	Total additional consumptive use (lines 3 and 4) (ac-ft)	-120	-3,140	-3,920
6.	Net discharge (line 1 plus line 5) (ac-ft)	4,199,880	4,196,860	4,196,080
	Salinity:			
7.	Total dissolved solids load in Colorado River near Colorado-Utah state line without additional development (see table R2-24) (tons)	3,260,700	3,260,700	3,260,700
8.	Additonal dissolved-solids load:			
9.	Coal mining operations (tons)	0	-660	-1,160
10.	Municipal and rural (tons)	-20	-240	-420
11.	Total additional dissolved-solids load (lines 9 and 10) (tons)	-20	-900	-1,580
12.	Total dissolved solids load in Colorado River near Colorado-Utah state line (line 7 plus line 11) (tons)	3,260,680	3,259,800	3,259,120
13.	Change in discharge-weighted average dissolved-solids concentration in Colorado River near Colorado-Utah state line (mg/l)	+0.02	+0.28	+0.26
14.	Percent change	+0.003	+0.05	+0.05
15.	Change in discharge-weighted average dissolved-solids concentration in Colorado River below Hoover Dam (mg/l)	+0.01	+0.16	+0.16
16.	Percent change	+0.002	+0.02	+0.02

a/ Increase (+) or decrease (-) in indicated items.

TABLE R4-14

ESTIMATED ANNUAL CONSUMPTIVE USE OF WATER AND INCREASED SALINITY IN THE COLORADO RIVER
AS A RESULT OF CUMULATIVE DEVELOPMENT AT THE MOST PROBABLE LEVEL WITHOUT THE GRAND VALLEY PROJECT

No.	Item	1980 a/	1985 a/	1990 a/
	Water yield:			
1.	Net discharge without additional development (see (table R2-24) (ac-ft)	4,200,000	4,200,000	4,200,000
2.	Additional consumptive use:			
3.	Irrigation (Dallas Creek Project) (ac-ft)	-500	-17,100	-17,100
4.	Coal mining operations (ac-ft)	-420	-1,920	-1,710
5.	Other mining operations (ac-ft)	-200	-300	-400
6.	Oil shale development (ac-ft)	-640	-12,600	-12,600
7.	Municipal and rural (ac-ft)	-7,280	-14,250	-15,130
8.	Total additional consumptive use (lines 3 through 7) (ac-ft)	-9,040	-46,170	-46,940
9.	Net discharge (line 1 plus line 8) (ac-ft)	4,190,960	4,153,830	4,153,060
	Salinity:			
10.	Total dissolved solids load in Colorado River near Colorado-Utah state line without additional development (see table R2-24) (tons)	3,260,700	3,260,700	3,260,700
11.	Additonal dissolved-solids load:			
12.	Irrigation (Dallas Creek Project) (tons)	+300	+9,800	+9,800
13.	Coal mining operations (tons)	-70	-410	-570
14.	Other mining operations (tons)	-80	-120	-160
15.	Oil shale development (tons)	-480	-9,420	-9,420
16.	Municipal and rural (tons)	+860	+370	+1,850
17.	Total additional dissolved-solids load (lines 12 through 16) (tons)	+530	+220	+1,500
18.	Total dissolved solids load in Colorado River near Colorado-Utah state line (line 10 plus line 17) (tons)	3,261,230	3,260,920	3,262,200
19.	Change in discharge-weighted average dissolved-solids concentration in Colorado River near Colorado-Utah state line (mg/l)	+1.33	+6.39	+6.73
20.	Percent change	+0.23	+1.12	+1.18
21.	Change in discharge-weighted average dissolved-solids concentration in Colorado River below Hoover Dam (mg/l)	+0.60	+3,25	+3.20
22.	Percent change	+0.09	+0.48	+0.47

a/ Increase (+) or decrease (-) in indicated items.

salinity of the Colorado River. As stated in chapter 2 (Water Resources), an increase of 1 mg/l in the 1972 level of 879 mg/l at Imperial Dam would cost Lower Basin water users about $230,000 annually.

Any assessment of the effects of additional development in the ES area on the salinity of the Colorado River downstream at points near the Colorado-Utah State line and below Hoover Dam 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 North Fork Valley in the Somerset coal field, for example, does not mean that an additional ton of salt would pass undiminished through the river system, especially if the water containing that additional salt load is subject to irrigation activities enroute. More probably, the increase in salt load downstream would be somewhat less than one ton. For the purposes of this analysis, however, it was assumed that a change in discharge or salt loading upstream would cause a corresponding change downstream. The results, therefore, should be regarded as a "worst case" condition where degradation in water quality is expected and a "best case" condition where improvement of water quality is expected because of the Grand Valley salinity control project.

On that basis, the estimated salinity of the Colorado River as a result of cumulative development at the most probable level would decrease by as much a 11.5 percent (66 mg/l) at the Colorado-Utah state line and 4.1 percent (27.8 mg/l) below Hoover Dam by 1990 (table R4-12). Without the Grand Valley Project, which would remove an estimated 410,000 tons of salt annually from the river by 1990, the salinity at cumulative mid-level development would increase by as much as 1.2 percent (6.7 mg/l) at the state line and 0.5 percent (3.2 mg/l) below Hoover Dam by 1990 (table R4-14). The six proposed coal-mining operations alone would increase the salinity of the river by only about 0.05 percent (0.26 mg/l) at the state line and 0.02 percent (0.16 mg/l) below Hoover Dam by 1990 (table R4-13). Assuming an increased cost to downstream users of $230,000 per milligram per year, the increased cost attributable to the proposed coal mines would be about $37,000 per year.

Impacts of the increased salt load on aquatic biology are most pronounced during periods of low flow when dissolved-solids concentrations are highest. Accordingly, a summary of salinity changes in the Colorado River at both mean and low flow conditions at the state line is presented in table R4-15. Because of the mixing that occurs in the main stem reservoirs on the Colorado River, the salinity at low flow should be essentially the same as at mean flow below Hoover Dam. The impacts of these changes in salinity levels on aquatic biology are discussed in that section of the statement.

Erosion and Sedimentation

Changes in sediment yield as a result of cumulative development at the most probable level range widely from one activity to another, depending on required mitigation measures. For example, runoff from areas disturbed by surface activities associated with underground mining must be passed through sedimentation ponds from which the outflow can transport no more than 30 mg/l total suspended solids as an average of daily values for 30 consecutive discharge days (30[CFR]: 717.17[a]). The effect is to reduce sediment yield from these areas to less than one percent of pre-mining rates. In contrast, regulations pertaining to coal-mining operations do not apply to other activities included in cumulative mid-level development such as housing construction and related urbanization. Increased sediment yield from these sources would be virtually unmitigated and probably would be double the predisturbance rate for a period of one to two years. Once streets are paved and lawns are established, however, rates of sediment yield from these areas should decrease to significantly less than the predisturbance rates.

Estimated sediment yields as a result of cumulative development at the most probable level for the time frames addressed in this report are listed in table R4-16. Results indicate that the combined sediment yield from all disturbed areas would increase about 28 percent initially during 1978-80, would be only slightly higher than predisturbance rates during 1981-85, and would decrease about 18 percent during 1986-90. The overall effect for the period 1978-90 would be to reduce the sediment yield from all disturbed areas by almost 7 percent. The reduced sediment yield during the period 1986-90 is attributed to fewer acres disturbed by new activities, to limitation of suspended solids in runoff from mined areas as described above, and to the significant reduction in erosion in established urban areas.

The relative significance of this estimated change in sediment yield as a result of cumulative mid-level development can be illustrated by a comparison with the annual suspended sediment load in the Colorado River at the Colorado-Utah state line which averages about 10.8 million tons. Assuming that the net change in sediment yield summarized

TABLE R4-15

ESTIMATED CHANGE IN SALINITY IN THE COLORADO RIVER AS A RESULT OF DIFFERENT LEVELS OF DEVELOPMENT IN WEST-CENTRAL COLORADO

Activity	Flow in River	Increase (+) or Decrease (-) in Salinity of River Water: 1980 (mg/l)	1980 (percent)	1985 (mg/l)	1985 (percent)	1990 (mg/l)	1990 (percent)
Effect of most probable level of development (state line)	Mean flow	-13.05	-2.3	-44.38	-7.8	-65.79	-11.5
	Low flow	-141.98	-10.9	-497.27	-38.2	-787.81	-60.6
Effect of most probable level of development (below Hoover Dam)	Mean flow a/	-5.55	-0.8	-18.61	-2.7	-27.83	-4.1
Effect of most probable level of development without Grand Valley Project (state line)	Mean flow	+1.33	+0.2	+6.39	+1.1	+6.73	+1.2
	Low flow	+33.28	+2.6	+196.75	+15.1	+197.45	+15.2
Effect of most probable level of development without Grand Valley Project (below Hoover Dam)	Mean flow a/	+0.60	+0.09	+3.25	+0.5	+3.20	+0.5
Effect of the proposed coal-mining operations (state line)	Mean flow	+0.02	+0.003	+0.28	+0.05	+0.26	+0.05
	Low flow	+0.40	+0.03	+9.85	+0.8	+11.35	+0.8
Effect of the proposed coal-mining operations (below Hoover Dam)	Mean flow a/	+0.01	+0.002	+0.16	+0.02	+0.16	+0.02

a/ Mean flow is essentially the same as low flow becuase of the mixing that occurs in main stem reservoirs on the Colorado River.

TABLE R4-16

ESTIMATED SEDIMENT YIELD AS A RESULT OF CUMULATIVE DEVELOPMENT AT THE MOST PROBABLE LEVEL

Activity	Area Disturbed (acres)	Total Sediment Yield Before Disturbance (tons)	Total Sediment Yield After Disturbance (tons)	Net Change in Sediment Yield Increase (+) or Decrease (-) (tons)
		1978-80		
Existing coal mines	1,104	3,310	7	-3,303
Proposed coal mines	332	940	2	- 938
Oil shale mines/refineries	60	180	300	+ 120
Uranium mines/mills	780	2,340	3,900	+1,560
Oil and gas exploration/ drilling	285	860	1,425	+ 565
Roads	2,010	6,030	10,050	+4,020
Railroads	7	20	35	+ 15
Power lines/pipelines/ telephone lines	0	0	0	0
Population related disturbances	4,061	12,180	17,260	+5,080
Subtotal	8,639	25,860	32,979	+7,119
		1981-85		
Existing coal mines	1,265	6,320	14	-6,306
Proposed coal mines	548	2,640	6	-2,634
Oil shale mines/refineries	4,500	22,500	31,380	+8,880
Uranium mines/mills	2,340	11,700	14,820	+3,120
Oil and gas exploration/ drilling	795	3,980	4,995	+1,015
Roads	6,081	30,400	38,550	+8,150
Railroads	504	2,520	2,894	+ 374
Power lines/pipelines/ telephone lines	2,000	10,000	14,000	+4,000
Population related disturbances	8,122	40,610	24,370	-16,240
Subtotal	26,155	130,670	131,029	+ 359
		1986-90		
Existing coal mines	1,393	6,960	15	-6,945
Proposed coal mines	590	2,850	6	-2,844
Oil shale mines/refineries	4,500	22,500	22,500	0
Uranium mines/mills	3,900	19,500	22,620	+3,120
Oil and gas exploration/ drilling	1,320	6,600	7,650	+1,050
Roads	10,081	50,400	58,400	+8,000
Railroads	504	2,520	1,010	-1,510
Power lines/pipelines/ telephone lines	2,000	10,000	10,000	0
Population related disturbances	9,143	45,720	15,000	-30,720
Subtotal	33,431	167,050	137,201	-29,849
TOTAL	33,431	323,580	301,209	-22,371

in table R4-16 would be reflected by a corresponding change in the sediment load in the Colorado River, that load would increase about 0.02 percent by 1980, would be essentially unchanged by 1985, and would decrease about 0.06 percent by 1990. These changes would be insignificant compared with annual and seasonal fluctuations in sediment load in the Colorado River and should have no discernable effect on water and sewage treatment facilities or on aquatic biology. Similarly, it is doubtful that locally increased sedimentation during the constuction phases of mine facilities, roads, railroads, etc., would present any significant downstream threat to aquatic biology,

Estimated sediment yields as a result of the six proposed coal-mining operations desribed in volume 2 are listed in table R4-17. Results show that a net decrease in sediment yield is expected during each of the time frames addressed in this statement. Sediment yields from disturbed areas would decrease about 69 percent below predisturbance rates by 1980, dropping to 27 percent by 1985, and increasing again to 64 percent by 1990. This inferred decrease in sediment yield is attributed primarily to the effects of sedimentation ponds required by regulations as described above and to the stabilizing effects of urbanization once the construction phases are over.

On completion of mining and reclamation after the removal of sedimentation ponds, sediment yields from the reclaimed areas would probably return eventually to approximate predisturbance rates. The notable exception would be the urbanized areas, which should remain stable over the long term.

Soils

Surface disturbance resulting from the six site-specific operations and associated urban area expansion would amount to 413 acres by 1980; 1,934 acres by 1985; and 2,467 acres by 1990. Comparable values for regional disturbance due to all causes would be 8,639 acres by 1980; 26,155 by 1985; and 33,431 acres by 1990 respectively. Thus, in 1990, site-specific actions would account for about 7 percent of the total disturbance.

In the case of the six specific mine sites, soils would be removed from any production function on 349 acres by 1980; 1,133 acres by 1985; and 1,175 acres by 1990. Approximately 65 percent of the 1990 acreage is classed as Entisols (see Soils, chapter 2); 25 percent and 10 percent are classed as Aridisols and Mollisols, respectively. The 1,175-acre figure includes about 160 acres of land which would be affected by a portion of Sheridan Enterprises' corridor. Some of that 160 acres includes soil types which would qualify as prime farmland; the degree of impact on such land would depend on design specifications, which Sheridan has not yet submitted.

Urban area expansion associated with the six mines would permanently remove from any production function another 64 acres by 1980; 801 acres by 1985; and 1,292 acres by 1990. Although exact locations cannot be predicted, at least a portion of this requirement would likely come from prime farmland in the Grand Junction Area (soil units 6 and 28 on map 5 in the appendix) and prime or unique farmland in the Delta area (soil units 6, 10, and 28).

Erosion rates would increase in response to any surface disturbance. Gross estimates of background rates and potential increases are given in table R4-18. Within the design limitations of the six specific proposed actions, most of the increased erosion at the mine site would be contained through drainage systems and other sediment control measures.

The net effect of erosional losses of soil, along with a deterioration of soil structure and biological activity due to compaction, handling, and stockpiling, would be a reduction in soil productivity. Any such reduction, although not quantifiable, would prolong and/or increase the efforts necessary to achieve successful reclamation.

Vegetation

Development of mine portals and associated facilities, refuse piles, etc., for the proposed actions would disturb 349 acres of vegetation by 1980; 1,133 acres by 1985; and 1,175 acres by 1990. The acreage of each vegetation type that would be disturbed by 1990 and the significance of the disturbance in relation to the total acreage of the vegetation types in the ES area are shown in table R4-19.

In addition to the direct acreage disturbance caused by the proposed actions in the ES area, 64 acres of land would be disturbed by 1980; 801 acres by 1985; and 1,292 acres by 1990 due to population growth and urban expansion associated with the proposed actions. Much of this disturbance would be on agricultural land around existing population centers.

The vegetative disturbance caused by the proposed actions would be very small when compared with the total acres of disturbance that are projected due to cumulative regional development and urban expansion: 8,639 acres by 1980; 26,155 acres by 1985; and 33,431 acres by 1990. The impacts of the vegetative disturbance caused by the proposed actions and the cumulative regional development would be to reduce the visual aesthetics of the area; increase soil erosion, and reduce the mass of vegetation produced on the sites disturbed, result-

TABLE R4-17

ESTIMATED SEDIMENT YIELD AS A RESULT OF MINING AND ASSOCIATED ACTIVITIES AT THE SIX PROPOSED MINES DESCRIBED IN VOLUME 2

Activity	Area Disturbed (acres)	Total Sediment Yield Before Disturbance (tons)	Total Sediment Yield After Disturbance (tons)	Net Change in Sediment Yield Increase (+) or Decrease (-) (tons)
		1978-80		
Surface facilities of underground mines	281	780	2	- 778
Refuse disposal	51	150	1	- 149
Roads	10	30	50	+ 20
Railroads	7	20	35	+ 15
Population related disturbances	64	190	270	+ 80
Subtotal	413	1,170	358	- 812
		1981-85		
Surface facilities of underground mines	372	1,760	4	-1,756
Refuse disposal	176	880	2	- 878
Roads, new	71	355	500	+ 145
Roads, existing	7	35	35	0
Railroads, new	497	2,480	2,880	+ 400
Railroads, existing	7	35	14	- 21
Population related disturbances, new	737	3,680	3,500	- 180
Population related disturbances, existing	64	320	80	- 240
Subtotal	1,934	9,545	7,015	-2,530
		1986-90		
Surface facilities of underground mines	389	1,850	4	-1,846
Refuse disposal	201	1,000	2	- 998
Roads, new	0	0	0	0
Roads, existing	81	400	400	0
Railroads, new	0	0	0	0
Railroads, existing	504	2,520	1,010	-1,510
Population related disturbances, new	491	2,460	2,330	- 130
Population related disturbances, existing	801	4,000	1,000	-3,000
Subtotal	2,467	12,230	4,746	-7,484
TOTAL	2,467	22,945	12,119	-10,726

TABLE R4-18

ESTIMATED INCREASES IN EROSION DUE TO SURFACE DISTURBANCE

Protective Ground Cover a/ (Before Disturbance)	Soil Erosion b/ Background Erosion (Tons/Acre/Year)	Expected Increase c/ (After Disturbance)
Low (15 - 20%)	1 to 10	2 times
Moderate (35-45%)	1 to 8	3 times
High (Greater than 75%)	1 to 6	7 times

a/ Low category corresponds roughly to the greasewood-saltbush type; soils are primarily Entisols. Moderate category corresponds roughly to the pinyon-juniper type; soils are both Entisols and Aridisols. High category corresponds roughly to the oakbrush type; soils are primarily Mollisols.

b/ Based on calculations using the Universal Soil Loss Equation (SCS 1977).

c/ Assumes bare soil conditions prior to any mechanical stabilization or revegetation efforts; such efforts can often bring erosion rates back to or below normal background levels.

Note: Table values do not reflect the tremendous variability that normally occurs from year to year. For example, in the Badger Wash area northwest of Grand Junction (low protective cover), measured erosion over a 13-year period ranged from 0.03 to 30 tons per acre per year (Lusby et al. 1971).

TABLE R4-19

ACRES OF DISTURBANCE OF VEGETATION TYPES DUE TO THE PROPOSED ACTION BY 1990, COMPARED WITH THE TOTAL ACRES OF THE VEGETATION TYPES IN THE ES AREA

Vegetation Type	Number of Acres Disturbed In Vegetation Type due to Proposed Actions	Total Acres of Vegetation Type in ES Area	Percent Disturbance
Agricultural Land	114	2,079,898	Less than 1
Riparian Land (Cottonwoods)	2	207,450	Less than 0.1
Greasewood	212	103,950	0.2
Saltbush	429	277,200	0.15
Sagebrush	22	242,550	Less than 0.1
Pinyon-Juniper	119	966,250	Less than 0.1
Mountain Shrub	64	294,500	Less than 0.1
Aspen	7	346,500	Less than 0.1
Mountain Meadow	27	129,200	Less than 0.1
Annual Weeds	48	96,400	Less than 0.1
Barren a/	218	48,500	0.45
All other Types	0	1,129,100	0
Totals	1,262	5,921,498	

a/ Less than 2 percent vegetative cover.

ing in a reduction in the carrying capacity for wildlife and livestock in the ES area.

A secondary impact of regional population growth and growth associated with the proposed actions would be increased off-road vehicle (ORV) use. ORV use would disturb vegetation, particularly in the ecologically sensitive areas above the timberline in the alpine zone and in the low elevation Mancos shale hills.

Increased commercial and noncommercial firewood cutting would also accompany an increase in population. A large amount of the cutting would be done during the winter in the pinyon-juniper zone. Removal of the pinyon-juniper overstory would result in a beneficial increase in density of understory plants that are more desirable livestock forage than pinyon and juniper.

Revegetation Requirements

The mining companies would be required to revegetate the disturbance upon abandonment of the mines. Parts of the disturbance may be revegetated before abandonment for example, on road cutbanks, refuse piles, etc. Specific revegetation measures that would be required by the federal coal mining regulations are stated in 30(CFR): 717.20, 30(CFR): 211.40, 211.41, and 211.62, and 43(CFR): 3041. The major regulations covering revegetation of the surface effects of underground coal mines are in 30(CFR): 211 and 43(CFR): 3041. Much of the same wording is present in both sets of regulations.

Both 30(CFR): 211.40(a)(1) and 43(CFR): 3041.2-2(e)(1) state that lands disturbed by mining activities must be reclaimed to a condition capable of supporting the previous land use before mining or a better land use.

Regulations contained in 43(CFR): 3041.2(e)(3) and 30(CFR): 211.40(a)(4) state that topsoil must be removed from the areas to be disturbed and stored for replacement onto areas no longer needed for mining operations. If the topsoil will not be used immediately after being stockpiled, a quick growing vegetative cover must be established and maintained, or other measures may be employed (such as placing mulches) so that the topsoil is protected from wind and water erosion and weed infestation.

Regulations contained in 43(CFR): 3041.2-2(f)(13)(i) and 30(CFR) 211.40(a)(13)(i) state that on areas disturbed by mining activities a diverse vegetative cover, native to the area and capable of regeneration and plant succession at least equal in density and permanence to the native vegetation originally on the site must be established. They further state that approved mixtures of introduced species may be used to achieve quick cover or assure successful revegetation.

Regulations contained in 43(CFR):3041.2-2(f)(13)(ii) and 30(CFR): 211.40(a)(13)(ii) state that the mining companies' responsibility for revegetation after the mine is abandoned must extend until such a time when the authorized officer of the federal-land managing agency, in consultation with the Area Mining Supervisor of USGS and the surface owner, determine that successful revegetation has been achieved. This period of liability will extend for a minimum of five years and a maximum of ten years. If natural conditions are stable and favor revegetation, the period of liability may be less than the minimum period. If natural conditions are unstable so as to favor only slow and uncertain revegetation, the period of liability may be extended five years beyond the minimum period of five years initially established.

Regulations contained in 43(CFR): 3041.6 and 30(CFR): 211.62(a, b) require the mining companies to file a report to the Mining Supervisor within 30 days after each planting is completed. In the report the mining companies are required to (1) show the types of planting or seeding, including mixtures and amounts; (2) show the date of planting or seeding; (3) identify or describe the planted or seeded lands; (4) describe any surface manipulation, mulching, fertilization, and irrigation procedures. These regulations further state that the Mining Supervisor and the authorized officer will inspect and evaluate the revegetated areas after each full growing season to determine whether satisfactory vegetative growth is being established, or whether additional revegetation efforts should be ordered by the Mining Supervisor.

Regulations contained in 43(CFR): 3041(f)(14)(ii) and 30(CFR): 211(a)(14)(ii) state that the mining companies will regulate public access, vehicular traffic, and wildlife and lifestock grazing on the areas undergoing reclamation, in order to protect the revegetated areas.

The Office of Surface Mining Regulations, 30(CFR): 700, briefly describe the revegetaton requirements for the surface effects of underground mines. The regulations in 30(CFR): 717.20(b) require the mining company to establish on land that has been disturbed by mining operations a diverse, effective, and permanent vegetative cover capable of self-regeneration and plant succession, and adequate to control soil erosion. They further state that approved introduced species may be substituted for native species, and that introduced species must meet applicable state and federal seed or introduced species statutes and may not include poisonous or potentially toxic species.

Problems may be encountered in attempting to revegetate the disturbed areas, particularly in the lower altitudes of the region. This may prolong the period of time required for successful revegetation, even if adapted species and advanced revegetation techniques are used. The main limiting factor in the revegetation attempts would be the low annual precipitation (9 to 11 inches). There may also be drought periods, as in 1977 when the annual precipitation was as low as 5 inches. In such years, very little revegetation would occur unless the planted or seeded areas are irrigated. High soil salinity, steep south-facing slopes, and weed infestation compound the problem of low annual precipitation. Various techniques of revegetation (use of adapted species, soil preparation, mulches, herbicides) have been developed to counter such problems and may be successful (see Cook 1974; Thames 1977; Vories 1976); see next section, Revegetation Techniques. In such cases where low annual precipitation, high soil salinity, steep, south-facing slopes, and weed infestation, are serious problems, a five-year extension of the mining companies' responsibility for revegetation efforts may be necessary (beyond the five-year period initially established by regulations in 30[CFR]: 211.40[a][13][ii] and 43[CFR]: 3041.2-2[f][13][ii]).

Revegetation Techniques

Cook (1976) states that, according to most researchers, successful reestablishment of vegetation following surface disturbance requires a plant growth medium to a depth of at least 18 to 24 inches. This depth would be necessary to hold moisture following snowmelt so that it would be available to plants during the drier summer months.

With few exceptions, untreated mine waste will not sustain plant growth due to high acidity, deficiencies in nitrogen or phosphorus, excesses in soluble salts and sodium, high clay content, or lack of fine soil texture. A suitable growth medium may be prepared by placing soil over the spoil material or by adding soil or chemical and organic amendments to the spoil. The growth medium should be analyzed to determine any chemical imbalances or deficiencies it possesses, and to assess what treatments and amendments are necessary to make it suitable for plant growth. Nitrogen and phosphorus are often added to the growth medium at various rates, usually within a range of 40 to 80 available pounds per acre.

Many researchers are of the opinion that it is not desirable to apply nitrogen at the time of seeding, but to wait until the seedlings have come up. Applying nitrogen at the seeding tends to encourage top growth and discourage root development (Hodder 1976) and to increase weed growth (Cook, Hyde, and Sims 1974).

An adequate supply of phosphorus in the growth medium is essential for vigorous root development. Since phosphorus will not move readily through the soil, it must be mixed with the soil before planting rather than just broadcast on the surface (Berg 1976).

If topsoil is scraped from the surface before mining and stockpiled for later use, precautions may have to be taken to prevent weed invasion and erosion on the stockpiles. This can best be accomplished by seeding the stockpiles with a quick-growing annual plant cover. Another method is applying a preemergence herbicide and covering the stockpiles with mulch blankets.

The surface of the growth medium can be prepared by various techniques, such as deep chiseling, offset listering, gouging, and dozer basins. Deep chiseling involves creating a series of parallel surface furrows on the contour of a disturbed slope. Offset listering is a process which results in alternately arranged pits approximately 6 inches deep and 4 feet long. Gouging results in a series of depressions 10 inches deep, 18 inches across, and 25 inches long. Dozer basins are large depressions about 2 feet deep and 15 feet long.

The purpose of each of these techniques is to impede surface runoff, increase infiltration, and consequently increase available soil moisture. Surface water drains to the depressions and creates conditions favorable for initial plant establishment during the first growing season. The established plants will ultimately spread to spaces between the depressions (Hodder 1977).

It is necessary to use plant species adapted to the environmental conditions at the mine site if successful revegetation is to be achieved. Native species indigenous to the region are highly desirable since they have, through natural selection, evolved over long periods of time to the conditions of their environment (Plummer 1977). Plant species occurring naturally within the region that may be used for revegetation are listed in volume 3 in the appendixes.

Revegetation with shrubs, grasses, and forbs will result in a plant community which will more closely resemble a composition found in the natural environment of the ES area and which will better blend into the adjacent landscape (see figure R4-1). A diversity of shrubs, forbs, and grasses is also necessary to satisfy the plant composition requirements of the post-mining land uses. Deer utilize mostly shrubs, while wild horses and livestock graze mostly grasses. All three classes of animals utilize forbs to a certain extent, mainly in the early spring.

The use of mulches at the time of seeding is essential to achieve successful revegetation on arid sites with less than 10 inches average annual precipitation. Mulches conserve soil moisture by reducing evaporation from the soil surface and help to minimize erosion. Various surface cover mulches have been developed, some of which are wood fiber (applied at 1,500 pounds per acre), straw asphalt (straw at 3,000 pounds per acre; asphalt at 300 gallons per acre), soil-anchored mulches (straw or hay at 2,500 to 3,000 pounds per acre punched into the soil for anchoring), or agronomy blankets (see figure R4-2). The establishment of an annual plant cover in conjunction with a mulch would create conditions particularly favorable for the growth of permanent perennial species.

The most favorable time of seeding is immediately preceding the season of highest precipitation, which in much of the ES area is in late summer or fall.

In desert areas (at or less than 10 inches annual precipitation), conditions favorable for establishing vegetation may come only every four to six years (Hassell 1977). Numerous researchers have indicated that supplemental water may be needed for initial establishment of vegetation in desert areas (Hodder 1977; Aldon 1977; Hassell 1977; Cook, Hyde, and Sims 1974). Hodder (1977) suggests that irrigation could be used to extend the growing season but should be taken off the plants during the dry season. This would adapt the plants to seasonally dry weather and make their conversion from irrigation less drastic.

Drip or "trickle" irrigation is a method that has shown promise in the revegetation of disturbed desert land (Aldon 1977; Bengson 1977; DeReemer and Bach 1977). Drip irrigation is designed to deliver water and soluble nutrients to individual plants at very low rates (1 to 2 gallons per hour). If the system is carefully adjusted, the infiltration rate of the soil can be closely matched so that little if any water collects on the surface. Maximum water penetration is achieved, enabling the plants to develop deeper, stronger roots more rapidly, a condition which better prepares the plants to survive on natural rainfall once irrigation is removed. By deep, slow irrigation, water is conserved and used more efficiently by the plant. Less water is lost by evaporation, and consequently irrigation is required less frequently. Drip irrigation is particularly desirable on very steep slopes where rapid surface runoff occurs (Bergen 1977).

Hodder (1976, 1977) has developed techniques such as pitting or gouging the soil surface (discussed previously), or applying moisture or condensation traps around individual plants, which may be useful for reestablishment of vegetation in arid environments without irrigation. The purpose of these techniques is to trap or collect moisture, thereby increasing the available soil moisture in selected areas where conditions would be favorable for plant establishment.

Moisture traps are often used with tree and shrub species. The plant is seeded within cardboard tubes which are 2 feet long and 2.5 inces in diameter. The cardboard tubes are surrounded by a plastic mesh for support. When roots begin to show out of the bottom or sides of the cardboard tube, the tubes are ready for planting on a disturbed site (Hodder 1976, 1977).

A condensation trap is another method developed by Hodder which is used to establish trees or shrubs. A condensation trap consists of a large funnel-like depression in the soil with a small mount at the bottom of the funnel, where the tree or shrub is planted. A plastic tarp is placed over the funnel with the plant protruding through it. The edges of the tarp are covered with soil to secure it. Rocks placed on the tarp around the plant provide protection for the plant and keep the tarp taunt in a funnel form. Water condenses on the underside of the plastic tarp and trickles to where the plant is rooted, effectively irrigating it. Diagrams of a condensation trap are shown in Hodder (1976, 1977).

The limitation of pitting, gouging, or applying moisture or condensation traps to increase available soil moisture is that these methods are less effective on very steep slopes where droughty conditions are severe due to rapid surface runoff. On very steep slopes in arid regions drip irrigation may be the most successful method for revegetating disturbed soil (Bengson 1977).

Seed can be planted by either broadcasting or drilling. Drilling involves the use of a rangeland drill which discs the surface, dropping the seeds into furrows. Broadcasting is any method that scatters the seed directly on the soil surface without soil coverage.

Drilling is prferred to broadcasting because it distributes the seed more uniformly and places it at a uniform depth. However, rangeland drills cannot be used on very steep slopes (Cook, Hyde, and Sims 1974). In such cases, broadcasting is the preferred method. Due to the lower germination rate of seed planted by broadcasting (due to less coverage of the seed), more seed is required.

Broadcasting is also the preferred method when roughened seedbed treatments such as gouging and basins are used (discussed above). If the area is seeded as soon as the surface is roughened, clods of dirt on the edges of the basins erode into them, trapping the seeds and covering them (Hodder 1976).

Broadcasting the seed mixed with a cellulose mulch is called hydroseeding. Hydroseeding is a common practice in much of the east (Cook, Hyde, and Sims 1974). However, in the arid west, hydromulching used as the only method rarely results in significant revegetation success, except in high mountain areas where spring moisture is sufficient to keep the mulch constantly moist for two to three weeks. If mulches are used in conjunction

Figure R4-1.

Agronomy blankets -- at CWI Orchard Valley Mine

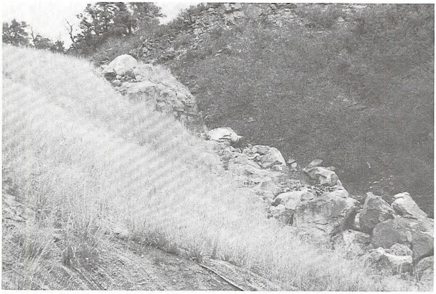


Figure R4-2. Successfully revegetated slope consisting of grasses and legumes - at CWI Orchard Valley Mine with broadcast seeding, the best results can be achieved by broadcasting the seed, covering it with soil, and then applying the mulch (Cook, Hyde, and Sims 1974). In all cases, broadcast seeding will meet with little success in arid environments if the seed is not covered in some way.

Care must be taken to ensure that the seedbed is free of weed seeds prior to seeding (see figure R4-3). Weedy annual forbs and grasses frequently severly compete with revegetated seedlings, causing high mortality which may result in seeding failure. Several methods of controlling weeds with the use of pre- and post-emergent herbicides have been developed, and are discussed in Cook, Hyde, and Sims (1974). The use of post-emergent herbicides may be restricted after the seed has germinated if grasses and forbs or shrubs are used in the seeding mixture. There are no post-emergent herbicides which can be used simultaneously on both weedy grasses and forbs without harming desirable grasses, forbs, or shrubs.

The utilization of newly seeded areas by livestock and big game may result in revegetation failure. Precautions must be taken by fencing or other measures, to ensure that the revegetated areas are not utilized by livestock and wildlife until they can support such use without deterioration. Intensive grazing management of these areas will be necessary, particularly since revegetation will be difficult and success uncetain.

The rodent population in the vicinity of the seeded areas may have to be controlled if excessive loss of seeds and seedlings occurs due to rodents.

Endangered and Threatened Plants

Cryptantha elata, a proposed threatened plant in the *Federal Register* could potentially be impacted by Sheridan's proposed railroad/utility corridor. This impact is discussed in the site-specific volume.

A possible impact of population expansion would be an increase in the exploitation of endangered and threatened plants in the ES area (see chapter 2, Vegetation, for a list of the plants). This impact would be most serious for plants which currently are exploited by commercial and amateur horticulturists (e.g., two endangered cacti, *Sclerocactus glaucus,* and *Echinocereus triglochidiatus* var. *inermis*).

The endangered and threatened plants in the Mancos shale hills (*Penstemon retrorsus* and *Sclerocactus glaucus*) may also be harmed by increased ORV use in these areas.

It should be noted that the impacts resulting from population increases will occur regardless of the proposed federal coal actions and could be much more severe as a result of cumulative regional development of existing coal operations, non-coal-related activities, and their attendent population and urban growth than as a result of the proposed site-specific actions.

Wildlife

Proposed Actions

The first level of analysis is the aggregate impact of the six site-specific projects. Two kinds of impacts would result from regional coal development. On-site activities, such as exploration, construction, operation of mine and support facilities, and transportation of coal, would directly affect animals and their habitat. Additionally, off-site impacts from population growth due to development of the coal resources could increase harassment of wildlife and degradation of their habitats.

ON-SITE IMPACTS

Most of the acreage that would be utilized by the coal mines for their surface facilities is currently the habitat for numerous small mammals. It is also occasionally used by the larger species, such as mule deer and elk. Construction of portals, mine benches, roads, pipelines, power lines, conveyor and railroad systems, waste piles, and settling ponds would destroy 349 acres of wildlife habitat by 1980; 1,133 acres by 1985; and 1,175 acres by 1990. These figures represent approximately 0.004 percent, 0.012 percent, and 0.013 percent respectively of the habitat available to most wildlife species in the ES area. Some of this acreage could be reestablished over the short term through reclamation, while the remainder would be lost for at least the life of the mining operations. Smaller, less mobile animals and burrowing species could be killed outright during construction activities. Human activity and destruction of food and cover would eliminate habitat on this acreage for the larger, mobile species, such as elk, mountain lion, black bear, and golden eagle, and to a lesser extent, mule deer, bobcat, coyote, and ringtailed cat. The significance of these impacts would depend on the species and the extent of a particular disturbance; see site-specific volume for discussion of impacts of each project.

In addition, 10,000 acres of habitat by 1990 would be utilized to a lesser degree by wildlife species. This loss would be primarily due to the human activity around the mines and on the roads to them. Generally, it is assumed that the impacted use would average 50 percent less than present use for the larger, more mobile species. Use would be least on the habitat closest to the disturbance (0 percent) and would increase as the distance from the disturbance increased. At about one mile from the disturbance, depending on topography and the wildlife species, the wildlife use could be 100 per-

Figure R4-3. Invasion of annual weeds on revegetated area at CWI Orchard Valley Mine cent or "normal" (Al Whitaker 1978, personal communication).

Overall, the carrying capacity of the area could be reduced for big game species, as shown in table R4-20. This reduction is considered to be insignificant (less than 0.1 percent) in relation to the total amount of habitat available in the ES area.

The Little Bookcliffs Wild Horse Management Area near Grand Junction would also be impacted by the proposed coal development. The primary impact would be the loss of some of the winter range utilized by the horses in Coal Canyon and a subsequent reduction of the herd to maintain numbers within the carrying capacity of the remaining range. Mining activities and vehicle traffic would also reduce the wild horse use on an additional 4,000 acres. (For a more complete description of the area and the impacts, see the Coal Canyon site-specific analysis.)

Most of the mine portals would be located in canyon country with many sheer cliffs. At a minimum, 3 miles of suitable nesting cliffs could become unsuitable as nest sites for raptors such as golden eagles, prairie falcons, and red-tailed hawks due to human activities in the vicinity of the cliffs.

Much of the current transportation system is located along major river bottoms in or adjacent to riparian habitat. The increased use and expansion of the system would increase disturbance to wildlife in the area, particularly waterfowl nesting areas and bald eagle wintering habitat.

Off-Site Impacts

As a result of the proposed actions, the regional population would increase by 750 people by 1980; 9,400 by 1985; and 15,200 people by 1990. The residential and commercial facilities needed for this growth would require 64; 801; and 1,292 acres of land, respectively.

In the Grand Junction, Montrose, and Delta areas, most of this growth would occur on many lands currently used for agriculture. Thus, many of the species affected would be those found in rural agricultural areas, such as pheasants, rabbits, skunks, and raccoons. Other areas of growth include Carbondale, Glenwood Springs, Rifle, and the North Fork Valley. In these areas, limited agricultural land and naturally occurring habitat types would be impacted.

In recent years, a portion of the residential growth has occurred in outlying areas on or very near deer crucial winter areas and in riparian areas (for example, in the North Fork Valley). Future growth could also occur there to some degree, although it cannot be quantified at this time. The impacts from this type of growth would be the loss of some crucial wintering habitat. Increased human activity in wintering areas and the increased presence of pets could cause additional stress on animals already weakened by the stresses of winter survival.

The expanding population of the region can be expected to spend much of its leisure time outdoors, which would subject virtually all wildlife populations throughout the region to some increased human disturbance. Legal and illegal hunting would increase, as would harassment of animals. Illegal hunting could increase ten times, or 1,000 percent over current levels (Al Whitaker 1978, personal communication).

Harassment could be merely the operation of a motor vehicle in the vicinity of wildlife, causing energy expenditures in the animals as they flee the area, or it could be actual pursuit of wildlife with motor vehicles even though this is in violation of state law (CRS 33-6-114). As the number of people increases, use of back roads in wildlife areas and the frequency of harassment would also increase. Certain of the larger, more secretive species, such as mountain lions, black bear, and elk, might stop using portions of the region which they now utilize during all or part of the year.

It is also anticipated that road kills of deer would increase throughout the region as a result of the proposed action. Table R4-21 shows a projected deer loss of 75 per year for 1978 and beyond on a total of approximately 98 miles of roads and highways in the proposed project areas. This total mileage of roads and highways includes 34 miles of new roads to be constructed by 1980 and 43 miles of new road by 1990. Basically, the roads to be constructed would be low-volume, gravelled or paved, reduced-speed roads that would not have a large number of road kills. However, this would be offset by the increased number of kills on existing roads, primarily due to the increased mine worker traffic and increased recreational traffic. In addition, animal/train collisions could be expected to increase, although the number of wildlife kills is unquantifiable at this time.

It is doubtful that elk would be affected by increased traffic because they generally stay away from roads and therefore have fewer road kills than deer. No antelope road kills have been recorded in the areas of concern.

It is also possible that raptors may be hurt of killed due to increased road traffic; however, no studies or data are available for the ES area.

Threatened and Endangered Species

Endangered species known to exist in the region either as migratory or resident could be impacted to some extent by the proposed coal development. The primary species which could be affected is the peregrine falcon, whose nesting, hunting, and breeding sites in the DeBeque Canyon area east of

TABLE R4- 20

EFFECTS OF PROPOSED SITE-SPECIFIC ACTIONS ON BIG GAME SPECIES

Type of Activity	Acres Disturbed or Converted 1980	1985	1990	Carrying Capacity Reduced in Number of Animals a/ 1980 Deer	1980 Elk	1985 Deer	1985 Elk	1990 Deer	1990 Elk
Proposed Actions									
Mines	349	1,133	1,175	27	4	88	14	92	15
Urban Expansion	64	801	1,292	5	1	62	10	101	16
Subtotal	413	1,934	2,467	32	5	150	24	193	31
Percentage of Region b/	0.004	0.02	0.03	0.01	0.01	0.06	0.05	0.08	0.07
Other Energy Related Development	4,229	16,900	23,113	330	53	1,318	211	1,803	289
Dallas Creek Project	-	1,620	1,620	-	-	127	21	127	21
Grant Valley Unit c/	-	-	14,400	-	-	-	-	180	1,123
Paradox Valley Unit c/	-	3,800	3,800	-	-	297	-	297	-
Urban Expansion	3,997	7,321	7,851	312	50	571	92	612	98
Subtotal	8,226	29,641	50,784	642	103	2,313	324	3,019	1,531
Percentage of Region b/	0.09	0.33	0.56	0.27	0.24	0.97	0.76	1.26	3.60
Total	8,639	31,575	53,251	674	108	2,463	348	3,212	1,562
Percentage of Region	0.009	0.35	0.59	0.28	0.25	1.03	0.82	1.35	3.68

a/ Based on an estimated .0125 elk per acre and .078 deer per acre density; densities for other animals and birds are unavailable and therefore only deer and elk are presented here. Additional wildlife reductions would occur but are unquantifiable. Urban expansion disturbance and habitat losses do not reflect urban expansion in Mesa County where little deer and elk habitat is expected to be inhabited.

b/ Percentages are of available habitat (about 9 million acres) and regional populations of 237,744 deer and 42,416 elk.

c/ Grand Valley scheduled for completion in 1987, some impacts will occur before 1990. Paradox Valley Unit scheduled for completion in 1984, some impacts will occur prior to this.

TABLE R4-21

REPORTED AND ESTIMATED DEER ROAD KILLS

Approximate Location	Highway or Road	Miles	Deer Counted Adjacent Both Sides of the Road or Estimated Populations	Mean Reported Road Kill Per Year (1976-77) a/	Projected Road Kill Per Year b/
Proposed Action					
8 miles south of Douglas Pass to Fruita	139 & I-70	61	400	7.0	30
Above Cameo to Palisade	Unknown & I-70	12	100-300	2.0	15
Up Thompson Creek	Unknown	12	115 c/	0	10
Somerset to Paonia	133	13	200-300	8.0	20
Subtotals		98	415-1,115	17.0	75
Other Coal Development					
Rifle to Rifle Gap	325	17	50-100	2.0	6
Paonia north on Stevens Gulch Rd.	Unknown	6	100	1.0	6
Austin to Cedaredge and northeast	65	21	No data	0.5	4
Austin to Cedaredge and northwest	65	18	No data	0.5	4
Subtotal		62	-	4.0	20
Total		160	-	21.0	95

Note: Mean number of road kills reported by Wildlife Conservation Officers for 1976-77 and estimated number of road kills based on number of deer counted or estimated populations adjacent to both sides of the road for eight different areas.

a/ Due to potentially low traffic volume and infrequent check by Wildlife Conservation Officers on most of these roads, these data should be considered a minimum.

b/ Based on Highway 13 data and projections for Parachute Creek.

c/ Based on aerial count (n=194) of December 1977 and night ground count (n=36) of February 1978, both conducted by Division of Wildlife personnel.

Grand Junction could be impacted. The impacts could be disturbances in the vicinity of nesting sites and breeding areas and destruction of riparian habitat that harbors the primary prey species of the falcon. Locally heavy concentrations of human activity could cause some falcons to abandon their nest site and not use it for the life of the mine operation.

The bald eagle could also be impacted by destruction of riparian habitat near the Cameo mines and loadout. This could reduce the prey base for them and also eliminate roost trees as feeding and rest sites. Much of this land has been cleared and additional clearing will further degrade the habitat. This would amount to 100 acres in this area (less than 0.04 percent of the riparian habitat in the region). In general, the bald eagle is more tolerant of human activity than the peregrine falcon and therefore should not be significantly impacted by increased activity unless such activity is in direct association with the birds.

Cumulative Regional Development

Table R1-6 in chapter 1 summarizes the amounts of acreage expected to be disturbed by various energy-related developments in the region, as well as the site-specific acreages disturbed, for a total of 8,639 acres disturbed by 1980; 26,155 acres disturbed by 1985; and 33,431 acres disturbed by 1990. In addition to this energy-related disturbance, disturbance resulting from the U.S. Bureau of Reclamation, Grand Valley Unit, Paradox Valley Unit, and Dallas Creek projects (Western Colorado Projects Office 1977) must be considered.

The Grand Mesa, Dominguez, and West Divide water storage projects (for irrigation and/or power) will remove some wildlife habitat from production after implementation. The U.S. Bureau of Reclamation (USBR), Colorado Division of Wildlife (DOW), Bureau of Land Management (BLM), U.S. Forest Service (USFS), and the U.S. Fish and Wildlife Service (USFWS) are coordinating mitigation plans to minimize impacts. It is anticipated that wildlife populations will initially decrease because of these projects.

The grazing programs in the Montrose and Grand Junction Districts of BLM will also affect future wildlife populations. The impacts of grazing and the various revegetation projects associated with grazing have been analyzed in the final environmental statement for the Uncompahgre Basin Resource Area's proposed grazing system (U.S. Department of the Interior, BLM 1978). An environmental statement is currently being drafted by the Grand Junction District for grazing systems in the Grand Junction Resource Area. In general, wildlife populations should benefit from implementation of grazing systems and revegetation projects.

Adding all these disturbances together, with the projected urban expansion, there would be 8,636 acres disturbed by 1980; 31,575 acres by 1985; and 53,251 acres by 1990. This amounts to approximately 0.009 percent, 0.35 percent, and 0.59 percent respectively of the habitat available to wildlife species in the ES area. It is apparent that impacts from this disturbance should be insignificant when compared with the region's available habitat. However, locally heavy losses and displacement of wildlife could occur because of changes in microenvironments and certain habitat types. Moreover, because the distribution of wildlife species is not even, significant impacts could occur to locally heavy populations. A case in point is the Roan Creek deer herd. A comparison of environmental statements and assessments prepared by oil shale companies indicates that some displacement of deer will occur from the Piceance Basin and the Parachute Creek areas. Increased competition would occur in adjacent habitats and some density-dependent limiting factors could cause winter die-offs and a lack of reproduction in the herd. Additionally this herd winters just north of two proposed coal developments (Coal Canyon and Cameo) which would tend to harass the animals from both sides at the same time.

The impacts of oil shale development in and adjacent to the ES region would be some of the most significant impacts on wildlife species. Population expansion in the region and the associated impacts from this expansion would primarily impact agricultural lands, affecting small mammals and birds more than large mammals, such as deer and elk.

As a result of cumulative development (including the proposed actions) in the ES area, regional populations would increase to 197,600 people by 1980; 245,300 people by 1985; and 252,800 people by 1990. The residential and commercial facilities needed for this growth would require 4,061 acres by 1980; 8,122 acres by 1985; and 9,143 acres by 1990. This increase in acres needed would undoubtedly cause the conversion of some crucial wildlife areas, as well as agricultural lands, to housing in the region. The possible loss of crucial wildlife wintering areas is unquantifiable at this time. Increasing populations would in general also cause the following impacts on wildlife: increased road kills due to increased vehicular traffic; increased poaching and indiscriminate shooting of wildlife; increased harassment of wildlife during stress periods (especially winter and reproductive periods); and increased recreational use of wildlife.

It is anticipated that road kills of deer would increase throughout the region as a result of this development. Table R4-21 shows a projected deer loss of 95 per year for 1978 on a toal of approximately 160 miles of roads and highways in the region. The number of road kills and number of vehicles are in general proportional; thus, as the number of vehicles increases, the probability of accidents increases. Assuming a constant number of deér crossings, the projected deer loss could be doubled (190) with a doubling of current traffic volume, and tripled (285) with a tripling of traffic volume. Assuming at least a doubled traffic volume by 1990, an $85,880 loss could be attributed to deer-vehicle accidents in the proposed action areas (190 x $452 = $85,880; $452 is the mean damage-to-vehicle repair cost, according to a DOW 1977-78 survey). These figures are based on an estimated number of deer killed per mile per year as supplied by the DOW (Reed, 1978, personal communication).

It is doubtful that elk would be affected by increased traffic because they generally stay away from roads and therefore have fewer road kills than deer. No antelope road kills have been recorded in the areas of concern. It is possible that raptors may be hurt or killed due to increased road traffic, but no studies or data are available for the ES area.

The number of trains would increase to transport coal, which could cause an increase in the number of animal/train collisions. Data on the number of collisions per mile are unavailable; therefore, the possible increase in unquantifiable.

Losses due to poaching, indiscriminate shooting, and harassment are difficult to quantify because of the lack of basic data concerning losses associated with these activities. Some investigations on harassment due to people, dogs, and snowmobiles are being conducted by the DOW. Results at this time are inconclusive, but within the near future some usable data should be available (Carpenter 1978, personal communication). Poaching could increase ten times or 1,000 percent over the present level (Whitaker 1978, personal communication).

Although impacts due to the proposed actions would be small, impacts of cumulative regional development would be significant. It is speculative just how much harassment, intrusion on habitat, or loss of habitat certain species of animals can tolerate. As more and more people move into the ES area and development takes place, less and less habitat would be available for species such as elk, deer, bear, antelope, and mountain lion and for endangered species such as peregrine falcon and black-footed ferret. As the available habitat shrinks, the populations of these animals would also shrink, either at a controlled rate through reproduction declines or through catastrophic declines such as winter die-offs. This would be brought about by overutilization of remaining available food supplies or the effects of population density.

THREATENED AND ENDANGERED SPECIES

While some animals are adaptive enough to survive almost anything, endangered species lack this adaptive capability. They developed in one particular type of habitat or ecological niche, and that is the only place they can survive. Some of these niches could be impacted by development throughout the ES region. It is difficult to quantify just how much habitat could be lost, primarily because of lack of information on the presence or absence of the species. Areas where endangered species habitat exists need to be carefully studied over a long period of time to make this determination. Development in or adjacent to these areas must be carefully designed to minimize impacts on the habitats and/or the species involved.

Summary

Impacts as discussed above are mostly unquantifiable. Either data do not exist or are being gathered by state and federal agencies. The most significant impacts on wildlife populations would not be the mines themselves, except for the Coal Canyon Mine and its impacts on wild horses, but the impacts of more people and their activities. Of these impacts, the greatest would be the loss of wintering areas to housing and recreational activities, subsequent harassment of wildlife, and the possible increase of illegal and indiscriminate shooting of wildlife.

These same impacts would also occur due to the cumulative development in the region, except to a greater degree. The cumulative effect of this development could be very detrimental to wildlife populations if proper and timely mitigation measures are not carried out.

As a result of regulations concerning coal mining on federal leases and reclamation of disturbed areas (43[CFR]: 3041; 30[CFR]211; and 30[CFR]: 700), reclamation of areas disturbed by coal mining would begin as soon as possible. However, a return to full use by wildlife species could take many years after a mine closes. Therefore impacts to wildlife would continue for the long term. With respect to rare and endangered wildlife species which could be affected by the proposed actions, coordination with the USFWS has been completed; USFWS comments can be found in chapter 9.

Aquatic Biology

Proposed Actions

CHEMICAL WATER QUALITY

Direct changes in the chemical quality of water from the proposed actions in the regional area do not pose a major threat to aquatic life and fisheries. An extensive U.S. Geological Survey study was completed by Wentz (1974) that sampled water quality in streams adjacent to coal mining areas in Colorado. Wentz did not find any significant degradation of aquatic life attributable to changes in chemical water quality from coal mining. In the ES area, the Anschutz Coal Corporation's North Thompson Creek mines are the only site where water quality degradation has occurred.

Historically in the eastern United States, extensive degradation has occurred from acid mine drainage in coal mining areas. The cause of this degradation is aerobic decomposition of pyrite (FeS_2) materials associated with coal and spoils piles. This process produces sulfuric acid, which subsequently lowers pH and releases metal ions, particularly iron, to the surrounding waters. Natural waters subject to this would characteristically have a pH below 6.0, a high sulfate concentration, and a high dissolved iron concentration. However, conditions are different in Colorado, where waters in the coal mining areas of this region in all cases have pHs above 7.0. In some western coal mining areas, iron and sulfate are found (partially due to irrigation return flow), but in no areas have these been shown to reach the toxic limits for aquatic organisms. Cold water fish and aquatic insects are highly susceptible to metal ions and cannot survive high iron concentrations. The reasons that acid mine drainage should not present a major problem in the ES area are then, the absence of pyrite, the low sulfur content of the coal, the high pH of natural waters, and the high buffering capacity of the natural waters.

Increases in total dissolved solids (TDS) in aquatic ecosystems adjacent to coal mining areas commonly occur. Impacts from increased TDS from ground-water discharge by 1990 would cause a decline in the fishery in North Thompson Creek (which will also occur without the proposed action), may affect cold water species in the North Fork of the Gunnison, but would not affect the Colorado River aquatic species. In the Colorado River at low flow of 960 cubic feet per second (cfs), increases in TDS from proposed coal mining would be 0.4 milligrams per liter (mg/l) or 0.31 percent by 1980, 9.8 mg/l or 0.76 percent by 1985, and 11.3 mg/l or 0.87 percent by 1990. These amounts of increased TDS would be insignificant and have no impact on the aquatic life in the Colorado River. Generally smaller streams found higher in the watershed would be more susceptible to impacts from increased TDS due to coal mining. There are presently no water quality standards limiting the concentration of dissolved solids which may be discharged.

SEWAGE

The increased human population of 750 people by 1980; 9,400 people by 1985; and 15,200 people by 1990 due to the proposed actions would cause a minor increase in water pollution from sewage in the ES area. Several areas in the Colorado River Basin are predicted to have degraded aquatic habitats by 1990 due to a greater load on some presently existing sewage treatment facilities (Water Quality Management Plan Colorado River Basin 1975). Computer model studies have shown that, with secondary sewage treatment throughout the basin, three segments of river may reach ammonia (NH_3) concentrations that are above the toxic limit for some fish species. Ammonia discharged from waste-water treatment plants can be toxic to fish if the concentrations in the river water exceed 0.3 to 0.8 mg/l, depending upon the water temperature and the pH. The USFWS (see comment letter 11 in chapter 9) has noted that chlorine added to lower bacteria numbers to meet effluent standards in overloaded sewage facilities can also be toxic to fish if concentrations reach 0.01 mg/l in the aquatic environment (EPA 1972). The areas where model studies have shown that aquatic life may be excluded are the Uncompahgre River from Montrose its confluence with the Gunnison River, the Gunnison River directly below Delta, and several miles of the Colorado River from the Grand Junction waste-water treatment plant to the Redlands Canal return flow. The toxicity problem in the Grand Junction area exists because of the low flows resulting from diversion of river waters (Water Quality Management Plan for the Colorado River Basin 1975). Plans presently exist to upgrade waste-water treatment facilities in most areas, but until all such planned facilities are operating properly, which in the three cases mentioned may require expensive nitrification, impacts on aquatic life can occur (see community facilities section of Socioeconomic Conditions).

CONSUMPTIVE USE OF WATER

In the ES area, all factors involved with coal development would increase the consumptive use of water by 120 acre-feet per year (ac-ft/yr) by 1980; 3,130 ac-ft/yr by 1985; and by 3,910 ac-ft/yr by 1990. This represents 0.3 percent of the increased consumptive regional use of water by 1980, 4 percent of the increased use by 1985, and 5 percent of the increased regional use by 1990. The significance of this amount of consumptive use to fisheries and aquatic habitats depends on where and when the water is obtained. The water would come from the North Fork of the Gunnison River subbasin, from the Crystal River subbasin, and from the lower Colorado River subbasin. Four of the mines would obtain water from Colorado River water rights while Atlantic Richfield Company (ARCO) and Anchutz would have sufficient ground water supplies. No impacts on aquatic organisms are expected from consumptive use of water. Population growth in Paonia, Delta, Carbondale, Palisade, and Grand Junction may cause impacts on fisheries as these areas develop new or expand existing domestic water supplies.

STREAM SEDIMENT LOADS

In coal mining areas in the eastern United States and in some mining areas in Colorado, fisheries located downstream from mines have been subject to degradation from large scale spills, dam failures, and washouts due to floods. Before any M&R plans for coal mines in the ES area are approved, the operations must comply with OSM regulations. All runoff from surface areas disturbed by mine construction and operations must be retained in sediment ponds as required by 30(CFR): 717.17. Sediment retention ponds will contain all runoff from a storm event up to a 10-year/24-hour storm. Spillways on ponds will be designed to safely pass a 24-year storm event. Discharges of water from these ponds, should it be necessary under normal conditions, may not exceed 45 mg/l total suspended solids, and the 30-day average discharge may not exceed 30 mg/l. A discharge of this concentration of suspended solids, should it occur, would not adversely affect the aquatic ecosystem of the region.

Sediment retention ponds may legally spill in a precipitation event larger than a 10-year/24-hour storm. In such a case, some coal dust and other fine sediments from the ponds would flow into the adjacent streams. In cold water trout streams such as North Thompson Creek and the North Fork of the Gunnison, this would have a very serious negative effect on the aquatic insects and fish species. (In the case of the North Thompson Creek operation, this could occur regardless of the proposed action; however, approval of Anschutz' M&R plan would extend the mine life by fifteen years.)

Total sediment yield from areas with many highly erosive watersheds adjacent to the Colorado River would be so large that the amount of sediment coming from the retention pond spillway would be unmeasurable in the river and have insignificant impacts. Also, the increased dilution in the Colorado River during a large storm would largely decrease the concentration of all water-quality parameters. No adverse effects on the aquatic habitat or the threatened and endangered fish species are presently predicted. Aquatic organisms presently living in this part of the Colorado River normally withstand a TDS concentration ranging from 59 to 4,420 parts per million (ppm) with an average of 2,270 ppm, and a total dissolved solid content averaging 200 to 250 mg/l in the spring and 600 to 650 mg/l during low-flow periods.

There would be a minor increase in sediment carried to stream courses due to the disturbance of a maximum of 1,175 acres by the proposed coal mines by 1990 (see Soils). Loss of aquatic invertebrates through smothering and decreased reproductive capability for cold water fish would result. Due to the small size of the disturbance in relation to the size of the watersheds, the impact would be minor. North Thompson Creek and the North Fork River would be the fisheries most affected by this type of impact.

INCREASED FISHING PRESSURE

Population increases due to the proposed action would increase the number of fishermen in the study area by 1,364 in 1980; 4,659 in 1985; and 5,750 in 1990 (DOW 1977). In many cases, increased fishing pressure would increase the crowding along streams and lower the quality of the fishing in the areas. Hatchery-stocked trout are susceptible to angling pressure, and thus the numbers of hatchery raised fish in the streams and lakes would be more quickly depleted. Although the demand for hatchery fish may increase, it is unlikely that the DOW will have any more fish available unless new hatcheries are built. Populations of wild trout are influenced to a lesser degree by increased fishing pressure. Areas such as the Gunnison Gorge, the Crystal and Roaring Fork rivers, and the lakes on Grand Mesa would receive significant increases in use.

THREATENED AND ENDANGERED FISH SPECIES

The water in this section of the Colorado River and the lower portion of the Gunnison River is characterized by high concentrations of sodium, magnesium, sulfate, and chloride, which originate from leaching of soluble sedimentary rocks by precipitation and agricultural runoff. Iron, manganese, and selenium concentrations are also high for most of the Colorado River in the Grand Valley. These constituents originate from metal mining areas in the upper basins and from irrigation return flows. None of these constituents are presently known to be limiting to aquatic life in the Colorado River.

Aquatic organisms presently living in this part of the Colorado River normally withstand a total suspended solid concentration ranging from 59 to 4,420 ppm, with an average of 2,270 ppm, and a TDS content averaging 200 to 250 mg/l in the spring and 600 to 650 mg/l during low-flow periods. Tolerance limits to most water quality parameters for the fish species concerned are presently unknown, but it should be mentioned that all of the three species envolved in the highly erosive Colorado River drainage where silt can average 0.62 percent by volume.

The water quality parameters that could possibly increase in runoff from coal mining areas are sulfate, iron, manganese, and TDS. No significant increases in the concentration of sulfate, iron, or manganese are expected, and none would be legally allowable under state and federal water-quality discharge standards. The increase in TDS concentration from the proposed coal mining would be less than 1 percent of the existing concentration during low-flow periods on the Colorado River, and such a small increase would have no effect on the aquatic ecosystem or the endangered and threatened fish species (see Water Resources).

Sediments in the river may increase slighly, but OSM regulations will adequately prevent sediments, coal spoils, and debris from reaching the river; therefore, the fish should be protected. Consumptive use of 3,910 ac-ft/yr by 1990 in coal development would be insignificant on the Colorado River habitat. The sewage problem at Grand Junction is a serious one for the endangered fish species, and completion of the plan for upgrading the facility is essential. Some of these fish would also be killed accidently by fishermen.

Consultation with the USFWS in compliance with Section 7 of the Endangered Species Act has determined that the endangered and threatened fish species (the Colorado squawfish, the humpback chub, and the humpback sucker) would not be impacted by the proposed actions. The biological opinion of the USFWS is included in chapter 9.

Cumulative Development in the Region

CHEMICAL WATER QUALITY

Direct changes in the chemical quality of water in the ES area would result primarily from oil shale developments. The Colorado River drainage area may suffer from industrial wastes. This type of waste water could contain toxic materials, chemicals, oil and grease, heavy metals, and odorous substances. Any release of large quantities of low quality mine water to local streams could temporarily but severly impact the aquatic life in these waters. Water leaching from excavations, overburden piles, and spent shale piles may cause a shift in pH into a range that would interfere with the vital functions of aquatic organisms. Heavy metals would also come from leaching of spent shale piles. Metals can originate from waste chemicals and spent catalysts buried in the shale piles. Unless carefully controlled, such dischargess would reduce populations of invertebrates, fish, aquatic mammals, birds, and riparian vegetation.

Total dissolved solids would increase due to all development in the basin. In the Colorado River at the Utah state line during low flow of 960 cfs, the TDS concentration would increase 130 mg/l or 11 percent by 1980, 320 mg/l or 24 percent by 1985, and 320 mg/l or 24 percent by 1990. TDS concentrations would result from the removal and use of ground water, reservoir evaporation, leaching from overburden and spoils piles, consumption of large amounts of surface water, and discharge of low quality water used in mining. The aquatic ecosystems in the region would not be significantly altered by this increase in TDS, except in specific cases previously mentioned, because the majority of the projects are on the main stem of the Colorado River.

With the construction of the USBR Grand Valley project, the salinity of the Colorado River at the state line during low flow would be reduced as much as 60 percent by 1990 (see Water Resources). This would have a net positive effect on the aquatic ecosystem of the Colorado River.

About 190 miles of new pipeline would be required to transport 1 million barrels of oil shale daily to major existing pipelines. This increase in pipeline mileage increases the risk of oil spills. If oil reaches local surface waters in sizeable amounts; depletion of fish populations and other aquatic life would be possible for some distance downstream. Mortality from contact with oil would occur to riparian trees and shrubs, larvae of many aquatic organisms, fish species, water fowl, shore and wading birds. Revegetation of oil-soaked shorelines would be extremely slow. The magnitude of mortality and other adverse impacts would depend upon the location and volume of the spill and the particular habitat type affected.

Increased urbanization and associated human activities would degrade water quality and aquatic habitats. Since urban areas would be located on or near water courses such parameters of aquatic systems as suspended sediment, turbidity, nutrients, biological oxygen demand, and temperature would increase. Human activities such as boating and fishing would degrade water quality through the introduction of gas, oil, and litter. Pollutants and toxic substances from streets and storm sewers would increase. The aquatic environment may be so altered that some present fish species, most likely the endemic species, would no longer be able to sustain themselves and more tolerant species would take their places.

SEWAGE IMPACTS

Cumulative regional populations of 197,000 people by 1980; 245,300 people by 1985; and 252,800 people by 1990 would be the major cause of increased water pollution from sewage effluents. Fast-growing cities such as Grand Junction and Delta would face overloading of existing waste-water treatment facilities to the point where the concentration of ammonia in waters receiving plant effluents would be toxic to aquatic life and fish. The Colorado River from the Grand Junction waste-water treatment plant to the return flow of the Redlands Canal, the Uncompahgre River from Montrose to Delta, and the Gunnison River at Delta are areas where conditions toxic to fish life have been predicted by computer modeling studies (Water Quality Management Plan Colorado River Basin 1975).

Impacts to the aquatic habitats from sewage discharges would be mainly due to oil-shale population increases and increased consumptive use of water in the Grand Valley, while increased population numbers from coal development in the North Fork would cause the sewage discharge problems in the Delta area. Plans presently exist to upgrade waste-water treatment facilities in most areas, but until all such planned facilities are operating properly, which in the three areas mentioned may require expensive nitrification treatment, impacts on aquatic life can occur (see community facilities section of Socioeconomic Conditions).

CONSUMPTIVE USE OF WATER

Cumulative development in the ES area would increase water consumption by 38,410 ac-ft/yr by 1980; 73,900 ac-ft/yr by 1985; and 75,800 ac-ft/yr by 1990. In 1990, 5 percent of this water would be for coal processing, 17 percent for oil shale mining and processing, 23 percent evaporated from Ridgeway Reservoir, and 54 percent consumed by the increased human population. Aquatic habitats and fisheries in the following drainages would most likely be impacted by regional development: North Thompson Creek and the Crystal River (coal), Parachute Creek (oil shale), Roan Creek (oil shale), Uncompahgre River (USBR Dallas Project), North Fork of the Gunnison River (coal), and the lower Colorado River (coal, oil shale, USBR Grand Valley Project, increased population).

During low-flow periods on streams and rivers in the region, the energy companies and municipalities needing new water would not be able to obtain rights to divert water from surface streams because the water is already owned by parties holding decrees for water rights senior to the date of appropriation received by recent applicants. This would prevent the dewatering of streams such as North Thompson Creek and the North Fork of the Gunnison during low-flow periods. Any water rights from surface streams obtained by direct filings by a recent applicant with the state water court would have to be diverted during high flows when previously unappropriated water is available and stored for future use. Aquatic habitats and fisheries in most cases would not suffer impacts from dewatering due to increased filings by junior appropriators.

Companies and municipalities in some cases would be forced to purchase existing senior water rights (most likely from agricultural users) to satisfy their future needs. Depending on where these rights are purchased and the seniority of the decree, the potential exists for streams to be dewatered when points of diversion are moved from downstream points to points higher in the watershed. Where minimum stream-flow filings by the Colorado Division of Wildlife exist, the aquatic and fishery habitat is protected from dewatering due to a change in the point of diversion of a senior decree. In some cases, unappropriated water or junior water rights may be put to use by construction of new reservoirs or enlargement of existing ones in headwater areas. In some cases, this could benefit aquatic habitats.

STREAM SEDIMENT LOADS

Sediment carried in streams would increase due to development in the region. In addition to sediment from coal areas, oil shale development would introduce more sediments from both wind and water erosion. Erosion of disposal piles (both during buildup and after revegetation) and of off-site construction areas, such as utility corridors, transportation networks, and townsite expansion would lead to increased sediment load in local streams. Channeling and head-cutting due to natural erosion would occur for extended period of time with increasing amounts of sediments reaching local streams. Increased operations for sand and gravel recovery would cause large-scale disruption of some stream habitat areas (riparian) and siltation in streams. In aquatic habitat the increased siltation and turbidity would exceed natural levels and adverse effects would occur in the form of lowered biological productivity. This results from reduced aquatic flora due to reduced light penetration, mechanical damage to gills of aquatic animals, and physical covering of fish spawning and nursery areas. The extent of such erosion and its effects cannot be predicted since detailed information on quantity of erosion is not available.

INCREASED FISHING PRESSURE

Increased population from cumulative development will result in 20,812 new fishermen by 1980; 46,684 by 1985; and 54,032 by 1990. A decrease in the quality of angling would result. The average size and number of fish taken by each angler would decline in some fishing areas. More intensive management of fisheries would help to offset this trend. While the demand for hatchery-raised trout would increase, it is doubtful that any more fish will be stocked unless new hatcheries are built. Crowding in quality fishing areas would increase significantly.

THREATENED AND ENDANGERED FISH SPECIES

The impact of cumulative regional development on the Colorado squawfish, the humpback sucker, and humpback chub is impossible to predict without further knowledge about these fish species and their ecological requirements. A river system as large and complex as the Colorado, subjected to oil shale, coal, water project, and salinity control developments, would need extensive study if direct interactions between the endangered fish species and minor changes in water quality and quantity are to be delineated.

Cultural Resources

Archeological Resources

The mitigation of archeological sites as precribed by law (see chapter 3) provides for the protection of archeological values through identification and recovery, prior to the initiation of potentially damaging activities. Class III surveys (intensive full inventory; see BLM Manual, Section 8111) provide the basis for evaluation and subsequent protection of archeological sites in the surveyed areas. The efficiency of the Class III survey would depend on topography, vegetation cover, and past land use at any particular site. These factors would account for hidden and subsurface sites remaining undetected and therefore unprotected. On a regional basis, the potential for destruction of unknown archeological sites would increase in proportion to the number of acres disturbed, although the occurrence of sites in specific areas would vary in relation to the topography, land use, and environmental constraints of that area.

Projected regional surface disturbance is expected to reach 8,639 acres by 1980; 26,155 acres by 1985; and 33,431 acres by 1990. Of these acres, only 413; 1,934; and 2,467 respectively, would be a result of the proposed federal actions and associated community expansion. Mining and construction activities could displace and damage archeological resources that remained undetected despite the Class III surveys in these areas. Surface disturbance would destroy evidence of human use on areas previously undisturbed. It should be noted that a large percentage of the total disturbance would be due to community expansion caused by growth not associated with the proposed coal mines and would occur on lands previously disturbed for farming, orchards, etc., in the valley areas (3,997 acres by 1980--44 percent; 7,321 acres by 1985--30 percent; and 7,851 acres by 1990--27 percent).

Subsidence, as a surface disturbing impact, could affect 600 acres by 1980; 3,550 acres by 1985; and 7,650 acres by 1990 as a regional projection. Of these acres, 90 acres by 1980; 1,370 acres by 1985; and 3,920 acres by 1990 would result from the federal proposed actions. Slumping, cracking, and caving of the soil could result in horizonal and vertical displacement of archeological values (Smith 1973, Turnbaugh 1977). The significance of archeological materials lies not only in the physical presence of the artifacts themselves, but in the relationship of those artifacts to cultural, paleoecological, and geological materials. Any alteration of an archeological site by ground movement would disrupt the integrity of that site, distorting data and the resulting analysis.

There are 1,989 archeological sites identified in the ES area, 29 of which occur in the areas of the proposed mines. As an indirect impact, surface disturbance affecting land areas surrounding existing archeological sites could impact archeological resources by (1) altering the existing environment which might otherwise serve as a model for past conditons and (2) introducing new elements into the area which would disrupt the integrity of the site. The natural resources in the ecological setting of a site can provide insight in reconstructing earlier cultures and the functional basis of their cultural material. Changes in the adjacent environment would limit the boundaries of data collection as needed for the interpretation of the site.

Mitigating measures (see 36[CFR]: 800), depending upon the nature of a site, could include (1) avoidance of site through redesign of the project; (2) descriptive and photographic records, or surface collecting; or (3) excavation according to a specific research design or as a salvage effort. Efficiency of these mitigating measures depends on their potential for complete preservation of archeological values. The success with which the archeological data is preserved is related to the amount of information and technology available with which to evaluate the significance. Due to the importance of on-site preservation, mitigating measures involving recording, collection, and excavation result in only partial recovery and remove the site from future, more efficient means of analysis.

Although the 1906 Antiquities Act declares the unauthorized removal and alteration of archeological resources an illegal action, subject to prosecution, lack of enforcement and public awareness of the law negates the effectiveness of the legislation. Increasing instances of vandalism have been shown to be correlated with increased visitor use of an area (William 1977). Population in the ES area is expected to reach 197,600 by 1980; 245,300 by 1985; and 252,800 by 1990. Of this increase 750 people (1980); 9,400 people (1985); and 15,200 people (1990) would result from the proposed federal actions. Increased recreation visitor pressure on areas outlying the population centers (see Recreation), combined with the presence of 2,307 mine-associated employees by 1980; 3,744 by 1985; and 4,111 by 1990 (468; 1,850; and 2,464 of these due to the federal proposed actions, respectively), would result in increased exposure of archeological values to public passage. Upgrading and expansion of the regional road system (approximately 2,000 miles of new roads in the regional area by 1990, 13 miles are due to the proposed action) would act as a contributing factor to increased occurrences of vandalism (Scott 1977).

Greater accessiblity opens up previously less traveled areas, increasing exposure and visitation. Illegal collecting and excavation, or unintentional damage by recreators, unaware of the value of archeological resources, would destroy irreplaceable data. Vandalism results in the complete removal and damage of archeological values, tending to affect diagnostic materials which often form the basis for dating and analysis. While the extent of vandalism cannot be quantified, it is a significant impact in its destruction of the resource, resulting in loss of information that might have otherwise been recoverable and applied through scientific research.

Historic Resources

Based on existing surveys, none of the six proposed mining plans would directly disturb any known historic sites within the ES area. Should any historic sites be discovered in the future, those areas that would be subject to direct earth disturbance have been legislatively mitigated and would be protected by measures described in chapter 3.

Secondary impacts similar to those described under archeology could occur when development changes the character of the region. Some 123 historic sites could be vandalized as a result of increased population and visitor use. The development of roads, railroads, power lines, etc., could degrade the integrity of historic sites in the region by altering the aesthetic surroundings.

A less obvious secondary impact could result from population increases in established towns, which could cause new construction to displace older buildings and sites. This would be true of those towns near new coal mines. However, certain areas, particularly in Pitkin County, are already classified or zoned as historic districts and thus are protected from rapid, undisciplined development.

Land Use

The six proposed mines would result in the direct conversion of 64 acres by 1980; 801 acres by 1985; and 1,292 acres by 1990 from livestock range, wildlife habitat, and wild horse range to industrial usage as mine sites. In addition, 64; 1,333; and 1,175 acres by 1980, 1985, and 1990 would be converted from primarily agricultural uses to urban development as a result of community expansion due to the new mining.

Tables R4-22 and R4-23 break down the projected regional amount of land needed for urban purposes as a result of cumulative development and the proposed federal actions. These figures were derived using the land requirement ratios listed in table R4-35 in Socioeconomic Conditions. Approximately 4,061 acres by 1980; 8,122 acres by 1985; and 9,143 acres by 1990 would have to be converted from existing uses to support expected population growth from 149,850 people in 1977 to 197,600; 245,300; and 252,800 people by 1980, 1985, and 1990 respectively. Most of this land would be used for new housing development, with large amounts also being committed to roadway construction, schools, parks, and commercial or industrial facilities. These land use requirements assume a concentrated pattern of development. If that is not the case, and development takes place in a scattered fashion, much more land would be required to support these urban functions. To a large extent, the pattern of development would depend on local land-use planning and zoning.

Most existing communities in the area are surrounded by irrigated agricultural land. In order for existing communities to expand, it is likely that irrigated agricultural land would have to be converted for urban purposes (see figure R4-4).

The western portion of the Grand Valley would be a primary impact area because of the proximity of proposed coal mines and because the Grand Junction area would absorb much of the new population growth resulting from regional mineral development.

The proposed Cameo No. 2, Cottonwood Creek No. 1 and 2, and Coal Canyon mines, along with GEX Colorado Company's existing nearby Cameo and Roadside mines and Public Service Company of Colorado's Cameo power plant, would contribute to the trend toward industrialized land use in DeBeque Canyon.

The East Salt Creek area would also be partially industrialized by Sheridan Enterprises' proposed Loma Project. Lands on the valley floor, which are now primarily desert grazing lands, would be partly converted by surface facilities and a rail/utility corridor.

TABLE R4- 22

CUMULATIVE REGIONAL COMMUNITY EXPANSION
WEST-CENTRAL ES AREA (ACRES)

County	1980	1985	1990
Delta	183	633	846
Garfield	1,207	1,747	2,737
Gunnison	60	867	799
Mesa	2,134	3,948	3,426
Montrose	128	234	357
Ouray	26	17	43
Pitkin	323	667	935
Total	4,061	8,122	9,143

Note: Land converted to urban use to support population increases above 1977 level.

TABLE R4-23

CUMULATIVE COMMUNITY EXPANSION DUE TO PROPOSED FEDERAL ACTIONS
WEST-CENTRAL ES AREA (ACRES)

Proposed Actions	1980	1985	1990
ARCO	34	153	264
Anschutz	0	0	0
Coal Canyon			
Mesa County	0	26	89
Garfield County	0	4	17
Cottonwood			
Mesa County	0	170	174
Garfield County	0	26	38
Sheridan	30	247	493
Cameo			
Mesa County	0	149	179
Garfield County	0	26	38
Total	64	801	1,292

Note: Land converted to urban use to support population increases above 1977 level.

Figure R4-4

Conversion of farmland to residential areas would accelerate.

Some of the residential and urban expansion resulting from these mines would probably encroach on agricultural land and wildlife habitat in and around the Grand Valley. Orchard land in the Grand Valley is considered unique farmland, and much of it is in areas which meet the definition of prime farmland.

Anschutz Coal Corporation's North Thompson Creek mine site would continue to be characterized by industrial development through 1990 (with or without the proposed action). However the general area would also continue to be used for livestock range, terrestrial wildlife habitat, and recreation. Urban expansion due to the Anschutz operation is likely to occur around existing population centers in Garfield County and may encroach on agricultural lands and wildlife habitat.

Projected oil shale and uranium development would also contribute significantly to population growth in both Mesa and Garfield counties. Associated urban development would accelerate changes from agricultural (including prime farmland) and wildlife land (including some crucial winter range) uses to urban and industrialized land uses in those two counties.

Additional coal development in the North Fork Valley would be accompanied by more power lines, roads, and bridges, increased vehicle and railroad traffic, as well as expanded urban development, particularly around Paonia and Delta. In general, ARCO's proposed Mt. Gunnison Mine, particularly when combined with other existing and likely coal development in the valley, would establish coal mining as a major land use in the valley and would accelerate the trend toward urban/industrial development, with consequent reduced agricultural, wildlife, recreational, and scenic potentials.

Overall, if cumulative coal- and non-coal-related development occurs as projected, human land use in the ES area would change from predominantly agricultural to predominantly urban and industrial. Recreation is also likely to continue as a major human land use in the area. Wildlife habitat, on the other hand, is likely to decrease as a result of cumulative development. Once the demand for energy and recreational development is established in an area, as it is being established in the ES area, resources are generally committed to continued development. In particular, land committed to urban development is unlikely to be returned to agricultural, wildlife, or other uses in the foreseeable future.

Transportation

HIGHWAYS

Impact on transportation networks would be caused by (1) transportation of coal out of the ES area and (2) increased employment and population, with their attendant increase in vehicles and miles traveled.

Based on a 1975 population of 119,822 in Delta, Garfield, Mesa and Montrose counties, and a combined vehicle registration of 128,853 in the four counties, population increase projections can be used to calculate increases in vehicle registration. Using the population increases from the proposed actions and assuming that the 1975 value of 1.08 vehicles per person would remain constant, vehicle registration in the ES area would increase by 810 by 1980; 10,152 by 1985; and 16,416 by 1990. Based on cumulative growth projections, total vehicle registration in the ES area would be 213,408 in 1980; 264,924 in 1985; and 273,024 in 1990.

Table R4-24 summarizes the increases in average daily traffic volumes that would result from the proposed actions, at selected points. To estimate these it was assumed that increases in average daily traffic would be proportional to the population increase of the county in which the sample point is located. Regional population increases were used for points on major highways such as I-70 and U.S. 50.

Increases in average daily vehicle miles would cause traffic slow-downs on a number of state and federal highways. U.S. 50 east of Montrose would probably experience traffic slow-down for one to two hours per day. State Highway 133 would also be likely to experience slow-downs for one to three hours per day in the Carbondale, Somerset, and Hotchkiss area, as would State Highway 92 at the junction with State Highway 65. Increased traffic would also cause more accidents (see table R4-25).

Transportation of coal and service supplies as well as travel by increased populations is expected to impact highways. Traffic from Grand Junction, which serves as a regional supply center, to the coal mining areas and developing residential areas would increase, producing incremental road wear and higher maintenance costs. Completion of I-70 would assure a high standard roadway through the area. Much of the supply distributed to outlying areas from Grand Junction would arrive by truck via I-70. Other highways and roads in the region would have to be improved to accommodate the higher use. Highways designed for light vehicle use, although paved, would deteriorate rapidly if used repeatedly by heavy coal trucks of 25 to 30 net tons per load. Planned haulage over specific roads is discussed in the site-specific analyses.

TABLE R4-24

PROJECTED MID-LEVEL VEHICLE TRAFFIC BY 1990

Road a/	Location b/	Average Daily Traffic (1976)	Average Daily Traffic (1990)	Average Peak-Hour Volume (1990)	Design-Hour Volume (DHV) (1990)	Vsl_C (Capacity) c/	Peak-Hour Vsl_C / $\frac{DHV}{Vsl_C}$	Vehicle Miles Travelled (1990)
I-70	W/o Grand Valley	5,300	9,600	780	1,550	4,980	0.15/0.31	137,149
I-70	Rifle	3,500	6,450	450	970	4,980	0.09/0.19	8,579
I-70	W/o Glenwood Springs	6,450	12,100	850	1,820	4,980	0.17/0.37	5,929
I-70	E/o Glenwood Springs	5,350	10,000	700	1,500	4,980	0.14/0.30	17,600
I-70	E/o Grand Junction	5,300	9,800	1,210	1,900	5,000	0.24/0.38	69,972
I-70	W/o Grand Junction	2,000	5,050	470	830	4,980	0.10/0.17	19,998
I-70	Junction 139	2,600	4,900	490	840	5,000	0.10/0.17	19,355
US-50	N/o Delta	8,450	15,250	1,070	2,440	5,100	0.11/0.22	305
US-50	S/o Delta	4,900	9,150	820	1,460	1,480	0.69/1.24	32,483
US-50	N/o Montrose	9,550	17,850	1,250	2,860	5,100	0.25/0.56	157,259
US-50	E/o Montrose	3,660	6,750	610	1,150	510	1.19/2.25	210,870
US-550	S/o Montrose	4,950	9,250	830	1,020	1,050	0.81/0.97	294,155
US-550	S/o Ridgway	1,750	3,250	290	520	1,050	0.28/0.50	33,800
US-550	N/o Ridgway	2,100	3,950	355	630	1,050	0.34/0.60	21,528
SH-82	S/o Glenwood Springs	7,950	20,300	1,950	2,350	5,260	0.37/0.45	285,012
SH-82	W/o junction with SH-133	5,900	15,250	1,500	1,800	5,260	0.28/0.34	153,720
SH-82	E/o junction with SH-133	4,250	11,000	1,100	2,200	1,130	0.97/1.95	110,990
SH-133	N/o Carbondale	3,250	8,400	960	1,800	460	2.08/3.91	4,368
SH-133	S/o Carbondale	2,250	5,800	760	1,340	460	1.65/2.91	4,466
SH-133	E/o McClure Pass	200	400	40	80	460	0.07/0.17	1,040
SH-133	W/o McClure Pass	730	1,450	170	290	500	0.34/0.58	141,085
SH-133	E/o Somerset	550	1,100	430	520	500	0.86/1.04	13,860
SH-133	W/o Somerset	900	1,800	520	660	500	1.04/1.32	6,480
SH-133	E/o junction with SH-187	1,500	3,000	660	900	500	1.32/1.80	5,100
SH-133	W/o junction with SH-187	1,800	3,600	580	870	500	1.16/1.74	2,160
SH-133	E/o Hotchkiss	1,800	3,600	580	870	500	1.16/1.74	720
SH-92	E/o Delta	5,950	11,900	1,120	1,580	1,860	0.60/0.85	88,060
SH-92	W/o junction with SH-65	4,800	9,800	930	1,330	860	1.08/1.55	63,994
SH-92	E/o junction with SH-65	2,250	4,400	500	680	860	0.58/0.79	26,664
SH-92	W/o Hotchkiss	2,600	5,200	570	770	860	0.66/0.90	7,280
SH-65	N/o junction with SH-92	2,750	5,500	440	660	1,100	0.40/0.60	8,800
SH-139	Junction road N/o Junction 6	950	1,450	440	610	740	0.59/0.82	1,796
SH-139	Junction road at Mesa-Garfield County line	690	800	60	160	740	0.08/0.22	10,664

Source: Based on Colorado Highway Department projections.

a/ I = Interstate; US - United States; SH = State Highway.

b/ N/o = north of; S/o = south of; E/o = east of; W/o = west of.

c/ Vsl_C = volume service level C, which indicates an efficient flow of traffic at 55 miles per hour with adequate opportunities to pass.

TABLE R4-25

PROJECTED INCREASES IN ACCIDENTS BY 1990

Highway a/	Location b/	Segment Length	Average Daily Traffic (1990)	Injury Accident Rate	Number of Injuries c/	Fatality Rates	Fatal Accidents c/	Total Accident Rate	Total Accidents c/
I-70	Junction W/o 139	3.95	4,900	0.27	2	0	-	0.53	4
I-70	W/o Grand Junction	3.96	5,050	0.63	5	31.42	1	1.57	11
I-70	E/o Grand Junction	2.10	9,800	0.98	7	0	-	1.47	11
I-70	W/o Grand Valley	8.40	9,600	0.50	15	7.18	2	2.08	61
U.S. 50	N/o Delta	4.33	10,000	0.24	4	0	-	2.95	47
U.S. 50	S/o Delta	1.91	15,250	0.31	3	0	-	0.94	10
U.S. 550	S/o Montrose	8.57	9,250	0.23	7	11.63	1	3.02	87
U.S. 82	Jct. rd. S/o Glenwood	2.42	20,300	1.73	8	0	-	11.95	211
U.S. 82	Jct. S.H. 133	3.88	15,250	0.46	10	0	-	2.33	50
S.H. 133	N/o Carbondale	0.15	8,400	0	-	0	-	0	-
S.H. 133	S/o Carbondale	1.75	5,800	0.71	3	0	-	1.42	5
S.H. 133	E/o Somerset	6.32	1,100	0.87	2	0	-	5.20	17
S.H. 133	W/o Somerset	1.80	1,800	3.38	4	0	-	6.76	8
S.H. 133	E/o Jct. W. 187	8.54	3,000	0.92	7	36.68	1	5.87	55
S.H. 92	E/o Delta	0.14	11,900	3.26	2	0	-	22.83	14
S.H. 92	W/o Hotchkiss	3.10	5,200	0.74	4	0	-	4.06	24
S.H. 139	At Loma	1.28	1,450	0	-	0	-	7.61	5
S.H. 139	Jct. rd. at Mesa Co. line	11.45	800	1.04	3	0	-	2.43	8

Source: Based on figures supplied by Colorado Department of Highways.

a/ I = Interstate; U.S. = United States; S.H. = State Highway.

b/ N/o = north of; S/o = south of; E/o = east of; W/o = west of.

c/ Rounded to nearest whole number.

Upgrading of highways to handle anticipated traffic volumes could be expensive. The cost of road upgrading in the mountains (two to four lanes) is approximately $750,000 per mile, excluding right-of-way acquisition.

Money received by the state of Colorado and by counties in the region from Section 35 of the Mineral Leasing Act could be used to upgrade the transportation network. Projects such as grade separations at rail crossings and improving and maintaining existing roads could improve the safety and convenience of the systems. However, the Department of the Interior cannot guarantee that these improvements will be made, since the distribution of Section 35 monies is determined annually by the state legislature.

RAILROADS

Coal transported from the region would move by unit train. It is assumed that unit trains operating through the Moffat Tunnel would consist of 100 cars, each having a capacity of 100 net tons, and that unit trains operating over Tennessee Pass would consist of 50 similar cars. It is also assumed that, as part of a normal program of facility upgrading, the Denver and Rio Grande Western (D&RGW) would lengthen passing tracks on the Moffat Tunnel route to accommodate 100-car unit trains if traffic increases necessitate such improvements.

At the most probable level of production, approximately 143,000 carloads of coal would be moved from the region annually by 1990. Based on preliminary information concerning destinations of coal produced in the region, 100,000 carloads would move to destinations east of the region and the remainder would move west. The larger mining operations would most likely ship by unit train. While the smaller mining operations would likely ship in multicar shipments, it is assumed that these shipments would be assembled into a train similar in length to a unit train for the main line haul from the region. Westbound coal movements would add an average of 2.5 unit train trips daily to the main line (including returning empty trains). Approximately 15 of these trains per week would be the direct result of the projected level of development. If all the eastbound coal traffic would move over the Moffat Tunnel route (using 100-car unit trains), an average of 5.5 trains per day would be added to the main line; approximately 4.5 trains per day would be the direct result of the probable level of development. The Moffat Tunnel is single track, and there is no potential for double-tracking unless the tunnel itself can be widened. Moving over the Tennessee Pass route, approximately twice as many train trips would be required as moving through Moffat Tunnel.

Coal loading at new mine sites would require the construction of small lengths of spur track and loading facilities. Except for the line between Delta and Somerset, all D&RGW lines are running at less than 50 percent capacity. The Delta-Somerset line would have to be upgraded by automatic switching to increase its carrying capacity. No other major modifications to the rail system in the region would be necessary to accommodate the amount of traffic generated by the most probable level of production. Overall, power, crews, and rolling stock would be the limiting factors in rail capacity, not trackage (Roy Johnson, D&RGW, 1978, personal communication).

Regional Impacts

The amount of fuel consumed by transporting coal by rail from west-central Colorado would depend on numerous factors, many of which are presently unknown. The ultimate coal markets, train routing, and type of rail carriage (unit train or general freight) would influence the total amount of fuel consumed. To assist in understanding this impact, the amount of fuel consumed per 100 miles of trip was estimated assuming (1) total annual haul of 14.34 million tons and (2) net fuel efficiency of 300 net ton-miles per gallon (typical for unit trains). Under these conditions 4.78 million gallons of diesel fuel would be consumed annually per 100 miles of shipment.

Primary sources of air pollution associated with coal train movements are pollutants emitted as part of the diesel exhaust, and dust blown from uncovered coal cars. The three primary locomotive emissions are carbon monoxide, hydrocarbons, and nitrogen oxides. These pollutants would increase in raw terms (pounds per mile) as the train frequencies increase. On an annual basis, the amount of these pollutants emitted per 100 miles of haul would be 310 tons of carbon monoxide, 225 tons of hydrocarbons, and 884 tons of nitrogen oxides. These pollutants would be distributed fairly uniformly throughout the year and over long distances of relative rural air with good dispersion characteristics. Therefore these emissions would not significantly impact regional air quality.

Increased train frequencies would result in an increase in existing noise levels at points along the rail line. The area in which noise levels exceed the Environmental Protection Agency's long-term noise control goal (55 decibles--dBA) would expand. The relationship between frequency of train operations and distance at which noise exceeds the 55 dBA level is presented in figure R4-5. It should be pointed out that this figure is based on noise generated by current rail locomotive and rolling stock. Maximum locomotive and car single exposure noise level standards have been established which would tend to lessen the magnitude of the noise impact of future rail operations.

Increased rail traffic would bring about a corresponding increase in the number of potential conflicts between trains, motor vehicles, and pedestrians at highway-rail grade crossings. These increases are shown in table R4-26 as hazard ratings for selected crossings in the region. The most significant increases in expected auto train collisions over a five-year period would occur at two points on the D&RGW main line. The hazard rating at the State Highway 146 crossing at Clifton would increase from 3.33 accidents over a five-year period to 4.25. Similarly, the crossing at State Highway 139 at Loma would increase from 0.15 to 1.28 accidents in five years. In addition to this, at a crossing of an industrial line and U.S. 6 in Rifle, the hazard rating would increase from 1.25 to 2.01 accidents by 1990. Collisions between autos and trains at the several county and municipal crossings in the region would also increase but cannot be quantified because traffic volumes are unknown.

Trains create a barrier at highway-rail grade crossings preventing normal highway movements (see figure R4-6). A typical 100-car unit train moving at 20 miles per hour would physically block a crossing for about 3.5 minutes. Warning devices and driver anticipation would further extend the amount of time a particular crossing is closed. Assuming a 4-minute delay per train, 28 trains would block a particular crossing for 1 hour and 52 minutes. Approximately 32 minutes of this total could be attributed to the projected level of development. This is the "worse case" occurrence in the region and would occur only on the main line. Under normal conditions, train movements would be spread throughout the entire day; therefore, blockages would not normally be longer than 8 to 12 minutes at any one time. Furthermore, the regional rail system is such that few, if any, grade crossings would be subjected to all train movements. The delay, however, is an adverse impact. In addition to the general inconvenience created by this delay, such blockages could increase response time for emergency vehicles. The unnecessary idling by motor vehicles stopped at grade crossings would also be another source of air pollution.

Extra-Regional (Down Line) Impacts

Impacts resulting from rail operations would not be confined to the region; rather they would be manifested, to some degree, wherever the coal shipment goes. The generic impacts discussed previously would pertain to rail movement regardless of routing. As could be seen in the discussion of generic impacts, the effect of an individual train would not be significant. It is the repetition of these small impacts which may become significant. The major extra-regional implications of the movement of west-central Colorado coal comes where these movements are added to lines with already high volumes of rail traffic.

The ultimate destination and routing of much of the potential coal traffic is unknown so an analysis of impacts on a specific point outside the region is impossible. A division of traffic routes into easterly and westerly destinations has been developed from recent trends in coal utilization and marketing, and discussions with some of the existing and potential mine operators. These general destinations, either east or west, are presented in table R1-3.

Coal transported to the west would travel by way of the D&RGW main line to the Salt Lake area. Here it would interchange with either the Union Pacific for shipment to southern California, or the Southern Pacific or Western Pacific for shipment to northern California and the Pacific Northwest. These three railroads operate high-grade main lines with average volumes of 24, 30, and 11 trains per day respectively. These lines are presently under capacity, and the addition of west-central Colorado coal traffic would not significantly affect operations.

To reach markets to the east, the coal would be routed over the D&RGW to its main line on the front range, either at Denver or Pueblo, to interchange with other carriers. Selection of one of the two possible routes that would be used to reach the front range would depend, to a large extent, on which carrier would receive the traffic from D&RGW. At the present time, line capacity is not a major factor in routing rail traffic over these lines.

The growth of coal traffic, in particular the traffic moving between Wyoming and Texas in a north-south direction, has begun to create rail-community conflicts on the front range. These problems are most pronounced in the Fort Collins to Colorado Springs area, which includes Denver. Routing of west-central Colorado coal through Moffat Tunnel to an interchange with another carrier in Denver, although not seriously affecting north-south movements, would add to already high rail congestion in the city. If this traffic then moves south to Colorado Springs or Pueblo for interchange, it would further aggrevate existing problems.

Routing the traffic over Tennessee Pass to Pueblo would minimize the impact on front range communities. The severe grades on this route, however, would require the use of twice as many trains.

In addition to west-central Colorado, D&RGW provides the only main line rail service to two other coal regions, central Utah and northwest Colorado. Coal produced in these regions may

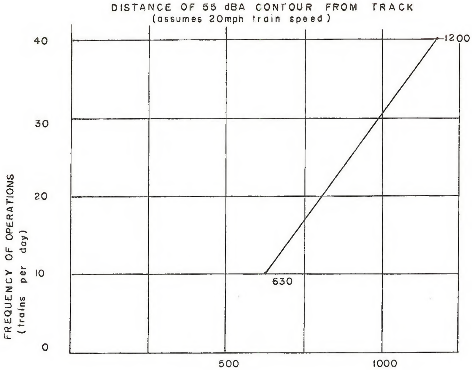


Figure R4-5. Relationship between frequency of train operations and distance at which noise exceeds the Environmental Protection Agency's long-term noise control goal (55 dBA)

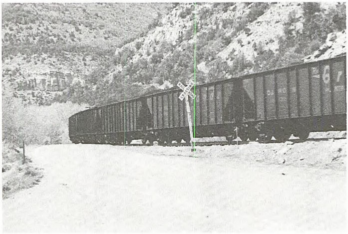


Figure R4-6. Greater rail traffic in region would increase delay times and accident potential at grade crossings.

TABLE R4-26

PROJECTED RAIL CROSSING HAZARD RATINGS

Highway	Location	Average Daily Vehicular Traffic (1990)	Numbers of Trains Per Day	Projected Hazard Rating
S.H. 90	Montrose - St. S.W. of Rio Grande Ave. (Montrose)	12,500	2.8	1.86 acc./5 yrs.
S.H. 92	Hotchkiss - 6.3 mi. W. of S.H. 133 (Delta)	5,200	5	2.39 acc./5 yrs.
S.H. 92	Hotchkiss - 0.75 mi. W. of S.H. 133 (Delta)	5,200	5	2.39 acc./5 yrs.
S.H. 133	Hotchkiss - 0.50 mi. N.E. of S.H. 92 (Delta)	2,950	5	1.75 acc./5 yrs.
S.H. 133	Bowie - 1.0 mi. N.E. of (Delta)	1,000	5	0.66 acc./5 yrs.
S.H. 133	Bowie - 1.5 mi. N.E. of (Delta)	1,000	5	0.66 acc./5 yrs.
S.H. 133	Bowie - 1.9 mi. N.E. of (Delta)	1,000	5	0.66 acc./5 yrs.
S.H. 133	Somerset - 1.0 mi. E. of (Gunnison)	1,100	5	0.66 acc./5 yrs.
S.H. 133	Carbondale - 0.4 mi. S. of S.H. 82 (Garfield)	5,800	2	1.61 acc./5 yrs.
S.H. 139	Loma - 0.03 mi. S. of S.H. 6 (Mesa)	1,450	20	2.35 acc./5 yrs.
I-70	Grand Valley - 0.55 mi. N.E. of R.R. Ave. (Garfield)	9,600	25	6.99 acc./5 yrs.
U.S. 6	Rifle - at 1st St. & West Ave. (Garfield)	5,600	25	2.79 acc./5 yrs.
U.S. 50	Delta - N. of - 0.04 mi. N. of S.H. 92	15,250	5	4.06 acc./5 yrs.
S.H. 65	Delta - E. of - 0.02 mi. N. of S.H. 92	5,500	5	2.39 acc./5 yrs.

compete with west-central Colorado coal for future rail capacity.

The ultimate destinations for coal that would be produced in central Utah are unknown. Regardless of destination, any coal shipped from the region would go by rail and would use a part of the D&RGW main line. Traffic volumes could range up to 13 trains per day for the probable level of production.

If this coal moves to the west, west-central Colorado coal would first encounter Utah coal near Mounds, and almost all Utah coal would be on the main line before it crosses the Wasatch Plateau. Since the main line is double tracked from Castlegate to Provo, the addition of the probable production of west-central Colorado coal going to western destinations could be accommodated even with the high level of central Utah coal production.

Once in the Salt Lake area, this traffic would have to be interchanged with one or a combination of the three lines connecting this area with destinations farther west. In addition to accommodating the existing traffic, potential general traffic growth, and the combined Utah and Colorado coal traffic, these lines would also have to accommodate coal traffic from the southwest Wyoming coal region destined for points west. If all coal with western destinations would be delivered to one carrier, that carrier would most likely have to expand its facilities to accommodate the coal traffic as well as normal traffic growth. The magnitude of these improvements would be lessened to the extent that the coal is not shipped by rail to the west and/or the remaining traffic is divided among the three competing carriers. A judicious division of the traffic could obviate the need for major expansion.

If the central Utah coal moves east, it would encounter west-central Colorado coal near Grand Junction. The combined traffic of these two regions, which could amount to 29 trains per day, could be accommodated on the main line between Grand Junction and Dotsero. East of Dotsero this traffic would have to move over either the Moffat Tunnel route to Denver or the Tennessee Pass Route to Pueblo. Shipment of coal from the northwest Colorado region would enter the former route near Bonds. This region would generate 16 trains per day at the probable level of production. All these trains would be routed east, through the Moffat Tunnel to Denver and an interchange with other railroads.

The two existing main lines east of Dotsero could accommodate the eastbound movement of west-central Colorado coal generated by the most probable level of production, together with the probable levels of production from central Utah (assuming it all moves east) and the probable level from northwest Colorado. (This assumes that D&RGW lengthens its short passing tracks to accommodate 100 car trains.)

Normal operations over the two main lines between Dotsero and the front range, however, could not accommodate a combination of the existing traffic over the main lines, any growth in general freight traffic, traffic generated by the high level of production in the northwest Colorado and central Utah regions (again assuming all production from the latter goes east), and the eastbound traffic resulting from the most probable level of development in the west-central Colorado region. D&RGW has indicated that it would make improvements necessary to handle growth in traffic. Among the options available would be longer sidings (or alternate sections of single and double track) or the use of helper locomotives to permit the operation of 100 car trains over Tennessee Pass. It should be pointed out that the coal traffic levels from central Utah assumed that all coal produced in the region would be shipped from the region by rail in one direction. There are presently three coal fired power plants in central Utah (two of which are expanding) which would be probable local markets for large quantities of coal. Additionally, there are alternative transportation plans under discussion as well as tentative contracts for coal shipments both east and west from the region. It is unlikely, therefore, the level of traffic from the central Utah region used in this analysis could be reached.

Seven main lines connect the D&RGW main line on the front range with destinations to the east and south. If all the coal traffic generated in the three regions were to be routed over one or two of these lines, major improvements would be necessary to provide the needed capacity. However, if the traffic is divided among the various lines, no individual line's capacity would be seriously taxed and the impact at any particular point downline from additional train operations would be less than would occur at points in the region.

AIRPORTS

Both the proposed actions and other mid-level development would generate and increase in air traffic to those airports presently served by scheduled air lines, particularly Walker Field in Grand Junction. Although there is not enough information available to quantify this increase, it is likely that the airports would be able to handle increased traffic generated by the proposed actions.

Agriculture

LIVESTOCK GRAZING

It is estimated that the number of animal unit months (AUMs) of livestock forage lost per year due to the proposed actions would be approximately 14 by 1980, 60 by 1985, and 69 by 1990, based on the disturbance of 64; 1,133; and 1,175 acres of natural vegetation, respectively. This is very small when compared with the 535,221 AUMs produced annually on the 5,389,916 acres of public land and national forest systems land within the ES area.

The disturbed areas would be revegetated to a level of productivity of approximately 232 AUMs per year of livestock forage. This figure is based on assuming the species mixture used in revegetation would consist mostly of grasses (as is indicated in the mining and reclamation plans) and that 5 acres or less of the successfully revegetated areas would support 1 AUM. However, the restoration of AUMs is dependent on the assumption that all of the disturbed areas can be successfully revegetated. As discussed in the vegetation sections of the site-specific volume, this is not certain on the harsher sites within the ES area (areas of 10 inches or less average annual precipitation). Livestock grazing in the mining tracts would be regulated during reclamation operations to protect the revegetated areas (required in 43[CFR]: 3041[f][14][ii] and 30[CFR]: 211[a][14][ii]).

It is very likely that some of the urban expansion due to increased population from 152,050 in 1977 to 197,600 in 1980; 245,300 in 1985; and 252,800 in 1990 would disturb irrigated and nonirrigated hayland and pasture. This would adversely affect the livestock industry because these lands are used as livestock wintering areas, and the hay harvested from them in the summer is used to feed the livestock during winter.

Increased commercial and noncommercial cutting of pinyon-juniper for firewood would result in increased density of understory plants beneath the cut pinyon and juniper. This would benefit livestock because the understory plants would be available for livestock forage, while pinyon-juniper is not.

The increased off-road vehicle (ORV) use as a result of population increases would kill or decrease the vigor of plants; as a result, livestock range conditions would decline. This adverse impact would be most serious in the high altitude alpine areas and the low altitude Mancos shale hills, since these areas are particularly sensitive to ORV use. The alpine zone is grazed by sheep generally from July to September, while sheep are grazed on the Mancos shale hills during the winter and spring months, from November to May.

A loss of livestock forage and of livestock wintering areas would also result from cumulative regional development of existing coal operations, non-coal-related activities, and associated community expansion, regardless of the proposed federal action. This cumulative development would disturb 8,226 acres of vegetation in the region by 1980; 24,221 acres by 1985; and 30,964 acres by 1990 and would be much more severe because of the higher level of growth. Pinyon-juniper cutting and ORV use would also increase as a result of cumulative development.

The loss of livestock forage due to vegetative disturbance caused by the proposed actions by 1990 (69 AUMs) would also be very small when compared with the loss that is projected by 1990 due to vegetative disturbance from cumulative regional development: 457 AUMs in 1980; 1,796 AUMs in 1985; and 2,424 AUMs in 1990.

FARMING

The most obvious impact upon agriculture is the direct conversion of farmland to other uses. Within the region it is estimated that by 1980 4,061 acres of land would be required to support community expansion for cumulative development. By 1985 this would double to 8,122 acres and reach 9,143 acres by 1990. Population growth from the proposed actions would require the development of 64 acres in 1980; 801 acres in 1985; and 1,430 acres in 1990. Because of the difference between the various counties in the region with respect to degree of land-use planning and zoning ordinances, it is not possible to estimate how much of this land would actually be farmland. However, since most of the development is expected to occur close to existing communities where it is easier to gain access to utilities, and since most of the towns in the area are surrounded by farmland, it is possible that much of the land required for community expansion would be met by farmland. This change would affect the relative wealth position of farmers whose farms were developed for housing. Instead of their assets being tied up in farmland, they will have liquid assets to invest in other industries or on agriculture in a different location. Farmers may not be able to obtain an equal operation or a different location at the same price as they sold their original farm.

Increased employment in the coal industry at wage rates higher than prevail in the local economy would tend to attract farm laborers away from low-paying farm jobs. The shortage of labor, at wages farmers are willing to pay, particularly at harvest time, has already caused problems in the area. The attraction of high-paying jobs in the coal industry would add to this problem.

Important in the agricultural economy of the region is the number of farm operators who work at least part-time off their farms. Regionally 46 percent of farm operators reported some off-farm work in 1974. In Delta County 49 percent of the farmers worked off-farm. In Garfield County this was 41 percent and in Mesa County 56 percent.

The development of a more active coal industry would greatly increase the opportunity for good paying off-farm work to these farmers. This would also provide the opportunity for people who prefer to live on their farms but who are unable to make an adequate living from them to stay in the area and live the life they prefer.

Use of water for mining and community develo-pent could indirectly affect the productivity of agricultural land by removing the source of irrigation water. If all of the water used by the mines and communities would be transferred from agricultural use by sale of senior water right ("worst case") and assuming an average of 3 acre-feet of water needed per acre of producing land, coal development would cause 538 acres to go out of production by 1980; 1,911 acres by 1985; and 2,463 acres by 1990. Cumulative community growth would cause enough water to be transferred from agricultural use to irrigate 1,743 acres by 1980; 8,075 acres by 1985; and 11,018 acres by 1990. This loss could be offset by a change from the present surface irrigation to more water efficient systems such as sprinkle or drip irrigation, and the further development of regional water supplies.

An indirect result of population growth and industrial development would be a decrease in the number of farmers. This would have an adverse effect on the agriculture-support industry in the area. Suppliers of farm equipment, etc., would have a more difficult time staying in business. The result would be consolidation of existing service, making it harder for remaining farmers to obtain products they need.

A phenomenon that could have an adverse affect upon agriculture in the region is the development of "ranchettes" or very small farms. Often, these are not managed as effectively as they might, and production of agricultural goods declines as a result. This also causes problems for neighboring commercial farmers who may experience problems in using chemicals or other products in their operations.

Prime and Unique Farmland

Because the mines are located away from the developed portions of the area, they would have very little effect on prime or unique farmland. The exception is the utility corridor proposed as part of Sheridan Enterprises' Loma Project. This would disturb 160 acres, some of which could be classified as prime farmland.

Development of housing and other facilities to serve the population increase would also affect prime farmland. Community development as a result of the proposed actions would result in the conversion of 64 acres from farmland to other uses by 1980; 801 acres by 1985; and 1,292 acres by 1990. This is only a portion of the land that would be converted to community development because of cumulative growth (4,061 acres by 1980; 8,122 acres by 1985; and 9,143 acres by 1990).

It is not possible to estimate the proportion of the above farmland that would be considered prime. However, most of the cities and towns are situated within the irrigated portions of the soil associations that are candidates for prime designation. Assuming that community growth would occur in the vicinity of present communities, a large portion of the land taken out of agricultural production could be prime farmland.

As noted in chapter 2, the ES area is the major fruit-producing area in Colorado. All of the 10,127 acres of orchards in the area are considered unique farmlands. Much of this orchard land is in the same areas considered to be prime farmland. Community development would undoubtedly decrease the quantity of land suitable for orchards in the ES area.

The extent of the loss of prime farmland in the ES area will depend on how effective local planning authorities are in establishing and implementing means to control development on prime and unique farmland.

Recreation

The cities and towns with increased populations would experience increased demand for recreational opportunities requiring community facilities (e.g. ballfields, playgrounds, swimming pools, tennis courts). Since use of most community facilities is now maximum (Grand Junction Recreation Department 1977; Colorado Comprehensive Outdoor Recreation Plan 1976) increased use would result in overuse, which would degrade the facilities and lower their capacities to provide enjoyable recreation. Quantification of this impact is best presented in the form of facilities required to prevent the overuse and deterioration of existing facilities. The standards used to compute requirements for community facilities based on population increases were taken from a study prepared by Bickert, Browne, Coddington and Associates, Inc. (1976) for six western Colorado communities, and they are representative of this region. Table R4-27 summarizes projected community facilities needs and capital investment costs to provide the facilities.

The greatest potential for overuse of recreational facilities would occur in the growing communities in Mesa County. Growth due to the proposed actions would require 1.2 acres of active/improved park land (e.g. ballfields, playgrounds, tennis courts, etc.) by 1980, 38.4 acres by 1985, and 44.6 acres by 1990 to prevent overuse. A need for an additional swimming pool and nine-hole golf course would also be felt about 1985. Total growth

TABLE R4- 27

COMMUNITY RECREATION FACILITIES NEEDED FOR ADDITIONAL POPULATIONS (CUMULATIVE)

	MESA COUNTY						GARFIELD COUNTY					
	1980		1985		1990		1980		1985		1990	
	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth
Population growth	350	25,100	11,650	46,450	13,500	41,000	800	14,200	1,450	20,550	2,400	27,600
Active/improved parkland a/ (3.3 acres per 1,000)	1.2	82.8	38.4	153.3	44.6	135.3	2.6	46.9	4.8	67.8	7.9	91.0
Capital investment (66,666 per 1,000)	$23,333	$1,673,317	$776,659	$3,096,636	$899,991	$2,733,306	$53,333	$946,657	$96,666	$1,369,986	$159,998	$1,839,982
Swimming pools (1 per 10,000)	0.0	2.5	1.2	4.6	1.4	4.1	0.1	1.5	0.1	2.1	0.2	2.8
Capital investment ($70,000 per 10,000)	$2,450	$175,700	$81,550	$325,150	$94,500	$287,000	$5,600	$99,400	$10,150	$143,850	$16,800	$193,200
Nine-hole golf courses (1 per 10,000)	0.0	2.5	1.2	4.6	1.4	4.1	0.1	1.4	0.1	2.1	0.2	2.8
Capital investment ($160,000 per 10,000)	$5,600	$401,600	$186,400	$743,200	$216,000	$656,000	$12,800	$227,200	$23,200	$328,800	$38,400	$441,600
Total investment	$31,383	$2,250,617	$1,044,609	$4,164,986	$1,210,491	$3,676,306	$71,733	$1,273,257	$130,016	$1,842,636	$215,198	$2,474,782

Source: Bickert, Browne, Coddington, and Associates, Inc., 1976.

a/ Ballfields, playgrounds, tennis courts, etc.

TABLE R4-27

COMMUNITY RECREATION FACILITIES NEEDED FOR ADDITIONAL POPULATIONS (CUMULATIVE)
(continued)

	DELTA COUNTY						MONTROSE COUNTY					
	1980		1985		1990		1980		1985		1990	
	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth
Population growth	400	2,150	1,800	7,450	3,100	9,950	--	1,500	--	2,750	--	4,200
Active/improved parkland a/ (3.3 acres per 1,000)	1.3	7.1	6.0	24.6	10.2	32.8	--	5.0	--	9.1	--	13.9
Capital investment ($66,666 per 1,000)	$26,666	$143,332	$119,999	$496,662	$206,665	$663,327	--	$99,999	--	$183,332	--	$279,997
Swimming pools (1 per 10,000)	0.0	0.2	0.2	0.7	0.3	1.0	--	0.2	--	0.3	--	0.4
Capital investment ($70,000 per 10,000)	$2,800	$15,050	$12,600	$52,150	$21,700	$69,650	--	$10,500	--	$19,250	--	$29,400
Nine-hole golf courses (1 per 10,000)	0.0	0.2	0.2	0.7	0.3	1.0	--	0.2	--	0.3	--	0.4
Capital investment ($160,000 per 10,000)	$6,400	$34,400	$28,800	$119,200	$49,600	$159,200	--	$24,000	--	$44,000	--	$67,200
Total investment	$35,866	$192,782	$161,399	$668,012	$277,965	$892,177	--	$134,499	--	$246,582	--	$379,597

TABLE R4-27

COMMUNITY RECREATION FACILITIES NEEDED FOR ADDITIONAL POPULATIONS (CUMULATIVE)
(continued)

	GUNNISON COUNTY						PITKIN COUNTY					
	1980		1985		1990		1980		1985		1990	
	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth
Population growth	--	700	--	10,200	--	9,400	--	3,800	--	7,850	--	11,000
Active/improved parkland a/ (3.3 acres per 1,000)	--	2.3	--	33.7	--	31.0	--	12.5	--	25.9	--	36.3
Capital investment ($66,666 per 1,000)	--	$46,666	--	$679,993	--	$626,660	--	$253,331	--	$523,328	--	$733,326
Swimming pools (1 per 10,000)	--	0.1	--	1.0	--	0.9	--	0.4	--	0.8	--	1.1
Capital investment ($70,000 per 10,000)	--	$4,900	--	$71,400	--	$65,800	--	$26,600	--	$54,950	--	$77,000
Nine-hole golf courses (1 per 10,000)	--	0.1	--	1.0	--	0.9	--	0.4	--	0.8	--	1.1
Capital investment ($160,000 per 10,000)	--	$11,200	--	$163,200	--	$150,400	--	$60,800	--	$125,600	--	$176,000
Total investment	--	$62,766	--	$914,593	--	$842,860	--	$340,731	--	$703,878	--	$986,326

TABLE R4-27

COMMUNITY RECREATION FACILITIES NEEDED FOR ADDITIONAL POPULATIONS (CUMULATIVE)
(continued)

	OURAY COUNTY					
	1980		1985		1990	
	Proposed Action	All Growth	Proposed Action	All Growth	Proposed Action	All Growth
Population growth	--	300	--	200	--	500
Active/improved parkland a/ (3.3 acres per 1,000)	--	1.0	--	0.7	--	1.6
Capital investment ($66,666 per 1,000)	--	$20,000	--	$13,333	--	$33,333
Swimming pools (1 per 10,000)	--	--	--	--	--	--
Capital investment ($70,000 per 10,000)	--	--	--	--	--	--
Nine-hole golf courses (1 per 10,000)	--	--	--	--	--	--
Capital investment ($160,000 per 10,000)	--	--	--	--	--	--
Total investment	--	$20,000	--	$13,333	--	$33,333

in the county would require substantial acreages for additional recreation facilities. Cumulative requirements would amount to 82.8 acres by 1980, 153.3 acres by 1985, and 135.3 acres by 1990. Increased demand would be felt for two additional swimming pools and nine-hole golf courses by 1980 and two more of each by 1985, which should be sufficient through 1990.

Garfield County would also experience substantial growth; however, it would be mostly non-coal-related. The proposed actions would require 2.6 acres of active/improved park land by 1980, 4.8 acres by 1985, and 7.9 acres by 1990. Facilities needed due to all growth in the county would be of more significance, with 46.9 acres needed by 1980, 67.8 acres by 1985, and 91 acres by 1990 to prevent overuse. A need for an additional swimming pool and nine-hole golf course would be felt by 1980; another of each would be needed by 1985, and possibly another by 1990.

The increases in Delta County would not be as large as those in Mesa and Garfield counties, but they would be more related to coal development. Facilities needed to prevent overuse because of the proposed actions include 1.3 acres of active/improved park land by 1980, 6 acres by 1985, and 10.2 acres by 1990. For all growth the county would require 7.1 acres of active/improved park land by 1980, 24.6 acres by 1985, and 32.8 acres by 1990. The demand could be felt for an additional swimming pool and nine hole golf course by 1990.

Montrose County is not expected to experience coal-related growth due to the proposed actions. Cumulative growth in the county would require 5 acres of active/improved park land by 1980, 9.1 acres by 1985, and 13.9 acres by 1990.

The counties of Gunnison, Pitkin, and Ouray are not expected to have any growth related to the proposed actions; however, these counties would experience growth, particularly Gunnison and Pitkin. Additional recreational facilities needed to prevent overuse of existing facilities in Gunnison County would require 2.3 acres of active/improved park land by 1980, 33.7 acres by 1985, and 31 acres by 1990. A need for an additional swimming pool and nine hole golf course would also be felt by 1985. Growth in Pitkin County would require 12.5 acres of active/improved park land by 1980, 25.9 acres by 1985, and 36.3 acres by 1990. A need for an additional swimming pool and nine hole golf course would also be felt by about 1985. Growth in Ouray County would be minimal (500 people by 1990), and it is questionable whether additional facilities would be needed.

To provide the additional recreational facilities and prevent overuse and deterioration, monies and land would be needed. The Heritage Conservation and Recreation Service, through the Land and Water Conservation Fund Act (PL 88-578), could provide monies for this purpose if matching funds are provided by the local agency. The Mineral Leasing Funds (Colo. SB No. 35, Sect. 2, 34-63-103), which can be used for public facilities and services, could also be used to provide these facilities. Lands for these facilities could possibly be obtained under the Recreation and Public Purposes Act, 43(CFR): 2740, which allows nonprofit associations to acquire public lands for recreational purposes consistant with their creating authority. The Department of the Interior cannot commit these courses of action; therefore, the success of mitigation would depend upon the commitment of local agencies to initiate the actions and provide the facilities.

As the populations of the communities grow, the market for recreation activities would also grow. This would allow the private sector to provide additional facilities such as bowling lanes and movie theatres. Private and public organizations may also find a larger audience for plays and musical performances.

Increased populations would also have an impact on hunting and fishing in the region. In Colorado, 44 percent of the population are anglers (Colorado Division of Wildlife 1977) and engage in 7.1 recreation days per year (average of cold water stream, cold water lake, warm water predator, and warm water panfish). Using these figures and population projections, increased fishing pressure from the proposed actions would amount to an additional 682 anglers (4,842 recreation days) by 1980; 4,488 anglers (33,865 recreation days) by 1985; and 7,260 anglers (51,546 recreation days) by 1990. All growth in the region would produce the following increased demand: 21,010 anglers (149,171 recreation days) by 1980; 41,998 anglers (298,186 recreation days) by 1985; and 45,606 anglers (323,002 recreation days) by 1990. This increase in demand and the fact that demand already exceeds supply for cold water fisheries (Colorado Division of Wildlife 1977) points to a lowering of the quality of fishing in the region.

Hunting pressure would also increase in the region. Seventeen percent of the Colorado population are hunters (Colorado Division of Wildlife 1977) and spend an average of 4.3 recreation days per year (average of deer, elk, pheasant, and cottontail rabbit recreation days). Using these figures and population projections, increased hunting pressure due to the proposed action would be 264 hunters (1,133 recreation days) by 1980; 1,734 hunters (7,456 recreation days) by 1985; and 2,805 hunters (12,062 recreation days) by 1990. All growth in the region would produce the following increased demand: 8,118 hunters (34,907 recreation days) by 1980; 16,226 hunters (69,772 recreation days) by

1985; and 17,620 hunters (75,768 recreation days) by 1990. This increased demand plus the fact that demand already exceeds supply for species such as deer and elk point to a lowering of the quality of the hunting in the region.

Wildlife for both hunting and viewing could be displaced by loss of habitat due to mining facilities and increased urbanization. Also, increased human activity (from mining activity and increased recreational use) could displace intolerant species from their habitats. These impacts would result in a loss of recreation opportunities (see Wildlife for the extent of impacts).

Direct and indirect water quality impacts from the proposed action (see Water Resources) should not adversely affect water-based recreation or classification of possible Wild and Scenic River segments since all water bodies in the region (except Sweitzer Lake, Delta County) are currently classified as unsuitable for primary contact recreation, such as swimming and water skiing (Colorado Department of Health 1974), and this classification would not change due to these impacts. Refer to the Aquatic Biology section for water quality impacts on fisheries.

Increased use of recreational facilities and lands managed by various agencies such as Colorado Division of Parks and Outdoor Recreation, NPS, USFS, and BLM could be expected due to increased populations. Estimates of future use are projected in table R4-28 based on population projections for the region and recreation activities demand from the 1976 Colorado Comprehensive Outdoor Recreation Plan (SCORP). Allocation of activity increases to specific sites was not attempted due to the mobility of the people using facilities in the area. The increased use would impact the managing agencies by creating a need for additional monies for maintenance and supervision of existing sites and construction of additional recreational sites as existing facilities become overloaded.

Off-road vehicle use presents a special problem since dramatic increases have occurred since the 1974 SCORP data was compiled. Rising income levels (see socioeconomic section) could continue to make this recreational activity grow faster than the rate of population growth. Increased use of certain areas (such as along Peach Valley Road in Delta County) has led to vegetative deterioration and harassment of wildlife. Substantial monies would be needed to manage and control this activity.

The increased use of downhill skiing facilities in the ES area (as projected in table R4-28) could require additional facilities. The proposed actions would generate about 0.1 percent increase per year over 1975 levels, while cumulative growth could increase use levels about 3 percent per year.

The region offers opportunities for the primitive or wilderness experience which is dependent on a low density use and minimal human intrusions. Mining activity due to the proposed action on lands adjacent to potential wilderness areas could prevent these areas from being designated as wilderness (see ARCO, Anschutz, and Coal Canyon site-specific analyses). The coal developments addressed in the regional analysis would not occur adjacent to any existing wilderness areas and are not expected to impact areas which may be studied by the USFS or BLM for wilderness potential. Increased use of wilderness areas could be expected from population growth due to the proposed actions and from total growth in the region. The amount of increased use is presently unquantifiable. If new areas which the BLM and USFS are studying for wilderness status receive this status, it would help absorb the increased use and no significant adverse impacts on wilderness values would be expected.

Sightseeing in the region is a major recreational activity for many residents and non-residents alike. Therefore, any impacts on the visual character, such as increased urbanization of the Colorado River corridor, would also impact recreation (see Visual Resources for extent of these impacts).

A beneficial recreational impact could occur from increased capabilities for geologic and industrial interpretation. Guided tours and interpretive signs have potential for informing visitors of the physical and economic conditions conducive to coal production.

Visual Resources

Regional projections for cumulative development and associated population growth (from 152,050 people in 1977 to 197,600 by 1980; 245,300 by 1985; and 252,800 by 1990) would cause a sequence of scenic quality changes as a result of land-use changes. Mine-site expansions, residential development, urban growth, and associated service facilities (power lines, sewage facilities, etc.) would create new focal elements, expand the perimeters of developed area, and modify existing urban qualities. The land-use changes due to the proposed coal mines would occur simultaneously with overall regional growth.

As a result of land use changes due to the coal mining and associated urban expansion, 413 acres by 1980; 1,934 acres by 1985; and 2,467 acres by 1990 would be visually altered. Comulative development and associated population growth would alter 8,639 acres by 1980; 26,155 acres by 1985; and 33,431 acres by 1990. Countless additional acres would also be visually influenced by development on adjacent lands.

TABLE R4- 28

RECREATION PARTICIPATION INCREASES IN STATE PLANNING REGION 10

	Region per 100 Residents	1980 Proposed Action (activity days a/)	1980 All Growth (activity days a/)	1985 Proposed Action (activity days a/)	1985 All Growth (activity days a/)	1990 Proposed Action (activity days a/)	1990 All Growth (activity days a/)
Delta, Montrose, Ouray counties:							
Hiking	2,498	9.992	116,157	44,964	514,588	77,438	600,769
Horseback Riding	1,093	4,372	50,824	19,674	225,158	33,883	262,866
Bicycling	5,955	23,820	276,908	1,071,190	1,226,730	184,605	1,432,178
Motorcycling	491	1,964	22,832	8,838	101,146	15,221	118,086
Sightseeing	1,472	5,888	68,448	26,496	303,232	45,632	354,016
Off-Road Vehicles	558	2,232	25,947	10,044	114,948	17,298	134,199
Swimming	714	2,856	33,201	12,852	147,084	22,134	171,717
Picnicking	758	3,032	35,247	13,644	156,148	23,498	182,299
Camping	669	2,676	31,108	12,042	137,814	20,739	160,894
Game Playing	1,405	5,620	65,332	25,290	289,430	43,555	337,902
Tennis	67	268	3,116	1,206	13,802	2,077	16,114
Golf	290	1,160	13,485	5,220	59,740	8,990	69,745
Target Shooting	45	180	2,092	810	9,270	1,395	10,822
Downhill Skiing	268	1,072	12,462	4,824	55,208	8,308	64,452
Cross-Country Skiing	379	1,516	17,624	6,822	78,074	11,749	91,150
Snowmobiling	268	1,072	12,462	4,824	55,208	8,308	64,454
Sledding-Tubing	379	1,516	17,624	6,822	78,074	11,749	91,150
Ice Skating	156	624	7,254	2,808	32,136	4,836	37,518
Other	491	1,964	22,832	8,838	101,146	15,221	118,086
TOTALS		71,824	834,955	323,208	3,698,936	556,636	4,318,417
Garfield and Mesa counties:							
Hiking	2,565	29,498	1,008,045	215,460	1,718,550	343,710	1,759,590
Horseback Riding	235	2,702	92,355	19,740	157,450	31,490	161,210
Bicycling	4,647	53,440	1,826,271	390,348	3,113,490	622,698	3,187,842
Motorcycling	682	7,843	268,026	57,288	456,940	91,388	467,852
Sightseeing	1,078	12,397	423,654	90,552	772,260	144,452	739,508
Off-Road Vehicles	273	3,140	107,289	22,932	182,910	36,582	187,278
Swimming	1,301	14,962	511,293	109,284	871,670	174,334	892,486
Picnicking	692	7,958	271,956	58,128	463,640	92,728	474,712
Camping	347	3,990	136,371	29,148	232,490	46,498	238,042
Boating and Rafting	409	4,704	160,737	34,356	274,030	54,806	280,574

Source: Colorado Division of Parks and Recreation, 1976 Colorado Comprehensive Outdoor Recreation Plan.
a/ All or part of a day.

TABLE R4-28

RECREATION PARTICIPATION INCREASES IN STATE PLANNING REGION 10 (Continued)

	Region per 100 Residents	1980 Proposed Action (activity days a/)	1980 All Growth (activity days a/)	1985 Proposed Action (activity days a/)	1985 All Growth (activity days a/)	1990 Proposed Action (activity days a/)	1990 All Growth (activity days a/)
Garfield and Mesa counties (Continued):							
Game Playing	1,549	17,814	608,757	130,116	1,037,830	207,566	1,062,614
Tennis	233	2,564	87,639	18,732	149,410	29,882	152,978
Golf	409	4,704	160,737	34,356	274,030	54,806	280,574
Target Shooting	25	288	9,825	2,100	16,750	3,350	17,150
Downhill Skiing	285	3,278	112,005	23,940	190,950	38,190	195,510
Snowmobiling	174	2,001	68,382	14,616	116,580	23,316	119,364
Sledding-Tubing	409	4,704	160,737	34,356	274,030	54,806	280,574
Ice Skating	62	713	24,366	5,208	41,540	8,308	42,532
Other	508	5,842	199,644	42,672	340,360	68,072	348,488
TOTALS		182,542	6,238,089	1,333,332	10,634,910	2,126,982	10,888,878
Pitkin County:							
Hiking	8,683	-	329,954	-	681,616	-	955,130
Horseback Riding	1,665	-	63,270	-	130,702	-	183,150
Bicycling	6,304	-	239,552	-	494,864	-	693,440
Motorcycling	476	-	18,088	-	37,366	-	52,360
Sightseeing	506	-	19,228	-	39,721	-	55,660
Off-Road Vehicles	416	-	15,808	-	32,656	-	45,760
Swimming	1,606	-	61,028	-	126,071	-	176,660
Picnicking	416	-	15,808	-	32,656	-	45,760
Camping	416	-	15,808	-	32,656	-	45,760
Boating and Rafting	773	-	29,374	-	60,680	-	85,030
Game Playing	833	-	31,654	-	65,390	-	91,630
Tennis	565	-	21,470	-	44,352	-	62,150
Golf	149	-	5,662	-	11,696	-	16,390
Downhill Skiing	8,743	-	332,234	-	686,326	-	961,730
Cross Country Skiing	1,844	-	70,072	-	144,754	-	202,840
Snowmobiling	506	-	19,228	-	39,721	-	55,660
Sledding-Tubing	753	-	28,614	-	59,110	-	82,830
Ice Skating	1,338	-	50,844	-	105,033	-	147,180
Other	238	-	9,044	-	18,683	-	26,180
TOTALS			1,376,740		2,844,053		3,985,300

The three landscape types described in chapter 2 (river valleys, plateaus, and mountain regions) provide points for discussing the nature of the visual changes which can be anticipated for the ES area. The fact that the coal seams outcrop along the bases of the plateaus means that the proposed mine sites would predominantly be located on the edges of the river valleys. These same valley landscapes must also accommodate the residential and urban growth generated by coal development.

RIVER VALLEYS

The western portion of the Grand Valley would be a primary impact area because of the proximity of proposed mines. The North Fork Valley in Delta and Gunnison counties would also absorb some visual changes, and coal development would add to urban growth projections in the Roaring Fork Valley (Pitkin and Garfield counties).

The planning and environmental controls that are cited in chapter 3 will be implemented by federal, state, and local governments at various stages in the development process. Landscape aesthetics are not specifically regulated by any one law or agency, but they are criteria in the BLM and USFS decision-making process for public lands.

Grand Valley

The southern portion of DeBeque Canyon would be the location for a concentration of new mines (Cameo No. 1 and No. 2, Coal Canyon, and Cottonwood Creek No. 1 and No. 2), rail loadout facilities, existing industrial developments, and other landscape alterations. The presence also of the I-70 travel corridor (5,550 vehicles per day in 1976) in the narrow canyon provides a large viewing public for these developments, which would generate a significant contrast to the natural grandeur of the canyon landscape. Visually, the Cameo area is already modified by the Cameo power plant and Roadside Mine; further mining would enlarge the impacted area and intensify its industrial character.

The open, natural setting of the East Salt Creek Valley would be significantly altered for about 3 miles by construction of the proposed Sheridan Enterprises central facilities and a portal entry. Associated visual changes would continue 20 miles south to the Loma area because of trucks hauling coal. Previous agricultural development was small scale and in harmony with the natural landscape; the proposed mining complex would introduce a new, larger scale which would contrast significantly with existing landscape modifications. Side canyons (e.g., Spink Canyon) would also be visually altered by other portal facilities and refuse piles.

The development of Sheridan's proposed 20-mile railroad, pipeline, and power line corridor across the Grand Valley would add another linear land use of existing roads, power lines, ditches, and fences. Rail activity on the spur corridor would also have visual implications, especially for local residents.

The transportation systems (highways, railroads, and air corridors) of western Grand Valley would all have increased usage due to employee circulation and coal shipments (see Transportation), which would significantly change the visual character of these travel corridors. Increased visual activity, street noise, and air pollution would make the motor vehicle corridors more apparent and visually bothersome for adjacent landowners; increased rail traffic would likewise affect adjacent landowners, and also the motoring public (because of intersection delays).

Conversion of land to urban use to support population increases would further erode the pastoral character of the Grand Valley. For many people, this change would be a visual impact; for others, it would be progress. In general, the visual quality of this growth would depend on local controls as they are articulated in regional master plans and zoning ordinances. Coal-related growth would be a land use that would contribute to the replacement of the pastoral character.

North Fork Valley

The visual quality of the North Fork Valley landscapes would be influenced by future coal development and regional growth. Topographic limitations have constrained existing developments to a narrow corridor adjacent to the North Fork River, which accommodates a sequence of urban, industrial, agricultural, and natural landscape views. Visual alterations due to potential federal action would involve only ARCO's proposed Mt. Gunnison No. 1 Mine (east of Somerset) and the landscape in which it is located. The initial development of 77 acres by 1980 would create a dominant focal element which would establish the industrial character of the landscape. The eventual development of 91 acres by 1985 and 106 acres by 1990 would increase the surface disturbance and maintain the industrial character of the landscape for a limited viewing area.

Landscapes in the North Fork Valley would also be changed by the expansion of other mining operations in the valley. The further alteration of this portion of the North Fork Valley would eliminate more acres of natural landscape. The sequence of Somerset, the proposed Mt. Gunnison No. 1 Mine, the Oliver Power Plant, and the Hawksnest mines would create a 3-mile corridor of urban and industrial landscapes. Increased highway and railroad utilization (244 trains per year) would emphasize the valley's growing industrial/urbanization development.

The ARCO operation would employ 565 persons by 1985 and 1990, which would mean an overall population increase of 3,100 by 1990. The landscape alterations for residences, urban development, etc., for this population growth would be integrated with cumulative population growth in Delta County totalling 2,150 people by 1980; 7,450 people by 1985; and 9,950 people by 1990. Approximately 846 acres would be needed by the 1990 population for houses, schools, etc., and 264 of those acres would be used by the population growth associated with the ARCO operation.

If the combination of land use changes due to the Mt. Gunnison No. 1 Mine, other known mine expansions (see tables R1-1, R1-2, and R1-3), and cumulative population growth concentrates on the limited valley lands of the eastern valley, visual changes to urban and industrial images would be more significant because they would dominate the landscape's scenic quality. If urban development is located in the wider western valley, it would be more dispersed and would be more in character with the existing modifications. The visual impact of the proposed action would be slight to moderate when cumulative area growth and other mine expansions are considered.

Other Valleys

Visual impacts from the proposed actions on other valleys within the ES region would be minimal. The location of the Anschutz North Thompson Creek No. 1 and No. 3 mines near Carbondale in the Roaring Fork Valley would indicate some residential and urban land use changes in Garfield County. Their contribution to cumulative visual changes from other regional developments would be slight.

PLATEAUS

The majority of the proposed mines would be located on the edges of the river valleys and would, therefore, also be on the edges of the plateau topography. Future acreage disturbances for residential development and urban growth would predominantly concentrate in the valley landscapes, but some development would occur on the plateaus. The more montane landscapes would attract primary and second home development for an unknown percentage of the population growth. This disturbance would primarily occur within a one-hour drive of the mine sites and, therefore, would affect Grand Mesa and the Roan Plateau landscapes.

MOUNTAIN LANDSCAPES

Mountain landscapes would accommodate increased recreational use and second-home development also. The upper Roaring Fork Valley is in a mountain region, and it would be further developed to accommodate population increases in Pitkin County. The visual impact of coal development growth in the mountain regions due to the proposed actions cannot be distinguished from the impacts of regional population growth.

REGIONAL VISUAL QUALITY SUMMARY

The existing arrangement of natural and modified landscapes in the ES area would be redistributed by 1990 because of the introduction of new land uses, the expansion of existing urban areas, mineral resource development, and population growth. Most of the surface disturbance would occur in the major river valleys; the balance in these landscapes between agricultural and urban lands would be tipped by the expansion of the urban communities. A population of 252,800 people by 1990 would introduce forms of urban congestion and development pressure, which would rapidly erode the current visual status of the valley landscapes.

Coal development due to the six proposed actions is only one of many factors that would attract and subsidize population growth and land use change. The development of four coal-mine-dominated landscapes (East Salt Creek, DeBeque Canyon, Somerset, and North Thompson Creek) would introduce less visually attractive land uses, establishing new industrial landscape character types. The implementation of reclamation regulations, 30(CFR): 700, 30(CFR): 211, and 43(CFR): 3041, would make these landscape changes temporary, but population impacts would result in permanent urban changes.

Development in the valley landscapes would define a stronger visual contrast between the extensively modified valley lands and the more natural plateau and mountain landscapes. Valley landscape alterations would dominate the foreground views of the majority of travelways in west-central Colorado and, therefore, cause a new regional landscape image to develop. Extensive visual modification would further remove the natural or "country" feel of the landscape, and urban qualities would replace much of the valley open spaces.

Socioeconomic Conditions

This analysis focuses on the projected socioeconomic impacts associated with the proposed actions and total cumulative regional development projected through the study period (1990).

Demography

Because certain assumptions in the Colorado Population and Employment Model used to forecast population growth in the Draft ES cast some doubt on the viability of the results, it was felt that the modeling should be redone. However, the original model was no longer available, and therefore a different model was used for the final draft of the ES. The new model is similar to the previous one in that it too is a cohort-survival model. It is also felt that this model provides more realistic projections than the original model (for a discussion of methodology, see volume 3).

Table R4-29 summarizes the projected population for each county in the ES area for each of the four bench-mark years, and the percentage change in each county population between those years. Table R4-30 shows the population increase due to the federal proposed actions and their percentage of the total projected population increase from 1977. Figure R4-7 is a graphic representation of projected population growth in the ES area for both the base and cumulative projections.

Population growth resulting from the proposed actions has been allocated to only three of the seven counties in the ES area, primarily because Gunnison, Montrose, Ouray, and Pitkin counties lack communities and developable land within a reasonable commuting distance of any of the mine sites; however, other types of mining and economic growth would promote population increases in these counties. The North Fork area of Gunnison County, in which ARCO's Mt. Gunnison No. 1 Mine would be located, is severely limited by topography for any additional population growth. Therefore, all of the population growth associated with that mine was allocated to Delta County. (All population growth resulting from the Anschutz operation in Pitkin County was allocated to Garfield County; however, this growth would occur without the proposed action and is therefore subsumed under cumulative growth.) Neither Montrose nor Ouray county was allocated any population growth resulting from the proposed actions because of the great distance between them and any of the mine sites being assessed in this ES.

The most dramatic increases in population would occur in Delta and Mesa counties. The proposed actions would result in a population increase in Delta County of about 400 people by 1980; 1,800 people by 1985; and 3,100 people by 1990. This would be 18.6 percent of the cumulative population increase in 1980, 24.2 percent in 1985, and 31.2 percent in 1990. The population of Mesa County would grow by 350 persons by 1980; 6,950 persons by 1985; and 10,300 persons by 1990 as a result of the proposed actions. This would be 1.4 percent, 15.0 percent, and 25.6 percent of the projected population increase in 1980, 1985, and 1990, respectively.

Garfield County is expected to grow very rapidly between 1977 and 1980, primarily as a result of the development of nearby oil shale resources. The proposed actions would contribute about 650 persons by 1985 and 1,100 persons by 1990. Cumulative growth in the county would bring county population to 33,000 people in 1980; 39,350 people in 1985; and 46,400 people in 1990. Coal development would amount to only 4.3 percent of the cumulative population increase in 1985 and 4.0 percent in 1990.

The county population projections were not allocated to individual communities. Instead, it was assumed that those communities closest to the mine sites would absorb population growth up to the limits of their facilities to accommodate that growth. Additional population would be forced to reside farther away from the mine sites. Most of the smaller communities in the area, those with populations less than 3,000, are very limited in their ability to house and to provide basic water and sewer service for new population. Many of the small communities would reach those limits in the near future, and further growth would depend upon the expansion of their housing supply and their success in expanding necessary community facilities and services.

In Delta County, the small communities of Paonia, Hotchkiss, Crawford, Cedaredge, and Orchard City would absorb much of the population which is either working in or directly associated with the mining industry. All of these communities combined, however, would have difficulty in accommodating more than 4,000 to 5,000 additional persons. That assumption is based upon their present small size and their limited excess capacities in basic governmental services, as indicated under Community Facilities. It is likely that the city of Delta, because of its larger size and the urban services which it offers, could absorb 7,000 to 8,000 new people. The remainder of the expected growth in the county would have to live wherever housing becomes available.

In Mesa County, the bulk of population growth would occur in the urbanized Grand Junction area. The small communities of Collbran, DeBeque, and Palisade, which could reasonably double in population due to their proximity to major mining operations, would still account for only a small percentage of the total population growth expected in Mesa County.

Garfield County communities, from Grand Valley on the west to Glenwood Springs on the east, would be under extreme pressure to accommodate the expected population growth from oil

TABLE R4-29

CUMULATIVE POPULATION PROJECTIONS

County	1977	1980	Percent Change	1985	Percent Change	1990	Percent Change
Delta	18,950	21,100	11.3	26,400	25.1	28,900	9.5
Garfield	18,800	33,000	75.5	39,350	19.2	46,400	17.9
Gunnison	8,700	9,400	8.0	18,900	101.1	18,100	-4.2
Mesa	66,850	91,950	37.5	113,300	23.2	107,150	-5.4
Montrose	21,400	22,900	7.0	24,150	5.5	25,600	6.0
Ouray	1,900	2,200	15.8	2,100	-4.5	2,400	14.3
Pitkin	13,250	17,050	28.7	21,100	23.8	24,250	14.9
Region	149,850	197,600	31.9	245,300	24.1	252,800	3.1

Note: Each column indicates total projected population for that year.

TABLE R4-30

CUMULATIVE POPULATION INCREASES DUE TO THE PROPOSED FEDERAL ACTIONS

County	1980	Percent of Cumulative Change From 1977	1985	Percent of Cumulative Change From 1977	1990	Percent of Cumulative Change From 1977
Delta	400	18.6	1,800	24.2	3,100	31.2
Garfield	0		650	3.2	1,100	4.0
Gunnison	0		0		0	
Mesa	350	1.4	6,950	15.0	11,000	25.6
Montrose	0		0		0	
Ouray	0		0		0	
Pitkin	0		0		0	
Region	750	1.6	9,400	9.8	15,200	14.8

Note: Each column is cumulative and indicates total additional population for that year above 1977 populations.

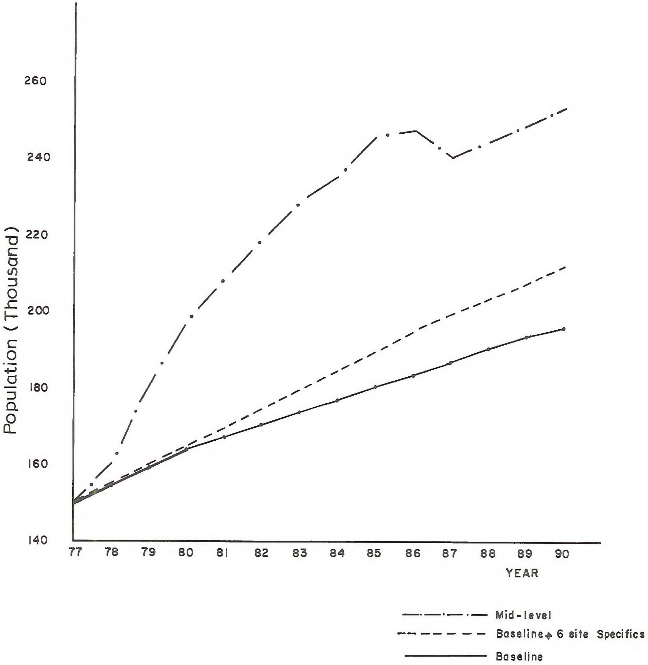


Figure R4-7. Population growth

shale development. New population from coal development, although small when compared with the total expected population growth in Garfield County, would place an increased burden on the ability of these communities to absorb population growth.

The distribution of population growth among communities in the area would be significantly influenced by the actions of local government officials, who would assume the responsibility of the required support facilities. It is important that these officials be provided with current and accurate information concerning industry's plans in the area. It is also important that they cooperate among themselves to address the problems associated with rapid growth and development as early in the process as possible.

Community Attitudes and Lifestyles

Increased coal development is expected to have the most profound effect upon the existing lifestyle in Delta County. The rate of population growth would almost double in that county as a result of the cumulative level of development, averaging over 7 percent per year between 1978 and 1985. The influx of many outsiders to fill jobs in coal mining and other related activities would create a shift away from the agrarian, rural environment which now exists. Land which is now used for agricultural production is expected to be converted to urban use to support the growing population. The increase in population would bring an increase in traffic congestion and resulting air and noise pollution, all of which would detract from what existing residents value as part of their lifestyle.

A more diversified economic base, however, would diminish the dependence on agricultural incomes and bring a new economic prosperity to the county. This increase in purchasing power would also bring about some inflation in prices, which would be a hardship to those on low or fixed incomes, such as the elderly who are a significant part of the county's population.

The new residents in Delta County, by the nature of their occupations, would have a somewhat different lifestyle and value system. Newcomers, for the most part, would be well paid and able to afford more of the amenities associated with a more urbanized lifestyle. They would have the time and the money to support more and varied recreational activities. They are expected to be more transient, however, and less likely to develop the strong community ties which exist among the long-time residents. If these changes occur very rapidly it may serve to polarize the community between newcomers and older residents. This would, in turn, cause a breakdown in the existing political and social structure and have an adverse effect upon efforts to upgrade community infrastructures.

Mesa and Garfield counties would experience much of the same types of lifestyle changes as Delta County, but the changes in these counties would occur regardless of the proposed action. These two counties would be affected by a large influx of a relatively transient population associated with construction activities, over the short term. That type of rapid growth is associated more with disruptive social problems than the growth in Delta County, which would derive from more permanent employment. However, Garfield and Mesa counties, especially the Grand Junction area because of its more urbanized nature, would be more capable of adjusting to the expected population increases. The proposed actions would intensify the rate of population growth, in these two counties, but it would also provide a more permanent growth in employment, to complement the anticipated high level of temporary construction employment.

Noise

The principal cause of higher noise levels would be the increase in vehicular and train traffic. Table R4-24 indicates that the major increase in highway traffic would be in the Delta-Hotchkiss area. The development of uranium deposits in the Four Corners region probably would add to the traffic in the Montrose area. Additional traffic may be expected along I-70 due to the development of oil shale deposits in the Piceance Basin and along the Little Bookcliffs. Increased rail traffic is predicted between Paonia and Grand Junction, Carbondale and Glenwood Springs, and east and west out of Grand Junction. The main noise corridors therefore would be (1) along the Colorado River from Glenwood Springs to the Colorado-Utah state line; (2) along U.S. 50 from Grand Junction to Montrose, and (3) along the North Fork of the Gunnison River from Delta to Somerset.

With the exception of Cameo No. 2 and the Cottonwood Creek mines, noise from construction and surface operations would have no impact on inhabited areas due to the isolated locations of the mine portals and surface facilities. A group of twenty residences northeast of Palisade is located astride a road which is proposed as the access road to the Cottonwood mines. Daytime equivalent noise levels (L_{eq}) through this neighborhood vary from 57 to 48 decibles (dBA), the principal sources of noise being interstate highway and railroad traffic. Since the proposed access road is narrow, tortuous, and steep, it is estimated that daytime values of L_{eq} would vary between 62 and 70 dBA at residences within 200 feet of the access road. This assumes a work force of 400 and traffic spread over a 12-hour period. (Two alternative methods for transporting coal from the Cottonwood Creek mines, both of which would reduce the noise impact on the community are presented in Cottonwood Creek site-specific, chapter 8.)

Because of the current attitude of the community toward the proposed Cottonwood Creek mines, it is probable that the community reaction would be "severe." The interference with speech would be disturbing to a community oriented toward outdoor activities for both occupational and recreational purposes. The sound levels are not high enough to be considered a contributor to hearing loss, but sleep interruption would be a problem if mine traffic continues into normal sleeping hours.

There would also be some noise impact on this community during the construction phase of the Cameo No. 2 Mine. Once the mine is in operation the increase in L_{eq} may vary from 0 to 3 dBA, depending on the location of individual residences. The principal surface noise source from the mining operation is expected to be the ventilating system.

Tables R2-72 and R4-24 list predicted traffic increases at selected locations in the ES area. Based on these data, equivalent vehicular noise levels have been calculated for distances of 50 and 200 feet from the traffic lines (table R4-31, R4-32). The numbers in these tables not contained in parentheses are noise levels predicted without the proposed actions. The numbers in parentheses are the additional increase in L_{eq} as a result of the proposed actions.

With the exception of traffic on the main line, the contribution of coal train traffic would not exceed the L_{eq} produced by vehicular traffic except for areas closer to the railroad than to the highways parallelling them. Assuming a worst case of 100-car train with five locomotives moving at a velocity between 10 and 30 miles per hour the day-night average sound level (L_{dn}) for a train on an average track is 58.5 dBA at a distance of 100 feet from the track. Table R4-33 lists higher levels which are predicted in the case of additional traffic. In using this table, count trains between 10:00 p.m. and 7:00 a.m. as ten events.

Community Facilities

Table R4-34 shows the status of the five basic social-support facilities in the four counties which are expected to experience population growth from the proposed action. This table quantifies information presented in chapter 2 on community, educational, and health care facilities, using population as a common unit of measure. The figures include existing facilities, as well as planned facilities to which some financing has been committed. Plans for the Project 7 water system in Delta, Montrose, and Olathe, and plans for major sewer system expansions in Grand Junction, Glenwood Springs, Delta, and Rifle are included in these figures, which represent the significant excess capacities which are shown for those areas.

The excess capacity figures were totaled by county for each of the five basic service sectors. Obviously, the excess capacities in these community facilities are not evenly matched in each community, so that the total figures represent an absolute maximum which would be available. However, it is realistic to assume that the availability of these services has an effect on the distribution of in-migrating population, suggesting that the larger communities (Grand Junction, Delta, Glenwood Springs, and Montrose) would absorb the most growth because any available capacity in the smaller communities would be rapidly depleted (figure R4-8).

The figures in table R4-34 have been graphed in figure R4-9 along with the cumulative county population projections. The difference between each shaded bar and the population projection lines represents the minimum number of persons for which new facilities would have to be provided.

The impacts of the proposed actions are not, of course, limited to only these five types of government services. Other community facilities and services are estimated to be at a level which provides for the needs of the present and projected population.

Table R4-35 lists a standardized set of requirements and cost figures which were used to compute the estimated need for increased social-support facilities and their estimated cost. The requirement and cost figures were extracted from research publications which were concerned primarily with western Colorado, so they are localized figures. All cost figures have been adjusted for inflation to a 1978 level.

By applying the requirement ratios to the projected population increases, and considering the excess capacity data from table R4-34, a set of physical and financial requirements was derived for each county. Table R4-36 is a breakdown of those requirements for community facilities and services which are commonly provided by county, municipal, or special district units of government. Total capital and operation and maintenance costs associated with the proposed actions represent about one-fifth of both the total projected capital needs and the total projected increase in operating cost.

It is important to note that a large portion of additional capital costs presented in this table are associated with street and road construction. Included in the capital cost figures are costs attributed to raw land purchase. The regional land requirements have been presented in tables R4-22 and R4-23 under Land Use, and the cost of land purchase was set at $4,000 per acre throughout the area. A

TABLE R4-31

THEORETICAL EQUIVALENT NOISE LEVELS (L_{eq})
BASED ON TRAFFIC VOLUMES WITH AND WITHOUT THE
PROPOSED FEDERAL ACTIONS AT SELECTED POINTS IN THE ES AREA
(50 FEET FROM TRAFFIC LANE)

Location			1976 a/ (dBA)	1980 (dBA)	1985 (dBA)	1990 (dBA)
I-70	E/O	Grand Valley	68	70	71	71
I-70	Rifle		67	67 (+1)	70	70
I-70	W/O	Glenwood Springs	68	70	71	71 (+1)
I-70	E/O	Glenwood Springs	68	70	71 (+1)	72
US-50	N/O	Delta	68	70	71	71 (+1)
US-50	S/O	Delta	66	68	70	70
US-50	N/O	Montrose	68	71	72	72
US-50	E/O	Montrose	64	66	69 (+1)	70
US-550	S/O	Montrose	67	68	70	70
US-550	S/O	Ridgway	60	63	64	64
US-550	N/O	Ridgway	63	64	64	64
SH-139	Douglas Pass		65	68	69	69
SH-139	N/O	Mesa-Garfield County Line	60	63	63	63
SH-325	S/O	Jct. with SH-789	65	68	68	69
SH-325	N/O	Jct. with SH-789	56	60	61	61
SH-789	W/O	Jct. with SH-325	63	64	66	67
SH-82	S/O	Glenwood Springs	67	70	71 (+1)	72 (+2)
SH-82	W/O	Jct. with SH-133	64	69	70	71
SH-82	E/O	Jct. with SH-133	63	66	67	67
SH-133	N/O	Carbondale	63	64	66	67
SH-133	S/O	Carbondale	60	64	64	64
SH-133	E/O	McClure Pass	60	60	60	60 (+1)
SH-133	W/O	McClure Pass	60	63	64 (+1)	65 (+1)
SH-133	E/O	Somerset	60	61	62 (+1)	62 (+1)
SH-133	W/O	Somerset	61	62	62 (+1)	63 (+1)
SH-133	E/O	Jct. with SH-187	61	64	64 (+1)	65 (+1)
SH-133	W/O	Jct. with SH-187	63	64	65 (+1)	65 (+1)
SH-133	E/O	Hotchkiss	63	63	63 (+1)	64
SH-62	E/O	Ridgway	60	60	62	63
SH-62	W/O	Ridgway	60	60	60	60
SH-92	E/O	Delta	67	67	68 (+2)	68 (+2)
SH-92	W/O	Jct. with SH-65	66	67	67 (+2)	67 (+3)
SH-92	E/O	Jct. with SH-65	63	63	64	64 (+2)
SH-92	W/O	Hotchkiss	63	64	64	64 (+2)
SH-65	N/O	Jct. with SH-92	63	64	64 (+2)	64 (+3)

Note: SH = State Highway; N/O = North of; S/O - South of; E/O = East of; W/O = West of. Numbers in parentheses indicate additional increase in equivalent noise levels due to the proposed actions.

a/ Source of 1976 data is the Colorado Department of Highways.

TABLE R4-32

THEORETICAL EQUIVALENT NOISE LEVELS (L_{eq})
BASED ON TRAFFIC VOLUMES WITH AND WITHOUT THE
PROPOSED FEDERAL ACTIONS AT SELECTED POINTS IN THE ES AREA
(200 FEET FROM FRAFFIC LANE)

Location		1976 a/ (dBA)	1980 (dBA)	1985 (dBA)	1990 (dBA)
I-70	E/O Grand Valley	68	70	71	71
I-70	Rifle	67	67 (+1)	70	70
I-70	W/O Glenwood Springs	68	70	71	71 (+1)
I-70	E/O Glenwood Springs	68	70	71 (+1)	72
US-50	N/O Delta	68	70	71	71 (+1)
US-50	S/O Delta	66	68	70	70
US-50	N/O Montrose	68	71	72	72
US-50	E/O Montrose	64	66	69 (+1)	70
US-550	S/O Montrose	67	68	70	70
US-550	S/O Ridgway	60	63	64	64
US-550	N/O Ridgway	63	64	64	64
SH-139	Douglas Pass	65	68	69	69
SH-139	N/O Mesa-Garfield County Line	60	63	63	63
SH-325	S/O Jct. with SH-789	65	68	68	69
SH-325	N/O Jct. with SH-789	56	60	61	61
SH-789	W/O Jct. with SH-325	63	64	66	67
SH-82	S/O Glenwood Springs	67	70	71 (+1)	72 (+2)
SH-82	W/O Jct. with SH-133	64	69	70	71
SH-82	E/O Jct. with SH-133	63	66	67	67
SH-133	N/O Carbondale	63	64	66	67
SH-133	S/O Carbondale	60	64	64	64
SH-133	E/O McClure Pass	60	60	60	60 (+1)
SH-133	W/O McClure Pass	60	63	64 (+1)	65 (+1)
SH-133	E/O Somerset	60	61	62 (+1)	62 (+1)
SH-133	W/O Somerset	61	62	62 (+1)	63 (+1)
SH-133	E/O Jct. with SH-187	61	64	64 (+1)	65 (+1)
SH-133	W/O Jct. with SH-187	63	64	65 (+1)	65 (+1)
SH-133	E/O Hotchkiss	63	63	63 (+1)	64
SH-62	E/O Ridgway	60	60	62	63
SH-62	W/O Ridgway	60	60	60	60
SH-92	E/O Delta	67	67	68 (+2)	68 (+2)
SH-92	W/O Jct. with SH-65	66	67	67 (+2)	67 (+3)
SH-92	E/O Jct. with SH-65	63	63	64	64 (+2)
SH-92	W/O Hotchkiss	63	64	64	64 (+2)
SH-65	N/O Jct. with SH-92	63	64	64 (+2)	64 (+3)

Note: SH = State Highway; N/O = North of; S/O - South of; E/O = East of; W/O = West of. Numbers in parentheses indicate additional increase in equivalent noise levels due to the proposed actions.

a/ Source of 1976 data is the Colorado Department of Highways.

TABLE R4-33

(L_{dn}) VALUES FOR A TYPICAL UNIT TRAIN OVER STANDARD TRACK

No. of Events	L_{dn}
1	55.5
2	58.5
3	60.3
4	61.5
5	62.5
6	63.3
7	64.0
8	64.5
9	65.0
10	65.5
11	65.9
12	66.3
13	66.6
14	67.0
15	67.3
16	67.5
17	67.8
18	68.1
19	68.3
20	68.5
21	68.7
22	68.9
23	69.1
24	69.3
25	69.5
26	69.6
27	69.8
28	70.0

Source: U.S. Environmental Protection Agency, 1975, Background Document for Railroad Noise Emission Standards. EPA-550/9-76-005.

Assumptions:

1. 100-car train (length 6,200 feet) with 5 locomotives.
2. Velocity = 30 mph (add 1.8 dB for 20 mph, add 4.8 dB for 10 mph).
3. Noise levels measured 100 feet from track.
4. Count each night train as 10 events.

TABLE R4-34

EXCESS CAPACITY IN BASIC GOVERNMENT SERVICES

Counties and Communities	Treated Water a/	Sewage Treatment a/	Police Protection b/	Schools c/	Health Care d/
Delta County				0	0
Paonia	1,600	0	1,000		
Crawford	0	0	0		
Hotchkiss	3,000	0	500		
Cedaredge	1,000	1,800	500		
Orchard City	-	0	0		
Delta	8,000-10,000	8,000	2,000		
Total County	13,600	9,800	4,000	0	0
Garfield County				3,130	9,600
Carbondale	6,000	3,000	0		
Glenwood Springs	2,000	8,000	2,000		
Grand Valley	0	0	0		
New Castle	400	400	400		
Rifle	2,500	7,500	0		
Silt	700	700	0		
Total County	11,600	19,600	2,400	3,130	9,600
Mesa County				11,000	23,700
Ute Water District	35,000	0	0		
Collbran	500	0	0		
DeBeque	700	700	0		
Fruita	1,500	4,000	0		
Grand Junction	12,500	80,000	0		
Palisade	1,500	1,400	0		
Total County	51,700	87,100	0	11,000	23,700
Montrose County				2,200	3,700
Montrose	11,000-15,000	20,000	0		
Naturita	2,500	0	0		
Nucla	0	500	0		
Olathe	2,500	4,000	0		
Total County	16,000	24,500	0	2,200	3,700

a/ Capacity information for water and sewer systems is included in chapter 2, Community Facilities.

b/ General standards of two police officers per 1,000 population and one patrol car per 1,000 population were used to determine capacity (Source: Oil Shale Project 1976).

c/ Calculated from information contained in Education, chapter 2.

d/ Calculated using a standard of 2.5 hospital beds for 1,000 population in rural areas, and 4.0 hospital beds per 1,000 persons in Mesa County (Source: Oil Shale Project 1976; Briscoe, Maphis, Murray, and Lamont, Inc., 1977).

Figure R4-8.

Small towns such as DeBeque would grow faster than the ability to provide public services.

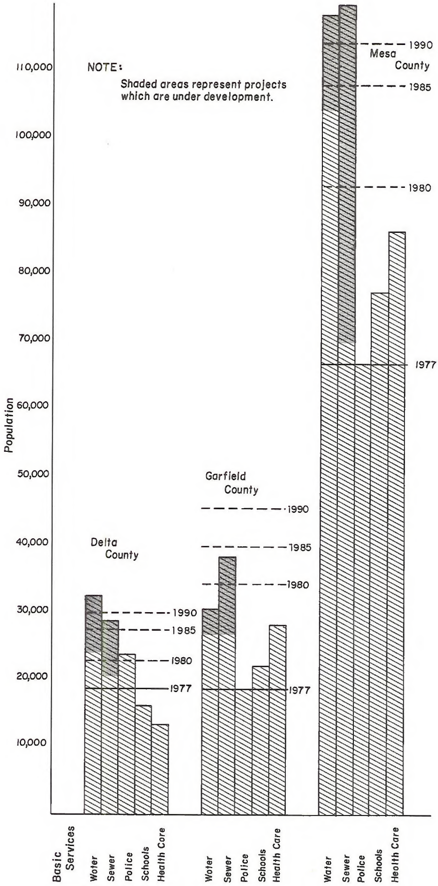


Figure R4-9. Projected population vs. the capacity to provide basic government services

TABLE R4-35

STANDARDS FOR COMMUNITY FACILITY NEEDS

Facility	Standard (per 1,000 persons)	Land Requirement
Water supply and treatment	200,000 gallons per day b/ ($174,910 capital cost) c/ ($12,520 per year operating cost) c/	1 acre a/
Sewage treatment	60,000 gallons per day a/ ($198,000 capital cost) c/ ($9,660 per year operating cost) c/	1 acre a/
Police protection	2 police officers b/ ($40,000 per year) e/ 0.67 police vehicle d/ ($8,000 per vehicle) d/ 400 sq. ft. of building space d/ (@ $67 per sq. ft.) d/	0.06 acre a/
Fire protection	1 firefighter a/ ($18,000 per year) e/ 0.33 fire vehicle a/ (@ $75,000 per vehicle) d/ 1,000 sq. ft. of building space d/ (@ $40 per sq. ft.) c/	0.07 acre a/
Streets and roads	$232,000 per mile f/ $7,000 per mile per year f/	30 percent of total land requirement a/
General government	1.8 employees a/ (@ $18,000 per employee per year) e/ 250 square feet of building space d/ (@ $56 per sq. ft. plus 15 percent of cost for equipment and furnishings) d/	0.034 acre d/
Libraries	3,000 volumes d/ (@ $3 per volume) d/ 550 sq. ft. of space d/ (@ $50 per sq. ft. plus 15 percent for equipment and furnishings) c/ ($8,300. per year operations and ,aomtemamce) c/	0.14 acre c/
Education	140 sq. ft. per student c/ (@ $45 per sq. ft. includes equipment and architectural fees.) $1,230 per student per year operating and maintenance costs c/	6 acres a/
Health Care	2.5 hospital beds (rural) c/ 4.0 hospital beds (urban) a/ (@ $55,000 per bed) d/ 1.8 doctors a/ 0.20 emergency vehicle d/ (@ $15,000 per vehicle) d/	0.25 acre a/

Sources:

a/ Environmental Protection Agency, Action Handbook for Small Communites Facing Rapid Growth (June 1977).

b/ Average of cities and towns in region. Personal telephone contact.

c/ C-b Oil Shale Project, "Socioeconomic Assessment, Oil Shale Tract C-b" (March 1976).

d/ Bickert, Browne, Coddinton, and Assoc., "Boomtown Financing Study," Vol. II (July 1976).

e/ Professional judgment. Costs include overhead.

f/ Oblinger and Smith, Garfield County.

TABLE R4-36

ADDITIONAL REQUIREMENTS FOR COMMUNITY FACILITIES BY 1990
(1978 DOLLARS)

Facility	Delta County: Physical Plant Requirements	Capital Costs (dollars)	Operating and Maintenance Costs (dollars/year): 1980	1985	1990
Police protection:					
Cumulative scenario	4 vehicles and 2,380 sq.ft. of space	191,500	-	138,000	238,000
Proposed action only	2 vehicles and 1,240 sq.ft. of space	99,100	-	72,000	124,000
Fire protection:					
Cumulative scenario	3 vehicles and 9,950 sq.ft. of space	623,000	Volunteer	Volunteer	Volunteer
Proposed action only	1 vehicle and 3,100 sq.ft. of space	199,000	Volunteer	Volunteer	Volunteer
Streets and roads:					
Cumulative scenario	235 acres	7,572,000	49,200	170,300	228,000
Proposed action only	73 acres	2,352,000	9,100	41,200	70,800
General government:					
Cumulative scenario	2,490 sq.ft. of space	160,400	69,700	241,400	322,700
Proposed action only	775 sq.ft. of space	50,000	13,000	58,300	100,400
Libraries:					
Cumulative scenario	29,850 volumes and 5,470 sq.ft. of space	404,100	17,800	61,800	82,600
Proposed action only	9,300 volumes and 1,710 sq.ft. of space	126,200	3,300	14,900	25,700
TOTAL COSTS:					
Cumulative scenario		8,951,000	136,700	611,500	871,300
Proposed action only		2,827,300	25,400	186,400	320,900

TABLE R4-36 continued

ADDITIONAL REQUIREMENTS FOR COMMUNITY FACILITIES BY 1990
(1978 DOLLARS)

	Garfield County				
			Operating and Maintenance Costs (dollars/year)		
Facility	Physical Plant Requirements	Capital Costs (dollars)	1980	1985	1990
Water treatment:					
Cumulative scenario	Carbondale and Rifle water projects and 7.2 mgd	6,306,000	57,100	196,500	452,400
Proposed action only	0.22 mgd	192,400	0	8,140	13,700
Sewage treatment:					
Cumulative scenario	Rifle, Glenwood Springs, and Carbondale sewer projects 1.3 mgd	4,158,000	0	16,100	202,900
Proposed action only	0.06 mgd	217,800	0	6,280	10,630
Police protection:					
Cumulative scenario	20 vehicles and 11,920 sq.ft. of space	958,600	472,000	726,000	1,192,000
Proposed action only	1 vehicle and 440 sq.ft. of space	29,480	0	26,000	44,000
Fire protection:					
Cumulative scenario	11 vehicles and 32,200 sq.ft. of space	2,113,000	Volunteer	Volunteer	Volunteer
Proposed action only	1,100 sq.ft. of space	44,000	Volunteer	Volunteer	Volunteer
Streets and roads:					
Cumulative scenario	759 acres	24,455,000	325,000	469,500	765,300
Proposed action only	26 acres	837,720	0	14,550	25,220
General government:					
Cumulative scenario	8,050 sq.ft. of space	518,400	460,100	666,100	1,043,300
Proposed action only	280 sq.ft. of space	18,000	0	20,740	36,290
Libraries:					
Cumulative scenario	96,600 volumes and 17,710 sq.ft. of space	1,308,100	117,900	170,600	267,300
Proposed action only	3,300 volumes and 610 sq.ft. of space	44,980	0	5,400	9,130
TOTAL COSTS:					
Cumulative scenario		39,817,100	1,432,100	2,249,800	3,923,200
Proposed action only		1,384,380	0	81,110	139,040

TABLE R4-36 continued

ADDITIONAL REQUIREMENTS FOR COMMUNITY FACILITIES BY 1990
(1978 DOLLARS)

	Mesa County				
			Operating and Maintenance Costs (dollars/year)		
Facility	Physical Plant Requirements	Capital Costs (dollars)	1980	1985	1990
Police protection:					
Cumulative scenario	27 vehicles and 16,120 sq.ft. of space	1,296,000	1,004,000	1,858,000	1,612,000
Proposed action only	7 vehicles and 4,120 sq.ft. of space	332,000	14,000	278,000	412,000
Fire protection:					
Cumulative scenario	13 vehicles and 40,300 sq.ft. of space	2,587,000	457,800	836,100	725,400
Proposed action only	3 vehicles and 10,300 sq.ft. of space	637,000	6,300	125,100	185,400
Streets and roads:					
Cumulative scenario	950 acres	30,609,000	573,300	1,062,200	921,500
Proposed action only	243 acres	7,829,000	7,800	159,100	235,700
General government:					
Cumulative scenario	10,075 sq.ft. of space	648,800	813,200	1,505,000	1,305,700
Proposed action only	2,575 sq.ft. of space	165,800	11,400	225,200	333,700
Libraries:					
Cumulative scenario	120,900 volumes and 22,165 sq.ft. of space	1,637,200	208,300	385,500	334,500
Proposed action only	30,900 volumes and 5,665 sq.ft. of space	418,400	2,900	57,700	85,500
TOTAL COSTS:					
Cumulative scenario		36,778,000	3,050,600	5,646,800	4,899,100
Proposed action only		9,382,200	42,400	845,100	1,252,300

TABLE R4- 36 continued

ADDITIONAL REQUIREMENTS FOR COMMUNITY FACILITIES BY 1990
(1978 DOLLARS)

Total Capital Cost Associated with Cumulative Development	85,546,100
Total Capital Cost Associated with Proposed Action	13,593,880

	1980	1985	1990
Total Operating Cost Associated with Cumulative Development	4,619,400	8,508,100	9,693,600
Total Operating Cost Associated with Proposed Action	67,800	1,112,610	1,712,240

portion of these street and road construction costs would be borne by private developers and another portion by the state and federal governments. The majority of yearly costs associated with road and street maintenance, however, is the responsibility of local governments.

It should also be understood that much of the additional capital cost requirement is expected of local governments which already have incurred large amounts of debt for recent improvement projects. Outstanding debt and costs associated with projects which are now under way are discussed by local jurisdiction in chapter 2.

Housing

In calculating the requirements for housing to support population growth due to the proposed actions, it was assumed that over the long term the demand for single-family housing in the area would remain high. Since most new employment created by the proposed actions would be permanent, it is expected that most of these new residents would be inclined to establish permanent residences.

A ratio of 65 percent single-family units, 25 percent mobile home units, and 10 percent multi-family units was used to estimate the housing requirements due to the proposed actions. The rapid growth expected from oil shale development in Garfield and Mesa counties may require a higher concentration of mobile homes and/or modular units (figures R4-10 and R4-11). For this reason a ratio of 50 percent single-family units, 40 percent mobile homes, and 10 percent multi-family units was used in calculating the housing requirements for Garfield and Mesa counties in 1980.

A factor of 3.0 persons per household was also used in the calculations. This factor is based upon the permanent nature of employment opportunities associated with the proposed actions, and it is consistent with household size ratios used to evaluate other large-scale developments in the same area.

Table R4-37 is a projection of housing requirements based on the projected population growth. Cumulative figures are the total housing units that would be necessary to accomodate population growth above the present level. The increase in housing that would be necessary for population growth due to the proposed actions is also given.

In Delta County, the proposed actions would account for 18.5 percent of the total increase in housing stock in 1980, 40.5 percent in 1985, and 31.1 percent in 1990. In Mesa County, increases in the housing stock due to the proposed actions would be 1.4 percent in 1980, 15 percent in 1985, and 25.6 percent in 1990 of the cumulative increase. In Garfield this would be 3.2 percent in 1985 and 3.1 percent in 1990.

Location of new housing within each county would be a factor of available urban services, available developable land, and local land-use regulations. For the most part, these factors indicate that the existing urban centers (Grand Junction, Delta, Glenwood Springs, and Rifle) are the most likely places for most of the new housing to be built. The land requirements associated with new housing were included in table R4-22 and R4-23.

The capability of the area to meet the demand for these projected housing needs would be a critical factor in minimizing the adverse impacts of rapid growth. Often the primary obstacle to providing housing in a "boom" situation is the difficulty in obtaining construction financing. This problem has already hindered efforts in Garfield County to construct housing in anticipation of the oil shale-related growth. The basis of the problem is the unavailability of local capital to finance housing and the reluctance of larger financial institutions to risk the uncertainties connected with developing energy resources.

Another measure of the area's ability to provide housing, is the number of housing starts in the past. Table R2-58 in chapter 2 lists housing starts by county between 1970 and 1975. Company housing starts data with the housing requirements show that the maximum number of housing starts during this period would be sufficient to keep pace with growth in Montrose, Ouray, and Pitkin counties during the study period and would provide for growth related to the proposed actions in Delta, Garfield, and Mesa counties. Housing starts in Delta County would have to double to provide housing for cumulative growth through 1990. In Garfield County, housing starts would need to triple to meet 1980 needs and remain at double the 1970-75 maximum through 1990. In Mesa County, starts would have to increase to 130 percent above the maximum to meet needs through 1985. Housing starts in Gunnison County would need to be tripled during the period 1980 to 1985. These increases in housing construction would generate additional population and income to the area. There would also be increased pressure placed upon the established land-use regulation system and local governments' ability to enforce housing and building codes.

Education

The expected increase in school-aged population which would result from the proposed actions is shown in table R4-38. The table lists the increases in school-aged children associated with both the cumulative population projection and the proposed actions. These figures were generated by the socio-economic impact model and represent total school-aged population. The figures are presented by

Figure R4-10.

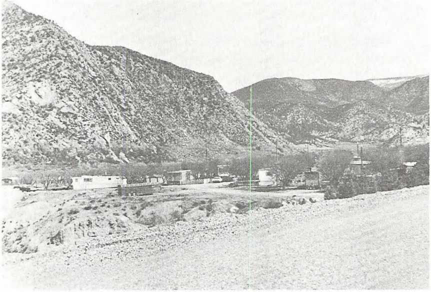


Figure R4-11.

Mobile homes would provide a substantial portion of new housing.

TABLE R4-37
NEW HOUSING REQUIREMENTS

		Single Family	Mobile Homes	Multi-Family	Total Units
Delta County:					
Total:	1980	466	179	72	717
	1985	1,614	621	248	1,483
	1990	2,156	829	332	3,317
Due to the proposed action:					
	1980	87	33	13	133
	1985	390	150	60	600
	1990	672	258	103	1,033
Garfield County:					
Total:	1980	2,367	1,893	473	4,733
	1985	4,453	1,712	685	6,850
	1990	6,977	2,683	1,073	10,733
Due to the proposed action:					
	1980	0	0	0	0
	1985	141	54	22	217
	1990	219	84	34	337
Mesa County:					
Total:	1980	4,184	3,347	836	8,367
	1985	10,064	3,871	1,548	15,483
	1990	8,732	3,358	1,343	13,433
Due to the proposed action:					
	1980	58	47	12	117
	1985	1,506	579	232	2,317
	1990	2,232	858	343	3,433

TABLE R4-38

SCHOOL-AGED POPULATION PROJECTIONS

	1977	1980	1985	1990
Delta County:				
Proposed Action	0	100	430	740
Cumulative	4,150	5,060	6,330	6,940
Garfield County:				
Proposed Action	0			
Cumulative	4,300	7,920	9,440	11,140
Mesa County:				
Proposed Action	0	81	1,675	2,651
Cumulative	14,500	22,070	27,200	25,720

county, rather than by school district; since most school districts in the ES area conform to county jurisdictional boundaries, they can be aggregated to a county level.

From these figures, the increased requirement for school facilities for the proposed actions and the three affected counties can be estimated, using the standards for school requirements contained in table R4-35. The present excess capacities of school facilities, as outlined in table R4-34, were included as part of these calculations. The figures are contained in table R4-39.

As is the case with community facilities, the school facility requirements in Garfield and Mesa counties are expected to be high even without the proposed actions. In Garfield County, the projected total school facility requirements for 1990 represent about 136 percent of the three school districts' combined present legal limit for bonding capacity (set by state law at 20 percent of assessed valuation) and 105 percent of the projected increased bonding capacity. Most of the available school bonding capacity in the county is presently absorbed in outstanding debt so that any future school bond issues can be supported only through an increase in district assessed valuations. The $1.7 million requirement for school facilities which is directly associated with the proposed actions represents about 10 percent of the present county-wide school bonding capacity and 8 percent of the projected increased capacity.

In Mesa County, the cumulative school facility requirements for 1990 represent about 4 percent of the present legal bonding capacity of all districts and 3 percent of the projected bonding capacity. The districts in Mesa County are now carrying 30 percent or less of their bonding capacity in outstanding debt, which puts them at an advantage over school districts in Garfield County. The $16.7 million school facilities requirement in Mesa County associated with the proposed actions represents about 50 percent of the present county-wide school bonding capacity.

In Delta County, the school facility needs have been documented by a recent detailed capital facilities study, done for the school district by the University of Northern Colorado. The study identifies the need for a school facilities improvement program with a total cost of about $29 million. Much of the need for these new facilities is due to existing inadequacies, but the estimate is also based on accommodating population growth through 1987. The $17.6 million cost figure represents 180 percent of the available bonding capacity of the district, which presently has no outstanding debt and 96 percent of the projected bonding capacity. The Delta County School District 50(J) capital requirements due to the proposed actions alone represent about 47 percent of the district's present bonding capacity and 25 percent of the projected capacity.

Table R4-40 lists the expected increases in school district assessed valuation and the increases in school district bonding capacities due to the proposed actions. The school district assessed valuation figures include increases in residential, commercial, and industrial tax bases due to population growth, and increases due to the mining installations themselves. This table, when compared with table R4-39, shows that the school districts in all three counties would be able to recover the capital costs associated directly with the proposed actions through increased bonding capacity. However, in Delta County, much of the total school capital requirement is needed to provide for present population, so that a deficit would still exist between total capital requirements and total district bonding capacity. In Mesa County, much of the total school capital requirement is directly related to projected growth due to oil shale development, but the county would not experience any increase in tax base due to oil shale installations.

Health Care

As discussed in chapter 2, the present capacities of health care facilities vary widely from county to county. The delivery of health care services, however, is not easily broken down county by county. St. Mary's Hospital in Grand Junction, for instance, provides services which can only be offered by a major hospital, to a wide area of western Colorado. The same is true, although to a lesser degree, of hospitals in Montrose and Glenwood Springs.

By 1980 all health care facilities within the four-county area would be operating near maximum capacity. Table R4-41 is an estimate of health care requirements and associated costs to accommodate the expected increases in population both with and without the proposed actions. The factors used in arriving at these figures are contained in table R4-35.

Again the cost requirements presented in table R4-41 assume that each county would provide health care facilities which are sufficient to meet its own needs. It is more likely that facilities in Mesa County would be expanded to a greater degree than the figures indicate in order to maintain the ability to serve the region's health care needs. Facility needs in the other counties would also be influenced by the demands of their entire service area, which in most cases exceeds the county jurisdictional boundaries.

It is likely that, in addition to expanding existing hospitals, more localized clinics may need to be established closer to the mine sites to provide for emergency services. The North Fork area in Delta

TABLE R4-39

INCREASED SCHOOL DISTRICT FACILITY REQUIREMENTS

	Facility Requirements (Square Feet)	Facility Costs ($ Million)	Operation and Maintenance ($ Million/Year)
Delta County - 50(J)			
1980			
Cumulative	127,400	5.7	1.1
Proposed Action	14,000	0.6	0.2
1985			
Cumulative	305,200	13.7	2.7
Proposed Action	60,200	2.7	0.5
1990			
Cumulative	390,600	17.6	3.4
Proposed Action	103,600	4.6	0.9
Garfield County - RE-1(J), RE-2, 16			
1980			
Cumulative	72,800	3.3	0.6
Proposed Action	0	0	0
1985			
Cumulative	281,400	12.7	2.5
Proposed Action	21,700	1.0	0.2
1990			
Cumulative	519,400	23.4	4.6
Proposed Action	36,820	1.7	0.3
Mesa County - 49(JT), 50, 51			
1980			
Cumulative	0	0	0
Proposed Action	11,340	0.5	0.1
1985			
Cumulative	238,000	10.7	2.1
Proposed Action	234,500	10.6	2.1
1990			
Cumulative	30,800	1.4	0.3
Proposed Action	371,140	16.7	3.3

TABLE R4- 40

INCREASES IN SCHOOL DISTRICT ASSESSED VALUATIONS
AS A RESULT OF THE PROPOSED ACTION (1978-1990)

School District	Increased Assessed Valuation (Dollars)	Increased School Bonding Capacity (Dollars)
Delta County 50(J)	43.5 million	8.7 million
Garfield County RE-1(J) RE-2 16	21.4 million	4.3 million
Mesa County 49(JT) 50 51	109.0 million	21.8 million

TABLE R4-41

PROJECTED HEALTH CARE REQUIREMENTS (1990)

	Health Care Facility Requirements	Costs
Delta County:		
Cumulative	25 hospital beds and 2 emergeny vehicles	$ 1,405,000
Proposed action	8 hospital beds and 1 emergency vehicle	455,000
Difference	17 hospital beds and 1 emergency vehicle	$ 950,000
Garfield County:		
Cumulative	53 hospital beds and 4 emergency vehicles	$ 2,978,600
Proposed action	3 hospital beds	165,000
Difference	50 hospital beds and 4 emergency vehicles	$ 2,813,600
Mesa County:		
Cumulative	66 hospital beds and 3 emergency vehicles	$ 3,675,000
Proposed action	41 hospital beds and 2 emergency vehicles	2,285,000
Difference	25 hospital beds and 1 emergency vehicle	$ 1,390,000
Total facility cost due to proposed action		$ 3,140,000

County and the Palisade area in Mesa County are logical sites for this type of service.

An increase in physicians would also be required in the area, especially in Delta County. Although that is not normally considered a public expense, other areas of the west which have undergone population boom conditions have had to use public resources to attract an adequate number of physicians.

Revenue

Part of the funds that would be required by the counties and school districts could be supplied by revenues from the mines through existing laws. Section 35 of the mineral leasing act provides for 50 percent of the money collected as bonuses, rentals, or royalties from federal mineral leases to be returned to the state. This has been allocated among various uses by the state legislature.

The present law calls for 25 percent of the amount the state receives to be paid into the public school fund and used to support the schools of the state. Fifty percent of the funds are to go to the county in which they originate. This is limited to a maximum of $200,000 to any county in a year. Any money remaining of the 50 percent goes into the public school fund. Money the counties receive is to be used for planning, construction, and maintenance of public facilities and for the provision of public services. Ten percent of the funds are paid to the Colorado water conservation board construction fund. The remaining 15 percent is paid into a special local government mineral impact fund. The executive director of the Department of Local Affairs is responsible for distributing this money among state agencies, public schools, and political subdivisions.

To estimate amounts that would be received by the state, it was assumed that the average mine-mouth price of coal would be $20 per ton. Average royalty was assumed to be 8 percent of the mine-mouth price of coal. At these rates royalty payments of $1.60 per ton would be paid to the federal government. Table R4-42 shows the estimated amount that the state would receive from the royalties paid due to the proposed actions. In addition to these amounts, the state would also receive its share of any bonuses paid to secure leases.

Of the amount received by the state, 50 percent is scheduled to be paid to the county of origin. As noted earlier, the state limits payment to a county to $200,000 in a year. With increased production of coal and other minerals, all of the counties in the region but Montrose and Ouray would receive that amount. Because of this limit, the ability of Section 35 of the Mineral Leasing Act to help counties pay for facilities and services required by the large increases in population is severely limited.

A new law in Colorado designed to help lessen the impacts of mineral development is the State Severance Tax, which took effect January 1, 1978. This law establishes a tax of $0.30 per ton for underground mined coal and $0.60 per ton for strip mined coal. The first 8,000 tons per quarter from a mine are exempt from taxation. Monies from this tax are to be distributed in the following manner:

1. For fiscal years ending on or before June 30, 1979:
   40 percent to the State General Fund
   15 percent to the State Severance Tax Trust Fund
   45 percent to the Local Government Severance Tax Fund
2. Fiscal year ending June 30, 1980:
   30 percent to the State General Fund
   25 percent to the State Severance Tax Trust Fund
   45 percent to Local Government Severance Tax Fund
3. Fiscal years ending after June 30, 1980:
   20 percent to the State General Fund
   35 percent to State Severance Tax Trust Fund
   45 percent to Local Government Severance Tax Fund
4. After June 30, 1981, all money collected under the severance tax will go to the State Severance Tax Trust Fund.

The State Severance Tax Trust Fund as established by this law is to be a perpetual trust held as a replacement for depleted natural resources. The income from investment of the trust fund will go to the state's general fund.

The local government severance tax fund has been established in the state Department of Local Affairs. The executive director of the department distributes the money from the fund to be used for the planning, construction, and maintenance of public facilities and for the provision of public services. Eight-five percent of the fund is to be distributed to those political subdivisions socially or economically impacted by the development. Fifteen percent is to be distributed to counties or municipalities on the basis of the proportion of a mine's employees who live in each. This money can only be used for capital and general operating expenses. Table R4-43 shows the amounts that would be received by the state from the severance tax for selected years as a result of the proposed actions and the way these funds would be distributed.

Counties would also receive increased revenues from property taxes on the mines. These taxes are levied against improvements and against coal mined. In Colorado, assessed value is set by law at 30 percent of market value. To estimate possible future property taxes received by counties in the region, information from Colorado Westmoreland, Inc., was used. This information showed that a mine and facilities designed to produce 1.25 million tons per year would cost $45 million, or an investment of $36 per ton. Although individual mines vary greatly in investment, Colorado Westmoreland was the only firm for which this type of information was available.

The tax on production is calculated using a formula which takes 5 percent of the price of coal and finds the present value of this income stream for 30 years at 11.5 percent and then multiplies by the production to get the value of the coal. Thirty percent of this value is then taken as the assessed value and the mill levy applied.

Property tax mill levies vary considerably among counties in the region. Table R4-44 shows 1976 mill levies for the seven counties. Municipal levies were excluded because the coal mines are located outside of municipalities.

Table R4-45 shows the amount of coal expected to be produced from new mines and increased production on existing mines, due to the proposed actions, and the projected property taxes from coal mined and improvements for each county in 1980, 1985, and 1990. This table shows that by 1990 counties in the area could be receiving over $9 million a year from coal mines above what they are now receiving in property taxes. Of the seven counties in the region Delta, Garfield, Gunnison, and Mesa would receive the greater portion of the increased property tax revenues.

In addition, as new people move into the area and establish residency, county tax receipts would grow from the increased value of new houses and businesses. Sales taxes from new and higher incomes in the area would also provide revenue to local governments. Estimates of the magnitude these may reach from the proposed action are shown in table R4-46, and in table R4-47 for the cummulative projection.

In addition to increased property and sales tax, local governments would also receive revenue from water and sewer tap fees and service fees. Tap fees would be a one-time payment to the local government unit where the house is being built. Table R4-48 shows the amounts the counties would receive by 1990. Service fees would be received by the counties as long as the houses are inhabited. Table R4-49 shows the amounts the counties would receive in 1980, 1985, and 1990. Tap fees are generally assumed to be used for capital expenditure and service fees used for operating expenses.

The preceding analysis shows that coal mining generates large amounts of income for local governments that can be used to solve economic and social problems created by the rapid growth. However, because of the time lag between start of a project and receipt of revenues by the county, funds are often not available when the employees move into an area causing the impacts. To help solve this problem many state and federal programs have been developed.

Tabulated information on state or federal financial and technical assistance programs that are available to energy-impacted communities is available as back-up material at the Montrose District Office of the Bureau of Land Management. The *Catalog of Federal Domestic Assistance* may also give information about other helpful federal programs.

Employment

Coal development in west-central Colorado would have significant impacts on employment in the region. Mining, which has been relatively unimportant, would increase in importance as this sector grows. The secondary impact of an increase in employment in a basic industry such as mining is the increase in employment in other sectors to serve the mine and mine employees. Total employment associated with the proposed actions would be 517 people in 1980; 5,056 people in 1985; and 8,434 people in 1990. This is out of a total cumulative projected employment increases of 27,440 people in 1980; 50,500 people in 1985; and 55,440 people in 1990. Increases in employment opportunities in mining and other sectors would help to solve the unemployment in the Delta County area.

Income

As noted in chapter 2, personal incomes in the region have tended to remain below state and national averages. Coal miners would have incomes above the regional average. Because of the higher wages offered by the mining industry, employees from other sectors would be attracted to it. In order to attract the necessary employees, other sectors would be forced to raise wage rates. The overall effect would be an increase in the income level of area residents. Total payroll from the mines would be $13,855,400 in 1980; $31,671,000 in 1985; and $39,207,400 in 1990. As this is circulated through the regional economy, part of it becomes income to people in other sectors. The total increase in regional income would be $21,337,320 in 1980; $48,773,340 in 1985; and $60,379,400 in 1990.

Summary

Table R4-50 lists the total estimated capital and operating and maintenance costs associated with providing new and expanded community, educational, and health care facilities and services for the projected increase in population brought about by the proposed actions and cumulative projection.

TABLE R4-42

COLORADO'S SHARE OF ROYALTIES
FROM PROJECTED COAL MINES

Year	States Share of Royalties
1980	$2,024,000
1985	$6,912,000
1990	$9,232,000

TABLE R4-43

REGIONAL PAYMENT TO STATE SEVERANCE TAX
DUE TO THE PROPOSED ACTION

Year	State Severance Tax (dollars)	To State General Fund (dollars)	To State Severance Tax Trust Fund (dollars)	To Local Government Severance Tax Fund (dollars)
1980	988,200	274,460	269,040	444,690
1985	2,914,600		2,914,600	
1990	3,403,600		3,403,600	

TABLE R4-44

1976 COUNTY MILL LEVIES

County	Levy
Delta	52.09
Garfield	75.65
Gunnison	47.49
Mesa	65.82
Montrose	71.25
Ouray	58.97
Pitkin	43.66

TABLE R4-45

INCREASES IN COUNTY PROPERTY TAXES FROM INCREASED COAL MINING DUE TO THE PROPOSED ACTION

County	Year	Increased Production (Million Tons)	Property Tax Paid On		Total
			Improvements	Coal Mines	
Delta a/	1980	0	0	0	0
	1985	0	749,640	152,340	901,980
	1990	0	749,640	179,140	923,780
Garfield	1980	0.73	0	0	0
	1985	3.51	4,085,000	666,190	4,751,190
	1990	5.00	4,085,000	948,990	5,033,990
Gunnison	1980	0	0	0	0
	1985	2.13	1,249,400	253,900	1,503,300
	1990	2.44	1,249,400	290,240	1,539,640
Mesa	1980	0	0	132,110	132,110
	1985	0	2,203,600	330,270	2,533,870
	1990	0	2,203,600	511,830	2,715,430
Pitkin	1980	1.00	377,220	109,540	486,760
	1985	1.00	377,220	109,540	486,760
	1990	1.00	377,220	109,540	486,760

a/ Note that Delta County would receive no direct revenue in property taxes due to the proposed federal actions. Amount shown is what would be received by the Delta County School District.

TABLE R4-46

INCREASED PROPERTY TAXES, AND SALES TAXES, ACCRUING TO COUNTIES FROM THE POPULATION INCREASE ASSOCIATED WITH THE PROPOSED ACTION

	Property Tax (dollars)			Sales Tax (dollars)		
County	1980	1985	1990	1980	1985	1990
Delta	93,520	420,260	723,790	30,400	136,800	235,600
Garfield	0	231,410	367,090	0	107,510	181,940
Mesa	99,190	2,189,910	3,345,090	43,610	865,970	1,283,380

TABLE R4-47

INCREASED PROPERTY TAXES, AND SALES TAXES ACCRUING TO COUNTIES FROM THE CUMULATIVE POPULATION INCREASE

	Property Tax (dollars)			Sales Tax (dollars)		
County	1980	1985	1990	1980	1985	1990
Delta	502,200	1,731,150	2,608,880	163,400	566,200	756,200
Garfield	4,583,230	11,306,790	11,448,590	2,348,680	3,398,970	5,325,880
Mesa	7,115,550	14,633,930	12,696,680	3,127,460	5,787,670	5,058,760

TABLE R4-48

TAP FEE REVENUES

County	1980 (Dollars)	1985 (Dollars)	1990 (Dollars)
Proposed Action:			
Delta	138,320	624,000	1,074,320
Garfield	0	442,000	748,000
Mesa	74,880	1,482,880	2,197,120
Cumulative Development:			
Delta	746,680	2,582,320	3,449,680
Garfield	3,218,440	4,658,000	7,298,440
Mesa	5,354,880	9,909,120	8,597,120

TABLE R4-49

WATER AND SEWER SERVICE FEE REVENUE

County	1980 (Dollars)	1985 (Dollars)	1990 (Dollars)
Proposed Action:			
Delta	1,330	1,920	3,310
Garfield	0	5,590	9,460
Mesa	1,470	28,970	42,910
Cumulative Development:			
Delta	6,630	24,710	33,000
Garfield	40,700	58,910	92,300
Mesa	104,590	193,530	167,910

TABLE R4-50

OPERATING COSTS AND CAPITAL REQUIREMENTS

	Community Facilities and Services	Public Education	Health Care
Cumulative Development			
Operating Costs			
1980	$ 4,619,400	$ 1,700,000	**
1985	8,503,100	7,300,000	**
1990	9,693,600	11,000,000	**
Capital Costs 1990	85,546,100	42,400,000	$ 8,058,000
Amortized Capital Cost	7,458,340	3,696,640	702,540
Proposed Action			
Operating Costs			
1980	$ 67,800	$ 342,400	**
1985	1,125,510	2,800,000	**
1990	1,711,940	4,500,000	**
Capital Costs 1990	13,593,880	23,000,000	$ 2,905,000
Amortized Capital Costs	1,182,050	2,005,250	253,280

	Total Annual Cost		Annual Revenues	
	Proposed Actions	Cumulative	Proposed Actions	Cumulative
1980	$ 3,850,780	$ 17,176,920	$ 2,888,580	$ 18,263,100
1985	7,366,090	26,660,620	12,175,930	56,000,930
1990	9,652,520	31,551,120	14,865,770	45,937,620

TABLE R4-50
(continued)

DELTA COUNTY: OPERATING COSTS AND CAPITAL REQUIREMENTS

	Community Facilities and Services	Public Education	Health Care
Cumulative Development			
Operating Costs			
1980	$ 136,700	$ 1,100,000	**
1985	611,500	2,700,000	**
1990	871,300	3,400,000	**
Capital Costs 1990	8,951,000	17,600,000	$ 1,405,000
Amortized Capital Cost	780,390	1,534,460	122,490
Proposed Action			
Operating Costs			
1980	$ 25,400	$ 200,000	**
1985	186,400	500,000	**
1990	320,900	900,000	**
Capital Costs 1990	2,827,300	4,600,000	$ 455,000
Amortized Capital Costs	246,500	401,050	39,670

	Total Annual Cost		Annual Revenues	
	Proposed Actions	Cumulative	Proposed Actions	Cumulative
1980	$ 872,950	$ 3,551,540	$ 125,220	$ 672,230
1985	1,333,950	5,626,250	1,459,960	3,224,040
1990	1,813,450	6,586,150	1,886,480	4,321,860

TABLE R4-50
(continued)

GARFIELD COUNTY: OPERATING COSTS AND CAPITAL REQUIREMENTS

	Community Facilities and Services	Public Education	Health Care
Cumulative Development			
Operating Costs			
1980	$ 0	$ 0	**
1985	81,110	0.2	**
1990	139,040	0.3	**
Capital Costs 1990	1,384,380	1.7	$ 165,000
Amortized Capital Cost	117,560	148,210	14,390
Proposed Action			
Operating Costs			
1980	$ 1,432,100	$ 0.6	**
1985	2,244,800	2.5	**
1990	3,923,200	4.6	**
Capital Costs 1990	39,817,100	23.4	$ 2,978,600
Amortized Capital Costs	3,471,450	2,040,130	259,690

	Total Annual Cost		Annual Revenues	
	Proposed Actions	Cumulative	Proposed Actions	Cumulative
1980	$ 0	$ 8,803,370	$ 0	$ 6,972,610
1985	561,270	11,516,070	5,095,700	19,515,860
1990	719,200	15,294,470	5,592,480	21,900,760

TABLE R4-50
(continued)

MESA COUNTY: OPERATING COSTS AND CAPITAL REQUIREMENTS

	Community Facilities and Services	Public Education	Health Care
Cumulative Development			
Operating Costs			
1980	$ 42,400	$ 142,400	**
1985	845,000	2,100,000	**
1990	1,252,000	3,300,000	**
Capital Costs 1990	9,382,200	16,700,000	$ 2,285,000
Amortized Capital Cost	817,990	1,455,990	199,220
Proposed Action			
Operating Costs			
1980	$ 3,050,600	$ 0	**
1985	5,646,800	2,100,000	**
1990	4,899,100	300,000	**
Capital Costs 1990	36,778,000	1,400,000	$ 3,675,000
Amortized Capital Costs	3,206,490	122,060	320,400

	Total Annual Cost		Annual Revenues	
	Proposed Actions	Cumulative	Proposed Actions	Cumulative
1980	$ 2,658,000	$ 6,699,550	$ 2,763,380	$ 10,479,710
1985	9,918,200	11,395,750	5,618,770	23,149,000
1990	7,045,200	8,848,050	7,386,810	20,638,380

Annual revenues from the population increases are also shown.

Comparing costs with revenues reveals that the ES area would experience a net deficit in revenue to 1980 from growth caused by the proposed actions. This would change to a substantial surplus by 1985 and continue to 1990. Cumulative growth would realize a surplus throughout the study period. Only Delta County's cumulative needs would not be met by the expected revenue.

The aggregation of these revenue and expenditure figures to county and regional levels, of course, does not consider the many jurisdictional mismatches which would occur. None of the proposed mining installations would lie within the incorporated area of a municipality. Consequently, the municipalities would not benefit from the increased tax bases generated by the mines themselves, yet the municipalities would have to bear much of the expense for upgrading community facilities and services.

These figures also fail to take into consideration the lag time involved in recovering property taxes from population growth. That time is estimated to range between 12 and 24 months.

Population growth from other factors is expected to have a much greater effect on the area, with the exception of Delta County, than coal-related growth. In Garfield and Mesa counties, the proposed action would compound the adverse social and front-end economic impacts expected to occur due to oil shale and expanded private coal development, all of which would be occurring simultaneously. In Delta County, the fact that much of the new tax base would be located outside of the jurisdiction of those entities which would have to absorb the population growth would severely strain the county's financial structure.

CHAPTER 5

ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

This chapter summarizes the adverse impacts which cannot be avoided if the proposed actions are implemented, as well as the unavoidable adverse impacts which will result from cumulative regional development (oil shale, uranium, existing coal development, etc., and associated urban expansion). These impacts are presented by resource in order of significance (from most significant to least significant).

Socioeconomic Conditions

The communities which are expected to experience the most severe population growth pressures from the proposed actions include Paonia, Hotchkiss, Cedaredge, Delta, and Palisade. Other communities, such as Fruita, Grand Junction, DeBeque, Grand Valley, and Rifle, would also be subject to substantial population growth pressures resulting from a combination of the proposed actions and other types of energy resource development activities.

The demand for housing would force a rapid expansion of the housing stock, with little consideration given to the long-term implications for the community. Because of population pressure, new housing may be put in places which do not have adequate water or sanitary sewer facilities, where requirements for roadway surfacing and curb and gutter installation have been overlooked, or where building construction does not conform to recognized health and safety standards. These kinds of practices could result in immediate health hazards to residents and ultimately in increased costs to local governments.

An annual increase in local government revenues of $31,551,120 would be necessary by 1990 to provide and operate the new facilities and services required by cumulative growth. Only $9,652,520 annually would be required to provide for growth associated with the proposed actions. Revenue from property and sales taxes and utility service charges would provide $45,937,620 by 1990; $14,865,000 of this can be attributed to the proposed actions. Revenues from the proposed actions would be greater than costs in all three impacted counties. From cumulative growth, Delta County would have expenses greater than revenues through the period, while Garfield County would have surplus revenues in 1985 and 1990, and Mesa County would have surplus revenues through the period. Because revenues would not keep pace with required expenditures in some areas, there would be an unavoidable shortage of social support facilities and services.

The lag between population increase and revenue flow from local tax sources would have adverse financial implications for local governments in the area. Some local jurisdictions would shift to a net revenue benefit position after a few years, while others may never be able to fully recover increased costs from locally derived tax receipts (see chapter 4). Rapid increases in the cost of living, over and above normal rates, would be expected as a result of rapid injection of new purchasing power in the regional economy. This unavoidable inflation would most seriously affect people with fixed incomes (usually retired people and those people in the lower income brackets).

The disparity in wages between established workers and new employees associated with coal development is likely to cause some labor turnover, especially in some of the traditionally low-paying service industries and the agricultural sector. Employers would experience difficulty in replacing these employees without increasing their wage rates.

Projected rapid population growth in the ES area is certain to result in changes to the existing social structure. Increased population density alone, according to opinion surveys, is viewed as negative by most area residents. Because increases in local revenues would lag behind population increases, shortages in social services and other amenities are expected to occur. Coupled with shortages in housing, which are expected over the short term, this would increase feelings of social discontent in the area, among both long-time residents and newcomers. This type of discontent often leads to an increase in crime, marital problems, alcoholism, juvenile delinquency, and mental illness. The rate of growth of these disorders would likely be significantly greater than the population growth rate. Social discontent can also contribute to a polarization of the community, as long-time residents blame newcomers for the communities' problems, and vice versa. This in turn, would reduce any community's ability to achieve solutions.

Even with the application of the Mine Health and Safety Administration's coal mine safety standards, there would be about 4 mine fatalities and 76 nonfatal mine injuries per year.

Mineral Resources

As a result of all coal mining in the region, 39.58 million short tons of coal, a nonrenewable energy resource, would be lost from the regional reserve (10,022 million short tons) by 1980, 158.32 million short tons by 1985, and 321.08 million short tons by 1990. In 1980, 22 percent of this loss (8.7 million short tons) would be due to the six site-specific proposed actions; in 1985, 43 percent (68.1 million short tons); and in 1990, 55 percent (165.88 million short tons). Aproximately 50 percent of the coal which is depleted in 1980, 1985, and 1990 would be consumed for energy production. The other 50 percent would be left in place and, depending upon the advances which are made in mining techniques, may be recoverable at some future date.

If oil and gas deposits are discovered by drilling on the areas of the site-specific proposed actions or the other mining development in the ES area, conflicts would arise concerning the coordination and phasing for extraction of both resources.

Air Quality

The federal coal cannot be produced by underground mining from the proposed actions without generating fugitive dust. The proposed actions would not cause the regional air quality to deteriorate. However, within and at the boundary of some of the individual mines, the Class II prevention of significant deterioration (PSD) increments and Colorado air quality standards for total suspended particulates (TSP) would be exceeded. Beyond 2.5 miles from the individual mines, the annual TSP concentrations are predicted to be less than 1 microgram per cubic meter ($\mu g/m^3$) above the baseline concentrations.

The Loma, Cottonwood Creek, and North Thompson Creek mines all are predicted to exceed the Class II PSD increments. The annual TSP concentrations for the Loma Project, when added to the baseline concentration, would cause the ambient TSP levels to reach 90 $\mu g/m^3$ in 1990. This total concentration would exceed both the federal secondary and the Colorado standards. The 24-hour standard, however, would not be exceeded. If fugitive dust emissions were excluded from contributing to the PSD increments, the proposed actions would not cause the Class II increments to be exceeded.

In addition, the proposed actions would lead to a small but noticeable increase of TSP levels around the town of Delta. The annual and 24-hour concentrations would increase by 1 $\mu g/m^3$ and 3 to 4 $\mu g/m^3$, respectively. The area affected would have a radius of less than five miles from the center of Delta.

Horizontal visibilities are expected to exceed 60 miles almost 50 percent of the time in the region as a whole if the proposed actions are implemented. Regional visibilities (related to atmospheric particulates) would be reduced to 40 to 52 miles over small areas around major towns in the ES area for the three study years, due, in part to growth in urban emissions caused by implementation of the proposed actions. These reduced visibilities would not extend beyond about 10 to 15 miles from the towns. Much lower visibilities may occur near specific sources within the towns; however, these visibility reductions would be very localized.

During the study period, average regional visibilities would be reduced to around 53 miles over areas 5 miles in diameter or less around individual mines and groups of mines of the proposed actions. Much higher short-term visibility reductions would occur very close to the individual mines; however, these reductions would be highly localized. In many cases, the slight reductions in atmospheric clarity around mines in the region would not be apparent as actual visibility reductions because lines of sight would be obstructed by canyons, mountains, and other complex terrain features.

Water Resources

Coal mining at cumulative mid-level development would permanently remove an estimated 7,600 acres of potential coal aquifers by 1990, about half of which would be attributable to production from the six proposed mines. Since less than 0.08 percent of the ES area would be affected, no impact on the regional ground-water system should occur. The permeable rubble zone left behind after removal of the coal, followed by eventual subsidence, however, would tend to disrupt perched ground-water conditions locally in the Somerset coal field and permanently dry up some springs. Subsidence and cracking at the surface also can be expected to intercept surface streams in the Mount Gunnison area, which would damage existing irrigation water rights, and to break cast-iron pipes in the Cottonwood Creek area, which would interrupt Palisade's municipal water supply. With these notable exceptions, cumulative development at the most probable level would probably adversely impact somewhat less than 1 percent of existing water supplies in the ES area.

Stream channels would be removed, relocated, or altered on approximately 33,500 acres or 0.36 percent of the ES area. Only about 7 percent of these channels would be in areas disturbed by the six proposed mines. Impacts on long-term channel stability should be local and very minor.

Increased consumptive use of water at cumulative mid-level development would decrease annual water yield from the Upper Main Stem of the Colorado River by about 8,460 acre-feet (0.2 percent) by 1980; 44,120 acre-feet (1.1 percent) by 1985; and 44,010 acre-feet (1.0 percent) by 1990. Consumptive use attributable to the proposed mines would reduce water yield by only 120 acre-feet (0.003 percent) by 1980; 3,140 acre-feet (0.07 percent) by 1985; and 3,920 acre-feet (0.09 percent) by 1990. Salt concentration downstream as a result of this consumptive use would be far more than offset by the effects of the Grand Valley salinity control project. The net effect of cumulative mid-level development would be to decrease salinity in the Colorado River below Hoover Dam by about 5.5 mg/l (0.8 percent) by 1980, 18.6 mg/l (2.7 percent) by 1985, and 27.8 mg/l (4.1 percent) by 1990. Without the Grand Valley Project, the salinity would increase about 0.6 mg/l (0.09 percent) by 1980, and 3.2 mg/l (0.5 percent) by 1985 and 1990. The proposed mines alone would increase the salinity in the Colorado River below Hoover Dam by only 0.01 mg/l (0.002 percent) by 1980 and 0.2 mg/l (0.02 percent) by 1985 and 1990. Since the salinity of the lower Colorado River currently exceeds desirable limitations, any further increase in salinity would be reflected by correspondingly higher treatment costs for municipal and industrial water and reduced agricultural yields. The U.S. Department of Interior, Bureau of Reclamation (1977) estimates that an increase of 1 mg/l in the 1972 level of 879 mg/l at Imperial Dam would cost Lower Basin water users about $230,000 annually.

A short-term increase in sediment yield to receiving streams would occur during construction phases of development, but the net effect by 1990 would be to reduce sediment yield to the Colorado River from the ES area by an estimated 22,400 tons for the period 1978-90. Any impacts on channel morphology and aquatic biology would be local and very minor.

Aquatic Biology

Sewage pollution from 252,800 people in the region in 1990 would overload existing facilities. Ammonia levels in some river sections would reach the toxic limits for fish until waste water treatment facilities are upgraded. This would include the nitrification process in the most concentrated population areas.

Urbanization would increase silt, nutrients, gas, oil, litter, temperature, and biological oxygen in some streams. Some highly sensitive game and endemic fish and aquatic species may decline, to be replaced by more tolerant, less desirable fish species.

Increased sediment yield from cumulative surface disturbance would decrease the productivity of aquatic habitats for aquatic vegetation, invertebrates, and fish. Sedimentation would be the greatest during construction periods at the mines and in housing areas. Once the facilities are finished and protective features are operational sedimentation would decrease to original conditions.

Minor increases in TDS due to coal and significant increases due to all regional development would be offset by a large decrease in TDS due to the Grand Valley project. Aquatic habitats would be benefited overall.

Stream flow depletion by 1990 would depend largely on where and when water supplies are developed. Impacts from coal development alone would be very small. Purchase of existing senior water rights by energy companies and muncipalities would pose a serious threat to minimum stream flows, fisheries, and riparian habitats.

Increased fishery pressure by 52,998 new anglers would cause increased crowding along streams and lakes. Pressure on hatchery-raised fish would increase and unless new hatcheries are built the supply would not increase. Areas of the Colorado River and the North Fork would be less desirable to anglers due to extensive development along the river.

No impacts from coal development on the threatened and endangered fish species in the Colorado River are expected. The effects of total regional development are unknown.

Agriculture

Both cumulative regional surface disturbance and surface disturbance due to the proposed actions are summarized in table R5-1. This table applies to all resource sections concerned with surface disturbance: agriculture, vegetation, and soils.

An unquantifiable amount of farmland would be disturbed and probably permanently removed from production due to energy development (oil shale, uranium, coal, oil and gas), roads, railroads, and community expansion, including community expansion resulting from the proposed actions.

As the result of cumulative regional development, approximately 457 animal unit months (AUMs) would be lost by 1980, 1,796 AUMs by 1985, and 2,424 AUMs by 1990. As a result of the proposed actions, approximately 14 AUMs would be lost each year by 1980, 60 AUMs by 1985, and

TABLE R5-1

SURFACE DISTURBANCE

	1980	1985	1990
Cumulative Regional Surface Disturbance:			
Urban Area Expansion	4,061	8,122	9,143
Other Development	4,578	18,033	24,288
Total	8,639	26,155	33,431
Surface Disturbance due to Proposed Action:			
Urban Area Expansion	64	801	1,292
Mine Site Development	349	1,133	1,175
Total	413	1,934	2,467

69 AUMs by 1990. In addition, irrigated and nonirrigated hayland and pasture would be lost due to urban expansion associated with coal development. These areas are used to grow hay for livestock and also provide livestock wintering areas.

Increased off-road vehicle (ORV) use would decrease the condition and livestock carrying capacity of rangeland. This problem would be particularly serious on alpine areas above timberline and on low-elevation Mancos shale hills.

In all cases, impact from cumulative regional development would be more severe than impacts from the six site-specific proposed actions.

Vegetation

Natural vegetation would be temporarily disturbed due to mine site development as part of the proposed actions and due to other regional cumulative development (see table R5-1 for acreages). There would also be increased vegetative disturbance due to increased ORV and motorcycle use, resulting from population expansion associated with both the proposed actions and cumulative regional development.

Increased ORV use could also harm endangered and threatened plants. The Mancos shale in Montrose and Delta counties is the habitat for two proposed endangered plants in the *Federal Register* (*Sclerocactus glaucus* and *Penstemon retrorsus*). In addition, population increases could result in increased exploitation of endangered and threatened plants by commercial and amateur horticulturists. This problem is most serious in relation to the two endangered cacti in the region, *Sclerocactus glaucus* and *Echinocereus triglochidiatus* var. *inermis*.

In all cases, the impacts from the cumulative regional development would be more severe than the impacts of the proposed actions.

Soils

The development of site-specific mine facilities would result in a temporary loss of any production function on the acreages involved, as well as a temporary decrease in soil productivity due to increased erosion, decreased soil biotic activity, and a deterioration of natural soil structure. The net effect of decreased soil productivity would be to prolong those efforts necessary to achieve successful reclamation.

There would be permanent loss of any production function on acreage appropriated for urban expansion. An indeterminate, but substantial portion of this acreage would likely come from existing croplands in the Grand Valley and the Delta and Carbondale areas.

Topography

Surface subsidence due to all mining in the ES area would disturb a total of 600 acres by 1980; 3,550 acres by 1985; and 7,650 acres by 1990. Surface subsidence due to the proposed actions would disturb approximately 90 acres in 1980; 1,370 acres in 1985; and 3,920 acres in 1990. The secondary effects of subsidence may cause the disappearance of surface water bodies, rerouting or disruption of streams, geologic hazard potentials, and changes in ground water flow.

Transportation

Congestion on regional highways would increase as a result of population growth. Greater coal production would give rise to more rail traffic in the region. When added to projected increases from other areas that use the same lines, it could mean possible delays in shipping. The potential for train-automobile collisions in the region would be greater. Delay time at crossings would be longer, which would delay emergency vehicles operating in the region.

Noise

Ambient noise levels would increase with increasing population. In addition, there would be added increases in the noise corridors described in chapter 4.

Wildlife

As a result of cumulative regional development and associated population increases, 13,040 acres of wildlife habitat would be disturbed by 1980; 43,628 acres by 1985; and 67,187 acres by 1990. However, locally heavy losses and displacement of wildlife could occur. In addition, road kills would increase to 95 deer per year, and harassment and displacement of animals would increase as the human population expands.

As a result of the proposed actions the wild horse wintering areas in Coal Canyon would be reduced in size and a reduction of use would occur. This would necessitate a reduction in the herd to maintain it within the carrying capacity of the remaining range.

Also as a result of the proposed actions, about 1,175 acres of habitat would be lost by 1990 (0.013 percent of the region). This would in turn reduce the carrying capacity by 158 deer (0.06 percent) and 26 elk (0.06 percent). The proposed actions would also cause the loss of potential eagle nesting habitat, the possible loss of an active peregrine falcon nest, and the loss of small mammals, dens and burrows, and immobile reptiles.

A projected 1,000 percent increase in poaching and illegal killing is also anticipated due to the greatly increased regional population. Increased recreational use would increase harassment of animals and displace some animals to less suitable habitat. Approximately 75 deer per year would be killed by automobiles.

Cultural Resources

Cultural resources would be damaged by vandalism due to increased use of the regional area for mine and recreation activities. Although removal and alteration of cultural resources is an illegal action subject to prosecution, lack of enforcement and public awareness negates the effectiveness of such legislation. Loss of cultural values due to increased visitor-use pressure would go unmitigated.

Cultural resources would also be impacted by surface disturbance. Although archeological and historic clearance is required prior to the initiation of any surface disturbing activities, some unintentional damage and destruction could still occur. Not all cultural sites would be identified in the survey, including those which are subsurface or hidden from view. With projected surface disturbance by the respective time points (see table R5-1) as well as a maximum of 7,650 acres to undergo subsidence by 1990, damage and displacement of these unknown sites could occur.

Excavation procedures to mitigate loss of archeological resources are in themselves an unavoidable adverse impact. Once excavated, a site is essentially destroyed and removed from future research consideration; any information not recorded would be permanently lost. In salvage excavations, as opposed to research excavation, data are lost because of time and budget limitations.

Any activities which disrupt the integrity of a site bias interpretation of the remaining evidence and obstruct attempts to recreate earlier cultures and their adaptions to the environment.

Recreation

Greater numbers of people in the region would increase pressure on recreational resources and facilities. This increased use would increase maintenance and overhead costs for the managing agencies. Since many of the community recreational facilities are now fully utilized, increased use would also exceed the facilities' carrying capacity; a decline in the visitor's enjoyment as well as the sites' productive capacity would occur. The community facilities needed to prevent overuse of existing recreation facilites are projected in chapter 4. The extent of this impact would depend upon how aggressive the managing agencies are in providing the additional facilities through the measures discussed in chapter 4 and additional local funding. The increased use of recreation resources for dispersed activities such as fishing, hunting, and ORV use would also impact the managing agencies with increased costs for game stocking and management of their resources, in order to prevent resource deterioration (see estimates of increased use in chapter 4). The extent of this impact would again depend on how actively the agencies provide for the increased use.

Visual Resources

The land use changes that would be caused by the implementation of the proposed actions would establish new focal elements in many of the regional landscapes. The presence of an array of mine facilities, associated roads, railroads, power lines, etc., and the expanded urban complexes for employee housing and community services would introduce new landscape ingredients which would modify or change the overall character of certain landscapes. For example, the location of the Sheridan facilities along East Salt Creek would replace the present lightly modified range and natural landscape character with a heavily modified mine development that would stand in significant contrast to the surrounding landscape.

A second type of visual modification would result from the building of houses, roads, and community facilities to accommodate mine-related population growth. Urban expansion for about 102,000 people would predominantly concentrate around existing communities and would expand this urban landscape character, primarily in the western Grand Valley and the North Fork Valley. As a result of this expansion, urban landscapes would become more visually dominant in the region. In the western Grand Valley and North Fork Valley, they could create a continuous sequence of significantly modified landscapes.

Paleontology

Unavoidable destruction, disturbance, and removal of paleontological resources, both exposed and unexposed, would occur. The significance of this impact cannot be assessed due to the lack of data and evaluatory criteria.

CHAPTER 6

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE HUMAN ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The region has an established coal mining industry, and is facing impacts from other development such as oil shale, oil and gas, and uranium. Approval of the six site-specific proposed actions would be a continuation and expansion of an ongoing activity.

Both the six site-specific proposed federal actions and the cumulative regional development would result in short-term and long-term alterations of natural resources and the human environment. The short term would extend to 2025, a period of time which covers development, end of mine life, and some post-mining reclamation for both site-specific and cumulative operations. The long term refers to that period of time beyond 2025 in which subsequent impacts, both adverse and beneficial, would still affect the environment.

Over the short term, there would be the following alterations in the environment:

1. An estimated 321.08 million short tons of coking and noncoking bituminous quality coal would be affected in the ES area; 165.88 million short tons (55 percent) would be affected as a result of the proposed federal actions. Approximately 50 percent of the coal (160.54 million short tons) would be used by local and out-of-state public utilities, industries, and metallurgical markets (see table R1-3 in chapter 1 for a breakdown of market areas). The other 50 percent would be left in place and, depending upon the advances which are made in mining techniques, may be recoverable at some future date.

2. The proposed actions would not affect the future regional air resources. While in operation, several of the major proposed actions would consume the prevention of significant deterioration (PSD) increments for areas near the mine boundaries. If the fugitive dust emissions from the mines were excluded from contributing to the PSD increments, only a very small portion of the PSD increments would be consumed. In 1990 emissions from the Loma Project would cause total suspended particulate concentrations to exceed both the annual federal secondary and the annual Colorado standards.

3. Subsidence following removal of the coal would form open cracks at the surface that would intercept springs and surface runoff and very probably would damage existing water rights in the Mount Gunnison area near Somerset. Subsidence also can be expected to break cast-iron pipes in the Cottonwood Creek area and interrupt Palisade's municipal water system.

4. Cumulative mid-level development would consume an estimated additional 44,010 acre-feet of water by 1990, reducing water yield of the Colorado River by about 1.0 percent. Consumptive use as a result of the proposed mines would reduce water yield of the Colorado River by only about 3,920 acre-feet (0.09 percent) by 1990. This consumptive use of water, coupled with changes in salt load as a result of development, would decrease the salinity of the Colorado River below Hoover Dam by an estimated 27.8 mg/l (4.1 percent) by 1990. The proposed mines alone would increase the salinity of the Colorado River below Hoover Dam by about 0.16 mg/l (0.02 percent) by 1990.

5. A small short-term increase in sediment yield to receiving streams would occur during construction phases of development, but the net effect by 1990 would be to reduce sediment yield to the Colorado River from the ES area by an estimated 22,400 tons for the period 1978-90. Sediment yield from areas disturbed by the proposed mines and associated activities would decrease an estimated 10,700 tons for the period 1978-90.

6. Soil and vegetative productivity would be lost on 24,414 acres of land due to regional minerals development; 1,261 acres of the total would be disturbed by mine site development due to the proposed actions. Revegetation of the disturbed areas would be required upon abandonment of the mines, and productivity would be regained over time following successful reclamation.

7. Approximately 2,424 animal unit months (AUMs) would be lost through 2025 as a result of cumulative development in the region; ap-

proximately 69 AUMs would be lost for the life of the mines due to the proposed actions.

8. Wildlife habitat would be lost on 24,414 acres due to cumulative regional development; 2,261 acres of this total would be due to mine site development under the proposed federal actions.

9. Sewage treatment facilities would be overloaded, causing toxic ammonia levels in three river segments until planned improvements including the nitrification process are operational.

10. Developed mine facilities would diminish angler use in some stream areas during the lives of the mines.

11. Greater coal production would increase rail and truck traffic, which would increase traffic accidents including train-automobile collisions, train/animal collisions, truck/animal collisions, lengthen waiting periods at railroad crossings, and cause delays in shipping.

12. Mine facilities, along with expected changes in vegetation and topography, could alter visual resources.

13. The increased demand for recreation facilities would not be met until sufficient funds are available, if then.

14. Fruita, Grand Junction, DeBeque, Grand Valley, and Rifle would be subjected to substantial population growth pressures resulting from a combination of the proposed action and other types of energy resource development. Paonia, Hotchkiss, Cedaredge, Delta, and Palisade would be subjected to population growth pressures resulting from the proposed federal actions.

15. Because of population pressures, new housing may be put up in places which do not have adequate water or sanitary sewer facilities, adequate roads or curbs and gutters, or adequately and safely constructed houses.

16. As a result of cumulative development, Delta County would have more expenses than revenues through 1990, although revenue from the proposed actions would be greater than their costs. Garfield and Mesa counties would have surplus revenues resulting from both cumulative development and the proposed actions through the same period.

17. Rapid inflation would be expected over the short term.

18. Rapid population growth coupled with shortages in social services and housing would increase social discontent in the area. This type of discontent often leads to an increase in crime, marital problems, alcoholism, juvenile delinquency, and mental illness.

19. A substantial portion of the regional employment and earnings would depend on the health of the coal and other mineral resource industries. If changing market conditions cause a drop in the prices of coal or other minerals, the ES region could expect to suffer extreme economic recession.

20. There would be about 4 mine fatalities and 76 nonfatal mine injuries per year through the life of the mines.

Residual effects of mining (after post-mining reclamation) on long-term productivity would be as follows:

1. An estimated 321.08 million tons of coal, a nonrenewable energy resource, would be depleted after 2025; 265.88 million tons (55 percent) of this total would be depleted by the proposed federal actions. The total represents a depletion of approximately 2.3 percent of the 10,022 million tons of coal reserves in the ES area. It includes not only the coal removed and consumed, but also the coal left in place due to the limitations of existing mining technology. If advances in technology permit higher recovery rates in the future but do not allow recovery of reserves left in place by previous mining operations, long-term productivity would be reduced by some unknown amount. On the other hand, future mining technology may allow the recovery of all or part of the coal left in place by present techniques.

2. Current mining may preclude future mining of reserves lying in coal seams which are not currently feasible to mine particularly if those seams lie close to previously mined seams.

3. Current coal mining may preclude recovery of other energy resources, particularly oil and gas.

4. In the long term, the increased population growth associated with the proposed actions would cause a rise in the pollutant concentrations in the towns of the ES region. If the labor force remains after the coal mining has ceased, the projected urban air pollutant concentrations would persist. Moreover, if the labor force is reemployed, new sources of industrial pollution may arise.

5. Subsidence produced by mining may cause a broad spectrum of impacts limiting future land use and productivity. Among these are disruption of the surface, increased soil erosion, loss of vegetation and wildlife, loss or disruption of surface water bodies, and damage to cultural sites.

6. An undetermined number of uninventoried exposed and unexposed fossil resources would be impaired or destroyed by mineral development.

7. An unquantifiable gain in knowledge would result from surveys and exposure of fossil resources which might never have been found without development.

8. Subsidence related impacts on springs and surface runoff in the Mount Gunnison area and to Palisade's municipal water supply system in the Cottonwood Creek area would probably continue beyond 2025 in the absence of corrective actions.

9. Consumptive use of water by the increased population and by the Dallas Creek and Grand Valley projects (an estimated 29,300 acre-feet annually of which about 2,390 acre-feet would be attributable to the proposed actions) can be expected to continue beyond 2025. The corresponding long-term effect of cumulative mid-level development on the salinity of the Colorado River below Hoover Dam is estimated to be a reduction in dissolved-solids concentration of about 4.1 percent (28.0 mg/l).

10. The stabilizing effects of urbanization on erosion can be expected to reduce long-term sediment yield from the ES area by an estimated 6,000 tons per year.

11. Increased fishing pressure by 5,750 people due to coal and 52,998 people due to regional development would increase crowding along lakes and streams.

12. Erosion of coal and oil shale refuse piles may potentially degrade stream water quality and fisheries dependent on the success of revegetation efforts.

13. Increased urbanization would increase pollutants to aquatic systems. Aquatic species that are intolerant of such changes would diminish in numbers. Less desirable fish species would become more prevalent.

14. Endangered and threatened fish species would be subjected to continued alterations of the Colorado River from many sources.

15. Oil and chemical spills will occasionaly degrade aquatic habitats.

16. Water rights would continue to shift from agricultural use to energy development and municipal uses. Water consumption would increase and low water flows may cause some aquatic habitats to be lost. Flow regimes will be altered by reservoir construction.

17. Long-term soil and vegetative productivity would be lost on 7,851 acres due to cumulative urban area expansion, including 1,292 acres disturbed by urban expansion resulting from the proposed federal actions.

18. The long-term productivity of natural vegetation disturbed on 12,288 acres by cumulative mineral development, including 1,175 acres disturbed by the site-specific proposed actions, would not be permanently lost if successful revegetation is achieved. If the disturbed areas are revegetated primarily with a mixture of forbs, shrubs, and grasses, an increase in the productivity of the land for livestock and wildlife use would be expected. However, successful revegetation may be difficult in the Cottonwood Creek, Coal Canyon, Cameo, and Loma Project areas because of arid climate and erosive soils.

19. An unquantifiable amount of farmland would be permanently removed from production due to community expansion associated with cumulative regional development, including the proposed actions.

20. An unquantifiable amount of farmland would be removed from production due to the cumulative mineral development. This land could be reclaimed to cropland and irrigated hayland, but it probably would not be.

21. An increase in AUMs could be expected on the 1,175 acres disturbed by mine site development under the proposed actions if the disturbed areas are revegetated with species mixture consisting primarily of grasses. Livestock carrying capacity could be increased to as low as 5 acres or less per AUM. Similar increases could occur on the 12,288 acres disturbed by other mineral development if that acreage is also revegetated with grasses, but it is impossible to determine whether this will in fact happen.

22. Habitat for endangered and threatened plants, particularly *Sclerocactus glaucus* and *Penstemon retrorsus*, could be harmed by increased off-road vehicle use in the region. Exploitation of endangered and threatened plants, particularly *Sclerocactus glaucus* and *Echinocereus triglochidiatus* var. *inermis*, by amateur and commercial horticulturalists could increase.

23. The long-term productivity of the bald eagle and the peregrine falcon could be impaired by the destruction of riparian habitat and subsequent reduction of prey species due to mining activity under the proposed actions. In addition, the peregrine nest site in DeBeque Canyon could be abandoned due to activity from the mines.

24. The golden eagle and prairie falcon could lose some productivity due to the loss of potentially suitable nesting habitat in the cliffs above the proposed action mine sites and also above transportation corridors through the canyons.

25. Cumulative regional development and urban expansion, including the proposed actions, could reduce productivity of deer and elk herds in the ES area by an unquantifiable amount. In particular, the Roan Creek, Parachute Creek, and Piceance Basin deer herds' habitats and ranges would be greatly restricted by oil shale development.

26. Cultural surveys associated with some of the proposed surface disturbance could provide immediate gains in the understanding of prehistoric and historic use of the region. However,

salvage procedures which remove cultural values, necessarily eliminate specific sites from future research.

27. Vandalism of cultural resources would increase in association with regional population growth and would permanently reduce cultural resources.

28. An unquantifiable number of cultural resources would be damaged or destroyed by surface disturbance resulting from construction activities associated with mine and community development.

29. New recreational facilities developed in response to increased demands would remain as a long-term benefit. However, if additional facilities and increased management funding are not provided the overuse and deterioration of existing facilities and resources would continue.

30. The visual character of the region would change due to the shift from a rural to an urban setting and from agricultural to industrial development.

31. Initial conflicts between old and new residents would be absorbed into more urban lifestyles and attitudes over the long term.

32. Increased population density would be expected to contribute to increased traffic volumes, crime and other social disorders, air and water pollution, noise levels, and competition for recreational resources.

33. The supply of needed social services would come more in line with demand as property values increase to provide a tax base that would support new facilities and services.

34. The initial disparity in wages would be replaced by a new equilibrium with higher wage levels in all sectors, which would reduce the disproportionate short-term inflation.

CHAPTER 7

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

This chapter identifies the extent to which cumulative regional development, including the proposed federal actions, would irreversibly or irretrievably diminish the range of potential uses of the human environment. In this context, the term "irreversible" is defined as use that cannot be reversed; once initiated, it would continue. The term "irretrievable" means not recoverable; once used, it is not replaceable. Actions committing future generations to continue similar use are also considered irretrievable.

Approximately 160.54 million tons of coal, including approximately 82.94 million tons due to the proposed federal actions, would be recovered from coal mines in the ES area. An additional 160.54 million tons, including an additional 82.94 million tons due to the proposed actions, would be left in place because of the limitations of existing mining technologies. It might be recoverable at some future date, depending upon advances in technology.

Unquantifiable amounts of uranium, oil shale, oil and gas, limestone-gypsum, and hardrock minerals would be recovered from mines in the ES area.

Energy, in the forms of petroleum products and electricity, would be expended to obtain the coal and other minerals. Some materials used in manufacturing machinery and buildings would not be recycled and thus would be irretrievable.

The loss of clean, clear air during the operation of the proposed site-specific mines would be irretrievable but not irreversible.

Local emissions of particulates by the mines would irretrievably reduce visibilities around the mines. However, these impacts would not be irreversible.

Increased urbanization of the ES region by implementation of the proposed actions would irretrievably increase ambient pollution concentrations. The air quality impact caused by urbanization would be reversible to the extent that the population associated with the proposed federal actions would move out of the region after the mining of the proposed actions cease.

Accelerated erosion, increased landslide and rockslide potential, and loss of surface bodies of water induced by subsidence may be difficult to stop or reverse.

An undetermined number of uninventoried fossils would be lost or disturbed.

Approximately 4,000 acres of potential coal aquifers would be removed, about half of which would be as a result of the proposed mines. Stream channels would be removed, relocated, or altered on approximately 33,500 acres. About 7 percent of these channels would be in areas disturbed by the proposed mines.

An undetermined number of springs would be permanently lost because of subsidence as a result of mining.

Water consumption would be increased by an estimated 44,010 acre-feet per year by 1990, about 3,920 acre-feet of which would be attributable to the proposed actions.

Salinity in the Colorado River below Hoover Dam would decrease about 4.1 percent (27.8 mg/l) by 1990. The proposed mines alone would increase the salinity below Hoover Dam by about 0.02 percent (0.16 mg/l) by 1990. An increase of 1 mg/l in the 1972 level of 879 mg/l at Imperial Dam would cost Lower Basin water users about $230,000 annually.

Soil and vegetative production would be irretrievably lost on 24,414 acres (including 1,261 acres associated with the proposed action) for the life of the various operations (coal, uranium, oil shale, etc.) and irreversibly lost on 10,465 acres (including 1,112 acres under the proposed actions) which would be converted to urban use. This includes an unquantifiable amount of cropland irreversibly removed from production.

Approximately 2,424 animal unit months (AUMs), including 69 AUMs on lands affected by the proposed federal actions, would be irretrievably lost for the life of the various operations. In addition, an unquantifiable amount of irrigated and nonirrigated hayland and pasture would be irreversibly lost due to urban expansion associated with cumulative regional development, including the proposed federal actions.

Increased off-road vehicle use would disturb an unquantifiable amount of natural vegetation, reduce the carrying capacity on an unquantifiable amount of rangeland, and potentially harm populations of endangered and threatened plants.

Some endangered and threatened plants could be irretrievably lost due to increased exploitation by amateur and professional horticulturalists.

The individual animals and habitats that would be destroyed during construction and operation of equipment, as well as any offspring that could have been produced by these animals, are irretrievable wildlife resources. However, there would be no irreversible commitment of wildlife resources if the reproductive potential of the wildlife species and their habitats are not seriously impaired.

Species of fish that have been shown to be intolerant of habitat changes, notably the Colorado River endangered fish species and cold water trout species, would diminish in numbers and would be replaced by highly tolerant but less desirable species, such as carp, red shiners, bullheads, and some species of suckers.

Cold water trout streams and lakes which harbor wild fish populations would decline in quality due to increased angler pressure. If these fisheries are to remain productive, more intensive management or use of hatchery fish would be necessary.

Irreversible and irretrievable commitments of archeological and historical resources could result from disturbance or destruction of cultural sites. These sites would no longer be available for future study, resulting in data gaps and obstructing attempts to recreate and study the prehistory and history of the area.

The materials used for construction of additional recreational facilities (if provided) would be an irretrievable commitment of these resources. If the additional recreational facilities or increased monies for management are not provided, the deterioration of existing facilities and resources would be an essentially irreversible commitment of these resources.

The development of the proposed coal resources would initiate a sequence of land use changes that would alter the visual quality of many local landscapes, which would be an irretrievable commitment of today's visual resources to an alternative future status.

There would be about 4 mine fatalities and 76 nonfatal mine injuries per year throughout the life of the mines.

Increased population density could produce an irreversible increase in traffic volumes, crime and other social disorders, air and water pollution, noise levels, and competition for recreational resources.

There would be an irreversible change in lifestyles as new types of people contribute to variety within community groups. The small town atmospheres would be irretrievably lost in the population centers of the ES area.

An irretrievable commitment of capital and land (at least 9,000 acres) would be required to support population growth. Developments needed to support this growth (water, sewage treatment, schools, housing etc.) would require long-term commitments of scarce capital, which would not be available for other uses. Similarly, the land required for this growth would probably not be returned to previous uses, such as agriculture or wildlife habitat.

CHAPTER 8

ALTERNATIVES TO THE PROPOSED ACTIONS

The proposed federal actions analyzed in this environmental statement (ES) are the review and consideration for approval of six mining and reclamation (M&R) plans for coal mining on existing federal leases. None of the proposed M&R plans have been reviewed for compliance with the Surface Mining Control and Reclamation Act of 1977 (SMCRA), and they do not fully reflect the requirements of the interim regulations. Each M&R plan will be returned to the applicant for revision in accordance with the appropriate federal regulations. As each applicant's plan is resubmitted to the Office of Surface Mining (OSM), it will be evaluated for compliance with the requirements of 30(CFR): 211 and 30(CFR): 700. In addition, the Bureau of Land Management (BLM) must evaluate all the M&R plans in relation to the Department of the Interior's proposed unsuitability criteria developed in compliance with Section 522 of SMCRA.

In this regional volume of the ES, the six proposed actions are evaluated in the context of projected probable coal development in west-central Colorado. The production level evaluated as most probable is dependent in part on federal approval of the six M&R plans and, in some cases, future analysis and consideration for approval of short-term competitive leases under agreed-upon criteria. However, the Secretary of the Interior is not proposing a particular production level for coal in this ES region. Instead he is considering actions within his authority that will allow federal coal to be available where needed and under environmentally acceptable conditions to meet market demands and the energy needs of the nation.

In this regional ES, decisions regarding M&R plans and coal-related actions are considered on a regional or subregional basis. Accompanying and future related site-specific statements will evaluate alternatives specific to the individual coal mine proposals. Thus, alternatives for the M&R plans and coal-related actions are evaluated on an aggregate basis in this regional ES, providing a means of responding to regional or subregional environmental problems or social and economic concerns.

Pursuant to implied covenants of both the federal mineral leasing laws and the existing lease agreements, the Department of the Interior is obligated to respond to a legitimate application to conduct mining operations on a valid lease, provided that all terms and conditions thereunder have been met. The Department's action with regard to the M&R plans under consideration in this ES may be approval as proposed, rejection on various environmental or other grounds, approval or rejection in part, or approval subject to such additional requirements or modifications as may be imposed under existing laws and regulations. The Department may also defer decision pending submittal of additional data, completion of required studies, or for other specific reasons. If there are serious environmental concerns as to the coal development, the Department may prevent further development of the leases by exercising the Secretary's exchange authority as to the federal coal rights, or seeking congressional action to cancel the federal leases involved.

In addition, in this regional ES, a low-level scenario and a high-level scenario are presented to provide further perspectives on the proposed actions. These scenarios identify impacts of production levels above and below the most probable level of development discussed in chapters 1 through 7 of this volume.

Development of alternative sources of energy, energy conservation, federal development of the coal, and emphasis on coal development in other regions of the United States are more appropriate for consideration on a program rather than a regional basis. These evaluations were made in the previous coal programmatic statement (U.S. Department of the Interior 1975) and will be updated and revised as necessary in the new coal programmatic statement now under way (to be completed in 1979).

Only those resources which could or would be affected are analyzed in these alternatives or scenarios. At the end of chapter 8 there are three summary tables (tables R8-34, R8-35, and R8-36) comparing impacts of the proposed actions, the most probable level of cumulative development, and the high-level and low-level scenarios.

APPROVAL AS PROPOSED

The Department has the choice of approving the M&R plans as proposed. However, as pointed out above, none of the six proposed M&R plans has been reviewed for compliance with the interim regulations. Therefore, the M&R plans cannot be considered for approval by the Department until they have been revised to comply with all appropriate federal regulations.

REJECTION ON ENVIRONMENTAL OR OTHER GROUNDS

The Department may reject any individual proposal that does not meet the prescriptions of applicable law and regulations under its authority, including the potential for environmental impact that could be reduced or avoided by adoption of a significantly differently designed course of action by the lessee (operator). In addition, the BLM must evaluate all the M&R plans in relation to the Department's proposed unsuitability criteria developed in compliance with Section 522 of SMCRA. Except when an M&R plan does not comply with existing regulations, the Department cannot under present circumstances reject the proposed plans to the extent that a de facto cancellation of a lease results unless it seeks and obtains additional authority from Congress.

Environmental impacts of rejecting an M&R plan could vary greatly, depending upon the administrative action taken. If the affected company did not submit a new M&R plan for some time, the lease area would continue in its present condition, subject to further modification by natural processes, the continuation of existing mining activity, and such future uses of the surface as the owners or managing agency may decide upon. (See chapter 2, Future Environment Without the Proposal; the low-level scenario later in this chapter; and chapter 8 of each site specific for likely future developments or land uses if a particular M&R plan is rejected or for other reasons not implemented.)

Should the affected company submit a new M&R plan, that plan would require both environmental analysis and review for compliance with applicable regulations. The net result would be a deferral and perhaps reduction of impacts discussed under the proposed actions, because of changed technology, different methods of mining, transportation, etc., or additional requirements or stipulations imposed at that time.

APPROVAL OR REJECTION IN PART

The Department has the choice of approving or rejecting part of a particular M&R plan, based on projected adverse environmental impacts.

Restrict Development on Existing Leases

The subject leases convey the right to develop, produce, and market the federal coal resource thereon if all other terms and conditions have been met by the lessee. In general, the Department does not possess the authority to arbitrarily constrict development if all other requirements of the lease have been met. However, various measures that may tend to restrict development may be taken by the Department at any time in the interest of conservation of the resources or in the protection of various specific environmental values in accordance with existing laws and regulations (for example, the National Historic Preservation Act of 1966, the Endangered Species Act of 1973, etc.). Similarly, the Department could permit only selective exploration and development of existing leaseholds if analysis indicates wholly unacceptable environmental impacts that could not be reduced to an acceptable level.

Adoption of this alternative would reduce adverse impacts by reducing the area in which the impacting activities could take place. At the same time, application of this alternative would not permit maximum recovery of the coal resources and would thus be contrary to principles of conservation embodied in the legislation which authorizes the leasing of these lands for the purposes described. It is entirely possible that such selective mining would leave isolated blocks of coal that might never be recovered owing to the high costs of mining such remnant areas at a later date.

Diligent Development and Continuous Operations

The socioeconomic analysis indicates that three counties of the west-central Colorado region (Delta, Mesa, and Garfield) would experience adverse impacts as a result of mineral and other development which would occur under the most probable level of development (including the six proposed M&R plans). Most of the adverse impacts are directly attributable to the rapid rate of population growth to be caused by intensive simultaneous development of multiple energy resources or by moderate development in areas which have a small base population. In all three counties, the rate of population growth would be most rapid in the period before 1985 and is predicted to slow to more moderate rates in the period from 1985 to 1990. (Table R4-29 in chapter 4, Socioeconomic Conditions shows the projected cumulative population and resulting growth rates by county for the period before 1990. The percent change shown in the table is for a five-year period. The capability of each county to respond to the projected population growth is shown in figure R4-7 under Socioeconomic Conditions, chapter 4.)

County planning departments have indicated that the infrastructures of their counties can continue to provide normal governmental services if population growth rates are slow. When growth rates reach a level of around 5 percent annually, the resulting impacts become unmanageable. A diligent development and continuous operations alternative could minimize some of these adverse socioeconomic impacts by controlling the rate of coal development.

The assumptions used to project production and employment represent a comprehensive policy which would effectively limit coal development in the ES area to "acceptable" or "manageable" levels and reduce the level of unacceptable growth. By fully implementing each of the assumptions listed below, coal production, employment, and most importantly adverse socioeconomic impacts due to coal development would be reduced to a minimal level in the ES area.

The basic assumptions underlying this alternative are as follows:

1. No new leasing in the ES area would be allowed except to maintain production at existing (1978) levels or to supply existing contracts dated and signed prior to or in 1978. This would mean severely limiting all new preference right leases and short-term leases and, if a new leasing policy is developed, all new competitive coal leases.
2. Both new M&R plans and modifications of approved M&R plans would be approved only to allow a lessee to maintain existing (1978) production levels or to produce the quantities of coal necessary to meet diligent development and continuous operations requirements and, therefore, maintain the federal lease. (In no case would the lessee be required to pay advance royalties in lieu of production or to forfeit a lease from failure to produce.)
3. All applications for federal rights-of-way which would make possible increased production from private coal reserves would be denied.
4. The above stipulations would be reconsidered periodically and would be continued until the economies of the area could handle additional coal development.

The effectiveness of this alternative would depend on the full implementation of all of the assumptions above. If the alternative were applied only in part or only to one subregion or to some of the mining companies, it can be expected that development in the areas or by the companies to which it was not applied would continue at rates projected under the most probable level of development. This would negate the effectiveness of the alternative and cause undue hardships for the coal companies singled out to comply with the alternative. To some extent, this alternative also depends on development of a uniform coal policy for the ES area. Additionally, if diligent development and continuous operations requirements or other federal requirements change over the next ten years, the stipulations established for this alternative might have to be adjusted accordingly.

Table R8-1 summarizes proposed production schedules under this alternative. Table R8-2 shows projected employment, number of unit trains, and market areas. This alternative is not intended to provide environmental analysis of possible mining of site-specific leases (active or inactive). Any specific proposals to meet diligent development criteria would have to be assessed at the time they are submitted.

Socioeconomic Conditions

Population growth from the diligent development alternative level of production is expected to occur in only three counties: Delta, Garfield and Mesa. Projected population for these counties and percentage growth above the low-level population are given in table R8-3 (the low-level scenario is discussed later in this chapter). Since the purpose of this alternative is to keep population growth from coal development at a minimum, the most probable level (mid-level) population projections are given for comparison (the most probable level of development is discussed in chapters 1 through 7 of this volume).

From 1977 to 1990, low-level development in Delta County would average a population increase of 2.1 percent per year. The diligent development alternative would increase this to 2.4 percent per year, and the most probable level would increase this to 3.3 percent. In Garfield County the low-level population increase would average 7.0 percent per year, and the diligent development alternative would also be 7.0 percent per year. This would be compared with the 7.2 percent level of mid-level development. The low-level growth rate in Mesa County from 1977 to 1990 would average 2.7 percent per year. Diligent development would increase this to 2.9 percent per year, while the mid-level of development would result in a growth rate of 3.7 percent per year.

Community Attitudes and Lifestyles

Changes in lifestyles and general attitudes are expected to occur throughout the ES area as the result of natural population growth and the development of the area's non-coal energy resources. The diligent development level of coal production would add a small amount of population to this expected growth. This growth would add to the expected changes of rising divorce rates, increased

TABLE R8-1

LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROJECTED MINING OPERATIONS
UNDER THE DILIGENT DEVELOPMENT SCENARIO: PRODUCTION

	Recoverable Reserves (million tons)	Annual Production (million tons per year)				Time Points		
		1977	1980	1985	1990	Start Construction	Full Mine Operation	Mine Life (Years)
1. Existing and projected mining operations producing from private reserves only (production not federally controlled)								
Belden Enterprises, Inc.: Red Canyon No. 1 Mine	Unknown	(412 tons)	0.001	0.0	0.0	1916	1916	Unknown
Western States Coal Company: Fairview Mine	7.0	0.0	0.0	0.250	0.250	1982	by 1985	30
Quinn Coal Company: Tomahawk Strip Mine	3.0	0.024	0.250	0.250	0.0	1976	1980	12 (to 1988)
Peabody Coal Company: Nucla Strip Mine	Not available	0.094	0.096	0.100	0.100	1965	1972	Not available
Henry Bendetti Coal Company: Nu Gap No. 3 Mine	Unknown	(397 tons)	0.001	0.001	0.001	1970	1977	Unknown
Louis Bendetti Coal Company: Eastside Mine	Unknown	(257 tons)	0.001	0.001	0.001	1973	1977	Unknown
Carbon King Ltd.: Sunlight Mine	Unknown	(1,792 tons)	0.030	0.050	0.050	1977	1981	Unknown
Coal Fuels Corporation: Farmers Mine	7.0	0.0	0.200	0.200	0.200	1977	1979	35
	Subtotal	0.118	0.597	0.852	0.602			

TABLE R8-1

(continued)

	Recoverable Reserves (million tons)	Annual Production (million tons per year)				Time Points		
		1977	1980	1985	1990	Start Construction	Full Mine Operation	Mine Life (Years)
2. Existing mining operations producing from federal leases (and possibly adjacent private reserves) for which either an exploration or a mining and reclamation plan (submitted according to the requirements of 30 CFR: 211.10) has been approved								
Sheridan Enterprises: (Exploration plan only)	100.0	0.068	0.1	0.0	0.0	1976	Not applicable	3
GEX Colorado Company: Roadside Mine	9.0	0.300	0.800	0.200	0.0	1973	1975	14 (to 1987)
O.C. Mine Company: O.C. No. 2 Mine	0.04	(3,696 tons)	0.004	0.004	0.0	1968	1969	20 (to 1988)
Mid-Continent Coal and Coke Co.: Coal Basin Mines	Not available	0.921	0.900	0.900	0.900	1973	1975	Not available
United States Steel Corp.: Somerset Mine	Not available	0.915	0.940	0.940	0.940	1961	1970	25 +
ARCO (Bear Coal Co.-assignee) Bear Mine	Not available	0.226	0.240	0.0	0.0	1932	1937	49 (to 1981)
Colorado Westmoreland Inc.: Orchard Valley Mine	2.0	0.286	0.700	0.700	0.700	1976	1979	Indefinite

TABLE R8- 1

(continued)

	Recoverable Reserves (million tons)	Annual Production (million tons per year)				Time Points		
		1977	1980	1985	1990	Start Construction	Full Mine Operation	Mine Life (Years)
2. (continued)								
Western Slope Carbon, Inc.:								
Hawksnest No. 3 Mine	Not available	0.19	0.0	0.0	0.0	1970	1972	Indefinite
Hawksnest East Mine		0.01	0.600	0.750	0.750	1975	1981	Indefinite
	Subtotal	2.916	4.284	3.494	3.290			
3. Federal leases for which mining and reclamation plans, as required by 30 CFR: 211.10, have not been approved								
C-01538 (GEX Colorado Company: Cameo Mine Property)	29.7	0.0	0.800	0.297	0.297	1977	1979	107
C-037277	12.621	0.0	0.0	0.126	0.126			
D-040389	0.567	0.0	0.0	0.006	0.006			
C-059420	2.762	0.0	0.0	0.028	0.028			
(Mid-Continent Coal and Coke Co.: Coal Canyon Mine Property) Subtotal	15.95	0.0	0.0	0.160	0.160	1983	1984	100
C-020740	0.210	0.0	0.0	0.002	0.002			
C-024998	13.5	0.0	0.0	0.135	0.135			
C-029889	13.0	0.0	0.0	0.130	0.130			
(Mid-Continent Coal and Coke Co.: Cottonwood Creek Mine Property) Subtotal	26.71	0.0	0.0	0.267	0.267	1983	1984	100

TABLE R8- 1

(continued)

	Recoverable Reserves (million tons)	Annual Production (million tons per year) 1977	1980	1985	1990	Time Points: Start Construction	Full Mine Operation	Mine Life (Years)
3. (continued)								
C-0125436	13.0	0.0	0.0	0.130	0.130			
C-0125437	12.5	0.0	0.0	0.125	0.125			
C-0125438	13.5	0.0	0.0	0.135	0.135			
C-0125439	13.0	0.0	0.0	0.130	0.130			
C-0125515	13.5	0.0	0.0	0.135	0.135			
C-0125516	13.0	0.0	0.0	0.130	0.130			
(Sheridan Enterprises: Loma Mine Property; see No. 1 above)								
Subtotal	78.5	0.0	0.0	0.785	0.785	1983	1984	100
C-08172	a/	a/	a/	a/	a/			
C-08173	a/	a/	a/	a/	a/			
(Anschutz Coal Company: Thompson Creek Mine Property)	70.0	0.016	1.000	1.000	1.000	1974	1980	30
D-044569	26.225	0.0	0.0	0.262	0.262			
C-1362	83.300	0.0	0.0	0.833	0.833			
C-0117192	25.366	0.0	0.0	0.254	0.254			
(Atlantic-Richfield Company: Mt. Gunnison Mine Property)								
Subtotal	134.9	0.0	0.0	1.349	1.349	1983	1984	100
D-055156 (Utah International)	3.240	0.0	0.0	0.032	0.032	1983	1984	100
D-043937 (Evelyn Welch, Shirley Wiggins)	1.026	0.0	0.0	0.010	0.010	1983	1984	100

a/ Production from the Anschutz mining operation would reach 1 million tons per year from private reserves, which would be sufficient to meet diligent development-continuous operation criteria if the M&R plan were approved under those criteria.

TABLE R8- 1

(continued)

	Recoverable Reserves (million tons)	Annual Production (million tons per year)				Time Points		
		1977	1980	1985	1990	Start Construction	Full Mine Operation	Mine Life (Years)
3. (continued)								
C-012765 (Garland Coal and Mining Company)	5.200	0.0	0.0	0.052	0.052	1983	1984	100
C-074632 (Mid-Continent Coal and Coke Co.)	5.720	0.0	0.0	0.057	0.057	1983	1984	100
D-037766 (Thompson Creek Mining Company)	1.050	0.0	0.0	0.011	0.011	1983	1984	100
C-1894	1.200	0.0	0.0	0.012	0.012			
C-7852	1.600	0.0	0.0	0.016	0.016			
C-7853	7.60	0.0	0.0	0.076	0.076			
C-012638	3.200	0.0	0.0	0.032	0.032			
C-012639	8.400	0.0	0.0	0.084	0.084			
C-030344	4.400	0.0	0.0	0.044	0.044			
C-030346	5.360	0.0	0.0	0.054	0.054			
C-0125485	2.00	0.0	0.0	0.020	0.020			
C-051669	14.775	0.0	0.0	0.148	0.148			
C-068389	7.563	0.0	0.0	0.076	0.076			
D-052558	3.780	0.0	0.0	0.080	0.080			
(U.S. Steel Corporation)								
Subtotal	59.878	0.0	0.0	0.642	0.642	1983	1984	100
D-052501 (Anchor Coal Company: Edward's Mine Property)	5.400	0.0	0.0	0.054	0.054	1983	1984	100
C-033301 (Sunflower Energy: Blue Ribbon Mine Property)	0.7	0.010	0.070	0.070	0.070	1977	1979	10

TABLE R8- 1

(continued)

	Recoverable Reserves (million tons)	Annual Production (million tons per year)				Time Points		
		1977	1980	1985	1990	Start Construction	Full Mine Operation	Mine Life (Years)
3. (continued)								
D-036955 (Pittsburg-Midway: Farmers Mine Property)	2.800	0.0	0.0	0.028	0.028	1983	1984	100
D-038385	1.05	0.0	0.0	0.011	0.011			
C-0120073	13.5	0.0	0.0	0.135	0.135			
C-0120076	14.2	0.0	0.0	0.142	0.142			
C-0120077	7.5	0.0	0.0	0.075	0.075			
C-0120078	12.0	0.0	0.0	0.120	0.120			
C-0120079	15.5	0.0	0.0	0.155	0.155			
C-0120080 (Kemmerer Coal Company)	9.8	0.0	0.0	0.098	0.098			
Subtotal	73.5	0.0	0.0	0.735	0.735	1983	1984	100
	Subtotal	0.026	1.870	5.549	5.549			
	GRAND TOTAL	3.060	6.733	9.895	9.441			

TABLE R8-2

LEVEL OF DEVELOPMENT OF PROPOSED, EXISTING, AND PROPOSED MINING OPERATIONS UNDER THE DILIGENT DEVELOPMENT SCENARIO: EMPLOYMENT, UNIT TRAINS, MARKET AREA

	Employment Construction / Permanent				Estimated Number and Direction of Unit Trains per Year				
	1977	1980	1985	1990	1977	1980	1985	1990	Market Area
1. Existing and projected mining operations producing from private reserves only (production not federally controlled)									
Belden Enterprises, Inc.: Red Canyon No. 1 Mine	0 / 1	0 / 1	0 / 0	0 / 0	0	0	0	0	Local domestic sales only
Western States Coal Company: Fairview Mine	0 / 0	0 / 0	0 / 60	0 / 60	0	0	0	0	Local industrial and domestic market
Quinn Coal Company: Tomahawk Strip Mine	3 / 5	0 / 18	0 / 18	0 / 18	0	0	0	0	Various unspecified utilities and local domestic sales
Peabody Coal Company: Nucla Strip Mine	0 / 24	0 / 24	0 / 24	0 / 24	0	0	0	0	Nucla Power Plant, Nucla, Colorado; local domestic sales
Henry Bendetti Coal Company: Nu Gap No. 3 Mine	0 / 1	0 / 1	0 / 1	0 / 1	0	0	0	0	Local and domestic markets
Louis Bendetti Coal Company: Eastside Mine	0 / 1	0 / 1	0 / 1	0 / 1	0	0	0	0	Local and domestic markets
Carbon King Ltd.: Sunlight Mine	0 / 4	0 / 10	0 / 10	0 / 10	0	0	0	0	Local and domestic markets

TABLE R8-2

(continued)

	Employment: Construction / Permanent				Estimated Number and Direction of Unit Trains per Year				
	1977	1980	1985	1990	1977	1980	1985	1990	Market Area
Coal Fuels Corporation: Farmers Mine	0 / 0	0 / 50	0 / 50	0 / 50	0	0	0	0	Unspecified utility
Subtotals:	3 / 36	0 / 105	0 / 164	0 / 164	0	0	0	0	
2. Existing mining operations producing from Federal leases (and possibly adjacent private reserves) for which an exploration or mining and reclamation plan (submitted according to the requirements of 30 CFR: 211.10) has been approved									
Sheridan Enterprises: (exploration plan only)	0 / 30	0 / 40	0 / 0	0 / 0	0	0	0	0	Various out-of-state utilities
GEX Colorado Company: Roadside Mine	14 / 102	0 / 213	0 / 148	0 / 0	0	80 West	20 West	0	Arizona Electric Power Company, Page (or Benson), Arizona; local domestic sales
O.C. Mine Company: O.C. No. 2 Mine	0 / 5	0 / 6	0 / 6	0 / 0	0	0	0	0	Local domestic market
Mid-Continent Coal and Coke Company: Coal Basin Mines	0 / 344	0 / 492	0 / 492	0 / 492	145 West	140 West	140 West	140 West	U.S. Steel Geneva Works, Orem, Utah; Kaiser Steel Fontana Plant, Fontana, California

TABLE R8-2

(continued)

	Employment Construction / Permanent				Estimated Number and Direction of Unit Trains per Year				
	1977	1980	1985	1990	1977	1980	1985	1990	Market Area
U.S. Steel Corporation: Somerset Mine	0 / 298	0 / 298	0 / 298	0 / 298	94 West	94 West	94 West	94 West	U.S. Steel Geneva Works, Orem, Utah
ARCO (Bear Coal assignee): Bear Mine	0 / 49	0 / 55	0 / 55	0 / 55	23	24	0	0	Various public utilities and industries; local and domestic sales
Colorado Westmoreland, Inc.: Orchard Valley Mine	200 / 102	0 / 160	0 / 160	0 / 160	28 East	70 East	70 East	70 East	Northern Indiana Public Service Co., Hammond, Indiana; local and domestic sales
Western Slope Carbon: Hawksnest No. 3 Mine Hawksnest East Mine	20 / 100	0 / 180	0 / 200	0 / 200	20	60	75	75	Colorado Fuel and Iron, Pueblo, Colorado; local and domestic sales
Subtotals:	234 / 1,030	0 / 1,444	0 / 1,359	0 / 1,205	310	468	399	379	
3. Federal leases for which mining and reclamation plans as required by 30 CFR: 211.10 have not been approved									
C-01538 (GEX Colorado Company: Cameo Mine Property)	0 / 0	0 / 213	0 / 82	0 / 82	0	80 East	30 East	30 East	a/

a/ It is impossible to predict potential market areas for these leases.

TABLE R8-2

(continued)

	Employment Construction / Permanent 1977	1980	1985	1990	Estimated Number and Direction of Unit Trains per Year 1977	1980	1985	1990	Market Area
C-037277					0	0	13	13	
D-040389					0	0	1	1	
C-059420					0	0	3	3	
(Mid-Continent Coal and Coke Company: Coal Canyon Mine Property)	0 / 0	0 / 0	0 / 25	0 / 25					
C-020740					0	0	0	0	
C-024998					0	0	14	14	
C-029889					0	0	13	13	
(Mid-Continent Coal and Coke Company: Cottonwood Creek Mine Property)	0 / 0	0 / 0	0 / 65	0 / 65					
C-0125436					0	0	13	13	
C-0125437					0	0	13	13	
C-0125438					0	0	13	13	
C-0125439					0	0	13	13	
C-0125515					0	0	14	14	
C-0125516					0	0	13	13	
(Sheridan Enterprises: Loma Mine Property)	0 / 0	0 / 0	0 / 215	0 / 215					
C-08172									
C-08173									
(Anschutz Coal Company: Thompson Creek Mine Property)	0 / 112	0 / 320	0 / 320	0 / 320	0	100 West	100 West	100 West	
D-044569					0	0	26	26	
C-1362					0	0	83	83	
C-0117192					0	0	26	26	
(ARCO: Mt. Gunnison Mine Property)	0 / 0	0 / 0	0 / 315	0 / 315					
D-055156 (Utah International)	0 / 0	0 / 0	0 / 9	0 / 9	0	0	3	3	

TABLE R8- 2

(continued)

	Employment Construction / Permanent 1977	1980	1985	1990	Estimated Number and Direction of Unit Trains per Year 1977	1980	1985	1990	Market Area
D-043937 (Eileen Tolley)	0 / 0	0 / 0	0 / 3	0 / 3	0	0	0	0	
C-012765 (Garland Coal and Mining Company)	0 / 0	0 / 0	0 / 14	0 / 14	0	0	5	5	
C-074632 (Mid-Continent Coal and Coke Company)	0 / 0	0 / 0	0 / 15	0 / 15	0	0	6	6	
D-037766 (Thompson Creek Mining)	0 / 0	0 / 0	0 / 3	0 / 3	0	0	1	1	
C-1894	0 / 0	0 / 0	0 / 3	0 / 3	0	0	1	1	
C-7852	0 / 0	0 / 0	0 / 4	0 / 4	0	0	2	2	
C-7853	0 / 0	0 / 0	0 / 20	0 / 20	0	0	8	8	
C-012638	0 / 0	0 / 0	0 / 9	0 / 9	0	0	3	3	
C-012639	0 / 0	0 / 0	0 / 22	0 / 22	0	0	8	8	
C-030344	0 / 0	0 / 0	0 / 12	0 / 12	0	0	4	4	
C-030346	0 / 0	0 / 0	0 / 14	0 / 14	0	0	5	5	
C-0125485	0 / 0	0 / 0	0 / 5	0 / 5	0	0	2	2	
C-051669	0 / 0	0 / 0	0 / 22	0 / 22	0	0	15	15	
C-068389	0 / 0	0 / 0	0 / 8	0 / 8	0	0	8	8	
D-052558	0 / 0	0 / 0	0 / 10	0 / 10	0	0	9	8	
(U.S. Steel Corporation)									
D-052501 (Anchor Coal Company: Edwards Mine Property)	0 / 0	0 / 0	0 / 9	0 / 9	0	0	6	6	
C-033301 (Sunflower Energy: Blue Ribbon Mine Property)	20 / 8	0 / 10	0 / 10	0 / 0	0	7	7	0	
D-036955 (Pittsburg-Midway: Farmers Mine Property)	0	0	4	4	0	0	3	3	

TABLE R8-2

(continued)

	Employment: Construction / Permanent 1977	1980	1985	1990	Estimated Number and Direction of Unit Trains per Year 1977	1980	1985	1990	Market Area
D-038385	0	0	3	3	0	0	1	1	
C-0120073	0	0	22	22	0	0	14	14	
C-0120076	0	0	23	23	0	0	14	14	
C-0120077	0	0	15	15	0	0	7	7	
C-0120078	0	0	20	20	0	0	12	12	
C-0120079	0	0	25	25	0	0	16	16	
C-0120080	0	0	15	15	0	0	10	10	
(Kemmerer Coal Company)									
Subtotal	0	0	123	123	0	0	74	74	
Subtotals:	20 / 120	0 / 543	0 / 1,341	0 / 1,331	0	187	557	550	
GRAND TOTAL	257 / 1,186	0 / 2,092	0 / 2,864	0 / 2,700	310	655	956	929	
West:					239	414	354	334	
East:					28	150	100	100	
Unknown:					43	91	502	495	

TABLE R8- 3

DILIGENT DEVELOPMENT ALTERNATIVE:
PROJECTED POPULATION GROWTH

County	Year	Low-Level Scenario Population	Diligent Development Population	Percent Difference	Mid-Level Scenario Population
Delta	1980	20,600	20,600	0	21,100
	1985	22,900	23,700	3.5	26,400
	1990	24,800	25,850	4.2	28,900
Garfield	1980	33,000	33,000	0	33,000
	1985	38,650	38,900	0.7	39,350
	1990	45,100	45,200	0.2	46,400
Mesa	1980	91,750	91,750	0	91,950
	1985	106,000	107,800	1.7	113,300
	1990	94,800	96,350	1.6	107,150

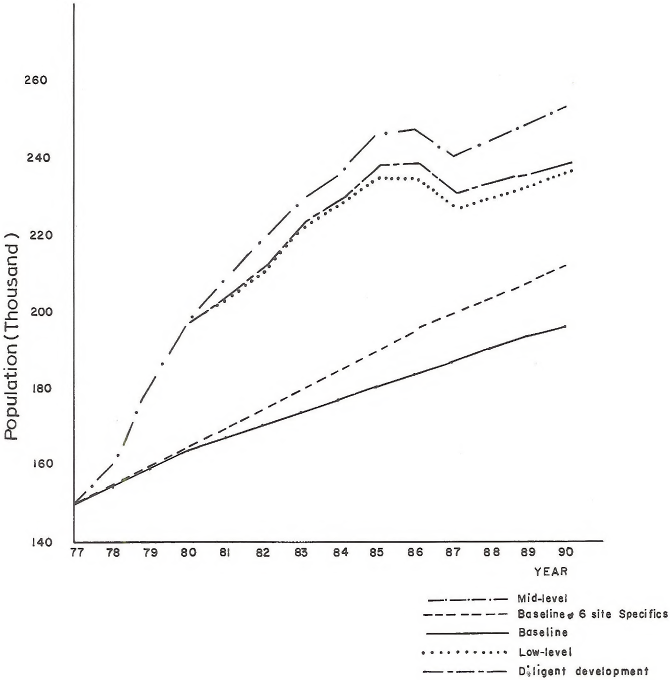


Figure R8-1. Population -- diligent development alcoholism, mental illness, and lower levels of job productivity. Polarization of communities between the newcomers and long-time residents would increase the difficulty in solving problems.

Community Facilities and Services

Table R8-4 shows community facilities that would be needed to provide for population growth above the 1977 population. These figures take into account the existing and planned excess capacity in these counties. Table R8-5 compares capital and operation and maintenance costs for the diligent development alternative with those of the cumulative mid-level requirements.

Under the alternative, capital costs in Delta County would be 31 percent less than with the most probable level of development. Operation and maintenance costs would be 24 percent lower in 1980, 46 percent lower in 1985, and 8 percent lower in 1990. In Garfield County capital costs would be 30 percent lower than under the mid-level of development, while operation and maintenance costs would be 2 percent lower in 1980, 7 percent lower in 1985, and 26 percent lower in 1990. In Mesa County capital costs would be 27 percent lower under this alternative as compared with the mid-level of development. Operation and maintenance costs would be 15 percent lower in 1980, 25 percent lower in 1985, and 38 percent lower in 1990. This alternative would result in significantly lower expenditures for public goods and services than the mid-level of development.

Housing

Housing needs under the diligent development alternative are shown in table R8-6. This table also gives housing needs for the mid-level of development. As shown on the table, the need for new housing would be substantially less under the diligent development alternative and would require correspondingly less labor and capital to meet these needs.

Education

School-aged population projections in the three counties affected by this alternative are given in table R8-7. Low- and mid-level school-aged populations are also given for comparison. This level of development would require lower capital investments and operating costs for the affected school districts than the cumulative level of development, as shown on table R8-8.

Health Care

Population growth induced by this level of coal production would increase pressure on local health care facilities and require more investment to provide for the people's needs. (Table R8-9 shows the investment that would be needed.) More physicians would need to be attracted to the area to adequately meet the needs.

Employment

The diligent development level of coal mining would create jobs in the coal sector for 710 persons in 1985 and 487 persons in 1990. Total employment in the region would increase by 1,420 persons in 1985 and 1,330 persons in 1990. This would help alleviate the unemployment that has been a problem in the ES area.

Revenue

Revenue to provide the needed facilities and services to accommodate projected population would come from several sources. Local government units would receive property tax revenues from mines and coal mined, new houses, and new businesses. In addition they would receive revenue from sales taxes and water and sewer service fees. Table R8-10 shows the revenues that could be generated by the increased population in the affected counties.

Summary

A comparison of projected costs and revenues under the alternative (table R8-11) shows that only Delta County would experience a period of revenue deficits and that even these would change to substantial surpluses by 1985. This alternative would effectively slow the rate of population growth in Delta, Mesa, and Garfield counties and allow them time to cope with growth from development of non-coal energy sources and to better prepare for development of the area's substantial coal reserves.

Other Resources

Environmental impacts due to coal mining could be expected to be similar in kind to those projected under the most probable level of development. However, in general they would be of lower magnitude and more restricted or isolated. In some cases, they would be deferred or spread out over a longer period of time.

Under this alternative, approximately 6.7 million tons of coal would be mined annually by 1980, 9.9 million tons annually by 1985, and 9.4 illion tons annually by 1990. This compares with approximately 7.5 million tons per year by 1980, 13.2 million tons per year by 1985, and 15.5 million tons per year by 1990 under the most probable level of development. If the coal produced is not sufficient to help meet national energy needs, then comparable quantities of coal from other areas or alternative sources of energy would have to be found.

TABLE R8-4

DILIGENT DEVELOPMENT ALTERNATIVES:
COMMUNITY FACILITY NEEDS ABOVE 1977 POPULATION

	1990	Operation and Maintenance		
Facility	Capitol Requirements	1980	1985	1990
Delta County:				
Water	0	0	0	0
Sewer	0	0	0	0
Police	2 vehicles 1,160 sq.ft. of space $ 93,720	0 0	$ 30,000	$116,000
Fire	2 trucks 6,900 sq.ft. of space $426,000	-	-	-
Streets and Roads	163 acres $5,251,900	$ 37,830	$108,640	$158,110
General Government	1,725 sq.ft. of space $111,090	$ 53,140	$154,220	$223,560
Libraries	20,700 books 3,800 sq.ft. of space $280,600	$ 13,400	$ 39,430	$ 57,270
Total	$6,163,310	$104,370	$332,290	$554,940

TABLE R8-4

DILIGENT DEVELOPMENT ALTERNATIVES:
COMMUNITY FACILITY NEEDS ABOVE 1977 POPULATION
(continued)

Facility	1990 Capitol Requirements	Operation and Maintenance 1980	1985	1990
Mesa County:				
Water	0	0	0	0
Sewer	0	0	0	0
Police	20 vehicles 11,820 sq.ft. of space $951,940	$ 998,000	$1,640,000	$1,192,000
Fire	10 vehicles 29,550 sq.ft. of space $1,932,000	-	-	-
Streets and Roads	696 acres $22,425,100	570,360	937,020	675,120
General Government	7,390 sq.ft. of space $424,930	808,700	1,328,400	957,740
Libraries	88,650 books 16,250 sq.ft. of space $1,200,330	207,090	340,300	245,270
Total	$26,934,300	$2,584,150	$4,245,720	$3,060,130

TABLE R8-4

DILIGENT DEVELOPMENT ALTERNATIVES:
COMMUNITY FACILITY NEEDS ABOVE 1977 POPULATION
(continued)

Facility	1990 Capitol Requirements	Operation and Maintenance 1980	1985	1990
Garfield County:				
Water	2.96 mgd $2,588,670	$ 32,550	$ 106,420	$ 185,300
Sewer	0.4 mgd $1,346,400	0	4,830	65,690
Police	16 vehicles 9,608 sq.ft. of space $771,200	472,000	708,000	960,000
Fire	9 vehicles 26,400 sq.ft. of space $1,731,000	-	-	-
Streets and Roads	622 acres $20,040,800	324,950	459,780	603,340
General	6,600 sq.ft. of space	460,080	651,240	855,360
Government	$425,040			
Libraries	79,200 books 14,520 sq.ft. of space $1,072,500	117,860	166,830	219,120
Total	$27,975,610	$1,407,440	$2,097,100	$2,888,810

TABLE R8-5

DILIGENT DEVELOPMENT ALTERNATIVE:
COMPARISON OF COSTS

County	Scenario	Capital Requirements	Operation and Maintenance		
			1980	1985	1990
Delta	Diligent Development	$ 6,163,310	$ 104,370	$ 332,290	$ 550,940
	Mid-Level Cumulative	8,951,000	136,700	611,500	871,300
Garfield	Diligent Development	27,975,610	1,407,440	2,097,100	2,888,810
	Mid-Level Cumulative	39,817,100	1,432,100	2,244,800	3,923,200
Mesa	Diligent Development	26,934,300	2,584,150	7,245,720	3,060,130
	Mid-Level Cumulative	36,778,000	3,050,600	5,696,800	4,899,100

TABLE R8-6

DILIGENT DEVELOPMENT ALTERNATIVE:
HOUSING NEEDS

Scenario	Year	Single Family	Mobile Homes	Multi-Family	Total
Delta County:					
Diligent Development	1980	358	137	55	550
	1985	1,029	396	158	1,583
	1990	1,495	575	230	2,300
Mid-Level Cumulative	1980	466	179	72	717
	1985	1,614	621	248	2,483
	1990	2,156	829	332	3,317
Garfield County:					
Diligent Development	1980	2,367	1,893	473	4,733
	1985	4,355	1,675	670	6,700
	1990	5,720	2,200	880	8,800
Mid-Level Cumulative	1980	2,367	1,893	473	4,733
	1985	4,453	1,712	685	6,850
	1990	6,977	2,683	1,073	10,733
Mesa County:					
Diligent Development	1980	4,158	3,327	832	8,317
	1985	8,884	3,417	1,366	13,667
	1990	6,403	2,462	985	9,850
Mid-Level Cumulative	1980	4,184	3,347	836	8,367
	1985	10,064	3,871	1,548	15,483
	1990	8,732	3,358	1,343	13,433

TABLE R8- 7

DILIGENT DEVELOPMENT ALTERNATIVE:
PROJECTED SCHOOL AGE POPULATION

County	Year	Low-Level Scenario	Diligent Developent Alternative	Mid-Level Scenario
Delta	1980	4,950	4,950	5,050
	1985	5,500	5,700	6,350
	1990	5,950	6,200	6,950
Garfield	1980	7,900	7,900	7,900
	1985	9,300	9,350	9,450
	1990	10,800	10,850	11,150
Mesa	1980	22,050	22,050	22,050
	1985	25,450	25,850	27,200
	1990	22,750	23,100	25,700

TABLE R8-8

DILIGENT DEVELOPMENT ALTERNATIVE:
NEEDED SCHOOL FACILITIES

Scenario	Capital Requirements	Operation and Maintenance		
		1980	1985	1990
Delta County:				
Diligent Development	$12,915,000	$ 984,000	$1,906,500	$2,521,500
Mid-Level Cumulative	17,600,000	1,100,000	2,700,000	3,400,000
Garfield County:				
Diligent Development	21,546,000	578,100	2,361,600	4,206,600
Mid-Level Cumulative	23,400,000	600,000	2,500,000	4,600,000
Mesa County:				
Diligent Development	0	0	430,000	0
Mid-Level Cumulative	16,700,000	0	2,100,000	300,000

TABLE R8-9

DILIGENT DEVELOPMENT ALTERNATIVE:
PROJECTED HEALTH CARE REQUIREMENTS (1990)

Scenario	Facility Requirements	Cost
Delta County:		
Diligent Development	12 hospital beds 1 emergency vehicle	$ 675,000
Mid-Level Cumulative	25 hospital beds 1 emergency vehicle	$1,405,000
Garfield County:		
Diligent Development	42 hospital beds 3 emergency vehicles	$2,355,000
Mid-Level Cumulative	53 hospital beds 4 emergency vehicles	$2,978,600
Mesa County:		
Diligent Development	23 hospital beds 1 emergency vehicle	$1,280,000
Mid-Level Cumulative	66 hospital beds 3 emergency vehicles	$3,675,000

TABLE R8-10

DILIGENT DEVELOPMENT:
REVENUE TO COUNTIES

Source	1980	1985	1990
Delta County:			
Property Tax			
Coal Mine Facilities	$ 0	$ 77,520	$ 77,520
Coal Mined	0	14,900	14,900
Homes	346,700	997,130	1,448,810
Businesses	38,780	111,640	162,170
Sales Tax	125,400	361,000	524,400
Water and Sewer Service Fees	5,470	15,750	22,890
Total	$516,350	$1,577,940	$2,227,800
Garfield County:			
Property Tax			
Coal Mine Facilities	$ 0	$ 731,760	$ 731,760
Coal Mined	0	150,860	158,860
Homes	3,368,040	5,426,060	7,127,170
Businesses	1,215,190	1,720,100	2,259,240
Sales Tax	2,348,680	3,324,540	4,366,560
Water and Sewer Service Fees	40,700	57,620	75,680
Total	$6,972,610	$11,418,940	$14,644,090
Mesa County:			
Property Tax			
Coal Mine Facilities	$ 673,750	$ 609,740	$ 609,740
Coal Mined	132,110	119,560	119,560
Homes	5,700,580	10,663,010	7,685,180
Businesses	1,371,200	2,254,590	1,624,950
Sales Tax	3,108,770	5,108,600	3,681,930
Water and Sewer Service Fees	103,960	170,840	123,130
Total	$11,060,370	$18,926,340	$13,844,490

TABLE R8-11

DILIGENT DEVELOPMENT ALTERNATIVE:
COMPARISON OF COSTS AND REVENUES

	1980	1985	1990
Delta County:			
Annual Costs	$ 641,720	$ 869,640	$ 1,088,290
Annual Revenues	516,350	1,577,940	2,227,800
Garfield County:			
Annual Costs	$ 3,846,480	$ 4,536,140	$ 5,327,850
Annual Revenues	6,972,610	11,418,940	14,644,040
Mesa County:			
Annual Costs	$ 4,932,410	$ 6,593,980	$ 5,408,390
Annual Revenues	11,060,370	18,926,340	13,844,490

The emission sources and emission rates of the diligent development alternative would be similar to those of the low-level scenario (discussed later in this chapter), except for the addition of the diligent development coal projects. The diligent development coal projects are located in the vicinity of the Coal Basin mines, the Hawksnest mines, and the Tomahawk Mine (see map 1 in the map packet of volume 3). The effect of these coal mines would be to increase the total annual particulate emissions given in table R8-17 (low-level scenario) by 316 tons for 1980 and 1985. About 300 tons of these additional emissions would originate from the diligent development projects near the Coal Basin mines.

The other diligent development projects located near the Hawksnest and Tomahawk mines would generate about 13 tons and 3 tons per year of particulate emissions, respectively. The population levels for the diligent development alternative do not differ significantly from the low-level scenario. Therefore, no significant differences exist for the pollutant emissions from towns and vehicles. The emissions from the major point sources are identical.

On a regional basis the impacts on air quality, visibility, and meteorology produced by the low-level scenario and the diligent development alternative would be almost identical because the differences between pollutant emission rates are very small. The individual impacts of the coal mines in the vicinity of the Hawksnest and Tomahawk mines would be small and confined to the immediate vicinity of the mine site. Because their locations do not coincide with the maximum impact areas of the low-level scenario, they would not produce an increase in adverse impacts as a result of interaction with emissions from existing sources. Also, the impacts of the Coal Basin mines are confined to a dispersion subarea which does not interact significantly with other areas of major impact.

Impacts to water resources would depend largely on the particular mining method used and on the extent of the aquifer in the area to be mined. On the whole, however, impacts would be of the same type as those predicted for the most probable level of development but lower in magnitude and scope. Additionally, many impacts would be deferred (e.g., impacts to Palisade's water pipelines as described in the Cottonwood Creek site-specific), and impacts which are projected to occur after mining has been completed would be deferred past the year 2000.

To some extent, subsidence impacts would also depend on whether mining would be by longwall or room-and-pillar methods. In general, subsidence would initially occur more slowly and in more restricted areas, although eventually, as more and more coal is mined, it would affect much the same areas as predicted for the most probable level of development.

Some rehabilitation of disturbed areas would occur during mine life. However, successful revegetation and return to pre-mining uses would probably be postponed well beyond the mine-lives predicted in chapter 1 (table R1-1.)

Wildlife might have more time to adapt to loss of habitat. The major loss of on-site habitat would still be due to development of surface facilities, and it is possible that slightly less acreage would be lost under this alternative. Additionally, disturbed habitat would be lost to most or all wildlife for a much longer period of time. Impacts to rare and endangered species would be similar to those projected in the most probable level of development. To the extent that communities would have more time to upgrade sewage treatment facilities, impacts to aquatic wildlife would be lessened.

Cultural resources would still be subject to potential damage due to vandalism, illegal collecting, etc. Use of recreational facilities would be less than under the most probable level of development, in proportion to the lower population growth. Communities would also have a longer period of time to improve or replace existing facilities. Landscapes would be altered more slowly, but visual impacts of mine development would last longer, particularly those which require successful revegetation for amelioration.

Some coal companies might decide to truck coal to existing rail loadout facilities rather than construct new facilities, in which case roads in the ES area would be subject to deterioration, increased accidents, and traffic delays. To the extent that production would be lower, fewer unit trains would be needed, reducing the potentials for car-train collisions and crossing delays in the ES area and rail congestion outside the area.

All of these resources would still be subject to impacts due to other kinds of development in the ES area, such as oil shale and uranium, to the extent that they occur.

APPROVAL SUBJECT TO ADDITIONAL REQUIREMENTS OR MODIFICATIONS

Subject to existing laws and regulations, the Department has the choice of approving an M&R plan with additional stipulations or changes to lessen adverse environmental impacts. For example, operation, transportation, or other alternatives could be adopted when such alternatives would reduce adverse impacts.

Operational Alternatives

Operational alternatives have been proposed for particular M&R plans when reasonable alternatives could be identified (see site-specific chapter 8s). No operational alternatives have been identified on a regional basis, since impacts of each proposed operation are different and no one alternative would be applicable to all.

Coal Transportation Alternatives

Transportation alternatives have been proposed for particular M&R plans when reasonable alternatives could be identified (see site-specific chapter 8s).

All six M&R plans propose to transport coal out of the region by rail, although Sheridan Enterprises has not so far submitted an application for a right-of-way. The two major alternatives to rail transport would be truck transport and slurry pipelines, but neither is considered a feasible alternative to rail transport in the ES area.

The trucking of 10.54 million tons of coal per year by 1990 would cause severe deterioration of local and secondary roads and federal and state highways, most of which are inadequate to withstand repeated usage by heavyduty trucks, even if the gross vehicle weights were within the posted limits. The costs of repairing or upgrading many of the affected roads would fall heavily on state and county governments. Part of the funds needed could be supplied by revenues from the mines (bonuses, rentals, royalties, etc.) through existing laws. However, it is doubtful that such monies would be adequate to solve the problem, and there is no legal requirement that the state or affected counties spend such monies on road systems. In addition, the increase in truck traffic in the ES area would greatly increase air pollution, traffic accidents, and congestion on roads throughout the ES area. Local communities would be affected by traffic volume, noise and vibrations, air pollution, and coal spillage. It is also questionable whether trucking over long distances would be economically justified when compared with rail transport.

Although the technology of slurry pipelines is well developed, only one such pipeline system, the Black Mesa slurry line in Arizona, is currently operational. Due to the time required to plan, construct, and make coal slurry pipelines operational, and to resolve the issues surrounding the development of this industry, no significant coal pipeline capacity is anticipated in the United States through 1990.

The major foreseeable impact of slurry pipelines is water consumption. The process of coal slurrying requires approximately 1 ton of water for each ton of coal, and this water would be lost from the area in which it is obtained.

Acquisition of rights-of-way is also a problem. A proposal to grant pipeline developers the right to exercise the power of eminent domain to obtain rights-of-way for proposed pipelines was recently rejected by the U.S. Congress. Although a number of western states have legislation that would permit the granting of such rights, it is difficult to predict future developments in this area.

For all of the above reasons, slurry pipelines are not considered reasonable alternatives on either a site-specific or regional basis.

Alternative Available to Other Agencies

Increased traffic would cause delays for motorists at grade crossings. A 75-car unit-train at 30 miles per hour (mph) would take approximately 1.5 minutes to clear the crossing. Hazard ratings would also increase at all grade crossings, ranging from 0.03 accidents per 5 years to 1.76 accidents per 5 years above present ratings. Many of these impacts could be reduced by construction of overpasses at crossings where congestion proves to be a problem. Signal lights could also reduce hazards at crossings where topography or other obstructions decrease visibility. However, state and county agencies may have difficulty obtaining funds to finance these improvements.

Busing of Coal Mine Employees

Busing of employees to the mine sites would reduce the total vehicle miles travelled (VMT) in the ES area. As a direct result of reducing VMT, air pollution, noise levels, and accident rates would also be reduced. Impacts on road service levels would also proportionally decrease; for example, by using eight buses rather than 300 cars, Atlantic Richfield Company could reduce the impacts on State Highways 133 and 92 by a factor of 58 percent, and other companies could also expect similar reductions on roads impacted by employee traffic. Car-pooling and van-pooling would also reduce VMT, but not to as great an extent as busing.

DEFER ACTION

For proper cause, the Department may defer final action on a proposed M&R plan. Reasons for deferring action can include, but are not limited to, the need and time required for:

1. Modification of the proposal to correct administrative or technologic deficiencies;
2. Redesign to reduce or avoid environmental impact;

3. Acquisition of additional data to provide an improved basis for technical or environmental evaluation;

4. Further evaluation of the proposal and/or alternatives.

The principal effect of deferring action on a proposed M&R plan on these grounds would be a comparatively short-term delay in the occurrence of all related impacts of the proposals (both adverse and beneficial), as previously described in the chapter 3s of the site-specific volume and chapter 4 of the regional volume. To the extent that an M&R plan can be redesigned to alleviate adverse impacts, those impacts would be lessened. For example, not enough information is available from Sheridan Enterprises for complete environmental assessment of the company's proposed rail corridor. Approval of the M&R plan could be deferred until Sheridan submits a right-of-way application. Additionally, approval of all of the M&R plans could be deferred until they have been evaluated with regard to best management practices for nonpoint sources of water pollution and the guidelines of the Colorado River Salinity Forum (as suggested by the Environmental Protection Agency; see letter 6 in chapter 9).

As pointed out at the beginning of this chapter, none of the M&R plans has been reviewed for compliance with the interim regulations, and the Department will not consider the plan for approval until it is brought into compliance with all applicable federal requirements.

PREVENTION OF FURTHER DEVELOPMENT

No Action Alternative

"No action" on proposals for extention of existing private mining operations onto federal coal (such as Anschutz Coal Corporation's North Thompson Creek operation and GEX Colorado Company's Cameo operation) would equate to preventing further development of those mines onto federal coal. "No action" on mining proposals for the initial development of existing leases (such as Sheridan Enterprises' Loma Project, Mid-Continent Coal and Coke Company's Coal Canyon and Cottonwood Creek proposals, and Atlantic Richfield's Mt. Gunnison proposal) would equate to maintaining the status quo on those leases.

Under existing regulations, operations may not proceed in the absence of approved M&R plans and related permits. The alternative of rejecting the M&R plans is discussed earlier in this chapter.

Relinquishment of Leases

The BLM is reviewing nonproducing existing leases. Nonproducing leases are to be reviewed in accordance with planning standards and in compliance with the unsuitability criteria developed pursuant to the requirements of section 522(b) of SMCRA.

If an area was found to be unsuitable for mining, there would be no additional incremental environmental impact on the area, and it would continue in its present condition, subject to further modification by natural processes, the continuation of existing mining activity, and such future uses of the surface as the owners may decide upon.

Under Congressional Bill S3189 (October 13, 1978), the Secretary may exchange leased lands that are determined and/or proven to be unmineable for an equivalent area of unleased land. In addition, the Federal Land Policy and Management Act of 1976 (PL 94579), Section 206, gives the Secretary general authority to dispose of public lands by exchange, subject to applicable laws, when the Secretary "determines that the public interest will be well served by making that exchange: *Provided* that when considering public interest the Secretary concerned shall give full consideration to better Federal land management and the needs of State and local people, including needs for lands for the economy, community expansion, recreation areas, food, fiber, minerals, and fish and wildlife and the Secretary concerned finds that the values and the objectives which Federal lands or interests to be conveyed may serve if retained in Federal ownership are not more than the values of the non-Federal lands or interests and the public objectives they could serve if acquired."

SOCIOECONOMIC ALTERNATIVES AVAILABLE TO STATE AND LOCAL GOVERNMENTS

The socioeconomic analysis in chapter 4 indicates that communities in the ES area would experience severe adverse impacts due to projected regional development and its associated rapid population growth. Most of the adverse impacts are attributable to simultaneous development of multiple energy resources (oil shale, uranium, coal, etc.) or to moderate development (particularly coal development) in areas such as the North Fork Valley which have a small base population. An alternative level of coal development for the ES area is discussed as the Diligent Development and Continuous Operations alternative under Approval or Rejection in Part earlier in this chapter; this alternative would moderate some of the adverse socioeconomic impacts of regional minerals development.

However, additional actions may be available to state and local governments which, if implemented, could further reduce some of the major socioeconomic impacts.

One of the major adverse impacts of regional development would be the inability of local communities to improve or increase facilities. In some communities or counties, the major difficulty would be the time lag between the start of a project and the receipt of revenues (severance taxes, property taxes, etc.); as a result, funds are often not available to meet the needs of new populations generated by the project. One possible solution to this problem is prepaid taxes, that is, the company or companies would pay an agreedupon portion of future taxes (e.g., for the first five years) in advance to the affected county. It is possible that the state could require prepayment as a stipulation before approval of a mining permit. However, a more feasible method would be for the county and company involved to negotiate an agreement themselves.

This kind of advance payment would provide money to counties to upgrade facilities as populations begin to increase. It might also help prevent the "boomtown" syndrome by attracting people who wanted to make the area a permanent home and who would be interested in preserving an attractive, stable community. A more stable population might also result in less employee turn-over, which would benefit the company. In addition, the company might gain certain tax advantages on the advanced payments.

An additional difficulty for some communities is that a project which causes population growth and attendant strains on facilities in a town may be located outside town limits so that the town gets no revenue from property taxes. A possible solution to this problem is for communities in the area of a project to establish special service districts, as has been done in Emery County, Utah. The service district would then be able to levy taxes on the project, which would provide revenues to the communities in the district for improving facilities, etc.

A similar problem can affect some counties: a project may be located in one county, which receives the revenues from the project, while population growth due to the project may occur in a neighboring county. The two counties might be able to reach an agreement whereby they would share tax and other revenues from the project. State legislation might be required to allow counties to negotiate such solutions to their problems or to make provision for transfer of revenues to the county which would be impacted by the project. Another possible legislative action would be relocation of county boundaries so that the project and the impacted communities would end up in the same county; however, this action could have political ramifications which might in practice outweigh local needs.

Another major impact of regional development would be the transfer of agricultural land, including prime and unique farmland, to other uses, particularly urban expansion. As pointed out throughout the ES, the primary means to prevent this encroachment is adequate land-use planning and zoning by the counties and municipalities in the ES area. If zoning is effectively enforced, community development can be located in those areas which best suit the needs of the counties and towns involved.

Another method for protecting agricultural lands would be for the state or county to buy the development rights on agricultural lands. The state or county would have to pay a price for the rights comparable to that offered by housing and industrial developers, and finding money for this could be difficult. Once the state or county has obtained development rights, the landowner would be able to sell the land only to people who would guarantee to use the land for agricultural purposes.

Zoning and purchase of development rights are only two mechanisms for protecting agricultural lands. Research by the appropriate state and local agencies may reveal others.

LOW-LEVEL SCENARIO

The analysis developed in this section is an assessment of regional impacts expected to occur through 1990 from the concurrent development of fifteen existing mines (thirteen underground and two surface), two projected private coal mines (GEX Colorado Company's Cameo No. 1 Mine and Western States Coal's Fairview Mine), and other mineral resources (oil, oil shale, gas, etc.). The existing coal mines would continue to operate under current plans on private, state, and federal coal reserves with expansions as summarized in tables R8-12, R8-13, and R8-14. They will also have to comply with the requirements of the interim regulations, 30(CFR): 700, after May 3, 1978. Table R8-15 summarizes projected development, and table R8-16 summarizes projected surface disturbance. This scenario is not an alternative to the proposed actions. It is presented to provide additional baseline perspectives on the most probable level of development.

Air Quality

Emissions and Modeling Procedures

The emissions sources that constitute the low-level scenario are existing coal mines, major point sources, towns, and highways. Emissions of total

TABLE R8-12

EXISTING LOW-LEVEL OPERATIONS: MINING METHODS, RECOVERABLE RESERVES, ANNUAL COAL PRODUCTION, TIME POINTS

Map Unit	Company and Mine Name	Mining Method	Recoverable Reserves (million tons/year)	Annual Coal Production (million tons/year) 1977	1980	1985	1990	Time Points: Start Construction	Full Mine Operation	Mine Life (years)
	Colorado Westmoreland, Inc.: Orchard Valley Mine	Conventional room & pillar by continuous mining units (underground)	2	0.29	0.70	0.00	0.00	1976	1979	3 (to 1981)
	U.S. Steel Corporation: Somerset Mine	Conventional room & pillar by continuous mining units (underground)	Not available	0.92	0.94	0.94	0.94	1961	1970	25 + (or indefinite)
	Sunflower Energy Corporation: Blue Ribbon Mine	Conventional room & pillar (underground)	1	0.01	0.07	0.00	0.00	1977	1978	4 (to 1982)
	Atlantic-Richfield Company (Bear Coal Company operator): Bear Mine	Conventional room & pillar by continuous mining units (underground)	Not available	0.23	0.24	0.00	0.00	1932	1937	25 + (or indefinite)
	Western Slope Carbon, Inc.: Hawksnest East Mine	Conventional room & pillar by continuous mining units (underground)	Not available	0.19	0.60	0.75	0.75	1975	1985	Indefinite
	Hawksnest No. 3 Mine			0.01	0.00	0.00	0.00	1970	1972	Indefinite
			Subtotal	0.20	0.60	0.75	0.75			
	Belden Enterprises, Inc.: Red Canyon No. 1 Mine	Conventional room & pillar (underground)	Unknown	(412 tons)	(1,000 tons)	(1,000 tons)	(1,000 tons)	1916	1916	Unknown
	Quinn Coal Company: Tomahawk Strip Mine	(Surface)	2 (strippable)	0.02	0.25	0.25	0.00	1976	1980	12 (to 1988 or 89)

TABLE R8-12

EXISTING LOW-LEVEL OPERATIONS: MINING METHODS, RECOVERABLE RESERVES, ANNUAL COAL PRODUCTION, TIME POINTS (Continued)

Map Unit	Company and Mine Name	Mining Method	Recoverable Reserves (million tons/year)	Annual Coal Production (million tons/year) 1977	1980	1985	1990	Time Points: Start Construction	Full Mine Operation	Mine Life (years)
	Sheridan Enterprises, Inc.: Loma Project (exploratory only)	Conventional room & pillar by continuous mining units (underground)	Not applicable	0.07	0.10	0.00	0.00	1976	Not applicable	4 (to 1980)
	GEX Colorado Company:									
	Cameo No. 1 Mine	Conventional room & pillar by continuous mining units (underground)	8	0.00	0.80	0.00	0.00	1977	1979	1981
	Roadside Mine		9	0.30	0.80	0.20	0.00	1973	1979	14 (to 1987)
			Subtotal	0.30	1.60	0.20	0.00			
	Coal Fuels Corporation: Farmers Mine	Retreating longwall and advancing entries by continuous mining units (underground)	7	0.00	0.20	0.20	0.20	1977	1979	35
	Louis Bendetti Coal Co.: Eastside Mine	Raise methods and recovery on steeply pitching beds (updip or upslope mining) (underground)	Unknown	(257 tons)	(1,000 tons)	(1,000 tons)	(1,000 tons)	1973	1977	Unknown
	Henry Bendetti Coal Co.: Nu Gap No. 3 Mine	Raise methods and recovery on steeply pitching beds (updip or upslope mining) (underground)	Unknown	(397 tons)	(1,000 tons)	(1,000 tons)	(1,000 tons)	1970	1977	Unknown
	Anschutz Coal Co.: North Thompson Creek No. 1 and No. 3 Mines	Retreating longwall and advancing entries by continuous mining units (underground)	Not available	0.02	1.00	1.00	1.00	1975	1980	15

TABLE R8-12

EXISTING LOW-LEVEL OPERATIONS: MINING METHODS, RECOVERABLE RESERVES, ANNUAL COAL PRODUCTION, TIME POINTS
(Continued)

Map Unit	Company and Mine Name	Mining Method	Recoverable Reserves (million tons/year)	Annual Coal Production (million tons/year)				Time Points		
				1977	1980	1985	1990	Start Construction	Full Mine Operation	Mine Life (years)
	Mid-Continent Coal and Coke Company: Coal Basin Mines	Advancing longwall and conventional room & pillar by continuous mining units (underground)	Not available	0.92	0.90	0.90	0.90	1973	1975	Not available
	Carbon King, Ltd.: Sunlight Mine	Conventional room & pillar (underground)	Unknown	(1,792 tons)	0.03	0.05	0.05	1977	1981	Unknown
	O.C. Mine Company: Ohio Creek No. 2 Mine	Conventional room & pillar (underground)	0.04	(3,696 tons)	(4,000 tons)	(4,000 tons)	0.00	1968	1969	20 (to 1988)
	Peabody Coal Company: Nucla Strip Mine	Surface	Not available	0.09	0.10	0.10	0.10	1963	1972	Not available
	Western States Coal Company: Fairview Mine	Conventional room & pillar by continuous mining units (underground)	7	0.00	0.00	0.25	0.25	1983	by 1985	less than 30
			TOTAL	3.07	6.73	4.64	4.19			

R8-13

EXISTING LOW-LEVEL OPERATIONS: TOTAL ACREAGE, FEDERAL LI TOTAL ACREAGE DISTURBED, CUMULATIVE ADDITIONAL ACREAGE DISTURBED

Map Unit	Company and Mine Name	Total Project Acres	Federal Lease Acres (in project acres)	Total Disturbance as of 1977	Cumulative Additional Surface Disturbance (acres): Railroads 1980	Railroads 1985	Railroads 1990	Roads 1980	Roads 1985	Mine Facilities 1980	Mine Facilities 1985	Mine Facilities 1990	Refuse Disposal 1980	Refuse Disposal 1985	Refuse Disposal 1990	Powerlines and Communications Lines 1980	Powerlines and Communications Lines 1985	Powerlines and Communications Lines 1990	Cumulative Total Base Level 1977	Cumulative Total 1980	Cumulative Total 1985	Cumulative Total 1990
	Colorado Westmoreland, Inc.: 1/ Orchard Valley Mine	608	311	139	-13	-13	-13	-5	-5	0	0	1	2	8	15	3	3	5	139	126	132	145
	U.S. Steel Corporation: Somerset Mine	7,600	4,095	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	39	39	39
	Sunflower Energy Corporation: Blue Ribbon Mine	160	0	10	0	0	0	0	0	0	0	0	1	1	1	0	0	0	10	11	11	11
	Atlantic-Richfield Company (Bear Coal Company operator): 1/ Bear Mine	12,578	7,461	25	0	0	0	0	0	0	0	-25	0	0	0	0	0	0	25	25	25	0
	Western Slope Carbon, Inc.: Hawksnest East Mine Hawksnest No. 3 Mine	1,260	1,250	35	14	14	14	0	0	0	0	0	15	40	65	0	0	0	35	64	89	114
	Belden Enterprises, Inc.: Red Canyon No. 1 Mine	60	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	35	35	35
	Quinn Coal Company: Tomahawk Strip Mine	480	0	30	0	0	0	0	0	0	0	0	20	40	65	0	0	0	30	50	70	95
	Sheridan Enterprises, Inc: Loma Project (exploratory only)	Not applicable	Not applicable	20	0	0	0	8	8	2	2	2	0	0	0	0	0	0	20	30	30	30
	GEX Colorado Company: Cameo No. 1 Mine	2,255	0	0	7	7	7	0	0	180	180	180	51	51	51	0	0	0	0	238	238	238
	Roadside Mine	1,360	810	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	60	60	60
	GEX-Colorado Subtotals	3,615	810	60	7	7	7	0	0	180	180	180	51	51	51	0	0	0	60	298	298	298
	Coal Fuels Corporation: Farmers Mine	440	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	26	26	26

1/ Negative disturbed acres represent reclamation of existing disturbance.

TABLE R8-13

EXISTING LOW-LEVEL OPERATIONS: TOTAL ACREAGE, FEDERAL LEASE ACREAGE, TOTAL ACREAGE DISTURBED, CUMULATIVE ADDITIONAL ACREAGE DISTURBED (continued)

Map Unit	Company and Mine Name	Total Project Acres	Federal Lease Acres (in project acres)	Total Disturbance as of 1977	Cumulative Additional Surface Disturbance (acres)																	
					Railroads			Roads			Mine Facilities			Refuse Disposal			Powerlines and Communications Lines			Cumulative Total			
					1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990	Base Level 1977	1980	1985	1990
	Louis Bendetti Coal Co.: Eastside Mine	500	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10
	Henry Bendetti Coal Co.: NuGap No. 3 Mine	800	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10
	Anschutz Coal Co.: North Thompson No. 1 and No. 3 mines	2,800	0	46	40	40	40	0	0	0	0	0	0	0	0	0	0	0	0	46	86	86	86
	Mid-Continent Coal and Coke Company: Coal Basin Mines	6,050	5,310	290	0	0	0	0	0	0	0	0	0	15	40	65	0	0	0	290	305	330	355
	Carbon King, Ltd.: Sunlight Mine	480	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2
	O.C. Mine Company: Ohio Creek No. 2 Mine	80	80	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10
	Peabody Coal Company: Nucla Strip Mine	Not available	0	220	0	0	0	0	0	0	0	0	0	20	80	120	0	0	0	220	240	300	340
	Western States Coal Company: Fairview Mine	600	0	0	0	0	0	0	0	0	0	10	10	0	15	40	0	0	0	0	0	25	50
	Total	38,111	19,317	1,007	48	48	48	3	3	6	182	192	168	124	275	422	3	3	5	1,007	1,367	1,528	1,656

TABLE R8- 14

EXISTING LOW-LEVEL OPERATIONS: EMPLOYMENT, UNIT TRAINS, MARKET AREA

Map Unit	Company and Mine Name	Employment 1977 Const./Perm.	Employment 1980 Const./Perm.	Employment 1985 Const./Perm.	Employment 1990 Const./Perm.	Estimated Number and Direction of Unit Trains per Year 1977	1980	1985	1990	Market Area
	Colorado Westmoreland, Inc.: Orchard Valley Mine	200 / 100	0 / 160	0 / 0	0 / 0	28 East	70 East	0	0	No. Indiana Public Service, Hammond, Indiana; local domestic sales.
	U.S. Steel Corporation: Somerset Mine	0 / 298	0 / 298	0 / 298	0 / 298	94 West	94 West	94 West	94 West	Geneva works, Orem, Utah.
	Sunflower Energy Corporation: Blue Ribbon Mine	20 / 8	0 / 8	0 / 0	0 / 0	0	0	0	0	Local domestic market and public utilities (no information on locations available).
	Atlantic-Richfield Company (Bear Coal Company operator): Bear Mine	0 / 49	0 / 55	0 / 0	0 / 0	23 East	0	0	0	Various public utilities and industries; local domestic sales. (Bear and Hawksnest production are combined and shipped approximately once per week by unit train. This is broken out here into 23 for Bear and 20 for Hawksnest, in proportion to their production.)
	Western Slope Carbon, Inc.: Hawksnest East Mine Hawksnest No. 3 Mine	20 / 102	0 / 180	0 / 200	0 / 200	20 East	60 East	75 East	75 East	Colorado Fuel and Iron, Pueblo, Colorado; local domestic sales.
	Belden Enterprises, Inc.: Red Canyon No. 1 Mine	0 / 1	0 / 1	0 / 1	0 / 1	0	0	0	0	Local domestic sales only.

TABLE R8- 14

EXISTING LOW-LEVEL OPERATIONS: EMPLOYMENT, UNIT TRAINS, MARKET AREA
(Continued)

Map Unit	Company and Mine Name	Employment 1977 Const./Perm.	Employment 1980 Const./Perm.	Employment 1985 Const./Perm.	Employment 1990 Const./Perm.	Estimated Number and Direction of Unit Trains per Year 1977	1980	1985	1990	Market Area
	Quinn Coal Company: Tomahawk Strip Mine	3 / 5	0 / 18	0 / 18	0 / 0	0	0	0	0	Various unspecified utilities and local domestic sales.
	Sheridan Enterprises, Inc.: Loma Project (exploratory only)	0 / 30	0 / 40	0	0	0	0	0	0	Various unspecified out-of-state utilities.
	GEX Colorado Company: Cameo No. 1 Mine	14 / 102	0 / 426	0 / 148	0 / 0	0	80 East and	0	0	Cameo: Mississippi Power Co., Jackson Co., Mississippi.
	Roadside Mine					0	80 West	20 West	0	Roadside: Arizona Electric Power Company, Page (or Benson), Arizona; local domestic sales.
					Subtotal	0	160	20	0	
	Coal Fuels Corporation: Farmers Mine	0 / 0	0 / 50	0 / 50	0 / 50	0	0	0	0	Not available (unspecified).
	Louis Bendetti Coal Co.: Eastside Mine	0 / 1	0 / 1	0 / 1	0 / 1	0	0	0	0	Local and domestic market.
	Henry Bendetti Coal Co.: Nu Gap No. 3 Mine	0 / 1	0 / 1	0 / 1	0 / 1	0	0	0	0	Local and domestic market.
	Anschutz Coal Co.: North Thompson Creek No. 1 and No. 3 mines	0 / 112	0 / 320	0 / 320	0 / 320	0	100 West?	100 West?	100 West?	Metallurgical market.
	Mid-Continent Coal and Coke Company: Coal Basin Mines	0 / 344	0 / 492	0 / 492	0 / 492	145[a] West	140[a] West	140[a] West	140[a] West	U.S. Steel Geneva Works, Orem Utah; Kaiser Steel Fontana Plant, Fontana, California.

TABLE R8- 14

EXISTING LOW-LEVEL OPERATIONS: EMPLOYMENT, UNIT TRAINS, MARKET AREA
(Continued)

Map Unit	Company and Mine Name	Employment 1977 Const./Perm.	Employment 1980 Const./Perm.	Employment 1985 Const./Perm.	Employment 1990 Const./Perm.	Estimated Number and Direction of Unit Trains per Year 1977	1980	1985	1990	Market Area
	Carbon King, Ltd.: Sunlight Mine	0 / 4	0 / 10	0 / 10	0 / 10	0	0	0	0	Local and domestic market.
	O.C. Mine Company: Ohio Creek No. 2 Mine	0 / 5	0 / 6	0 / 6	0 / 6	0	0	0	0	Local and domestic market.
	Peabody Coal Company: Nucla Strip Mine	0 / 24	0 / 24	0 / 24	0 / 24	0	0	0	0	Nucla Power Plant, Nucla, Colorado; local and domestic market.
	Western States Coal Company: Fairview Mine	0 / 0	0 / 0	0 / 60	0 / 60	0	0	0	0	Local industrial and domestic market.
	Subtotal					70 East 239 West	185 East 414 West	75 East 354 West	75 East 334 West	
	TOTAL	0 / 1,419	0 / 2,090	0 / 2,019	0 / 1,866	309	599	429	409	

TABLE R8-15

ESTIMATED LOW-LEVEL DEVELOPMENT FOR WEST-CENTRAL COLORADO

Projected Development	1977	1980	1985	1990
Coal:				
Coal mining operations (existing and projected private)	15	17	14	11
Coal production (million tons per year)	3.07	6.73	4.64	4.19
Power generation:				
Power plants	11	11	11	
Power plant capacity (megawatts)	354	354	354	354
Uranium:				
Active DOE uranium lease tracts	22	NA	NA	NA
Inactive DOE uranium lease tracts	16	NA	NA	NA
Total tracts	38	38	38	38
Uranium mines (active lease)	31	NA	NA	NA
Uranium mills (nonlease)	2	2	2	2
Oil shale:				
Mines	2	2	4	4
Processing plants	2	2	4	4
Oil and gas:				
Wells drilled	-	95	265	440
Limestone-gypsum:				
Mines	1	1	2	2
Processing plants	2	2	3	3
Hardrock minerals:				
Mines	7	7	7	7
Mills	1	1	1	1
Smelters	0	0	0	0
Population:				
Population	149,850	196,850	212,750	235,150
Community expansion (acres)	-	3,995	5,347	7,251
Auxiliary development:				
New power and telephone lines (miles)	-	44	101	153
New railroads (miles)	-	2	2	2
Type of development:				
New roads (miles)	-	400	1,200	2,000
New pipelines (miles)	-	50	200	300

Note: DOE = Department of Energy; NA = not available.

TABLE R8-16

LOW-LEVEL SCENARIO:
ESTIMATED REGIONAL SURFACE DISTURBANCE AND RECLAMATION FOR WEST-CENTRAL COLORADO

Activity	Cumulative Acreage a/					
	1978--1980		1978--1985		1978--1990	
	Disturbed	Reclaimed	Disturbed	Reclaimed	Disturbed	Reclaimed
Existing and projected coal mines	1,367	0	1,528	180	1,656	265
Uranium mines/mills	780	NA	2,340	NA	3,900	NA
Power line/pipeline/ telephone line	0	0	2,000	0	2,000	0
Oil and gas exploration and drilling	285	NA	795	NA	1,320	NA
Community expansion	3,995	0	5,347	0	7,251	0
Road construction	2,000	0	6,000	0	10,000	0
Railroad construction	0	0	0	0	0	0
Oil shale mines/ refinery	60	NA	4,500	NA	4,500	NA
Total	8,487	0	22,510	180	30,627	265

Note: NA - Not available.

a/ Acreage in addition to that disturbed or reclaimed as of 1977.

suspended particulate (TSP), sodium oxides (SO_x), and nitrogen oxides (NO_x) from mines, towns, and highways were computed using the assumptions and methods in chapter 4, Air Quality, of the regional ES technical report. Emissions from major point sources as modeled for the low-level scenario were obtained from data sources presented in chapter 4.

The particulate emissions for fifteen underground mines and two strip mines constituting this alternative are listed in table R8-17. Maps R4-1 and R4-2 (chapter 4, Air Quality, of the regional ES) show the locations of the existing mines and the major point sources, respectively.

Emissions from highway segments and from towns (assuming growth associated with this alternative) are presented in the technical report (Air Quality) for chapter 4 of the regional ES on file at BLM District Office in Montrose, Colorado. Also, emissions from major point sources modeled for the low-level scenario are presented in of the technical report for chapter 4.

Emissions from railroads serving coal mines in the west-central Colorado ES area were not quantified and modeled. Fugitive dust emissions from the construction of additional lines should be small and have no significant effect on regional TSP concentrations. In addition, emissions from trains would be intermittent and their impact is expected to be site-specific.

Several major pollutant sources were not modeled because their emissions would not interact with emissions related to mines of this alternative. A large area of existing uranium and vanadium mines is located in and near the Paradox Valley. Also, the Colorado Ute Nucla Power Plant is located in this area. Emissions from sources in this region, approximately 30 to 40 miles southwest of the Grand Valley, would not interact with coal mines in the ES area because of the great distances between mines and because the Paradox Valley sources are in a dispersion subarea not connected to the area of the ES area containing the proposed actions.

Oil shale Tracts Ca and Cb are in the White River Valley dispersion subarea. The emissions from these major pollutant sources would not interact with emission from coal-related developments in the ES region.

The modeling procedures employed to predict the annual and short-term TSP concentrations and horizontal visibilities resulting from this alternative's development are the same as those presented in chapter 4 (Air Quality) of the regional ES.

Resultant Air Quality and Climate

Maximum ambient concentrations of TSP, SO_2, and NO_2 for this low-level scenario would include the contribution from the baseline levels and the contribution from towns and highways. Impacts of existing mines on ambient air quality would not be significant in comparison with these contributors. Since most of the fugitive dust generated by mining operations consists of relatively large-diameter particles, considerable particle deposition occurs before particles are transported far.

Highest annual average TSP concentrations in 1980, 1985, and 1990 would occur in the areas of Grand Junction, Delta, and the Western Oil Refinery northwest of Fruita. Annual average TSP levels would exceed 55 micrograms per cubic meter ($\mu g/m^3$) over areas about 5 miles in diameter or less (see maps R8-1, R8-2, and R8-3). These concentrations represent increases of approximately 15 $\mu g/m^3$ above the estimated baseline TSP levels of 40 $\mu g/m^3$ in the Grand Valley. The predicted ambient concentrations would exceed the Colorado TSP standard of 45 $\mu g/m^3$. A small area of 60 $\mu g/m^3$ equaling the federal secondary standard for TSP is predicted in the Fruita/Western Oil Refinery area.

Fruita, Grand Junction, and Paonia are located in an area designated by the Environmental Protection Agency (EPA) as not in attainment of National Ambient Air Quality Standards (NAAQS) for TSP. A regional level of analysis of air quality impacts does not show these violations except for the small area in the vicinity of Fruita. However, as existing monitoring data indicate (technical report for chapter 2 of the regional ES), numerous violations of state and federal annual average and 24-hour ambient air quality standards for TSP occur in this nonattainment area and near other major urban particulate sources in the ES region. These numerous violations should continue during the study years unless reductions in particulate emissions occur in major towns in the ES region.

Maximum 24-hour TSP levels would exceed the national secondary and the Colorado standards with predicted concentrations of 190 to 200 $\mu g/m^3$ over small areas around Grand Junction, Fruita, and Delta during all three study years. These standards would also exceed the Colorado 24-hour standard of 180 $\mu g/m^3$ around Grand Junction. In all other parts of the ES area, the concentrations would exceed the 150 $\mu g/m^3$ 24-hour TSP standard by a larger margin.

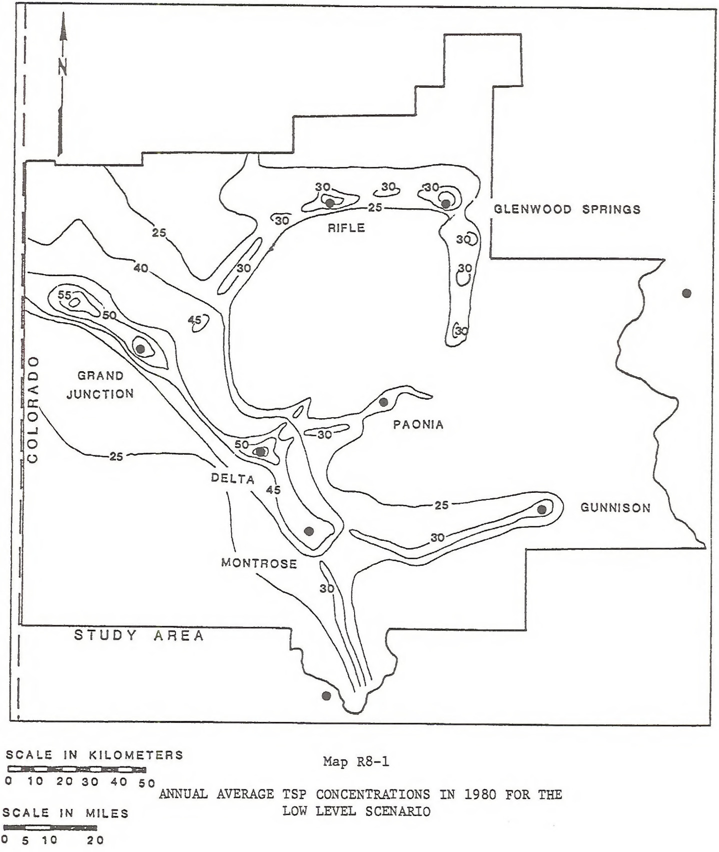
The primary contributor to the relatively high 24-hour ambient TSP levels in the Grand Valley would be baseline TSP concentrations and not the particulate emissions from towns and highways. The baseline level primarily reflects fugitive dust from agricultural activities in the Grand Valley.

Annual average TSP concentrations along roadways and around towns in the remainder of the ES area would be well below Colorado and National

TABLE R8-17

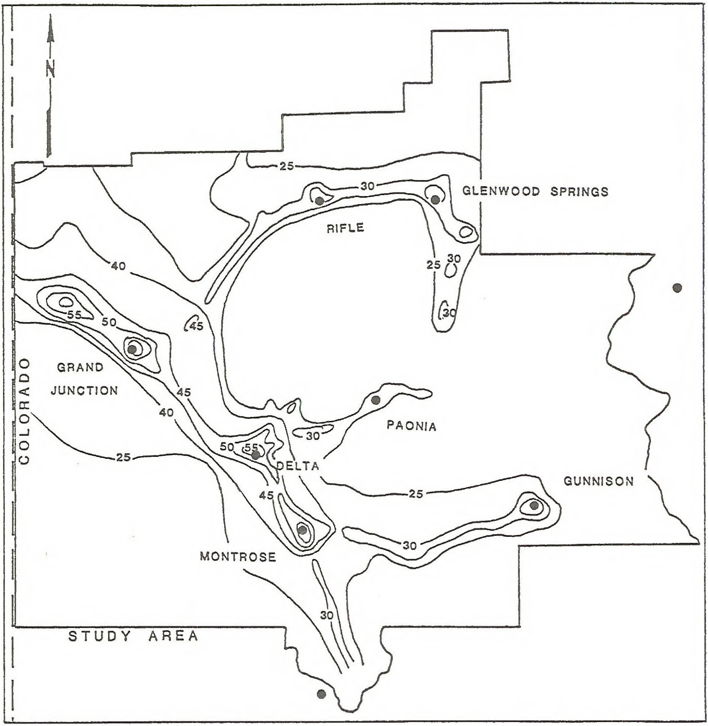
PARTICULATE EMISSIONS FROM COAL MINES IN WEST-CENTRAL COLORADO (TONS/YEAR) FOR THE LOW LEVEL SCENARIO

Mine	1980	1985	1990
Hawksnest	42.65	97.65	97.65
Bear	15.0	15.0	15.0
Somerset	148.5	148.5	148.5
Blue Ribbon	58.8		
Orchard Valley	11.5		
Coal Basin	609.0	609.0	609.0
Sunlight	3.8	6.2	6.2
Ohio Creek No. 2	0.50	0.50	
East Side	0.25	0.25	0.25
Nu Gap No. 3	0.25	0.25	0.25
Roadside-Cameo No. 1	34.4	12.1	7.1
Fairview		168.5	168.5
Bookcliffs Farmers	461.0	461.0	461.0
Tomahawk	92.5	91.6	
Red Canyon No. 1	0.15	0.15	0.15
North Thompson Creek Nos. 1 & 3	3,631.0	3,631.0	3,631.0
Nucla	46.0	46.0	46.0
Totals	5,164.3	5,287.7	5,190.6



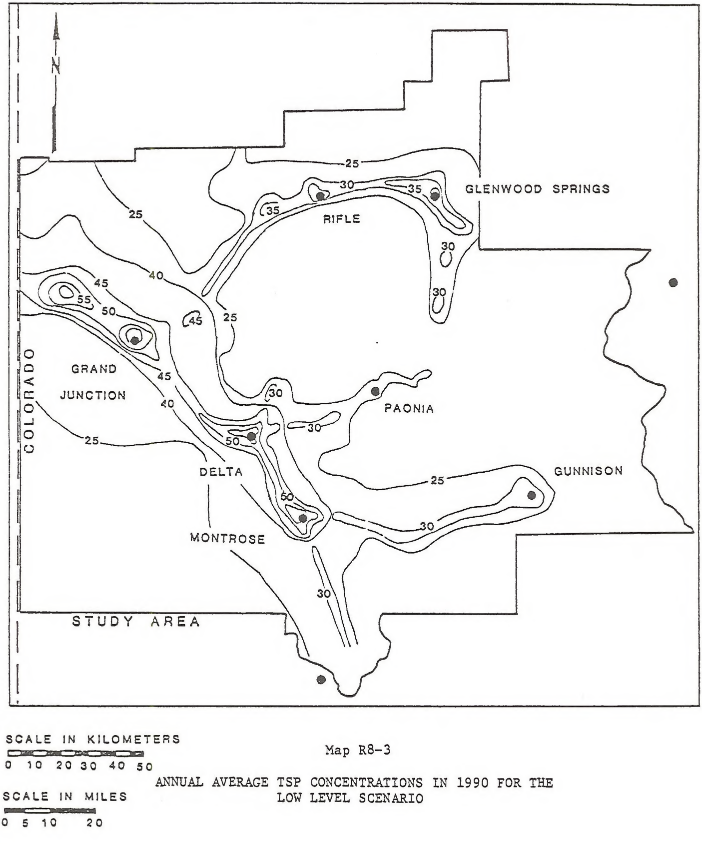
Map R8-1

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1980 FOR THE LOW LEVEL SCENARIO



Map R8-2

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1985 FOR THE LOW LEVEL SCENARIO



Map R8-3

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1990 FOR THE LOW LEVEL SCENARIO

Ambient Air Quality standards except for areas very near the sources. Maps R8-1, R8-2, and R8-3 show ambient TSP concentrations of about 5 to 15 $\mu g/m^3$ above the rural baseline of 24 $\mu g/m^3$ over small areas around Rifle, Glenwood Springs, and Gunnison. Maximum 24-hour average TSP levels would reach 120 $\mu g/m^3$ over small areas around Rifle and Glenwood Springs in 1980 and 1985. By 1990, these levels should increase to 140 $\mu g/m^3$ around Rifle. Therefore, no violations of Colorado or national ambient air quality standards are predicted.

Annual average TSP concentrations about 5 $\mu g/m^3$ above the baseline levels are predicted to occur over small areas around existing mines in the DeBeque Canyon area, around existing mines south of Glenwood Springs, and around existing mines on the slopes of the Grand Mesa north of Delta. These concentration maximums, however, are smaller in extent and magnitude than those predicted around the towns.

Highest concentrations of gaseous pollutants (SO_2 and NO_2) would occur around towns and along highways in the ES region. Mining activities in 1980, 1985, and 1990 under the low-level scenario would have no noticeable impact on the levels of these pollutants.

Map R8-4 shows that regional annual average SO_2 levels exceed 5 $\mu g/m^3$ over only very small areas around Grand Junction, Delta, Montrose, Gunnison, Rifle, and Glenwood Springs. Still lower concentrations would occur around Fruita, Paonia, and the Occidental Oil Shale facility in the Parachute Creek area. Maximum 24-hour and 3-hour SO_2 levels for all study years should not exceed 8 $\mu g/m^3$ and 28 $\mu g/m^3$, respectively, outside areas about five miles in diameter around the towns. Therefore, no regional violations of Colorado or national ambient air quality standards are predicted to occur.

Similarly, NO_2 levels should remain relatively low during the study years. Maps R8-5 and R8-6 show that highest annual average NO_2 concentrations would reach 40 to 45 $\mu g/m^3$ within small areas around Grand Junction and Delta. Maximum ambient levels of 10 to 20 $\mu g/m^3$ are predicted within small areas around other major towns in the ES region. Annual average NO_2 levels fall well below the NAAQS of 100 $\mu g/m^3$ for all three study years.

Away from towns, mines, and other major pollutant sources the annual horizontal visibilities related to atmospheric particulates are expected to exceed 60 miles almost 50 percent of the time. Regional visibilities (related to atmospheric particulates) would be reduced to 40 to 52 miles over small areas around major towns in the ES area for the three benchmark years. These reduced visibilities would not extend beyond about 10 to 15 miles from the towns. Much lower visibilities may occur near specific sources within the towns; however, these visibility reductions would be very localized.

High short-term visibility reduction would occur very close to the individual mines; however, these reductions would be highly localized. In many cases, the slight reductions in atmospheric clarity around mines in the ES area would not be apparent as actual visibility reduction because canyons, mountains and other complex terrain features restrict lines of sight.

The existing mines and related secondary development are not expected to cause a significant change in the regional climate or meteorology. However, changing the surface contours and the distribution of extracted materials, and the temporary lack of vegetation, may cause local changes in the surface meteorology.

Geologic and Geographic Setting

Topography

As shown in table R8-16, excavation and earthwork associated with site preparation for mine facilities would alter the natural topography of 1,367 acres by 1980; 1,528 acres by 1985; and 1,656 acres by 1990. These acreages constitute about 16 percent of the 8,487 acres which would be disturbed by total low-level development (including urban expansion) by 1990; about 7 percent of the 22,510 acres to be disturbed by total low-level development by 1985; and about 5 percent of the 30,627 acres to be disturbed by total low-level development by 1990.

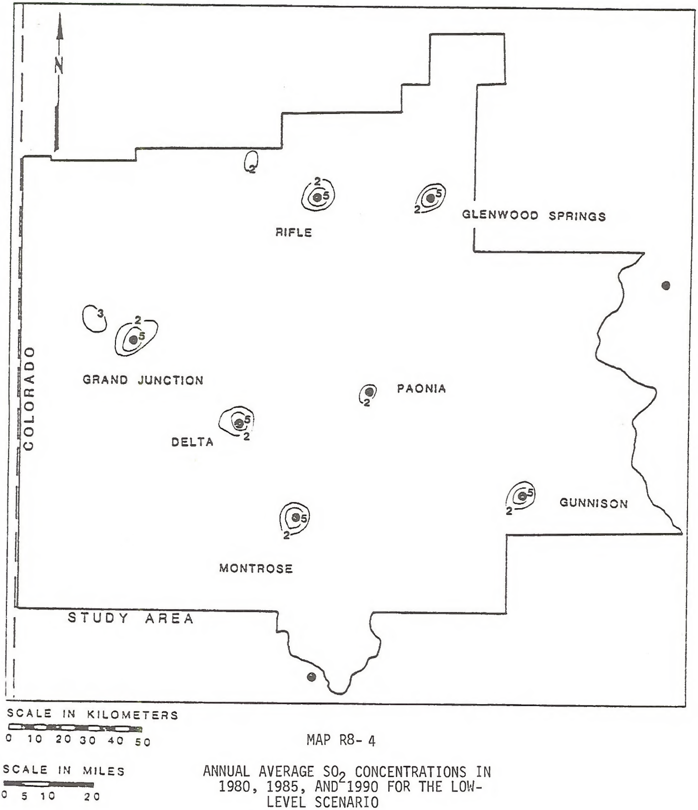
Subsidence induced by coal mining would disturb 550 acres by 1980; 2,150 acres by 1985; and 3,390 acres by 1990. The amount of subsidence which would occur at any site would be very dependent upon the mining method used and stratigraphic characteristics of the area.

Paleontology

Both adverse and beneficial impacts would occur to paleontological resources in approximate proportion to the level of regional development and the area disturbed.

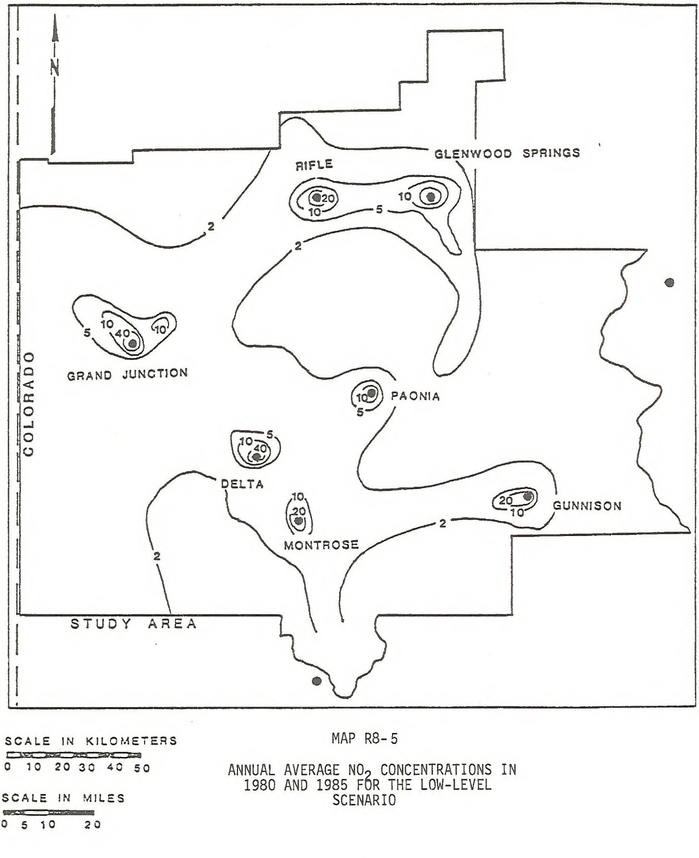
Mineral Resources

Under this alternative, the rate of coal production would decrease from 6.73 million tons per year in 1980 to 4.64 million tons per year in 1985 and 4.19 million tons per year in 1990. In addition, existing mining technologies may ruin coal reserves which are not currently considered to be mineable due to their depth, the thinness of the seam, or their proximity to the bed being mined. Access to



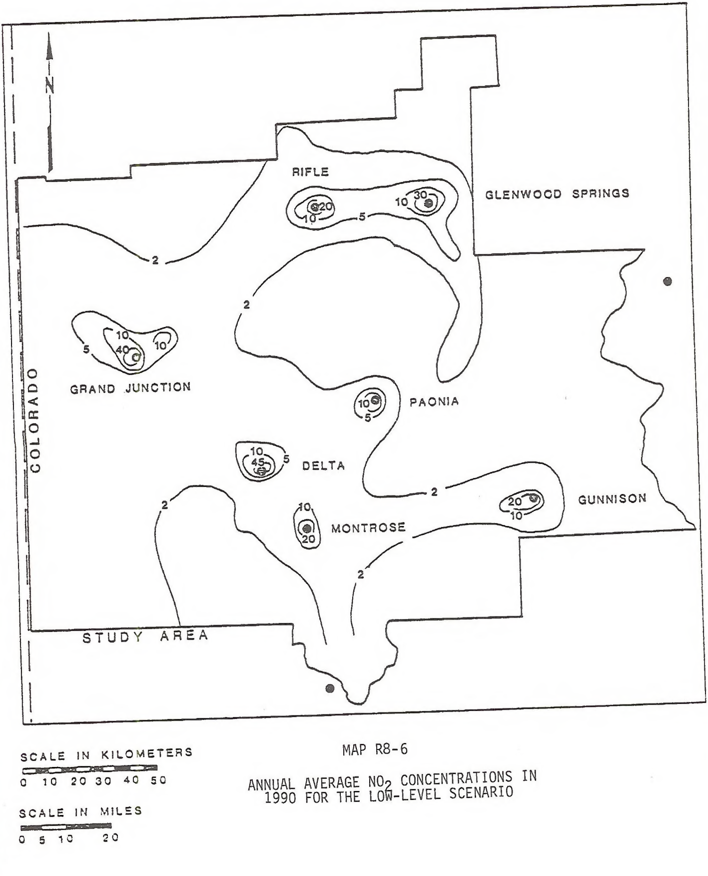
MAP R8- 4

ANNUAL AVERAGE SO_2 CONCENTRATIONS IN 1980, 1985, AND 1990 FOR THE LOW-LEVEL SCENARIO



MAP R8-5

ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1980 AND 1985 FOR THE LOW-LEVEL SCENARIO



MAP R8-6

ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1990 FOR THE LOW-LEVEL SCENARIO coal reserves lying at depths of greater than 3,000 feet may be blocked if shallower reserves are mined out first. Subsidence from mining may ruin either reserves that lie in beds too thin to be mined currently (less than 42 inches) or in mineable beds too close to the seam being mined.

Water Resources

Impacts stemming from low-level development should be largely the same in kind as those described in chapter 4, but generally of slightly lesser magnitude because of the lower coal production compared with cumulative development at the most probable level. The principal difference would be the elimination of the inferred adverse impacts on existing irrigation water rights that would have occurred as a result of Atlantic Richfield Company's proposed mine in the Mount Gunnison area (volume 2) and elimination of the threat to Palisade's municipal water system posed by Mid-Continent's proposed mine in the Cottonwood Creek area (volume 2).

Under low-level development, approximately 3,390 acres of coal beds, only about half of which probably would be saturated, would be removed by mining by 1990 (table R8-18). This is about 56 percent less area of potential coal aquifers removed than would occur at cumulative mid-level development. A correspondingly smaller area, therefore, would be subject to subsidence and consequent cracking of overlying rocks and, thus, to possible permanent loss of springs and diversion of surface water into the mines. The effects of this lesser disturbance, although important locally, would not measurably alter the regional ground-water system because the areas disturbed at both low-level and cumulative mid-level production comprise only about 0.04 percent of the ES area.

Stream channels would be removed, relocated, or altered on an area of about 30,627 acres by 1990, which is only about 8.4 percent less than under cumulative mid-level development and would affect only about 0.33 percent of the ES area (table R8-19). Impacts on channel stability should be local and short term and only slightly less than those occurring from cumulative mid-level development.

Additional consumptive use of water at low-level development would be about 39,680 acre-feet annually by 1990 (table R8-20) which is about 4,330 acre-feet (9.8 percent) less than at cumulative mid-level development. The impact on downstream water users would be reduced accordingly. The effect of this reduced consumptive use of water, coupled with a comparatively small increase in dissolved-solids load of about 740 tons/year, would be to decrease the dissolved-solids concentration in the Colorado River at the Colorado-Utah state line by about 0.40 milligram per liter (mg/l) by 1990 (table R8-20). The dissolved-solids concentration in the Colorado River below Hoover Dam during the same period would decrease by only about 0.24 mg/l. It is stressed, however, that any decrease in the salinity of the lower Colorado River is regarded as a significant beneficial impact. Annual savings to downstream users would be about $55,200.

Estimated changes in sediment yield as a result of low-level development are shown in table R8-21 for the periods 1978-80, 1981-85, and 1986-90. Computations indicate that sediment yield from all disturbed areas would increase about 35 tons compared with cumulative mid-level development during 1978-80; 1,713 tons during 1981-85; and 13,227 tons during 1986-90. A higher sediment yield would occur at low-level production than at cumulative mid-level production because a reduction in coal mining would primarily decrease the size of those areas from which overall sediment yield is minimized by effluent limitations (30[CFR]: 717.17 [a]) or reduced below predisturbance rates as a result of urbanization. This relatively small increase in sediment yield compared with cumulative mid-level development possibly might have a very local impact on channel morphology or water use. The total estimated sediment yield from all disturbed areas for the period 1978-90, however, would be 7,396 tons less than the predisturbance yield for the same period. This slight reduction in sediment yield would be insignificant compared with the annual suspended sediment load of 10.8 million tons in the Colorado River at the Colorado-Utah state line.

Soils

Major disturbance and alteration of soils as a result of coal mining would cause a short-term reduction in soil productivity on 1,367 acres by 1980; 1,528 acres by 1985; and 1,656 acres by 1990. Soil disturbance due to total low-level development would affect 8,487 acres by 1980; 22,510 acres by 1985; and 30,627 acres by 1990.

Vegetation

The operation of coal mines under this alternative would disturb 1,367 acres of native vegetation by 1980; 1,528 acres by 1985; and 1,656 acres by 1990. This disturbance would result in a loss of vegetative productivity, an increase in soil erosion, a reduction in visual aesthetics, and a reduction in the amount of wildlife and livestock forage for varying lengths of time, depending on reclamation schedules and the nature of the disturbance.

Problems may be encountered in attempting to revegetate the disturbed areas, particularly in the

TABLE R8-18

AREA OF COAL BEDS REMOVED BY MINING AT LOW-LEVEL DEVELOPMENT

Activity	1978-80	1981-85	1986-90	1978-90
Approximate total area of coal beds removed at low-level development (acres)	550	1,600	1,240	3,390
Percent of total coal area disturbed at low-level development	0.13	0.38	0.30	0.81
Percent of ES area disturbed at low-level development	0.01	0.02	0.01	0.04
Percent decrease (-) from cumulative mid-level development	- 8	-46	-70	-56

TABLE R8-19

STREAM CHANNELS AFFECTED BY LOW-LEVEL DEVELOPMENT

Activity	1978-80	1981-85	1986-90	1978-90
Approximate total surface area disturbed at low-level development (acres)	8,487	14,023	8,117	30,627
Percent of ES area in which stream channels would be affected	0.09	0.15	0.09	0.33
Percent increase (+) or decrease (-) from cumulative mid-level development	-1.8	-20	+12	-8.4

TABLE R8-20

ESTIMATED CONSUMPTIVE USE OF WATER AND CHANGE IN SALINITY IN THE COLORADO RIVER AS A RESULT OF LOW-LEVEL DEVELOPMENT

No.	Item	1980 a/	1985 a/	1990 a/
	Water yield:			
1.	Net discharge without additional development (see (table R2-24) (ac-ft)	4,200,000	4,200,000	4,200,000
2.	Additional consumptive use:			
3.	Irrigation (Dallas Creek Project) (ac-ft)	-500	-17,100	-17,100
4.	Coal mining operations (ac-ft)	-420	-260	-180
5.	Other mining operations (ac-ft)	-200	-300	-400
6.	Oil shale development (ac-ft)	-640	-12,600	-12,600
7.	Grand Valley Project (ac-ft)	+800	+2,800	+4,000
8.	Municipal and rural (ac-ft)	-7,400	-9,900	-13,400
9.	Total additional consumptive use (lines 3 through 8) (ac-ft)	-8,360	-37,360	-39,680
10.	Net discharge (line 1 plus line 9) (ac-ft)	4,191,640	4,162,640	4,160,320
	Salinity:			
11.	Total dissolved solids load in Colorado River near Colorado-Utah state line without additional development (see table R2-24) (tons)	3,260,700	3,260,700	3,260,700
12.	Additonal dissolved-solids load:			
13.	Irrigation (Dallas Creek Project) (tons)	+300	+9,800	+9,800
14.	Coal mining operations (tons)	-70	+250	+590
15.	Other mining operations (tons)	-80	-120	-160
16.	Oil shale development (tons)	-480	-9,420	-9,420
17.	Grand Valley Project (tons)	-81,500	-285,300	-407,500
18.	Municipal and rural (tons)	+860	+150	+1,460
19.	Total additional dissolved-solids load (lines 13 through 18) (tons)	-80,970	-284,640	-405,230
20.	Total dissolved solids load in Colorado River near Colorado-Utah state line (line 11 plus line 19) (tons)	3,179,730	2,976,060	2,855,470
21.	Change in discharge-weighted average dissolved-solids concentration in Colorado River near Colorado-Utah state line (mg/l)	-13.06	-45.16	-66.19
22.	Percent change	-2.3	-7.9	-11.6
23.	Change in discharge-weighted average dissolved-solids concentration in Colorado River below Hoover Dam (mg/l)	-5.56	-19.04	-28.07
24.	Percent change	-0.82	-2.8	-4.1

a/ Increase (+) or decrease (-) in indicated items.

TABLE R8-21

ESTIMATED SEDIMENT YIELD AS A RESULT OF LOW-LEVEL DEVELOPMENT

Activity	Area Disturbed (acres)	Total Sediment Yield Before Disturbance (tons)	Total Sediment Yield After Disturbance (tons)	Net Change in Sediment Yield Increase (+) or Decrease (-) (tons)
		1978-80		
Existing coal mines	1,104	3,310	7	-3,303
Projected coal mines	263	790	2	- 788
Oil shale mines/refineries	60	180	300	+ 120
Uranium mines/mills	780	2,340	3,900	+1,560
Oil and gas exploration/ drilling	285	860	1,425	+ 565
Roads	2,000	6,000	10,000	+4,000
Railroads	0	0	0	0
Power lines/pipelines/ telephone lines	0	0	0	0
Population related disturbances	3,995	11,980	16,980	+5,000
Subtotal	8,487	25,460	32,614	+7,154
		1981-85		
Existing coal mines	1,265	6,320	14	-6,306
Projected coal mines	263	1,320	3	-1,317
Oil shale mines/refineries	4,500	22,500	31,380	+8,880
Uranium mines/mills	2,340	11,700	14,820	+3,120
Oil and gas exploration/ drilling	795	3,980	4,995	+1,015
Roads	6,000	30,000	38,000	+8,000
Railroads	0	0	0	0
Power lines/pipelines/ telephone lines	2,000	10,000	14,000	+4,000
Population related disturbances	5,347	26,740	11,420	-15,320
Subtotal	22,510	112,560	114,632	+2,072
		1986-90		
Existing coal mines	1,393	6,960	15	-6,945
Projected coal mines	263	1,320	3	-1,317
Oil shale mines/refineries	4,500	22,500	22,500	0
Uranium mines/mills	3,900	19,500	22,620	+3,120
Oil and gas exploration/ drilling	1,320	6,600	7,650	+1,050
Roads	10,000	50,000	58,000	+8,000
Railroads	0	0	0	0
Power lines/pipelines/ telephone lines	2,000	10,000	10,000	0
Population related disturbances	7,251	36,260	15,730	-20,530
Subtotal	30,627	153,140	136,518	-16,622
TOTAL	30,627	291,160	283,764	-7,396

lower altitudes of the region. In such cases where low annual precipitation; high soil salinity; steep, south-facing slopes; and weed infestation are serious problems, the period of time required for successful revegetation may be prolonged, even if adapted species and advanced revegetation techniques are used.

Total low-level development would disturb vegetation on 8,487 acres by 1980; 22,510 acres by 1985; and 30,627 acres by 1990. Of these totals, 3,995 acres would be due to community expansion in 1980; 5,347 acres in 1985; and 7,251 acres in 1990. Most of these latter acreages would convert agricultural lands to housing areas and other forms of urban development and this disturbance can be considered permanent.

Population increases would also result in unquantifiable impacts to vegetation from increased off-road vehicle (ORV) use, firewood cutting, and exploitation of certain endangered and threatened plants.

Wildlife

Wildlife habitat, carrying capacity, and populations would be lost as a direct result of coal mining on 1,367 acres by 1980; 1,528 acres by 1985; and 1,656 acres by 1990. Carrying capacity for deer would be reduced by 67, 75, and 81 animals, respectively; carrying capacity for elk by 11, 12, and 14 animals, respectively. Some of these losses may be restored through reclamation of habitat; however it is impossible to quantify this factor due to insufficient data.

As shown in table R8-16, total low-level development would disturb 8,487 acres by 1980; 22,510 acres by 1985; and 30,627 acres by 1990. This amounts to 0.09 percent, 0.25 percent, and 0.34 percent, respectively, of the habitat available to wildlife in the ES area. It is apparent that impacts from this disturbance would be insignificant when compared with the region's available habitat. However, locally heavy losses and displacement of wildlife could occur because of changes in microenvironments and certain habitat types, particularly as a result of oil shale development and urban expansion. Oil shale development in and adjacent to the ES area would displace deer from the Piceance Basin and Parachute Creek areas into the Roan Creek drainage where another oil shale development is located. As a result of this displacement, the Roan Creek habitat would be severely overutilized. Community expansion due to population increases (see table R8-16) would primarily affect agricultural lands, disturbing small mammals and birds more than large mammals, although it is possible that some crucial deer and elk wintering areas could also be converted to housing. Increasing human populations would in general also cause the following impacts on wildlife: increased road kills due to increased vehicular traffic; increased poaching and indiscriminate shooting of wildlife; increased harassment of wildlife during stress periods (especially winter and reproductive periods); and increased recreational use of wildlife.

Aquatic Biology

As a result of coal development under this scenario, the aquatic habitats adjacent to coal areas would have some increased short-term sediment loads, minor increases in total dissolved solids (TDS), increased sewage effluent, minor increases in consumptive use of water, and minor increases in fishing pressure. Sediment yield from 1,367 acres in 1980; 1,528 acres in 1985; and 1,656 acres in 1990 would cause slight sediment load increases from the presently disturbed 1,007 acres (as of 1977). North Thompson Creek, where the Anschutz mines are located, would be the fishery most affected by sediment yield. In terms of water quality, existing water quality laws and the state fish management program would be more capable of dealing adequately with this low level of coal development and maintaining the present quality of fisheries affected by coal mining in the area.

The impacts from total low-level development would be much more significant. Fisheries in the area which would receive potentially high impacts from regional developments include Thompson Creek (coal), Parachute Creek (oil shale), Roan Creek (oil shale), Uncompahgre River (USBR Dallas Project), and the Colorado River (oil shale and USBR projects).

Any release of large quantities of low quality mine water from oil shale developments to local streams could temporarily but severely impact the aquatic life in these waters. Water leaching from excavations, overburden piles, and spent shale piles may cause a shift in pH into a range that would interfere with the vital functions of aquatic organisms. Heavy metals would also come from leaching of spent shale piles. Metals can originate from waste chemicals and spent catalysts buried in the shale piles. Unless carefully controlled, such discharges would reduce populations of invertebrates, fish, aquatic mammals, birds, and riparian vegetation.

Oil shale development would also introduce sediments from both wind and water erosion. Erosion of disposal piles (both during buildup and after revegetation) and of off-site construction areas, such as utility corridors, transportation networks, and townsite expansion, would lead to increased sediment load in local streams. Channeling and head-cutting due to natural erosion would occur for extended periods of time with increasing amounts of sediments reaching local streams. Increased operations for sand and gravel recovery would cause large-scale disruption of some stream habitat areas and siltation in streams. In aquatic habitat the increased siltations and turbidity would exceed natural levels and as a result would lower biological productivity. This results from reduced aquatic flora due to reduced light penetration, mechanical damage to gills of aquatic animals, and physical covering of fish spawning and nursery areas. The extent of such erosion and its effects cannot be predicted since detailed information on quantity of erosion is not available.

If oil spills from pipelines reach local surface waters in sizeable amounts, depletion of fish populations and other aquatic life would be possible for some distance downstream. Mortality from contact with oil would occur to riparian trees and shrubs, larvae of many aquatic organisms, fish species, water fowl, and shore and wading birds. Revegetation of oil-soaked shorelines would be extremely slow. Magnitude of mortality and other adverse impacts would depend upon the location and volume of the spill and the particular habitat type affected.

Unless sewage treatment facilities are enlarged to handle the increased sewage effluent due to increased human populations in the area, localized adverse impacts on water quality are expected due to increases in ammonia in the aquatic habitat. Delta and Montrose may be able to upgrade their sewage treatment facilities without much difficulty. Sewage problems in Grand Junction would occur regardless of coal development.

Increased urbanization and associated human activities would degrade water quality and aquatic habitats, mainly in the Colorado River adjacent to Grand Junction. Since urban areas would be located on or near water courses, such parameters of aquatic systems as suspended sediment, turbidity, nutrients, biological oxygen demand, and temperature would increase. Human activities such as boating and fishing would degrade water quality through the introduction of gas, oil, and litter. Pollutants and toxic substances from streets and storm sewers would increase. The aquatic environment may be so altered that some present fish species, most likely the endemic species, would no longer be able to sustain themselves and more tolerant species would take their places.

Increased population from cumulative development would increase the number of anglers and increase crowding along streams and lakes in the ES area. Increased demand for hatchery-raised fish would not be met unless new hatcheries are built. More intensive fish management may alleviate some problems.

The extent to which total low-level development would affect rare and endangered fish, such as the Colorado squawfish, humpback chub, and the razorback sucker, is dependent upon the quality of the surface water. It is not possible to predict the effect of low-level coal plus regional development on the endangered species without further studies.

Cultural Resources

Archeological Resources

On a regional basis, the potential for destruction of 1,999 identified and countless unknown archeological sites would increase in direct proportion to the number of acres disturbed. (See table R8-16 for projected surface disturbance due to coal development and total low-level development.) Surface disturbance from mineral development and associated construction could displace and damage archeological resources that remain undetected. Vandalism associated with regional population growth is certain to increase, although at a slightly less accelerated rate than under the proposed actions.

Historic Resources

Impacts to the historical sites would be similar to impacts on the archeology of the ES area. A potential exists for the destruction of some 123 known sites in the ES area and countless unknown sites. A secondary impact would be the displacement of older structures in towns and cities which would develop rapidly.

Transportation

Under the low-level scenario, vehicles registered in the region would total 212,598 in 1980; 229,770 in 1985; and 253,926 in 1990. Average daily traffic levels on regional roads would increase over existing levels, and traffic accidents in the region would increase as a result.

Trains entering and leaving the region as a result of coal development would number 599 in 1980, 429 in 1985, and 409 in 1990. There would be a resulting increase in auto-train collisions, and longer delays for automobiles at crossings.

Agriculture

Livestock Grazing

The animal unit months (AUMs) which would be lost due to total low-level development would be 448 by 1980; 1,708 by 1985; and 2,330 by 1990. This would be 0.08 percent, 0.32 percent, and 0.44 percent, respectively, of the 535,221 AUMs produced on the nearly 5.4 million acres of public land and national forest systems land in the ES area.

It is very likely that some of the urban expansion due to increased population (see table R8-16) would disturb irrigated and nonirrigated hayland and pasture. This would adversely affect the livestock industry because these lands are used as livestock wintering areas, and the hay harvested from them in the summer is used to feed the livestock during winter. Increased off-road vehicle use as a result of population increases would kill or decrease the vigor of plants; as a result, livestock range conditions would decline.

Farming

It is likely that some of the acreage disturbed by low-level development (8,487 acres by 1980; 22,510 acres by 1985; and 30,627 acres by 1990) would be prime farmland, particularly some of the acreage disturbed by community expansion (3,995 acres by 1980; 5,347 acres by 1985; and 7,251 acres by 1990). Without the exact acreage and location of this disturbance, however, it is virtually impossible to determine its significance.

Recreation

Coal production under this scenario would have no significant impact on recreation. The population growth associated with low-level development, however, would produce increased demand for recreational opportunities and facilities. This demand could have a significant impact on community recreational facilities; because most community facilities are now fully utilized, the increased use would result in overuse and deterioration of the facilities. Prevention of overuse would require construction of additional facilities amounting to 151.1 acres of active/improved parks (e.g., ballfields, playgrounds, tennis courts, etc.) by 1980, 277.2 acres by 1985, and 281.5 acres by 1990.

The increased demand for recreational opportunities would also affect the managing agencies (federal, state, and local) of recreational resources and facilities with maintenance and overhead costs to maintain visitor safety and protect the resources. The increased costs are not known, but they would be in line with population increases.

Socioeconomic Conditions

Demography

Population growth projections for each county within the region assume a normal rate of growth in employment (based on data from recent years) and the development of major oil shale, uranium, power generation, and water reclamation projects which are planned for the area even without new coal development on public lands. The special projects considered are listed, along with their employment schedules, in table R8-22. Table R8-23 summarizes population projections for the low-level scenario.

The projections in tables R8-22 and R8-23 reflect the large increases in employment which are expected if the oil shale industry develops according to schedule. Garfield and Mesa counties are expected to absorb most of the oil shale-related growth in the ES area. Mesa County is expected to receive most of its impact from the oil shale boom in the early stages, when the demand for construction workers would be high and the available labor pool in those areas closer to the actual sites have been exhausted. Population in Mesa County may decline slightly once the oil shale industry reaches a permanent operations level and housing is available closer to the sites.

Gunnison County is expected to experience a large population increase if the Mt. Emmons molybdenum deposits are developed as scheduled. Projections are based on the assumption that 100 percent of the work force requied for molybdenum development in Gunnison County would be supplied by existing residents or newcomers who reside within the county boundaries.

A rigid allocation of population growth to individual communities within the ES area has not been done because of the many variables which enter into individual community growth. It can be assumed, however, that those communities closest to major project sites would experience the most immediate population growth. The small communities of Rifle, Silt, New Castle, Grand Valley, and DeBeque, all within a relatively short commuting distance from major oil shale projects, should have most of their available living spaces occupied as soon as major construction activity begins. Even if additional housing units can be supplied as they are needed, these towns can only accommodate about an additional 4,500 people (see Community Facilities) before major new additions would be needed for their water and sewer systems. The same is true of the small communities in Rio Blanco County which are also close to major oil shale sites. As a result, it would be necessary for communities such as Grand Junction, Fruita, and Glenwood Springs to absorb much of the rapid population growth expected in Garfield and Mesa counties.

Community Attitudes and Lifestyles

The current trends of in-migration to the ES area by persons who like the living conditions are expected to continue. The expected increase in job opportunities and population under this alternative is not expected to significantly alter the existing lifestyle in Delta, Montrose, Ouray, and Pitkin counties. If oil shale and molybdenum projects are developed according to schedule, the influx of large construction work forces can be expected to

TABLE R8-22

LOW-LEVEL SCENARIO:
EMPLOYMENT SCHEDULES FOR FUTURE MINING, WATER, AND POWER PROJECTS

	Total Employment (Construction & Permanent)							
	1977		1980		1985		1990	
	Const.	Perm.	Const.	Perm.	Const.	Perm.	Const.	Perm.
US Bureau of Reclamation:								
Dallas Creek	20		300			10		10
Paradox Valley			160			4		4
Grand Valley			61		196			5
Dominguez					1,955			10
Rio Blanco Oil Shale (C-A)	104		121		2,500			2,075
Occidental Oil Shale (C-B)	100		1,350			1,600		1,600
Superior Oil Shale			93	173	403	882		882
Colony Oil Shale			2,400	994		2,052		2,052
Paraho Oil Shale			300	300	100	300		300
Amax Molybdenum					2,400			1,500
Uranium Mining								
Pioneer Uravan		4		12	50	45		95
Brooks Minerals		8		24		40		40
Cotter Corp.		58		58		58		58
Uranium Independents		70		100		150		150
Homestake Mining			90	60		150		150
Coal Mining:								
CWI	200	100		160		0		0
U.S. Steel		298		298		298		298
Sunflower	20	8		8		0		0
Bear Coal		49		55		0		0
Western Slope Carbon	20	102		180		200		200
Belden		1		1		1		1
Quinn	3	5		18		18		0
Sheridan	1	30	1	40		0		0
GEX Colorado	14	102		426		148		0
Coal Fuels		0		50		50		50
Bendettis		2		2		2		2
Anschutz		112		320		320		320
Coal Basin		344		492		492		492
Carbon King		4		10		10		10
O.C. Mine Co.		5		6		6		0
Peabody Coal		24		24		24		24
Western States		0		0		60		60

TABLE R8-23

LOW-LEVEL SCENARIO:
POPULATION PROJECTIONS FOR THE REGIONAL ES AREA

County	1977	1980	Percent Change	1985	Percent Change	1990	Percent Change
Delta	18,950	20,600	8.7	22,900	11.2	24,800	8.3
Garfield	18,800	33,000	75.5	38,650	17.2	45,100	16.7
Gunnison	8,700	9,350	7.5	18,950	102.7	18,200	-4.0
Mesa	66,850	91,750	37.3	106,000	15.5	94,800	-10.6
Montrose	21,400	22,900	7.0	24,150	5.5	25,600	6.0
Ouray	1,900	2,200	15.8	2,100	-4.6	2,400	14.3
Pitkin	13,250	17,050	28.6	21,100	23.6	24,250	14.9
Total	149,850	196,850	31.4	212,750	8.1	235,150	10.5

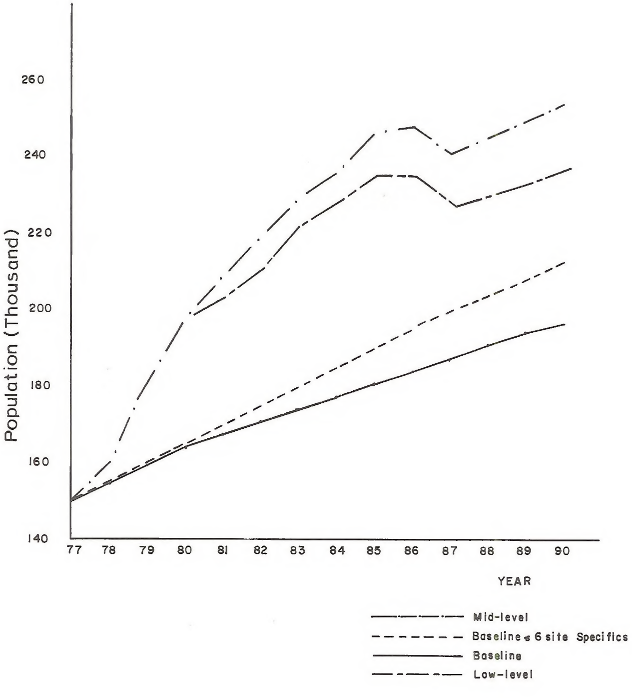


Figure R8-2. Population -- low level

cause some change in Mesa, Garfield, and Gunnison counties. The influx of similar large work forces in other rural areas of the west has led to a number of sociological changes which are commonly referred to as the "boom town syndrome." The more commonly documented changes include rising rates of divorce, increased cases of alcoholism and mental illness, and decreased levels of job productivity. Also, and probably more importantly, there tends to be a polarization in small communities between the long-time residents and the more transient newcomers, which causes difficulty in accomplishing needed reforms.

Community Facilities and Services

Due primarily to the expected population growth from oil shale development, existing community facilities in Garfield and Mesa counties would be forced to operate at or beyond their capacity. This is especially true of the smaller towns of DeBeque, Grand Valley, Rifle, Silt, and New Castle. Both the Grand Junction and Glenwood Springs communities now have or are building improvements which will allow them to greatly expand water and sewer service. As a result, much population growth in Mesa and Garfield counties should be attracted to these two communities.

In Gunnison County, all community facilities would be stressed to the maximum to accommodate growth from molybdenum development. Other counties within the ES area would exerience moderate growth rates and would be able to maintain an adequate level of public facilities and services.

Housing

In Mesa, Delta, Gunnison, and Garfield counties, conventional housing would have to be constructed at a more rapid rate than between 1970 and 1976, if housing is to keep pace with the projected population growth. Garfield County, with a projected growth rate of over 21 percent per year between 1977 and 1980, has added houses at a rate of less than 5 percent per year since 1970. Unless labor and capital are imported to the regions for housing construction, these four counties would require many new mobile or modular style houses to fill the demands for housing.

Education

Table R8-24 is a projection of school-aged population for each county in the ES area without the proposed action. They represent total population in the 5-to-18-years-of-age group, which does not correspond directly to school enrollment figures. Most districts in Delta, Garfield, Gunnison, and Mesa counties would reach the capacity of present facilities by 1985.

Health Care

The ES area, as a whole, has adequate health care facilities for its present population, but it is somewhat lacking in number of physicians. Using the standard ratio of 2.5 hospital beds per 1,000 persons in rural areas, and 4 beds per 1,000 persons in urbanized areas (e.g., Mesa County), all counties but Delta have some excess capacity in hospital facilities. By 1985, however, projected population growth would result in every county in the area having less than the minimum standard for hospital bed capacity. Gunnison and Delta counties would have to almost double the bed capacity of their existing facilities to achieve the standard ratio by 1985. Most counties in the ES area are far short of the standard ratio of two physicians per 1,000 persons, a ratio which remains fairly constant from county to county, except in Garfield County where the ratio is close to the standard. Population growth by 1985 would create a need for many more physicians, especially in the fastest growing areas of Gunnison, Mesa, and Garfield counties.

Employment

Total employment in the region is expected to increase dramatically, primarily due to mineral developments other than coal (such as oil shale, uranium, and molybdenum). Garfield, Gunnison, and Mesa counties are expected to receive the bulk of this growth, but uranium mining would also cause growth in Montrose County.

Unemployment has been a problem in the region in recent years. Economic growth in the region may help to alleviate this situation. However, if national unemployment remains high, the local unemployment rate may remain high as unemployed people migrate from other areas in search of work. A problem to be expected is the fluctuation of employment rates in many of the counties. This is due to the completion of various construction projects that are scheduled throughout the region.

HIGH-LEVEL SCENARIO

The high-level scenario is an analysis of the most probable level of development (six proposed federal actions; existing coal operations; other probable regional mineral development, such as oil, gas, oil shale, and uranium; water developments), plus the possible development of two preference right lease applications, eleven federal areas of interest, fifteen existing inactive federal leases, and one existing lease with proposed revisions of an existing M&R plan. The high-level scenario includes all of those actions which could develop as a result of federal approvals. However, the eleven federal areas of interest and the two PRLAs are included only to indicate "areas of interest" for foreseeable future

TABLE R8-24

LOW-LEVEL SCENARIO:
SCHOOL-AGED POPULATION PROJECTIONS IN ES AREA

County	1977	1980	Percent Change	1985	Percent Change	1990	Percent Change
Delta	4,550	4,950	8.8	5,500	11.1	5.950	8.2
Garfield	4,500	7,900	75.6	9,300	17.7	10,800	16.3
Gunnison	2,100	2,250	7.1	4,550	102.2	4,350	-4.4
Mesa	16,050	22,050	37.4	25,450	15.4	22,750	10.6
Montrose	5,150	5,500	6.8	5,800	5.5	6,150	6.0
Ouray	450	550	22.2	500	9.9	600	20.0
Pitkin	3,200	4,100	28.1	5,050	23.2	5,800	14.9

development. No leasing actions are proposed or planned at this time. In addition, the proposed revised M&R plan will require environmental analysis before it could be approved.

The high-level scenario is not an alternative to the proposed actions or the most probable level of development. It is possible that there could be very rapid, extensive development of some sort (not necessarily coal development) in the ES area. This scenario is an attempt to provide additional perspective on the proposed actions by placing them in a context of such increased development. Increased coal development is utilized since information is available to provide useful projections, while sufficient data on other possible development in the ES area are not presently available.

The proposed actions, the existing coal mines, and the non-coal-related development have been previously identified (see tables R1-1, R1-2, R1-3, etc.). Table R8-25 provides detailed information pertaining to all coal mining which would occur in the high-level scenario. Table R8-26 summarizes projected surface disturbance. Map 1 in volume 3 shows the locations of all of the existing, proposed, and possible coal developments covered under the high-level scenario.

Where information is available, impacts are analyzed at two levels under the high-level scenario: (1) cumulative impacts expected to occur as a result of all possible development under this scenario and (2) aggregate impacts of the possible new developments (the one existing lease with a proposed revised M&R plan, the eleven federal areas of interest, the fifteen inactive existing leases, and the two PRLAs). Impacts are analyzed at the 1980, 1985, and 1990 time points.

Air Quality

Emissions and Modeling Procedures

The emissions of pollutants from possible new coal development were computed using the assumptions and methods described in chapter 4 (Air Quality) of the regional ES. The on-site emissions for the six proposed M&R plans analyzed under the most probable level of development were computed using an average factor of 14 tons of controlled TSP emissions per million tons of coal mined. The factor assumes a 95 percent control efficiency for all mine operations and was used for mines with little or no operating information available. Particulate emissions from haul roads were calculated using either a 50 percent control factor for watering or an 85 percent control factor for surface treatment of the road with chemical sealant.

The particulate emission factor of 14 tons per million tons of coal mined was also used for calculating on-site emissions from the possible new coal development mines. However, haul road emissions for all mines of this development level were calculated assuming an 85 percent control factor for roadways. Table R8-27 summarizes the particulate emissions for the three benchmark years.

Emissions from towns and highways were computed using the assumptions and methods of chapter 4 of the regional ES technical report. Table R8-28 presents emission from towns. Emission from highway traffic in the ES region would not increase significantly with the possible new coal developments. Therefore, the emissions calculated for the most probable level of development in chapter 4 of the regional ES technical report are representative of highway traffic emissions that would occur under the high-level scenario.

Modeling procedures for predicting annual average pollutant levels and resulting visibilities for the high-level scenario are the same as those presented in chapter 4 (Air Quality) of the regional ES. Similarly, statistical modeling methods for predicting maximum 24-hour concentrations around towns are also identical to those described in chapter 4.

Highest regional 24-hour TSP concentrations for areas around mines were calculated using short-term Gaussian modeling procedures described in the technical report for chapter 4 (Air Quality) of the regional ES. The only mines modeled were those with large TSP emissions and/or with the potential for significant interaction with mines of the high-level scenario.

Short-term modeling methods for mines belonging to the six proposed M&R plans are discussed in the technical report for chapter 6 of the site-specific ESs. Modeling methods for mines along the North Fork of the Gunnison River (existing and those belonging to the high-level scenario) are discussed in chapter 4 (Air Quality) of the regional ES.

The sources examined in the high-level short-term modeling analysis of the North Fork area consist of the eight mines listed for this area in chapter 4 and two federal interest areas.

The only other possible development mines with significant TSP emissions would be a PRLA and a federal interest area in the Little Bookcliffs near Grand Junction. Modeling methods and worst-case meteorological conditions for these mines are similar to those used for the North Fork area. However, the worst-case meterological conditions differ somewhat from those determined for the North Fork area because the two areas are in different dispersion subareas.

The 24-hour meteorological sequence modeled for mines in the DeBeque Canyon area (described in the technical report for chapter 3 of the site-specific analyses) was selected for modeling the

TABLE R8-25

HIGH-LEVEL SCENARIO FOR COAL PRODUCTION IN WEST-CENTRAL COLORADO

	Coal Production (million tons per year)				Cumulative Surface Disturbance (acres)				Permanent Employment			Unit Trains per year		
	1977	1980	1985	1990	1977	1980	1985	1990	1980	1985	1990	1980	1985	1990
Preference Right Lease Applications:														
Coal Fuels Corporation C-0127832 C-0127833 C-0127834	--	--	1.000	3.800	--	--	621	621	--	190	690	--	100	380
Kemmerer Coal Co. C-0120075 C-0124288	--	--	--	2.000	--	--	--	790	--	--	300	--	--	200
Subtotal:	--	--	1.000	5.800	--	--	621	1,311	--	190	990	--	100	580
Federal Areas of Interest (11 areas of interest)	--	--	3.450	11.400	--	--	1,162	2,111	--	621	3,150	--	345	1,140
Existing Federal Leases Affected By Diligent Development and Continuous Operations Requirements:														
Thompson Creek: D-037766	--	--	0.011	0.011	--	--			--	3	3	--	1	1
U.S. Steel: D-052558	--	--	0.037	0.037	--	--			--	10	10	--	4	4
C-1894	--	--	0.012	0.012	--	--			--	3	3	--	1	1
C-7852	--	--	0.016	0.016	--	--			--	4	4	--	2	2
C-7853	--	--	0.076	0.076	--	--			--	20	20	--	8	8
C-012638	--	--	0.032	0.032	--	--			--	9	9	--	3	3
C-012639	--	--	0.084	0.084	--	--			--	22	22	--	8	8
C-030344	--	--	0.044	0.044	--	--			--	12	12	--	4	4
C-030346	--	--	0.054	0.054	--	--			--	14	14	--	5	5
C-051669	--	--	0.148	0.148	--	--			--	22	22	--	15	15
C-068389	--	--	0.076	0.076	--	--			--	8	8	--	8	8
C-0125485	--	--	0.020	0.020	--	--			--	5	5	--	2	2

TABLE R8-25

HIGH-LEVEL SCENARIO FOR COAL PRODUCTION IN WEST-CENTRAL COLORADO
(continued)

	Coal Production (million tons per year)				Cumulative Surface Disturbance (acres)				Permanent Employment			Unit Trains per year		
	1977	1980	1985	1990	1977	1980	1985	1990	1980	1985	1990	1980	1985	1990
Utah International C-055156	--	--	0.032	0.032	--	--			--	9	9	--	3	3
Garland Coal Co. C-012765	--	--	0.052	0.052	--	--			--	14	14	--	5	5
Mid-Continent Coal & Coke Co. C-074632	--	--	0.053	0.053	--	--			--	15	15	--	5	5
Subtotal:	--	--	0.747	0.747	--	--			--	170	170	--	74	74
Western Slope Carbon Hawksnest East Mine	--	--	0.250	0.250	--	--			--	80	80	--	25	25
Existing projected and proposed private & federal coal mines (Tables R1-1, R1-2, R1-3, Ch. 1)	3.07	7.49	13.170	15.560	999	1,479	2,449	2,694	2,145	3,744	4,111			
TOTAL:	3.07	7.49	18.617	33.757	999	1,479	4,232	6,216	2,145	4,805	8,501			

TABLE R8-26

HIGH-LEVEL SCENARIO:
PROJECTED SURFACE DISTURBANCE

	1978-1990	1978-1985	1978-1990
Cumulative high-level regional surface disturbance:			
Urban area expansion	4,061	8,675	11,196
Other development	4,578	19,816	27,710
Total	8,639	28,491	38,906
Surface disturbance due to possible new coal development (above mid-level):			
Urban area expansion	0	553	2,053
Mine-site development	0	1,783	3,422
Total	0	2,336	5,475

TABLE R8-27

TOTAL SUSPENDED PARTICULATE EMISSIONS FROM COAL MINES IN WEST-CENTRAL COLORADO (TONS/YEAR) FOR THE HIGH-LEVEL SCENARIO

Mine	1980	1985	1990
Proposed Actions			
North Thompson Creek Nos. 1, 3	3,648	3,648	3,648
Mt. Gunnison		63	74
Loma	1,389	921	1,161
Cameo 1 & 2	52	60	82
Coal Canyon		181	312
Cottonwood Creek		188	418
Possible Additional Development			
Preference Right Lease Applications		922	3,283
Federal Areas of Interest:		516	1,505

TABLE R8- 28

EMISSIONS OF PARTICULATES, SO_x AND NO_x (TONS/YEAR) FROM TOWNS FOR THE HIGH-LEVEL SCENARIO

TOWN	POLLUTANT	1980	1985	1990
Delta	Particulates	16.9	18.1	25.8
	SO_x	7.8	8.4	12.1
	NO_x	87.9	92.9	133.0
Paonia	Particulates	7.6	8.4	13.1
	SO_x	3.4	4.1	6.0
	NO_x	39.0	43.5	66.4
Montrose	Particulates	23.6	21.5	25.1
	SO_x	9.6	8.7	9.9
	NO_x	109.6	99.9	116.0
Grand Junction	Particulates	41.8	44.9	44.0
	SO_x	18.2	19.5	19.3
	NO_x	272.6	293.7	288.5
Glenwood Springs	Particulates	37.5	40.7	48.7
	SO_x	11.0	12.2	14.6
	NO_x	160.4	174.1	208.1
Cedar Edge	Particulates	4.4	4.9	7.9
	SO_x	1.9	2.4	3.4
	NO_x	22.3	25.4	40.0
Gunnison	Particulates	45.2	57.0	58.5
	SO_x	9.5	12.1	12.4
	NO_x	106.6	134.5	138.1
Fruita	Particulates	11.0	13.3	13.6
	SO_x	5.0	5.9	6.0
	NO_x	72.2	87.8	88.8
Orchard Mesa	Particulates	25.1	28.5	28.5
	SO_x	11.0	12.5	12.5
	NO_x	163.3	187.5	186.8
Rifle	Particulates	24.8	27.8	34.1
	SO_x	7.5	8.2	10.0
	NO_x	105.5	119.5	145.6

PRLA and the federal interest area in the Little Bookcliffs. Both mines would be in a surface wind drainage area oriented approximately along a northeast-southwest line. Therefore, the meteorological data that were collected at a site with wind patterns similar to those postulated for the area of these mines were used. Data collected at the Occidental Oil Company Mt. Callahan site were determined to be most representative of worst-case 24-hour dispersion conditions for the Little Bookcliffs PRLA and federal interest area as well as for the DeBeque Canyon area.

Resultant Air Quality and Climate

Impacts from two types of activities are discussed. The first is the effect of mine-generated fugitive dust on TSP concentrations. The second are the impacts on TSP, SO_2 and NO_2 concentrations related to the population growth associated with the various levels of activity.

Since most of the fugitive dust generated by mining operations consists of relatively large diameter particles, considerable particulate deposition would occur before the particles are transported far. Thus, the area affected by particulate emission from mines is expected to be limited to within a few miles of the individual mines.

SIX PROPOSED M&R PLANS AND POSSIBLE HIGH-LEVEL COAL DEVELOPMENT

Concentrations mentioned in this section refer only to the contributions of the six proposed M&R plans and possible new high-level coal developments to the air quality. These contributions do not include baseline levels nor contributions from other activities.

The annual Colorado ambient air quality standards for TSP may be exceeded very near specific mining operations within or just outside the mine boundaries. However, concentrations would drop below standard levels at very short distances from the individual sources. Increases in TSP concentrations are predicted to be less than 1 $\mu g/m^3$ beyond a five-mile radius from the mines and their haul roads for all three benchmark years (see maps R8-7, R8-8, and R8-9).

At and slightly beyond the mine boundaries of most of the mines, the total particulate emissions from the mines would cause the Class II increments for prevention of significant deterioration (PSD) to be exceeded. However, the proposed mines would have no impact on the air quality of nearby Class I areas within the ES region.

Under the new PSD review procedure promulgated by the U.S. Environmental Protection Agency in June 1978 (*Federal Register*, June 19, 1978), the impact of fugitive dust emissions from coal mines would not be included in the analysis of the impact of the mines on either the PSD increments or the national ambient air quality standards. However, any coal mine with potential (uncontrolled) particulate emissions of at least 250 tons per year would be required to obtain a PSD permit for construction and operation. A full PSD review would be required only for mines with actual (controlled) emissions of at least 50 tons per year or 1,000 pounds per day. Mines with particulate emissions less than these limits would not be required to apply Best Available Control Technology (BACT) or to make an analysis of the impact of the mine on the ambient air quality of the area in order to get a PSD permit.

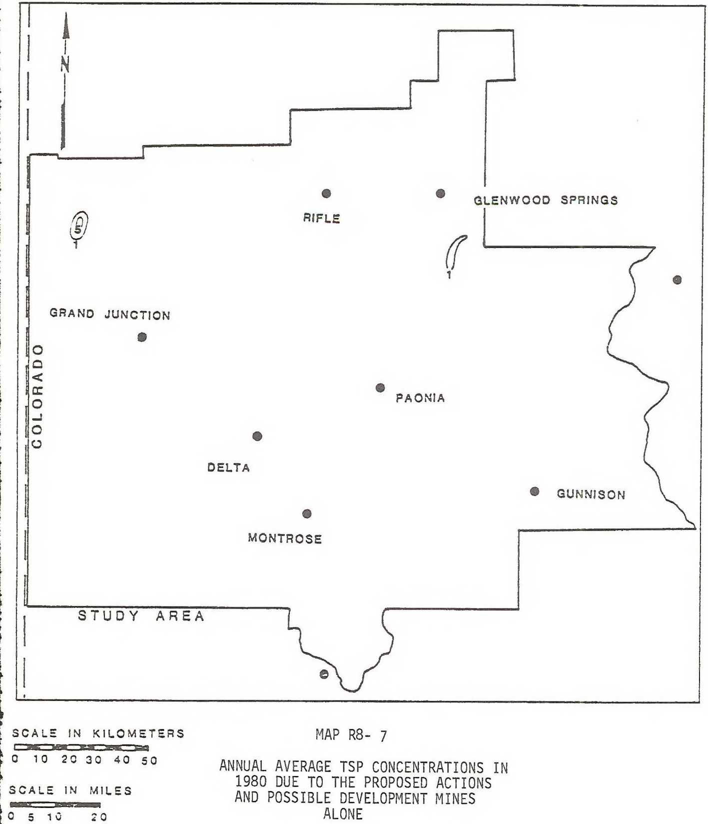
Because the new PSD review procedures have neither been implemented by EPA nor reviewed by parties of interest, the regional air quality analysis has been prepared using the previous PSD regulations. The previous regulations require that the air quality impact of all particulate emissions from surface mines be analyzed for PSD review.

The mines of the proposed actions are located in predominantly rural areas of the region. The areas of impact of the mines are confined to a few square miles around each mine. Therefore, the mines are not expected to have a noticeable impact on the TSP concentrations of the towns in the ES area.

Standards for PSD for Class II areas would be exceeded outside the boundaries of the Loma Project, Cottonwood Creek No. 1 and No. 2, North Thompson Creek No. 1 and No. 3, and the Little Bookcliffs PRLA and federal interest area. In 1990 maximum 24-hour concentration of 65 $\mu g/m^3$ would occur over a small area just south of the surface facilities of the Loma Project. Slightly lower maximum levels would occur in 1980 and 1985 in the same area. Maximum 24-hour TSP concentrations would reach 88 $\mu g/m^3$ over a small area around the Cottonwood Creek mines in 1990 exceeding the Class II PSD increment. In 1985 much lower emissions would result in maximum 24-hour levels of about 42 $\mu g/m^3$ within the same area. However, these concentrations would still slightly exceed the Class II increment.

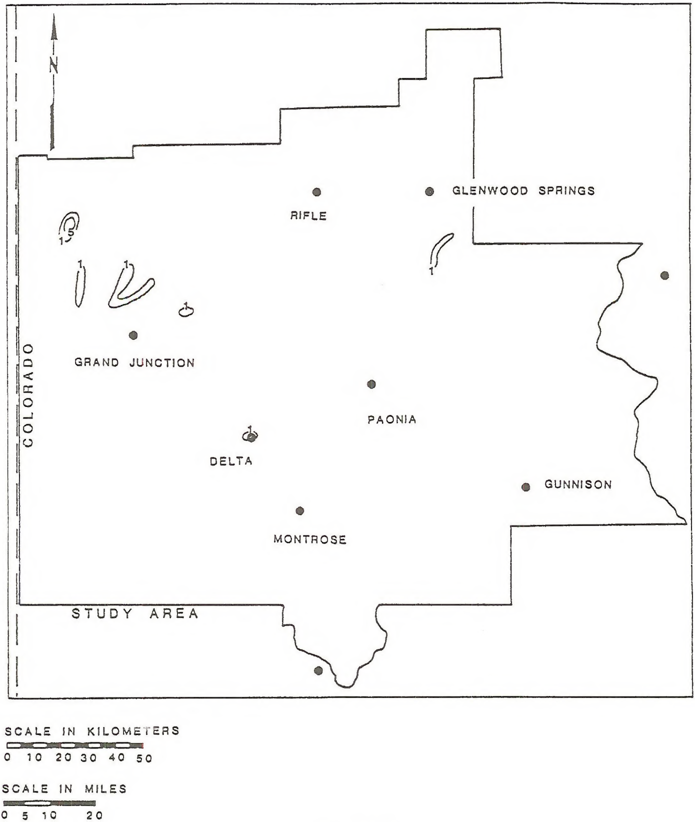
Particulate emissions from the North Thompson Creek mines in 1980, 1985, and 1990 would cause maximum 24-hour TSP levels to reach 53 $\mu g/m^3$ along the haul road northeast of the mine.

Particulate emissions from the Little Bookcliffs PRLA and federal interest area would result in violations of the 24-hour Class II increment in 1990. Maximum 24-hour TSP levels would reach 117 $\mu g/m^3$ about 700 feet south of the active mining area, but would drop to less than 10 $\mu g/m^3$ beyond 2,300 feet from the mine. Similarly, maximum 24-hour levels near the federal interest area would occur very near the mine and drop off rapidly with distance. In 1990 the maximum 24-hour



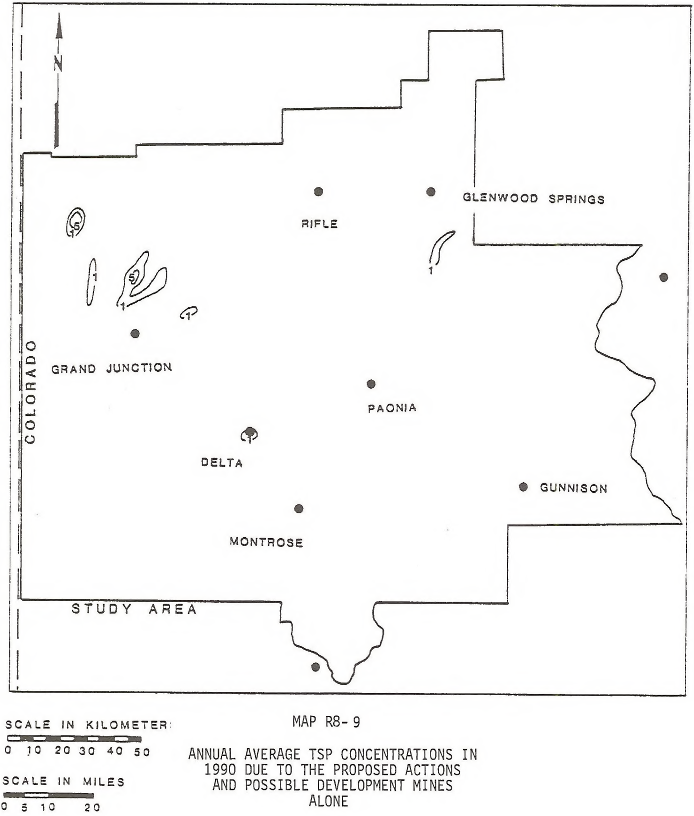
MAP R8- 7

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1980 DUE TO THE PROPOSED ACTIONS AND POSSIBLE DEVELOPMENT MINES ALONE



Map R8- 8

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1985
DUE TO THE PROPOSED ACTIONS AND POSSIBLE DEVELOPMENT MINES ALONE



MAP R8- 9

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1990 DUE TO THE PROPOSED ACTIONS AND POSSIBLE DEVELOPMENT MINES ALONE levels would exceed the Class II increment of 37 $\mu g/m^3$ to about 400 feet from the active mine area, but the TSP concentrations would drop to less than 10 $\mu g/m^3$ beyond 1,000 feet from the mine.

The increases in TSP, SO_2, and NO_2 concentrations from population growth in towns and from increased vehicular traffic created by the six proposed M&R plans and possible high-level coal developments are expected to be small. Maps R8-8 and R8-9 show that the only noticeable increases in annual TSP levels would occur around the town of Delta in 1985 and 1990. These increases would be about 1 $\mu g/m^3$ within five miles of the town. Increases of 24-hour TSP levels would reach only about 3 to 4 $\mu g/m^3$ over the same area. Similarly, small increases in NO_2 levels would occur in 1990 around Delta (map R8-10) with concentrations reaching 5 $\mu g/m^3$ over about the same area containing the 1 $\mu g/m^3$ TSP concentration increase.

No noticeable increase in SO_2 levels would occur in the ES region resulting from growth induced by the six proposed M&R plans and possible high-level development coal mines except in 1990 around Delta (map R8-11). In 1990 annual SO_2 concentrations would increase by 5 $\mu g/m^3$ over about a three to five-mile diameter area around Delta. Maximum 24-hour and 3-hour levels would increase by 17 $\mu g/m^3$ and by 28 $\mu g/m^3$, respectively, over the same area.

The commuter traffic to the proposed mines and increased travel on all highways in the ES area as a result of the six proposed M&R plans and possible development mines is not expected to significantly increase TSP, NO_2, and SO_2 concentrations in the ES region.

Cumulative High-Level Activities

Concentrations discussed in this section refer to contributions from all significant sources in the ES area which would emit pollutants under the high-level scenario. These sources include towns, highways, mines, major point sources, and the sources contributory to the rural baseline concentrations.

Maximum ambient concentrations of TSP, SO_2, and NO_2 for the possible new high-level coal development would result from baseline contributions and from emissions from towns in the ES area. In addition relatively high TSP concentrations would occur near federal areas of interest in the Little Bookcliffs, the Loma Project, the Little Bookcliffs PRLA, and the group of existing and proposed mines (Coal Canyon, Cameo No. 2, and Cottonwood Creek) in DeBeque Canyon. TSP concentrations near major towns and near several of the mines would exceed Colorado and national standards over relatively small areas centered around the sources.

Highest annual average TSP concentrations in 1980, 1985, and 1990 would occur in the vicinity of Grand Junction, Montrose, and Delta and in the area of Fruita and the Western Oil Refinery. The annual TSP levels would exceed 55 $\mu g/m^3$ over small areas about five to ten miles in diameter or less in these areas (maps R8-12, R8-13, and R8-14). These concentrations represent increases of approximately 15 $\mu g/m^3$ above the estimated background TSP levels of 40 $\mu g/m^3$ in the Grand Valley. The predicted ambient concentrations would exceed the Colorado annual TSP standard of 45 $\mu g/m^3$.

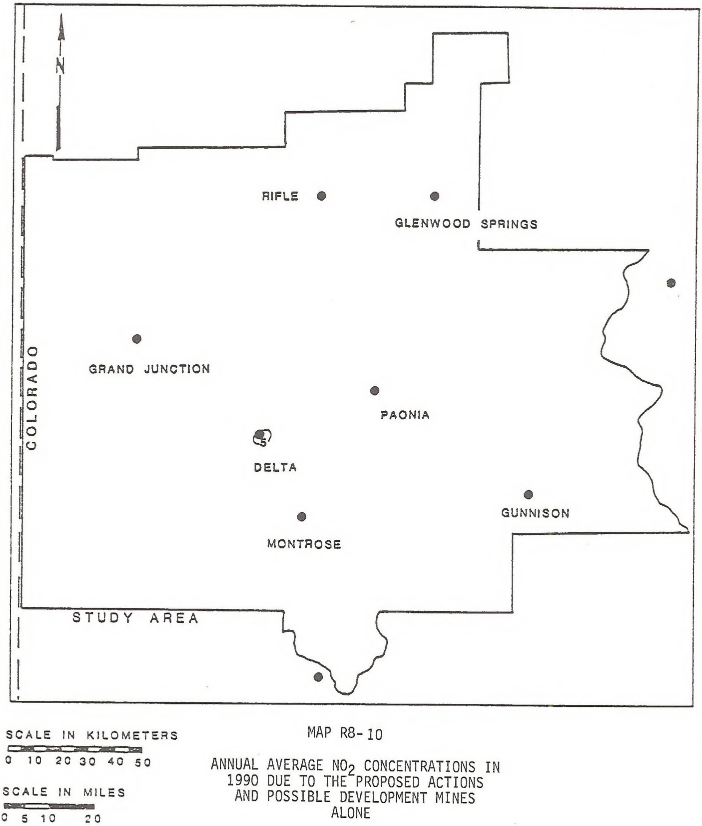
In 1980 concentrations in excess of 50 $\mu g/m^3$ would occur over a small area in the Fruita/Western Refinery area and by 1985 and 1990 concentrations of 50 $\mu g/m^3$ would occur over a small area around Grand Junction. These levels would equal the federal secondary TSP standard.

Fruita, Grand Junction and Paonia are in an area designated by the Environmental Protection Agency (EPA) as not attaining national ambient air quality standards (NAAQS) for TSP. The regional air quality analysis of air quality impacts does not show violations of the TSP standards except for the small areas in the vicinity of Fruita and Grand Junction. However, as existing monitoring data indicates, extensive violations of Colorado and federal annual and 24-hour TSP standards occur in this nonattainment area and near other major urban particulate sources in the ES region. (See technical report of chapter 2 of the regional ES.) These local violations should continue during the study years unless reductions in particulate emissions occur in the major towns of the ES region.

Maximum 24-hour TSP levels would exceed the national secondary and the Colorado standards with predicted concentrations of 190 to 200 $\mu g/m^3$ over small areas around Grand Junction, Fruita, and Delta during all three benchmark years. These standards would also be exceeded in the Montrose area in 1985 and 1990. These concentration levels would only slightly exceed the Colorado standard of 180 $\mu g/m^3$ around Grand Junction, but would exceed by a larger margin, the 150-$\mu g/m^3$ 24-hour TSP standard applicable in all other parts of the ES region.

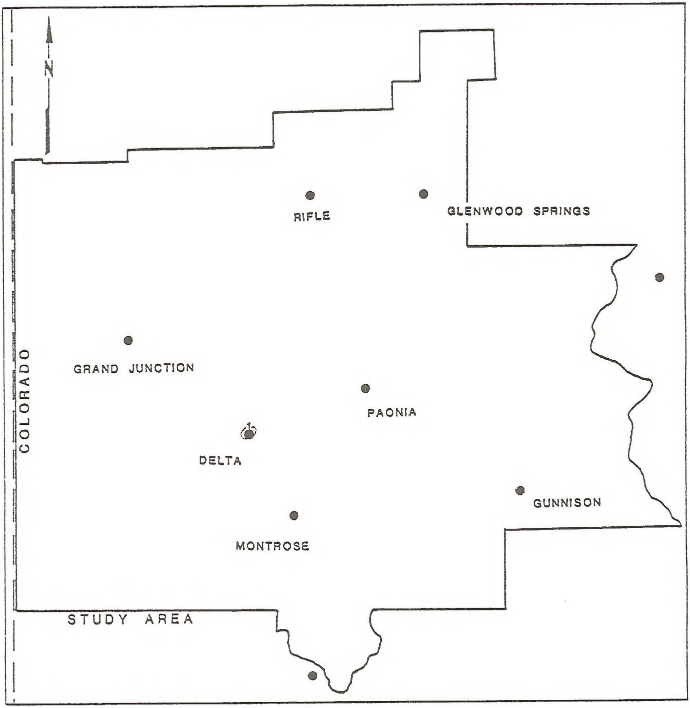
The primary contributors to these relatively high 24-hour ambient TSP levels around towns in the Grand Valley would be the baseline TSP contributions and not the contributions from particulate emissions from towns and highways. The baseline TSP levels are expected to be primarily from fugitive dust from agricultural activities in the Grand Valley.

Annual TSP concentrations along roadways and around towns in the remainder of the ES area would be well below Colorado and national ambi-



MAP R8-10

ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1990 DUE TO THE PROPOSED ACTIONS AND POSSIBLE DEVELOPMENT MINES ALONE

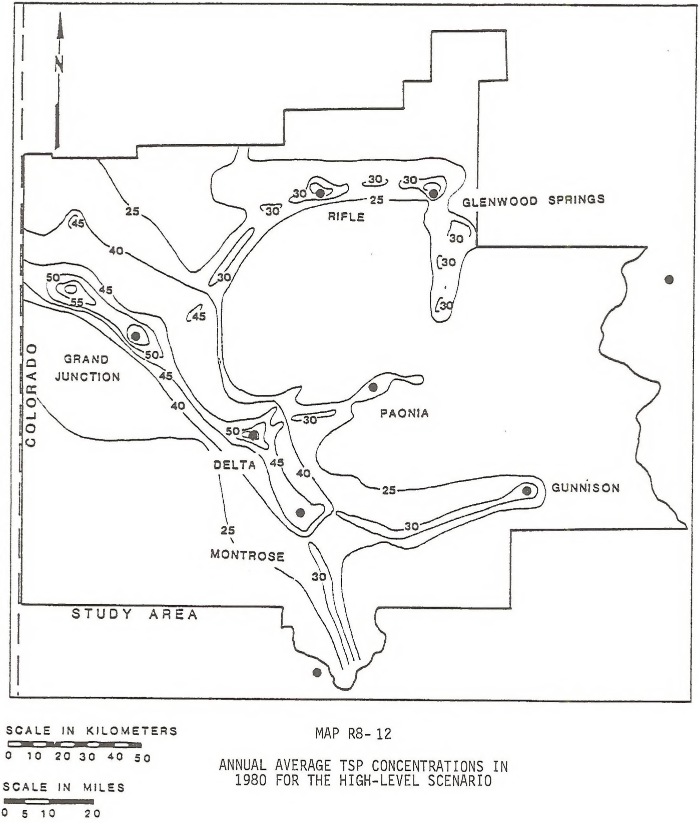


SCALE IN KILOMETERS
0 10 20 30 40 50

SCALE IN MILES
0 5 10 20

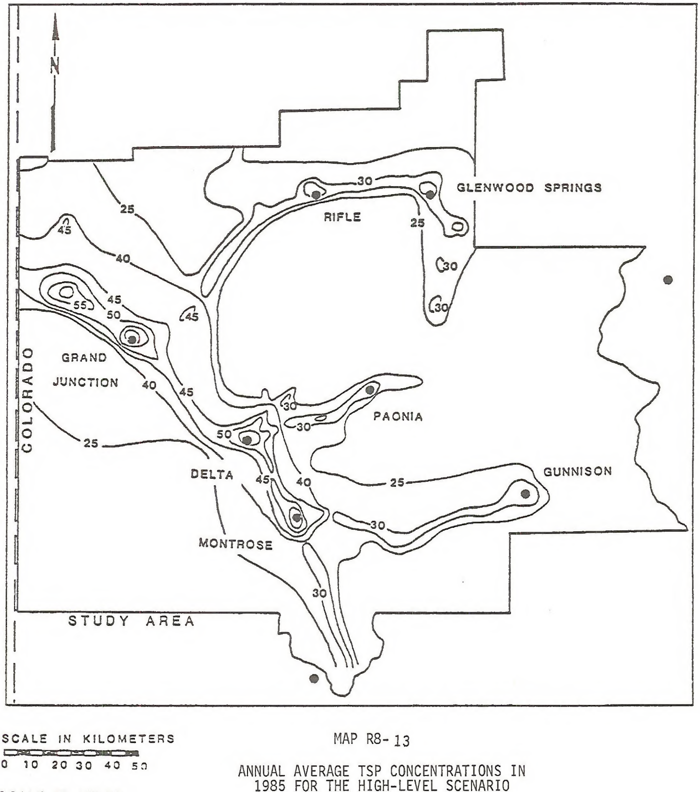
MAP R8-11

ANNUAL AVERAGE SO_2 CONCENTRATIONS IN 1990 DUE TO THE PROPOSED ACTIONS AND POSSIBLE DEVELOPMENT MINES ALONE



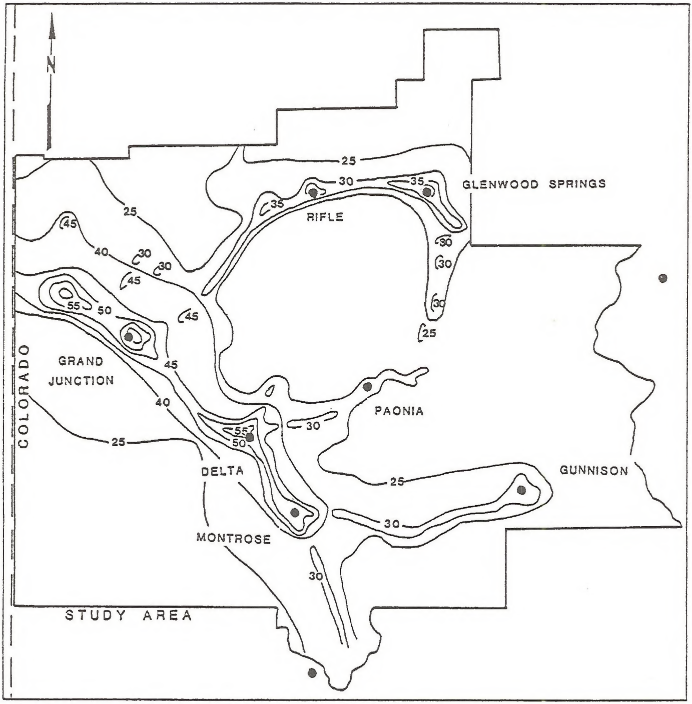
MAP R8- 12

ANNUAL AVERAGE TSP CONCENTRATIONS IN
1980 FOR THE HIGH-LEVEL SCENARIO



MAP R8- 13

ANNUAL AVERAGE TSP CONCENTRATIONS IN
1985 FOR THE HIGH-LEVEL SCENARIO



SCALE IN KILOMETERS
0 10 20 30 40 50

SCALE IN MILES
0 5 10 20

MAP R8-14

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1990 FOR THE HIGH-LEVEL SCENARIO ent air quality standards except very near specific roadways and pollutant sources in the towns. Maps R4-7, R4-8, and R4-9 (chapter 4) show ambient TSP concentrations of about 5 to 10 $\mu g/m^3$ above the rural baseline of 24 $\mu g/m^3$ over small areas around Rifle, Glenwood Springs, and Gunnison. Maximum 24-hour TSP levels would reach 120 $\mu g/m^3$ over small areas around Rifle and Glenwood Springs in 1980 and 1985. By 1990, these levels should increase to 140 $\mu g/m^3$ around Glenwood Springs but remain at 120 $\mu g/m^3$ around Rifle. Therefore, no violations of Colorado or national standards are predicted.

In 1980 and 1985 annual average TSP concentrations about 5 $\mu g/m^3$ above the baseline levels are predicted for small areas around the Loma Project mines in the DeBeque Canyon area, and mines south of Glenwood Springs. By 1990 additional areas of particulate concentrations about 5 $\mu g/m^3$ above background would occur around federal interest areas in the Little Bookcliffs. The areas of highest concentrations around the mines would be smaller in extent than those predicted around the towns and would not add to TSP concentrations around the towns. However, relatively high annual and 24-hour average concentrations would occur over very small areas near several mines in the ES area.

By 1990 interactions of particulate emissions from all sources in DeBeque Canyon would result in annual TSP concentrations in excess of 65 $\mu g/m^3$ over a 0.25-square-mile area near the bridge over the Colorado River. This concentration would exceed the national secondary and the Colorado ambient air quality standards. Slightly lower annual average concentrations would occur in this area for the two 1980 and 1985. The maximum 24-hour TSP concentrations would reach 150 $\mu g/m^3$ in 1990 equaling the federal secondary and the Colorado 24-hour ambient air quality standards.

Particulate emissions from existing and proposed mines in the North Fork Valley would also interact although maximum annual 24-hour TSP concentrations are predicted to be lower than those in DeBeque Canyon and would not exceed any standards. Maximum annual and 24-hour concentrations are expected for other study years. These maximum concentrations would occur over a very small area near Somerset, Colorado.

Emissions from the Loma Project would contribute to annual average TSP concentrations of 55 $\mu g/m^3$ in 1980 and would cause ambient levels to reach 60 $\mu g/m^3$ by 1990, exceeding both the federal secondary and the Colorado standards. These concentrations would be limited to areas of less than one-half square mile. Maximum 24-hour TSP levels in the same area would reach 105 $\mu g/m^3$ by 1990 and would not exceed state or federal standards.

Due to the apparent wind drainage flows from the northeast, emissions from the federal interest areas southeast of the Loma Project along the Little Bookcliffs would not significantly interact with emissions from the Loma Project. Maximum annual and 24-hour concentrations of 48 $\mu g/m^3$ and 157 $\mu g/m^3$, respectively, would be predicted for small areas around the Little Bookcliffs PRLA in 1990, causing the Colorado annual and 24-hour standards and the national secondary 24-hour standard to be exceeded. However, these high concentrations would be very localized and decrease rapidly with distance from the mine.

In 1990 ambient concentrations over a small area around two federal interest areas in the Little Bookcliffs would reach 50 $\mu g/m^3$ and 80 $\mu g/m^3$ for a maximum annual and a maximum 24-hour concentration, respectively. The annual concentrations would violate the Colorado standard, while the 24-hour concentration conforms to all state and national standards.

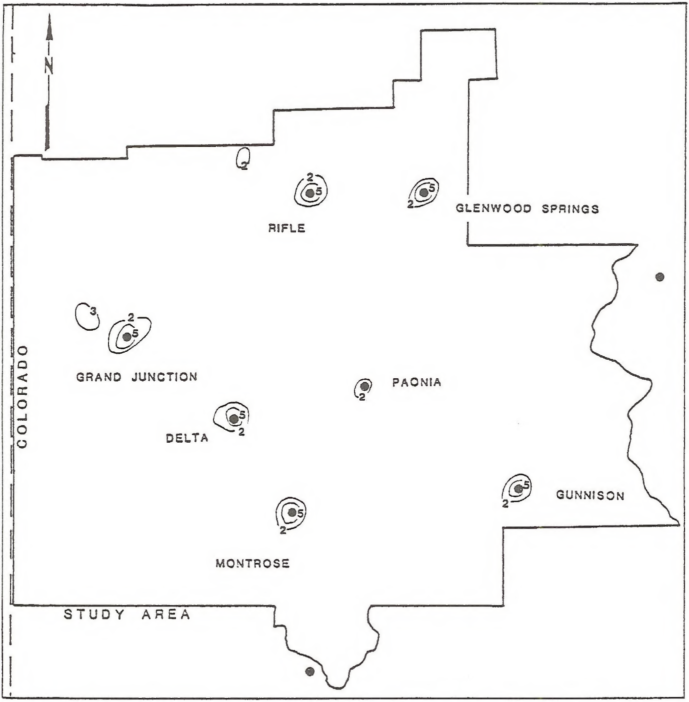
Emissions from the North Thompson Creek mines would contribute to maximum annual and 24-hour average TSP concentrations of 40 $\mu g/m^3$ and 77 $\mu g/m^3$, respectively. Neither of these levels, occurring in the vicinity of the mine, would result in violations of any state or federal standards.

Other mines and groups of mines in the ES area would increase TSP concentrations during the study years. However, maximum concentrations would be localized and would be lower than the maximum impact reported for the four mine groups discussed above.

Highest concentrations of gaseous pollutant (SO_2 and NO_2) would occur around towns and along highways in the ES area. Mining activities in 1980, 1985, and 1990 would have no noticeable impact on levels of these pollutants.

Map R4-15 shows that annual average SO_2 levels for the region exceed 5 $\mu g/m^3$ over very small areas around Grand Junction, Delta, Montrose, Gunnison, Rifle, and Glenwood Springs. Still lower concentrations would occur around Fruita and Paonia, and at the Occidental Oil Shale facility in the Parachute Creek area. Maximum 24-hour and 3-hour SO_2 levels for all study years should not exceed 8 $\mu g/m^3$ and 28 $\mu g/m^3$, respectively, outside of five miles from the towns. Therefore, no regional violations of Colorado or national standards are predicted.

Similarly, NO_2 levels should remain relatively low during the study years. Maps R8-16 and R8-17 show that highest annual average NO_2 concentrations would reach 40 to 45 $\mu g/m^3$ within small areas around Grand Junction and Delta. Maximum ambient levels of 10 to 20 $\mu g/m^3$ are predicted

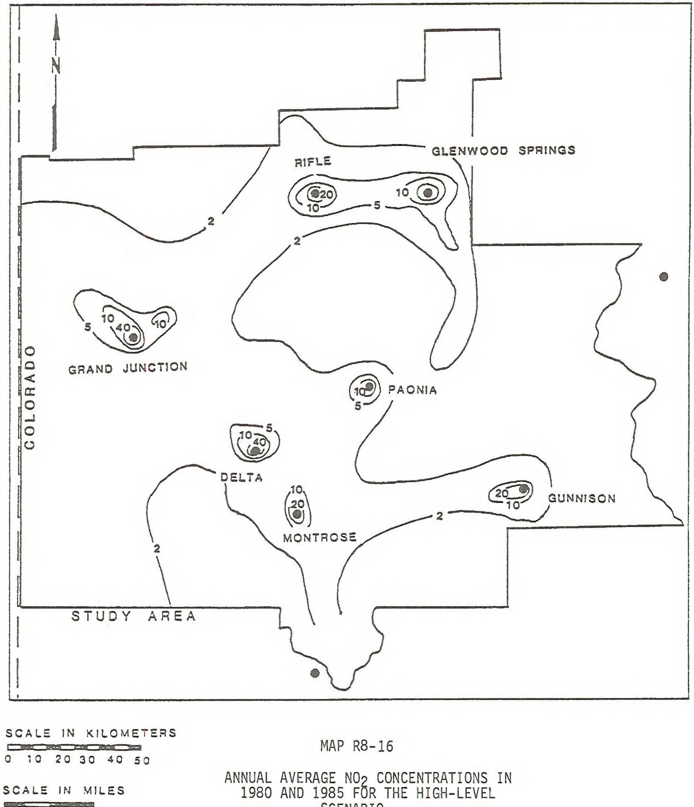


SCALE IN KILOMETERS
0 10 20 30 40 50

SCALE IN MILES
0 5 10 20

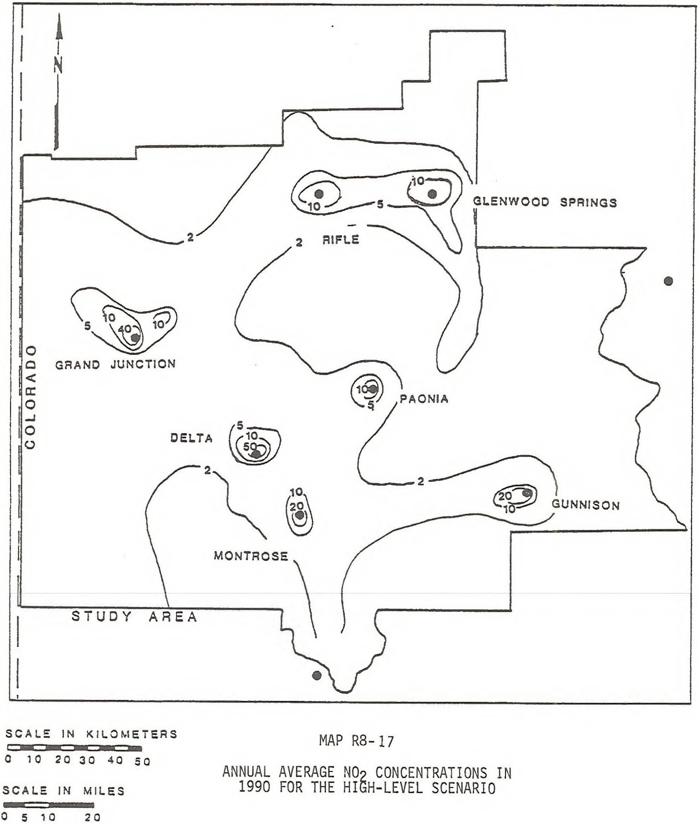
MAP R8- 15

ANNUAL AVERAGE SO_2 CONCENTRATIONS IN 1980, 1985, AND 1990 FOR THE HIGH-LEVEL SCENARIO



MAP R8-16

ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1980 AND 1985 FOR THE HIGH-LEVEL SCENARIO



MAP R8-17

ANNUAL AVERAGE NO_2 CONCENTRATIONS IN
1990 FOR THE HIGH-LEVEL SCENARIO

within small areas around other major towns in the region. Annual average NO_2 levels fall well below the NAAQS of 100 $\mu g/m^3$ for all three benchmark years.

Away from towns, mines, and other major pollutant sources, the annual horizontal visibilities related to atmospheric particulates are expected to exceed 60 miles almost 50 percent of the time. During 1980, 1985, and 1990 average regional visibilities would be reduced to around 53 miles over areas five miles in diameter or less around major mines and groups of mines in the ES region. These include areas around the Loma, Sunlight, Coal Basin, North Thompson Creek, Fairview, Little Bookcliffs PRLA, Tomahawk, and Red Canyon No. 1 mine areas, around the mines in DeBeque Canyon, and around federal interest areas in the Little Bookcliffs. Much higher short-term visibility reductions would occur very close to the individual mines; however, these reductions would be highly localized. In many cases, the slight reductions in atmospheric clarity around mines in the ES area would not be apparent because canyons, mountains, and other complex terrain features restrict lines of sight.

Regional visibilities (related to atmospheric particulates) would be reduced to 40 to 52 miles over small areas around major towns in the ES region for the three benchmark years. These reduced visibilities would not extend beyond about 10 to 15 miles from the towns. Much lower visibilities may occur near specific sources within the towns; however, these visibility reductions would be very localized.

The proposed mines would not significantly modify the climate and meteorology of the ES area.

Temporary loss of vegetation in active mining areas of the proposed mines may slightly decrease the amount of moisture locally available for the formation of thunderstorms during the late spring and early summer. However, the exposed soil would enhance convective heating, which contributes significantly to thunderstorm formation. Any increase of thunderstorms caused by lack of vegetation would be extremely localized.

The redistribution of soils and other materials at the mines, railroad, and transmission lines proposed for the ES area may cause small changes in the local climate. The modification of surface contours and albedo may result in local changes in wind speeds and directions, temperatures, and relative humidities of the disturbed material.

Geologic and Geographic Setting

Topography

Surface disturbance associated with excavation and earthwork in preparation for construction of surface facilities for possible new high-level coal development would alter the natural topography of 1,783 acres by 1985 and 3,422 acres by 1990 (see tables R8-25 and R8-26).

Cumulative surface disturbance due to subsidence could affect the topography of approximately 600 acres by 1980; 4,270 acres by 1985; and 11,630 acres by 1990. Of these totals, 720 acres by 1985 (17 percent) and 3,980 acres (34 percent) by 1990 would be due to possible new high-level coal development.

Paleontology

Both adverse and beneficial impacts would occur to fossil resources in approximate proportion to the level of regional development and the area disturbed.

Mineral Resources

As a result of all coal development under the high-level scenario, 7.49 million tons of coal per year would be produced in 1980, 18.6 millions tons per year by 1985, and 33.8 million tons per year by 1990. Of these totals, 5.4 million tons per year would be due to the possible new developments in 1985 and 18.2 million tons per year in 1990.

In addition, existing mining technologies may ruin coal reserves which are not currently considered to be mineable due to their depth, the thinness of the seam, or their proximity to the bed or beds being mined. Access to coal reserves lying at depths of greater than 3,000 feet may be blocked if shallower reserves are mined out first. Subsidence from mining may ruin either reserves that lie in beds too thin to be mined currently (less than 42 inches) or reserves in mineable beds too close to the seams being mined.

Water Resources

Impacts stemming from cumulative high-level development should be the same in kind as those described in chapter 4, but generally of slightly greater magnitude because of the higher coal production compared with cumulative development at the most probable level.

Under cumulative high-level development, approximately 600 acres of coal beds would be removed by 1980; 4,270 acres by 1985; and 11,630 acres by 1990 (table R8-29). This represents no increase by 1980 compared with cumulative mid-level development, an increase of 20 percent by 1985, and an increase of 52 percent by 1990. Data

TABLE R8-29

AREA OF COAL BEDS REMOVED BY MINING AT CUMULATIVE HIGH-LEVEL DEVELOPMENT

Activity	1978-80	1981-85	1986-90	1978-90
Approximate total area of coal beds removed at cumulative high-level development (acres)	600	3,670	7,360	11,630
Percent of total coal area disturbed	0.14	0.88	1.76	2.78
Percent of ES area disturbed	0.01	0.04	0.08	0.13
Percent increase (+) above cumulative mid-level development	0	+24	+80	+52
Approximate total area of coal beds removed by possible new coal development above mid-level	0	720	3,260	3,980
Percent of total coal area in which coal beds would be removed by possible new coal development above mid-level	0	0.17	0.78	0.95
Percent of total ES area in which coal beds would be removed by possible new coal development above mid-level	0	0.01	0.04	0.04

are not available from which to determine what percentage of the coal beds removed would be saturated and, thus, comprise potential aquifers, but as a general rule, most coal beds and overlying rocks in the eastern coal fields should be water bearing whereas those in the western coal fields are probably dry. A correspondingly larger area in the eastern part of the ES area, therefore, can be expected to undergo a permanent loss of springs and diversion of surface water into the mined-out areas as a result of subsidence and the extention of open cracks to the surface. Such impacts should be minor in the western part of the ES area. The effects of this disruption of the ground-water and surface-water systems could be important locally, but should have no measurable impact on the regional ground-water or surface-water systems because only about 0.13 percent of the ES area would be affected.

Stream channels would be removed, relocated, or altered on an area of about 8,639 acres by 1980; 28,491 acres by 1985; and 38,906 acres by 1990 (table R8-30). This represents no increase by 1980 compared with cumulative mid-level production, an increase of 8.9 percent by 1985, and an increase of 16 percent by 1990. Since only about 0.4 percent of the ES area would be affected by channel disturbances by 1990, any impacts on channel stability and aquatic biology should be very local and short term.

Additional consumptive use of water at cumulative high-level development would be about 8,460 acre-feet by 1980; 45,820 acre-feet by 1985; and 50,100 acre-feet by 1990 (table R8-31). This represents no increase compared with cumulative mid-level production by 1980, an increase of 3.8 percent by 1985, and an increase of 13.8 percent by 1990. The impact on downstream water users would be increased accordingly. The effect of this increased consumptive use of water, coupled with a comparatively small decrease in salt load of about 960 tons/year, would be to increase the dissolved-solids concentration in the Colorado River at the Colorado-Utah state line by about 0 milligram per liter (mg/l) by 1980, 0.17 mg/l by 1985, and 0.57 mg/l by 1990 (table R8-31). The dissolved-solids concentration in the Colorado River below Hoover Dam would increase by about 0 mg/l by 1980, 0.10 mg/l by 1985, and 0.34 mg/l by 1990. Annual increased costs to downstream users would be about $23,000 by 1985 and $78,000 by 1990.

Estimated changes in sediment yield as a result of cumulative high-level development are shown in table R8-32 for the periods 1978-80, 1981-85, and 1986-90. Computations indicate that sediment yield from all disturbed areas would decrease about 0 tons compared with cumulative mid-level development during 1978-80; 9,041 tons during 1981-85; and 19,503 tons during 1986-90. The decrease in sediment yield would occur despite the higher level of development because an increase in coal mining would primarily increase the size of those areas from which overall sediment yield would be minimized by effluent limitations (30[CFR]: 717.17[a]) or reduced below predisturbance rates as a result of urbanization. This relatively small decrease in sediment yield compared with cumulative mid-level production might slightly reduce local impacts on channel morphology or water use, but the decrease would be insignificant compared with the annual suspended sediment load of 10.8 million tons in the Colorado River at the Colorado-Utah state line.

Soils

Major disturbance and alteration of soils as a result of possible new coal development would cause a short-term reduction in soil productivity on 1,783 acres by 1985 and 3,552 acres by 1990 (see table R8-26). Cumulative regional development (including urban expansion due to population growth) would disturb a total of 8,639 acres in 1980; 28,491 acres in 1985; and 38,906 acres in 1990.

Urban area expansion (see table R8-26) would cause a permanent loss of soil surface due to construction of housing and support facilities. This acreage would also likely include land classified or eligible for classification as prime or unique farmland.

An increase in population would also result in greater use of the region's soils for recreation, particularly by off-road vehicles (ORVs). The amount of impact on soils that would result from recreation is unknown.

Vegetation

Possible new coal development in the region would result in the removal of native vegetation and loss of productivity for varying periods of time on an estimated 1,783 acres by 1985 and 2,053 acres by 1990. Problems may be encountered in attempting to revegetate the disturbed areas, particularly in the lower altitudes of the region. In such cases where low annual precipitation; high soil salinity; steep, south-facing slopes; and weed infestation are serious problems, the period of time required for successful revegetation may be prolonged, even if adapted species and advanced revegetation techniques are used.

Vegetation disturbed by urban expansion due to population increases (see table R8-26 for acreages) would be permanently lost. In addition, population increases due to cumulative development would result in unquantificable impacts to vegetation from

TABLE R8- 30

STREAM CHANNELS AFFECTED BY CUMULATIVE HIGH-LEVEL DEVELOPMENT

Activity	1978-80	1981-85	1986-90	1978-90
Approximate total surface area disturbed at cumulative high-level development (acres)	8,639	19,852	10,415	38,906
Percent of ES area in which stream channels would be affected by cumulative high-level development	0.09	0.21	0.11	0.42
Percent increase (+) above cumulative mid-level development	0	+13	+43	+16
Approximate surface area disturbed by possible new coal development above mid-level	0	2,336	3,139	5,475
Percent of total coal area in which channels would be affected by possible new coal development above mid-level	0	0.56	0.75	1.31
Percent of total ES area in which channels would be affected by possible new coal development above mid-level	0	0.03	0.03	0.06

TABLE R8-31

ESTIMATED CONSUMPTIVE USE OF WATER AND CHANGE IN SALINITY IN THE COLORADO RIVER AS A RESULT OF CUMULATIVE HIGH-LEVEL DEVELOPMENT

No.	Item	1980 a/	1985 a/	1990 a/
	Water yield:			
1.	Net discharge without additional development (see (table R2-24) (ac-ft)	4,200,000	4,200,000	4,200,000
2.	Additional consumptive use:			
3.	Irrigation (Dallas Creek Project) (ac-ft)	-500	-17,100	-17,100
4.	Coal mining operations (ac-ft)	-420	-2,620	-4,000
5.	Other mining operations (ac-ft)	-200	-300	-400
6.	Oil shale development (ac-ft)	-640	-12,600	-12,600
7.	Grand Valley Project (ac-ft)	+800	+2,800	+4,000
8.	Municipal and rural (ac-ft)	-7,500	-16,000	-20,000
9.	Total additional consumptive use (lines 3 through 8) (ac-ft)	-8,460	-45,820	-50,100
10.	Net discharge (line 1 plus line 9) (ac-ft)	4,191,540	4,154,180	4,149,900
	Salinity:			
11.	Total dissolved solids load in Colorado River near Colorado-Utah state line without additional development (see table R2-24) (tons)	3,260,700	3,260,700	3,260,700
12.	Additonal dissolved-solids load:			
13.	Irrigation (Dallas Creek Project) (tons)	+300	+9,800	+9,800
14.	Coal mining operations (tons)	-70	-600	-1,200
15.	Other mining operations (tons)	-80	-120	-160
16.	Oil shale development (tons)	-480	-9,420	-9,420
17.	Grand Valley Project (tons)	-81,500	-285,300	-407,500
18.	Municipal and rural (tons)	+870	+300	+1,550
19.	Total additional dissolved-solids load (lines 13 through 18) (tons)	-80,960	-285,340	-406,930
20.	Total dissolved solids load in Colorado River near Colorado-Utah state line (line 11 plus line 19) (tons)	3,179,740	2,975,360	2,853,770
21.	Change in discharge-weighted average dissolved-solids concentration in Colorado River near Colorado-Utah state line (mg/l)	-13.05	-44.21	-65.22
22.	Percent change	-2.3	-7.7	-11.4
23.	Change in discharge-weighted average dissolved-solids concentration in Colorado River below Hoover Dam (mg/l)	-5.55	-18.51	-27.49
24.	Percent change	-0.81	-2.7	-4.0

a/ Increase (+) or decrease (-) in indicated items.

TABLE R8-32

ESTIMATED SEDIMENT YIELD AS A RESULT OF CUMULATIVE HIGH-LEVEL DEVELOPMENT

Activity	Area Disturbed (acres)	Total Sediment Yield Before Disturbance (tons)	Total Sediment Yield After Disturbance (tons)	Net Change in Sediment Yield Increase (+) or Decrease (-) (tons)
		1978-80		
Existing coal mines	1,104	3,310	7	-3,303
Proposed coal mines (volume 2)	332	940	2	- 938
Possible new coal development	0	0	0	0
Oil shale mines/refineries	60	180	300	+ 120
Uranium mines/mills	780	2,340	3,900	+1,560
Oil and gas exploration/ drilling	285	860	1,425	+ 565
Roads	2,010	6,030	10,050	+4,020
Railroads	7	20	35	+ 15
Power lines/pipelines/ telephone lines	0	0	0	0
Population related disturbances	4,061	12,180	17,260	+5,080
Subtotal	8,639	25,860	32,979	+7,119
		1981-85		
Existing coal mines	1,265	6,320	14	-6,306
Proposed coal mines (volume 2)	548	2,640	6	-2,634
Possible new coal development	1,783	8,920	19	-8,901
Oil shale mines/refineries	4,500	22,500	31,380	+8,880
Uranium mines/mills	2,340	11,700	14,820	+3,120
Oil and gas exploration/ drilling	795	3,980	4,995	+1,015
Roads	6,081	30,400	38,550	+8,150
Railroads	504	2,520	2,894	+ 374
Power lines/pipelines/ telephone lines	2,000	10,000	14,000	+4,000
Population related disturbances	8,675	43,380	27,000	-16,380
Subtotal	28,491	142,360	133,678	-8,682
		1986-90		
Existing coal mines	1,393	6,960	15	-6,945
Proposed coal mines (volume 2)	590	2,850	6	-2,844
Possible new coal development	3,422	17,100	37	-17,063
Oil shale mines/refineries	4,500	22,500	22,500	0
Uranium mines/mills	3,900	19,500	22,620	+3,120
Oil and gas exploration/ drilling	1,320	6,600	7,650	+1,050
Roads	10,081	50,400	58,400	+8,000
Railroads	504	2,520	1,010	-1,510
Power lines/pipelines/ telephone lines	2,000	10,000	10,000	0
Population related disturbances	11,196	55,980	22,820	-33,160
Subtotal	38,906	194,410	145,058	-49,352
TOTAL	38,906	362,630	311,715	-50,915

increased ORV use, firewood cutting, and exploitation of certain endangered and threatened plants.

Wildlife

Wildlife habitat, carrying capacity, and populations would be lost as a direct result of possible new coal development on 1,783 acres by 1985 and 3,422 acres by 1990. Carrying capacity would be reduced for deer by about 87 by 1985 and 168 by 1990 and for elk by 15 animals by 1985 and 28 by 1990.

Cumulative regional development would disturb 8,639 acres by 1980; 28,491 acres by 1985; and 38,906 acres by 1990. This amounts to 0.10 percent, 0.32 percent, and 0.43 percent, respectively, of the habitat available to wildlife in the ES area. However, locally heavy losses and displacement of wildlife could occur because of changes in microenvironments and certain habitat types, particularly as a result of oil shale development and urban expansion.

Increasing human populations would in general also cause the following impacts on wildlife: increased road kills due to increased vehicular traffic; increased poaching and indiscriminate shooting of wildlife; increased harassment of wildlife during stress periods (especially winter and reproductive periods); and increased recreational use of wildlife.

Aquatic Biology

Water consumption resulting from cumulative high-level development would be 8,460 acre-feet by 1980; 45,820 acre-feet by 1986; and 50,100 acre-feet by 1990. Fisheries in such streams and the North Fork River and North Thompson Creek would decline due to increased dewatering. Other fisheries in the region may be subject to similar impacts as the mining and development interests seek new sources of water.

An increase in the acreage disturbed by mining activities would increase the sediment yield to stream fisheries. A declining trend in cold water sport fisheries is expected as more sediment is carried to the streams. Fishing pressure would increase in easily accessible areas which would cause reliance on trout produced from hatcheries.

The probability of major water pollution accidents and losses of aquatic habitat from tailing pond breaks, spills, or flood washouts would increase as the number and size of mining operations increase. Major mining areas in Colorado and the eastern United States have historically suffered such problems. Areas along the Colorado River and along the North Fork River would be most susceptible to such occurrences.

The influx of 6,500 more people to the region by 1985 and 24,150 more people by 1990 due to the possible new coal development would prolong water pollution problems from inadequate sewage systems until the construction of new and additional facilities can catch up with growth and development.

Cultural Resources

Archeology

Impacts to archeological resources would be intensified by the high-level scenario. Increased population pressures on land use and a greater number of acres to undergo surface disturbance would result in increased exposure of archeological values to potentially damaging activities, which could lead to the destruction of some 1,989 identified and countless unknown archeological sites in the ES area. The effects of possible new coal production would be minor when compared with the effects of regional development.

Historic Resources

Impacts to the historical sites would be similar to those on the archeology of the ES area. A potential exists for the destruction of some 123 known and countless unknown sites in the ES area. A secondary impact that would occur would be the displacement of older structures in towns and cities that would develop rapidly.

Transportation

Increased production of coal and greater population growth as a result of the high-level scenario would result in an increase in impacts to the transportation system. Vehicles registered in the area would increase to 264,924 vehicles by 1985 and 273,024 vehicles by 1990. This would include increases of 7,020 vehicles by 1985 and 26,082 vehicles by 1990 due to possible new coal development.

Average daily traffic levels at points throughout the region would increase, as would accident rates. Greater use of roads and facilities would result in greater wear and higher maintenance costs. Use of public highways to transport coal and supplies would require some upgrading of roads and also increase maintenance costs.

Greater production in the region would result in 99 more unit trains on the region's branch lines than would occur with the most probable level of producton. Adverse impacts associated with rail operations, such as fuel consumption, air pollution, noise, highway-rail grade crossing accidents, and delay would increase to a similar degree.

As with the probable level, this level of production could be accommodated on the existing rail system as long as only the probable level of coal development is reached in central Utah and northwest Colorado. The high levels of development in these regions could not be accommodated on the existing rail system together with the traffic generated in west-central Colorado. The magnitude of improvements required would be similar to those discussed in chapter 4.

Agriculture

Livestock Grazing

Due to cumulative regional development, 457 animal unit months (AUMs) would be lost by 1980; 1,796 AUMs by 1985; and 2,755 by 1990, including 331 AUMs lost in 1990 due to possible new coal development. This would be 0.08 percent, 0.34 percent, 0.51 percent, and 0.06 percent, respectively, of the 535,221 AUMs produced on the nearly 5.4 million acres of public land and national forest systems land in the ES area.

It is very likely that some of the urban expansion due to increased population (see table R8-26 for acreages) would disturb irrigated and nonirrigated hayland and pasture. This would adversely affect the livestock industry because these lands are used as livestock wintering areas, and the hay harvested from them in the summer is used to feed the livestock during the winter. Increased ORV use as a result of population increases would kill or decrease the vigor of plants; as a result, livestock range condition would decline.

Farming

Although exact locations of vegetative disturbance cannot be predicted, it is likely that some of it would be on prime farmland, particularly disturbance from community expansion (see table R8-26).

Recreation

The possible new coal development would not have a significant direct impact on recreation; however, the associated population growth, along with regional growth due to cumulative development, would affect recreation with increased demand for recreational opportunities. This could have a significant impact on community recreational facilities since most are currently fully utilized, and the increased use would result in overuse and deterioration. Prevention of this overuse would require construction of additional facilities amounting to 156.9 acres of active/improved park land (e.g. ballfields, playgrounds, tennis courts) by 1980, 335.6 acres of active/improved parkland by 1985, and 419.4 acres of active/improved parkland by 1990.

The increased demand for recreational opportunities would also impact the managing agencies (federal, state, and local) of recreational resources and facilities with increased maintenance and overhead costs to maintain visitor safety and protect the resources. The increased costs are not known but would be increased from the mid-level in proportion to population growth.

Socioeconomics Conditions

Additional employment opportunities associated with the high-level scenario are expected in the ES area beginning in 1986 and 1987. Initially, this additional employment would result from mine development activities. By 1990 all mines included in the high-level scenario would be operating at full production.

Table R8-33 lists the 1990 population projections under the high-level scenario for the counties in the ES area. Figure R8-3 compares high-level population projections with baseline and mid-level projections. Population growth, resulting from this alternative, would occur in Delta, Garfield, Mesa, Ouray, and Montrose counties. The high-level scenario would cause a more rapid rate of growth between 1986 and 1990 than otherwise expected in these counties. In rural areas this new population would settle wherever housing and utility service became available, since most of the excess housing and service capacity would be exhausted by population growth before 1985. If little is done to expand the housing supply and provide increased utility services in Delta County, new populations allocated to Delta County may be forced to locate farther away, most likely in Montrose or Mesa counties. Most of the population growth associated with the high-level scenario would locate in or around the cities of Montrose, Delta, Grand Junction, Rifle, and Glenwood Springs.

Further expansion of coal development after 1985 in Mesa and Garfield counties would supplement some of the loss in employment which is expected once construction activity in the oil shale industry begins to decline. As a result, it would not generate more rapid population growth, but rather serve to stabilize population growth in Mesa County and somewhat reduce unemployment in Garfield County. This effect assumes that oil shale development would proceed according to schedule, and that most construction would be completed by 1985. If that is not the case, and oil shale development is further delayed, the additional coal development in the late 1980s would have a similar effect to that which is now projected under the cumulative schedule of development, that of coal development compounding already rapid population growth due to oil shale development.

The additional population growth would be most difficult to provide for in the Delta County area. Delta County, and all its communities, are expected to be severely strained in the effort to provide for

TABLE R8-33

HIGH-LEVEL POPULATION PROJECTIONS

Year	County	Mid-Level Population	Population due to Possible Coal Development	Percent Difference from Mid-Level
1980	Delta	21,000	0	-
	Garfield	33,000	0	-
	Gunnison	9,400	0	-
	Mesa	91,950	0	-
	Montrose	22,900	0	-
	Ouray	2,200	0	-
	Pitkin	17,050	0	-
	Total	197,600	0	-
1985	Delta	26,400	2,200	8.3
	Garfield	39,350	500	1.3
	Gunnison	18,900	0	-
	Mesa	113,300	3,800	3.4
	Montrose	24,150	0	-
	Ouray	2,100	0	-
	Pitkin	21,100	0	-
	Total	245,300	6,500	2.6
1990	Delta	28,900	9,550	33.0
	Garfield	46,400	2,300	5.0
	Gunnison	18,100	0	-
	Mesa	107,150	10,600	9.9
	Montrose	25,600	1,300	5.1
	Ouray	2,400	400	16.7
	Pitkin	24,250	0	-
	Total	252,800	24,150	9.6

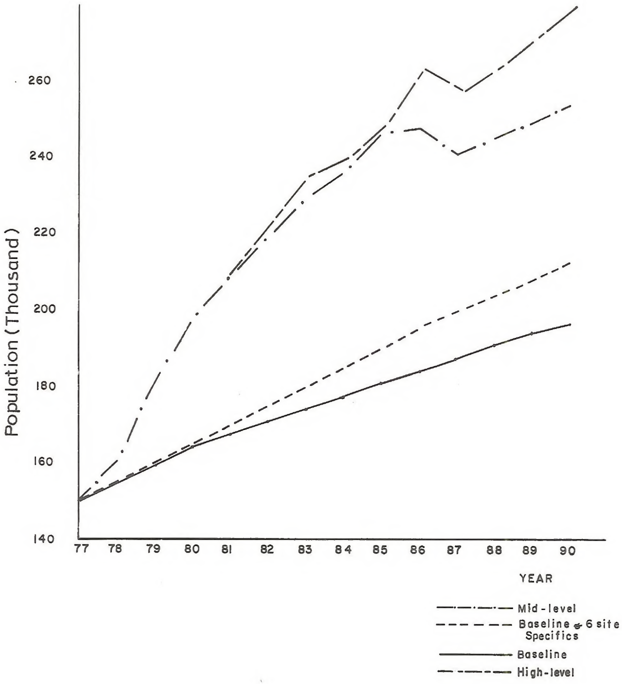


Figure R8-3. Population -- high level

population growth from the mid-level schedule. Additional coal development before 1990 would jeopardize the area's ability to maintain a quality living environment, because it would force a second "boom" situation before enough time had elapsed to adjust to the first "boom" in coal development. High-level development would compound the revenue deficit situation of local governments in Delta County, because most of the additional mine facilities would be located inside Gunnison County, while new employees would most likely reside in Delta County. Adequate housing for the mine workers and their families would be particularly difficult to locate close to the sites because of the unavailability of developable land within the area. Larger quantities of productive agricultural land would be needed to support the increased population. This level of population growth would exceed the scope of school planning which is presently being done for the area, and would perpetuate overcrowding of school facilities.

Additional population growth in Montrose County resulting from this scenario would be more easily accommodated. With the addition of regional water and sewer treatment and distribution systems around the city of Montrose, it would be possible to provide for a largely expanded population in the near future. Because Montrose is an established commercial center, it would benefit from increased trade and resulting tax receipts due to population growth throughout the region. But local governments in Montrose County would not be able to collect any ad valorem tax revenues from the coal facilities themselves, since all the mines would be located outside of their jurisdictional boundaries.

The high-level scenario of development would not significantly increase the burden of providing adequate facilities and services on local governments in Mesa and Garfield counties. Because this level of production would provide new employment during the period when construction activity on oil shale projects in the area is declining, it is not expected to contribute to substantial population increase. New mining activity in Mesa and Garfield counties, under this scenario, would be located such that it should provide tax base increases primarily to those local jurisdictions which can be expected to absorb most of the impact. The exceptions, as usual, are the municipalities which would not benefit from any direct revenues from the mine facilities themselves.

Income level in the region would be higher under this scenario. More miners would be required and their higher incomes would cause all measures of income to rise. The disparity between miners' incomes and those in other industries would cause some movement of labor resources with the result of raising the overall wage level in the region. Greater coal production with the resultant increase in basic employment would result in increased employment in secondary industries.

Greater coal production would result in more rapid population growth and an increase in the social problems that accompany such growth. Conflicts between groups in the communities would increase. Eventually political powers would shift from traditional agricultural interests to the newcomers. Social problems such as drug abuse, alcoholism, and crime would increase at a faster rate.

The region would become economically dependent upon one industry. A decline in the demand for coal at some time in the future could cause a serious recession in the local economy.

TABLE R8-34

COMPARISON OF IMPACTS - 1980
(PARTIAL LISTING)

Resource	Unit	Proposed Actions	Mid-Level Development (Cumulative)	Low-Level Scenario a/	High-Level Scenario (Additional Coal)	High-Level Scenario (Cumulative)
Air Quality - total suspended particulate emissions from coal mines	Tons per year	5,089	6,615	5,164	0	6,615
Topography - subsidence due to underground mining	Acres	90	600	550	0	600
Topography - surface disturbed	Acres	413	8,639	8,487	0	8,639
Paleontology - loss of fossils due to collecting and mining	Sites	NA	NA	NA	0	NA
Minerals - annual coal production	Million tons	1.53	7.49	6.73	0	7.49
Water - area of coal beds (possible aquifers) removed	Acres	90	600	550	0	600
Water - area in which stream channels disturbed	Acres	413	8,639	8,487	0	8,639
Water - estimated annual water consumption	Acre-feet	120	8,460	8,360	0	8,460
Water - change in dissolved-solids concentration - Colorado River at Colorado-Utah State Line	Milligrams per liter	+0.02	-13.05	-13.06	0	-13.05
Water - change in dissolved-solids concentration - Colorado River below Hoover Dam	Milligrams per liter	+0.01	-5.55	-5.56	0	-5.55
Water - Cumulative change in estimated sediment yield from disturbed areas	Tons per year	-270	+2,375	+2,385	0	+2,375

Note: NA = not available

a/ The impacts of a no action alternative would be essentially the same as the low-level scenario.

TABLE R8-34

(continued)

Resource	Unit	Proposed Actions	Mid-Level Development (Cumulative)	Low-Level Scenario a/	High-Level Scenario (Additional Coal)	High-Level Scenario (Cumulative)
Soil and vegetation - reduced productivity	Acres	413	8,639	8,487	0	8,639
Vegetation - disturbed lands which would be reclaimed b/	Acres	349	1,453	1,367	0	1,453
Wildlife - loss of fish and wildlife habitat and carrying capacity	Acres	-413	-8,639	-8,487	0	-8,639
Wildlife - antelope lost	Antelope	0	0	0	0	0
Wildlife - deer lost	Deer	-32	-674	-67	0	-674
Wildlife - elk lost	Elk	-5	-108	-11	0	-108
Cultural - number of archeological sites with potential disturbance	Sites	4	1,989	1,989	0	1,989
Cultural - number of historical sites with potential disturbance	Sites	0	123	123	0	123

b/ Land disturbed by coal mining only; this reclamation would not be successfully completed until after completion of mining (generally after 1990). Information is not available to predict how much land disturbed by other energy development would eventually be reclaimed. It is unlikely that land converted by urban development would be returned to previous land uses.

TABLE R8-34

(continued)

Resource	Unit	Proposed Actions	Mid-Level Development (Cumulative)	Low-Level Scenario a/	High-Level Scenario (Additional Coal)	High-Level Scenario (Cumulative)
Land Use - lands needed for industrial development	Acres	349	4,578	4,492	0	4,578
Land Use - lands needed for urban development	Acres	64	4,061	3,995	0	4,061
Transportation - increase in vehicle registrations	Vehicles	+810	+51,570	+50,760	0	+51,570
Transportation - increase in number of coal trains	Trains per year	+80	+661	+559	0	+661
Agriculture - number of animal unit months (AUMs) lost	AUMs	-14	-457	-448	0	-457
Recreation - increase in anglers	Anglers	+682	+21,010	NA	NA	NA
Recreation - increase in hunters	Hunters	+264	+8,118	NA	NA	NA
Recreation - active/improved parkland required	Acres	5	157	151	0	157
Socioeconomic - increase in population	People	+750	+47,750	+47,000	0	+47,750
Socioeconomic - increase in employment	Jobs	+517	+27,440	+26,923	0	+27,440

TABLE R8-35

COMPARISON OF IMPACTS - 1985
(PARTIAL LISTING)

Resource	Unit	Proposed Actions	Mid-Level Development (Cumulative)	Low-Level Scenario a/	High-Level Scenario (Additional Coal)	High-Level Scenario (Cumulative)
Air Quality - total suspended particulate emissions from coal mines	Tons per year	5,059	6,788	5,288	1,438	8,226
Topography - subsidence due to underground mining	Acres	1,370	3,550	2,150	720	4,270
Topography - surface disturbed	Acres	1,934	26,155	22,510	2,336	28,491
Paleontology - loss of fossils due to collecting and mining	Sites	NA	NA	NA	NA	NA
Minerals - annual coal production	Million tons	7.63	13.17	4.64	5.45	18.62
Water - area of coal beds (possible aquifers) removed	Acres	1,370	600	2,150	720	4,270
Water - area in which stream channels disturbed	Acres	1,934	8,639	22,510	2,336	28,491
Water - estimated annual water consumption	Acre-feet	3.140	8,640	37,360	1,700	45,820
Water - change in dissolved-solids concentration - Colorado River at Colorado-Utah State Line	Milligrams per liter	+0.28	-13.05	-45.16	+0.17	-44.21
Water - change in dissolved-solids concentration - Colorado River below Hoover Dam	Milligrams per liter	+0.16	-5.55	-19.04	+0.10	-18.51
Water - Cumulative change in estimated sediment yield from disturbed areas	Tons per year	-670	+2,375	+1,845	-1,807	-312

Note: NA = not available

a/ The impacts of a no action alternative would be essentially the same as the low-level scenario.

TABLE R8-35

(continued)

Resource	Unit	Proposed Actions	Mid-Level Development (Cumulative)	Low-Level Scenario a/	High-Level Scenario (Additional Coal)	High-Level Scenario (Cumulative)
Soil and vegetation - reduced productivity	Acres	1,934	16,155	22,510	2,336	28,491
Vegetation - disturbed lands which would be reclaimed b/	Acres	1,133	1,265	1,528	1,783	3,048
Wildlife - loss of fish and wildlife habitat and carrying capacity	Acres	-1,934	-26,155	-22,510	-2,336	-28,491
Wildlife - antelope lost	Antelope	0	0	0	0	0
Wildlife - deer lost	Deer	-150	-2,463	-75	-87	-2,550
Wildlife - elk lost	Elk	-24	-348	-12	-15	-376
Cultural - number of archeological sites with potential disturbance	Sites	26	1,989	1,98	NA	1,989
Cultural - number of historical sites with potential disturbance	Sites	0	123	123	NA	123

b/ Land disturbed by coal mining only; this reclamation would not be successfully completed until after completion of mining (generally after 1990). Information is not available to predict how much land disturbed by other energy development would eventually be reclaimed. It is unlikely that land converted by urban development would be returned to previous land uses.

TABLE R8-35

(continued)

Resource	Unit	Proposed Actions	Mid-Level Development (Cumulative)	Low-Level Scenario a/	High-Level Scenario (Additional Coal)	High-Level Scenario (Cumulative)
Land Use - lands needed for industrial development	Acres	1,133	18.033	17,163	1,783	19,816
Land Use - lands needed for urban development	Acres	801	8,122	5,347	553	8,675
Transportation - increase in vehicle registrations	Vehicles	+10,152	+103,086	+67,932	+7,020	+110,106
Transportation - increase in number of coal trains	Trains per year	+764	+1,276	+429	+544	+1,820
Agriculture - number of animal unit months (AUMs) lost	AUMs	-60	-1,796	-1,708	0	-1,796
Recreation - increase in anglers	Anglers	+4,488	+41,998	NA	NA	NA
Recreation - increase in hunters	Hunters	+1,734	+16,266	NA	NA	NA
Recreation - active/improved parkland required	Acres	49	314	277	44	336
Socioeconomic - increase in population	People	+9,400	+95,450	+62,900	+6,500	+101,950
Socioeconomic - increase in employment	Jobs	+5,056	+50,500	+45,444	+1,061	+51,561

TABLE R8-36

COMPARISON OF IMPACTS - 1990
(PARTIAL LISTING)

Resource	Unit	Proposed Actions	Mid-Level Development (Cumulative)	Low-Level Scenario a/	High-Level Scenario (Additional Coal)	High-Level Scenario (Cumulative)
Air Quality - total suspended particulate emissions from coal mines	Tons per year	5,694	7,267	5,191	4,788	12,055
Topography - subsidence due to underground mining	Acres	3,920	7,650	3,390	3,980	11,630
Topography - surface disturbed	Acres	2,467	33,431	30,627	5,475	38,906
Paleontology - loss of fossils due to collecting and mining	Sites	NA	NA	NA	NA	NA
Minerals - annual coal production	Million tons	10.54	15.56	4.19	18.20	33.76
Water - area of coal beds (possible aquifers) removed	Acres	3,920	7,650	3,390	3,980	11,630
Water - area in which stream channels disturbed	Acres	2,467	33,431	30,627	5,475	38,906
Water - estimated annual water consumption	Acre-feet	3,920	44,010	39,680	6,090	50,100
Water - change in dissolved-solids concentration - Colorado River at Colorado-Utah State Line	Milligrams per liter	+0.26	-65.79	-66.19	+0.57	-65.22
Water - change in dissolved-solids concentration - Colorado River below Hoover Dam	Milligrams per liter	+0.16	-27.83	-28.07	+0.34	-27.49
Water - Cumulative change in estimated sediment yield from disturbed areas	Tons per year	-2,165	-4,475	-1,480	-5,708	-10,183

Note: NA = not available

a/ The impacts of a no action alternative would be essentially the same as the low-level scenario.

TABLE R8-36

(continued)

Resource	Unit	Proposed Actions	Mid-Level Development (Cumulative)	Low-Level Scenario a/	High-Level Scenario (Additional Coal)	High-Level Scenario (Cumulative)
Soil and vegetation - reduced productivity	Acres	2,467	33,431	30,627	5,475	38,906
Vegetation - disturbed lands which would be reclaimed b/	Acres	1,175	2,568	1,656	3,422	5,990
Wildlife - loss of fish and wildlife habitat and carrying capacity	Acres	-2,467	-33,431	-30,627	-5,475	-38,906
Wildlife - antelope lost	Antelope	0	0	0	0	0
Wildlife - deer lost	Deer	-193	-3,212	-81	-168	-3,380
Wildlife - elk lost	Elk	-31	-1,562	-14	-28	-1,590
Cultural - number of archeological sites with potential disturbance	Sites	26	1,989	1,989	NA	1,989
Cultural - number of historical sites with potential disturbance	Sites	0	123	123	NA	123

b/ Land disturbed by coal mining only; this reclamation would not be successfully completed until after completion of mining (generally after 1990). Information is not available to predict how much land disturbed by other energy development would eventually be reclaimed. It is unlikely that land converted by urban development would be returned to previous land uses.

TABLE R8-36

(continued)

Resource	Unit	Proposed Actions	Mid-Level Development (Cumulative)	Low-Level Scenario a/	High-Level Scenario (Additional Coal)	High-Level Scenario (Cumulative)
Land Use - lands needed for industrial development	Acres	1,175	24,288	23,376	3,422	27,710
Land Use - lands needed for urban development	Acres	1,292	7,851	7,251	2,053	11,196
Transportation - increase in vehicle registrations	Vehicles	+16,416	+111,186	+92,087	+26,082	+137,268
Transportation - increase in number of coal trains	Trains per year	+1,054	+1,546	+409	+1,819	+3,365
Agriculture - number of animal unit months (AUMs) lost	AUMs	-69	-2,424	-2,330	-331	-2,755
Recreation - increase in anglers	Anglers	+7,260	+45,606	NA	NA	NA
Recreation - increase in hunters	Hunters	+2,805	+17,620	NA	NA	NA
Recreation - active/improved parkland required	Acres	63	348	282	50	336
Socioeconomic - increase in population	People	+15,200	+102,950	+85,300	+24,150	+127,100
Socioeconomic - increase in employment	Jobs	+8,434	+55,440	+47,006	+4,390	+59,830

* U.S. Government Printing Office: 1979—678-991