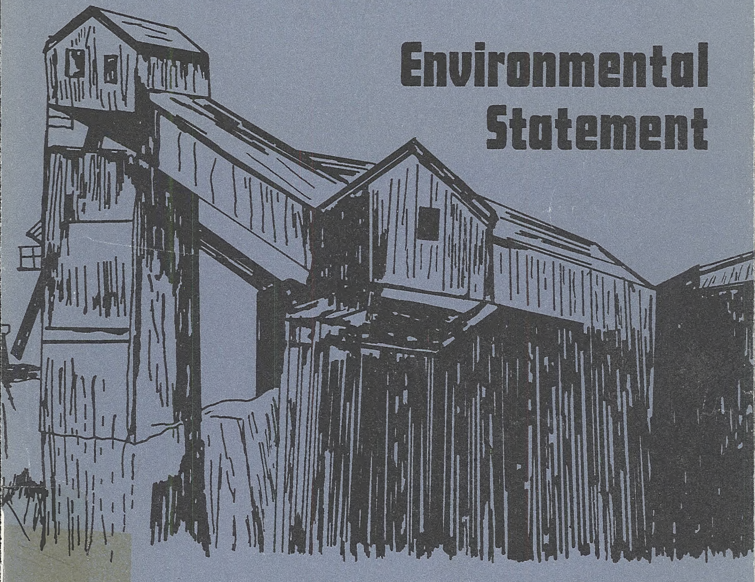
Volume 1

DRAFT

West-Central Colorado Coal



Environmental Statement

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

DEPARTMENT OF THE INTERIOR

DRAFT

ENVIRONMENTAL STATEMENT

PROPOSED

DEVELOPMENT OF COAL RESOURCES

WEST-CENTRAL COLORADO

Prepared by the

DEPARTMENT OF THE INTERIOR

State Director, Colorado State Office
Bureau of Land Management

SUMMARY

(X)Draft ( )Final 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 by 1980, 1985, and 1990. This environmental statement is developed in two parts: (1) a two-level analysis of regional impacts (aggregate impacts of six site-specific proposed actions and cumulative impacts of coal- and non-coal-related development) and (2) site-specific analyses of the six proposed actions. Annual production estimates for the proposed actions total 2.53 million tons by 1980, 8.64 million tons by 1985, and 11.6 million tons by 1990. Combined with existing mining expected to continue through 1990, a total of 17.10 million tons would be produced annually by that date.*
3. *Summary of Environmental Impacts by 1990:*

A. Land surface on 12,600 acres where coal is mined underground would be lowered from 0 to 12 feet.

B. 87.94 million tons of coal would be extracted.

C. Some fossils would be destroyed, others would be revealed.

D. Water quality may be lowered, total dissolved solids would increase.

E. Industrial and municipal use of water would increase 7,390 acre-feet per year.

F. 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.

G. Average regional visibilities would be reduced to around 53 $\mu g/m^3$ over areas 5 miles in diameter or less around individual mines and groups of mines.

H. Soil and vegetative productivity would be lost on 1,261 acres due to mine site development. Revegetation of the disturbed areas would be required upon abandonment of the mines, and productivity would be regained over time following successful reclamation.

I. Wildlife habitat, carrying capacity, and populations would be lost on 2,261 acres. Threatened and endangered fish species in the Colorado could suffer population declines due to changes in aquatic habitat.

J. Livestock and wildlife forage would be reduced by 69 AUMs annually during mining.

K. 290 acres of farmland would be lost to mine development.

L. Sites of cultural resources lying near proposed project areas could be vandalized.

M. The present visual quality of the landscapes would be changed as as a result of road, railroad, and transmission line construction; mine facilities; and urban expansion.

N. Urban recreational facilities would not meet increased population needs.

O. Social support facilities would not keep pace with population increases in some areas. Small towns would lose their small-town atmosphere. Social disorders would increase in larger towns.

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

Q. An increase of 2,784 jobs would reduce unemployment but lead to a population increase in the region.

R. Increased construction wages and investment in the area would increase personal income, retail sales, and property values but result in hardship for persons on fixed incomes.

S. Population of the region would increase by 13,100 as a result of the proposed actions.

4. *Alternatives Considered:* Two alternatives are analyzed in chapter 8: the No Action Alternative and the Different Rate of Production Alternative (the latter applies only to the North Fork Valley). In addition, two scenarios are presented: a low-level scenario based on 4.73 million tons of coal produced by 1990 and a high-level scenario based on 35.70 million tons of coal produced by 1990. Since the No Action Alternative and the low-level scenario are based on the same production level, they are discussed together.
5. *Comments Requested from the following:* See attachment.
6. *Date Draft Made Available to Environmental Protection Agency:*

COORDINATION IN REVIEW OF DRAFT ENVIRONMENTAL STATEMENT

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

Federal

- Advisory Council on Historic Preservation
- Department of Agriculture
  - Soil Conservation Service
  - U.S. Forest Service
- Department of Commerce
- Department of Defense
  - Army Corps of Engineers
- Department of Energy
  - Conservation and Energy Resource Development Division
- Federal Energy Regulatory Commission
- 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
  - U.S. Geological Survey
- Interstate Commerce Commission
- Department of Labor
  - Occupational Safety and Health Administration
  - Mining Enforcement and Safety Administration
- Office of Economic Opportunity
- Office of Management and Budget
- Rural Electrification Administration
- Department of Transportation
  - Federal Highways Administration
- Water Resources Council

State

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

Local

All entities included under the local contacts heading of the previous section (Consultation and Coordination in the Preparation of the DES) will be requested to provide comments on the document.

Nongovernment Organizations

- American Horse Protective Association
- American Institute of Mining Engineers
- American Mining Congress
- American Sportsman's Club
- Anschutz Coal Company
- 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
- Environmental Defense Fund
- Environmental Policy Institute
- Firends of the Earth
- General Exploration 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
- National Resources Defense Council
- National Wildlife Federation
- 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 for Range Management
- Sunflower Energy Corporation
- Thorne Ecological Institute
- Trout Unlimited
- U. S. Steel Corporation
- Weaver Brothers
- Western Slope Carbon, Inc.
- West Slope Energy Research Council
- Western States Coal Company
- Wilderness Society
- Wildlife Society, Colorado Chapter

VOLUME 1

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CHAPTER 1

DESCRIPTION OF THE PROPOSAL

Background

Scope

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 six coal mining and reclamation plans in west-central Colorado would constitute a major federal action. In addition, it has been concluded that these six site-specific proposed actions, in combination with other present and future coal development on federal and private lands could have a significant cumulative impact on regional values. Hence, both regional and site-specific environmental analyses relating to these six proposals are made in this environmental statement.

The purpose of the West-Central Colorado Coal Environmental Statement (ES) is to analyze through 1990 the cumulative environmental impacts of projected coal development in the seven-county ES area and to analyze specific plans to develop existing federal coal leases using underground mining methods. Impacts that extend beyond the principal ES region are analyzed to the extent they are significant to the region and are more associated with the proposed coal actions than with other actions outside the region.

Three possible levels of coal production are examined. The most probable level would result in the production of 17.1 million tons of coal per year by 1990 if federal and private actions described and analyzed in this regional ES are fully implemented. In addition, a low level of production (5.13 million tons of coal per year by 1990) and a high level of production (34.4 million tons of coal per year by 1990) are examined as possible scenarios in chapter 8 of this ES. Specific time frames of analysis used in this ES are 1980, 1985, and 1990.

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 federal lands (see map 1 in appendix A and figure R1-1). This is considered an area of economic interdependence, with Grand Junction as the primary economic center and Montrose, 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). This 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 will occur in west-central Colorado, the impacts on rail transportation of coal outside the regions are closely related. The assessment of environmental impacts of projected coal development in the Northwest ES region is being updated by a study currently in preparation at the Craig District Office of the BLM.

Agency Roles In Preparing ES

This ES was prepared by BLM as lead agency with participation by the U.S. Geological Survey (USGS), the U.S. Forest Service (USFS), and the state of Colorado. The team was composed of employees of these various agencies and 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, and on private land and coal to be developed in conjunction with federal leases.

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 those 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 analysis in compliance with NEPA include the following:

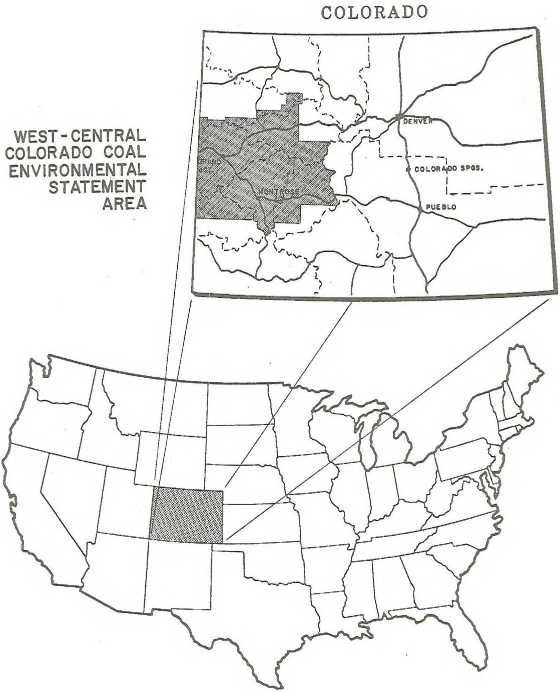


Figure R1-1. LOCATION MAP

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 the West-Central 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 federal 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 (SMCRA), Sect. 506(b)

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, 64346

Specific Proposed Actions

Applications

The proposed site-specific federal actions are the review and approval of six comprehensive underground mining and reclamation plans (M&R plans) for the development of existing federal coal leases, submitted by the following companies:

1. Anschutz Coal Company: 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. Sheridan Enterprises: Loma Project
6. General Exploration Company: Cameo No. 1 and No. 2 mines

M&R plans for these six proposed coal mines have been accepted by the Area Mining Supervisor of USGS for analysis of environmental impacts. Four of the M&R plans included in this ES were submitted for review prior to promulgation of the initial regulations, 30(CFR): 700, required under Sections 502 and 523 of the Surface Mining Control and Reclamation Act (SMCRA) of 1977 (PL 95-87), and two of the M&R plans were submitted after promulgation of the initial regulations. None of them has been officially reviewed for compliance with that act, and the applicants' plans may not fully reflect the requirements of the initial regulations. However, in this statement the initial regulations are considered as required federal mitigating measures the same as all other applicable regulations.

The M&R plans will be returned to the operator for revision in accordance with the applicable initial regulations. As soon as the applicants' plans are revised and returned to the USGS, they will be evaluated with the Office of Surface Mining to determine compliance with the requirements of federal regulations 30(CFR): 211 and 30(CFR): 700. The M&R plans cannot be approved until they conform to all applicable federal requirements.

Each of the proposed mines would be a new operation, except that Anschutz and General Exploration have completed or will soon complete construction of necessary surface facilities on adjacent private (fee) lands. In both cases, portals have been constructed and mining has begun on fee lands.

Surface ownership on 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 44,413 project acres containing 307 million tons of recoverable coal reserves. Tables R1-1, R1-2, and R1-3 contain detailed information summarizing the proposed actions. Complete descriptions of these proposals are discussed in the site-specific volume of this ES. (A discussion of typical mining operations can be found in appendix I.) The following is a brief description of applicant proposals.

ANSCHUTZ COAL COMPANY: NORTH THOMPSON CREEK NO. 1 AND NO. 3 MINES

On November 18, 1976, Anschutz Coal Company submitted an M&R plan to the USGS covering proposed underground coal production from its federal leases C-08172 and C-08173, totaling 4,935.20 acres of national forest systems lands, together with 5,326 acres of private land and coal. However, only 4,000 acres of this total would be included in the Thompson Creek No. 1 and 3 mines. Anschutz submitted a revised mining plan on April 17, 1978; this revision clarified some of the information contained in the original M&R plan.

The proposed North Thompson Creek No. 1 and 3 mines would be located 12 miles southwest of Carbondale, Colorado, in Pitkin County (see map 1 in appendix A). This mining operation would produce 1 million tons of coal per year for 30 years from a reopened underground mine which was abandoned in 1966. The coal would be produced for western metallurgical markets. The operation would utilize room-and-pillar methods initially, with subsequent longwall mining by retreat methods once the longwall panels have been developed. At the present time 46 acres have been disturbed from mining and surface facility construction on Anschutz' private lands. With the exception of con-

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	Retreating longwall and advancing entries by continuous mining units (underground)	30	0.02	1.00	1.00	1.00	1975	1980	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	2.50	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	25-100
	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	3.51	5.00	1977	1986	20

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.)									
	General Exploration: Cameo No. 1 Mine	Conventional room & pillar (underground)	30	0.00	0.80	1.00	1.20	1978	1986	47 (to 2025)
	Cameo No. 2 Mine	Conventional room & pillar (underground)		0.00	0.00	0.40	0.40	1982	1984	47 (to 2025)
		Subtotal	30	0.00	0.80	1.40	1.60			
		Subtotal	307	0.09	2.53	8.64	11.60			
	Existing Operations:									
	Colorado Westmoreland, Inc.: Orchard Valley Mine	Conventional room & pillar by continuous mining units (underground)	2.0	0.29	0.70	1.25	1.25	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)	.7	0.01	0.07	0.07	0.00	1977	1978	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) 1977	1980	1985	1990	Time Points: 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	0.35	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	0.35	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	0.25	1976	1980	15 (1976-1991)
	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	0.50	0.50	0.50	1977	1980	14

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 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.)										
	Western States Coal Company: Fairview Mine	Conventional room & pillar by continuous mining (underground)	7	0.00	0.00	0.25	0.25	Unknown	by 1985	less than 30
	Empire Energy: Edward's Mine	Conventional room & pillar by continuous mining units (underground)	Not available	0.00	0.00	0.50	0.50	1980	1981	Not specified
			Subtotal	2.98	4.89	5.77	5.50			
			TOTAL	3.07	7.42	14.41	17.10			

TABLE R1-2

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

				Cumulative Surface Disturbance (acres)																			
					Railroads			Roads			Mine Facilities			Refuse Disposal			Power Lines and Communications Lines			Cumulative Total Disturbed			
Map Unit	Company and Mine Name	Total Project Acres	Federal Lease Acres (in project acres)	Total Disturbance as of 1977	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990	Base Level 1977	1980	1985	1990
Site-Specific Actions:																							
	Anschutz Coal Corporation: North Thompson Creek No. 1 and No. 3 Mines	4,000.00	1,200	46	40	40	40	0	0	0	0	0	0	0	0	0	0	0	0	46	86 1/	86 1/	86 1/
	Atlantic-Richfield Company: Mt. Gunnison No. 1 Mine	12,579.00	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
	General Exploration: 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
			Subtotals:	0	7	7	7	0	0	0	175	175	175	51	51	51	0	0	0	0	233	233	233
	Subtotal	44,413.05	33,280	66	47	544	544	10	81	81	261	352	369	51	177	201	0	0	0	66	435	1,219	1,261

1/ The 86 acres of disturbance to result from construction of Thompson Creek No. 1 and No. 3 mines includes no acres of disturbance which will result from the site-specific proposed federal action.

2/ The 233 acres of disturbance to result from construction of Cameo No. 1 and No. 2 mines includes only 69 acres of disturbance which will 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	0	0	0	0	0	0	0	25	25	0 4/	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	Unknown	Unknown	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	510	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	15	40	65	0	0	0	26	41	66	91
	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)

					Cumulative Surface Disturbance (acres)																		
					Railroads			Roads			Mine Facilities			Refuse Disposal			Power Lines and Communications Lines			Cumulative Total Disturbed			
Map Unit	Company and Mine Name	Total Project Acres	Federal Lease Acres (in project acres)	Total Disturbance as of 1977	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990	Base Level 1977	1980	1985	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
	Empire Energy: Edward's Mine	280	280	0	0	0	0	6	6	6	10	10	10	0	25	50	0	0	0	0	16	41	66
	Subtotal			941	1	1	1	1	1	4	10	20	21	88	289	486	3	3	5	941	1,044	1,230	1,433
	TOTAL			1,007	48	545	545	11	82	85	271	372	390	139	465	687	3	3	5	1,007	1,479	2,449	2,694

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	0 / 140	0 / 320	0 / 320	0 / 320	0	100 West	100 West	100 West	Metallurgical market
	Atlantic-Richfield Company: Mt. Gunnison No. 1 Mine	0 / 0	130 / 160	0 / 565	0 / 565	0	0	213 East	244 East	Unspecified (probably out-of-state) utilities market.
	Mid-Continent Coal and Coke Company: Coal Canyon Mine	0 / 0	0 / 0	0 / 200	0 / 200	0	0	20 East	50 East	Unspecified out-of-state utilities market.
	Cottonwood Creek No. 1 and No. 2 Mines	0 / 0	0 / 0	0 / 400	0 / 400	0	0	40 East	100 East	Unspecified out-of-state utilities market.
	Sheridan Enterprises: Loma Project	0 / 30	92 / 85	0 / 470	0 / 900	0	0	351 East	500 East	Unspecified out-of-state utilities market.

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)

		Employment				Estimated Number and Direction of Unit Trains per Year				
		1977	1980	1985	1990					
Map Unit	Company and Mine Name	Const./Perm.	Const./Perm.	Const./Perm.	Const./Perm.	1977	1980	1985	1990	Market Area
Site-Specific Actions: (cont.)										
	General Exploration: 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	
	Subtotal	0 / 0	0 / 213	0 / 355	0 / 399	0	80	140 East	160 East	
					Subtotal	0	80 East	764 East	1,054 East	
							100 West	100 West	100 West	
	Subtotal	0 / 170	222 / 778	0 / 2,310	0 / 2,784	0	180	864	1,154	
Existing Operations:										
	Colorado Westmoreland, Inc.: Orchard Valley Mine	0 / 137	0 / 260	0 / 325	0 / 325	29 East	70 East	125 East	125 East	No. Indiana Public Service Co., Hammond, Indiana; local domestic sales.
	U.S. Steel Corporation: Somerset Mine	0 / 296	0 / 296	0 / 296	0 / 296	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	0 / 20	0 / 120	0 / 20	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 / 54	0 / 54	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 22 for Bear and 20 for Hawksnest, in proportion to their production.)
	Western Slope Carbon, Inc.: Hawksnest East Mine, Hawksnest No. 3 Mine	0 / 127	0 / 150	0 / 200	0 / 200	20 East	35 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	0 / 9	0 / 18	0 / 103	0 / 0	0	0	0	0	Various unspecified out-of-state 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.)									
	General Exploration: Roadside Mine	0 / 138	0 / 213	0 / 120	0 / 0	0	80 West	20 West		Arizona Electric Power Company, Page (or Benson), Arizona; local domestic sales.
	Coal Fuels Corporation: Farmers Mine	0 / 0	0 / 200	0 / 200	0 / 200	0	0	0	0	Not available (unspecified).
	Louis Bendetti Coal Co.: Eastside Mine	0 / 3	0 / 3	0 / 3	0 / 3	0	0	0	0	Local and domestic market.
	Henry Bendetti Coal Co.: NuGap No. 3 Mine	0 / 3	0 / 3	0 / 3	0 / 3	0	0	0	0	Local and domestic market.
	Mid-Continent Coal and Coke Company: Coal Basin Mines *	0 / 492	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 / 3	0 / 10	0 / 10	0 / 10	0	0	0	0	Local and domestic market.
	O.C. Mine Company: Ohio Creek No. 2 Mine	0 / 6	0 / 6	0 / 6	0 / 6	0	0	0	0	Local and domestic market.
	Peabody Coal Company: Nucla Strip Mine	0 / 23	0 / 23	0 / 23	0 / 23	0	0	0	0	Nucla Power Plant, Nucla, Colorado; local and domestic market.

* 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 / 160	0 / 160	0	0	0	0	Local industrial and domestic market.
	Empire Energy: Edward's Mine	0 / 103	0 / 103	0 / 103	0 / 103	0	0	0	0	Unspecified
	Subtotal	0 / 1,415	0 / 1,952	0 / 2,065	0 / 1,822	72 East 237 West	105 East 414 West	200 East 354 West	200 East 334 West	
	TOTAL	0 / 1,585	222 / 2,730	0 / 4,375	0 / 4,606	309	699	1,418	1,688	

struction of a railroad loadout facility near Carbondale (40 acres), no additional disturbance is expected before 1990, since refuse disposal will take place on land already disturbed. At full production, the mine would employ 320 persons.

ATLANTIC RICHFIELD COMPANY: MT. GUNNISON NO. 1 MINE

On August 4, 1976, Atlantic Richfield Company submitted an M&R plan to the USGS covering proposed underground coal production from the company's federal coal leases C-1362, C-011792, 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 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 appendix A). This new mine would produce 2.5 million tons of coal per year for 27 years to supply markets to unspecified out-of-state 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 underground 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 appendix A). This new mining operation would produce 0.5 million 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. Approximately 99 acres would be disturbed from 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 the company's federal coal leases C-020740, C-024998, and C-029889, totaling 5,113 acres of public lands, together with 454 acres of adjacent private coal 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 appendix A). These new mining operations would have a combined production of over 1 million tons per year for 25 years and would supply unspecified out-of-state utilities. The operation would utilize room- and-pillar methods for mine development followed by longwall methods on retreat for some sections of the mine and room-and-pillar retreat for others. Approximately 61 acres would be disturbed from mining and surface facilities by 1990. At full production, the mines would employ 400 persons.

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 utilize six portals and be located approximately 20 miles north of Loma, Colorado, in the Douglas Pass area of western Garfield County (see map 1 in appendix A). This new mining operation would produce 5 million tons of coal per year for twenty years to supply unspecified out-of-state utilities. The operation would utilize traditional room-and-pillar and longwall methods. Approximately 676 acres would be disturbed by mining and surface facilities by 1990. At full production, Sheridan would employ 900 persons.

GENERAL EXPLORATION COMPANY: CAMEO NO. 1 AND NO. 2 MINES

On February 22, 1978, General Exploration 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 proposed Cameo No. 1 and No. 2 mines would be located approximately 3 miles northeast of Palisade, Colorado, in Mesa County (see map 1 in appendix A). This proposed new mining operation would have a production of 1.6 million tons per year for 47 years and would supply Mississippi Power Company of Jackson County, Mississippi. The operation would utilize conventional room-and-pillar mining methods with potential later conversion to longwall mining (depending upon the roof conditions found once mining has begun). Approximately 233 acres would be disturbed from mining and surface facilities by 1990. At full production, the mines would employ 399 persons.

ANCILLARY FACILITIES

Although no applications for rights-of-way over public lands or national forest 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 the 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

DEPARTMENT OF THE INTERIOR AGENCIES

The authorized officer of the USGS must approve the M&R plan prior to commencement of mining operations by the applicant. The regulations governing mining and reclamation plan review and approval are contained in 30(CFR): 211. The USGS Area Mining Supervisor is authorized to approve exploration plans and minor modifications of existing mine plans, provided all necessary surface and environmental protection conditions have been adequately considered. Secretarial review is required prior to approval of proposed actions determined to be major federal actions significantly affecting the environment, and for all new or significantly modified surface and underground coal mining operations on federal lease lands in west-central Colorado.

The Office of Surface Mining (OSM) is responsible for the reclamation of surface coal mining and the surface impacts of underground coal mining. Regulations contained in 30(CFR): 700 establish the authorities of this new federal agency. The OSM will officially review all M&R plans with the USGS to determine compliance with the regulations in 30(CFR): 700. The Surface Mining Control and Reclamation Act of 1977, which established OSM, also requires the M&R plans be reviewed at a minimum of every five years for renewal.

The BLM must concur with the M&R plan before approval is granted by the USGS for mining on public lands and federal coal underlying private surface. BLM is also responsible for granting various rights-of-way on public lands for ancillary facilities, such as roads, power lines, communication lines, and railroad spurs.

OTHER FEDERAL AGENCIES

The USFS must concur with the M&R plan before approval is granted by the USGS for mining on national forest systems lands. The USFS is also responsible for granting various rights-of-way on national forest systems lands for ancillary facilities, such as roads, power lines, communication lines, and railroad spurs.

The Environmental Protection Agency (EPA) administers both the Clean Air Act of 1970, as amended, and the Federal Water Pollution Control Act, 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.

The Mining Safety and Health Adminstration (MSHA) of the Department of Labor enforces federal health and safety standards in all mining operations, including approval of roof control and ventilation plants for underground mines.

The Department of Labor's Occupational Safety and Health Administration (OSHA) 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.

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 Colorado Mined Land Reclamation Division issues a permit based on an acceptable plan of activity, application fee, and performance bond. The plan must comply with the Colorado Open Mining Land Reclamation Act, as amended in 1973, and the Colorado Mined Land Reclamation Act of 1976, which set standards, practices, time factors, and reporting procedures. Under cooperative agreement, effective July 1, 1977, between the state of Colorado and the Department of the Interior, the Colorado Department of Natural Resources and the Colorado Mined Land Reclamation Board are responsible for administering and enforcing federal reclamation requirements on federal coal leases in Colorado.

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 State Engineer has authority over water wells and other water sources, such as retention dams and mine drainage.

The Colorado Public Utilities Commission (PUC) works in concert with 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 Colorado Occupational Safety and Health Administration of the Division of Labor issues permits to acquire, transport, and store explo sives and other hazardous materials used in connection with construction or mining.

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

Initial regulations required under Section 502 of the Surface Mining Control and Reclamation Act (SMCRA) of 1977 (PL 95-87) 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. Section 523 of SMCRA requires that a federal lands program which includes the requirements of this act be promulgated and implemented no later than August 3, 1978. Until the federal lands program is implemented, the 30(CFR): 700 initial regulations, as modified, will apply to all federal coal leases. Under the authority of Sections 523(c) and 702(b) of SMCRA, these 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 used to design 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 initial regulations provides the underground mining general performance standards.

The initial 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 five of the proposed M&R plans have been identified as unsuitable for surface coal mining, as alluvial valley floor, or as prime farmland. 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.

Other environmental protection requirements and reviews are as follows:

1. Archeological and historical sites and rare or endangered flora and fauna species: Inventories will be conducted on the impacted federal lands by the surface management agency, and stipulations necessary to protect these resources will be included in the M&R plan.
2. Performance bonds: Surety bonds are required at the time of lease issuance and may be readjusted prior to approval of the M&R plans.
3. Use of explosives: The requirements of 30(CFR): 715.19 will be included in all M&R plans submitted for approval.
4. 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.

5. 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.

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, including all of the associated federal leases and private coal reserves). Table R1-4 shows diligent development and continuous operations requirements for the six site-specific tracts.

Preference Right Lease Application Status Review

Preference right lease applicants were required to prepare an initial showing in accordance with the 43(CFR): 3521 regulations indicating evidence of commercial quantities of coal. Initial showings were submitted by July 1977. The PRLAs will be evaluated in technical reports and environmental assessments to be prepared jointly by BLM and USGS.

The Department of the Interior, however, may not issue any new coal leases, including preference right leases, until an injunction issued by the U.S. District Court for the District of Columbia in the case Natural Resources Defense Council v. Royston B. Hughes is removed. On September 27, 1977, the Department was enjoined from issuing any new coal leases until a supplemental coal programmatic statement is issued correcting the deficiencies of the original September 1975 Federal Coal Programmatic Environmental Statement. The new statement is scheduled to be completed in final form in April 1979.

Recent interpretation of the Mineral Leasing Act of 1920 has determined that areas of federal coal under preference right lease application cannot be leased if there were existing mining claims under the Mining Law of 1872 at the time the prospecting permit was issued. Preference right lease applicants are required to submit abstracts of any mining claims that may exist within the application area.

Department of Energy Review

The Department of Energy (DOE) under SMCRA 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.

Exploration Drilling Program

In an effort to obtain better coal reserve estimates, the USGS is carrying out an exploration drilling program in the ES area. In 1977, the USGS had drilled 26 holes in the Cedaredge area and 1 hole in the Palisade area. These holes were drilled along existing roads, resulting in minimal disturbance. The USGS contemplates continuing this program with plans to drill 3 holes in the Gunnison area in 1978.

In addition to this federally sponsored drilling, six private mining companies are carrying out drilling exploration in the ES area. This private exploration accounts for 66 drill holes in the past few years, primarily in the Little Bookcliffs and in the North Fork of the Gunnison River Valley.

Regional Coal Projections

Three levels of coal development are analyzed in this regional ES (see figure R1-2). The most probable level of development (mid-level) is analyzed in chapter 4. Low- and high-level scenarios and a comparison of these with the most probable level are analyzed in chapter 8. A discussion of typical coal development practices can be found in appendix I.

The most probable level of development includes production from the six proposed mining ventures, continued production from existing mines, and projected development of privately owned coal requiring no federal action (see tables R1-1, R1-2, and R1-3). Map 1 in appendix A depicts the locations of these developments.

Production Projections

Table R1-1 depicts production schedules for proposed, existing, and projected new private mining operations through 1990. It is anticipated that by 1990, 17.1 million tons of coal per year would be

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

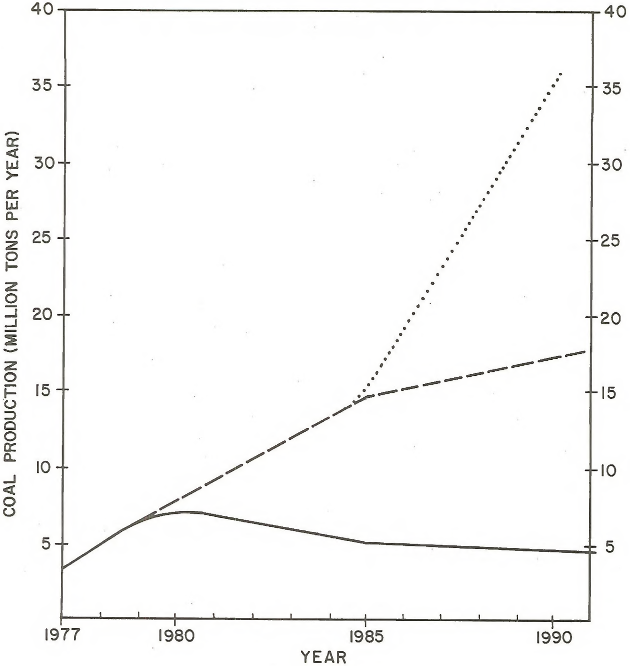
a/ Reserve estimates provided by the USGS, Conservation Division, CRMA.

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.



LEGEND:

—— Low-level production - includes both Federal and private coal production for which no further Federal actions are required as of 1-1-78.

— — Mid-level production - includes both Federal and private coal production which will occur with currently anticipated Federal actions prior to 1990.

····· High-level production - maximum coal production possible.

Figure R1-2. Projected west-central Colorado coal production (low-level, mid-level, and high-level) produced from this west-central region, of which 11.6 million tons per year would be produced from the six proposed mining ventures. Basic assumptions guiding development of this table are footnoted below the table. This projected schedule is based on consultation with all of the operations. Other projections developed for the ES area were looked at for comparison but were not used as a basis for analysis because they were incomplete and did not project development to 1990 (Department of Energy projections in Quarterly Summary, Western Coal Development Monitoring System, March 31, 1977, published by the Coal Projects Office, Energy Resource). Brief discussions follow of the eighteen existing operations included in the most probable level of development. These existing operations currently produce nearly 3 million tons of coal per year (see map 1 in Appendix A for locations).

COLORADO WESTMORELAND, INC.

Colorado Westmoreland owns the 120-acre, private Converse lease, of which approximately 42 acres contain recoverable coal reserves. The company is doing retreat room-and-pillar mining of the recoverable reserves in the first east panel of the Orchard Valley Mine.

Colorado Westmoreland submitted a short-term lease application for federal coal reserves north of the Converse lease. Subsequently an environmental assessment record (EAR) was prepared by the BLM prior to approval of the application. The Secretary of the Interior determined that Colorado Westmoreland meets the present short-term lease criteria, and a competitive lease was issued March 1, 1978, for a 1.97-million-ton block of coal north of the Orchard Valley Mine. The lease allows Colorado Westmoreland to produce approximately 700,000 tons of coal annually for a three-year period. This production rate will meet their present coal contract with Northern Indiana Public Service Company of Hammond, Indiana. The company will probably submit another short-term lease application in 1980 and every three years thereafter if the court-imposed short-term criteria remain in effect, in order to continue to meet contract commitments.

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 Somerset 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

Sunflower Energy has approximately 80 acres of private coal reserves and has subleased an estimated 80 acres of federal lease C-033301 from U.S. Steel. Sunflower's Blue Ribbon Mine production of 70,000 tons of coal annually is not expected to increase over the next ten years. The company is operating this underground mine on an approved M&R plan and is supplying local domestic and unspecified public utility markets.

BEAR COAL COMPANY

Bear will produce approximately 240,000 tons of coal annually from their Bear mine by underground methods up to about 1981, supplying various public utilities, industries, and local domestic markets. This production will come from federal lease D-044569, which Bear has subleased from Atlantic Richfield Company (ARCO). The 1981 closure date is dependent upon approval of ARCO's M&R plan for the Mt. Gunnison No. 1 Mine. ARCO's plan is being assessed on a site-specific basis as part of this regional ES.

WESTERN SLOPE CARBON, INC.

Western Slope produced 220,000 tons of coal in 1977 by underground methods from two mines located on federal leases C-056724, D-042921, and C-17130. The company projects a production of 400,000 tons annually by 1981. Production should increase to 750,000 tons by 1985 when another continuous miner unit is expected to be added. The company supplies coal to Colorado Fuel and Iron Company of Pueblo, Colorado, and local domestic markets. Additional coal contracts would be the determining factor for increased production. Western Slope is operating on an approved M&R plan.

BELDEN ENTERPRISES, INC.

Belden is presently rehabilitating the old Coalby Red Canyon Mine. Belden's anticipated production of 10,000 tons of coal annually by underground methods depends upon approval of an M&R plan for federal lease D-036906; the approval is expected in the latter part of 1978. The coal would be sold locally for domestic use.

QUINN COAL COMPANY

Quinn is presently producing coal by stripping private coal reserves; the company has no federal coal reserves under lease. With an anticipated increase in production, the strippable reserves would be exhausted by approximately 1983, and production would be by underground methods thereafter. The coal would be sold to unspecified out-of-state utilities and for local domestic use. By 1985, Quinn may qualify under the three- year short-term leasing criteria and would probably apply for federal coal reserves.

GENERAL EXPLORATION COMPANY

General Exploration presently produces 225,000 tons of coal annually by underground methods from the Roadside Mine, supplying coal to the Arizona Electric Power Company of Page, Arizona. The mine is operating under an approved M&R plan for both private reserves and federal lease C-078059. It is anticipated that the federal reserves in the Roadside Mine would be depleted by 1987. It is possible that the Roadside Mine may qualify under the three-year short-term leasing criteria, and it is anticipated that General Exploration would submit an application at that time.

The Roadside Mine is located across the Colorado River from where The General Exploration proposes to develop the Cameo No. 1 and No. 2 mines, which are assessed on a site-specific basis in this regional ES.

COAL FUELS CORPORATION

Coal Fuels is rehabilitating the Farmers (Nearing) Mine on a 380- acre private coal lease adjacent to its preference right lease application submitted in October 1966, which consists of prospecting permits C-0127832, C-0127833, and C-0127834. It is anticipated that the private reserves will be exhausted before 1995, and Coal Fuels operation will depend on submission of a short-term lease application or approval of the preference right application.

Production of 1,000 tons of coal per day by underground methods is expected by December 1978, increasing to approximately 500,000 tons per year by 1980. Production would increase rapidly to 1 million tons of coal per year if the M&R plan is approved by 1985. No market information is available from the company.

BENDETTI BROTHERS

The Bendetti Brothers are presently producing 2,000 tons of coal per year from two small mines (Eastside Mine and NuGap No. 3) on private coal reserves. Production is expected to remain constant up to and after 1990, supplying local domestic markets.

MID-CONTINENT COAL AND COKE COMPANY

Mid-Continent operates five mines in the Coal Basin area west of Redstone, Colorado. Production of 900,000 tons of coal per year is from private reserves and from federal reserves held under leases C-09004, C- 09005, C-0125456, C-0125457, C-0115606, C-011646, C-030345, and C-12646. Production schedules from Coal Basin are expected to remain fairly stable. The company is operating under an approved M&R plan at present. The company has submitted M&R plans for two additional mines; these are being examined site-specifically in this ES. The Coal Basin mines supply coal to U.S. Steel Geneva Works in Orem, Utah, and to Kaiser Steel Fontana Plant, Fontana, California.

CARBON KING, LTD.

Carbon King operates the Sunlight (Four Mile) Mine west of Carbondale. Production of 1,000 tons of coal per year is from private reserves and is expected to increase to 30,000 tons per year by 1980 and stabilize at 50,000 tons per year by 1985, supplying local domestic usage.

OHIO CREEK MINING COMPANY

The Ohio Creek Mining Company operates the Ohio Creek No. 2 coal mine on federal lease C-069942, north of Gunnison, Colorado. Production of 4,000 tons of coal per year from the mine is expected to hold steady until 1987, when present federal reserves would be depleted. The company is presently operating under an approved M&R plan.

PEABODY COAL COMPANY

Peabody is producing approximately 100,000 tons of coal annually by stripping private coal reserves to supply the Nucla Power Plant in Nucla, Colorado. Production schedules are expected to remain stable. Production would increase if power demand from the Nucla Power Plant increases, but no increase in power demand is presently anticipated.

WESTERN STATES COAL COMPANY

Western States is considering rehabilitation of the Fairview Mine. Production from private coal reserves is not expected before 1980, and under scheduled production rates, the private reserves should last beyond 1990. The coal would supply local industrial and domestic markets.

EMPIRE ENERGY CORPORATION

Empire Energy Corporation of Indianapolis, Indiana, is a subsidiary of Houston Natural Gas Corporation. Empire Energy is lessee for the 180-acre federal lease D-052501 and proposes to produce 500,000 tons of coal annually to supply unspecified markets from the Edward's Mine after approval of an M&R plan which is to be submitted at a later date, prior to 1985. The company has submitted a short-term lease application C- 13135, on which no action has been taken. Neither of these actions is considered site-specifically in this regional ES. The coal would supply unspecified markets.

Projected Aggregate 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 22 coal mines in the ES area in 1977. At the most probable rate of development the number is expected to increase to 24 by 1980, 30 by 1985, and then decrease to 26 by 1990. No plans are known to exis

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 699 by 1980, 1,418 by 1985, and 1,688 by 1990, based on 100 cars per unit train and 17.10 million tons of coal being shipped out of the ES area. This amount would result in approximately 30 percent of production being shipped west and 70 percent going 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. 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 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 407 miles of new road would be built by 1980, 1,213 miles by 1985, and 2,013 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.

At the writing of this ES, there were no specific applications to construct power lines in the ES area that would require federal approval; however, several projections in this report indicate that power line construction could occur in the region as a result of increased coal production. For this analysis, it is projected that a total of 64 miles of new power and communication lines would be installed by 1980, 121 miles by 1985, and 173 miles by 1990.

Projected Acreage Requirements

The proposed mines would result in cumulative disturbance of 435 acres by 1980, 1,219 acres by 1985, and 1,261 acres by 1990, 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 depicts 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 7,996 acres by 1980, 24,967 acres by 1985, and 32,500 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 Requirements

The two primary coal-related uses of water that would increase through 1990 are urban use and mine and coal handling. Table R1-7 depicts projected coal-related water requirements for the ES area through 1990. It is estimated that, with expected population increases, 3,481 additional acre-feet per year would be required for urban use by 1980,

TABLE R1-5

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

Projected Development	1977	1980	1985	1990
Coal:				
Coal mines (existing and projected private)	22	21	24	19
Coal production (million tons per year)	2.98	4.89	5.77	5.50
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	152,050	196,247	247,549	261,782
Community expansion (acres)	-	3,827	8,102	9,353
Auxiliary development:				
New power lines	-	25	50	75
New railroads (miles)	-	2	2	2
New telephone lines (miles)	-	19	51	78
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 R1-6

PROJECTED REGIONAL SURFACE DISTURBANCE AND RECLAMATION FOR WEST-CENTRAL COLORADO

Activity	Cumulative Acreage a/ 1980 Disturbed	1980 Reclaimed	1985 Disturbed	1985 Reclaimed	1990 Disturbed	1990 Reclaimed
Existing coal mines	1,044	0	1,230	180	1,433	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	3,827	0	8,102	0	9,353	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	7,996	0	24,967	180	32,506	265
Six site-specific coal mines	435	0	1,219	0	1,261	0
Community expansion (assoc. with six site-specifics)	265	0	902	0	1,112	0
Subtotals	700	0	2,121	0	2,373	0
Total Regional Disturbance	8,696	0	27,088	0	34,879	0

Note: NA - Not available.

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

TABLE R1-7

PROJECTED ANNUAL WATER REQUIREMENTS FOR
COAL-RELATED DEVELOPMENT BASED ON MOST-PROBABLE PRODUCTION

Facility	1980 (acre-feet/ year)	1985 (acre-feet/ year)	1990 (acre-feet/ year)
Power plant	498	498	498
Mine and coal handling	447	1,575	2,267
Population increase (urban)	3,481	4,159	5,123
Total	4,426	6,232	7,888

4,159 acre-feet per year by 1985, and 5,123 acre-feet per year by 1990. It is expected that additional water requirements for mines and coal handling would be 447 acre-feet per year by 1980, 1,575 acre-feet per year by 1985, and 2,267 acre-feet per year by 1990. Water for power plant use would be 498 acre-feet per year by 1980 and would remain at 498 acre-feet per year through 1990.

Most mining operations in the area would encounter some water. The water would be used to sprinkle roads for dust control, for washing coal, or would be evaporated in retention ponds.

Domestic water for use at most mines would come from local utilities or from springs or well on site. Additional water for industrial purposes would have to come from existing rights held by the companies, from rights purchased in the future, or from rights adjudicated to the companies after filing with the state of Colorado.

Other Major Regional Development

Oil and Gas

In the west-central Colorado area, a total of 23 oil and gas fields were producing or in storage status in 1976. Of these 23, 6 were in both producing and storage status, 12 were only producing, and 5 were used only for storage. Map 3 in appendix A shows the oil and gas fields for the west-central Colorado area. It should be noted that none of the producing oil and gas fields overlaps with the five proposed mining areas. However, approximately 65 to 70 percent of the area that is held under coal leases and preference right lease applications is also covered by nonproducing oil and gas leases.

Natural gas accounts for the majority of the production in the area. In 1976, the production from these four counties was 3,176 barrels, or less than 1 percent of the state's total petroleum production, and 335,085 million cubic feet, or only 2.5 percent of the state's natural gas production. In a number of cases, transportation systems which have been designed in support of the site-specific proposed mining operations may be forced to cross existing oil or gas pipelines.

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 appendix A). 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, C-A and C-B, 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 C-A, 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 C-B, will follow a similar scheme of modular retort development between 1978 and 1985. Tract C-B is scheduled to begin commercial production in 1985.

Colony Development Operation is proposing to develop an oil shale plant, mine, service corridor, and exchange, 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 study 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 Preliminary Draft Environmental Statement for the Proposed Superior Oil Company Land Exchange and Oil Shale Development has been prepared by the U.S. Department of the Interior and is scheduled for final publication in September 1978.

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 is 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 federal 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 appendix A). 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 being developed at Homestake's Pitch mine). 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.

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 gases 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 on-site 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 is 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. 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 on-site 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. An environmental statement will be prepared for this project.

Analysis Assumptions

The following assumptions are used for analysis of regional impacts:

1. Mining and reclamation technology will not change significantly over the time frame in the analysis.
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, it is assumed that none of the disturbed acres will actually be available for post-mining land-use until the end of the mine life.
4. Any impacts lasting over 30 years are considered permanent.

5. Accelerated development of other energy minerals will occur with coal development in west-central Colorado; this development will include oil shale as projected.

6. Additional assumptions regarding acreage and water requirements for various elements of projected coal-related development are presented in tables R1-8 and R1-9.

TABLE R1-8

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	100
Railraods (100-foot right-of-way)	12 per mile

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

TABLE R1-9

ASSUMED WATER REQUIREMENTS FOR DEVELOPMENT

Facility	Acre-feet/ year Required
Power plant (water cooled)	15 per megawatt
Per 1,000 population increase (urban)	400
Per 1,000 tons coal produced per year	0.1696

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 in 1990 if the proposed actions are not implemented.

EXISTING ENVIRONMENT

Climate

Introduction

The west-central Colorado study 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 ranges 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-A.

The mean annual temperatures for stations in or near the study region are listed in table R2-A (McKee 1972). An isotherm analysis based on these data is shown in map R2-A. 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 (degree 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-B 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 study 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 study region during the 20-year period 1951-1970 are presented in table R2-C (Benci and McKee 1977). There is a difference of 166 Fahrenheit degrees between the lowest (-60 degree 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 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 study region. Locations in the Grand Valley tend to experience the longest growing seasons. Locations 13 or 14 thousand feet above mean seal 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-D. 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 stripped 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, or trees that are used for revegetation may need to be mature 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-D.

PRECIPITATION

Total Precipitation

The precipitation totals (rainfall plus the water equivalent of snowfall) in the west-central Colorado study region are low compared with the totals in many other areas of the United States. The high elevation of the study 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-B 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-E 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 study region, Aspen, Crested Butte, Grand Junction, Gunnison, and Paradox were selected as generally representative of certain areas in the study region (see table R2-F). These are the same stations used for temperature in table R2-B. 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-G 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 study region range from about 4,500 feet just west of Fruita to 14,431 feet at the summit of Mt. Elbert on the eastern border of the study region. Annual snowfall at these locations ranges from less than 20 inches to more than 300 inches, respectively. The snowfall

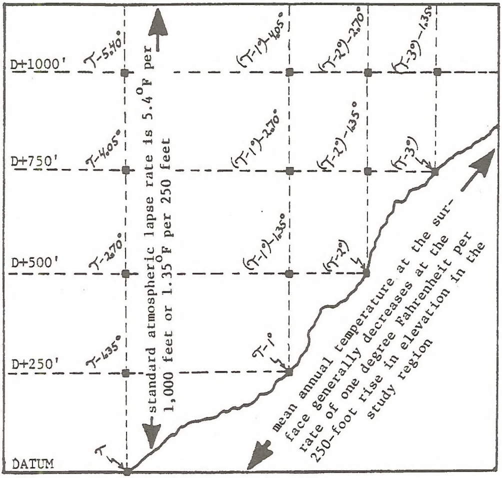


Figure R2-A. Generalized cross-sectional temperature structure of the atmosphere in the westcentral Colorado study region (in degrees Fahrenheit)

TABLE R2-A

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

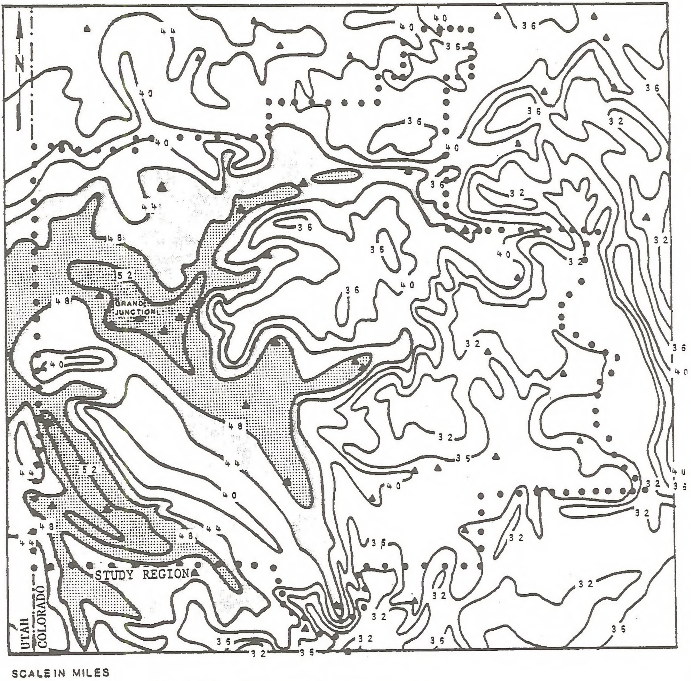
Station	Approximate Number of Years of Record	Mean Annual Temperature (°F)	Station	Approximate Number of Years of Record	Mean Annual Temperature (°F)
Altenbern	(14)	46.3	Little Hills*	(25)	42.8
Aspen	(43)	40.6	Marvine*	(12)	40.7
Basalt*	(6)	44.2	Meeker*	(29)	44.3
Bond*	(13)	43.9	Meeker 10NW* †	(20)	44.0
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
Collbran	(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)	13.5
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-A. 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-B

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-C

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	-12	January 1963
Aspen	91	June 1954	-33	January 1963
Cedaredge	101	June 1968	-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	-41	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	-23	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.

TABLE R2-D

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

STATION	ELEVATION (ft)	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				
		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.

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 study region, have a snowfall season of eleven months (September through July).

Annual snowfall data from stations in or near the study region are shown in table R2-H (McKee 1972). Snowfall isopleths, based on these data and topographically adjusted, are presented in map R2-C. 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-I shows monthly and annual snowfall averages for the same stations and period used to characterize temperature and precipitation in certain areas of the study region.

In most of the study 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 rain fall 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-J). 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 study region, maximum observed clock-hour rainfalls have ranged from 0.6 inch to slightly over 1 inch (Hansen 1977; see map R2-D). 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 (Iorns 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 reslt of thunderstorms.

Droughts

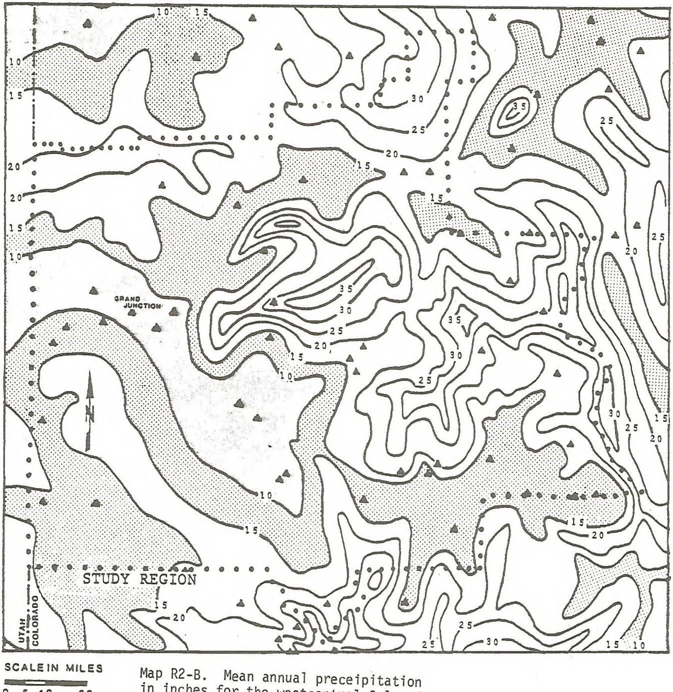
Data records indicate a one-year drought period once every seven years, a two-year drought period once every 44 years, and a three-year drought period once every 313 years. These drought frequencies were derived from statistical analysis of long-term data for Glenwood Springs, Grand Junction, Gunnison, 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-B. 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 study 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 Continental Divide (see map R2-E). The rest of the region averages about one hail day per year. Hailstorms in Colorado are most numerous in June and



Map R2-B. Mean annual preceipitation in inches for the westcentral Colorado study 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-E
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	(5[illegible])	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	(26)	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-F

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-G

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

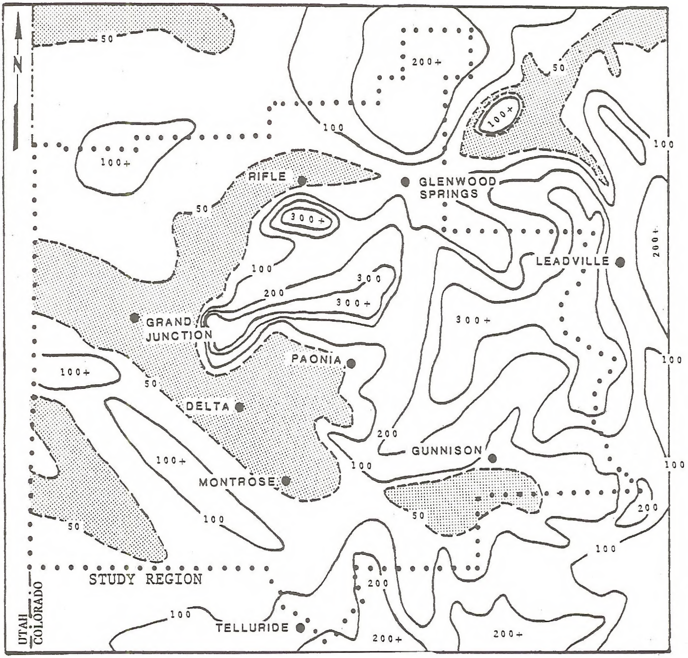
Source: U. S. Department of Commerce, 1968.

TABLE R2-H

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
Pickin	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)	118.9

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.



SCALE IN MILES

0 5 10 20

Map R2-C. 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-I

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.

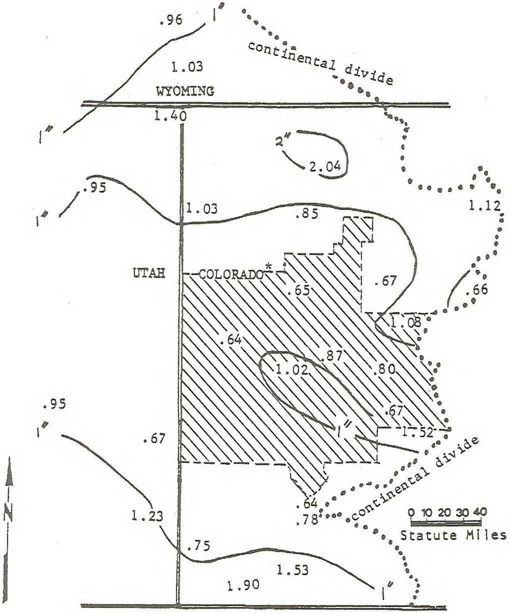
†Station at airport.

TABLE R2-J

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

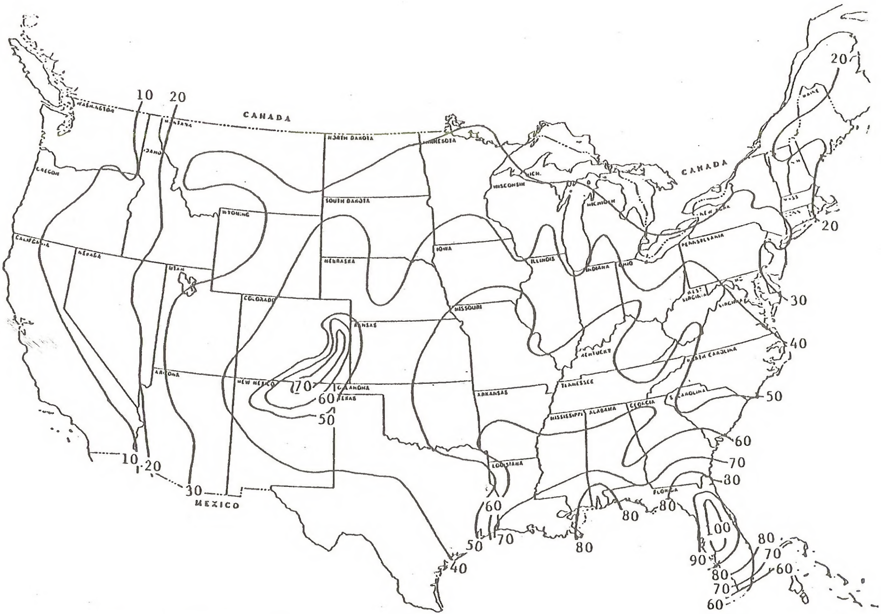
Sources: Hershfield, 1961; Miller, 1964.



*Shaded area represents the study region.

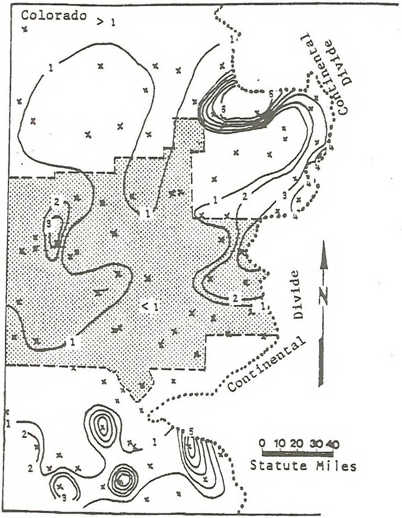
Map R2-D. Maximum clock-hour rainfalls at stations with records for period 1940-1972 (may through September)

Source: Hansen, 1977.



Source: Landsberg, 1969.

Figure R2-B. Mean annual number of days with thunderstorms in the United States



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

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

July between 4:00 and 5:00 p.m. Mountain Standard Time (Flora 1956).

Tornadoes are rare in the study 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 study 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-K shows average dew point data for the semiarid Grand Junction area and the mountainous areas in the study 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 study region. However, elevation differences are responsible for considerable variation of the relative humidity from one location to another. Table R2-L 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 study region. Available data indicate that heavy fog, which restricts visibility to 0.2 mile or less, occurs 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 study 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 study 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-M 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 cloudiness 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 study 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 visibilities (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 visibilities 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 study 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 study 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-C and R2-D. Both wind roses show the predominance of downslope or downvalley flow, with a secondary maximum for upslope or upvalley winds. This pattern is characteristic of most valley locations within the study 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-E 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 study 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.

The seasonal surface wind roses for Grand Junction are presented in figure R2-F. There is little change from the annual wind direction frequencies because of the dominance of the valley-induced

TABLE R2-K

MONTHLY AND ANNUAL DEW-POINT AVERAGES (^{o}F) 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-L

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.)

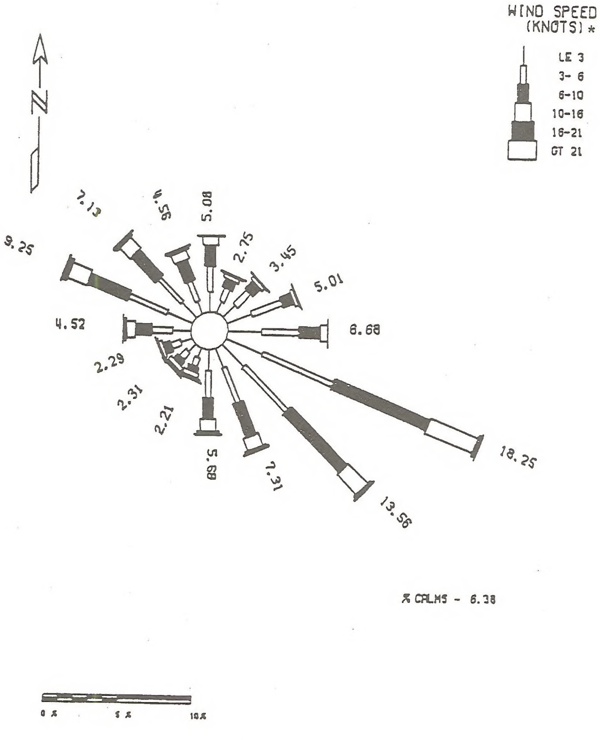
** Source: National Climatic Center, 1976.
(Averages are based on a 13-year period through 1976.)

TABLE R2-M

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

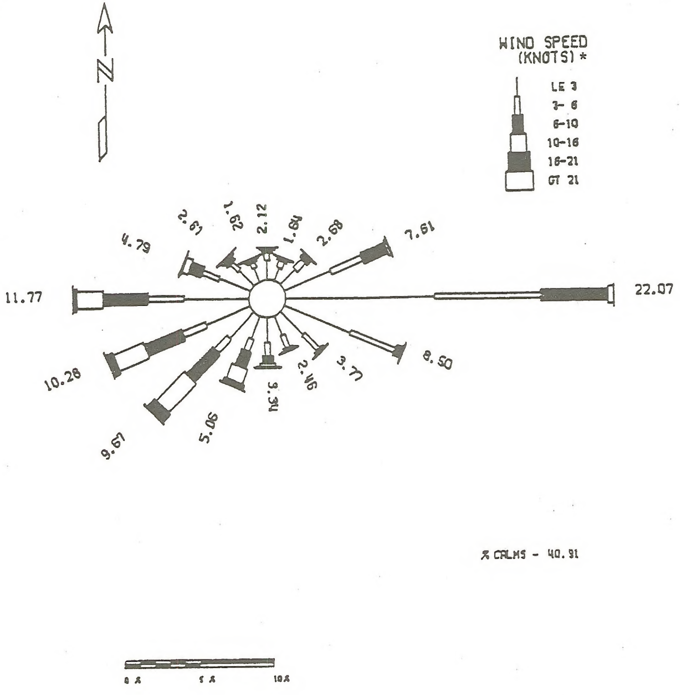
Source: U.S. Department of Commerce, 1968



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

* (1 knot = 1.15 miles per hour)

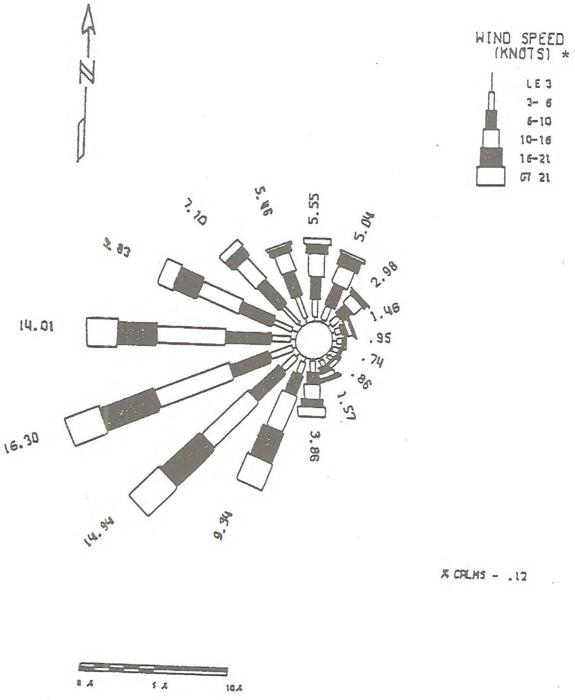
Figure R2-C. Annual wind rose - Grand Junction, Colorado, 1959-1968.



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

* (1 knot = 1.15 miles per hour)

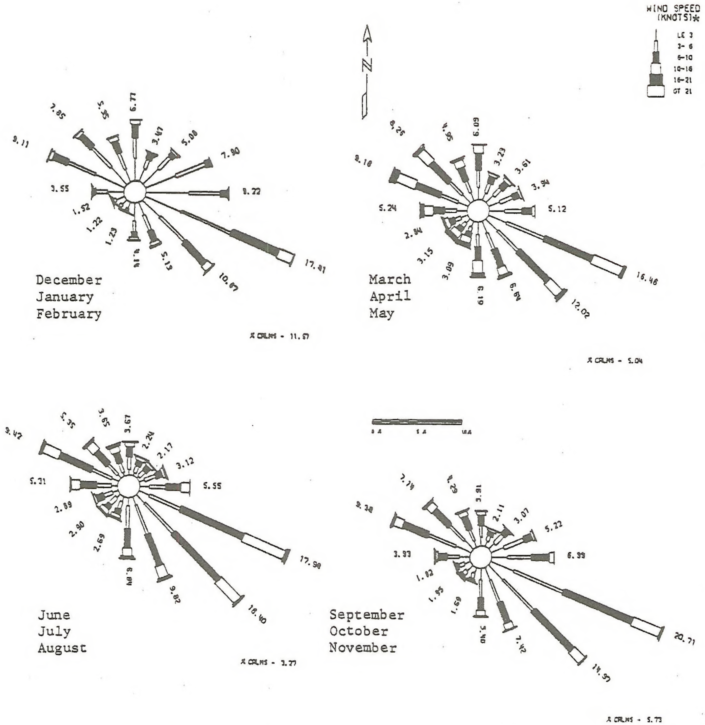
Figure R2-D. Annual wind rose - Eagle, Colorado, 1956-1974



Source: National Climatic Center, 1971-1976.

* (1 knot - 1.15 miles per hour)

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



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

* (1 knot - 1.15 miles per hour)

Figure R2-F. Seasonal wind roses - Grand Junction, Colorado, 1959-1968 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 for 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 study 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 study 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 disperion 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 study 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-N 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-N 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 study 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-F illustrates a typical example of the influence of upslope flow during the day and downslope during the night.

Valleys in the study region form airsheds where dispersion is often limited. Major airsheds are shown in map R2-G. 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.

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, nitrogen dioxide, carbon monoxide, photochemical oxidants (ozone), and hydrocarbons. These standards are shown in table R2-O. 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 sulfur dioxide 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 deterioration 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 sulfur dioxide above baseline concentrations. Ambient concentrations of TSP and sulfur dioxide 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-P. 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 sulfur dioxide 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 sulfur dioxide levels. Class III area increments were designed to allow the maximum increases in ambient TSP and sulfur dioxide 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 in 1979.

The Region VII office of U.S. Environmental Protection Agency 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 sulfur dioxide 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-P.

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 study region. These five wilderness areas have a total of 513,000 acres (see map R2-H). Besides the federal Class I, 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 study 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-I.

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 C-b, Mt. Gunnison Mine, Orchard Valley Mine, and Pitch Uranium Mine generally exhibit lower TSP concentrations that would be expected in undeveloped areas. Annual geometric means for these sites range from 7 $\mu g/m^3$ at Tract C-b 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 Ritter. 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-Q.

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 C-b Shale Oil projects. Table R2-R summarizes these gaseous pollutant monitoring data.

Sulfur dioxide concentrations at both sites were very low as compared with both federal and state standards. Tract C-b SO_2 concentrations averaged less than 1 $\mu g/m^3$ compared to 80 $\mu g/m^3$ federal stands. 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 C-b 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 C-b 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 C-b concentrations were consistently above the standard.

The U.S. Environmental Protection Agency recognizes that high concentrations of photochemical oxidants and their precursors, nonmethane hydrocarbons, may occur in remote areas, such as the Tract C-b site. The U.S. Environmental Protection Agency has determined that these areas should not be designed at 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. (U.S. Environmental Protection Agency 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 well over 13,000 feet. Most peaks lie at elevations of 10,000 to 12,000 feet. Drainage is primarily north into the headwaters of the Colorado and Roaring Fork Rivers, or south into the Gunnison River, a major tributary of the Colorado. (Map 4 in appendix A shows the topography of the ES area.)

Grand Mesa, the largest flat-topped mountain in the world, lies at elevations from 10,000 to 12,000 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 West 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.

Landforms

The ES area lies astride two major geomorphic provinces: the Colorado Plateau and the Eastern

TABLE R2-N

AVERAGE MOUNTAIN VALLEY DISPERSION
CONDITIONS IN THE WESTCENTRAL COLORADO
STUDY REGION

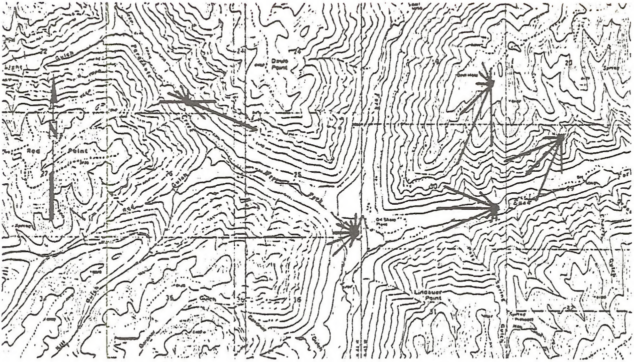
Season	Mixing Height* (Meters), (Feet) Morning		Afternoon		Transport Wind Speed (Meters/Second) (Miles/Hour) Morning		Afternoon		Ventilation** ($Meters^2/Second$) ($Feet^2/Second$) Morning		Afternoon	
Winter	350	1200	1150	3800	3.5	7.8	3.8	8.5	1100	12000	4400	47000
Spring	600	2000	3100	10200	5.2	11.6	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.

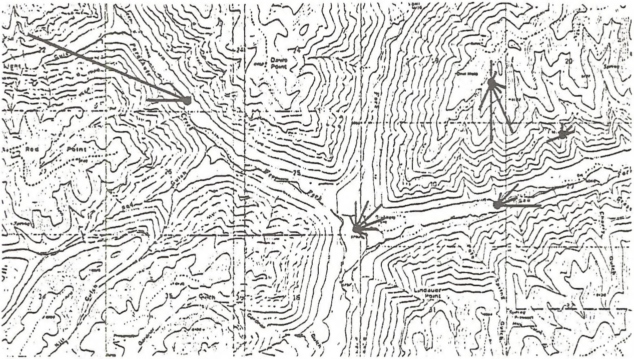
** Ventilation equals mixing height multiplied by transport wind speed and is presented to the nearest 100 $meters^2/second$ or 1000 $feet^2/second$.



DAYTIME FLOW (1:00 p.m.)

SCALE IN MILES

0 1

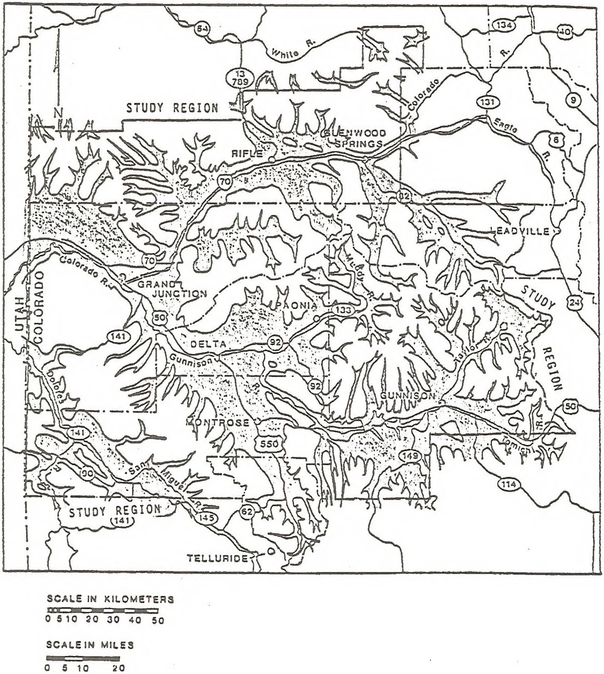


NIGHTTIME FLOW (1:00 a.m.)

Source: Stearns-Roger (1976).

Period of Record: 1974-1976

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



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

TABLE R2-0

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

Pollutant	Averaging Period***	Federal Primary Standards $\mu g/m^3$	Federal Primary Standards ppm	Federal Secondary Standards $\mu g/m^3$	Federal Secondary Standards ppm	Colorado State Standards $\mu g/m^3$
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-P

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

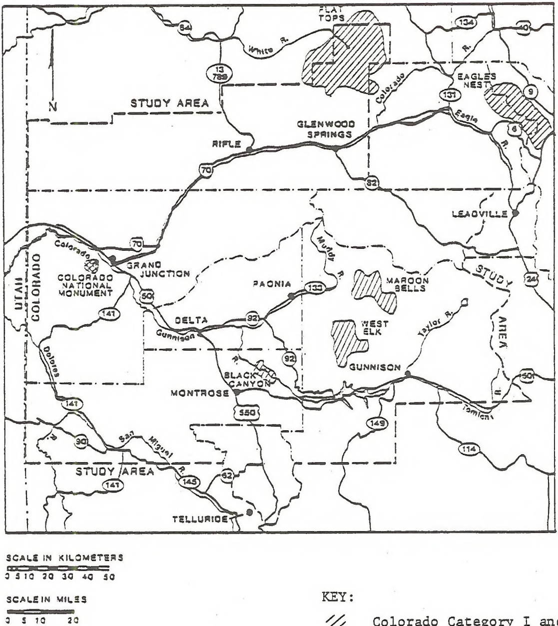
Pollutant	Averaging Time	Maximum Allowable Air Quality Increases ($\mu g/m^3$)		
		Category I	Category II	Category III
State*				
Sulfur Dioxide (SO_2)	Annual Mean	2	10	15
	24-hour***	5	50	100
	3-hour***	25	300	700
Federal**		Class I	Class II	Class III
Sulfur Dioxide (SO_2)	Annual Mean	2	20	40
	24-hour***	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.

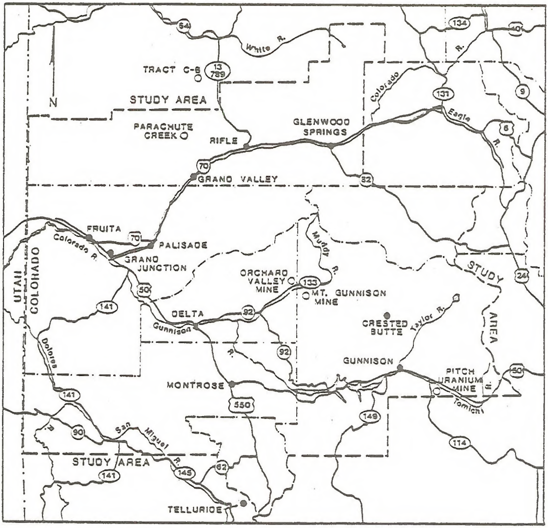


KEY:

Colorado Category I and PSD Mandatory Class I Areas

Colorado Category I Area Only

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



SCALE IN KILOMETERS

0 5 10 20 30 40 50

SCALE IN MILES

0 5 10 20

KEY:

● Monitoring Stations Operated by Colorado Air Control Division

○ Monitoring Stations Operated by Private Companies

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

TABLE R2-Q

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-R

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.

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 interrupt 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 resistant Cenozoic, Mesozoic, and Paleozoic sedimentary rocks around softer, more easily eroded sediments.

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 interlaid 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 and West 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 appendix A.

Paleontology

The BLM has determined that compliance with the National Environmental Policy Act of 1969, as amended, and the Federal Land Policy and Management Act of 1976 requires that paleontological resources be considered in the ES process. This compliance includes inventory and protection through mitigation of paleontological resources having scientific, educational, or other values.

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 R2-1. 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.

The BLM and USGS are currently devloping a memorandum of understanding for the protection of paleontological resources on federal lands. These agencies are also developing technical guidelines to define the resource and provide criteria for evaluation and measures for portection. When completed, the provisions of these documents will serve as a basis for management and protection of paleontological resources.

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 high-volatile C coals (ranging from 11,000 to 13,000 BTUs). Coking coal is present in the Carbondale, Somerset, and Crested Butte fields.

TABLE R2-1

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

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 7 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 R2-2 presents the coal reserves of the ES area by field.) Map 2 in appendix A 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 billin 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 in *Coal Resources of Colorado* (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 R2-3 presents the current and projected mining activity in the fields. The locations of the mines listed is shown on map 1 in appendix A.)

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 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. Table R2-2 presents the reserves of the Little Bookcliffs field by overburden depth. Table R2-3 shows the existing or projected mining activity in the Little Bookcliffs field. Map 1 in appendix A shows the location of the mining operations listed.

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. Table R2-2 presents the coal reserves of the Grand Mesa field by overburden depth. Table R2-3 shows the existing or projected mining activity in the field. Map 1 in appendix A shows the location of the mining operations listed.

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.

TABLE R2-2

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 R2-3

MINING ACTIVITY IN THE ES AREA BY COAL FIELD

Coal Field	Mine Name	Status	Mining to Occur in: Formation	Mining to Occur in: Coal Zone	Mining to Occur in: 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

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 R2-3 shows the existing or projected mining activity in the Somerset field. The location of mining activity listed on table R2-3 is shown on map 1 in appendix A.

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. Table R2-3 shows the existing or projected mining activity in the Crested Butte field. The location of the activity is shown on map 1 in appendix A.

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. Table R2-3 shows the exsiting or projected mining activity in the Carbondale field. The locations of mines listed are shown in map 1 in appendix A.

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 formations 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. Table R2-3 shows the existing and projected mining activity in the Grand Hogback coal field. Map 1 in appendix A shows the locations of the mines listed in table R2-3.

Tongue Mesa Field

A fingerlike extension of the Uncompahgre 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. Table R2-3 shows the current and projected mining activity in the field and map 1 in appendix A shows the location of each of the mines listed.

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 physiographic 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. Table R2-3 shows the current and projected mining activity in the Nucla field and map 1 in appendix A shows the location of the mine listed.

SUMMARY

There are eight coal fields in the ES area. A total of 10,023 million 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 appendix A 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 the 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 (C-a and C-b) 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 appendix A). These vary from the highly productive sedimentay 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; 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 (unpub) 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 on several other occurrences.

Water Resources

Surface Water

The regional boundaries of this ES area generally lie within the upper Colorado River basin, Colorado (map R2-1). This basin is composed of nine major subbasins: upper Gunnison, North Fork, Uncompahgre, Whitewater, Middle Park, Eagle River, Roaring Fork, Rifle-West Divide, and Grand Valley-Plateau. The elevation of the basin ranges from 4,300 feet to over 14,000 feet. The basin drains an area of 17,770 square miles, and the average annual (1951-74) water yield after all depletions is 4,214,000 acre-feet (5,816 cubic feet per second). The flow rate at the Utah-Colorado state line has varied from as low as 960 cubic feet per second (cfs) on September 7, 1956, to 56,800 cfs on June 9, 1957.

The average annual runoff of surface water from the ES area correlates with watershed elevation (figure R2-1). Data used in the development of this correlation are given in table R2-4. Below 7,700 feet mean sea level, much of the precipitation is consumed by vegetation and absorbed by the dry soils rather than flowing from the valley as runoff. However, at elevations above 9,000 feet, annual water yields average more than 800 acre-feet per square mile.

Peak runoff usually occurs during the months of May and June in response to melting snowpacks. River flow rates during this period increase some five to ten times over those of the other months of the year producing 60 to 65 percent of the total annual flow. Low flows can be expected to occur during the colder winter months when surface runoff is minimal. Tributaries which support agriculture experience very low flows during late summer when irrigation demands are high.

The total available water supply for the upper Colorado River basin, Colorado, is 5,395,341 acre-feet. The total depletion or amount consumed, including evaporative losses and vegetative consumption, is 2,828,049 acre-feet. These water supply figures represent surface water only. Price and Arnow (1974) estimate that 97 percent of the available water supply is ground water; however, only a small portion (15 percent) of this ground water can be economically recovered. Therefore, the 5,395,341 acre-feet of the surface water supply represent only about 3 percent of the total supply. (Table R2-5 summarizes, by subbasin, the water yield-depletion for the upper Colorado River basin. Of the nine subbasins only three will be directly impacted by expected coal development, the North Fork, Roaring Fork, and Grand Valley subbasins.)

The long-term records show that the annual flow for the upper Colorado River basin, computed at Lee's Ferry, near the Utah-Arizona border, is 14,952,000 acre-feet for the period from 1906 to 1973. This flow has ranged from 5.6 million acre-feet in 1934 to over 24.0 million acre-feet in 1917. Since 1923, the average annual virgin flow at Lee's Ferry has been about 13.8 million acre-feet.

Over a period of time, the mean flow of the Colorado River has been decreasing. The diversion of water between the upper and lower basin states was based on an assumed mean flow of 15,000,000 acre-feet. However, during the period from 1911 to 1962, the flow of the Colorado River averaged 12,923,000 acre-feet per year. The reasons for this decrease have been the object of several investigations to determine whether it is due to general changes in climate or increased human depletions. Several investigators have shown that stream flow data point to a general decrease in runoff for the period of record. The U.S. Bureau of Reclamation (USBR) has estimated that an annual average quantity of up to 5.8 million acre-feet is available for upper basin depletion (consumption), based on the estimated virgin runoff of the Colorado River at Lee's Ferry. The commitments of the Colorado River Compact of 1922 and the Mexican Water Treaty of 1944 must be subtracted from the virgin flows at Lee's Ferry. The treaty with Mexico allocated 1,500,000 acre-feet each year to Mexico. The upper and lower basins are presently supplying equal quantities of water for satisfaction of the treaty requirements (750,000 acre-feet each). The estimate of 5.8 million acre-feet is further based on the provision of approximately 26 million acre-feet of active storage capacity being available in the upper Colorado basin to carry water over from high water years to meet the commitments of the lower Colorado River basin in years of drought. These shortages will generally be sustained by agricultural water users because they cannot pay the cost to provide enough storage regulation to eliminate all shortages in their water supply.

The Upper Colorado River Basin Compact of 1948 gave Arizona the right to the consumptive use of the first 50,000 acre-feet per year, and the remaining water is apportioned to the other upper basin states in the following percentages: Colorado, 51.75; New Mexico, 11.25; Utah, 23.00; and Wyoming, 14.00.

Ground Water

The source of all ground water is precipitation. About 4 percent of the precipitation of the region is estimated to become ground-water recharge (Price and Arnow 1974). This includes percolation through the soil zone as well as seepage from streams, reservoirs, and land irrigated by streams. Over many years, any consumptive use or discharge of ground water is balanced by the natural ground water recharge. Consequently, any consumptive use of ground water by wells will cause some form of proportional decrease in ground water discharges to streams.

Because of the varying hydrologic properties of rocks, the geology of the region is the principal factor controlling the quantity and availability of ground water for development. The rocks that underlie the region consist mostly of consolidated and semiconsolidated sedimentary strata. Igneous and metamorphic rocks underlie parts of the mountains, and unconsolidated alluvial deposits underlie reaches of major stream valleys.

Ground water occurs under both water-table (unconfined) and artesian (confined) conditions and constitutes about 97 percent of the total available supply (Price and Arnow 1974). Water-table conditions commonly exist in shallow alluvial aquifers along the larger streams, in principal recharge areas. Artesian conditions occur locally throughout the region but are prevalent in the bedrock aquifers of the major structural basins.

Although the total volume of recoverable ground water in storage is great (180 million acre-feet), the water cannot be recovered in large quantities from wells at all places. For example, about 85 percent of the estimated maximum recoverable water in storage occurs in deeper sedimentary rocks, which have a relatively low permeability and yield water slowly. Only 5 percent of the estimated recoverable water in storage occurs in unconsolidated deposits, which includes permeable alluvium. Water yields of more than 50 gallons per minute can generally be expected along reaches of larger streams and in small, scattered alluvium-filled basins. Table R2-6 gives a brief description of the hydrologic character of each geologic unit common to this region down to the Chinle formation of the Triassic geologic period.

Water Quality

The major factors affecting the water quality of a river system are the following:

1. Soils and chemicals characteristic of the upper drainage basin
2. The volume of water in the stream
3. The relative magnitude of ground water and surface runoff
4. Reservoir
5. Diversion of water for irrigation and smaller amounts of municipal and industrial use
6. Return flow of irrigation water
7. Discharges from municipalities upstream
8. Discharges or runoff from upstream mining activities
9. Pesticides and herbicides used on cattle and crops

Of the above, the soil and chemical characteristics of the basin, the influence of reservoirs as a settling basin and modifiers of runoff, and dewatering and return flow from irrigation use are probably the most important.

The quality of the Colorado River and its tributaries to its confluence with Parachute Creek near Grand Valley, Colorado, is classified as a Quality Class B 1 by the Colorado Department of Health. From the confluence of Parachute Creek to the Colorado-Utah state line, the Colorado River is classified as a Quality Class B 2 . The primary reason for this classification change is due to the increase in water temperature. Table R2-7 gives the parameters and limits for the Colorado Water Quality Classification System.

The major problem of the Colorado River is salinity. This parameter is not currently considered in the Colorado classification system. At the headwaters of the Colorado River on the Continental Divide near the north edge of Rocky Mountain National Park, the average salinity of the river is less than 50 milligrams per liter (mg/l). The concentration increases downstream to Imperial Dam where its present concentration level is 850 mg/l. Some sections of the river are heavy salt-loaders, and irrigation water returning to the stream is often saline and sediment-loaded.

Although salinity is considered the most serious water quality problem, other potential problems are added municipal wastes, industrial wastes, dissolved oxygen content, temperature, heavy metals, toxic materials, and bacteria. Whereas water quality is not critical in the upper basin, the quality in the lower basin and in Mexico is seriously degraded by reuse, which adds and concentrates salts in the water.

The Crystal River, an upper tributary of the Colorado River, is classified as a Quality Class B 1 water system by the Colorado Department of Health. The water is moderately hard (less than 120 mg/l of calcium carbonate) and the major ion constituents are calcium, sulfate, chloride, and bicarbonate. The salinity is very low as compared with the rest of the region (less than 200 mg/l). The quality of the Crystal River above Redstone is very good compared with the rest of the region and is better than the state's classification system indicates. Below Redstone, the water quality becomes marginal with very high quantities of suspended sediment occurring after each storm and during spring now melts.

The North Fork of the Gunnison River is heavily impacted by human activities, primarily by agriculture, although this river is classified as a Quality Class B 1 water system by the Colorado Department of Health. Significant changes in the chemical parameters of the river begin to occur at and below Paonia, Colorado. Average hardness concentrations increase from 100 to 588 milligrams per liter as calcium carbonate sulfates increase from less than 10 to 532 mg/l and dissolved solids increase from 195 to more than 1,000 mg/l, as measured between Paonia and Lazear, Colorado (Colorado Department of Health 1975). The primary factors affecting the North Fork of the Gunnison River are (1) irrigation diversions and return flow and (2) municipal waste water effluent.

An interesting comparison of coal mine operations with irrigation return flow was made in the environmental assessment record, page II-43, for Colorado Westmoreland, Inc., in Paonia, Colorado. This comparison has been recompiled into table form (table R2-8). These data were obtained from a water quality report on the North Fork of the Gunnison written by the Colorado Department of Health.

Although shallow, unconfined ground water is present over much of the region, it is highly mineralized in many areas. In areas around Mancos shale, the concentrations of dissolved solids may exceed 1,000 mg/l. Water found in the Mesaverde formation, the formation containing most of the coal discussed in this statement, is generally very hard (greater than 180 mg/l as calcium carbonate) and is classified as a sodium-chloride-sulfate-bicarbonate type. Dissolved solid concentrations range from 500 to 2,000 milligrams (slightly saline). Dissolved iron usually exceeds drinking water standards, ranging from 50 to 4,500 micrograms per liter. Water from the Dakota sandstone is good quality water when found at relatively shallow depths. The water usually is high in sodium bicarbonate and iron, and in some location selenium and arsenic have been found to be a problem. However, many residences in the southwestern portion of the ES area use it as their sole domestic water supply. The Morrison formation produces water which is usually high in sodium bicarbonate or sodium sulfate. This water is generally acceptable for domestic use but is too high in sodium for some irrigation purposes.

Soils

General soil types for the region are shown in map 5 in appendix A; 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 has 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 limita tions 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,

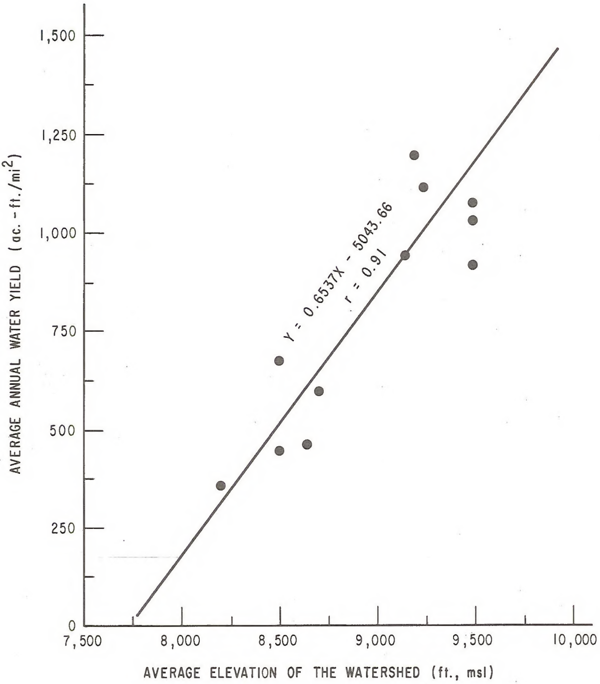
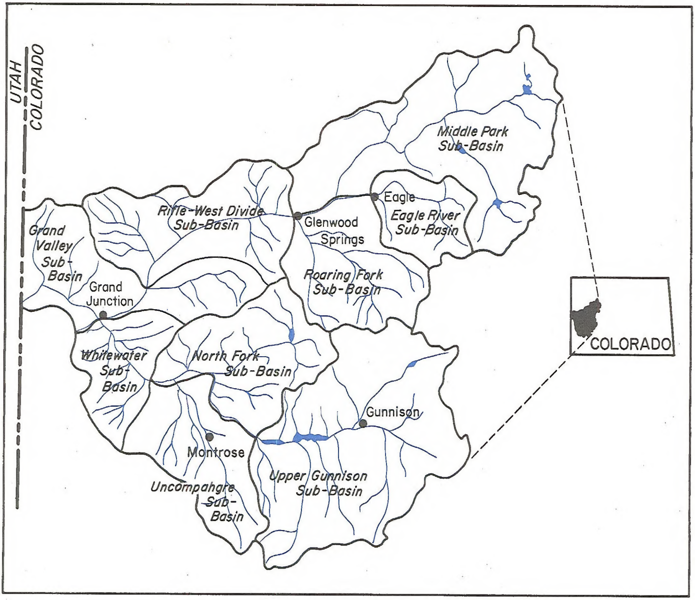


Figure R2-1. Average annual water yield (acre-feet) as correlated with the average elevation of the watershed



Map R2-1. Watersheds of the ES area

TABLE R2-4

UNDEPLETED WATER YIELDS OF SELECTED RIVERS/STREAMS THROUGHOUT THE REGION

River/Stream	U.S.G.S. Gage No.	U.S.G.S. Gage Location	Elevation of Gage (feet, mean sea level)	Drainage Area (square miles)	Average Elevation of the Drainage (feet, mean sea level)	Average Annual Discharge (acre-feet)	Average Annual Water Yield (acre-feet/ square miles)
Canyon Creek above New Colorado	09085200	NW¼NW¼, Sec. 24, T. 5S., R. 90W.	6,180	23.8	9,800	37,960	1594.96
West Hubbard near Bowie, Colorado	09132900	NW¼NE¼, Sec. 12, T. 12S., R. 92W.	9,630	2.4	9,500	2,563	1067.92
Mid-Hubbard near Bowie, Colorado	09132800	SE¼SW¼, Sec. 36, T. 11S., R. 92W.	9,650	1.3	9,500	1,326	1020.00
Main Hubbard near Bowie, Colorado	09132700	NE¼SE¼, Sec. 35, T. 11S., R. 91W.	9,690	1.3	9,500	1,190	915.38
East Canyon Creek above New Castle, Colorado	09085300	SE¼SE¼, Sec. 13, T. 5S., R. 90W.	6,280	15.1	9,250	16,740	1108.61
Surface Creek near Cedaredge, Colorado	09143000	NW¼NW¼, Sec. 25, T. 12S., R. 94W.	8,261	26.7	9,200	31,900	1194.76
Leroux Creek near Hotchkiss, Colorado	09135900	SE¼NW¼, Sec. 16, T. 13S., R. 93W.	7,250	35.1	9,150	32,900	937.32
North Fork of the Gunnison River. near Somerset, Colorado	09132500	SW¼SE¼, Sec. 9 T. 13S., R. 90W.	6,039	531.0	8,700	318,100	599.06
Beaver Creek near Rifle, Colorado	09092500	NW¼NE¼, Sec. 1 T. 7S., R. 94W.	6,685	7.9	8,650	3,630	459.49
Possum Creek above New Castle, Colorado	09085400	SW¼, Sec. 19 T. 5S., R. 89W.	6,410	6.4	8,500	4,300	671.87
West Muddy near Ragged Mountain, Colorado	09130600	SW¼NE¼, Sec. 5, T. 11S., R. 91W.	8,200	7.5	8,500	3,345	446.00
West Divide Creek near Raven, Colorado	09089500	W½, Sec. 29 T. 8S., R. 91W.	7,050	64.6	8,200	22,820	353.25

TABLE R2-5

REGIONAL SURFACE WATER BALANCE (AVERAGE ACRE-FEET/YEAR)

SUB-BASIN	Upper Gunnison	North Fork	Uncompahgre	Whitewater	Middle Fork	Eagle River	Roaring Fork	Rifle West Divide	Grand Valley Plateau
Undepleted water supply	1,271,481	536,100	259,400	105,900	1,544,320	455,490	988,460	347,430	220,710
Imported supply	0	0	361,500 (Gunnison)	0	2,750 (Yampa R.)	0	2,500 (Middle Park)	2,180 (Gunnison)	6,060 (Gunnison) 500 (White R.)
Exported supply	369,740	2,000	0	0	333,700	4,000	0	0	0
Total Available Supply	901,741	534,100	620,900	105,900	1,213,370	451,490	990,960	349,610	227,270
Consumptive use by crops (irrigation diversion - return flow)	100,958	159,333	117,176	10,070	91,546	17,518	67,124	50,685	148,045
Industrial consumption	713,958	7,509	15,715	0	710,378	11,253	1,412	0	341,386
Domestic and municipal consumption	7,055	11,320	2,288	3,616	12,413	3,095	11,753	2,240	7,775
Nonbeneficial phreatophytes, riparian vegetation, seeped land, and incidential area use	5,848	24,430	75,995	9,205	8,100	3,870	3,180	14,230	57,570
Total Unused Water Supply	73,922	331,508	409,726	83,009	390,933	415,754	907,491	282,455	-327,506

Source: Data compiled from Irrigation Division No. 4 and No. 5 Annual Reports (1971-1976), U.S. Department of Agriculture and Colorado Water Conservation Board (1962 and 1965) reports.

Note: Approximately 60 to 65 percent of this water supply occurs during May and June.

TABLE R2-6

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 formation	unknown	Source of water to many springs and large capacity wells but locally unimportant. Crops out only in northernmost portion of study area.
	Mancos shale	70-1,500	Not considered a source of water, although unconfined water is found in fractured or weathered zones. Water is of poor quality, highly alkaline.
	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 small amount of water up to 40 gpm. Generally salty and mineralized. Water is generally under artesian head. Quality degrades with distance from outcrop (recharge area.
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 for economic reasons. 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: Hydro-Search 1977.

---- Approximate formation contact.

TABLE R2-7

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 R2-8

A COMPARISON OF THE EFFECTS OF COAL MINING VS. IRRIGATION RETURN FLOW ON SELECTED WATER QUALITY PARAMETERS

Parameter	Percent Increase Due to: Coal Mining	Percent Increase Due to: Irrigation Return Flow
Total hardness	1.1	817
Calcium hardness	1.3	998
Electrical conductivity	1.0	630
Suspended solids	1.4	1,200
Chlorides	175	157

vegetation types adapted to the relatively drier sites of lower elevations may extend higher by way of dry southern slopes. Variabilities such as this in the boundaries of 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 R2-9. Table B-1 in appendix B gives the scientific and common names of the dominant plants and characteristic plant associations within each vegetation type in the region. The vegetation types are shown on map 6 in appendix A. 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 below 6,200 feet elevation.

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. 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 R2-2 and R2-3 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. The zones are 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 R2-4 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 R2-5 shows pinyon-juniper woodlands.)

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 R2-6 shows the mountain shrub type, and figure R2-7 shows Gambel oak.)

PONDEROSA PINE-DOUGLAS FIR

The Ponderosa pine-Douglas fir type occurs at elevations of 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 Douglas fir-ponderosa pine 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 R2-8 shows blue spruce, and figure R2-9 shows a spruce-fir forest.)

ASPEN

Aspen occurs as a stable, rather continuous forest belt between the elevations of 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 is what enables aspen to invade a mature grass community. (Figure R2-10 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 (Costillo 1954). Wet meadows consist of tufted hairgrass, blue joint reedgrass, buttercups, marsh marigolds, shrubby cinquefoil, and a variety of sedges and rushes. (Figure R2-11 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 elevation.

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 Engelman's 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 of 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 R2-10 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 elevation to the summits of the high peaks, above 14,000 feet. The vegetation is typically dense, with usually 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. A plant species may vary in size considerably from the lower edge of the alpine zone to the upper edge of the zone. 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 R2-12 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. Table B-1 in appendix B gives the common weed species found in the regional ES area.

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). A list of the plants is in table R2-10. 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 endangered or threatened status.

Five 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,* and *Cryptantha weberi*), and two are known to occur on national forest systems land (*Cryptantha weberi and Senecio porteri*). The rest of the fifteen plants may occur on public land, but attempts to rediscover them have failed; consequently, the actual ranges of the plants are not known. Some of the plants (*Cryptantha aperta, Astragalas linifolius*) have not been seen since the 1890s, when they were originally discovered.

Detailed endangered and threatened plant and floristic inventories of the areas that would be disturbed by the proposed actions have revealed no endangered or threatened plants are present. This is consistent with the known localities of the endangered or threatened plants in the region, which are not near any of the areas that would be disturbed by the proposed actions. The results of the inventories may be seen in the Grand Junction or Montrose district offices of the BLM.

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, about 38 percent (3,420,000 acres) is in use for communities and roads both rural and highway; another 0.5 percent (45,000 acres) is under streams, rivers, and impoundments; and 23 percent (2,070,000 acres) is in agriculture and ranching (Tyler 1977). That leaves 38.5 percent 3,465,000 acres) available to wildlife species. Some of the lands in agriculture and ranching are also available for use by most species of wildlife. Secretive species such as bear and mountain lion will not use these lands 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. There is some overlap in deer and elk areas which accounts for the apparent discrepency in addition of these figures. They can also be misleading because they do not exclude roads, ranch houses, rivers, water impoundments, and other human structures. Some of these acres are not in a usable condition for deer and elk due to 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 can be found in appendix C. This list is a composite of a number of lists which have been prepared for various areas within the region.

TABLE R2-9

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	
Total	3,841,600		

Figure R2-2. Saltbush type east of Palisade, showing shadscale and galleta grass in foreground.

Figure R2-3. Saltbush type in Mancos shale hills near Montrose, showing Gardner saltbush (on bottomlands) and mat saltbush (on hills).

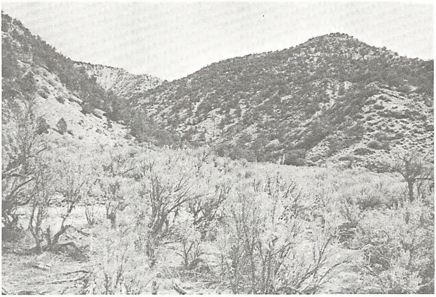


Figure R2-4. Sagebrush type. Pinyon-juniper is on the hills in the background.

Figure R2-5. Pinyon-juniper woodlands in the ES area.

Figure R2-6. Mountain shrub type, in the North Fork valley near Paonia.

Figure R2-7. Gambel oak, the dominant plant of the mountain shrub type. Douglas fir is in the background.

Figure R2-8. Blue Spruce, a riparian plant along water courses in the mountains.

Figure R2-9. Spruce-fir forest.

Figure R2-10. Aspen and spruce-fir vegetation types.

Figure R2-11. Mountain meadow consisting of Thurbers fescue, needlegrass, wheatgrass and bluegrass.

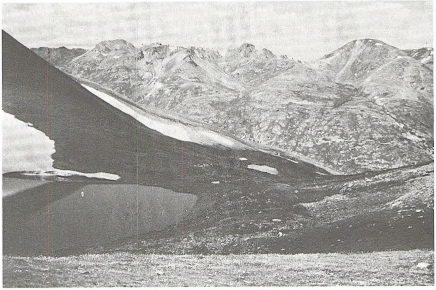


Figure R2-12. Alpine type, dominated by many species of grasses and forbs.

TABLE R2-10

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
Astragalas lutosus	
Astragalas microcymbus	
Astragalas 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.

Mammals

CARNIVORE (DOGS, CATS, BEARS, WEASELS, ETC.)

Twenty-two species of carnivore currently inhabit, or until recently inhabited, the region. The Rocky Mountain wolf, grizzly bear, and wolverine no longer inhabit this region, while the lynx 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 7 in appendix A. Mountain lions are most abundant in rough, broken country with pinyon-juniper or mountain shrub vegetation. The largest population within the region occurs in the Little Bookcliffs north of Grand Juntion. Black bear distribution can be determined from the vegetation map, map 6 in appendix A; areas above 7,000 feet in mountain shrub, 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 Antiodactyla 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 appendix A. 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 open to hunting since it was reestablished, and for the past two years this hunting has been restricted to archery only. Populations 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 7 in appendix A. 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 appendix A. 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 R2-11) 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 appendix A. 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 R2-12) 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. Established as a result of the Wild Horse and Burro Act of 1971, the area has 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 (map 7 in appendix A). 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

TABLE R2-11

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

DAU	Identifier	Rank	Mean 10-Year Kill	DAU Name and Units Involved	Post-Hunt Population a/ 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 R2-12

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

DAU	Identifier	Rank	Mean 10-Year Kill	DAU Name and Units Involved	Post-Hunt Population a/ 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.

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 these three 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 for ferrets to occur throughout the region where prairie dogs occur. (See map 9 in appendix A.)

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. A total of fifteen otters has 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 appendix A).

Birds

There are seven members of the orders Gaviiformes (loons), Podicipediformes (grebes), and Procellariiformes (tubenosea) 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 evenings and rest during the day on the less accessible portions of the main rivers. The species golden-eye and mergansers 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. Gambels 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 unit 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 occupation of the region.

Three species from the order Columbiformes are present in the unit. Two species (mourning dove and band-tailed pigeon) are classified as game birds, while the third (rock dove) is an introduced species. Mourning doves, a summer resident, 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 these birds. 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 Caprimulg iformes (goatsuckers), seven members of Aprodiformes (swifts and humming birds), 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.

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 appendix A.)

Bald eagles are quite common during the winter months along the major river bottoms (see map 9 in appendix A). 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 appendix A, and map R2-1 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 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 62 percent rainbow, 13 percent brown, 22 percent brook, and 8 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 in 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. Approxi mately 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 becomes 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 the study 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 study 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 Folsum-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.

Twelve different phases have been identified within the Uncompahgre Complex which appear to reflect specific responses and adaptations to outside influences and changing environment. These phases date from 8000 B.C. (Paleo-indian) to A.D. 1880 (end of Ute occupation). The seasonal rounds, as revealed by the material remains of these phases, appear very similar to the lifestyles of contact period Utes. The Uncompahgre Complex is thought by some authors to be the progenitor of the Ute culture (Buckles 1971). This archaic lifestyle remained comparatively unchanged until the beginning of intensive contact with Europeans.

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. Within these five categories are a number of subtypes which reveal the different cultural responses to the environment. Specific artifact types are used to differentiate among the different cultural phases and provide chronological sequences. Certain artifact categories, such as pottery and rock art, 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. (Figure R2-13 shows a 'picture rock' petroglyph; figure R2-14 shows a wickiup site.)

Although evidence of Anasazi occupation has not been found in the ES area, sites of the Fremont culture have been identified in the northern portions of the region. The Fremont group appeared about A.D. 700. These people constructed pithouse-like structures and aboveground masonry; they also grew crops, notably corn and squash, while still depending on hunting and gathering. Their lifestyle continued through A.D. 1100, when they returned to an archaic way of life. With the data available at this point, it is not known why the Fremont people abandoned horticulture.

As part of the studies conducted for this ES, Archeological Associates, Inc., is conducting a sampling inventory on 28,390 acres within the regional study area. The results of this survey will be used in an attempt to develop a model to predict location and density of archeological sites. At this time, only 49 percent of the survey has been completed. No full analysis of settlement patterns can be presented until completion of the survey; the final draft of the report is due December 15, 1978. For a preliminary report of the survey and a summary of sampling procedures, see appendix D.

Within the ES area there are 1,889 known archeological sites (19 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, 52 may be eligible for the National Register of Historic Places, based on the criteria developed by the Historic Preservation Act of 1966, as amended and 36(CFR): 800.10 (see table R2-13). These sites are considered significant because they have particular elements or characteristics that contain 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 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 R2-14 are either listed on the National Register of Historic Places or have been determined eligible for the National Register.

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 at below design capacity. (Figures R2-15 and R2-16 show views of I-70.)

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. 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 cur-

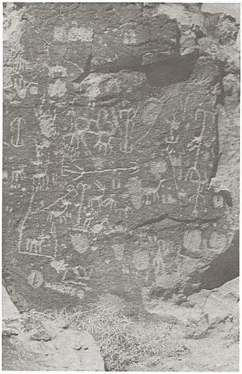


FIGURE R2-13. "Picture Rock" Petroglyph.

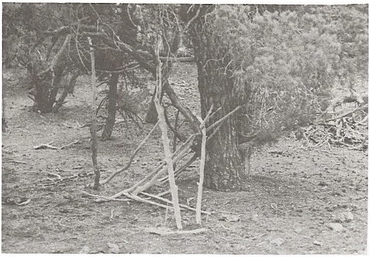


FIGURE R2-14. Wickiup site.

TABLE R2-13

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
AR-05-07-8		Lithic site
AR-05-07-9		Rockshelter
AR-05-07-14		Petroglyph
AR-05-07-16		Petroglyph
AR-05-07-20		Petroglyph
AR-05-07-81		Petroglyph
AR-05-07-84		Teepee poles
AR-05-07-85		Rockshelter
AR-05-07-100		Rockshelter/Petroglyph
AR-05-07-101		Rockshelter/Petroglyph
AR-05-07-104	Taylor site	Rockshelter
AR-05-07-109		Rockshelter
AR-05-07-114		Petroglyph/Rockshelter
AR-05-07-120		Rockshelter
AR-05-07-136		Petroglyph
AR-05-07-140		Rockshelter/Petroglyph
AR-05-07-151		Lithic site
AR-05-07-173		Rockshelter
AR-05-07-190		Handholes
AR-05-07-193		Petroglyph
AR-05-07-194		Petroglyph
AR-05-07-195		Handholes
AR-05-01-210		Petroglyph/handholes
AR-05-07-242		Petroglyph
AR-05-07-270		Pictograph/Rockshelter
AR-05-07-382		Petroglyph
AR-05-07-425		Petroglyph/Pictograph

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

TABLE R2-13

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

Site Number	Site Name	Description
AR-05-07-434		Rockshelter/handholes
AR-05-07-437		Pictograph
AR-05-07-439		Rockshelter/Petroglyph/Pictograph
AR-05-07-467		Rockshelter
AR-05-97-468		Lithic site
AR-05-07-494		Lithic site
AR-05-07-496		Rockshelter
AR-05-07-499		Lithic site
AR-05-07-538		Rockshelter
AR-05-07-568		Lithic site
AR-05-07-599		Lithic site
AR-05-07-604		Pictograph/Petroglyph
AR-05-07-624		Lithic site
AR-05-07-625		Lithic site
5 ME 377		Lithic site
5 MN 531		Lithic scatter

TABLE R2-14

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.	

rently 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.

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 but most is due to uranium and to oil and gas activity in the area, the expansion of which may increase traffic significantly.

County roads in the seven-county area provide access from main highways to a major portion of the area. The primary 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.

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 135 for 45 miles through Hotchkiss and Somerset before terminating at Oliver.

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 Ridgeway. 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.

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 6,500,000 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.

Airlines and Buses

As the major population center, Grand Junction is serviced by one major airline, United, and three feeder lines, Frontier, Aspen, and Rocky Mountain Airways. The Aspen-Glenwood Springs Area is serviced by Aspen Airways and the Montrose area by Frontier. All airlines connect with Denver, and United connects with Salt Lake City and Los Angeles as well.

Bus service is provided by Continental Trailways. It serves all areas except the North Fork Valley.

Agriculture

The ES area encompasses approximately 9,242,241 acres of federal and private land. Of this total, 32 percent is public land administered by BLM, 37 percent is national forest system land administered by the U.S. Forest Service (USFS), and the remaining 31 percent is land administered by other federal agencies, state owned land, or privately owned land. Much of the land along the major roads and drainages (where it is relatively flat) 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 R2-15 contains a summary of land ownership for the ES area.

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.

Livestock Grazing

Livestock grazing occurs on public and private lands. 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.

Table R2-16 shows the number of cattle and calves, stock sheep, and hogs and pigs within the regional ES area for each of the years 1972 to 1977. According to the figures from the 1977 agricultural census for the number of beef cattle and calves and stock sheep within the region, there are a total of 301,100 range livestock animal units within the region (one animal unit equals one cow, one cow and calf, or five sheep). Thus, the 1977 animal inventory requires 3,613,200 animal unit months (AUMs) of forage each year (one AUM is the amount of forage required to sustain one animal unit for one month). Most of the forage needed to

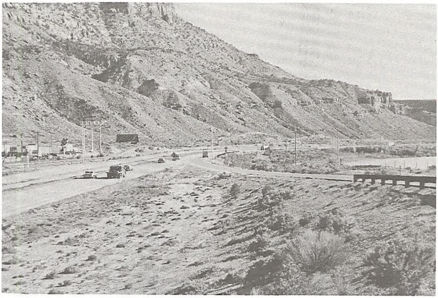


Figure R2-15

I-70 by Cameo is functioning below design capacity.

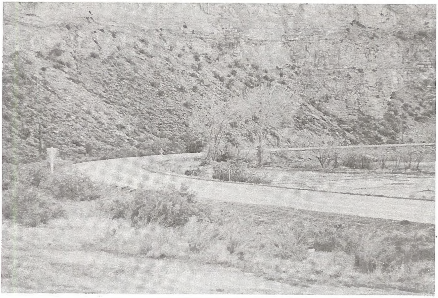


Figure R2-16

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

meet the above yearly AUM requirement comes from private land, and that provided by public land is minimal in comparison. All of the USFS and BLM administered land within the region provides 535,221 AUMs annually (for 5,389,916 acres of land). This is only about 15 percent of the AUMs required each year within the region.

Farming

Although commercial farming is not the traditional land use of most of the area, it is the most important industry in the ES area, contributing a greater amount of income than livestock production. In 1975 it accounted for $56,785,440 in income. Table R2-17 shows acreage and cash values of cultivated crops grown in the ES area. Although hay is the main crop grown by acreage and cash value, much of the value of hay is noncash, and it is used for livestock feed within the region. Fruit, barley, corn, and sugar beets are important cash crops within the region, although sugar beets have declined since the 1975 figures due to the closing of the Holly Sugar Refinery in Delta. Fruit production is a significant part of the agricultural income, particularly in Delta, Mesa, and Montrose counties, but it is subject to large yearly fluctuations in 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.

Recreation

The study region 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 National Park Service (NPS), the U.S. Forest Service (USFS), and the Bureau of Land Management (BLM). The private sector and the municipal, county, and state governments provide additional site-specific recreational opportunities and programs. (Map 15 shows recreational resources and map 16 shows recreational facilities; both maps can be found in appendix A.)

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 Tops Wilderness (102,124 acres) which is about 80 percent within the ES region. 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 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.

The BLM also has several areas offering wilderness-primitive values, such as the Powderhorn Primitive Area in Gunnison County. Management framework plans for the region have identified eight roadless areas of over 5,000 acres each, which will be studied for wilderness status.

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.

TABLE R2-15

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.

TABLE R2-16

LIVESTOCK NUMBERS WITHIN THE REGIONAL ES AREA -- 1972 TO 1977

	1972	1973	1974	1975	1976	1977
Cattle and Calves	277,800	283,700	304,000	287,400	265,000	267,500
Stock Sheep	187,500	183,300	175,500	175,400	171,000	168,100
Hogs and Pigs	16,800	13,500	21,600	21,050	19,000	Not available

TABLE R2-17

PRINCIPAL CROP ACREAGE AND CASH VALUE (1975)

Crop	Acres Planted	Dollar Value
Winter Wheat	6,100	805,200
Spring Wheat	2,700	260,000
Corn for Grain	29,100	3,883,800
Corn for Silage	14,800	4,602,300
Barley	21,000	4,060,700
Dry Beans	16,800	1,643,000
Sugar Beets	10,400	4,411,100
Oats	6,000	569,700
Hay	105,100	18,130,200
Other Crops a/	11,255 b/	13,993,050 c/
Total	223,255	52,359,050

a/ Includes rye, vegetables, and fruit.

b/ 1974 fruit acreage only; rye and vegetable acreage not available.

c/ Of this figure, approximately 7,616,000 is attributed to fruit.

Recreation Developments and Visitor Use

NATIONAL PARK SERVICE (NPS)

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 R2-18 summarizes visitor use.

U.S. FOREST SERVICE (USFS)

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 R2-19 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 (BLM)

The BLM provides land and developments for a variety of recreational activities in this 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 R2-20 provides a breakdown of visitor use.

COLORADO DIVISION OF WILDLIFE (DOW)

The DOW maintains nine wildlife areas, in the study region, with a total acreage of 23,640. 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, 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 study region: (1) Hanging Lake, 8.0 miles east of Glenwood Springs on I-70; (2) French Creek, 10.0 miles east of Glenwood Springs on I-70; (3) Glenwood Springs, 1.4 miles west of Glenwood Springs on I-70; (4) Delta-Antelope, 17.0 miles west of Delta on U.S. 50; (5) Rifle, at the junction of I-70 and Colorado 13.

MUNICIPAL-COUNTY FACILITIES

The facilities most often provided by municipal-county government 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., Grand Junction must presently turn people away from its leagues. Many communities use school facilities during off-hours for their recreation programs. See table R2-21 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- 22.)

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 228,114 recreation days in 1975. Residents of the state accounted for 97 percent of the small game licenses sold.

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 R2-23 summarizes small game hunting statistics, and table R2-24 summarizes small game trapping statistics; both are broken down by SGMUs. The locations of SGMUs can be found on map 12 in appendix A. (This information has been summarized from DOW, 1975 Colorado Small Game, Furbearer, Varmint Harvest, Colorado.)

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 appendix A. Table R2-25 provides information on hunter numbers and recreation days, broken down by GMU and game type. (DOW, 1976 Colorado Big Game Harvest).

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 R2-26. 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, Fisheries Questionnaire).

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 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 R2-27 indicates the demand for 21 types of recreation.

Subsequent to this 1974 SCORP report, the DOP got together 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 14,441 square miles of the ES area contain a wide variety of landscape types, each of which displays unique visual attributes. The landscapes of

TABLE R2-18

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 R2-19

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 R2-20

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.

TABLE R2-21

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 R2-21

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 R2-22

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 R2-23

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 R2-23

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 R2-24

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. Oays	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. Oays	-	-	-	310	189	-	120	-	619
Coyote									
Trappers	11	25	7	21	9	16	34	25	148
Rec. Oays	320	732	469	2,086	375	530	2,195	886	7,593
Fox									
Trappers	2	5	2	29	-	11	21	7	77
Rec. Oays	158	314	25	1,235	-	707	1,134	112	3,685
Marten									
Trappers	-	2	-	-	-	-	2	2	6
Rec. Oays	-	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. Oays	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. Oays	852	388	128	509	203	167	1,739	180	4,166
Skunk									
Trappers	5	7	2	7	7	7	15	15	55
Rec. Oays	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. Oays	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 Oivision of Wildlife.

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

* All or part of a day.

TABLE R2-25

COLORAOO 1976 BIG GAME HARVEST
FROM: 1976 COLORADO BIG GAME HARVEST, COLORADO O1VISION OF WILOLIFE

Unit	Deer		Elk		Bear		Mountain Lion		Total Recreation a/ Oays
	Hunters	Recreation a/ Oays	Hunters	Recreation a/ Days	Hunters	Recreation a/ Oays	Hunters	Recreation a/ Oays	
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 R2-26

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

TABLE R2-27

RECREATION PARTICIPATION IN REGIONS 10, 11, ANO 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
Oownhill 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 Oivision of Parks and Outdoor Recreation, 1976 Colorado Comprehensive Outdoor Recreation Plan.

a/ All or part of a day.

the ES area can be grouped into three major types: river valleys, plateaus, and mountain ranges (see figure 2 in appendix A for an aerial view of these landscapes 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 appendix F). 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 that 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.

Landscape 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 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 an angular grid of trees, fields, ditches, and fence lines along 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-junipers and then the mountain brushes and firs and spruces of the wetter, higher elevations, with strong edge lines between the different types of vegetation on the eastern slopes.

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 rainfall to allow 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 lower levels of cultural modification of the natural environment also adds to the local quality of life, which is primarily rural and low key; urban developments are modest in scale and widely separated, which supports the nautral character of the regional landscapes.

Socioeconomic Conditions

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 R2-28 lists the population of each county, town, and county census area; table R2-29 provides other population figures for the ES area. Map 17 in appendix A outlines the county census areas for which population census information is available. Figure R2-17 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, natural 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 R2-28 and R2-29 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 R2-30.

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 asset. 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 study area. Most of these have been 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, and Coddington 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 included in the appendix.) 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.

TABLE R2-28

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 R2-28

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 R2-28

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 R2-29

POPULATION STATISTICS FOR THE ES AREA

Area	Population Density (persons per square mile) 1970 a/	Population Density 1975 b/	Median Age 1970 a/	Median Age 1977 c/	Births and Deaths (1970-1976) d/ Births	Deaths	Net Change	Net In-Migration (1970-1976) d/ Total Persons	Percent of Total Population	Median School Years Completed (1970)
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).

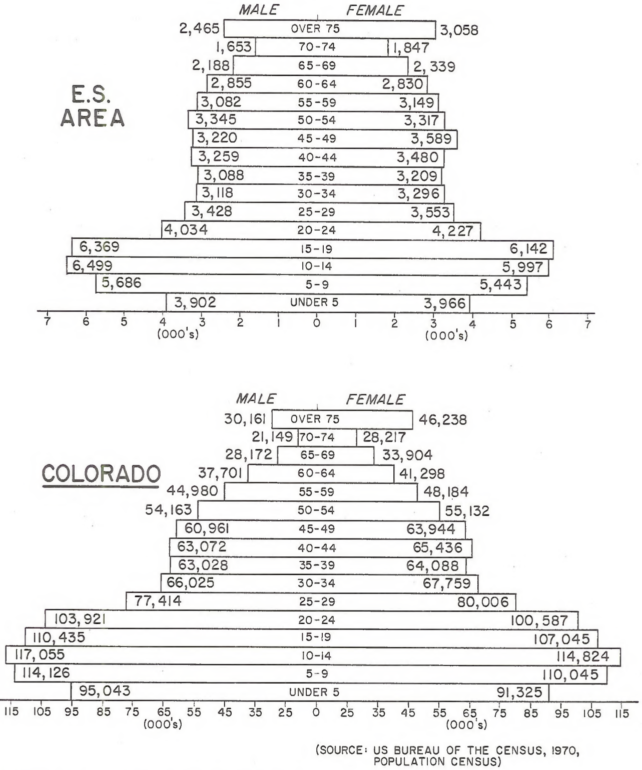


Figure R2-17. Population by age group in Colorado and the ES area

TABLE R2-30

REGIONAL MARRIAGE AND DISSOLUTION RATES (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.

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 study 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 study region is that found in much of the 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.

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 R2-18). 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

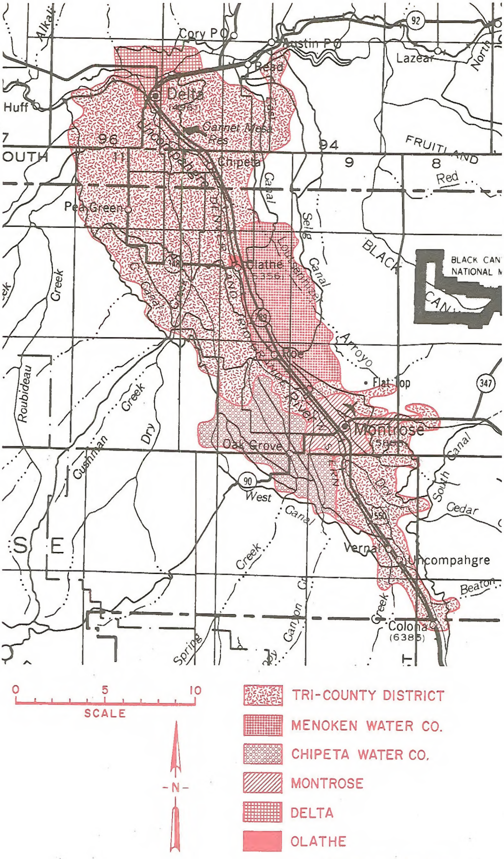


Figure R2-18. Project 7 service area

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 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 its 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, 20 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 supports 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 somewhat depends 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 cubic feet per second (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 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 and one part-time police officer. 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 study 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 R2-31 and R2-32 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 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 R2-33 shows the increases in reported crimes throughout the study 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 R2-34), the rate of increase in total housing units in the study 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 study 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 R2-34). 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 R2-35 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 appendix A). 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 R2-36). 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 R2-37 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 R2-37, the Garfield District is spending about 20 percent of its local revenues to retire existing debt, the most of any district in the ES area. (Figures R2-19 and R2-20 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 R2-38.) 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 accomodate 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 study 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 R2-39). 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 R2-40 lists those communities which have volunteer ambulance service and the main hospital to which service is provided. Figures R2-21 and R2-22 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 study 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 R2-41 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 be aggregated to regional totals because of data withheld under the Employment Security Act; the act restricts information where there is only one or two firms of an industry in a county. Table R2-42 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 arn, 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 R2-43 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 R2-44 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 nation incomes. However, table R2-44 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 R2-45 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 R2-46, 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 R2-47 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

The following section describes the possible future environment by 1990 if the actions proposed in chapter 1 are not implemented. Only the resources or land uses described in the preceding sections of chapter 2 which are expected to change in the future are discussed: air quality, mineral resources, water resources, soils, vegetation, wildlife, aquatic biology, archeological and historic resources, transportation, agriculture, recreation, and socioeconomic conditions.

Air Quality

Maximum future ambient levels of TSP, SO_2, and NO_2 would result from contributions from the rural baseline and from emissions from towns and highways. Highest pollutant levels would be centered about the major towns in the study region (Fruita, Grand Junction, Delta, and Montrose); however, concentrations would drop almost to rural baseline levels within 5 to 15 miles from the towns.

Increases in pollutant levels around towns in the ES area would indirectly result from population growth throughout the study years. Activities such as local vehicular traffic, residential and commercial space heating, building construction, and other municipal development, would be the primary sources of pollutant emissions from the towns.

TABLE R2-31

COUNTY REVENUE CAPABILITIES

County	County Assessed Valuation	County Mill Levy	Total Average County Levy	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 R2-32

MUNICIPAL REVENUE CAPABILITIES

	Municipal Assessed Valuation (dollars)	Municipal Mill Levy	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	None	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.

TABLE R2-33

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 R2-34

AREA HOUSING STOCK BY COUNTY

County	Estimated Year-Round Housing Inventory (1970) Total Conventional Units	Estimated Year-Round Housing Inventory (1970) Mobile Homes	Estimated Year-Round Housing Inventory (1976) Total Conventional Units	Estimated Year-Round Housing Inventory (1976) Mobile Homes	Net Additions a/ Total Conventional Units	Net Additions a/ 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 R2-35

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 R2-36

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	

TABLE R2-37

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.

TABLE R2-38

SCHOOL DISTRICT FACILITIES

District	Number of Schools		Percent of Design Capacity Now in Use
50(J) Delta County	7 2 2 2	Elementary Jr. High Jr./Sr. High 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 3 3	Elementary Jr. High Sr. High	80 percent.
RE-2 Garfield	3 2 1	Elementary Jr. High 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 1 1	Elementary Jr. High Sr. High	Decreasing enrollment
49(JT) DeBeque	1 1	Elementary Jr./Sr. High	85 percent -- Both buildings are 16 years old.
50 Plateau Valley	1 1 1	Elementary Jr. High Sr. High	80 to 90 percent -- Buildings are 19 years old and in good condition.
51 Mesa County Valley	24 6 4	Elementary Jr. High Sr. High	80 to 85 percent.
RE-1(J) Montrose	11 3 2	Elementary Jr. High Sr. High	Elementary and Sr. High near capacity, additional capacity in Jr. High.
RE-2 West End	3 1 1	Elementary Jr. High Sr. High	80 to 85 percent.

TABLE R2-38 -- Continued

R-1 Ouray	1 1	Elementary Jr./Sr. High	Decreasing enrollment; 1976 enrollment 87 percent of 1966.
R-2 Ridgway	1 1	Elementary Jr./Sr. High	Increasing enrollments.
1 Aspen	1 1 1	Elementary Jr. High Sr. High	Increasing enrollments.

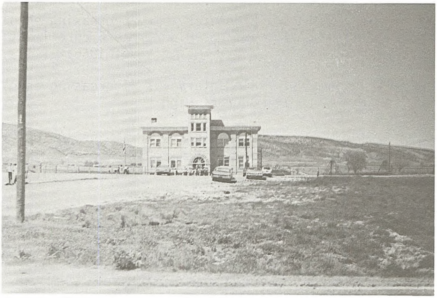


Figure R2-19

Figure R2-20

Loma School and Grand Junction High School: school facilities in the region vary considerably in age and capacity.

Figure R2-21

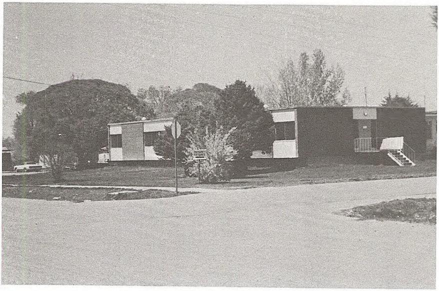


Figure R2-22

St. Mary's Hospital and Fruita Hospital: health care facilities vary considerably within the region.

TABLE R2-39

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 R2-40

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

TABLE R2-41

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

TABLE R2-42

EMPLOYMENT BY MAJOR DIVISION (JUNE 1970, 1975, and 1977)

Sector	Delta			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 Division of Employment, Research and Analysis Section, UI Reports.

Note: Self-employed, other than in agriculture, unpaid family workers, and domestics are not included.

* Confidential data as defined by the Employment Security Act.

TABLE R2-43

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

TABLE R2-44

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 R2-45

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 R2-46

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 R2-47

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.

Increased vehicular traffic due to all regional population growth would result in increased pollutant concentrations very near highways in the region. However, the portion of this increase resulting from coal development at existing mines would be insignificant.

Railroads serving future development at existing coal mines will produce increased pollutant emissions. However, 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.

Pollutant emissions would increase as a result of increased oil-shale development in the ES area. However, pollutant concentrations are predicted to be relatively low and localized in comparison with the impacts resulting from growth in the major towns of the region.

Ambient TSP levels in the vicinity of existing mines should not significantly increase above existing levels. Small, localized elevations of TSP levels above the rural baseline would occur around existing mines. Emissions from the mines should have no significant impact on the air quality of major towns in the ES region.

Existing and future uranium development would be confined to the Uravan mineral basin. Emissions from these mines would have no noticeable impact on portions of the ES area expected to experience coal and coal-related developments because of the great separation distance between the coal mining areas and uranium mining areas. The detailed analysis of the future air quality is presented in no action alternative/low-level scenario of chapter 8.

Mineral Resources

It is estimated that without the proposed action, approximately 4.73 million tons of coal per year would be produced from nineteen mines in the ES region by 1990.

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 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.

It is estimated that there will be 4 oil shale mines, 4 oil shale processing plants, 440 oil and gas wells, 2 limestone-gypsum mines, 3 limestone-gypsum processing plants, 7 hardrock mineral mines, and 1 hardrock mill in operation through 1990 in the ES area.

Water Resources

The water demand in 1990 without the proposed action is estimated to be approximately 2,853,713 acre-feet. Historically, any increase in water use is accompanied by a general decrease in water quality. Based on this trend, the overall quality of the Colorado River at the Colorado-Utah state line will decline each year as the regional population increases even without the proposed action. The Environmental Protection Agency, Water Resource Council, and Bureau of Reclamation estimate that without any corrective action to improve the water quality of the Colorado River, salinity will increase approximately 4 percent by the year 2010 (Bureau of Land Management 1978). All water quality parameters should increase in about the same proportions, 2 to 5 percent.

Soils

Without the proposed action, 32,500 acres will be disturbed by 1990, while only 265 acres will be reclaimed. Of the total acreage disturbed, 1,433 acres would be due to mine site development, 3,900 acres due to uranium mine and mill development, 1,320 acres due to oil and gas development, 4,500 acres due to oil shale development, 9,353 acres due to community expansion, and 12,000 due to road, power line, pipeline, and telephone line construction.

Vegetation

There would be a considerable amount of vegetative disturbance in the region due to development unrelated to the proposed action. Approximately 32,500 acres would be disturbed by 1990 primarily due to oil shale development and associated community expansion in Mesa and Garfield counties. Of this acreage, only 265 acres (at existing coal mines) would be reclaimed. The adverse impacts on the vegetative resource that are expected from population expansion associated with the proposed action (disturbance of vegetation from increased off-road vehicle use; increased exploitation of endangered and threatened plants; increased firewood cutting) would also result from non-coal-related population growth and would be much more severe than those caused by coal-related growth.

Wildlife

In the ES area, there are approximately 9 million acres of land. About 38.5 percent (3,465,000 acres) are partly available to wildlife species. There are about 2,942,800 acres of deer winter range, of which about 401,720 acres are considered to be crucial, and about 3,314,550 acres of elk range. (There is some overlap in deer and elk areas which accounts for the apparent discrepancy in addition of these figures.) With these figures as a basis, the following assumptions are made. All developments planned or proposed will be implemented by 1990; impacts as discussed will be those that are unmitigated by regulation, lease stipulation, or by project design.

In addition to 23,153 acres of disturbance due to energy developments, roads, power lines, etc., projects of the U.S. Bureau of Reclamation (USBR) Colorado River Basin Salinity Control Project will take or have taken 22,275 acres of wildlife habitat in the Curecanti Unit, the Paonia Project, the Smith Fork Project, the Bostwick Park Project, the Grand Valley Unit, the Paradox Valley Unit, and the Dallas Creek Project (Western Colorado Projects Office, 1977).

The Grand Mesa, Dominguez, and West Divide water storage projects (for irrigation and/or power) will also remove some wildlife habitat from production after implementation. The 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, if not on the impacted herd unit or species, then on some adjacent area of equal importance. 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 affect future wildlife population. The impacts of grazing and the various revegetation projects associated with grazing are analyzed in the final environmental statement on the Uncompahgre Basin Resource Area's proposed grazing system (U.S. Department of the Interior, BLM 1978) and the environmental statement currently being drafted by the Grand Junction District (no publication date set). In general, wildlife populations should benefit from implementation of grazing systems and revegetation projects if they are implemented properly.

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. A case in point would be the Roan Creek deer herd. A comparison of environmental statements and assessments put out by the oil shale operators indicated that some displacement of deer will occur from the Piceance Basin and the Parachute Creek areas. These deer will be forced into the Roan Creek drainage where another oil shale development is located. If this in fact does take place, the habitat in Roan Creek will become severely over-utilized, and the BLM management goal for this area as stated in the Roan Creek habitat management plan will be accomplished only through heavy harvest of this deer herd; increased competition will occur and some density dependent limiting factors could begin to occur, causing winter die-offs and a lack of reproduction in the herd.

This impact by the oil shale development in and adjacent to the ES region is one of the most significant impacts on wildlife species; the other is population expansion in the region and associated impacts from this expansion. The population increase from development in the region would be 274,850 people by 1990. The residential and commercial facilities needed for this growth would require 7,353 acres of land. This increase in acres needed would undoubtedly cause the conversion of some crucial wildlife areas to housing in the region because more people would want their own 'mini-ranch' of one to five acres, and available acres outside of wintering areas are limited. Local planning and zoning would be a major deterent to residential growth in outlying areas. The loss of crucial wildlife wintering areas is unquantifiable at this time.

Increased populations 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 recreational use of wildlife. 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 by 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 (Whitaker 1978).

It is speculative on just how much harassment, intrusion on their habitat, and loss of habitat certain species of animals can tolerate. As more and more people and/or development takes place, less and less habitat will be available for the larger, more visible species, such as elk, deer, bear, antelope, and endangered species, such as peregrine falcon and black-footed ferret. As the areas available shrink, the wildlife populations can do little else but shrink with them, 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 available food supplies and the action of density dependent limiting factors that require overcrowding to come into effect. A paradox becomes evident at this point: more and more people are going to demand more and more recreational use of wildlife (either consumptive e.g., hunting, or nonconsumptive, e.g., photography); these people will only be satisfied by more animals to see, which must be produced by herds living in fewer and poorer quality habitats. It is impossible to produce more healthy animals in poor habitats except in artificial situations.

While some animals are adaptive enough to survive almost anything, e.g., the coyote, endangered species are endangered due to their lack of this adaptive quality. They developed in one particular type of habitat or ecological niche, and that is the only place they can survive. Some of these niches will be impacted by the development throughout the ES region. It is difficult to quantify just how much habitat will be lost, primarily because of the lack of information on the presence or absence of the species. Areas where endangered species habitat is available need to be carefully studied over a long period of time to make this determination, and development in or adjacent to these areas must be carefully designed to minimize impacts on the habitats and/or the species involved. This development will decrease the long-term productivity of most wildlife species because of the reduction in the amount of habitat available and the increased harassment and illegal killing that will take place.

Aquatic Biology

Aquatic habitats in the regions will remain closer to their present condition through 1990. Lower population growth (105,420 by 1990), 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, which will slightly decrease the possibility of dewatering streams. Less sediment will be available to degrade trout streams. Tailing pond spills or leaks should constitute less of a hazard to fisheries in the region.

Cultural Resources

Archeological Resources

Through the year 1990, vandalism and weathering would be the two major factors causing the loss of archeological 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. The decrease in archeological resources is expected to continue or accelerate under the present land use management program.

Historic Resources

All historic sites would be subject to natural forces and would continue to be vandalized at the present rate. By 1990, certain delicate sites could be expected to be lost, while some sites (such as Ashcroft, Colorado, townsite) would remain in good condition due to patrols and ongoing restoration work.

Transportation

The following transportation and utilites developments are anticipated regardless of whether the proposed future federal actions are approved.

Highways

Even without the proposed action 2,000 miles of new roads will be developed and many of the highways in the region will still need to be upgraded and improved because of developments in coal mining, oil and gas exploration, oil shale, and uranium. The section of I-70 between 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. The environmental impact statement on the project states, 'The construction of this highway will be accomplished as the funds become available and on a basis of need and urgency. It is quite possible that the eastern third of the project will rate top priority and construction could begin as early as 1978, whereas the western third where improvement is not as critical may not be constructed for some time. U.S. Highway 50 will continue to be widened to accommodate increased local and through traffic. Smaller state, county, and private roads will also continue to be upgraded to meet needs. (Table R2-48 shows projected increases in traffic volumes without the proposed federal action. Significant increases in traffic are expected.)

Railroads

The existing railroads are adequate to handle the increased demands caused by population growth without the proposed federal action.

Airlines and Buses

Air and bus service to the area will increase with the population. Some improvement of facilities will be necessary to accommodate the greater traffic even without the proposed action.

Agriculture

Livestock

The number of beef cattle and calves is expected to remain constant in the region, with minor fluctu-

TABLE R2-48

INCREASES IN TRAFFIC VOLUMES WITHOUT THE PROPOSED FEDERAL ACTIONS AT SELECTED POINTS IN THE STUDY REGION

Location		1976 a/	1980	1985	1990
I-70	E/O Grand Valley	4,700	6,290	7,910	8,310
I-70	Rifle	3,500	4,690	5,890	6,190
I-70	W/O Glenwood Springs	6,450	8,640	10,860	11,400
I-70	E/O Glenwood Springs	5,350	7,160	9,000	9,460
US-50	N/O Delta	8,150	10,910	13,720	14,410
US-50	S/O Delta	4,900	6,560	8,250	8,660
US-50	N/O Montrose	9,550	12,790	16,070	16,880
US-50	E/O Montrose	3,600	4,820	6,060	6,360
US-550	S/O Montrose	4,950	6,630	8,330	8,750
US-550	S/O Ridgway	1,750	2,340	2,950	3,090
US-550	N/O Ridgway	2,100	2,810	3,530	3,710
SH-139	Douglas Pass	450	610	720	720
SH-139	N/O Mesa-Garfield County Line	500	670	800	790
SH-325	S/O Jct. with SH-789	1,850	3,490	4,290	4,660
SH-325	N/O Jct. with SH-789	600	1,130	1,390	1,510
SH-789	W/O Jct. with SH-325	1,300	2,450	3,020	3,280
SH-82	S/O Glenwood Springs	7,850	14,800	18,220	19,780
SH-82	W/O Jct. with SH-133	5,900	11,120	13,690	14,870
SH-82	E/O Jct. with SH-133	4,250	8,010	9,860	10,710
SH-133	N/O Carbondale	3,250	6,130	7,540	8,190
SH-133	S/O Carbondale	2,250	4,240	5,220	5,670
SH-133	E/O McClure Pass	200	240	280	330
SH-133	W/O McClure Pass	730	860	1,020	1,200
SH-133	E/O Somerset	550	650	770	900
SH-133	W/O Somerset	900	1,060	1,260	1,480
SH-133	E/O Jct. with SH-187	1,500	1,770	2,100	2,460
SH-133	W/O Jct. with SH-187	1,800	2,130	2,520	2,960
SH-133	E/O Hotchkiss	1,800	2,130	2,520	2,960
SH-62	E/O Ridgway	1,450	1,540	1,690	1,960
SH-62	W/O Ridgway	1,050	1,120	1,230	1,420
SH-92	E/O Delta	5,950	7,030	8,320	9,770
SH-92	W/O Jct. with SH-65	4,800	5,670	6,720	7,880
SH-92	E/O Jct. with SH-65	2,250	2,660	3,150	3,690
SH-92	W/O Hotchkiss	2,600	3,070	3,640	4,270
SH-65	N/O Jct. with SH-92	2,750	3,250	3,850	4,520

Note: SH = State Highway; N/O = North of; S/O = South of; E/O = East of; W/O = West of.

a/ Source of 1976 data is the Colorado Department of Highways.

ations, as has been the pattern since 1971. The number of hogs and pigs in the region is expected to remain at approximately 19,000, although yearly fluctuations will occur (sometimes rather large, as in 1973 and 1974). The number of sheep in the region is expected to show the continued decline that has been evident since before 1972. Since 1972, the total number of sheep in the region has declined an average of 2.15 percent a year.

With the final approval of the Uncompahgre Basin grazing ES (U.S. Department of the Interior, BLM 1978) and Grand Junction grazing ES (final draft scheduled for publication) 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.

Surface disturbance of 32,506 acres are projected by 1990 without the proposed action. Consequently, a loss of livestock forage would result from the disturbance of rangeland, and a loss of both livestock forage and livestock wintering areas would occur as a result of the disturbance of irrigated and nonirrigated haylands and pasture due to urban expansion associated with population growth.

Farming

The population increase projected in the ES area regardless of the proposed action (an increase of 105,410 people by 1990) would adversely affect the farming industry, since it is probable that much of the 9,353 acres of disturbance from community expansion associated with population growth would be on prime farmland around existing population centers, although exact locations of the disturbance cannot be predicted. For every acre that is disturbed, approximately $234 cash value of crops would be annually lost. The exact value will vary with the type of crop and the productivity of the soil.

The farming industry may be adversely affected by the disturbance of 23,153 acres in the ES area without the proposed action by 1990, from such activities as oil shale mines and refineries, uranium mines and mills, oil and gas exploration and drilling, road construction, and railroad construction. Again, although exact locations for the disturbance cannot be predicted, it is likely that some of the disturbance would be on prime farmland.

Recreation

The 1976 Statewide Comprehensive Outdoor Recreation Plan (SCORP) projected recreation participation in the state planning regions through 1990. This information is presented in table R2-49. 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 Region 12.

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 (NPS) has completed an environmental statement on the proposed designation of 11,180 acres of the Black Canyon of the Gunnison National Monument as wilderness (basically the area within the rim of the canyon). The NPS has indicated that they intend to upgrade the visitor center and sanitary facilities 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 also 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.

Socioeconomic Conditions

Even without the proposed action, parts of the ES area are expected to experience rapid population growth over the next ten years. By 1990, the regional population is estimated to be 257,550 people, and community expansion would require 8,885 acres of much of this growth is based upon the scheduled development of the area's oil shale, molybdenum, and uranium resources. 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.

Income in the region would be higher than at present but not rise to the same level as under the proposed action. The disparity between miners' income and that of other groups in the conomy will still exist but would not be as pronounced because of fewer miners. Fewer jobs in a basic industry will reduce jobs in the service sector and reduce opportunties for economic growth in the area.

Without the proposed action, social problems that accompany rapid population growth will be apparent but less pronounced. Conflicts between various groups in the community will still be a problem but of a smaller magnitude. Other social problems such as alcholism, crime, drug abuse will not be as serious.

TABLE R2-49

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.

TABLE R2-26

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

Chapter 3

PLANNING AND ENVIRONMENTAL CONTROLS

This chapter discusses the 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) a discussion of principal planning and environmental legislation, regulations, and policy which control federal, state, and local government actions on coal development; (2) a discussion of land use plans and other environmental controls and constraints; and (3) a summary discussion of institutional relationships.

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 under the initial 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.

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 Colorado Air Pollution Control Commission of the 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.

The mining operations under proposed federal actions would be required to obtain permits from the EPA based on PSD regulations and from the state based on Colorado Air Pollution Control Commission Regulation No. 1. Under the PSD regulations, the proposed mining operations would be subject to a two-tiered analysis to determine the impact of total suspended particulate emissions on air quality. First, the proposed actions would be required to employ best available control technology (BACT) for the prevention of total suspended particulate emissions. For the proposed actions, BACT may include measures such as paving access roads to reduce the generation of fugitive dust. Under the recently promulgated PSD regulations, fugitive dust emissions controlled at the BACT level would be excluded from the more detailed second-tier analysis. Each proposed federal action would be subject to the second-tiered air quality impact analysis (including increments, air quality standards, soils, vegetation, visibility, and monitoring) only if nonfugitive dust particulate emissions exceed 50 tons per year. The Colorado Air Pollution Control Commission Regulation No. 1, Section II.D.6, would require the proposed mines to employ dust preventive measures to all mining procedures including construction activities.

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.

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 Preservations Act of 1966 (80 Stat. 915; 16 USC 470)

National Environmental Policy Act of 1969 (33 Stat. 852; 42 USC 4321 et seq.)

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)

Both federal and state antiquities acts regulate antiquities excavation and collections, protect cultural values on public lands, and provide for fines and/or imprisonment for violators. The Historic Preservation Act, according to procedures outlined in 36(CFR): 800, requires that certain federal actions be submitted for review to the National Advisory Council on Historic Preservation prior to approval. 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 until the BLM has coordinated professional surveys of cultural resources (including archeological, architectural, and historical remains) with the Colorado State Historic Preservation Officer and the National Advisory Council and received their written review and comments. Approvals will require that the USGS Area Mining Supervisor be notified, prior to distrubance, of all archeological sites discovered during mining and that the ap proriate officer of the surface management agency be notified, prior to disturbance, of sites discovered during right-of-way construction.

PALEONTOLOGICAL RESOURCES

The BLM and USGS are currently developing a memorandum of undestanding 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 IMPOUNDMENT

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 State Highway Department are concerned with railroad construction and abandonment especially where crossings of public roads by a railroad are necessary.

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.

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.

ENDANGERED SPECIES

The Endangered 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 consul tation 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

Table R3-2 lists federal and state permit requirements. Table R3-3 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 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 coordinated land use allocations for all resources and 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 accu-

TABLE R3-2

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
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

TABLE R3-3

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

mulated. 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 R3-4 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 mandate, 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

TABLE R3-4

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.

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.

U.S. Forest Service Planning

The USFS has primary surface management responsibility on national forest system lands and provides recommendations 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 multiple-use 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.

State and Local Controls Land Use Plans

A number of state of Colorado agencies have development and adminis trative 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.

Local county governments have been authorized and instructed by the Colorado general assembly 'to plan for and regulate the use of land within their respective jurisdictions' (chapter 106, Colorado Revised Statutes, as amended). Five of the seven counties in the ES area have adopted formal zoning regulations: Pitkin, Garfield, Mesa, Montrose, and Ouray counties. Gunnison County has a land use resolution that it uses to regulate industrial activity. Only Delta County has adopted no zoning or other regulatory control.

Local comprehensive land use planning is in its initial stage in the ES area, with only Garfield and Mesa counties having adopted comprehensive land use plans. However, recent legislation should provide the resources necessary for the counties to proceed with their planning efforts.

Colorado House Bills 1034 and 1041 give counties and municipalities authority and funding to develop plans for all lands within their boundaries. A principal feature involves authority to designate 'areas and/or activities of state interest,' so that they may be maintained or protected to preserve specific values. Inventory and planning efforts are currently under way. 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

House Bill 1041 places primary responsibility for designation of areas and activities of state interest at the local level of government. Section 407 grants temporary emergency power to the state, exercised by the State Land Use Commission, for designation of interest areas and administration of the provisions of House Bill 1041 in extreme cases where local government has clearly abdicated its responsibility. Permits to develop in areas of state interest or to undertake activities of state interest must be obtained from the local county governments.

Senate Bill 35 gives counties the authority to approve or reject subdivision proposals. As a result, all subdivision plans must be submitted for review by designated agencies and affected municipalities. Considering the recommendations of the reviewers and the proposal by the developer, county commissioners approve or reject the applications. Modifications may be requested prior to approval.

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 of 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.

Institutional Relationships

In the ES area a large number of separate jurisdictional entities exercise certain types of land and resource use controls. 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. 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 Colorado 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.

In summary, all of the respective jurisdictions (federal, state, and county) have sufficient authority to impose effective land and resource use controls.

CHAPTER 4

ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

Impacts are analyzed at two levels in this chapter: (1) cumulative 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 coal actions which will occur regardless of federal actions and non-coal-related activities (oil and gas development, uranium development, etc.) 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) for analysis of environmental impacts. Four of the M&R plans included in this environmental statement (ES) were submitted for review before promulgation and two after promulgation of the initial 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 initial regulations. However, in this statement the initial regulations are considered as required federal mitigating measures the same as all other applicable regulations.

The M&R plans will be returned to the operators for revision in accordance with the applicable initial regulations. As soon as the applicants' plans are revised and returned to the USGS, they will be evaluated with the Office of Surface Mining (OSM) to determine compliance with the requirements of federal regulations 30(CFR): 211 and 30(CFR): 700. The M&R plans cannot be approved until they conform to 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 study 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, SO_2, and NO_2 concentrations, which are a consequence of the proposed actions alone, are examined for the study 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 major contributors of particulate emissions in the study region. The location of the mines (underground and surface) modeled in this study are shown in maps R4-A and R4-B. 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 mining and reclamation (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 proposed coal mines for 1980, 1985, and 1990 are shown in tables R4-A, R4-B, and R4-C.

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 Interior 1976).

Major towns in the study region are anticipated to have a significant effect on the regional air quality for total suspended particulates (TSP), sulfur dioxide (SO_2), and nitrogen dioxide (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-D and R4-E.

Traffic on major highways within the study 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-F, were predicted for each study year. Major highway segments examined in the analysis are depicted on map R4-C.

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-A. Emissions from these sources are summarized in table R4-G.

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 region. 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 study area containing the proposed actions.

Oil shale Tracts C-a and C-b 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.

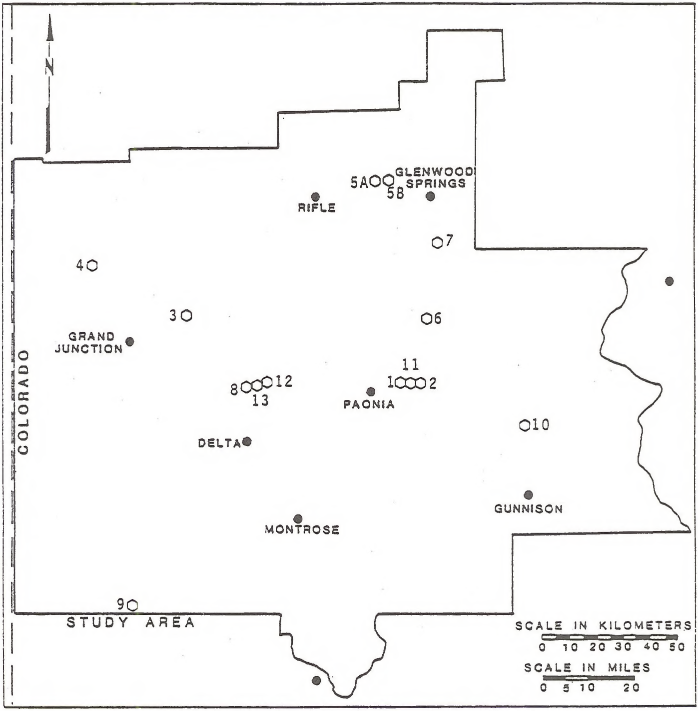
Railroads serve existing coal mines in west-central Colorado primarily transporting coal to eastern Colorado and beyond. The number of unit trains is expected to increase by 1980, 1985, and 1990 in order to move coal from the mines of the proposed actions to the expected markets. Construction of railroad 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 was 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 sulfur dioxide (SO_2). All nitrogen oxides (NO_x) emitted to the atmosphere were assumed to be converted to nitrogen dioxide (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



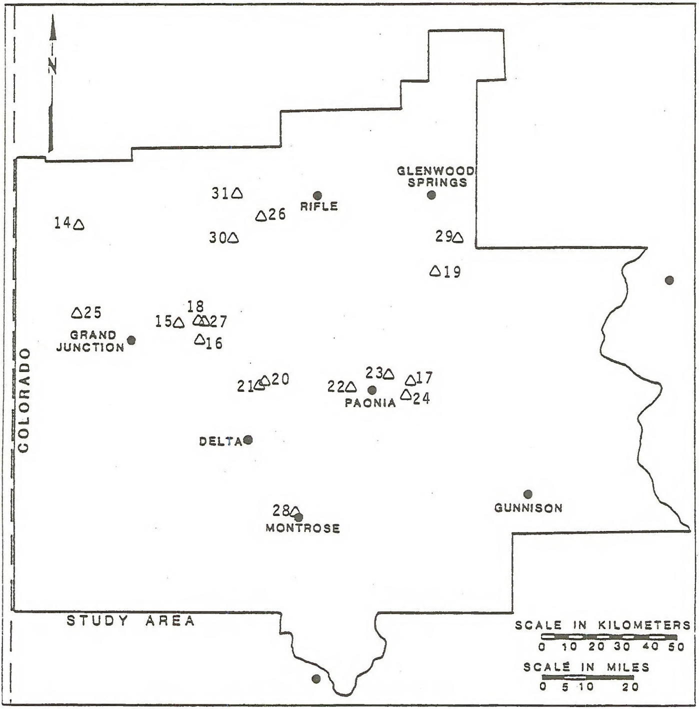
02-2903-1

LEGEND

EXISTING

1 SOMERSET
2 HAWKSNEST EAST & NO. 3
3 ROADSIDE
4 BOOKCLIFFS FARMERS
5A EASTSIDE
5B NU GAP NO. 3
6 COAL BASIN
7 SUNLIGHT
8 FAIRVIEW
9 NUCLA STRIP MINE
10 OHIO CREEK NO. 2
11 BEAR MINE
12 RED CANYON NO. 1
13 TOMAHAWK STRIP MINE

Map R4-A. 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 FACILITY
30 OCCIDENTAL OIL SHALE
31 COLONY OIL SHALE

Map R4-B. Location of highway segments for which emissions are calculated

TABLE R4-A

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 Federal Proposed		
North Thompson Creek Nos. 1, 2	1,199.0	0
Loma	1,349.0	0
Cameo 1 & 2	44.0	0
Minor Federal Proposed		
Coalby Red Canyon	1.5	0

TABLE R4-B

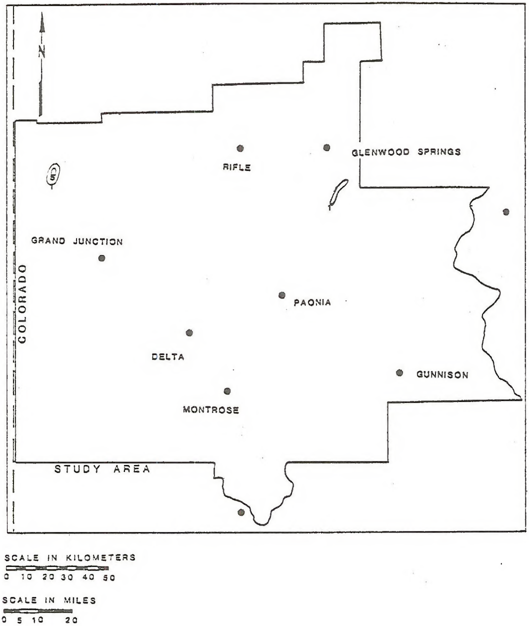
TOTAL SUSPENDED PARTICULATE EMISSIONS FROM COAL MINES IN WEST-CENTRAL COLORADO (TONS/YEAR) - 1985

Mine	With Proposed Actions	Without Proposed Actions
Existing		
Hawksnest	97.7	97.7
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 Federal Proposed		
North Thompson Creek Nos. 1, 2	1,199.0	0
Mt. Gunnison	53.5	0
Loma	921.0	0
Cameo 1 & 2	52.0	0
Coal Canyon	181.0	0
Cottonwood Creek 1 & 2	164.0	0
Minor Federal Proposed		
Edwards	7.0	0
Blue Ribbon	58.8	0
Orchard Valley	19.6	0
Coalby Red Canyon	1.5	0

TABLE R4-C

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
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 Federal Proposed		
North Thompson Creek Nos. 1, 2	1,199.0	0
Mt. Gunnison	63.6	0
Loma	1,161.0	0
Cameo 1 & 2	74.0	0
Coal Canyon	312.0	0
Cottonwood Creek 1 & 2	370.0	0
Minor Federal Proposed		
Edwards	7.0	0
Orchard Valley	19.6	0
Coalby Red Canyon	1.5	0



Map R4-D. Increase of annual average TSP concentrations in 1980 from the proposed actions alone

TABLE R4-E

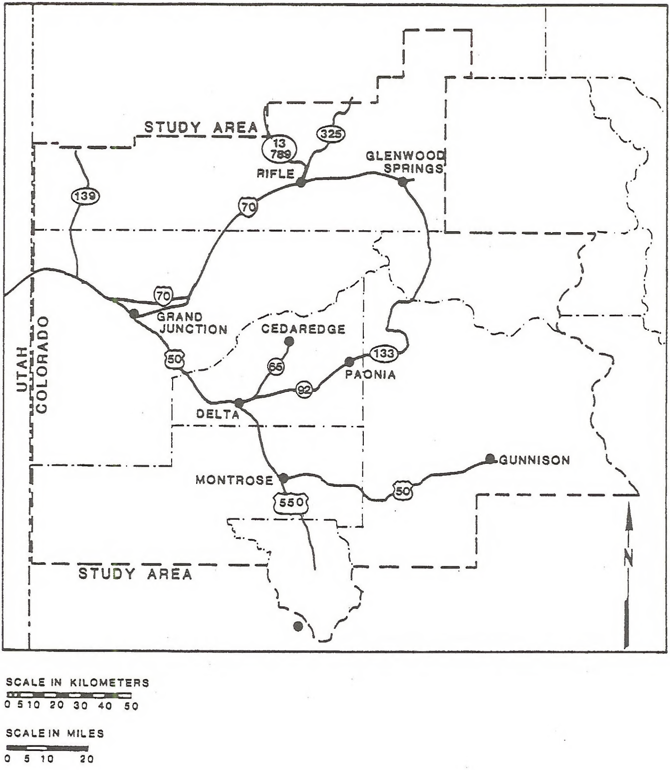
EMISSIONS OF PARTICULATES, SO_x, AND NO_x (TONS/YEAR) FROM MAJOR URBAN AREAS WITHOUT THE PROPOSED FEDERAL ACTION

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	19.0	8.8	96.7	21.2	9.9	109.1	23.7	166.4	108.4
Paonia	8.4	3.65	42.3	9.5	4.4	49.0	11.0	5.1	56.2
Montrose	28.8	11.7	133.6	30.3	12.4	141.6	32.8	13.1	153.3
Grand Junction	39.8	17.5	261.3	41.2	18.3	271.6	41.2	17.9	271.2
Glenwood Springs	38.7	11.3	165.0	43.4	12.8	185.0	45.3	13.5	192.4
Cedar Edge	4.7	2.2	24.1	5.5	2.6	28.5	6.2	2.9	32.9
Gunnison	48.5	10.2	114.6	77.0	16.4	181.8	74.1	15.7	174.8
Fruita	10.6	4.7	69.0	12.0	5.1	78.8	12.0	5.1	78.5
Orchard Mesa	23.7	10.2	156.2	26.6	11.7	174.5	25.9	11.3	170.5
Rifle	25.6	7.7	108.8	29.6	8.8	126.7	31.4	9.1	133.2

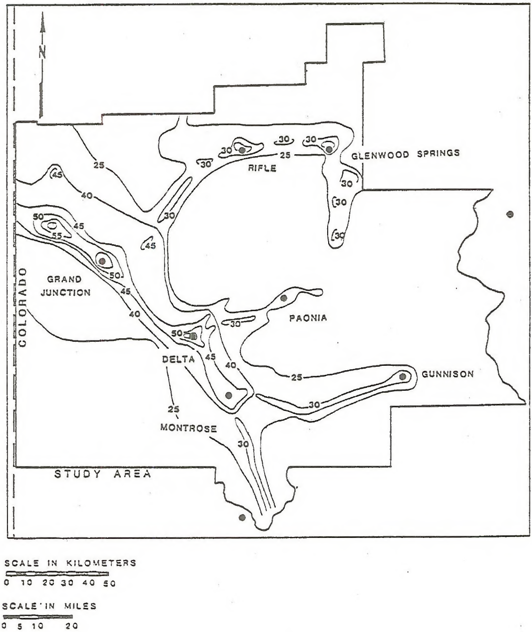
TABLE R4-F

TOTAL VEHICULAR EMISSIONS FROM MAJOR HIGHWAYS IN WEST-CENTRAL COLORADO

	Emission Rate (Tons/Year)			
	Without Proposed Action		With Proposed Action	
	Particulate	NO_x	Particulate	NO_x
1980	1,297	1,079	1,319	1,108
1985	1,616	903	1,707	953
1990	1,725	800	1,833	855



Map R4-C. Locations of major and minor federal action mines and major pollutant point sources in the study region



Map R4-G. Annual average TSP concentrations in 1980 for the most probable level of development 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 study 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 haulroads for the three study years (maps R4-D and R4-E).

Since most of the fugitive dust generated by mining operations consists of relatively large diameter particles, considerable particulate deposition would occur before the partcles 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 prevention of significant deterioration (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 proposed by the Region VIII office of the U.S. Environmental Protection Agency (Rachal 1978), the impact of fugitive dust emissions from coal mines would not be included in the air quality analyses for the PSD increments, nor for national ambient air quality standards. Particulate emissions from industrial process units of an underground mine are typically less than 40 ton per year. Hence, the proposed undergound mines would not be examined under the new PSD regulations.

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 the prevention of significant deterioration (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 mine. 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 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 haulroad 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 5 miles from the town. Increases in 24-hour TSP levels would reach only about 3-4 $\mu g/m^3$ over the same area. Similarly, small increases in NO_2 levels should occur in 1990 in Delta (map R4-F). 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 study 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 5 to 10 miles in diameter or less at these locations (maps R4-G, R4-H, and R4-I). 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 ES 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 190-200 $\mu g/m^3$ 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 study region.

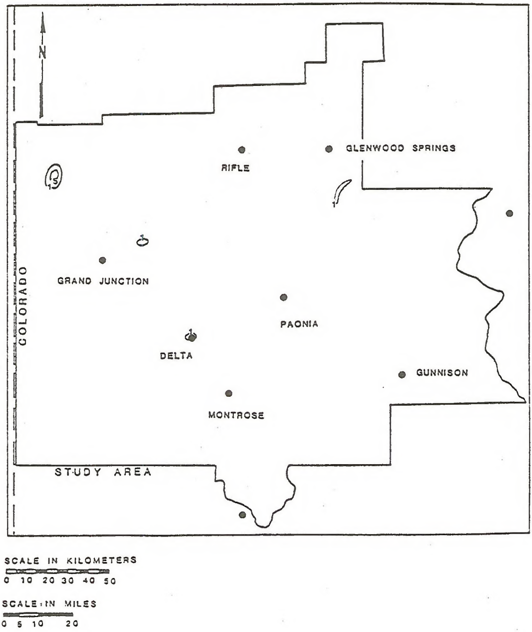
The primary contributor to the relatively high 24-hour ambient TSP levels around towns in the Grand Valley would be baseline TSP concentrations and not particulate emissions from towns and highways. The baseline TSP levels are primarily caused by fugitive dust from agricultural activies in the Grand Valley.

Annual average TSP concentrations along roadways and around towns in the remainder of the study 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-G, R4-H, R4-I show ambient TSP concentrations of about 5-10 $\mu g/m^3$ 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

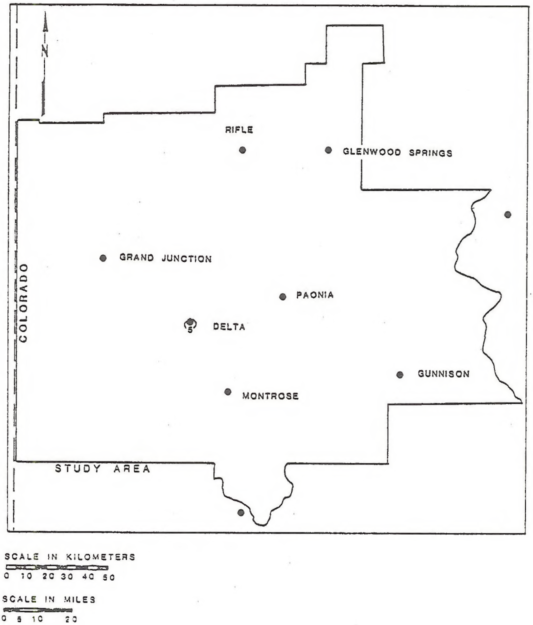
TABLE R4-D

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	19.7	9.1	102.2	24.5	11.3	125.6	26.6	12.4	137.2
Paonia	8.8	4.0	45.3	11.3	5.5	58.8	12.8	5.8	66.1
Montrose	28.8	11.7	133.6	30.7	12.4	142.7			
Grand Junction	40.2	17.5	262.1	41.0	18.2	274.5	41.0	18.2	274.8
Glenwood Springs	38.7	11.3	165.3	43.8	13.1	187.2			
Cedar Edge	5.1	2.2	25.9	6.6	3.3	47.1	7.7	3.6	39.1
Gunnison	48.5	10.2	114.6	77.0	16.4	181.8	74.1	15.7	174.8
Fruita	10.6	4.7	70.4	12.4	5.5	82.1	12.4	5.5	82.5
Orchard Mesa	24.1	10.6	156.9	26.6	11.7	175.2	27.0	11.7	175.9
Rifle	25.6	7.7	108.8	29.9	8.8	128.5			



Map R4-E. Increase of annual average TSP concentrations in 1985 and 1990 from the proposed federal action alone



Map R4-F. Increase of annual average NO_2 concentrations in 1990 from the proposed federal actions

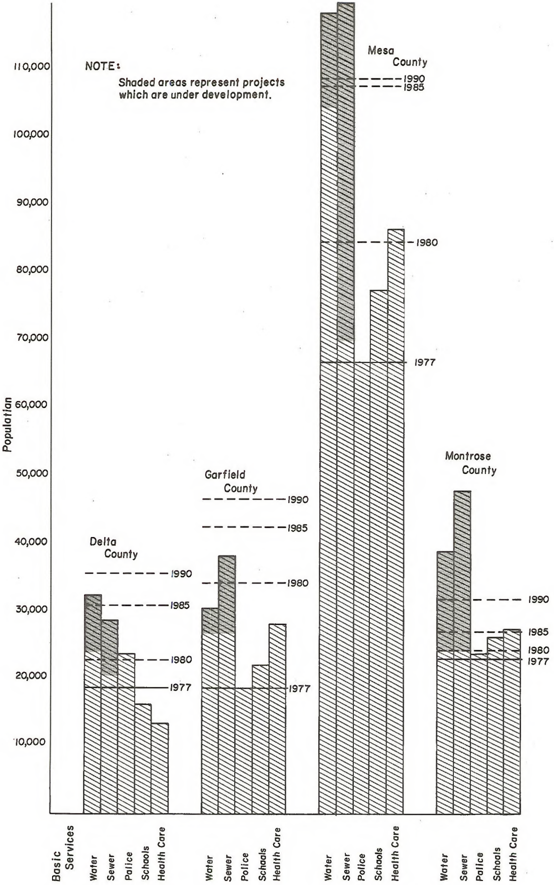
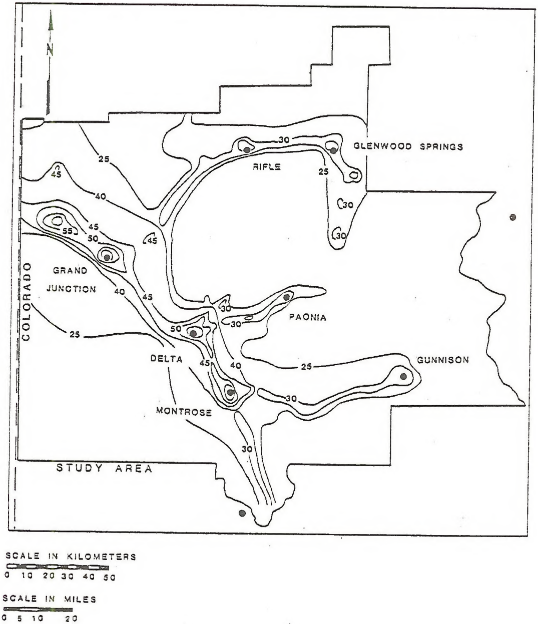
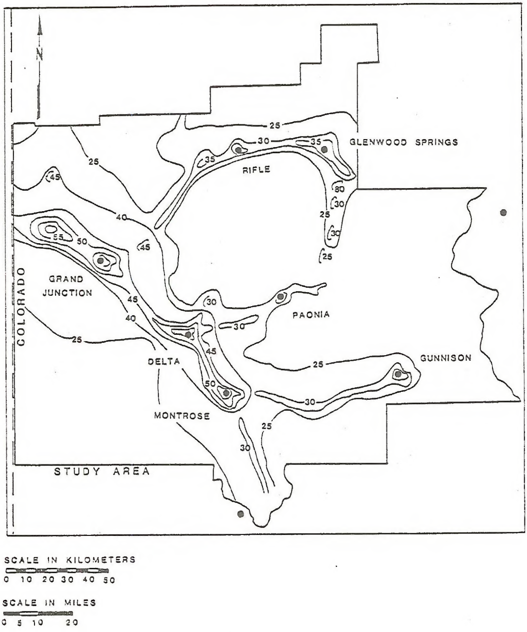


Figure R4-6. Projected population vs. the capacity to provide basic government services



Map R4-H. Annual average TSP concentrations in 1985 for the most probable level of development



Map R4-I. Annual average TSP concentrations in 1990 for the most probable level of development 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 study 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 mine, would result in violations of any state or federal ambient air quality standards.

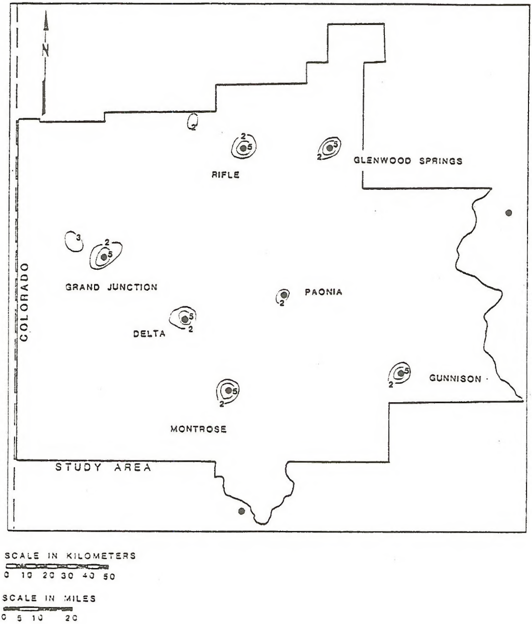
Other mines and groups of mines in the study area would cause increased TSP concentrations during the study years. However, maximum concentrations would be localized and would be lower than the maximum impact reported for the four mine groups discussed here.

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 $\mu g/m^3$.

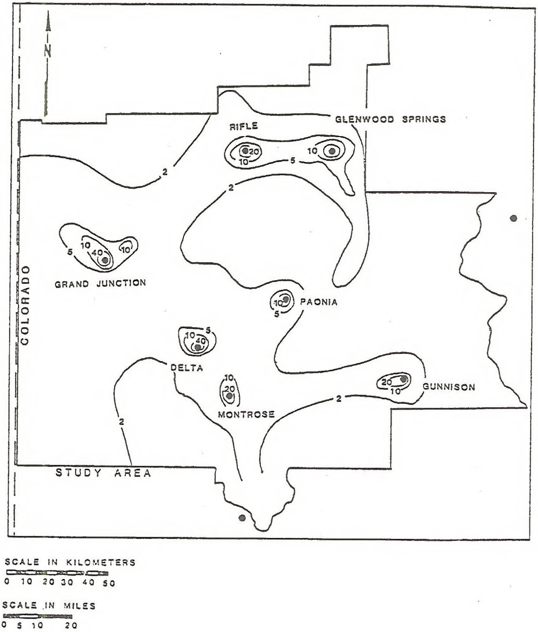
Map R4-J shows that regional annual average SO_2 levels exceed 5 $\mu g/m^3$ over only very small areas around Grand Junction, Delta, Montrose, Gunnison, Rifle, and Glenwood Springs. Still lower concentrations would occur around Fruita, Paonia, and the Occidental Oil Shale facility in the Parachute Creek 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-K and R4-L show that highest annual average NO_2 concentrations would reach 40-45 $\mu g/m^3$ within small areas around Grand Junction and Delta. Maximum ambient levels of 10-20 $\mu g/m^3$ 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.

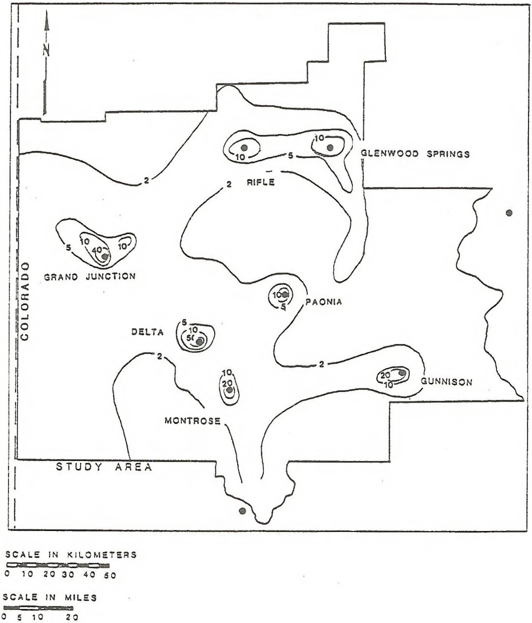
Away from towns, mines, and other major pollutant sources, the annual horizontal visibilities related to atmospheric particulates are expected to exceed 60 miles almost 50 percent of the time. During 1980, 1985, and 1990, average regional visibilities will be reduced to around 53 miles over areas 5 miles 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 cases, the slight reductions in atmospheric clarity around mines in the study region would not be apparent as actual visibility reductions because lines



Map R4-J. Annual average SO_2 concentrations in 1980, 1985, and 1990 for the most probable level of development



Map R4-K. Annual average NO_2 concentrations in 1980 and 1985 for the most probable level of development



Map R4-L. Annual average NO_2 concentrations in 1990 for the most probable level of development 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 study region for the three study years. These reduced visibilities would not extend beyond about 10-15 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 study region. The redistribution of soils and other materials at the mines, railroad, and transmission lines proposed for the study 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 435 acres by 1980, 1,219 acres by 1985, and 1,261 acres by 1990. This constitutes 5 percent of the total projected regional disturbance of 8,696 acres by 1980, 4.5 percent of 27,088 acres by 1985, and 3.6 percent of 34,879 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 600 acres by 1980; 4,800 acres by 1985; and 12,600 acres by 1990. These acreages would constitute 25 percent of the area (2,400 acres) to be disturbed by subsidence from the cumulative level of mining in the ES area by 1980, 50 percent (9,600 acres) by 1985; and 65 percent (19,385 acres) by 1990. In general, subsidence in the ES area would be less than 10 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 not well understood.

Horizontal movements caused by subsidence will cause distortions of the surface which may be manifested as open fractures, slumps, depressions, changes in slopes or squeezing and buckling. These features would be rapidly erased or masked by erosion, redeposition, and revegetation, particularly in areas of high precipitation and thick colluvial or alluvial sediments. Their effect will be to cause severe impacts to water courses or drainage basins and to human facilities and structures in the area.

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 is 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.

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 R4-1 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 mining technologies dictate that at least 50 percent of the coal resource will be left in place for mining to occur. Although today this coal is considered to be unrecoverable, advances in mining may make it available at some future date. Table R4-2 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.

At this time, the production of coal by underground methods is technologically dependent on the use of rock dust for methane suppression. Because of the low commodities price and the high cost of transportation, rock dust must be mined and processed in the proximity of its market. Roughly 4,000 tons of rock dust are needed to supply a 1-million-ton per year mining operation. Table R4-3 presents the demand for rock dust which would be created by the six site-specific proposed actions, as well as the cumulative level of mining in the ES area, for the years 1980, 1985, and 1990.

Oil and Gas

Oil and gas operations can at times conflict with potential 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:

TABLE R4-1

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

			Cumulative Impact of Production to the Mineable Coal Reserve					
			By 1980		by 1985		by 1990	
	Field	Amount of Mineable Coal Reserves (Million Short Tons)	Million Short Tons Produced	Percent of Mineable Reserves Produced	Million Short Tons Produced	Percent of Mineable Reserve Produced	Million Short Tons Produced	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 R4-2

CUMULATIVE IMPACT OF MINING ON THE COAL RESERVES OF THE ES AREA

	Field	Amount of Mineable Coal Reserves (Million Short Tons)	Cumulative Impact of Mining to the Mineable Coal Reserve (Tons Produced Plus Tons Left in Place)					
			By 1980		by 1985		by 1990	
			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.

TABLE R4-3

ROCK DUST NECESSARY FOR PRODUCTION OF COAL IN ES AREA

	Field Name	Amount of Rock Dust Needed for Coal Mining (Thousand Tons) By 1980	By 1985	By 1990
Six Site Specific Proposed Actions	Little Bookcliffs	11.9	86.7	215.4
	Grand Mesa	0	2.8	19.2
	Somerset	0	21.9	70.7
	Carbondale	5.2	25.8	46.4
	Subtotal	17.1	137.2	351.7
Existing and Projected Mining Activity	Includes all Fields	62.0	179.4	290.4
	Total	79.1	316.6	642.1

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.

Water Resources

Water Supply

Implementation of the proposed actions would cause an increase in water consumption, both domestic and industrial, throughout the region of 7,390 acre-feet by 1990. Table R4-4 depicts all increased water consumption associated with the proposed actions for the years 1980, 1985, and 1990. The regional water consumption as a result of cumulative development would be 5,328 acre-feet in 1980, 24,224 acre-feet for 1985, and 33,054 acre-feet for 1990. This would bring total water consumption of the region to 2,835,690 acre-feet in 1980, 2,852,273 acre-feet in 1985, and 2,861,103 acre-feet in 1990. These totals include oil shale mining and associated population increases, agricultural uses, and evaporational losses. From table R2-5, Regional Water Balance, the total potential available water supply for the region is approximately 5,400,000 acre-feet per year, which means that potential available water supplies of the region would still be in excess over consumption through 1990.

The North Fork Valley would be the most severely impacted area within the region. With the start up of Atlantic-Richfield's (ARCO's) Mt. Gunnison No. 1 Mine, there would be a total of eight active coal mines in the North Fork area. Water consumption by coal operations would increase from 89 acre-feet in 1977 to 265 acre-feet in 1980, 816 acre-feet in 1985, and 1,171 acre-feet in 1990. In addition, increased domestic water consumption associated with population increases for the same time periods would be 636 acre-feet in 1980, 2,321 acre-feet in 1985, and 2,154 acre-feet in 1990. Thus, the total water demand for the North Fork Valley would be 9,187 acre-feet in 1980, 12,941 acre-feet in 1985, and 14,845 acre-feet in 1990. Paonia, Hotchkiss, Cedaredge, and Delta have excess capacity to treat municipal water. Together, they can support approximately 13,600 additional people or treat an additional 5,334 acre-feet of municipal water. Because of the limited capacity to treat water for municipal uses, much of this water consumption, both domestic and industrial, would have to be fulfilled with ground water. Additional storage reservoirs and treatment facilities for municipal water would need to be constructed.

The Palisade-Grand Junction area would also experience a large increase in demand for municipal water due to three proposed mines within the area. Population increases from Mid-Continent's Coal Canyon and Cottonwood Creek mines and General Exploration's (GEX's) mines would cause a total increase in municipal water demand of 250 acre-feet by 1980, 1,856 acre-feet by 1985, and 1,855 acre-feet by 1990 for this area. The projected demand would exceed the current capacity for supply by approximately 1,267 acre-feet by 1985 and 1990.

As a result of the proposed actions, there should be no impacts or disturbances to the water supplies or rights of others. The initial regulations of 30(CFR): 717(i) require that a coal mine operator must replace a water supply that is contaminated, diminished, or interrupted in any way due to the mining operations. In addition, Colorado Regulations, Rule 7c,d, and f, require that if any coal mining development, mining operation, or 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. These

TABLE R4-4

INCREASED ANNUAL WATER CONSUMPTION DUE TO THE PROPOSED ACTIONS

Mine	Cause	1980	1985	1990
		(Acre-Feet per Year)		
Anschutz: North Thompson Creek No. 1 & No. 3	Mine	167	167	167
	Associated population increase	275	284	314
Atlantic Richfield: Mt. Gunnison No. 1	Mine	128	600	960
	Associated population increase	350	1,100	1,175
Sheridan Enterprises; Loma Project	Mine	40	670	950
	Associated population increase	339	919	1,455
Mid-Continent: Coal Canyon	Mine	5	15	27
	Associated population increase	102	412	465
Mid-Continent: Cottonwood Creek	Mine	6	27	53
	Associated population increase	102	827	934
General Exploration: Cameo No. 1 & No. 2	Mine	55	96	110
	Associated population increase	46	617	780
TOTAL		1,615	5,734	7,390

measures should be sufficient to prevent impacts to other water supplies due to the mining.

It should be noted that many of the companies have proposed to use ground water found within their mines to support their coal processing facilities, suppress dust, etc. However, they have not indicated any intent to file for water rights or well permits as specified by Colorado law, CRS 1969, 37-92-102, Water Right Determination and Administration Act of 1969. Any use of this unappropriated ground water is defined as theft under Colorado law and is punishable under the Colorado Criminal Code. Mining operators must file for the necessary permits and obtain rights from the state of Colorado.

Water Quality

The greatest impacts on water resources, would occur with respect to water quality. These impacts are also the hardest to control or correct. Historically, increased development has always been accompanied by both beneficial and adverse changes in the quality of the environment. Mining and associated activities, construction of power plants, construction of roads and railroads, population increases, etc., create a potential for significant increases in suspended sediments and dissolved solids. Appropriate sediment control measures must be designed, constructed, and maintained to prevent additional sediment from entering water courses outside the mining areas to the extent possible, using the best technology currently available. With proper engineering and construction of major facilities, the quality of the water resources, in some cases, can be improved.

Assuming that the proposed actions and all other coal mines will be brought into compliance with the OSM initial regulations 30(CFR): 715(e) and 717.17(e) and that the proposed actions will comply with regulations 30(CFR): 211.40(a)(3) and 43 (CFR): 3041.2-2(f)(7)(ii), and Colorado Regulation, Rule 6.1b, there should be no direct significant changes in water quality due to the proposed actions. In the case of coal mines, 30(CFR): 700 regulations require drainage systems that are capable of withstanding a 10-year/24-hour precipitation event. Any storm larger than this would exceed the design capacity of on-site drainage systems, causing temporary but significant reduction in water quality below the mining operations.

Unquantifiable degradation of water quality due to cumulative regional development of resources such as oil shale, uranium, and oil and gas is expected to exceed water quality impacts due to coal development. Increases in suspended sediments, dissolved solids, pH alkalinity, sulfates, and chlorides are expected.

Some of the mining operations will discharge excess water into adjacent streams. Effluent limits for Colorado are summarized in table R3-1. If the state of Colorado issues effluent permits that are reasonable and enforces control and treatment of polluted industrial waters, including runoff waters from disturbed areas, the quality of most surface waters within the region would be unaffected or improved as a result of mining. Without these controls, the surface waters would experience significant increases in suspended sediments, dissolved solids, pH alkalinity, sulfates, and chlorides.

The water quality impacts from population increases are the most expensive to control and hardest to finance. Municipal effluents significantly impact the natural water systems. Increases in biological oxygen demand, fecal coliforms, suspended solids, nitrates, nitrites, ammonia, and orthophosphates are common below waste treatment plants. Increases in population would add increased strain to the waste treatment facilities, causing additional impacts from these water quality parameters. Ground water supplies would be similarly affected due to increases in the numbers of septic tanks which drain into ground water supplies. Runoff from municipal areas, primarily from paved roads, is generally higher in salts, oil, and grease than that from natural areas and would impact water quality. Increased water consumption throughout the region would decrease water quality by causing a decrease in the dilution factor. The Environmental Protection Agency (1971) predicts that the projected increases in municipal water use would cause a 4 percent increase in salinity as measured at Hoover Dam by the year 2010.

Soils

Surface disturbance resulting from the six site-specific operations and associated urban area expansion would amount to 700 acres by 1980, 2,121 acres by 1985, and 2,373 acres by 1990. Comparable values for regional disturbance due to all causes would be 8,696 acres by 1980, 27,088by 1985, and 34,879 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 on 1,261 acres would be removed from any production function by 1990. Approximately 65 percent of this acreage is classed as Entisols (see Soils, chapter 2); 25 percent and 10 percent are classed as Aridisols and Mollisols, respectively. The 1,261-acre figure includes about 290 acres of cropland, 40 in the Carbondale area due to Anschutz' rail-loadout facility and 250 in Mesa County due to a portion of Sheridan's utility corridor (160 acres) and Cameo's rail loadout (90 acres). The Mesa County area qualifies as prime farmland; the area near Carbondale has not yet been formally evaluated.

Urban area expansion associated with the six mines would permanently remove another 1,112 acres from any production function. 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 map 5 in appendix A), and as yet unclassified cropland in the Delta area (soil units 6, 10, and 28) and Glenwood Springs area (soil unit 60).

Erosion rates would increase in response to any surface disturbance. Gross estimates of background rates and potential increases are given in table R4-5. 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. However, in accordance with 30(CFR): 717.17, these structures would only be designed to handle a 10-year/24-hour precipitation event; runoff amounts exceeding the design value could carry sediment and other debris into stream channels. The probability of exceeding the design value within the six given mine lives would be over 90 percent in all cases.

The net effect of erosional losses of soil, along with a deterioration of soil structure and biological activityt 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 435 acres of vegetation by 1980, 1,219 acres by 1985, and 1,261 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 R4-6.

In addition to the direct acreage disturbance caused by the proposed actions in the ES area, 265 acres of land would be disturbed by 1980, 902 acres by 1985, and 1,112 acres by 1990 due to population growth and urban expansion associated with the proposed actions. Much of this dis turbance 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 acres of disturbance that are projected due to cumulative regional development and urban expansion: 8,696 acres by 1980, 27,088 acres by 1985, and 34,879 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, resulting 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 revege tated 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 from mining activities must be reclaimed to a condition capable of supporting the previous land use before mining or a better land use.

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.

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

TABLE R4-5

ESTIMATED INCREASES IN EROSION DUE TO SURFACE DISTURBANCE

Protective Ground Cover a/ (Before Disturbance)	Soil Erosion b/ Background Erosion (Tons/Acre/Year)	Soil Erosion b/ 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 R4-6

ACRES OF DISTURBANCE OF VEGETATION TYPES DUE TO THE PROPOSED ACTION BY 1990, COMPARED TO 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	113	2,079,898 a/	Less than 1
Riparian Land (Cottonwoods)	1	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	120	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 b/	218	48,500	0.45
All other Types	0	1,129,100	0
Totals	1,261	5,921,498	

a/ Total land nonfarm 1974.

b/ Less than 2 percent vegetative cover.

achieve quick cover or assure successful revegetation.

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.

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 described 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.

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). 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).

Endangered and Threatened Plants

Detailed endangered and threatened plant and floristic inventories of the areas that would be disturbed by the proposed actons have revealed that no endangered or threatened plants are present. This finding is consistent with the known localities of the endangered or threatened plants in the region, which are not near any of the areas that would be disturbed by the proposed actions. Results of the inventories may be reviewed at the Grand Junction and Montrose offices of the BLM.

A second impact of population expansion would be an increase in the exploitation of endangered and threatened plants in the ES area (see table R2-10 for a list of the plants). This impact would be most serious for plants which currently are exploited by commercial and amateur horticulturists (i.e., two endangered cacti, AT3Schlerocactus glaucus, and *Echinocereus triglochidiatus* var. *inermis*).

The endangered and threatened plants in the Mancos shale hills (i.e., *Penstemon retrossus* and *Sclerocactus glaucus*) may also be harmed by increased ORV use in these area.

It should be noted that these impacts 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

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 435 acres of wildlife habitat by 1980; 1,219 acres by 1985 and 1,261 acres by 1990. These figures represent 0.01 percent, 0.035 percent, and 0.036 percent respectivly of the habitat available to most wildlife species in the ES area. Some of this acreage could be reestablished over the short term, 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 mountain lion, black bear, and golden eagle, and to a lesser extent, mule deer, bobcat, coyote, and ringtailed cat.

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 1 mile from the disturbance depending on topography, the wildlife use could be 100 percent 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 R4-7. 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 3,103 by 1980, 10,601 by 1985, and 13,068 people by 1990. The residential and commercial facilities needed for this growth would require 265,902, and 1,112 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, for example, 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 R4-8 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.

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.

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 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 the Coal Canyon-Cottonwood Creek 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 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 portrays 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 8,696 acres disturbed by 1980, 27,088 acres disturbed by 1985, and 34,879 acres disturbed in 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, if not on the impacted herd unit or species, then on some adjacent area of equal importance. 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 if they are implemented properly.

Adding all these disturbances together, with the projected urban expansion, there would be 13,040 acres disturbed by 1980, 43,628 acres by 1985, and 67,187 acres by 1990. This amounts to 0.37 percent, 1.25 percent, and 1.93 percent respectively of 3,465,000 acres of wildlife habitat 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 happen to locally heavy populations. A case in point is the Roan Creek deer herd. A compari-

TABLE R4-7

EFFECTS OF PROPOSED SITE-SPECIFIC ACTIONS ON BIG GAME SPECIES

Type of Activity	Acres Disturbed or Converted 1980	1985	1990	Carrying Capacity Reduced in Numbers of Animals a/ 1980 Deer	1980 Elk	1985 Deer	1985 Elk	1990 Deer	1990 Elk
Proposed Actions									
Mines	435	1,219	1,261	34	5	95	15	99	16
Urban Expansion	265	902	1,112	18	3	47	8	59	10
Subtotal	700	2,121	2,373	52	8	142	23	158	26
Percentage of Region b/	0.02	0.06	0.06	0.02	0.01	0.05	0.05	0.06	0.06
Other Energy Related Development	8,512	27,986	35,760	664	107	2,183	350	2,790	447
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	3,828	8,101	9,234	168	27	422	68	517	83
Subtotal	12,340	41,507	64,814	832	134	3,029	439	3,911	1,674
Percentage of Region b/	0.35	1.19	1.87	0.34	0.31	1.27	1.03	1.64	3.94
Total	13,040	43,628	67,187	884	142	3,171	471	4,069	1,700
Percentage of Region	0.37	1.25	1.93	0.37	0.33	1.33	1.11	1.71	4.00

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 impacted.

b/ Percentages are of available habitat (3,465,000 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 R4-8

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.

son 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. These deer will be forced into the Roan Creek drainage where another oil shale development is located. If this in fact does take place, the habitat in Roan Creek will become severely overutilized. As a result, BLM management goals for this area, as stated in the Roan Creek habitat management plan, could be accomplished only through heavy harvest of this deer herd. Increased competition would occur 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 push the animals back into the Parachute Creek and Piceance Basin areas.

The impacts of oil shale development in and adjacent to the ES region will be some of the most significant impacts on wildlife species. Population expansion in the region and the associated impacts from this expansion will primarily impact agricultural lands, affecting small mammals and birds more than large mammals, such as deer and elk.

The cumulative population increase of the proposed actions and other development in the region would be 199,350 people by 1980, 258,150 by 1985, and 274,850 people by 1990. The residential and commercial facilities needed for this growth would require 4,092 acres by 1980, 9,004 acres by 1985, and 10,346 acres of land 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. This possible loss of crucial wildlife wintering areas is unquantifiable at this time. Increasing populations will 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 R4-8 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 deer 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.

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.

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).

Although impacts due to the proposed actions would be virtually insignificant, impacts of cumulative regional development will be significant. It is speculative just how much harassment, intrusion on their 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 will be available for the larger more visible species, such as elk, deer, bear, antelope, and endangered species, such as peregrine falcon and black-footed ferret. As the available habitat shrinks the populations of these animals can do little else but shrink also, 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 does not exist or it is in the process of being gathered by state and federal agencies. The most significant impacts on wildlife population will 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, recreational activities and subsequent harassment of wildlife, and the possible increase of illegal and indiscriminate shooting of wildlife.

These same impacts will also occur due to the cumulative development in the region, except to a greater degree. The cumulative effect of this development can 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), direct impacts to wildlife as described in this section will be minimal or of relatively short-term duration. With respect to rare and endangered wildlife species, specific coordination with the U.S. Fish and Wildlife Service will be undertaken to be absolutely sure that no rare and endangered species will be impacted by the federal proposed actions.

Aquatic Biology

Proposed Actions

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 (1974) did not find any significant degradation of aquatic life attributable to changes in chemical water quality from coal mining. In this study area, the Anschutz mine is 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 two main reasons that acid mine drainage should not present a major problem in the ES area are the absence of pyrite and the low sulfur content of the coal.

Total dissolved solids (TDS) represent a potential problem to aquatic life in some coal areas. However, in mining areas located downstream from agricultural areas, the amount of dissolved solids added by coal mining is insignificant compared with the large amounts added by irrigation return flows. In areas where natural stream waters have not been subject to irrigation return flows, TDS can be a limiting factor to the normal assemblages of cold water fish and aquatic organisms. Highly sensitive species of mayflies and stoneflies usually disappear first. High concentrations of salts found in ground water can cause degradation of cold water fisheries if the water is not treated properly. Water quality laws described in chapter 3 restrict the amount of dissolved salts that can be added to streams from mine sites. Assuming total compliance with these laws and no accidental spills or tailing pond breakages, the aquatic habitats in the region should not suffer from TDS problems.

STREAM FLOW DEPLETION

In the study area 4,426 acre-feet of water would be required for mine water and community consumption by 1980; 6,232 acre-feet would be required by 1985, and 7,888 acre-feet by 1990. This amount is not highly significant to fisheries on a regional basis. Nevertheless, any water lost from streams during yearly low water periods, whether during the end of the summer months of August and September or during periods of heavy winter ice, would cause a proportional decline in the fishery. Development of coal and increased population will put greater demands on water than in previous years. Habitat losses would occur in the region where demands on water decrease the historical minimum stream flow during the critical low water periods mentioned.

Two examples where streams may be partially dewatered are presently known. In the North Fork Valley, annual low flows in the North Fork River range from 17 to 60 cubic feet per second (cfs) at Somerset, Colorado. ARCO has a 15 cfs water right above Somerset, and if this amount should be diverted during a low flow period, from 25 to 100 percent of the aquatic habitat could be lost. On North Thompson Creek, low flows range from 0.09 to 1.00 cfs yearly. Anschutz has a 0.25 cfs water right, and should this right be utilized, 25 to 100 percent of the aquatic habitat could be lost there also.

SEWAGE

The increased human population of 3,103 by 1980, 10,601 by 1985, and 13,068 by 1990 would increase water pollution from sewage in the ES area. Several areas in the Colorado River basin would suffer from degraded aquatic habitats where increased populations put a greater load on presently inadequate sewage treatment facilities. Plans presently exist to upgrade waste water treatment facilities in most areas but until all such planned facilities are operating properly, impacts on aquatic life would occur (see community facilities section of Socioeconomic Conditions). Ammonia (NH_4) discharged from waste water treatment facilities can be toxic to fish if the amount discharged exceeds 0.3 to 0.8 milligrams per liter (mg/l), depending on pH and water temperature. Low dissolved oxygen from decomposition of discharged organic matter may also exclude fish from some areas. Areas where this has happened and where increased populations can continue to pose a problem include the Uncompahgre River between Montrose and Delta, the North Fork River below Hotchkiss, Surface Creek below Cedaredge, and the Gunnison River below Delta.

INCREASED SEDIMENT LOAD IN STREAMS

There would be a minor increase in sediment carried to stream courses due to the disturbance of a maximum of 1,261 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 increases the total number of fish harvested, decreases the fish population, and in turn lowers the quality of the fishing in an area. An increased reliance on hatchery-raised fish would result. Areas such as the Gunnison Gorge, the Crystal and Roaring Fork rivers, and the lakes on Grand Mesa would receive a significant part of this fishing pressure.

THREATENED AND ENDANGERED SPECIES FISH SPECIES

The proposed actions should not adversely affect the threatened and endangered fish species found in the Colorado River and in the lower section of the Gunnison River. The river water 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 presentely known to be limiting to aquatic life in the Colorado River.

Total dissolved solids (TDS) values in the lower section of the Colorado presently average 500 to 700 parts per million (ppm). Squawfish and razorback suckers have reproduced successfully at Willow Beach National Fish Hatchery where TDS is 820 ppm. Tolerance limits to most water quality parameters for the fish species concerned are presently unknown, but it should be mentioned that these species evolved in the highly erosive Colorado River drainage where silt can average 0.62 percent by volume and where high concentrations of mineral salts, carbonates, sulfates, and chlorides of calcium, sodium, and magnesium are common.

The water quality parameters most likely to increase in runoff from coal mining areas are sulfate, iron, manganese, and TDS. No increase above present levels is projected with the proposed action, and state and federal water quality laws described in chapter 3 assure diligent compliance with effluent standards by developing mines. Continued monitoring of all waters with mine development along with further studies of the physical and chemical environment suitable for the endangered and threatened fish species will help ensure the survival of these fish populations.

Potential Spills or Structural Failures due to Flooding

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. In the ES aea, mine drainage systems, sediment control structures, and retention ponds will be designed to handle a 10-year/24-hour precipitation event. The probability of a precipitation event exceeding this size during the life of the six proposed mines is over 90 percent in all cases. Three of these mines are directly adjacent to and drain in to the critical habitat area for several of the Colorado River endangered and threatened fish species. Should a flood event occur on a coal mine site, the endangered fish populations could be seriously damaged. A large number of variables would influence the degree of impact on the fish population and quantification of such impacts would require extensive research.

SUMMARY

While no single factor would cause a major decline in fish habitat or populations, the combined effect of the proposed actions should be considered. Population increases would demand more municipal and industrial water. Sewage problems would increase. Sediment yields from much new construction would increase. Mine consumption of surface and ground water may deplete stream flows in low flow months. Fishing pressure would increase, causing a larger dependence on the stocking of hatchery raised fish and a decrease in wild fish populations. Spills and tailing ponds leakages may occasionally degrade aquatic habitats. Habitat decline would limit the reproduction of natural trout populations and favor the increase of nongame fishes such as suckers.

Cumulative Regional Development

Direct changes in the chemical quality of water in the ES area will 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 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 will 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 will reduce populations of invertebrates, fish, aquatic mammals, birds, and riparian vegetation.

Salinity will increase in the Colorado River as a result of removal and use of ground water, leaching from overburden and spoils piles, consupmtion of large amounts of surface water, and release of low quality mine water. Fish populations, invertebrates, aquatic mammals, and riparian vegetation in local streams may be lost or reduced as a result. The salinity concentration increase in the Colorado River will make it increasingly less suitable for most fish species.

Energy development will significantly change the water demand supply balances that currently exist in the ES are. The nature and severity of these impacts will change over time. Cumulative development in the region will result in consumption of 2.83 million acre-feet-per year of water by 1980, 2.85 million acre -feet per year by 1985, and 2.86 million acre-feet per year by 1990. The use of water for coal development will be significant in only a few areas. Increased municipal and industrial use could at the same time cause a shift away from irrigated lands. Several new water storage projects and the adaption of existing projects will change the flow regimes and total quantities of water available in the major river systems. Fisheries in the area which will receive potentially high impacts from regional developments include Thompson Creek (coal), Parachute Creek(oil shale), Roan Creek (oil shale), the Gunnison River (USBR Dominguez Project), Dolores River (USBR Dolores Project), San Miguel River (USBR San Miguel Project), Uncompahgre River (USBR Dallas Project), and the Colorado River (coal, oil shale, and USBR projects).

It has been estimated that about 190 miles of new pipeline will 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 extemely 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. The possibilities and and impacts of spills resulting from retention structure failures during precipitation events exceeding the 10-year, 24-hour storm in coal areas has been previously discussed.

Sediment carried in streams will increase due to development in the region. In addition to sediment from coal areas, oil shale development will 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, will lead to increased sediment load in local streams. Channeling and head-cutting due to natural erosion will occur for extended periods of time with increasing amounts of sediments reaching local streams. Increased operations for sand and gravel recovery will cause large-scale disruption of some stream habitat areas and siltation in streams. In aquatic habitat the increased siltation and turbidity will exceed natural levels and adverse effects will 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 human populations in the study area (69 percent increase by 1990) will increase problems from sewage pollution in fast growing cities such as Grand Junction, Delta, Rifle, and Glenwood Springs. Population increases will lead to larger amounts of sewage effluent. Most of this increase is expected to flow to sewage treatment facilities. Unless sewage treatment facilities are enlarged to handle the increase, localized adverse impacts on water quality are expected from increased amounts of organic materials and nutrients entering local streams. This could lead to localized entrophication and subsequent changes in the river ecosystem in these affected areas. Fish kills from ammonia pollution may also result.

Increased urbanization and associated human activities will degrade water quality and aquatic habitats. Since urban areas will be located on or near water courses, such parameters of aquatic systems as suspended sediment, turbidity, nutrients, biological oxygen demand and temperature will increase. Human activities such as boating and fishing will degrade water quality through the introduction of gas, oil, and litter. Pollutants and toxic substances from streets and storm sewers will increase. The aquatic environment may be so altered that some present fish species, most likely the endemic species, will no longer be able to sustain themselves and more tolerant species will take their places.

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 will result. The average size and number of fish taken by each angler will decrease and the dependency on hatchery stocked fish will increase.

THREATENED AND ENDANGERED AQUATIC SPECIES

The extent to which cumulative development will affect the Colorado squawfish, humpback chub, and the razorback sucker is dependent upon the quality of the surface waters. The water quality decline in some streams exposed to waste discharge and industrial accidents could have serious effects. In the case of the squawfish, impoundments could destroy breeding habitat. If degradation or physical alteration occurs in waters inhabited by these species, a further population decline would be expected. Fish kills of large proportion or the loss of an endangered species are serious possibilities.

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, required by the 1966 National Historic Preservation Act, as amended and outlined in 36(CFR): 800, 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 past land use, site density, and topography would also have some influence.

Projected regional surface disturbance is expected to reach 8,696 acres by 1980, 27,088 by 1985, and 34,879 by 1990. Of these acres, only 700, 2,121, and 2,373 respectively, would be a result of the federal proposed actions and associated community expansion. Dirt-moving procedures could displace and damage archeological resources that remained undetected despite the Class III surveys in these areas. In effect, surface disturbance would destroy evidence of human use on areas previously undisturbed. It should be noted that a large percentage of the 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 (3,827 acres by 1980 (44 percent), 8,102 acres by 1985 (30 percent), and 9,353 acres by 1990 (27 percent).

Subsidence, as a surface disturbing impact, could affect 2,400 acres by 1980, 9,600 acres by 1985, and 19,385 acres by 1990 as a regional projection. Of these acres, 600 acres by 1980, 4,800 acres by 1985, and 12,600 acres by 1990 would result from the federal proposed action. 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 spacially associated 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 1,899 archeological sites identified in the ES area, 18 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--such as testing, collecting, and excavation would preserve archeological values that might otherwise be lost. Notwithstanding their beneficial nature, these salvage efforts are only partial mitigations. Removing archeological resources from the impact areas destroys the in-place value of the resource. Any information not recorded would be permanently lost and removed from future research considerations.

Although the 1906 Antiquities Act declares the unauthorized removal and alteration of archeological resources is 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 growth of the ES area is expected to reach 198,900 by 1980, 259,150 by 1985, and 274,850 by 1990. Of this increase 3,103 (1980), 10,601 (1985), 13,068 (1990), would result from the proposed federal actions. Increased recreation visitor pressure on areas outlying the population centers (see Recreation, chapter 4), combined with the presence of 2,952 mine-associated employees by 1980, 4,375 by 1985, and 4,606 1990 (998, 2,310, and 2,754 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 of which 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.

Transportation

Highways

Impact on transportation networks would be caused by (1) transportation of coal out of the study 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, the changes in vehicle registration would be 3,400 in 1980, 11,450 in 1985, and 14,150 in 1990. Increases from cumulative growth would be 50,595 vehicles in 1980, 115,665 vehicles in 1985, and 132,620 vehicles in 1990.

Table R4-9 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.

TABLE R4-9

INCREASE IN AVERAGE DAILY TRAFFIC DUE TO THE PROPOSED ACTION

Location		1980	1985	1990
I-70	E/O Grand Valley	90	410	480
I-70	Rifle	90	300	360
I-70	W/O Glenwood Springs	70	560	660
I-70	E/O Glenwood Springs	100	460	550
US-50	N/O Delta	150	710	840
US-50	S/O Delta	90	430	500
US-50	N/O Montrose	180	830	980
US-50	E/O Montrose	70	310	370
US-550	S/O Montrose	90	430	510
US-550	S/O Ridgeway	30	150	180
US-550	N/O Ridgeway	40	180	220
SH-139	Douglas Pass	10	40	50
SH-139	N/O Mesa-Garfield County Line	10	40	50
SH-325	S/O Junction SH-789	10	110	120
SH-325	N/O Junction SH-789	0	30	40
SH-789	W/O Junction SH-325	10	70	80
SH-82	S/O Glenwood Springs	50	450	500
SH-82	W/O Junction SH-133	40	340	380
SH-82	E/O Junction SH-133	30	240	270
SH-82	N/O Carbondale	20	190	210
SH-133	S/O Carbondale	10	130	140
SH-133	E/O McClure Pass	20	70	70
SH-133	W/O McClure Pass	70	240	260
SH-133	E/O Somerset	50	180	200
SH-133	W/O Somerset	80	300	320
SH-133	E/O Junction SH-187	140	500	540
SH-133	W/O Junction SH-187	170	590	640
SH-133	E/O Hotchkiss	170	590	640
SH-133	E/O Ridgeway	0	20	30
SH-62	W/O Ridgeway	0	10	20
SH-62	E/O Delta	550	1,980	2,130
SH-92	W/O Junction SH-65	440	1,580	1,720
SH-92	E/O Junction SH-65	210	740	810
SH-92	W/O Hotchkiss	240	860	930
SH-65	N/O Junction SH-92	250	910	980

Note: I = Interstate; US = United States; SH = State Higheay; N/O = North of; S/O = South of; E/O = East of; W/O = West of.

Average daily vehicle miles in the study region would increase by 324,000 miles as a result of increased vehicle activity associated with the proposed actions. Increased traffic would cause more accidents. By 1990, there would be an additional 356 accidents annually, only one of which would be fatal. Fifty-eight would be injury-only accidents with 88 injuries, and 197 would be property-damage-only accidents. These accidents are over and above those associated with base-line growth.

Transportation of coal and service supplies would be expected to impact highways. Grand Junction serves as a regional supply center. Traffic from Grand Junction 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.

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. Moving over the Tennessee Pass route, approximately twice as many train trips would be required.

Coal loading at new mine sites would require the construction of small lengths of spur track and loading facilities. 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.

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. 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 will 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 are 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 dBA) would expand. The relationship between frequency of train operations and distance at which noise exceeds the 55 dBA level is presented in figure R4-1. 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 R4-10 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 R4-2). 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

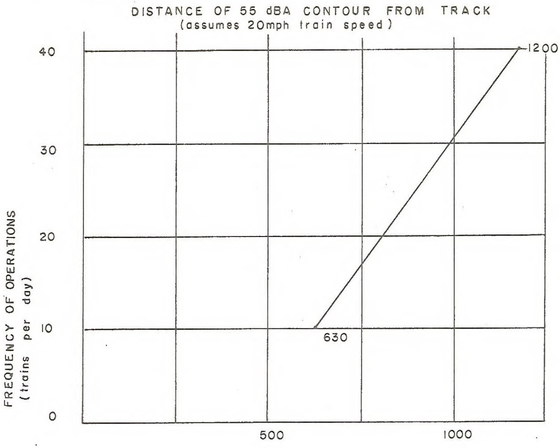


Figure R4-1. Relationship between frequency of train operations and distance at which noise exceeds the Environmental Protection Agency's long-term noise control goal (55 dBA)

Figure R4-2. Greater rail traffic in region would increase delay times and accident potential at grade crossings.

TABLE R4-10

EXISTING AND FUTURE RAILROAD CROSSING HAZARDS

National Railroad Crossing Number	Highway Number a/	Present Exposure Factor b/	Present Hazard Rating c/	1990 Exposure Factor	1990 Hazard Rating
253-575V	S-13	2,770	1.25	3,436	2.01
254-020N	US-50	22,260	2.50	28,939	2.07
254-031B	S-65	5,650	0.15	7,336	0.16
253-370C	S-90	10,420	0.31	15,424	0.81
254-041G	S-133	4,250	0.63	6,380	0.35
254-047X	S-133	5,130	0.63	7,972	0.35
253-542H	S-133	3,240	0.81	9,192	1.04
253-614J	S-133	1,440	1.02	6,500	1.60
254-051M	S-133	3,700	0.15	5,470	0.15
254-076H	S-133	1,850	0.63	2,738	0.35
254-077P	S-133	1,850	0.15	2,738	0.15
254-078P	S-133	1,850	0.15	2,738	0.15
254-081E	S-133	1,540	0.15	2,278	0.15
253-733T	S-133	2,310	0.63	3,282	0.77
253-800K	S-139	2,640	0.15	3,750	1.28
253-430J	S-141	2,160	0.15	2,544	0.16
253-771C	US-6	19,140	3.33	29,776	4.05
253-418C	C-348	2,560	1.25	2,748	1.05
253-395X	C-348	2,080	0.63	2,200	0.44

Source: Colorado Department of Highways.

a/ Highway Number Abbreviations: S = state; US = United States; C = county.

b/ Exposure Factors are the number of trains per day times the number of vehicles per day at the crossing.

c/ Hazard ratings are the number of auto-train collisions expected in a five-year period.

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 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 and up to 23 trains per day for the high production scenario.

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 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 destinated for points west. At the high level of development in this region, nine trains per day would be entering the Salt Lake area heading 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 and 32 trains at the high 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.

Agriculture

Livestock

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 20 by 1980, 60 by 1985, and 69 by 1990, based on the disturbance of 435, 1,219, and 1,261 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 regional ES area.

All of the disturbed land would be revegetated upon abandonment of the mines, as required by the federal coal mining regulations 30(CFR): 717, 30(CFR): 211, and 43(CFR): 3041 (see vegetation). Assuming that the species mixture used in revegetation would consist primarily of grasses, (as is indicated in most of the M&R plans), the disturbed areas would be restored to a productivity level for livestock of 5 acres per AUM or less. This would result in a restoration of approximately 232 AUMs per year of livestock forage to the disturbed areas. Livestock grazing in the mining tracts would be regulated during reclamation operations, so as 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 198,900 in 1980, 259,150 in 1985, and 274,850 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 (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 particularaly 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 34,879 acres of vegetation in the region by 1990, (8,696 by 1980, 27,088 in 1985) 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 developments.

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 population increase projected in the ES area as a result of the proposed actions would adversely affect the farming industry since it is probable that much of the disturbance from community expansion associated with population growth would be on prime farmland around existing population center, although exact locations of the disturbance cannot be predicted. For every acre of farmland that is disturbed, approximately $234 cash value (1974 dollars) of crops would be annually lost. The exact value annually lost would vary with the type of crop and the productivity of the soil.

Approximately 130 acres of farmland by 1980, 290 acres by 1985, and 290 acres by 1990 would be disturbed directly by the proposed actions, which would result in an annual loss of revenue of $30,420 by 1980, $67,860 by 1985, and $67,860 by 1990, since the land would be removed from crop production. This loss in revenue would not greatly affect the farming industry in the ES area, since it is only 0.12 percent of the total (Colorado Agricultural Statistics 1977).

Approximately 7,996 by 1980, 24,967 by 1985, and 34,879 acres by 1990 are expected to be disturbed due to cumulative regional development. Although exact locations for the disturbance cannot be predicted (with the exception of that from the proposed actions, discussed above), it is likely that some of it would be on prime farmland, particularly from community exansion.

Recreation

The impacts of the proposed actions would affect recreation to a small degree by the direct removal from the land base of approximately 435 acres which could have been used for recreation purposes by 1980, 1,219 acres by 1985, and 1,261 acres by 1990. The cumulative growth in the region would directly remove 4,604 acres by 1980, 18,084 acres by 1985, and 24,414 acres by 1990.

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) As 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 R4-11 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 communities of growth in Mesa County. Growth due to the proposed actions would require 4.2 acres of active/improved park land e.g. ballfields, playgrounds, tennis courts), etc.) by 1980, 19.3 acres by 1985, and 26 acres by 1990, to prevent overuse. A need for an addi tional swimming pool and nine hole golf course would also be felt about 1990. Total growth in the county would require substantial acreages for additional recreation facilities. Cumulative requirements would amount to 70.8 acres by 1980, 140 acres by 1985, and 144.9 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 3.1 acres of active/improved park land by 1980, 6.4 acres by 1985, and 7.2 acres by 1990. Facilities needed due to all growth in the county would be of more significance, with 50.5 acres needed by 1980, 76.2 acres by 1985, and 91.8 acres by 1990 needed 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 are not as large as those in Mesa and Garfield Counties, but they are more related to coal development. Facilities needed to prevent overuse because of the proposed actions include 3.0 acres of active/improved park land by 1980, 9.2 acres by 1985, and 9.9 acres by 1990. A need for an additional swimming pool and nine hole golf course could be felt by 1985 with possibly another of each by 1990. For all growth the county would require 12.5 acres of active/improved park land by 1980, 39.4 acres by 1985, and 55.4 acres by 1990. The demand could be felt for an additional swimming pool and nine hole golf course by 1985 with another of each by about 1990.

Montrose County is not expected to experience coal-related growth due to the proposed actions. Cumulative growth in the county would require 3.3 acres of active/improved park land by 1980, 13.4 acres by 1985, and 28.5 acres by 1990. A swimming pool and nine hole golf course would also be needed 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 5.6 acres of active/improved park land by 1980, 54.8 acres by 1985, and 46.9 acres by 1990. A need for an additonal 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 (450 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 Bureau of Outdoor Recreation, 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 will also grow. This will 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 coldwater stream, coldwater lake, warmwater predator, and warmwater panfish). Using these figures and population projections, increased fishing pressure from the proposed actions would amount to an additional 1,364 anglers (9,684 recreation days) by 1980, 4,659 anglers (33,083 recreation days) by 1985, and 5,750 anglers (40,830 recreation days) by 1990. All growth in the region would produce the following increased demand: 20,812 anglers (147,765 recreation days) by 1980, 46,684 anglers (331,456 recreation days) by 1985, and 54,032 anglers (383,627 recreation days) by 1990. This increase in demand and the fact that demand already exceeds supply for coldwater fisheries (Colorado Division of Wildlife, 1977) point 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 527 hunters (2,266 recreation days) by 1980, 1,800 hunters (7,741 recreation days) by 1985, and 2,222 hunters (9,554 recreation days) by 1990. All growth in the region would produce the following increased demand: 8,041 hunters (34,576 recreation days) by 1980, 18,037 hunters (77,559 recreation days) by 1985, and 20,876 hunters (89,767 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, this chapter, 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 as 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 R4-12 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 as 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 due to growth in the region should not adversely affect existing facilities, as projected increases (shown in table R4-12) would amount to about a 1 percent per year over the 1975-76 level of use.

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 do not occur in conjunction with 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.

TABLE R4-11

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	1,260	21,450	5,850	42,400	7,890	43,900	940	15,300	1,940	23,100	2,180	27,800
Active/improved parkland a/ (3.3 acres per 1,000)	4.2	70.8	19.3	140.0	26.0	144.9	3.1	50.5	6.4	76.2	7.2	91.8
Capital investment ($66,666 per 1,000)	$83,999	$1,429,986	$389,996	$2,826,638	$525,995	$2,926,637	$62,666	$1,019,989	$129,332	$1,539,985	$145,332	$1,853,315
Swimming pools (1 per 10,000)	0.1	2.1	0.6	4.2	0.8	4.4	0.1	1.5	0.2	2.3	0.2	2.8
Capital investment ($70,000 per 10,000)	$8,820	$150,150	$40,950	$296,800	$55,230	$307,300	$6,580	$107,100	$13,580	$161,700	$15,260	$194,600
Nine-hole golf courses (1 per 10,000)	0.1	2.1	0.6	4.2	0.8	4.4	0.1	1.5	0.2	2.3	0.2	2.8
Capital investment ($160,000 per 10,000)	$20,160	$343,200	$93,600	$678,400	$126,240	$702,400	$15,040	$244,800	$31,040	$369,600	$34,880	$444,800
Total investment	$112,979	$1,923,336	$524,546	$3,801,838	$707,465	$3,936,337	$84,286	$1,371,889	$173,952	$2,071,285	$2,266,757	$2,492,715

Source: Bickert, Browne, Coddington, and Associates, Inc., 1976.

a/ Ballfields, playgrounds, tennis courts, etc.

TABLE R4-11

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	900	3,800	2,800	11,950	3,000	16,800	--	1,000	--	4,050	--	8,650
Active/improved parkland a/ (3.3 acres per 1,000)	3.0	12.5	9.2	39.4	9.9	55.4	--	3.3	--	13.4	--	28.5
Capital investment ($66,666 per 1,000)	$59,999	$253,331	$186,665	$796,658	$199,998	$1,119,989	--	$66,666	--	$269,997	--	$576,661
Swimming pools (1 per 10,000)	0.1	0.4	0.3	1.2	0.3	1.7	--	0.1	--	0.4	--	0.9
Capital investment ($70,000 per 10,000)	$6,300	$26,600	$19,600	$83,650	$21,000	$117,600	--	$7,000	--	$28,350	--	$60,550
Nine-hole golf courses (1 per 10,000)	0.1	0.4	0.3	1.2	0.3	1.7	--	0.1	--	0.4	--	0.9
Capital investment ($160,000 per 10,000)	$14,400	$60,800	$44,800	$191,200	$48,000	$268,800	--	$16,000	--	$64,800	--	$138,400
Total investment	$80,699	$112,731	$251,065	$1,071,508	$268,998	$1,506,389	--	$89,666	--	$363,147	--	$775,611

TABLE R4-11

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	--	1,700	--	16,600	--	14,200	--	3,800	--	7,850	--	11,000
Active/improved parkland a/ (3.3 acres per 1,000)	--	5.6	--	54.8	--	46.9	--	12.5	--	25.9	--	36.3
Capital investment ($66,666 per 1,000)	--	$113,332	--	$1,106,656	--	$946,657	--	$253,331	--	$523,328	--	$733,326
Swimming pools (1 per 10,000)	--	0.2	--	1.7	--	1.4	--	0.4	--	0.8	--	1.1
Capital investment ($70,000 per 10,000)	--	$11,900	--	$116,200	--	$99,400	--	$26,600	--	$54,950	--	$77,000
Nine-hole golf courses (1 per 10,000)	--	0.2	--	1.7	--	1.4	--	0.4	--	0.8	--	1.1
Capital investment ($160,000 per 10,000)	--	$27,200	--	$265,600	--	$227,200	--	$60,800	--	$25,600	--	$176,000
Total investment	--	$152,432	--	$1,488,456	--	$1,273,257	--	$340,731	--	$703,908	--	$986,326

TABLE R4-11

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	--	250	--	150	--	450
Active/improved parkland a/ (3.3 acres per 1,000)	--	0.8	--	0.5	--	1.5
Capital investment ($66,666 per 1,000)	--	$16,666	--	$10,000	--	$30,000
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	--	$16,666	--	$10,000	--	$30,000

TABLE R4-12

FIFTEEN-YEAR RECREATION PARTICIPATION PROJECTIONS IN COLORADO PLANNING REGIONS 10, 11, AND 12

Activity	Region 10 (in thousands of activity days)			Region 11 (in thousands of activity days)			Region 12 (in thousands of activity days)		
	1980	1985	1990	1980	1985	1990	1980	1985	1990
Hiking	5,255.8	6,078.0	7,038.0	1,525.2	2,139.5	3,429.2	9,195.5	10,410.0	11,799.6
Horseback riding	973.8	1,115.9	1,280.6	920.1	1,021.3	1,073.4	1,273.4	1,447.8	1,649.0
Bicycling	5,191.8	3,667.7	4,073.4	4,614.5	5,126.5	5,645.2	2,821.6	3,113.4	3,435.9
Motorcycling	660.2	734.2	816.7	828.5	923.3	1,020.3	372.1	416.8	466.8
Sightseeing	5,582.7	6,506.7	7,592.7	4,181.8	4,883.3	5,695.0	9,024.7	10,538.4	12,317.9
Off-road vehicles	1,769.9	2,082.2	2,452.2	754.9	847.7	945.7	1,883.6	2,099.8	2,407.2
Tech. mntn. climbing	92.4	104.8	130.6	0	0	0	198.1	222.0	249.0
Swimming	599.1	674.6	760.3	1,939.2	2,184.5	2,445.7	2,184.4	2,504.6	2,876.0
Picnicking	2,546.1	2,993.3	3,522.3	1,722.2	1,980.8	2,271.2	3,260.1	3,807.0	4,450.1
Camping	2,824.0	3,289.1	3,834.7	2,054.3	2,360.2	2,703.5	4,887.9	5,590.4	6,396.5
Boating and rafting	316.2	366.7	425.8	550.7	619.0	741.2	743.6	826.7	926.6
Game playing	822.3	918.6	1,026.7	1,616.2	1,800.7	1,989.8	912.8	1,026.1	1,155.1
Tennis	71.9	82.3	94.3	225.3	251.0	277.3	664.7	762.8	876.7
Golfing	181.2	203.4	228.5	462.0	514.7	568.5	494.6	581.4	683.9
Target shooting	24.0	26.7	28.9	23.9	26.5	29.2	104.8	120.4	138.6
Downhill skiing	313.9	353.2	397.8	501.7	572.0	649.4	25,181.4	29,617.6	33,547.1
Cross-country skiing	265.1	299.1	337.6	11.9	13.2	14.6	1,251.7	1,403.0	1,574.1
Snowmobiling	159.2	178.1	199.3	215.0	238.8	262.6	439.3	495.1	546.7
Snowshoeing	0	0	0	0	0	0	356.7	409.4	469.9
Sledding and tubing	641.8	751.9	881.9	394.3	441.0	485.1	462.4	512.1	567.3
Ice skating	84.2	93.4	103.7	59.7	66.2	73.0	674.9	750.0	884.1
Other activities	1,016.8	1,196.3	1,409.2	947.2	1,089.8	1,250.8	683.9	804.1	946.5
Totals	29,393.4	31,716.2	36,635.2	23,548.6	27,100.0	31,570.7	67,072.2	77,458.9	88,364.6

Source: Colorado Division of Parks and Outdoor Recreation, 1976 Colorado Comprehensive Outdoor Recreation Plan.

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 capabil ities 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 increased coal production due to the proposed actions and associated population growth (from 152,050 people in 1977 to 198,900 by 1980, 259,150 by 1985, and 274,850 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 asociated service facilities (power lines, sewerage 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.

The three landscapes types described in chapter 2, (i.e. 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.

It is expected that the proposed actions would result in the conversion of primarily agricultural lands to residential and urban use on some 265 acres by 1980, 902 acres by 1985, and 1,112 aces by 1990. By comparison, regional cumulative growth would cause land use changes due to urban expansion on some 3,827 acres by 1980, 8,102 acres by 1985, and 9,353 acres by 1990.

Additionally, on-site mining development of the proposed mines would cause a land use change from livestock grazing and wildlife habitat to intensive mining uses on some 435 acres by 1980, 1,219 acres by 1985, and 1,261 acres by 1990.

As a result of land use changes due to the coal mining, associated urban expansion and other regional development activities and associated population growth, a total of 8,696 acres by 1980, 27,088 acres by 1985, and 34,879 acres by 1990 would be directly visually altered. Countless additional acres will be undisturbed, yet visually altered because of development on adjacent lands.

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 of Delta and Gunnison counties would absorb some visual changes, and coal development would add to urban growth projections for 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 it is a criterion in the BLM and USFS decision-making process for public lands.

WESTERN GRAND VALLEY

The proposed production by 1990 of 11.6 million tons of coal from mines located along the northern edge of the western Grand Valley and in DeBeque Canyon would initiate the development for mine-related uses of 128 acres by 1980, 602 acres by 1985, and 1,493 acres by 1990. Seventy-four miles of new road and 20 miles of new railroad would service 299 acres of mine facilities and 172 acres of refuse disposal by the latter date. The mine sites located around the perimeter of Grand Valley are not normally visible to the 63,509 (1977) residents of western Grand Valley or the traveling public but their construction and operation would cause visual changes in many local landscapes.

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 transportaiton systems (highways, railroads and air corridors) of western Grand Valley would all have increased usage for employee circulation and coal shipments (see Transportation, chapter 4, for quantification), 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).

The major land use change in the valley landscape that would be caused by increased coal production, would be urban expansion to accomodate new employees and their families. A projected 1,697 mine employees by 1990 in Mesa County would translate to an overall population increase of 9,268 persons, who would predominantly live in Grand Junction. Regional visual quality would be influenced by the location of the 2,018 dwellings that would house these persons. If the necessary 425 acres for those units are adjacent to existing developments, the visual impact would be less than if those acres were developed in completely natural landscapes. An additional 245 acres for schools, parks, hospitals, etc., would equal 670 acres of land use change for urban growth in western Grand Valley, which, when added to the mine acreage figure, would total over 1,700 acres of surface disturbance in the valley landscapes due to coal production at the proposed mines.

In addition to the mine-induced growth, western Grand Valley and Mesa County would simultaneously grow by 42,400 persons living in 9,848 new dwelling units. 4,870 acres would be used to accommodate that urban growth. The 2,450 acres of mine-generated land use change represent about one-third of the total change in western Grand Valley.

This expansion of Grand Junction would further erode the existing pastoral character. For many people, this change would be a visual impact; for others, it is progress. Urban growth is inevitable for Grand Junction, western Grand Valley, and Colorado; 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 only involve 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 landscape character of the viewshed. The eventual development of 230 acres by 1985 and 255 acres by 1990 would increase the surface disturbance and maintain the industrial character of the landscape for a limited veiwing area.

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 Mine 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.

The ARCO operation would employ 565 persons by 1985, which would mean an overall population increase of 3,000 by 1990. The landscape alterations for residences, urban development, etc., for this population growth would be integrated with cumulative population growth in Delta County of 3,800 people by 1980, 8,150 people by 1985, and 4,850 people by 1990 (or a total increase of 16,800 people by 1990). Approximately 1,390 acres would be needed by the 1990 population for houses, schools, etc., and 248 of those acres would be used by the mining community.

A third cause for growth and landscape character changes in the North Fork Valley would be the expansion of other mining operations and associated facilities such as storage silos and rail loadout facilities; 425 acres would be used for these aditional mine facilities.

The combination of land use changes due to Mt. Gunnison No. 1 Mine, other known mine expansions (see tables R-1, R1-2, and R1-3), and cumulative population growth would be a conversion of 2,070 acres by 1990. If this land use change 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 they are located in the wider western valley, they 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 study region would be minimal. The location of the Anschutz Thompson Creek No. 1 and No. 3 mines near Carbondale in the Roaring Fork Valley would indicate some residential and urban land use changes for the 320 projected employees and associated 480 family members in Garfield County. Their contribution to cumulative visual changes from other regional developments would be slight.

Plateaus

The majority of the proposed mines are located on the edges of the river valleys and are, therefore, also 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 pressure also. The upper Roaring Fork Valley is in a mountain region, and it would be further developed for the projected 11,000-person increase and 936 acres (1990) of land use changes 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 arrangment 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 34,879 acres of 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 increase of 122,800 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.

The development of the valley landscapes would define a higher degree of visual contrast between the extensively modified valley lands and the more natural plateau and mountain landscapes. Recreation pressures on these latter landscapes would increase as would pressure to develop the private lands. 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

The Colorado Population and Employment (CPE) Model was used to forecast population growth given projected employment increases from the activities under the cumulative level. An explanation of the CPE methodology and the assumptions which were made in generating the population projections are included in appendix 6.

Table R4-13 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 R4-14 shows the population increase due to the federal proposed actions and their percentage of the total projected population increase from 1977. Figure R4-3 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 action 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 is 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 because the majority of the urbanized area within proximity of those mines is within Garfield County. 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.

TABLE R4-13

CUMULATIVE POPULATION PROJECTIONS

County	1977	Percent Change	1980	Percent Change	1985	Percent Change	1990
Delta	18,950	+20.0	22,750	+35.8	30,900	+15.7	35,750
Garfield	18,800	+81.4	34,100	+25.8	42,900	+ 8.6	46,600
Gunnison	8,800	+14.2	10,050	+152.7	25,400	- 7.4	23,000
Mesa	66,800	+32.1	88,250	+23.7	109,200	+ 0.1	110,700
Montrose	23,200	+ 4.3	24,200	+12.5	27,250	+16.8	31,850
Ouray	2,250	+11.1	2,500	- 4.0	2,400	+12.5	2,700
Pitkin	13,250	+28.6	17,050	+23.6	21,100	+14.9	24,250
Total	152,050		198,900		259,150		272,850

TABLE R4-14

POPULATION INCREASE DUE TO THE FEDERAL PROPOSED ACTIONS

County	1980	Percent of Total Increase	1985	Percent of Total Increase	1990	Percent of Total Increase
Delta	900	23.7	2,800	23.4	3,000	17.9
Garfield	950	6.1	1,950	8.4	2,200	7.8
Gunnison	0	-	0	-	0	-
Mesa	1,300	5.9	5,850	13.8	7,900	18.0
Montrose	0		0		0	
Ouray	0		0		0	
Pitkin	0		0		0	
Region	3,150	6.6	10,600	10.0	13,100	10.6

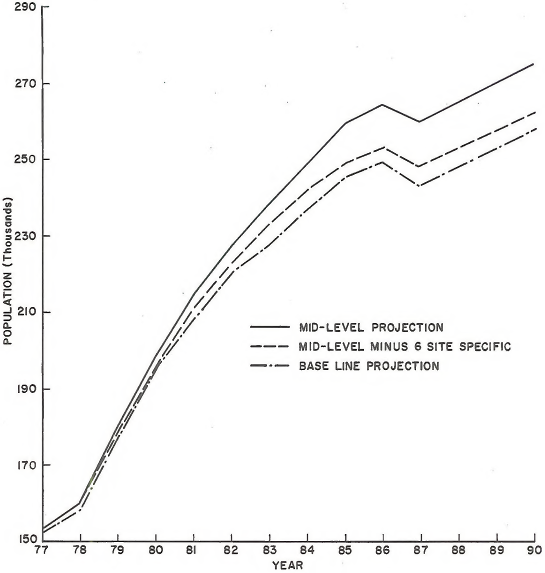


Figure R4-3. Projected population growth in the ES area resulting from proposed actions and cumulative development

The most dramatic increases in population would occur in Delta County. The proposed action would result in a population increase of about 900 people by 1980, 2,800 people by 1985, and 3,000 people by 1990. This is an increase of 4.2 percent (1980), 11.2 percent (1985), and 8.6 percent (1990) above what the population would be without the federal action. By comparison, cumulative development would increase Delta County population by 1,650 people in 1980, 5,900 people in 1985, and 6,400 people in 1990; respective increases of 7.8 percent, 23.6 percent and 21.8 percent above baseline projections.

Population of Mesa County would grow by 1,300 persons by 1980, 5,850 persons by 1985, and 7,900 persons by 1990 as a result of the proposed actions. This measure would be 5.9 percent, 13.8 percent, and 18.0 percent of the projected population incease 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 950 persons by 1980, 1,950 persons by 1985, and 2,200 persons by 1990. Cumulative growth in the county would bring county population to 34,100 people in 1980, 42,900 people in 1990, and 46,600 people in 1990. Coal development would amount to only 6.1 percent of the cumulative population increase in 1980, 8.4 percent in 1985, and 7.8 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 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.

Montrose County is expected to increase slightly in population as a direct result of new mining activity in Delta County. The effect on Montrose County would depend upon the ability of those communities in Delta County to absorb the projected population growth. The communities of Montrose and Olathe would be the only communities in Montrose County affected by population growth due to the proposed action.

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 action 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.

Montrose County would not experience change in lifestyle, due to the proposed action, because the associated employment and population growth in that county is expected to be small.

Land Use

The six proposed mines would result in the direct conversion of 435 acres, 1,219 acres, and 1,261 acres by 1980, 1985, and 1990 respectively, from livestock grazing and wildlife habitat usage to industrial usage as mine sites. In addition, 265, 902, and 1,112 acres by 1980, 1985, and 1990 would be converted from agricultural uses to urban development as a result of community expansion due to the new mining.

Table R4-15 and R4-16 break down the projected regional amount of land needed for urban purposes as a result of cumulative development and proposed federal action. These figures were derived using the land requirement ratios listed in table R4-17. Approximately 4,092 acres by 1980, 9,004 acres by 1985, and 10,465 acres by 1990 would have to be converted from existing uses to support expected population growth from 152,050 people in 1977 to 198,900, 259,150, and 274,850 people by 1980, 1985, and 1985 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.

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).

Community Facilities

Table R4-18 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 R4-5.)

TABLE R4-15

CUMULATIVE REGIONAL COMMUNITY EXPANSION
WEST-CENTRAL ES AREA

County	1980	1985	1990
Delta	273.3	1,054.9	1,390.4
Garfield	1,337.2	1,995.2	2,311.7
Gunnison	106.4	1,328.3	1,328.3
Mesa	1,940.8	3,577.3	3,721.6
Montrose	89.4	347.4	738.3
Ouray	21.3	12.8	38.3
Pitkin	323.5	668.4	936.6
Total	4,091.9	9,004.3	10,465.2

Note: Land converted to urban use to support population increases above 1977 level.

TABLE R4-16

CUMULATIVE COMMUNITY EXPANSION DUE TO PROPOSED FEDERAL ACTIONS
WEST-CENTRAL ES AREA

Proposed Actions	1980	1985	1990
ARCO	76.6	238.4	255.4
Anschutz	59.6	62.1	68.1
Coal Canyon			
Mesa County	17.0	69.0	78.3
Garfield County	5.1	20.4	23.0
Cottonwood			
Mesa County	17.0	138.8	155.8
Garfield County	5.1	40.9	46.8
Sheridan	74.1	199.2	315.9
Cameo			
Mesa County	0	91.1	121.8
Garfield County	9.8	42.6	46.7
Total	264.3	902.5	1,111.8

Note: Land converted to urban use to support population increases above 1977 level.

TABLE R4-17

STANDARDS FOR COMMUNITY FACILITY NEEDS

Facility	Standard (per 1,000 persons)	Land Requirement
Water supply and treatment	350,000 gallons per day b/ ($306,100 capital cost) c/ ($21,960 per year operating cost) c/	1 acre a/
Sewage treatment	100,000 gallons per day a/ ($330,000 capital cost) c/ ($16,102 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/ Bureau of Land Management, Regional Analysis, Final Environmental Statement Northwest Colorado Coal.

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.

Figure R4-4

Conversion of farmland to residential areas would accelerate.

The figures in table R4-18 have been graphed in figure R4-6 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 impact of the proposed action is not, of course, limited to only these five types of government services. Other community facilities and services are assumed to be at a level which provides for the needs of the present population, but with little or no capacity to provide for additional population.

Table R4-17 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 R4-18, a set of physical and financial requirements was derived for each county. Table R4-19 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 costs associated with the proposed actions represent about one-fifth of the total projected capital needs for the four counties. Operating cost increase associated with the proposed actions is about one-sixth of 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 R4-15 and R4-16, and the cost of land purchase was set at $4,000 per acre throughout the area. A 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 action, 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 action 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 action. 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 R4-7 and R4-8). 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 action, and it is consistent with household size ratios used to evaluate other large-scale developments in the same area. In Garfield and Mesa counties, a household size of 2.5 persons was used in 1980 to reflect the high level of construction employment.

Table R4-20 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 24 percent of the total increase in housing stock in 1980 and 1985, and 19 percent in 1990. In Mesa County, increases in the housing stock due to the proposed actions would be 6 percent in 1980, 14 percent in 1985, and 18 percent in 1990 of the cumulative increase. In Garfield this would be 6 percent in 1980, 8 percent in 1985, and 8 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, Rifle, and Montrose) 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 R4-15 and R4-16.

The capability of the area to meet the demand for these projected housing needs would be a criti-

TABLE R4-18

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 R4-5

Small towns such as DeBeque would grow faster than the ability to provide public services.

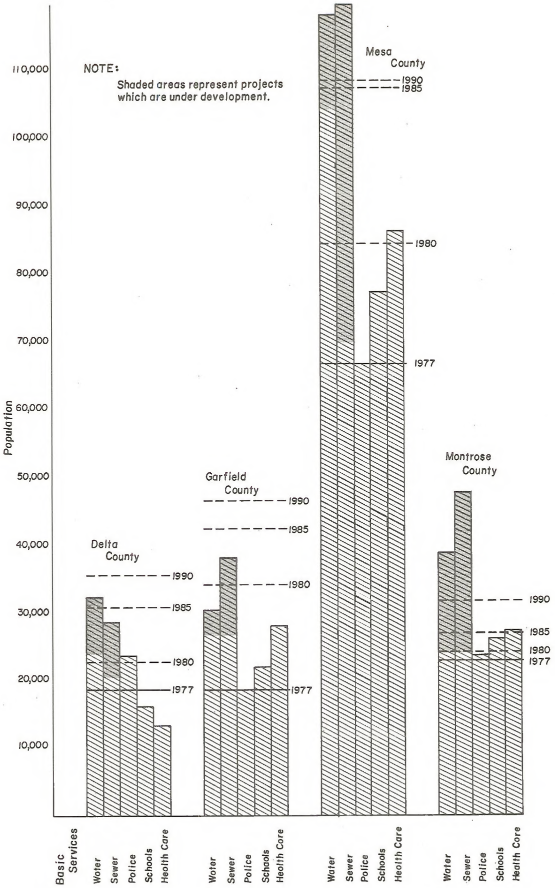


Figure R4-6. Projected population vs. the capacity to provide basic government services

TABLE R4-19

ADDITIONAL REQUIREMENTS FOR COMMUNITY FACILITIES BY 1990
(1978 DOLLARS)

	Delta County				
			Operating Costs (dollars/year)		
Facility	Physical Plant Requirements	Capital Costs (dollars)	1980	1985	1990
Water treatment:					
Cumulative scenario	Project 7, Cedaredge, Hotchkiss, and Paonia projects and 1.12 mgd	5,132,300	83,200	261,700	368,900
Proposed action only	1.05 mgd	918,000	19,800	61,500	65,880
Sewage treatment:					
Cumulative scenario	Delta sewer project and 0.70 mgd	3,421,000	61,200	192,400	207,500
Proposed action only	.3 mgd	990,000	14,500	45,000	48,300
Police protection:					
Cumulative scenario	9 vehicles and 5,120 sq.ft. of space	419,000	20,000	358,000	550,000
Proposed action only	1 vehicle and 1,200 sq.ft. of space	80,400	40,000	110,000	120,000
Fire protection:					
Cumulative scenario	6 vehicles and 16,800 sq.ft. of space	1,126,000	Volunteer	Volunteer	Volunteer
Proposed action only	1 vehicle and 3,000 sq.ft. of space	195,000	Volunteer	Volunteer	Volunteer
Streets and roads:					
Cumulative scenario	418.3 acres	13,479,000	110,800	348,500	406,700
Proposed action only	70.7 acres	2,278,000	29,100	81,200	87,500
General government:					
Cumulative scenario	4,200 sq.ft. of space	290,400	125,000	387,200	544,300
Proposed action only	750 sq.ft. of space	48,300	36,000	90,000	97,200
Libraries:					
Cumulative scenario	50,400 volumes and 9,240 sq.ft. of space	682,500	31,500	99,200	139,400
Proposed action only	9,000 volumes and 1,650 sq.ft. of space	121,875	7,500	23,200	24,900
TOTAL COSTS:					
Cumulative scenario		24,550,000	561,700	1,647,000	2,396,800
Proposed action only		4,631,000	146,900	410,900	425,000

TABLE R4-19 continued

ADDITIONAL REQUIREMENTS FOR COMMUNITY FACILITIES BY 1990
(1978 DOLLARS)

	Garfield County				
			Operating Costs (dollars/year)		
Facility	Physical Plant Requirements	Capital Costs (dollars)	1980	1985	1990
Water treatment:					
Cumulative scenario	Carbondale and Rifle water projects and 5.67 mgd	7,459,000	335,000	527,800	588,200
Proposed action only	.68 mgd	600,100	18,000	38,500	43,100
Sewage treatment:					
Cumulative scenario	Rifle, Glenwood Springs, and Carbondale sewer projects 0.64 mgd	4,006,000	246,400	388,000	419,500
Proposed action only	.19 mgd	644,600	13,250	28,300	31,550
Police protection:					
Cumulative scenario	17 vehicles and 10,400 sq.ft. of space	839,200	612,000	964,000	1,100,000
Proposed action only	1 vehicle and 790 sq.ft. of space	60,930	20,000	80,000	100,000
Fire protection:					
Cumulative scenario	9 vehicles and 27,800 sq.ft. of space	1,787,000	Volunteer	Volunteer	Volunteer
Proposed action only	1 vehicle and 1,960 sq.ft. of space	153,400	Volunteer	Volunteer	Volunteer
Streets and roads:					
Cumulative scenario	692.0 acres	22,298,000	369,400	582,400	672,800
Proposed action only	56.0 acres	1,656,000	25,100	48,300	54,100
General government:					
Cumulative scenario	6,950 sq.ft. of space	447,600	495,700	780,800	900,000
Proposed action only	490 sq.ft. of space	31,000	18,000	63,000	63,000
Libraries:					
Cumulative scenario	78,000 volumes and 14,300 sq.ft. of space	1,056,000	127,000	200,000	230,800
Proposed action only	5,850 volumes and 5,050 sq.ft. of space	290,400	6,800	14,600	16,300
TOTAL COSTS:					
Cumulative scenario		37,892,000	2,185,200	3,443,000	4,066,300
Proposed action only		3,436,400	101,200	272,700	308,000

TABLE R4-19 continued

ADDITIONAL REQUIREMENTS FOR COMMUNITY FACILITIES BY 1990
(1978 DOLLARS)

	Mesa County				
			Operating Costs (dollars/year)		
Facility	Physical Plant Requirements	Capital Costs (dollars)	1980	1985	1990
Water treatment:					
Cumulative scenario	Grand Junction and Palisade water projects	6,900,000	469,800	928,600	961,400
Proposed action only	2.8 mgd	2,089,700	27,890	128,500	131,600
Sewage treatment:					
Cumulative scenario	Grand Junction and Fruita sewer projects	4,400,000	345,400	682,800	706,900
Proposed action only	.78 mgd	2,613,600	20,400	82,400	96,400
Police protection:					
Cumulative scenario	28 vehicles and 16,600 sq.ft. of space	1,336,200	858,000	1,696,000	1,740,000
Proposed action only	5 vehicles and 3,160 sq.ft. of space	252,100	20,000	240,000	330,000
Fire protection:					
Cumulative scenario	13 vehicles and 41,500 sq.ft. of space	2,635,000	386,000	763,200	783,000
Proposed action only	3 vehicles and 7,870 sq.ft. of space	539,800	18,000	108,000	288,000
Streets and roads:					
Cumulative scenario	1,031.3 acres	33,231,000	490,000	989,000	1,015,000
Proposed action only	294.4 acres	9,466,000	37,100	168,100	285,600
General government:					
Cumulative scenario	10,400 sq.ft. of space	669,700	695,000	1,374,000	1,409,000
Proposed action only	1,980 sq.ft. of space	125,500	36,000	149,400	261,000
Libraries:					
Cumulative scenario	117,000 volumes and 21,500 sq.ft. of space	1,587,000	178,000	352,000	361,000
Proposed action only	23,700 volumes and 4,350 sq.ft. of space	321,300	10,600	48,500	65,700
TOTAL COSTS:					
Cumulative scenario		50,759,000	3,422,200	6,785,600	6,976,000
Proposed action only		15,408,000	170,000	924,900	1,458,300

TABLE R4-19 continued

ADDITIONAL REQUIREMENTS FOR COMMUNITY FACILITIES BY 1990
(1978 DOLLARS)

	Montrose County				
			Operating Costs (dollars/year)		
Facility	Physical Plant Requirements	Capital Costs (dollars)	1980	1985	1990
Water treatment:					
Cumulative scenario	Project 7	3,600,000	21,900	87,600	189,600
Proposed action only	None	--	--	--	--
Sewage treatment:					
Cumulative scenario	Montrose and Olathe sewer projects	3,100,000	16,102	64,400	139,000
Proposed action only	None	--	--	--	--
Police protection:					
Cumulative scenario	6 vehicles and 3.454 sq.ft. of space	281,400	40,000	160,000	345,400
Proposed action only	None	--	--	--	--
Fire protection:					
Cumulative scenario	3 vehicles and 8,635 sq.ft. of space	422,800	Volunteer	Volunteer	Volunteer
Proposed action only	None	--	--	--	--
Streets and roads:					
Cumulative scenario	215 acres	6,928,000	24,300	97,200	209,000
Proposed action only	None	--	--	--	--
General government:					
Cumulative scenario	2,159 sq.ft. of space	139,000	36,000	129,600	279,800
Proposed action only	None	--	--	--	--
Libraries:					
Cumulative scenario	25,905 volumes and 4,749 sq.ft. of space	350,800	8,300	33,200	71,700
Proposed action only	None	--	--	--	--
TOTAL COSTS:					
Cumulative scenario		14,822,000	146,600	572,000	1,306,000
Proposed action only		--	--	--	--

TABLE R4-19 continued

ADDITIONAL REQUIREMENTS FOR COMMUNITY FACILITIES BY 1990
(1978 DOLLARS)

Total Capital Cost Associated with Cumulative Development	128,023,000
Total Capital Cost Associated with Proposed Action	23,475,000

	1980	1985	1990
Total Operating Cost Associated with Cumulative Development	6,316,000	12,447,000	14,745,000
Total Operating Cost Associated with Proposed Action	418,000	1,609,000	2,191,000

TABLE R4-20

NEW HOUSING REQUIREMENTS

		Single Family	Mobile Homes	Multi-Family	Total Units
Delta County:					
Total:	1980	823	317	126	1,266
	1985	2,589	996	398	3,983
	1990	3,640	1,400	560	5,600
Due to the proposed action:					
	1980	195	75	30	300
	1985	607	233	93	933
	1990	650	250	100	1,000
Garfield County:					
Total:	1980	3,060	2,448	612	6,120
	1985	5,222	2,008	803	8,033
	1990	6,023	2,317	927	9,267
Due to the proposed action:					
	1980	187	150	38	375
	1985	423	162	65	650
	1990	472	181	73	726
Mesa County:					
Total:	1980	4,256	3,404	851	8,511
	1985	9,155	3,521	1,408	14,084
	1990	9,471	3,643	1,457	14,571
Due to the proposed action:					
	1980	253	202	51	506
	1985	1,269	488	195	1,952
	1990	1,710	657	263	2,630

Figure R4-7

Figure R4-8

Mobile homes would provide a substantial portion of new housing.

cal 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 R2-35 in chapter 2 lists housing starts by county between 1970 and 1975. Company housing starts data with the housing requirements shows 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. Increases of three to four times in Delta County would be necessary to provide housing for cumulative growth through 1990. Mesa and Garfield counties would need to increase housing starts by three to six times to provide necessary units by 1980; from 1980 to 1990 the maximum starts in the period 1970 to 1975 would be sufficient. 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 action is shown in table R4-21. The table lists the increases in school-aged children associated with both the cumulative population projection and the proposed action. These figures were generated by the Colorado Population and Employment Model, and they represent total school-aged population. The figures are presented by 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 four affected counties can be estimated, using the standards for school requirements contained in table R4-17. The present excess capacities of school facilities, as outlined in table R4-18, were included as part of these calculations. The figures are contained in table R4-22.

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 action. In Garfield County, the projected total school facility requirements for 1990 represent about 165 percent of the three school districts' combined present legal limit for bonding capacity (set by state law at 20 percent of assessed valuation) and 75 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 $0.6 million requirement for school facilities which is directly associated with the proposed action represents about 3 percent of the present county-wide school bonding capacity and 1 percent of the projected increased capacity.

In Mesa County, the cumulative school facility requirements for 1990 represent about 145 percent of the present legal bonding capacity of all districts and 90 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 $12.8 million school facilities requirement in Mesa County associated with the proposed action represents about 38 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 $25.8 million cost figure represents almost three times the available bonding capacity of the district, which presently has no outstanding debt and 133 percent of the projected bonding capacity. The Delta County School District 50(J) capital requirements due to the proposed action alone represent about 37 percent of the district's present bonding capacity and 19 percent of the projected capacity.

Table R4-23 lists the expected increases in school district assessed valuation and the increases in school district bonding capacities due to the proposed action. 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 R4-22, shows that the school districts in Garfield

TABLE R4-21

SCHOOL-AGED POPULATION PROJECTIONS

	1977	1980	1985	1990
Delta County:				
Proposed Action	0	250	550	575
Cumulative	4,150	4,850	6,650	8,250
Garfield County:				
Proposed Action	0	234	416	462
Cumulative	4,300	7,750	8,800	9,850
Mesa County:				
Proposed Action	0	341	1,350	2,035
Cumulative	14,500	18,750	23,150	25,100

TABLE R4-22

INCREASED SCHOOL DISTRICT FACILITY REQUIREMENTS

	Facility Requirements (Square Feet)	Facility Costs ($ Million)	Operation and Maintenance ($ Million/Year)
Delta County - 50(J)			
1980			
Cumulative	98,000	4.4	0.9
Proposed Action	35,000	1.6	0.3
1985			
Cumulative	350,000	15.8	3.1
Proposed Action	77,000	3.5	0.7
1990			
Cumulative	574,000	25.8	5.0
Proposed Action	80,500	3.6	0.7
Garfield County - RE-1(J), RE-2, 16			
1980			
Cumulative	336,000	15.1	3.0
Proposed Action	32,760	1.5	0.3
1985			
Cumulative	413,000	18.6	3.6
Proposed Action	58,240	2.6	0.5
1990			
Cumulative	630,000	28.4	5.5
Proposed Action	64,680	2.9	0.6
Mesa County - 49(JT), 50, 51			
1980			
Cumulative	186,200	8.4	1.6
Proposed Action	47,740	2.1	0.5
1985			
Cumulative	802,200	36.1	7.0
Proposed Action	189,000	8.5	1.7
1990			
Cumulative	1,075,200	48.4	9.4
Proposed Action	284,900	12.8	2.5

TABLE R4-23

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)	48,451,000	9.7 million
Garfield County RE-1(J) RE-2 16	188,646,000	37.7 million
Mesa County 49(JT) 50 51	101,336,000	20.2 million

county would experience a net deficit between capital facility costs and increased district bonding capacity. In both Delta and Mesa counties, the school districts would be able to recover the capital costs associated directly with the proposed action 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 R4-24 is an estimate of health care requirements and associated costs to accommodate the expected increases in population both with and without the proposed action. The factors used in arriving at these figures are contained in table R4-17.

Again the cost requirements presented in table R4-24 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 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 R4-25 shows the estimated amount that the state would receive from the royalties paid due to the proposed action. 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:

TABLE R4-24

PROJECTED HEALTH CARE REQUIREMENTS (1990)

	Health Care Facility Requirements	Costs
Delta County:		
Cumulative	57 hospital beds and 4 emergeny vehicles	$ 3,212,000
Proposed action	8 hospital beds and 1 emergency vehicle	455,000
Difference	49 hospital beds and 3 emergency vehicles	$ 2,757,000
Garfield County:		
Cumulative	46 hospital beds and 6 emergency vehicles	$ 2,620,000
Proposed action	6 hospital beds and 0 emergency vehicles	330,000
Difference	40 hospital beds and 6 emergency vehicles	$ 2,290,000
Mesa County:		
Cumulative	174 hospital beds and 9 emergency vehicles	$ 9,705,000
Proposed action	32 hospital beds and 2 emergency vehicles	1,790,000
Difference	154 hospital beds and 7 emergency vehicles	$ 7,915,000
Total facility cost due to proposed action		$ 2,575,000

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 R4-26 shows the amounts that would be received by the state from the severance tax for selected years as a result of the proposed action 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 R4-27 shows 1976 mill levies for the seven counties. Municipal levies were excluded because the coal mines are located outside of municipalities.

Table R4-28 shows the amount of coal expected to be produced from new mines and increased production on existing mines, due to the proposed action, 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 study area could be receiving from coal mines over $9 million a year 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 R4-29, and in table R4-30 for the cummulative projection.

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.

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 biult. Table R4-31 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 R4-32 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.

Tabulated information on state or federal financial and technical assistance programs that are available to energy-impacted communities is availa-

TABLE R4-25

COLORADO'S SHARE OF ROYALTIES FROM PROJECTED COAL MINES

Year	States Share of Royalties
1980	$2,024,000
1985	$6,912,000
1990	$9,280,000

TABLE R4-26

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	3,421,600		3,421,600	

TABLE R4-27

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 R4-28

INCREASES IN COUNTY PROPERTY TAXES FROM INCREASED COAL MINING DUE TO THE PROPOSED ACTION

County	Year	Increased Production (Million Tons)	Property Tax Paid On Improvements	Property Tax Paid On Coal Mines	Total
Delta a/	1980	0	0	0	0
	1985	0	0	0	0
	1990	0	0	0	0
Garfield	1980	0.73	0	138,550	138,550
	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	2.50	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.

TABLE R4-29

INCREASED PROPERTY TAXES, AND SALES TAXES, ACCRUING TO COUNTIES FROM THE POPULATION INCREASE ASSOCIATED WITH THE PROPOSED ACTION

County	Property Tax (dollars)			Sales Tax (dollars)		
	1980	1985	1990	1980	1985	1990
Delta	210,120	653,120	700,420	68,400	212,800	228,000
Garfield	452,040	784,890	858,250	135,620	288,630	324,190
Mesa	471,210	1,819,650	2,430,260	160,120	729,170	983,148

TABLE R4-30

INCREASED PROPERTY TAXES, AND SALES TAXES ACCRUING TO COUNTIES FROM THE CUMULATIVE POPULATION INCREASE

County	Property Tax (dollars)			Sales Tax (dollars)		
	1980	1985	1990	1980	1985	1990
Delta	864,240	2,259,460	3,176,670	288,800	908,200	1,276,800
Garfield	5,664,030	8,213,100	9,884,130	2,530,620	3,820,740	4,598,120
Mesa	6,970,640	13,358,290	13,830,870	2,672,670	5,283,040	5,469,940

TABLE R4-31

TAP FEE REVENUES

County	1980 (Dollars)	1985 Dollars)	1990 (Dollars)
Proposed Action:			
Delta	312,000	970,320	1,040,000
Garfield	343,980	733,320	819,000
Mesa	714,420	2,867,970	3,867,570
Cumulative Development:			
Delta	1,317,680	4,142,320	5,824,000
Garfield	7,711,200	9,702,000	11,676,420
Mesa	12,612,600	20,775,510	21,510,510

TABLE R4-32

WATER AND SEWER SERVICE FEE REVENUE

County	1980 (Dollars)	1985 Dollars)	1990 (Dollars)
Proposed Action:			
Delta	34,020	105,800	113,400
Garfield	37,010	77,700	83,520
Mesa	34,420	138,130	186,890
Cumulative Development:			
Delta	143,670	451,670	635,040
Garfield	829,870	1,044,120	1,256,610
Mesa	607,460	1,000,620	1,036,230

ble 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 action would be 1,189 people in 1980, 2,330 people in 1985, and 2,784 people in 1990. This is out of a total cumulative projected employment of 70,754 people in 1980, 77,800 people in 1985, and 79,141 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 $19,167,400 in 1980, $36,983,000 in 1985, and $44,519,400 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 $29,134,450 in 1980, $56,214,160 in 1985, and $67,669,490 in 1990.

Summary:

Table R4-33 lists the total estimated capital and operating 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. Annual revenues from the population increases are also shown.

Comparing costs with revenues reveals that the region 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 remain in a deficit situation throughout the study period. Only Garfield County and Montrose County could expect a revenue surplus. Delta County's cumulative needs would be more than double the expected revenue.

The aggregation of these revenue and expenditure figures to county and regional levels, of course, does not consider the many juris dictional 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.

TABLE R4-33

OPERATING COSTS AND CAPITAL REQUIREMENTS

	Community Facilities and Services	Public Education	Health Care
Proposed Actions			
Operating Costs			
1980	$ 418,100	$ 1,100,000	**
1985	1,608,500	2,900,000	**
1990	2,191,300	3,800,000	**
Capital Costs 1990	23,475,400	19,300,0000	$ 2,575,000
Amortized Capital Cost	2,046,690	1,682,660	224,500
Cumulative Development			
Operating Costs			
1980	$ 6,315,700	$ 5,500,000	**
1985	12,447,600	13,700,000	**
1990	14,745,100	21,400,000	**
Capital Costs 1990	128,023,000	100,200,000	$13,475,000
Amortized Capital Costs	11,161,630	8,735,890	1,174,810

	Total Annual Cost		Annual Revenues	
	Proposed Actions	Cumulative	Proposed Actions	Cumulative
1980	$5,471,950	$32,888,930	$ 1,882,610	$30,336,320
1985	8,462,350	47,219,930	12,659,790	46,685,190
1990	9,945,150	52,217,430	14,818,800	54,202,380

TABLE R4-33 continued

OPERATING COSTS AND CAPITAL REQUIREMENTS DELTA COUNTY

	Community Facilities and Services	Public Education	Health Care
Proposed Actions			
Operating Costs			
1980	$ 146,900	$ 300,000	**
1985	410,900	700,000	**
1990	425,000	700,000	**
Capital Costs 1990	4,631,000	3,600,000	$ 455,000
Amortized* Capital Costs	403,750	313,860	39,670
Cumulative Development			
Operating Costs			
1980	$ 561,700	$ 900,000	**
1985	1,647,000	3,100,000	**
1990	2,396,800	5,000,000	**
Capital Costs 1990	24,550,000	25,800,000	$3,212,000
Amortized* Capital Costs	2,140,380	2,249,360	280,040

	Total Annual Cost		Total Revenues	
	Proposed Action	Cumulative	Proposed Action	Cumulative
1980	$1,204,180	$ 6,131,480	$ 321,530	$1,305,700
1985	1,868,180	9,416,780	2,105,610	4,753,220
1990	1,882,280	12,066,580	2,203,120	6,249,810

TABLE R4-33 continued

OPERATING COSTS AND CAPITAL REQUIREMENTS GARFIELD COUNTY

	Community Facilities and Services	Public Education	Health Care
Proposed Actions			
Operating Costs			
1980	$ 101,200	$ 300,000	**
1985	272,700	500,000	**
1990	308,000	600,000	**
Capital Costs 1990	3,436,400	2,900,000	$ 330,000
Amortized Capital Costs	299,600	252,840	28,770
Cumulative Development			
Operating Costs			
1980	$ 2,185,200	$ 3,000,000	**
1985	3,443,000	3,600,000	**
1990	4,066,300	5,500,000	**
Capital Costs 1990	37,892,000	28,400,000	$2,620,000
Amortized Capital Costs	3,303,600	2,476,040	228,420

	Total Annual Cost		Annual Revenues	
	Proposed Actions	Cumulative	Proposed Actions	Cumulative
1980	$ 982,410	$11,193,260	$ 763,220	$ 9,163,070
1985	1,353,910	13,051,060	5,902,410	17,819,150
1990	1,489,210	15,574,360	6,299,950	20,772,850

TABLE R4-33 continued

OPERATING COSTS AND CAPITAL REQUIREMENTS MESA COUNTY

	Community Facilities and Services	Public Education	Health Care
Proposed Actions			
Operating Costs			
1980	$ 170,000	$ 500,000	**
1985	924,900	1,700,000	**
1990	1,458,300	2,500,000	**
Capital Costs 1990	15,408,000	12,800,000	$1,790,000
Amortized Capital Costs	1,343,340	1,115,960	156,060
Cumulative Development			
Operating Costs			
1980	$ 3,422,200	$ 1,600,000	**
1985	6,785,600	7,000,000	**
1990	6,976,000	9,400,000	**
Capital Costs 1990	50,759,000	48,400,000	$9,705,000
Amortized Capital Costs	4,425,400	4,219,730	846,130

	Total Annual Cost		Annual Revenues	
	Proposed Actions	Cumulative	Proposed Actions	Cumulative
1980	$3,285,360	$14,513,460	$ 797,860	$10,382,880
1985	5,240,260	23,276,860	4,651,770	22,175,820
1990	6,573,660	25,867,260	6,315,730	23,052,470

TABLE R4-33 continued

OPERATING COSTS AND CAPITAL REQUIREMENTS MONTROSE COUNTY

	Community Facilities and Services	Public Education	Health Care
Cumulative Development			
Operating Costs			
1980	$ 146,600	0	**
1985	572,000	0	**
1990	1,306,000	$1,500,000	**
Captial Costs	14,822,000	7,600,000	$695,000
Amortized Capital Costs	1,292,250	662,600	60,590

	Total Annual Cost		Annual Revenues	
	Proposed Actions	Cumulative	Proposed Actions	Cumulative
1980	--	$2,162,040	--	$ 484,670
1985	--	2,587,440	--	1,937,000
1990	--	3,321,440	--	4,127,250

** Operating costs are generally paid for by patient fees.

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 action 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 action 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 $57,217,430 would be necessary by 1990 to provide and operate the new facilities and services required by cumulative growth. Only $9,945,150 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 $54,202,380 by 1990; $14,818,800 of this can be attributed to the proposed action. Revenues from the proposed action would be greater than costs in Delta and Garfield counties, but Mesa County would retain a revenue deficit through 1990. From cumulative growth, Delta and Mesa counties would have expenses greater than revenues through the period, while Garfield County would have surplus revenues in 1985 and 1990. 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.

All coal mining in the ES area would require 79,160 tons of rock dust in 1980, 316,640 tons by 1985, and 642,160 tons by 1990. The proposed actions would require 17,120 tons of rock dust by 1980 (22 percent of the total requirement), 137,240 tons by 1985 (43 percent), and 351,760 tons by 1990 (55 percent).

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 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 $\mu g/m^3$ 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 5 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 implementatin 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 $\mu g/m^3$ 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 study region would not be apparent as actual visibility reductions because lines of sight would be obstructed by canyons, mountains, and other complex terrain features.

The proposed actions may change the surface meteorology at the mine sites by altering the surface contours, albedo and material distribution, and temporarily reducing vegetation during mining.

Water Resources

The total regional water consumption resulting from cumulative development would be approximately 5,328 acre-feet in 1980, 24,224 acre-feet in 1985, and 33,054 acre-feet in 1990. The total increased water consumption (industrial and municipal) as a result of the proposed actions would be approximately 1,615 acre-feet in 1980, 5,734 acre-feet in 1985, and 7,390 acre-feet in 1990.

Aquatic Biology

Sewage pollution from 120,450 more people would cause organic loading, increased ammonia levels, and possible eutrophication in major streams. Fisheries would decline in quality, and species composition may be altered.

Urbanization would increase silt, nutrients, gas, oil, litter, temperature and biological oxygen demand in streams. Game and endemic fish 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 mammals.

An increase in the salinity of streams and the Colorado River would decrease production of fish and aquatic species.

Stream flow depletion and changing flow regime will change and diminish the population of fish, aquatic species, and riparian habitats in the region.

Increased fishery pressure by 52,998 new anglers would cause a decrease in fish populations and a resultant loss of quality in some streams. Increased reliance on hatchery fish would result. On the Colorado River in the vicinity of the Mid-Continent mines, extensive development on both sides of the river would decrease the desirability of this section for anglers. North Thompson Creek below the Anschutz mine would be of limited value as a fishery unless runoff and discharge from the mine site is totally controlled.

Threatened and endangered fish species in the Colorado River may suffer population declines due to changes in the aquatic habitat.

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 a result of mine site development due to the proposed actions, approximately 130 acres of farmland would be disturbed by 1980, and 290 acres by 1985 and continuing through 1990, resulting in an annual loss of revenue of $30,420 by 1980 and $67,860 by 1985 and 1990.

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 20 AUMs would be lost each year by 1980, 60 AUMs by 1985, and 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 2,400 acres by 1980, 9,600 acres by 1985, and 19,385 acres by 1990.

TABLE R5-1

SURFACE DISTURBANCE

	1980	1985	1990
Cumulative Regional Surface Disturbance:			
Urban Area Expansion	4,092	9,004	10,465
Other Development	4,604	18,084	24,414
Total	8,696	27,088	34,879
Surface Disturbance due to Proposed Action:			
Urban Area Expansion	265	902	1,112
Mine Site Development	435*	1,219**	1,261**
Total	700	2,121	2,373

*Includes 130 acres of cropland and dryland as irrigated pasture.
**Includes 290 acres of cropland and dryland as irrigated pasture.

Surface subsidence due to the proposed actions would disturb approximately 600 acres in 1980 (25 percent of the total), 4,800 acres in 1985 (50 percent of the total), and 12,600 acres in 1990 (65 percent of the total). The secondary effects of subsidence may cause the disappearance of surface water bodies, rerouting or disruption of streams, geologic hazard potentials, changes in ground water flow, and damage to underlying coal beds.

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.

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. This amounts to 0.37 percent, 1.25 percent, and 1.93 percent, respectively, of 3,465,000 acres of wildlife habitat in the ES area. 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 2,373 acres of habitat would be lost by 1990 (0.06 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 from the proposed actions. 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 8,696 acres projected for surface disturbance by 1980, 27,088 acres by 1985, and 34,879 acres by 1990 (700, 2,121, 2,373 acres respectively, are due to the six proposed actions) as well as a maximum of 19,385 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 study regions would increase pressure on recreational resources and facilities. This increased use would increase maintenance and overhead costs for the managing agencies. As 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 120,450 people would predominantly concentrate around existing communities and would magnify 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, and 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 palentological 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

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:

. An estimated 321.08 million short tons of coking and non-coking bituminous quality coal would be mined in the ES area; 165.88 million short tons (55 percent) would be mined as a result of the proposed federal actions. Approximately 50 percent of the coal 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 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 TSP concentrations to exceed both the annual federal secondary and the annual Colorado standards.

3. The proposed actions may alter the micrometeorology of the mine sites by changing surface contours, albedo and material distributions, as well as temporarily reducing the vegetation.

4. Cumulative development would require the consumption of a minimum of 33,054 acre-feet of water per year through 1990, for both municipal and industrial purposes. Coal mining and processing as a result of the proposed actions would consume 5,123 acre-feet by 1990. The amount of water used for mining (5,123 acre-feet plus an unquantifiable percentage of 33,054 acre-feet) would probably be available for other purposes after the mineral reserves are exhausted.

5. Throughout the life of each coal mine, impacts on water quality would be minimized with proper engineering, construction, and maintenance of water control structures as prescribed by state and federal regulations. Nevertheless, most of these systems are only designed for the 10-year/24-hour event, and runoff amounts exceeding the design value are not covered by existing effluent standards. In such cases, sediment and other debris from mine sites would then cause at least short-duration impairment of stream quality with resultant degradation of aquatic habitats and diminishment of aquatic species.

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; approximately 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. Greater coal production would increase rail and truck traffic, which would increase traffic accidents including train-automobile collisions, lengthen waiting periods at railroad crossings, and cause delays in shipping.

10. The mere presence of mine facilities would alter access to potential recreational areas, specifically in the case of the Anschutz operation.

11. Mine facilities, along with expected changes in vegetation and topography, would alter visual resources.

12. The increased demand for recreation facilities would not be met until sufficient funds are available, if then.

13. 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 severe population growth pressures resulting from the proposed federal actions.

14. 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.

15. 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. Mesa County would have deficits through 1990 as a result of both cumulative development and the proposed actions. Garfield County would have surplus revenues resulting from both cumulative development and the proposed actions through the same period.

16. Rapid inflation would be expected over the short term.

17. 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.

18. A substantial portion of the regional employment and earnings would depend on the health of the coal and other mineral reource 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.

19. 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 mining may preclude recovery of other energy resources, particularly on oil and gas.

4. If the reclamation and revegetation at the proposed action mine sites are not equivalent to current vegetaton and surface characteristics, the local meteorology would be permanently altered.

5. 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.

6. 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.

7. An undetermined number of uninventoried exposed and unexposed fossil resources would be impaired or destroyed by mineral development.

8. An unquantifiable gain in knowledge would result from surveys and exposure of fossil reources which might never have been found without development.

9. The municipal water consumption resulting from cumulative development (an unquantifiable percentage of 33,054 acre-feet per year through 1990) and resulting from the proposed actions (5,123 acre-feet per year through 1990) can be expected to continue past 2025.

10. Overall water quality would change due to land disturbance and altered land use patterns. Historically, urbanization has led to decreased water quality due to increased runoff, added demands on sewage treatment systems, and additional industrial pollution.

11. Urbanization, increased total dissolved solids, sewage pollution, increased water use, and incidences of chemical pollution, would cause streams to decline as fisheries habitat. Aquatic species that are intolerant of such changes would diminish in numbers. The endangered species in

the Colorado River as well as other endemic river species, would be affected. Trout, which are very intolerant of habitat changes, would decline in some of the cold water stream areas. Fish species that are tolerant of such environmental changes such as carp, red shiners, bullheads, and some species of suckers, would be favored.

12. Cold water trout streams and lakes would decrease in quality due to the loss of wild fish populations from increased angler pressure. Fisheries would become more dependent on hatchery-raised fish.

13. Long-term soil and vegetative productivity would be lost on 10,465 acres due to cumulative urban area expansion, including 1,112 acres disturbed by urban expansion resulting from the proposed federal actions.

14. The long-term productivity of natural vegetation disturbed on 24,414 acres by cumulative mineral devlopment, including 1,261 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 grasses (as indicated in most of the site-specific plans), an increase in the productivity of the land for livestock and wildlife use would be expected.

15. An unquantifiable amount of farmland would be permanently removed from production due to community expansion associated with cumulative regional development, including the proposed actions.

16. An unquantifiable amount of farmland would be removed from production due to the cumulative mineral development, including 290 acres under the federal proposed actions. This land could be reclaimed to cropland and irrigated hayland, but it probably would not be.

17. An increase in AUMs could be expected on the 1,261 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 24,414 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.

18. Habitat for endangered and threatened plants, particularly *Sclerocactus glaucus* and *Penstemon retrorsus*, could be harmed by increased off-road vehicle use in the region. Exploitaiton of endangered and threatened plants, particularly *Sclerocactus glaucus* and *Echinocereus triglochdiatus* var. *inermis*, by amateur and commercial horticulturalists could increase.

19. 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 Cameo mines.

20. 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.

21. 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.

22. 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.

23. Vandalism of cultural resources would increase in association with regional population growth and would permanently reduce cultural resources.

24. 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.

25. The visual character of the region would change due to the shift from a rural to an urban setting and from agricultural to industrial devleopment.

26. Initial conflicts between old and new residents would be absorbed into more urban lifestyles and attitudes over the long term.

27. 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.

28. 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.

29. 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 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 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 actions would be irretrievable and 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.

Water consumption would be increased by 33,054 acre-feet per year.

Overall water quality would decline due to land disturbance and altered land use patterns, particularly urbanization.

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 asociated 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 extensive 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.

CHAPTER 8

ALTERNATIVES TO THE PROPOSED ACTIONS

This regional environmental statement (ES) evaluates the impacts of projected coal development in west-central Colorado. The production level evaluated as most probable is dependent in part on federal approval of mining and reclamation (M&RP) plans on existing federal leases and, in some cases, approval of short-term competitve 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. The proposed actions under review at this time are being considered in this context.

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 statement, providing a means of responding to regional or subregional environmental problems or social and economic concerns.

The Secretary'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 in part, or approval subject to such additional requirements or modifications as he may impose under existing laws and regulations. He 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 Secretary may exercise his exchange authority as to the federal coal rights or he may seek congressional action cancelling the federal leases involved.

Review of the federal coal leases and the M&R plans included in this ES indicates that the following administrative alternatives are appropriate for consideration: no action, approval (evaluated as the proposed actions), and approval subject to specific modifications or requirements. Therefore, this chapter describes the potential impacts of two alternatives to the proposed actions: the no action alternative and the differing rates of production alternative (the latter is applicable only to the North Fork Valley region of the ES area, for reasons discussed under that alternative). In addition, in order to identify impacts of production levels lower than and higher than the most probable levels discussed under the proposed actions, two scenarios, low and high, are discussed for comparison. Since the no action alternative and the low level scenario use the same coal production and data, they are presented together as the No Action Alternative/Low Level Scenario. The High-Level Scenario is discussed separately. Only those resources which have significant or potentially significant impacts are analyzed in these alternatives or scenarios. At the end of chapter 8 there is a summary table comparing impact of the proposed actions, most probable level of cumulative development, the two alternatives, and the two scenarios.

Alternative sites for surface facilities, mining technology and methods, coal transport methods, and rates of production on individual operations have been considered where appropriate, but no such modifications have been proposed or identified which would significantly reduce the adverse impacts of coal production from these lands. Any new alternatives suggested by the review will be carefully considered.

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. Dept. 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).

No Action Alternative and Low-Level Scenario

The analysis developed in this section is an assessment of cumulative regional impacts expected to occur through 1990 from the concurrent development of 22 existing mines (20 underground and 2 surface), two projected private coal mines (General Exploration'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 R8-1, R8-2, and R8-3. They will also have to comply with the requirements of the initial regulations, 30(CFR): 700, after May 3, 1978. Table R8-4 summarizes projected cumulative development, and table R8-5 summarizes projected cumulative surface disturbance.

Air Quality

EMISSIONS AND MODELING PROCEDURES

The emissions sources that constitute the no action alternative and low-level scenario are existing coal mines, major point sources, towns, and highways. Emissions of TSP, SO_x, and NO_x from mines, towns, and highways were computed using the assumptions and methods of 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 sixteen underground mines and two strip mines constituting this alternative are listed in table R8-A. Maps R4-A and R4-C (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 tables R4-9 and R4-10 of 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 tables R4-12 through R4-19 of the technical report for chapter 4.

Emissons from railroads serving coal mines in the west-central Colorado ES region 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 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 region 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 region containing the proposed actions.

Oil shale Tracts C-a and C-b 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 alternative 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 to 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 $\mu g/m^3$ over areas about 5 miles in diameter or less (see maps R8-A, R8-B, and R8-C). These cncentrations 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 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 indicates (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,

TABLE R8-1

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)				Time Points		
				1977	1980	1985	1990	Start Construction	Full Mine Operation	Mine Life (years)
	Colorado Westmoreland, Inc.: Orchard Valley Mine	Conventional room & pillar by continuous mining (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 (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 (underground)	Not available	0.23	0.24	0.24	0.24	1932	1937	25 + (or indefinite)
	Western Slope Carbon, Inc.: Hawksnest East Mine	Conventional room & pillar by continuous mining (underground)	Not available	0.19	0.35	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	0.35	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 R8-1

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 (underground)	Not applicable	0.07	Not available	0.00	0.00	1976	Not applicable	4 (to 1980)
	General Exploration: Cameo No. 1 Mine	Conventional room & pillar by continuous mining (underground)	8	0.00	0.80	0.00	0.00	1977	1986	18 (to 1995)
	Roadside Mine		9	0.30	0.80	0.20	0.00	1973	1975	14 (to 1987)
			Subtotal	0.30	1.60	0.60	0.00			
	Coal Fuels Corporation: Farmers Mine	Various underground methods	7	0.00	0.50	0.50	0.50	1977	1980	14
	Louis Bendetti Coal Co.: Eastside Mine	Raise (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 (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	Conventional room & pillar by continuous mining (underground)	Not available	0.02	1.00	1.00	1.00	1975	1980	30
	Mid-Continent Coal and Coke Company: Coal Basin Mines	Various underground methods	Not available	0.92	0.90	0.90	0.90	1973	1975	Not available

TABLE R8-1

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)
	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
	Western States Coal Company: Fairview Mine	Conventional room & pillar by continuous mining (underground)	7	0.00	0.00	0.25	0.25	Unknown	by 1985	less than 30
			TOTAL	2.78	5.98	5.18	4.73			

TABLE R8-2

EXISTING LOW-LEVEL OPERATIONS: TOTAL ACREAGE, FEDERAL LEASE ACREAGE, 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			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
	Colorado Westmoreland, Inc.:[1] Orchard Valley Mine	608	311.51	139	-13	-13	-13	-5	-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	0	39	39	39	39
	Sunflower Energy Corporation: Blue Ribbon Mine	160	0	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	0	0	0	0	0	0	0	25	25	25	25
	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	35	0	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	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	8	2	2	2	0	0	0	0	0	0	20	30	30	30
	General Exploration: Cameo No. 1 Mine	2,255	0	0	7	7	7	0	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	0	60	60	60	60
	Subtotals	3,615	810	60	0	0	0	0	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	15	40	65	0	0	0	26	41	66	91

1. Negative disturbed acres represent reclamation of existing disturbance.

TABLE R8-2

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 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	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
	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		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
	Total	31,453	19,006	1,007	48	48	48	3	3	6	182	192	193	139	315	487	3	3	5	1,007	1,382	1,568	1,746

TABLE R8-3

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	0 / 137	0 / 260	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 / 296	0 / 296	0 / 296	0 / 296	94 West	94 West	94 West	94 West	Geneva works, Orem, Utah.
	Sunflower Energy Corporation: Blue Ribbon Mine	0 / 20	0 / 12	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 / 54	0 / 54	0 / 54	0 / 54	22 East				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 22 for Bear and 20 for Hawksnest, in proportion to their production.)
	Western Slope Carbon, Inc.: Hawksnest East Mine Hawksnest No. 3 Mine	0 / 127	0 / 150	0 / 200	0 / 200	20 East	35 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 R8-3

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	0 / 9	0 / 18	0 / 103	0 / 0	0	0	0	0	Various unspecified out-of-state utilities and local domestic sales.
	Sheridan Enterprises, Inc.: Loma Project (exploratory only)	0 / 30	0 / 30	0	0	0	0	0	0	Various unspecified out-of-state utilities.
	General Exploration: Cameo No. 1 Mine	0 / 75	0 / 426	0 / 148	0 / 98	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 / 200	0 / 200	0 / 200	0	0	0	0	Not available (unspecified).
	Louis Bendetti Coal Co.: Eastside Mine	0 / 3	0 / 3	0 / 3	0 / 3	0	0	0	0	Local and domestic market.
	Henry Bendetti Coal Co.: Nu Gap No. 3 Mine	0 / 3	0 / 3	0 / 3	0 / 3	0	0	0	0	Local and domestic market.
	Anschutz Coal Co.: North Thompson Creek No. 1 and No. 3 mines	0 / 140	0 / 320	0 / 320	0 / 320	0	100 West?	100 West?	100 West?	Foreign industrial market (Japanese?)
	Mid-Continent Coal and Coke Company: Coal Basin Mines	0 / 492	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.
						(64 cars, 100 tons each = this unit train)				

TABLE R8-3

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 / 3	0 / 10	0 / 10	0 / 10	0	0	0	0	Local and domestic market.
	O.C. Mine Company: Ohio Creek No. 2 Mine	0 / 6	0 / 6	0 / 6	0 / 6	0	0	0	0	Local and domestic market.
	Peabody Coal Company: Nucla Strip Mine	0 / 23	0 / 23	0 / 23	0 / 23	0	0	0	0	Nucla Power Plant, Nucla, Colorado; local and domestic market.
	Western States Coal Company: Fairview Mine	0 / 0	0 / 0	0 / 160	0 / 160	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 / 2,304	0 / 2,019	0 / 1,866	309	599	429	409	

TABLE R8-4

PROJECTED CUMULATIVE DEVELOPMENT FOR WEST-CENTRAL COLORADO
UNDER THE NO ACTION ALTERNATIVE AND LOW-LEVEL SCENARIO

Projected Development	1977	1980	1985	1990
Coal:				
Coal mines (existing and projected private)	22	23	20	17
Coal production (million tons per year)	2.78	5.98	5.18	4.73
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	152,050	195,000	244,700	257,550
Community expansion (acres)	-	3,720	7,989	8,885
Auxiliary development:				
New power lines	-	25	50	75
New railroads (miles)	-	2	2	2
New telephone lines (miles)	-	19	51	78
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 R8-5

NO ACTION ALTERNATIVE/LOW-LEVEL SCENARIO:
PROJECTED REGIONAL SURFACE DISTURBANCE FOR WEST-CENTRAL COLORADO

	Cumulative Acreage a/		
Activity	1980	1985	1990
Coal mines	1,382	1,568	1,746
Uranium mines/mills	780	2,340	3,900
Power line/pipeline/ telephone line	0	2,000	2,000
Oil and gas exploration and drilling	285	795	1,320
Community expansion	3,720	7,989	8,885
Road construction	2,000	6,000	10,000
Railroad construction	0	0	0
Oil shale mines/ refinery	60	4,500	4,500
Total	8,227	25,192	32,351

Note: NA - Not available.

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

Fruita, and Delta during all three study years. These standards would also be exceeded the Colorado 24-hour standard of 180 $\mu g/m^3$ around Grand Junction. In all other parts of the ES region 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 region would be well below Colorado and National Ambient Air Quality standards except for areas very near the sources. Maps R8-A, R8-B, and R8-C 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 maxima, 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-D 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 5 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-E and R8-F 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 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.

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 region would not be apparent as actual visibility reducton 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 vegetations, may cause local changes in the surface meteorology.

Geologic and Geographic Setting

TOPOGRAPHY

As shown in table R8-2, excavation and earthwork associated with site preparation for mine facilities would alter the natural topography of 1,382 acres by 1980, 1,568 acres by 1985, and 1,746 acres by 1990. These acreages constitute about 17 percent of the 8,227 acres which would be disturbed by cumulative regional development (including urban expansion) by 1990, about 0.06 percent of the 25,192 acres to be disturbed by cumulative development by 1985, and about 0.05 percent of the 32,351 acres to disturbed by cumulative development by 1990 (see table R8-5 for comparison).

Subsidence induced by coal mining would disturb an additional 1,000 acres by 1980, 2,500 acres by 1985, and 4,000 acres by 1990. The amount of subsidence which would occur at any site would be highly dependent upon the mining and stratigraphic characteristics of the area.

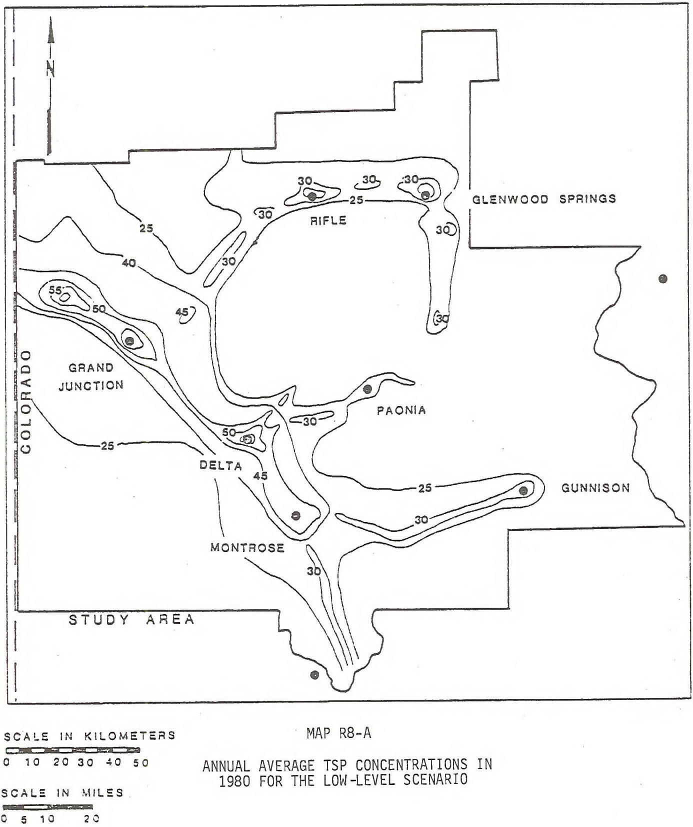
PALEONTOLOGY

Both adverse and beneficial impacts would occur to paleontological resources in approximate propor-

TABLE R8-A

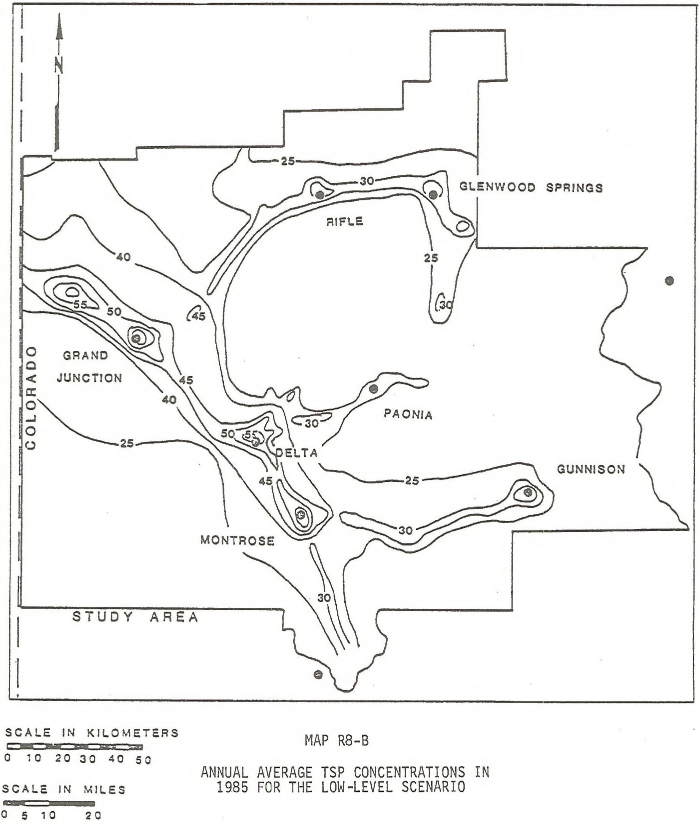
PARTICULATE EMISSIONS FROM COAL MINES
IN WEST-CENTRAL COLORADO (TONS/YEAR)
FOR THE LOW-LEVEL SCENARIO

Mine	1980	1985	1990
Hawksnest	42.65	97.65	97.65
Bear	15.0	15.0	15.0
Sommerset	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
Totals	1487.3	1610.7	1513.6



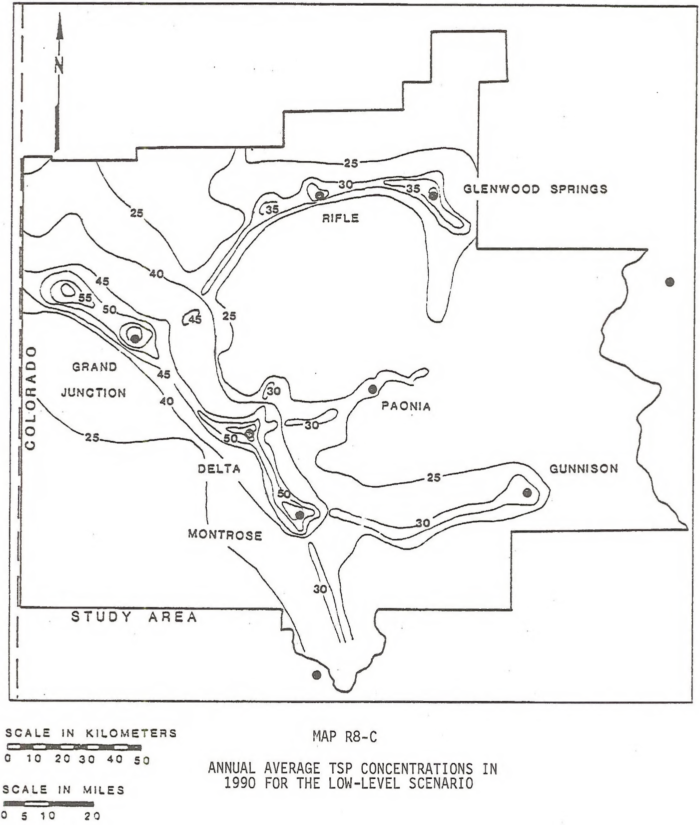
MAP R8-A

ANNUAL AVERAGE TSP CONCENTRATIONS IN
1980 FOR THE LOW-LEVEL SCENARIO



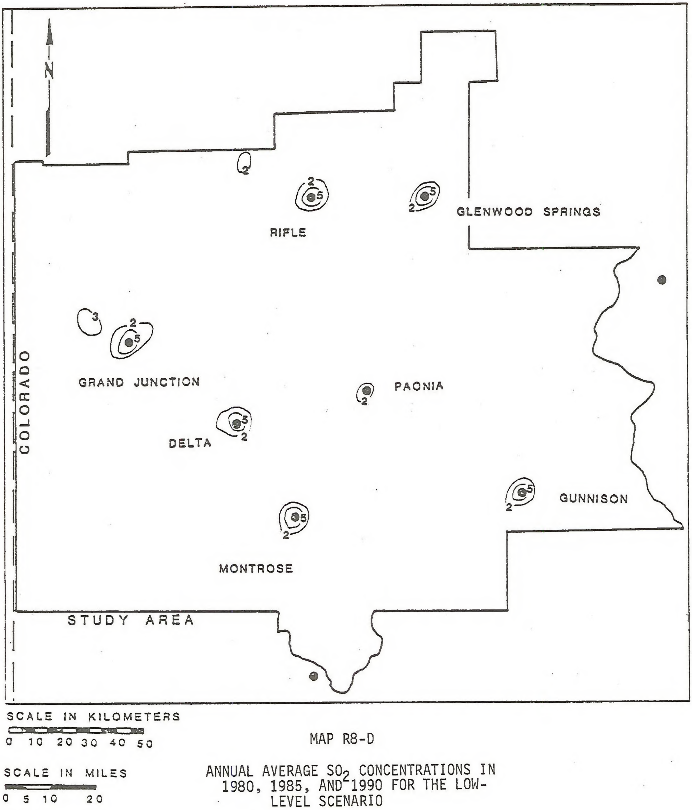
MAP R8-B

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1985 FOR THE LOW-LEVEL SCENARIO



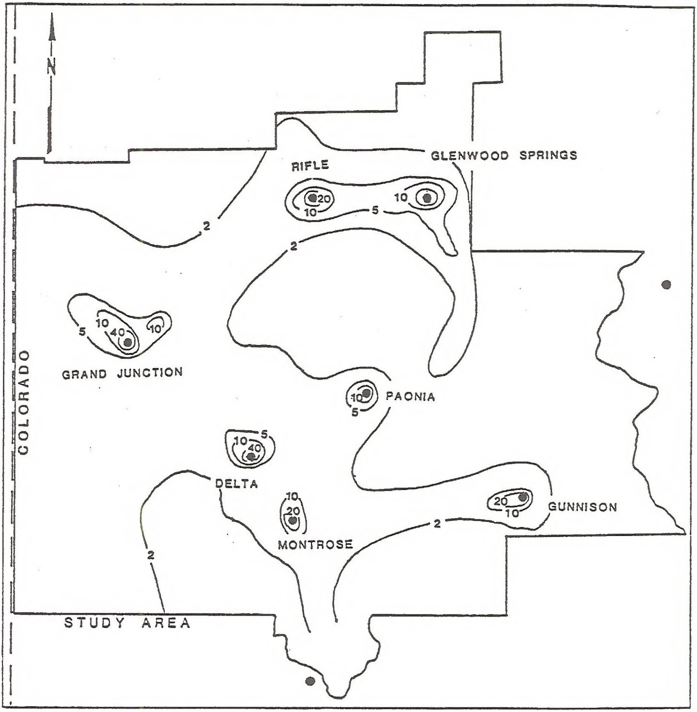
MAP R8-C

ANNUAL AVERAGE TSP CONCENTRATIONS IN
1990 FOR THE LOW-LEVEL SCENARIO



MAP R8-D

ANNUAL AVERAGE SO_2 CONCENTRATIONS IN 1980, 1985, AND 1990 FOR THE LOW-LEVEL SCENARIO



SCALE IN KILOMETERS

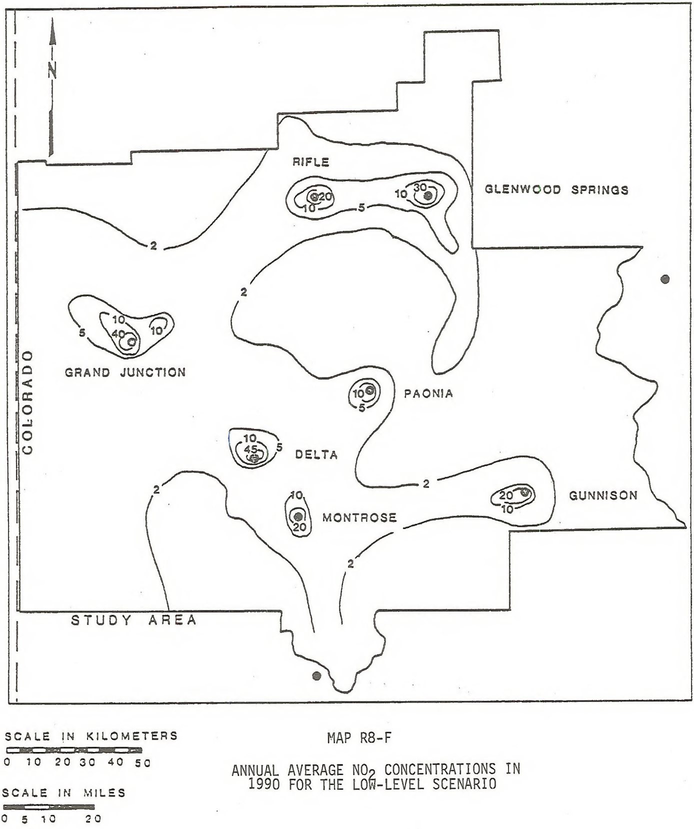
0 10 20 30 40 50

SCALE IN MILES

0 5 10 20

MAP R8-E

ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1980 AND 1985 FOR THE LOW-LEVEL SCENARIO



MAP R8-F

ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1990 FOR THE LOW-LEVEL SCENARIO tion to the level of regional development and the area disturbed.

Mineral Resources

Under this alternative, the rate of coal production would decrease from 5.98 million tons per year in 1980 to 5.18 million tons per year in 1985 and decrease again to 4.73 million tons per year in 1990. As a consequence, the cumulative amount of coal produced would reach 18 million tons by 1980, 45 million tons by 1985, and 70 millions by 1990. This would reduce the mineable coal reserves of the ES area 0.2 percent by 1980, 0.5 percent by 1985, and 0.7 percent by 1990. The remaining reserves would amount to 10,000 million tons in 1980, 9,977 million tons in 1985, and 9,952 million tons in 1990.

In addition, existing mining technologies may ruin coal reserves which are not curently considered to be mineable due to their depth, the thinness of the seam, or their proximity to the bed 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 in mineable beds too close to the seam being mined.

Water Resources

Cumulative development in the region would result in consumption of 3,729 acre-feet in 1980, 18,437 acre-feet in 1985, and 25,601 acre-feet in 1990. This would bring total water consumption to 2.83 million acre-feet per year of water by 1980, 2.85 million acre-feet per year by 1985, and 2.86 million acre-feet per year by 1990. The use of water for coal development would be significant in only a few areas. Increased municipal and industrial use could at the same time cause a shift away from irrigated lands. Several new water storage projects and the adaption of existing projects would change the flow regimes and total quantities of water available in the major river systems.

WATER QUALITY

Unquantifiable degradation of water quality due to cumulative regional development of resources such as oil shale, uranium, and oil and gas is expected to exceed water quality impacts due to coal development. Increases in suspended sediments, dissolved solids, pH alkalinity, sulfates, and chlorides are expected.

Increased human populations in the study area (see table R8-4) would increase problems from sewage pollution in fast growing cities such as Grand Junction, Delta, Rifle, and Glenwood Springs. Population increases would lead to larger amounts of sewage effluent. Most of this increase is expected to flow to sewage treatment facilities. Unless sewage treatment facilities are enlarged to handle the increase, localized adverse impacts on water quality are expected due to the increased amounts of organic materials and nutrients entering local streams. Pollutants and toxic substances from streets and storm sewers would increase. Human activities such as boating and fishing would also degrade water quality through the introduction of gas, oil, and litter.

Soils

Major disturbance and alteration of soils as a result of coal mining would cause a short-term reduction in soil productivity on 1,382 acres by 1980, 1,568 acres by 1985, and 1,746 acres by 1990. Soil disturbance due to cumulative regional development would affect 8,227 acres by 1980, 25,192 acres by 1985, and 32,351 acres by 1990.

Vegetation

The operation of coal mines under this alternative would disturb 1,382 acres of native vegetation by 1980, 1,568 acres by 1985, and 1,746 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 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.

Cumulative development would disturb vegetation on 8,227 acres by 1980, 25,192 acres by 1985, and 13,351 acres by 1990. Of these totals, 3,720 acres would be due to community expansion in 1980, 7,989 acres in 1985, and 8,885 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.

Under Section 7 of the Endangered Species Act of 1973, all areas that might contain endangered or threatened plants will be cleared with the U.S. Fish and Wildlife Service (USFWS) of any possible conflict with such species and their habitats at any time.

Wildlife

Wildlife habitat, carrying capacity, and populations would be lost as a direct result of coal mining on 1,382 acres by 1980, 1,568 acres by 1985, and 1,746 acres by 1990. Carrying capacity for deer would be reduced by 67, 76, and 85, respectively; carrying capacity for elk by 11, 12, and 14, 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 R8-5, cumulative regional development would disturb 8,227 acres by 1980, 25,192 acres by 1985, and 32,351 acres by 1990. This amounts to 0.23 percent, 0.72 percent, and 0.93 percent, respectively, of the 3,465,000 acres of wildlife habitat in the ES area. It is apparent that impacts from cumulative 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 R8-5) 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.

Under Section 7 of the Endangered Species Act of 1973 all areas will be cleared with the USFWS of any possible conflict with an endangered and threatened species and their habitat before any mining permit is issued. No adverse impact will be allowed to occur to any endangered or threatened species or their habitat at any time under any circumstances.

Aquatic Biology

As a result of coal development under this alternative, the area's fisheries would suffer from minor increases in total dissolved solids, pollution from sewage, sediment in streams, dewatering, and increased fishing pressure. Sediment yield from 1,382 acres in 1980, 1,568 acres in 1985, and 1,746 acres in 1990 would cause slight increases over the yield 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. North Thompson Creek, with low flows ranging from 0.09 to 1.00 cubic foot per second (cfs), is also the stream most likely to be affected by dewatering. Anschutz has a 0.25 cfs water right, and should this right be utilized, 25 to 100 percent of the aquatic habitat could be lost there. Overall, existing water quality laws and the state fish management program would be better to deal adequately with this low level of coal development and maintain the present quality of fisheries affected by coal mining in the area.

The impacts from cumulative regional 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), Gunnison River (USBR Dominguez Project), Dolores River (USBR Dolores Project), San Miguel River (USBR San Miguel Project), 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 imppact 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 dishcharges 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, will lead to increased sediment load in local streams. Channeling and headcutting due to natural erosion will 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, 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 the increased amounts of organic materials and nutrients entering local streams. This could lead to localized entrophication and subsequent changes in the river exosystem in these affected areas. Fish kills from ammonia pollution may also result.

Increased urbanization and associated human activities will degrade water quality and aquatic habitats. Since urban areas will be located on or near water courses, such parameters of aquatic systems as suspended sediment, turbidity, nutrients, biological oxygen demand and temperature will increase. Human activities such as boating and fishing will degrade water quality through the introduction of gas, oil, and litter. Pollutants and toxic substances from streets and storm sewers will increasse. The aquatic environment may be so altered that some present fish species, most likely the endemic species, will no longer be able to sustain themselves and more tolerant species will take their places.

Increased population from cumulative development will increase the number of anglers and decrease the quality of fishing. The average size and number of fish taken by each angler will decrease and the dependency on hatchery stocked fish will increase.

The extent to which cumulative development will affect rare and endangered fish, such as the Colorado squawfish, humpback chub, and the razorback sucker, is dependent upon the quality of the surface waters. The water quality decline in some streams exposed to waste discharge and industrial accidents could have serious effects. In the case of the squawfish, impoundments could destroy breeding habitat. If degradation or physical alteration occurs in waters inhabited by these species, a further population decline would be expected. Fish kills of large proportion or the loss of an endangered species are serious possibilities.

Cultural Resources

ARCHEOLOGICAL RESOURCES

On a regional basis, the potential for destruction of 1,899 identified and countless unknown archeological sites would increase in direct proportion to the number of acres disturbed. (See table R8-5 for projected surface disturbacne due to coal development and cumulative development.) Dirt-moving procedures in particular 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 action.

HISTORICAL 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

The result of the federal government taking no action would be a reduction in the impacts to transportation systems mentioned in chapter 4. Vehicles registered in the region would total 210,630 in 1980; 264,710 in 1985; and 278,070 in 1990. Average daily traffic levels on regional roads would increase over existing levels. Average daily vehicle miles would be 4,212,600 miles in 1980; 5,212,600 miles in 1985; and 5,561,400 miles in 1990. Traffic accidents in the region would increase to a total of 46,340 accidents in 1980; 57,340 accidents in 1985; and 61,180 accidents in 1990. There would be 93 fatalities from these accidents in 1980; 106 fatalities in 1985; and 122 fatalities in 1990.

Trains entering and leaving the region as a result of growth would increase by 680 trains per year above current levels. There would be a resulting increase in auto-train collisions, and longer delays for automobiles at crossings.

Agriculture

LIVESTOCK

The animal unit months (AUMs) which would be lost due to cumulative regional 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 R8-5) 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 cumulative development (8,227 acres by 1980, 25,192 acres by 1985, and 32,351 acres by 1990) would be prime farmland, particularly some of the acreage disturbed by community expansion (3,720 acres by 1980, 7,989 acres by 1985, and 8,885 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 alternative would have no significant impact on recreation. The population growth associated with cumulative development, however, would produce increased demand for recreational opportunities and facilities. This demand could have a significant impact on community recreational facilities; becuase most community facilities are now fully utilized, the increased us would result in veruse and deterioration of the facilities. Prevention of overuse would require construction of additional facilities amounting to 141.8 acres of active/improved parks (e.g., ballfield, playgrounds, tennis courts, etc.) by 1980, 307.1 acres by 1985, and 347.9 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 study 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 of federal lands. The special projects considered are listed, along with their employment schedules, in table R8-6.

The Colorado Population and Employment Model, which was developed for use by the Colorado Division of Planning, was used to generate the population projections for each county within the ES area (table R8-7). This model relies on changes in the basic (export) industry employment to forecast changes in total employment and the resulting changes in total population. An explanation of the mehtodology and the assumptions used in the projections are contained in appendix G.

The projections in tables R8-6 and R8-7 reflect the large increases in employmnet which are expected if the oil shale industry develops according to schedule. Garfield and Mesa counties ae 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

TABLE R8-6

NO ACTION ALTERNATIVE/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								
Colorado Westmoreland		137		260		260		260
Sunflower		20		12		12		12
West Slope Carbon		127		150		200		200
Quinn		9		103		103		103
GEX		157		426		148		98
Coal Fuels		0		200		200		200
Anschutz		140		320		320		320

TABLE R8-7

NO ACTION ALTERNATIVE/LOW-LEVEL SCENARIO:
POPULATION PROJECTIONS FOR THE REGIONAL ES AREA

County	1977	1980	Percent Change	1985	Percent Change	1990	Percent Change
Delta	18,950	21,100	+11.3	25,000	+18.4	29,350	+17.4
Garfield	18,800	34,000	+80.8	41,850	+23.0	45,500	+ 8.7
Gunnison	8,800	10,050	+14.2	25,400	+153.7	23,000	- 9.4
Mesa	66,800	86,100	+28.9	102,450	+19.0	101,500	- 0.9
Montrose	23,200	24,200	+ 4.3	26,500	+ 9.5	31,250	+17.9
Ouray	2,250	2,500	+11.1	2,400	- 4.0	2,700	+12.5
Pitkin	13,250	17,050	+28.6	21,100	+23.6	24,250	+14.9
Totals	152,050	195,000		244,700		257,550	

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 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 Grafield 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 15 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 R8-8 is a projection of school-aged population for each county in the ES area without the proposed action. These figures were developed using the Colorado Population and Employment Model. They represent total population in the 6-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 rations 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 failities. 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. Table R8-9 shows projected employment in 1980, 1985, and 1990 for the counties in the region.

Unemployment has been a problem in the region in recent years. The Colorado Population and Employment also projects the unemployment rate. The projected unemployment rate in the counties of the region for 1980, 1985, and 1990 is shown in table R8-10. This table shows wide 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. Generally, rates tend to stay below those of recent years as growth in the area develops new jobs.

High-Level Scenario

The high-level scenario is an analysis of the most probable level of development (six proposed federal actions; existing coal operations; and other probable regional mineral development, such as oil, gas,

TABLE R8-8

SCHOOL-AGED POPULATION PROJECTIONS IN ES AREA

County	1977	1980	Percent Change	1985	Percent Change	1990	Percent Change
Delta	3,700	3,550	- 4.0	4,520	+ 27.0	6,090	+ 34.9
Garfield	3,630	3,880	+ 6.9	4,900	+ 26.3	6,630	+ 35.3
Gunnison	1,560	1,710	+ 8.6	4,790	+ 180.1	3,830	- 25.1
Mesa	14,240	17,680	+ 24.2	21,580	+ 22.1	23,150	+ 7.3
Montrose	5,690	5,620	- 1.2	5,920	+ 5.3	7,500	+ 26.7
Ouray	500	500	0.0	440	- 12.0	610	+ 38.6
Pitkin							

TABLE R8-9

PROJECTED TOTAL EMPLOYMENT

County	Total Employment 1980	1985	1990
Delta	7,694	9,127	10,795
Garfield	15,338	19,090	19,767
Gunnison	3,034	9,729	8,123
Mesa	34,219	40,980	38,822
Montrose	9,715	10,749	12,436
Ouray	1,044	929	1,055
Pitkin			
Region	71,984	91,464	91,547

TABLE R8-10

PROJECTED UNEMPLOYMENT

County	Projected Percent Unemployment 1980	1985	1990
Delta	3.03	3.22	3.32
Garfield	4.72	5.00	7.93
Gunnison	2.99	5.11	9.00
Mesa	2.71	3.27	5.40
Montrose	5.12	5.18	3.92
Ouray	5.96	4.35	2.20
Pitkin			

oil shale, and uranium), plus the possible development of one existing lease currently without a mining and reclamation (M&R) plan, nine new competitive short-term lease application areas, and two preference right lease application (PRLA) areas. The high-level scenario includes all of those actions which could develop as a result of federal approvals. However, the nine new competitive short-term lease areas and the two PRLA areas are included only to indicate 'areas of interest' for foreseeable future development. No leasing actions are proposed or planned at this time.

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, R1-5, and R1-6, etc.). Table R8-11 provides detailed information pertaining to all coal mining which would occur in the high-level scenario. Table R8-12 summarizes projected surface disturbance. Map 1 in appendix A 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 without an M&R plan, the nine new competitive short-term lease areas, and the two PRLA areas). 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 proposed actions 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. Pariculate emissions from haul roads were calculated using either a 50 percent control factor for watering or an 85 percent control factor for surface treatement 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-B summarizes the particulate emissions for the three study years.

Emissions from towns and highways were computed using the assumptions and methods of chapter 4 of the regional ES, technical report. Table R8-C 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 proposed actions 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 anticipated leases.

The only other possible development mines with significant TSP emissions would be a PRLA and an anticipated lease 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 because the two leases are in a different dispersion subarea.

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 Little Bookcliffs' PRLA and the short-term lease.

Both mines are in a surface wind drainage area oriented approximately along a northeast-southwest line. Therefore, the meteorological data that was collected at a site with wind patterns similar to those postulated for the area of these mines was used. Data collected at the Occidental Oil Company Mt. Callahan site was determined to be most represetnative of worst-case 24-hour dispersion conditions for the Little Bookcliffs' PRLA and the short-term lease as well as for the DeBeque Canyon area.

TABLE R8-11

HIGH-LEVEL SCENARIO FOR COAL PRODUCTION IN WEST-CENTRAL COLORADO

Areas of Interest	Coal Production (million tons per year)				Cumulative Surface Disturbance from New Mine Facilities, Rights-of-Way, etc. (acres)				Permanent Employment			Unit Trains per Year		
	1977	1980	1985	1990	1977	1980	1985	1990	1980	1985	1990	1980	1985	1990
Possible new development:														
Existing federal lease w/o mining and reclamation plans (1 M&R plan expected)	0.00	0.00	0.00	1.40	0	0	0	143	0	0	330	0	0	140
Preference right lease applications (PRLAs)	0.00	0.00	0.00	8.00	0	0	0	1,396	0	0	1,210	0	0	800
Anticipated new short-term leases: 3-year criteria (9 short-term leases)	0.00	0.00	0.25	9.20	0	0	0	1,792	0	147	2,452	0	0	920
Subtotal	0.00	0.00	0.25	18.60	0	0	0	3,331	0	147	3,992	0	0	1,860
Most probable cumulative development:														
existing, projected, and proposed private and federal coal mines (tables R1-1, R1-2, R1-3, chapter 1)	3.07	7.42	14.41	17.10	999	1,479	2,449	2,694	2,730	4,375	4,606	699	1,418	1,708
Cumulative Total	3.07	7.42	14.66	35.70	999	1,479	2,449	6,025	2,730	4,522	8,598	699	1,418	3,568

TABLE R8-12

HIGH-LEVEL SCENARIO:
PROJECTED SURFACE DISTURBANCE

	1980	1985	1990
Cumulative regional surface disturbance:			
Urban area expanion	4,491	10,142	11,618
Other development	4,604	18,084	27,745
Total	9,095	28,226	39,363
Surface disturbance due to possible new development:			
Urban area expansion	399	1,138	1,153
Mine-site development	0	0	3,331
Total	399	1,138	4,484

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 realtively 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.

Proposed Actions and Possible Coal Development Alone

Concentrations mentioned in this section refer to the only contributions of the proposed actions and possible new 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 tha 1 $\mu g/m^3$ beyond a 5-mile radius from the mines and their haul roads for all three study years (see maps R8-H, R8-I, and R8-J).

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 proposed by the Region VIII office of the U.S. Environmental Protection Agency (Rachal 1978), the impact of fugitive dust emissions from coal mines would not be included in the air quality analyses for the PSD increments, nor for national ambient air quality standards. Particulate emissions from industrial process units of underground mines are typically less than 50 tons per year. Hence, the underground mines of the proposed actions would not be examined under the new PSD regulation.

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 requies 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 area of the region. The areas of impact of the mines ae 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 of the ES region.

Standards for prevention of significant deterioration (PSD) for Class II areas would be exceeded outside the boundaries of the Loma Project, Cottonwood Creek No. 1 and No. 2, and North Thompson Creek, No. 1 and No. 3, and the Little Bookcliffs PRLA and short-term lease. 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 short-term lease (north of Fruita) 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 short-term lease would occur very near the mine and drop off rapidly with distance. In 1990 the maximum 24-hour levels would exceed the Class II increment of 37 $\mu g/m^3$ to about 400 feet from the active mine aea. 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 proposed federal actions and possible coal developments are expected to be small. Maps R8-I and R8-J 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 from the town. Increases of 24-hour TSP levels would reach only about 3-4 $\mu g/m^3$ over the same area. Similarly, small increases in NO_2 levels would occur in 1990 around Delta (map R8-K) 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 proposed actions and possible development coal mines except in 1990 around Delta (map R8-L). In 1990 annual SO_2 concentrations would increase by 5 $\mu g/m^3$ over about a 3 to 5-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 region as a result of the proposed actions and possible development mines are not expected to significantly increase TSP, No_2, and SO_2 concentrations in the ES region.

Interaction of the Proposed and Possible Actions and Other Activities

Concentrations discussed in this section refer to contribtions from all significant sources in the ES region which would emit pollutants for 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 coal development would result from baseline contributions and from emissions from towns in the ES region. In addition relatively high TSP concentrations would occur near short-term leases in the Little Bookcliffs, the Loma Project, the Little Bookcliffs PRLA, and the group of existing mines and proposed actions 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 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 Fruita and the Western Oil Refinery. The annual TSP levels would exceed 55 $\mu g/m^3$ over small areas about 5 to 10 miles in diameter or less in these areas (maps R8-M, R8-N, and R8-O). 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 region 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 Protecion Agency (EPA) as not attaining national ambient air quality standards (NAAQS) for TSP. The regional air quality analyses of air quality impacts does not show violations of theTSP 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 emmissions 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 areas 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 study 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 region would be well below Colorado and national ambient air quality standards except very near specific roadways and pollutant sources in the towns. Maps R4-G, R4-H, and R4-I 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 mine, mines in the DeBeque Canyon area, and

TABLE R8-B

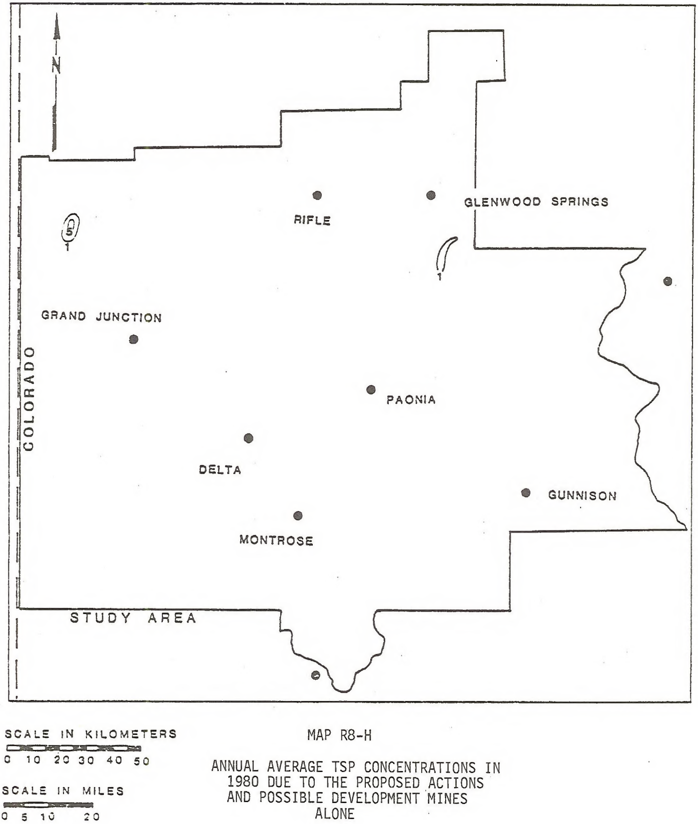
TOTAL SUSPENDED PARTICULATE EMISSIONS FROM COAL MINES IN WESTCENTRAL COLORADO (TONS/YEAR) FOR THE HIGH LEVEL SCENARIO

Mine	1980	1985	1990
Proposed Actions			
North Thompson Creek Nos. 1, 2		3,631.0	3,631.0
Mt. Gunnison		5.5	63.6
Loma	1,389.0	921.0	1,161.0
Cameo 1	113.0	122.0	144.0
Coal Canyon		181.0	312.0
Cottonwood Creek		211.0	475.0
Possible Level of Development			
Preference Right Lease Applications			3,352.7
Anticipated New Short Terms Leases: 3-year criteria (9 short term leases)			1,577.6

TABLE R8-C

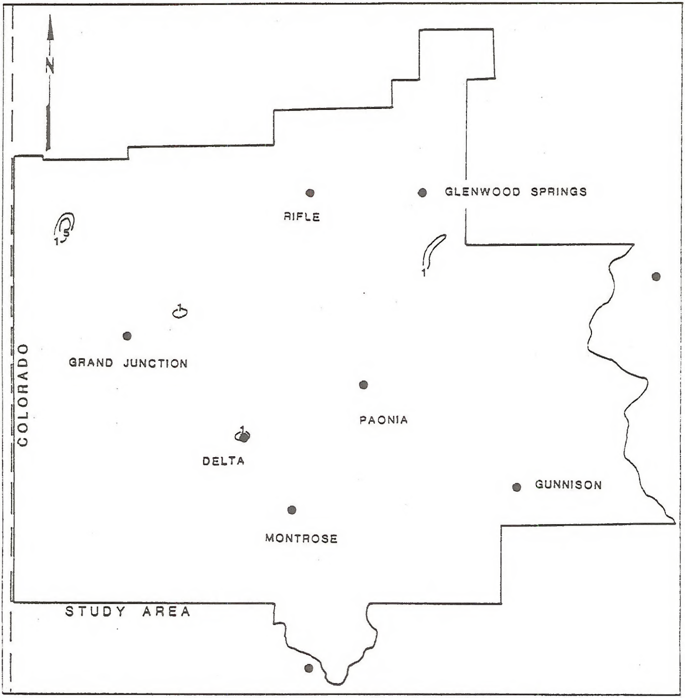
EMISSIONS OF PARTICULATES, SO_x, AND NO_x (TONS/YEARS) FROM TOWNS FOR THE HIGH-LEVEL SCENARIO

Town	Pollutant	1980	1985	1990
Delta	Particulates	19.7	24.5	29.6
	SO_x	9.1	11.3	13.9
	NO_x	102.2	125.6	152.9
Paonia	Particulates	8.8	11.3	15.0
	SO_x	4.0	5.5	6.9
	NO_x	45.3	58.8	76.3
Montrose	Particulates	28.8	30.7	35.8
	SO_x	11.7	12.4	14.2
	NO_x	133.6	142.7	165.7
Grand Junction	Particulates	40.2	42.0	42.3
	SO_x	17.5	18.2	18.6
	NO_x	262.1	274.5	277.4
Glenwood Springs	Particulates	38.7	43.8	46.4
	SO_x	11.3	13.1	13.9
	NO_x	165.4	187.2	198.2
Cedar Edge	Particulates	5.1	6.6	9.1
	SO_x	2.2	3.3	4.0
	NO_x	25.9	34.3	46.0
Gunnison	Particulates	48.6	77.0	74.1
	SO_x	10.2	16.4	15.7
	NO_x	114.6	181.8	174.8
Fruita	Particulates	10.6	12.4	13.1
	SO_x	4.8	5.5	5.8
	NO_x	69.4	82.1	85.4
Orchard Mesa	Particulates	24.1	26.6	27.4
	SO_x	10.6	11.7	12.0
	NO_x	157.0	175.2	179.6
Rifle	Particulates	25.6	29.9	32.5
	SO_x	7.7	8.8	9.5
	NO_x	108.8	128.5	138.7



MAP R8-H

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1980 DUE TO THE PROPOSED ACTIONS AND POSSIBLE DEVELOPMENT MINES ALONE



SCALE IN KILOMETERS

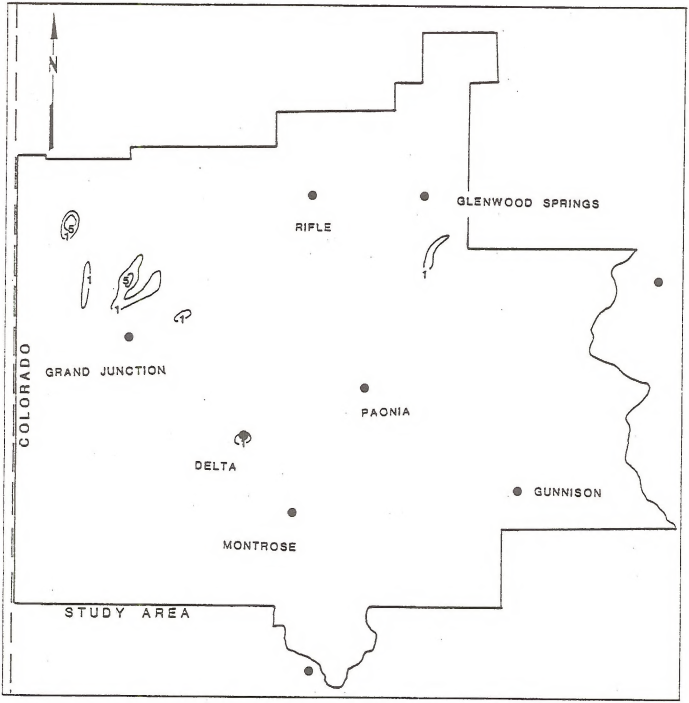
0 10 20 30 40 50

SCALE IN MILES

0 5 10 20

MAP R8-I

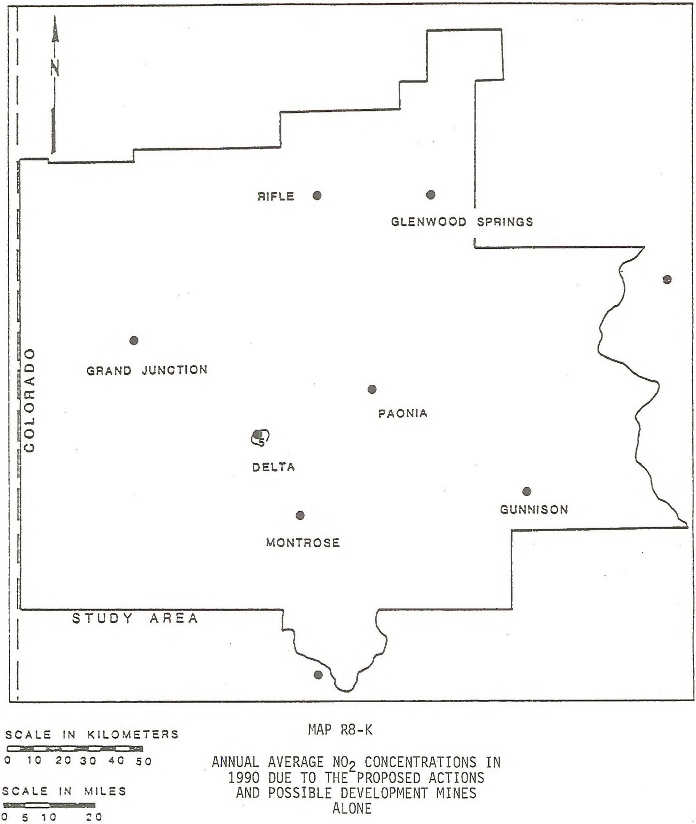
ANNUAL AVERAGE TSP CONCENTRATIONS IN 1985 DUE TO THE PROPOSED ACTIONS AND POSSIBLE DEVELOPMENT MINES ALONE



SCALE IN KILOMETERS
0 10 20 30 40 50
SCALE IN MILES
0 5 10 20

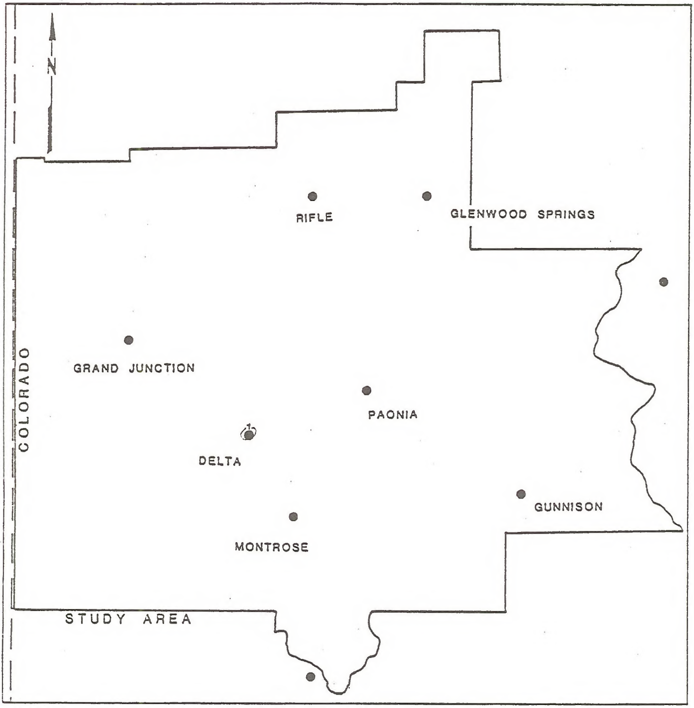
MAP R8-J

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1990 DUE TO THE PROPOSED ACTIONS AND POSSIBLE DEVELOPMENT MINES ALONE



MAP R8-K

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-L

ANNUAL AVERAGE SO_2 CONCENTRATIONS IN 1990 DUE TO THE PROPOSED ACTIONS AND POSSIBLE DEVELOPMENT MINES ALONE mines south of Glenwood Springs. By 1990 additional areas of particulate concentrations about 5 $\mu g/m^3$ above background would occur around short-term leases 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 region.

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 other study years. 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 0.5 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.

Possible new mines would be southeast of the Loma Project along the Bookcliffs. However, due to the apparent wind drainage flows from the northeast, emissions from these short-terms leases would not significantly interact with emissions from the Loma mine. 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 short-term leases 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 not result in violations of any state or federal standards.

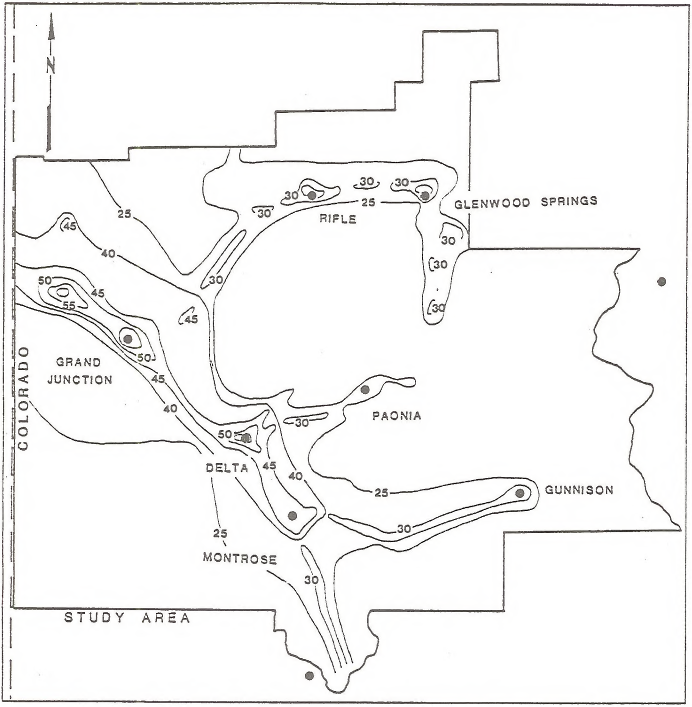
Other mines and groups of mines in the ES region would increase TSP concentrations during the study years. However, maximum concentrations would be localized and would be lower than the maximum impact reported for the four mine groups discussed above.

Highest concentrations of gaseous pollutant (SO_2 and No_2) would occur around towns and along highways in the ES region. Mining activities in 1980, 1985, and 1990 would have no noticeable impact on levels of these pollutants.

Map R4-P shows that annual average SO_2 levels for the region 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 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-Q and R8-R show that highest annual average No_2 concentrations would reach 40 to 45 $\mu g/m^3$ are predicted within small areas around other major towns in the study 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. 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



SCALE IN KILOMETERS

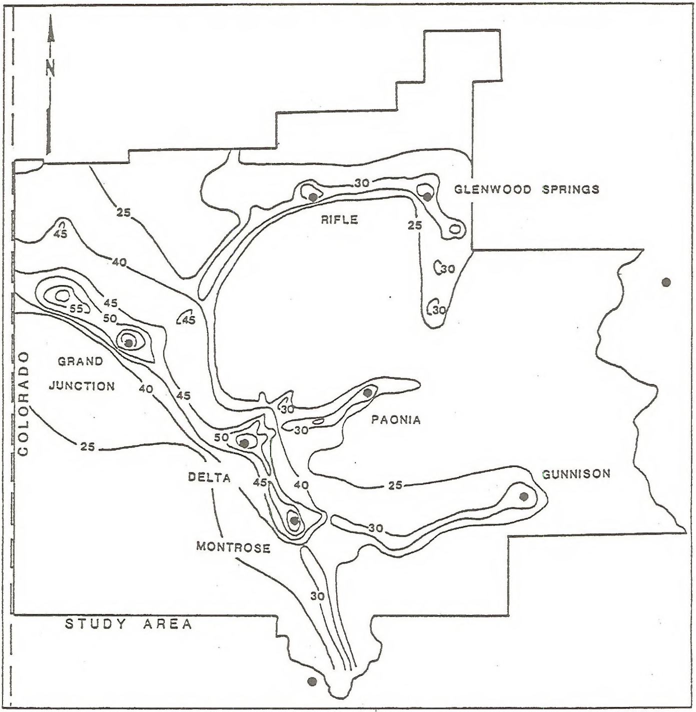
0 10 20 30 40 50

SCALE IN MILES

0 5 10 20

MAP R8-M

ANNUAL AVERAGE TSP CONCENTRATIONS IN
1980 FOR THE HIGH-LEVEL SCENARIO

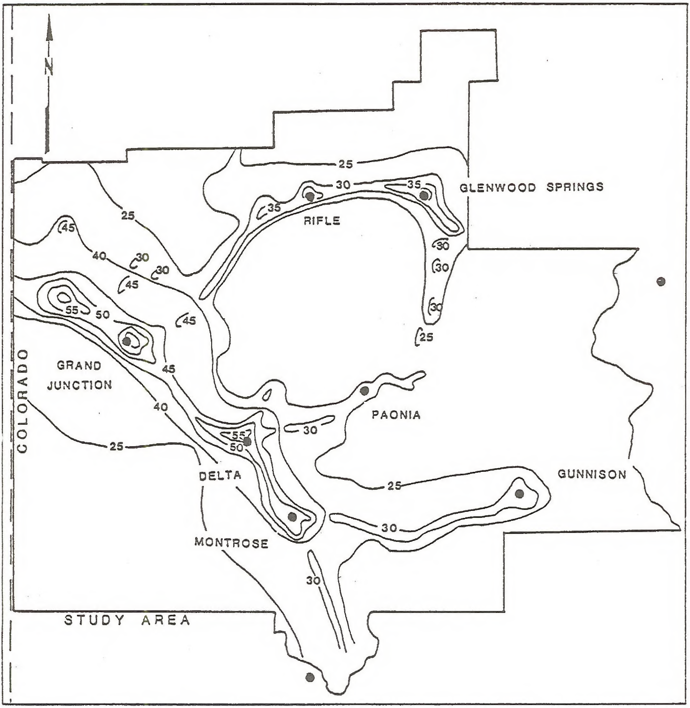


SCALE IN KILOMETERS
0 10 20 30 40 50

SCALE IN MILES
0 5 10 20

MAP R8-N

ANNUAL AVERAGE TSP CONCENTRATIONS IN
1985 FOR THE HIGH-LEVEL SCENARIO



SCALE IN KILOMETERS

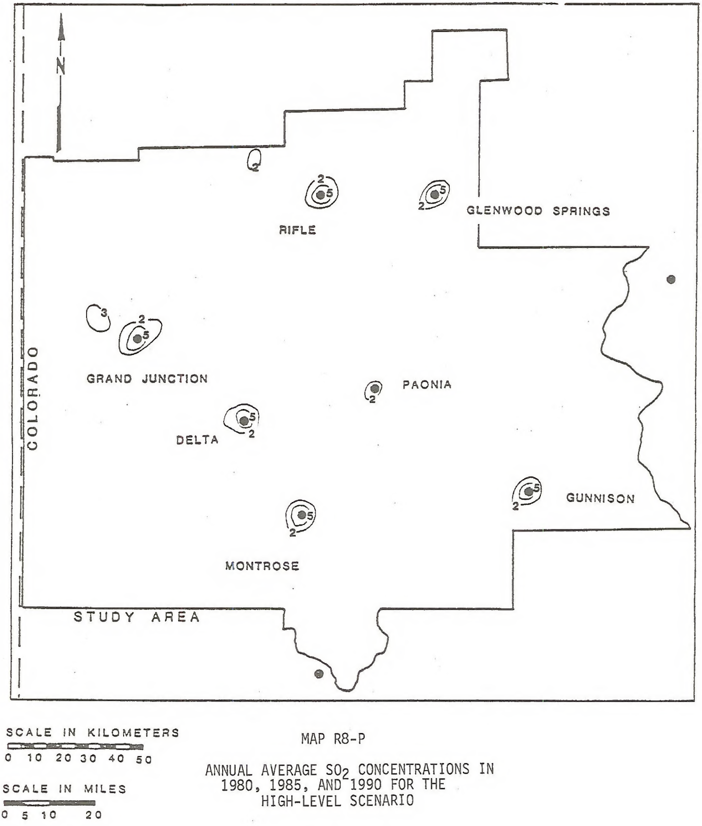
0 10 20 30 40 50

SCALE IN MILES

0 5 10 20

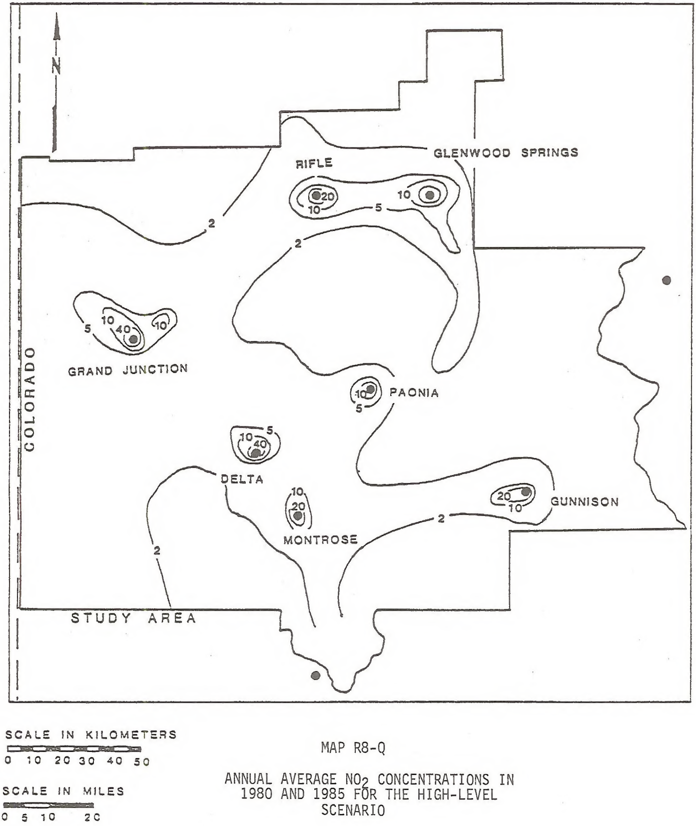
MAP R8-0

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1990 FOR THE HIGH-LEVEL SCENARIO



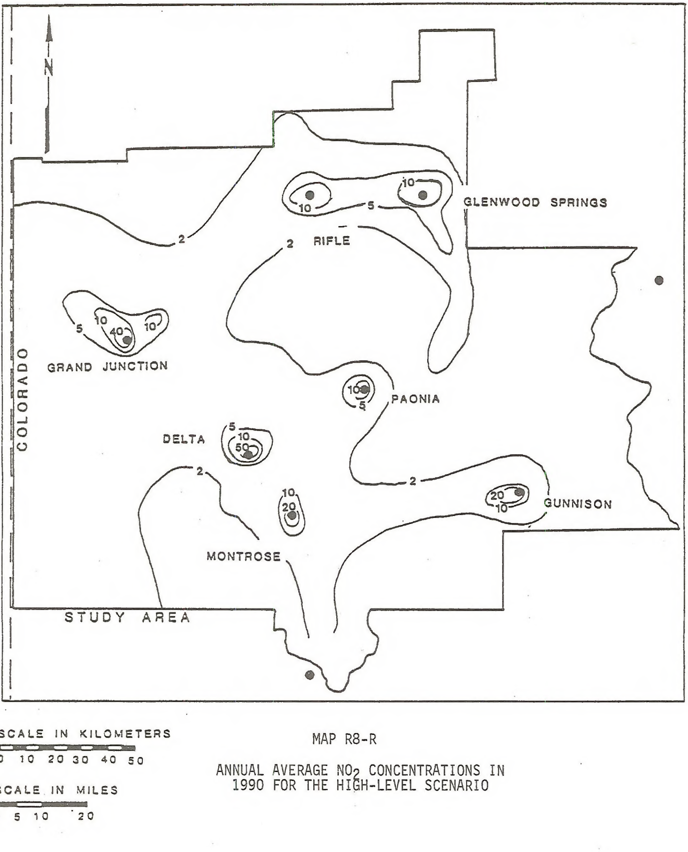
MAP R8-P

ANNUAL AVERAGE SO_2 CONCENTRATIONS IN 1980, 1985, AND 1990 FOR THE HIGH-LEVEL SCENARIO



MAP R8-Q

ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1980 AND 1985 FOR THE HIGH-LEVEL SCENARIO



SCALE IN KILOMETERS

0 10 20 30 40 50

SCALE IN MILES

0 5 10 20

MAP R8-R

ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1990 FOR THE HIGH-LEVEL SCENARIO mine areas around the mines in DeBeque Canyon, and areas around short-term leases on the Little Bookcliffs. Much higher short-term visibility reductions owuld 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 region 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 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.

The proposed mines would not significantly modify the climate and meteorology of the study region.

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 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 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 coal development would alter the natural topography of 0 acres by 1980, 0 acres by 1985, and 3,331 acres by 1990. (See tables R8-11 and R8-12.)

Cumulative surface disturbance due to subsidence would partially alter the topography of 2,400 acres in 1980, 9,600 acres in 1985, and 25,000 acres in 1990. Of these totals, 5,615 acres would be due to possible new 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, 7.42 million tons of coal per year would be produced in 1980, 14.66 millions tons per year by 1985, and 35.70 million tons per year by 1990. Of these totals, 0.25 million tons per year would be due to the possible new developments in 1985 and 18.60 million tons per year in 1990. The cumulative production and depletion of the regional coal reserves would reach approximately 19.79 million tons by 1980, 79.16 million tons by 1985, and 220 million tons by 1990. As a result of the limitations of existing technology, an approximately equal amount of coal would be left in place.

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

Water requirements associated with possible new developments, both industrial and municipal consumption, would be 0 acre-feet in 1980, 781 acre-feet in 1985, and 1,474 acre-feet in 1990. Water consumption resulting from total cumulative development would be 5,328 acre-feet in 1980, 25,256 acre-feet in 1985, and 37,790 acre-feet in 1990.

WATER QUALITY

Assuming that all coal mines will be brought into compliance with the OSM initial regulations 30(CFR): 211.40(a)(3) and 43 (CFR): 3041.2-2(f)(7)(ii), and Colorado Regulations, Rule 6.1b, there should be no direct significant changes in water quality due to the proposed actions. In the case of coal mines, 30(CFR): 700 regulations require drainage systems that are capable of withstanding a 10-year/24-hour precipitation event. Any storm larger than this would exceed the design capacity of on-site drainage systems, causing temporary but significant reduction in water quality below the mining operations.

Unquantifiable degradation of water quality due to cumulative regional development of resources such as oil shale, uranium, and oil and gas is expected to exceed water quality impacts due to coal development. Increases in suspended sediments, dissolved solids, pH alkalinity, sulfates, and chlorides are expected.

Increased human populations in the study area (see Socioeconomic Conditions) would increase problems from sewage pollution in fast growing cities such as Grand Junction, Delta, Rifle, and Glenwood Springs. Population increases would lead to larger amounts of sewage effluent. Most of this increase is expected to flow to sewage treatment facilities. Unless sewage treatment facilities are enlarged to handle the increase, localized adverse impacts on water quality are expected due to the increased amounts of organic materials and nutrients entering local streams. Pollutants and toxic substances from streets and storm sewers would increase. Human activities such as boating and fishing would also degrade water quality through the introduction of gas, oil, and litter.

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 0 acres in 1980 and 1985 and 3,331 acres in 1990 (see table R8-12). Cumulative regional development (including urban exansion due to population growth) would disturb a total of 9,095 acres in 1980, 28,226 acres in 1985 and 39,363 acres in 1990.

Urban area expansion (see table R8-12) 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 3,331 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 R8-12 for acreages) would be permanently lost. In addition, population increases due to cumulative development would result in unquantificable impacts to vegetation from increased ORV use, firewood cutting and exploitation of certain endangered and threatened plants.

Under Section 7 of the Endangered Species Act of 1973, all areas will be cleared with the U.S. Fish and Wildlife Service (USFWS) of any possible conflict with an endangered or threatened species or their habitat before any mining permit is issued. No adverse impact will be allowed to occur to any endangered or threatened species or their habitat at any time due to mining.

Wildlife

Wildlife habitat, carrying capacity, and populations would be lost as a direct result of possible new coal devlopment on 3,331 acres by 1990. Carrying capacity for deer would be reduced by about 164 and for elk by about 27.

Cumulative regional development would disturb 9,905 acres by 1980, 28,226 acres by 1985, and 30,363 acres by 1990. This amounts to 0.23 percent, 0.81 percent, and 0.88 percent, respectively, of the 3,465,000 acres of wildlife habitat, although 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.

Under Section 7 of the Endangered Species Act of 1973 all areas will be cleared with USFWS of any possible conflict with an endangered or threatened species or their habitat before any mining permit is issued. No adverse impact will be allowed to occur to any endangered or threatened species or their habitat at any time due to mining.

Aquatic Biology

Water consumption resulting from total cumulative development would be 5,328 acre-feet in 1980, 25,256 acre-feet in 1986, and 37,790 acre-feet in 1990. Of this 781 acre-feet in 1985 and 1,474 acre-feet in 1990 would be due to possible new coal development. 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 put more of a 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 will be most susceptible to such occurrences.

The influx of 5,211 more people to the region in 1980, 14,761 more people in 1985, and 17,414 more people in 1990 due to development of the 'areas of interest' would prolong water pollution problems from inadequate sewage systems until the construction of new and additional facilities can catch up with growth and development.

Under Section 7 of the Endangered Species Act of 1973 all areas will be cleared with USFWS of any possible conflict with an endangered or threatened species or their habitat before any mining permit is issued. No adverse impact will be allowed to occur to any endangered or threatened species or their habitat at any time due to mining.

Cultural Resources

ARCHEOLOGY

Impacts to archeological resources would be intensified by the high-level scenario. Increased population pressures on land use (174,543 people in 1980, 225,037 people in 1985, and 242,277 people in 1990) and a greater number of acreage to undergo surface disturbance (9,095 acres in 1980, 28,226 acres in 1985, and 39,363 acres in 1990) would result in increased exposure of archeological values to potentially damaging activities, which could lead to the destruction of some 1,899 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 (5,211 people in 1980, 14,761 people in 1985, and 17,414 people in 1985; 399 acres in 1980, 1,138 acres in 1985, and 4,484 acres in 1990).

HISTORICAL 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 by 54,960 vehicles by 1980, 130,130 vehicles by 1985, and 148,880 vehicles by 1990. This would include increases of 1,520 vehicles in 1980, 32,360 vehicles in 1985, and 35,400 vehicles in 1990 due to possible new coal development.

Average daily traffic levels at points throughout the region would increase. Average daily vehicle miles traveled would increase by 1,099,200 miles in 1980; 2,602,600 miles in 1985; and 2,977,600 miles in 1990. Increases due to possible new development would be 30,400 miles in 1980, 647,200 miles in 1985, and 708,000 miles in 1990. Accidents would increase by 1,207 in 1980, 2,860 in 1985, and 3,270 in 1990, including 33 in 1980, 710 in 1985, and 780 in 1990 due to possible new development. Fatal accidents would increase by 3 in 1980, 8 in 1985, and 9 in 1990; increases due to possible new developments would be 0 in 1980 and 2 in 1985 and 1990.

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 3,680 more 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

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 R8-12 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 R8-12).

Recreation

The possible new coal development would not have a significant direct impact on rereation; 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 as 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 167.9 acres of active/improved park land (e.g. ballfields, playground, tennis courts) by 1980, of which 15.5 acres would be due to population growth from possible new coal development. The 1985 populations would require 397.6 acres of active/improved parkland, including 44.2 acres due to possible new coal development. By 1990, increased demand would required 454.9 acres of active/improved parkland, including 49.8 acres due to possible new coal development.

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 R8-13 lists the 1990 population projections, assuming the high-level scenario, for the four counties which would be affected. Population growth, resulting from this alternative, would be concentrated primarily in Delta and Montrose counties. The high-level scenario would cause a much more rapid rate of growth between 1986 and 1990 than otherwise expected in both of these counties. In Delta County this new population would settle wherever housing and utility service become available, since all the excess housing and service capacity of the county 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 in Montrose County associated with the high-level scenario would locate in or around the city of Montrose.

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 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

TABLE R8-13

HIGH LEVEL POPULATION PROJECTIONS

Year	County	Population due to Cumulative Development	Population due to Possible Coal Development a/	Percent Difference from Mid-Level
1980	Delta	24,462	1,712	7.5
	Garfield	34,118	0	0
	Mesa	88,248	0	0
	Montrose	27,715	3,499	12.6
	Total	174,543	5,211	3.1
1985	Delta	38,893	7,973	25.8
	Garfield	42,883	0	0
	Mesa	109,223	0	0
	Montrose	34,038	6,786	24.9
	Total	225,037	14,761	7.0
1990	Delta	44,403	4,290	12.0
	Garfield	46,605	0	0
	Mesa	113,063	2,380	2.2
	Montrose	38,206	6,371	20.0
	Total	242,277	17,414	7.7

a/ One existing lease without M&R plan, nine new competitive short-term lease application areas, and two PRLA areas.

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, as 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 exception, 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 that 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 serious recession in the local economy.

Different Rate of Production

A major problem with coal development in west-central Colorado is the social and economic impacts that occur with rapid growth. In an effort to minimize these impacts, it is possible to control coal production and thus indirectly control employment rates and population growth in local communities. Given the current energy situation in the United States, it would not be expedient to curtail coal production completely. However, limiting growth to an acceptable level would lessen impacts on involved communities. A growth rate of 25 percent in five years, or 4.56 percent annually, is considered acceptable.

In west-central Colorado economic growth is expected from many sources, only one of which is coal. In some areas, particularly Garfield and Mesa counties, expected growth from oil shale is much greater than growth from coal and much greater than the standard of 25 percent in five years. Therefore, trying to hold down population by controlling rate of coal production would be ineffective. On the other hand, in the North Fork Valley area of Delta and Gunnison counties, growth would be almost entirely due to coal development. By limiting the rate of production from proposed mine expansion and new mines the rapid growth could be reduced to a manageable level.

Table R8-14 shows the total amount of new coal that could be produced in the North Fork Valley, the number of employees that would be required, and the population that would result. Mid-level population projections are also shown for comparison. Figure R8-1 is an aerial photograph of the North Fork Valley, showing the location of several existing and anticipated mining operations. Figure R8-2 shows Delta, Colorado, and the D&RGW rail spur from the valley.

Geologic and Geographic Setting

TOPOGRAPHY

It is impossible to estimate the amounts of acreages which will be disturbed by new surface facilities and subsidence before 1990 under this alternative. Allocation of increased coal production by mine is necessary before estimates can be made. Some surface disturbance is probable, however, when excavation and earthmoving occur in order to prepare sites for construction of surface facilities and subsidence occurs. Natural or existing slopes would be modified to create level areas and cut-and-fill slopes. Slumping and fracturing of the surface may occur as the result of subsidence. These modifications will affect both the surface and the subsurface hydrology of the area, the erosion rates, vegetation, wildlife, and visual quality of the areas involved. The impact under this alternative would be somewhat smaller than under the proposed action.

PALEONTOLOGY

Both adverse and beneficial impacts would occur to fossil resources in approximate proportion to the level of development and the areas disturbed.

Mineral Resources

Under this alternative, coal production from the North Fork Valley would be allowed to reach 2,344 million tons per year in 1980, 3,507 million

TABLE R8-14

ALLOWABLE INCREASES IN COAL PRODUCTION, EMPLOYMENT, AND RESULTING POPULATION UNDER THE DIFFERENT RATES OF PRODUCTION ALTERNATIVE

Year	Coal Production (tons per year)	Employees	Projected Population	Mid-level Population
1977	0	0	18,533	18,950
1978	0	0	19,349	19,349
1979	146,000	33	20,231	20,798
1980	146,000	33	21,309	22,750
1981	402,700	91	22,281	24,902
1982	694,700	157	23,297	25,818
1983	1,132,700	256	24,359	27,656
1984	1,132,700	256	25,543	29,231
1985	1,309,700	296	26,708	30,900
1986	1,460,200	330	27,926	32,103
1987	1,712,400	387	29,199	33,049
1988	2,031,000	459	30,530	33,972
1989	2,434,100	551	31,922	34,866
1990	2,973,500	664	33,378	35,750

Figure R8-1. Aerial photo looking northeast up the North Fork Valley from 3 miles north of Paonia, Colorado. The following five existing mines are shown: A - Orchard Valley Mine (Colorado Westmoreland, Inc.), E - Blue Ribbon Mine (Sunflower Energy Corporation), F - Somerset Mine (U.S. Steel Corporation), H - Bear Mine (Bear Coal Company), and I - Hawknest No. 3 and East mines (Western Slope Carbon). In addition, the following four anticipated mining operations are shown: B - Farmers Mine (Gulf Minerals), C - Terror Creek (Empire Energy). D - Bowie or Kine Mine (Coors Beer Company, I - Raven Gulch (A.T. Massey). The distance from point A to point I is approximately 10 miles.

Figure R8-2. Aerial photo looking northeast at Delta, Colorado. At the point marked A, the Denver and Rio Grande Western rail spur from the North Fork Valley crosses Colorado State Highway 50, a major north-south traffic corridor. A unit train carrying coal from the North Fork Valley to market is shown at point B.

tons per year in 1985, and 5,171 million tons per year in 1990. Production at these levels would be lower than the production levels of the proposed (mid-level) action by 8.4 percent in 1980, 43 percent in 1985, and 20 percent in 1990.

The depletion of the coal reserve which would result from this alternative would reduce the mineable reserves of the North Fork Valley by 0.0 percent in 1980, 0.3 percent in 1985, and 0.6 percent in 1990. Approximately 50 percent of this reduction would be the permanent loss of a nonrenewable resource as coal is consumed for energy production. An equal amount of coal would be left in place and may be recoverable depending on future advances in mining technologies. The residual quantities of mineable coal would be 4,299 million tons in 1980, 4,268 million tons in 1985, 4,224 million tons in 1990. This will be 0.02 percent more than under the proposed action in 1980, 0.3 percent more in 1985, and 0.6 percent more in 1990. An estimated 4,317 million tons of mineable reserves were originally present in beds greater than 42 inches thick under less than 3,000 feet of overburden. Table R8-15 summarizes the impacts discussed above.

Water Resources

The total controlled increased water consumption would be 221 acre-feet per year in 1980, 1,163 acre-feet per year in 1985, and 3,138 acre-feet per year in 1990. This is a decrease in increased water consumption over the mid-level production projections of 73 percent in 1980, 65 percent in 1985, and 6 percent in 1990. The total water consumption for the North Fork Valley under this alternative would be 8,957 acre-feet per year (down 1.7 percent) for 1980, 11,461 acres-feet per year (down 13 percent) for 1985, and 14,567 acre-feet per year (down 2 percent) for 1990.

The Paonia-Hotchkiss area would still require additional water treatment capacity by 1985. However, if the municipality of Delta is utilized by excess population increases, then there would be enough treated water to support the growth in the North Fork.

The capacity to treat sewage presents another problem. The only municipalities with excess capacity to treat sewage are Cedaredge and Delta; together they could support the growth increase. However, Paonia and Hotchkiss would receive a lot of pressure from population growth and would have to consider increasing their capacity to handle sewage. It appears that Delta is the only municipality in the North Fork area capable of withstanding the projected growth due to coal development.

Wildlife

There would be no significant difference between this alternative and the proposed action with regard to impacts on wildlife species except in the area of land use planning and zoning. If this occurred as part of Delta County's growth, then urban expansion onto deer and elk crucial winter range could be curtailed and wildlife habitat could be saved for wildlife. This would reduce the magnitude of the impacts in terms of lost habitat and carrying capacity.

Recreation

The limiting of coal production in the North Fork Valley would also have the effect of reducing the projected use of community recreational facilities. This would allow the communities to provide fewer facilities at a less accelerated rate to prevent the overuse and deterioration of existing facilities. The alternative rate of production would require 7.8 acres of active/improved parks (e.g. ballfields, playgrounds, tennis courts) by 1980, which would be 4.7 acres less than the mid-level projections. The 1985 facilities needs would be 25.6 acres of active/improved parks, which is 13.8 acres less than the mid-level. By 1990 the area would need 47.6 acres of active/improved parks, amounting to 7.8 acres less than the mid-level projection.

Socioeconomic Conditions

The result of this alternative would be a reduction in the social and economic problems caused by too rapid growth. Delta County population would be smaller by 1,441 persons in 1980, 4,192 in 1985, and 2,372 in 1990 under this development plan, as opposed to the projected mid-level populations. Demand on public facilities would be less. Also, more time would be available for local governments to provide facilities such as water and sewerage, parks, and schools for the increased population. Private individuals would also be better able to provide things such as housing and shopping centers.

Social upheaval caused by rapid influx of newcomers would be lessened as new people would have more time to get assimilated and long-time residents would have more time to get used to the new people. Conflicts between the two groups would still develop but could be expected to be less serious and with more chance for compromise. More casual development with less pressure would lower the incidence of alcoholism, drug abuse, crime, and mental health problems that often accompany rapid growth.

Inflation in the local economy would still develop. However, the magnitude would be less as developers would be better able to meet the increased demand for goods and services. The transition in jobs and wages caused by the availability of high-paying jobs in the coal industry would be more gradual. The end result would be a higher wage structure in the local economy.

In general, restricting coal production to lengthen the development period of the mines would lessen the effects on the economic and social structure of the North Fork Valley by slowing growth to a rate more easily managed.

TABLE R8-15

LEVEL OF IMPACT TO THE COAL RESERVE OF THE NORTH FORK VALLEY PRODUCED BY THE DIFFERENT RATES OF PRODUCTION ALTERNATIVE

Year	Coal Production (tons per year)	Cumulative Production (tons)	Percent Depletion of Mineable Coal Reserve	Residual Mineable Coal Reserve (tons)
1977	1,662,515	1,662,515		
1978	2,198,000	3,860,515		
1979	2,344,000	6,204,515		
1980	2,344,000	8,548,515	.4	4,299,450,000
1981	2,600,700	11,149,215		
1982	2,892,000	14,041,215		
1983	3,330,700	17,371,915		
1984	3,330,700	20,702,615		
1985	3,507,700	24,210,315	1.1	4,268,120,000
1986	3,658,200	27,868,515		
1987	3,910,400	31,778,915		
1988	4,229,000	36,007,915		
1989	4,636,100	40,644,015		
1990	5,171,500	45,815,515	2.1	4,224,910,000

TABLE R8-16

COMPARISON TABLE OF IMPACTS
PARTIAL LISTING

		Proposed Actions			Regional Cumulative			No Action Alternative Low Scenario			Additional Coal High Scenario			Cumulative High Scenario		
	Units	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990
Air Quality-suspended particulate emissions	Tons/year	2,592	2,571	3,180	NA	NA	NA	1,487	1,611	1,514	0	0	4,930	NA	NA	NA
Topography-subsidence due to underground mining	Acres	600	4,800	12,600	2,400	9,600	19,385	1,000	2,500	4,000	0	0	5,615	2,400	9,600	25,000
Topography-surface disturbed total	Acres	435	1,219	1,261	8,696	27,088	31,879	8,277	25,192	32,351	0	0	3,331	9,095	28,226	39,363
Paleontology-loss of fossils due to collecting and mining	Sites	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Minerals-annual coal production	Million tons	2.53	8.64	11.6	7.42	14.41	17.10	5.98	5.18	4.73	0	0.25	18.60	7.46	14.66	35.70
Water-estimated annual water consumption	Acre-feet	1,615	5,734	7,390	5,328	24,224	33,054	3,729	18,437	25,601	0	781	1,474	5,328	25,256	37,790
Soil-reduced productivity	Acres	435	1,219	1,261	4,604	18,084	24,414	1,382	1,568	1,746	0	0	3,331	4,604	18,084	27,745
Soil-soil surface required for increased population	Acres	265	902	1,112	4,092	9,004	10,465	3,827	8,102	9,353	399	1,138	1,153	4,491	10,142	11,618
Vegetation-acres of vegetation removal	Acres	700	2,121	2,373	8,696	27,088	34,879	5,209	9,670	11,099	399	1,138	4,484	9,095	28,226	39,363
Vegetation-acres of disturbed land which would be reclaimed	Acres	435	1,219	1,261	NA	NA	NA	1,382	1,568	1,746	0	0	3,331	NA	NA	NA
Wildlife-loss of fish and wildlife habitat and carrying capacity affected directly	Acres	435	1,219	1,261	4,604	18,084	24,414	1,382	1,568	1,746	0	0	3,331	4,604	18,084	27,745

Note: Since the different production level alternative applies only to the North Fork Valley, it is not included here.

TABLE R8-16
(continued)

	Units	Proposed Actions			Regional Cumulative			No Action Alternative Low Scenario			Additional Coal High Scenario			Cumulative High Scenario		
		1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990
Wildlife-loss of fish and wildlife habitat and carrying capacity affected indirectly	Acres	265	902	1,112	4,092	9,004	10,465	8,277	25,192	32,351	399	1,138	1,153	4,491	10,142	11,618
Wildlife-number of antelope lost	Number antelope	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wildlife-number of deer lost	Number deer	52	142	158	832	3,029	3,911	67	76	85	0	0	164	NA	NA	NA
Wildlife-number of elk lost	Number elk	8	23	26	134	439	1,674	11	12	14	0	0	27	NA	NA	NA
Cultural-number of archeological sites threatened by destruction	Sites	6	18	18	1,899	1,899	1,899	1,899	1,899	1,899	1,899	1,899	1,899	1,899	1,899	1,899
Cultural-number of historical sites with potential disturbance	Sites	0	0	0	123	123	123	123	123	123	0	0	123	123	123	123
Transportation-estimated vehicle registrations increase	Vehicles	3,400	11,450	14,150	50,595	115,665	132,620	47,195	104,215	118,470	1,520	32,360	35,400	54,960	130,130	148,880
Transportation-increase in number of coal trains east bound	Trains/year	80	764	1,054	185	964	1,254	NA	NA	NA	NA	NA	NA	NA	NA	NA
Transportation-increase in number of coal trains west bound	Trains/year	100	100	100	514	454	444	NA	NA	NA	NA	NA	NA	NA	NA	NA
Agriculture-number of AUMs lost	AUMs	20	60	69	457	1,796	2,424	448	1,708	2,330	0	0	NA	457	1,796	2,755
Recreation-number of anglers	Anglers	1,364	4,659	5,750	20,812	46,684	54,032	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE R8-16
(continued)

	Units	Proposed Actions			Regional Cumulative			No Action Alternative Low Scenario			Additional Coal High Scenario			Cumulative High Scenario		
		1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990
Recreation-number of hunters	Hunters	527	1,800	2,322	8,041	18,037	20,876	NA	NA	NA	NA	NA	NA	NA	NA	NA
Recreation-active/improved parkland required	Acres	10	35	43	156	350	405	142	307	348	15	44	50	168	398	455
Socioeconomic-total increase in population	People	3,150	10,600	13,100	46,850	107,100	120,800	42,950	49,700	12,850	5,211	14,761	17,414	22,493	50,494	17,240
Socioeconomic-total increase in employment	Jobs	1,189	2,330	2,784	6,177	13,223	14,564	4,988	10,893	11,780	NA	NA	NA	NA	NA	NA
Socioeconomic-total increase in income	Million dollars	29.1	56.2	67.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

CHAPTER NINE

CONSULTATION AND COORDINATION

This section describes the organization and functioning of the environmental statement (ES) interagency team, and discusses the contribution of various federal, state, and local organizations to the overall ES preparation effort.

Organization of Interagency Task Force Team for the Environmental Statement

A memorandum from the Office of the Secretary of the Interior assigned the Colorado State Director, Bureau of Land Management, lead responsibility for preparation of this ES. The project was organized as a joint effort between the Bureau of Land Management (BLM) and the U.S. Geological Survey (USGS). Other entities providing support to the statement were the state of Colorado and the U.S. Forest Service (USFS). During August and September 1977, a project approach was developed, including selection of team members and scheduling. Team members were selected from both the Montrose and Grand Junction BLM districts, the USGS Area Mining Supervisor's Office, the state of Colorado's Socioeconomic Impact Office, and the supervisor's offices of the Gunnison, Uncompahgre and Grand Mesa national forests. In addition, team members were selected for representation of broad categories of environmental concern, including soils and vegetation, range and wildlife, cultural values, socioeconomics, hydrology and aquatic biology, geology, mining, and ecological interrelationships. The state of Colorado provided regional and urban planning expertise to the team from its Socioeconomic Impact Office in Denver, and the USFS provided additional technical coordination support.

Consultation and Coordination in the Preparation of the Draft Environmental Statement

A meeting was held at the Denver Regional Library in Denver on June 2, 1977, with approximately 200 people in attendance. The purpose of this meeting was to notify all coal industry people of project plans and solicit industry's preliminary coal development plans. Those in attendance were told they had until September 2, 1977, to submit their final mining plans to the USGS for review and inclusion in the West- Central Colorado Coal ES. After this deadline, all letters of intent and mining proposals were assembled into a regional package and constituted the proposed actions which are analyzed in this ES. On October 2, 1977, the initial notification that the project was beginning was issued to Regions 10 and 11 of the Colorado Council of Governments (COG).

Federal Agencies

Table 9-1 lists the federal agencies contacted through formal consultation and coordination procedures and the type and extent of their assistance.

State Agencies

A special effort was made, through the Governor's Socioeconomic Impact Office, to expand the core team to include one member from the state with expertise in regional/urban planning. Under the terms of this agreement the state provided the team member for a period of six months, commencing October 1, 1977, lasting through March 1978, with intermittent duty from that point to the conclusion of the statement. In addition, specific areas of assistance were provided by the State Historical Society of Colorado, Office of the State Archaeologist, Colorado Bureau of Mines, Division of Wildlife, Department of Education, Division of Planning, Department of Health, Mesa College Information Services, Colorado Mountain College, Western Colorado University, Division of Highways, Water Engineers, Department of Agriculture, Department of Natural Resources, Mined Land Reclamation Board, Colorado State University (Delta and Montrose County Extension Services), Socioeconomic Impact Office, Department of Local Affairs, Division of Housing, HB 1041 Coordinator, Division of Parks and Recreation, Clearing House, University of Colorado, Colorado River Water Conservation District, Division of Water Resources, Water Quality Control Division, Colorado Geological Survey, and the Colorado Department of Education.

Local Contacts

Local contacts included: Region 10 Council of Governments, Region 11 Council of Governments, County Commissioners of Garfield, Pitkin, Mesa, Delta, Montrose, and Gunnison counties, Montrose

TABLE R9-1

FEDERAL AGENCY ASSISTANCE

	Agency	Nature of Contact	Type and Extent of Assistance
1.	United States Senate	Notification of Statement.	
2.	United States House of Representatives	Notification of Statement.	
3.	U.S. Geological Survey	Requested staff and data assistance, and preliminary review.	Provided one core team member for engineering and minerals section; provided the data assistance requested and continual review.
4.	U. S. Forest Service	Requested staff and data assistance, and preliminary review.	Provided liaison and data assistance and a team advisor for review purposes.
5.	Environmental Protection Agency	Requested data assistance and preliminary review.	Provided data assistance.
6.	Soil Conservation Service	Requested consultation with team and assistance with special areas.	Provided consultation and assistance with soil surveys.
7.	National Park Service	Requested data assistance.	Provided data assistance.
8.	Bureau of Reclamation	Requested data assistance.	Provided data assistance.
9.	Fish and Wildlife Service	Requested data and consultation with FWS concerning Section 7 of the Endangered Species Act (1973), and known coal lease areas.	Initiated Section 7 consultation (ongoing). Provided requested data.
10.	Department of Energy	Requested data assistance.	Provided data assistance.
11.	Rural Electrification Administration	Requested data assistance.	Provided data assistance.
12.	Department of Transportation	Requested data assistance.	Provided data assistance.

TABLE R9-1

FEDERAL AGENCY ASSISTANCE
(continued)

	Agency	Nature of Contact	Type and Extent of Assistance
13.	Federal Energy Regulatory Commission	Requested data assistance.	Provided data assistance.
14.	Federal Energy Administration	Requested data assistance.	Provided data assistance.
15.	Interstate Commerce Commission	Requested data assistance.	Provided data assistance.
16.	Advisory Council on Historic Preservation	Notification of Statement.	
17.	Interagency Archeological services	Requested data assistance.	Provided data assistance.
18.	Heritage Conservation and Recreation Service	Requested data assistance.	Provided data assistance.
19.	Department of Labor	Requested data assistance	Provided data assistance.
20.	Bureau of Mines	Requested data assistance.	Provided data assistance.

County Planning Commission, Mid-Western Colorado Mental Health Center, West End Development Committee, Delta County Development Department, Delta County School District RE-50, West End School District RE-2, Montrose County School District RE-1J, Mesa County Valley School District 51, Delta County Memeorial Hospital, Mesa County Development Department, Mesa County Energy Impact Assistance Committee, Garfield Couny Planning Department, Pitkin County Planning Department, Gunnison County Planning Commission, Gunnison Watershed School District RE-1J, Pitkin County Environmental Coordinator and Sanitarian, Delta County Water Commissioner, Mesa County Water Judge, Ouray County Planner, Montrose County Planner, Gunnison County Planner, Delta County Planner, Mesa County Planner, Pitkin County Planner, Garfield County Planner, Delta County Assessor, Montrose County Assessor, and Garfield County Assessor.

Cities

City governemnts which provided assistance included: Montrose, Olathe, Delta, Cedaredge, Eckert, Hotchkiss, Crawford, Paonia, Somerset, Grand Junction, Fruita, Glenwood Springs, Silt, DeBeque, Palisade, Clifton, Carbondale, Aspen, New Castle, Colbran, Ouray, Gunnison, Grand Valley, and Rifle.

Other

Other contacts included: Glenwood Springs Chamber of Commerce, Ouray County Chamber of Commerce, Montrose Chamber of Commerce, Western Colorado Health Systems Agency, Ute Water District, Mesa Engineering Co., Eldorado Engineering Co., Henningson, Durham and Richardson, Inc., Ute Engineering and Surveying, Rocky Mountain Inspections, Quality Development Associates, Rio Blanco OIl Shale Project, Atlantic Richfield Corp., Mid-Continent Coal and Coke, Superior Oil, United Bank of Montrose, General Exploration, Sheridan Enterprises, Anschutz Coal Company, Sundance Oil, Coal Fuels Corp., Public Service Company, Denver and Rio Grande Western Railroad, Grand Junction Chamber of Commerce, Quinn Coal Co., Hunter Canyon Enterprises, Kerr and Kerr Coal Company, Colorado Westmoreland, Inc., Bear Coal Company, Western Slope Carbon, Inc., A.T. Massey Coal Co., Delta-Montrose Electric Assn., John Ballah, Dale Hollingsworth, and M.M. Drake, Delta School Superintendent.

Coordination in the Review of the Draft Environmental Statement

Comments on the draft environmental statement have been requested from the following agencies, state clearing house, and interested groups.

Federal

- Advisory Council on Historic Preservation
- Department of Agriculture
  - Soil Conservation Service
  - U. S. Forest Service
- Department of Commerce
- Department of Defense
  - Army Corps of Engineers
- Department of Energy
  - Conservation and Energy Resource Development Division
- Environmental Protection Agency
- Federal Energy Regulatory Commission
- 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
  - U. S. Geological Survey
- Interstate Commerce Commission
- Department of Labor
  - Occupational Safety and Health Administration
  - Mining Enforcement and Safety Administration
- Office of Economic Opportunity
- Office of Management and Budget
- Rural Electrification Administration
- Department of Transportation
  - Federal Highways Administration
- Water Resources Council

State

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

Local

All entities included under the local contacts heading of the previous section (Consultation and Coordination in the Preparation of the DES) will be requested to provide comments on the document.

Nongovernment Organizations

- American Horse Protective Association
- American Institute of Mining Engineers
- American Mining Congress
- American Sportsman's Club
- Anschutz Coal Company
- Atlantic Richfield Company
- Bear Coal Company
- Belden Enterprises, Inc.
- Bendetti Brothers
- Carbon King, Ltd.
- 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
Environmental Defense Fund
Environmental Policy Institute
Friends of the Earth
General Exploration 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
National Resources Defense Council
National Wildlife Federation
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 for Range Management
Sunflower Energy Corporation
Thorne Ecological Institute
Trout Unlimited
U. S. Steel Corporation
Weaver Brothers
West Slope Energy Research Council
Western Slope Carbon, Inc.
Western States Coal Company
Wilderness Society
Wildlife Society, Colorado Chapter

Copies of this draft environmental statement will be available for public inspection at the BLM offices listed below.

Washington Office of Public Affairs
18th and C Streets
Washington, D.C., 20240
Phone: (202) 343-5717

Colorado State Public Affairs Office
Room 700, Colorado State Bank Building
1600 Broadway
Denver, Colorado 80202
Phone: (303) 837-4481

Grand Junction District Office
764 Horizon Drive
Grand Junction, Colorado 81501
Phone: (303) 243-6552

Montrose District Office
P.O. Box 1269
Montrose, Colorado 81401
Phone: (303) 249-7791

Public hearings will be held in Delta, Grand Junction, and Denver. Details of the hearings will be published in the *Federal Register* and local newspapers.

☆U.S. Government Printing Office: 1978-778-548/393 Region 8