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Environmental Impact Statement

Getty and Cities Service Shale Oil Projects

Prepared by:
U.S. Army Corps of Engineers
Sacramento District

DRAFT

Environmental Impact Statement
Getty and Cities Service
Shale Oil Projects

Prepared by:

US Army Corps of Engineers
Sacramento District

with the assistance of:

Camp Dresser & McKee Inc.

20 January 1984

US Army Corps
of Engineers

Sacramento District
650 Capitol Mall
Sacramento, CA 95814

Public Notice

Public Notice No. 8157-EIS

Date: January 20, 1984

In Reply Refer to: SPKCO-O

Comments Due by: March 20, 1984

TO WHOM IT MAY CONCERN:

Notice of Availability of Draft EIS for Getty and Cities Service Company Shale Oil Projects, Garfield County, Colorado.

The Sacramento District announces the release of the draft EIS for separate shale oil projects proposed by Getty and Cities Service Oil Companies. The draft EIS identifies the impacts of the construction and operation of the two 100,000 barrel per day projects and their alternatives. This EIS is being prepared as part of the Corps of Engineers permit responsibilities under Section 404 of the Clean Water Act.

Written comments on the draft that are received by **March 20, 1984** will be included in final EIS. Comments should be sent to Tom Coe, Regulatory Section, at the above address.

Copies of the draft EIS can be obtained by writing the address above, or by calling (916) 440-2541 (FTS 448-2541).

ARTHUR E. WILLIAMS
Colonel, CE
District Engineer

SUMMARY

This EIS addresses the environmental impacts of the proposed Getty and Cities Service shale oil projects in northwestern Colorado. The impacts of each project are assessed separately. The reader can review the Getty project description, baseline conditions, and impacts by locating the pages color-coded in blue. The Cities Service project and impact descriptions are presented on green color-coded pages. Common environmental features and impacts of the two projects are presented on white paper. The reader is advised to retain this Draft EIS, since all sections may not be reprinted in the Final EIS.

A brief overview of each project follows.

Getty

Getty Oil Company owns oil shale properties adjacent to the Clear Creek drainage in Garfield County, Colorado. These properties are primarily in R97W and 98W, Township 5S. The properties include 20,880 acres of resource land and about 11,600 acres of valley support lands. The support lands extend from the Colorado River south of De Beque northward up the Roan Creek valley to Clear Creek, and include Clear Creek canyon bordering the resource property.

If economically justified, Getty proposes to develop the resource using conventional room and pillar underground mining, combined with surface retorting and shale oil upgrading. Ultimate capacity would be 100,000 barrels per day (bpd) of upgraded shale oil. If developed, the project would be operated in phases starting with 50,000 bpd and followed by two 25,000-bpd additions. Construction could commence as early as 1987 with production comencing in 1990. Expected project life would be 30 years. Major elements of the project would include a water supply system, an underground room and pillar mine, retorting and upgrading facilities, raw shale transporting systems, and a spent shale disposal system. The primary source of water would be the GCC Industrial Supply System, whose primary impacts are addressed in the Clear Creek Shale Oil Project (CCSOP) EIS (BLM 1983a). As currently envisioned, ancillary facilities would include, but would not necessarily be limited to, a syncrude pipeline, electric powerlines, access roads, and a utility corridor. Current plans specify that the initial surface plant site would be located in Section 32 of Township 5S, Range 97W, with retort additions at a plant site in Sections 15 and 22 of Township 5S, Range 97W, and the proposed location for the shale disposal system in Wiesse Creek gulch.

Cities Service

Cities Service Company is planning a staged development of its oil shale holdings in the upper Conn Creek area of Garfield County, Colorado. These holdings are primarily in Range 97W, and Townships 6S and 7S. Most of this property, which includes the oil shale resource, was acquired by Cities in 1951. The property consists of 10,300 contiguous acres, with approximately 6,850 acres on the Roan Plateau underlain by oil shale and the remainder located in canyon drainages.

Cities Service plans include development of conventional room-and-pillar underground mining, combined with surface retorting and shale oil upgrading during the early stages of the project. This development would be followed by the use of a vertical modified-in-situ (VMIS) process to augment the surface retorting. Ultimately the capacity of the plant would be expanded to 100,000 barrels per day (bpd) of upgraded shale oil. Construction of the initial module is planned to commence in 1987 with production commencing in 1991. The ultimate production level is planned to be achieved by 2010. The estimated project life depends upon the precise implementation of the various project stages, but is expected to be a minimum of 25 years. Major elements of the project would include a water supply system, an underground room-and-pillar mine accommodating the VMIS processing, retort and upgrading facilities; raw shale transporting systems, and a retorted shale disposal system. The primary source of water would be the GCC Industrial Supply System. The impacts of this system are addressed in the Clear Creek Shale Oil Project (CCSOP) EIS (BLM 1983a). Ancillary facilities would include, but are not necessarily limited to, a syncrude pipeline, electric powerline, access roads, and a utility corridor. The surface plant site would be located on the Roan Plateau in the vicinity of the mine bench, and the proposed location for the shale disposal system would be the upper portion of Cascade Canyon. The initial phases of the project could include some spent shale disposal facilities on the mesa.

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1.0

Purpose and Need

1.0 PURPOSE AND NEED

1.1 Background

Getty Oil Company (Getty) and Cities Service Oil and Gas Corporation (Cities Service) each propose to independently develop their oil shale resource properties north of De Beque, Colorado (Figure 1.1-1). The ultimate capacity of each project is 100,000 bpd of shale oil. Details concerning the purpose and need for each project are given in Section 1.4.

The purpose of this EIS is to address the impacts of mine development and oil shale processing resulting from the granting of a Section 404 Dredge and Fill permit by the Army Corps of Engineers to the GCC Joint Venture (Getty, Cities Service, and Chevron Shale Oil Company participants). The 404 permit is a necessary part of constructing the water supply system, which would include an intake structure on the Colorado River, related pipelines, and a storage reservoir in the Roan Creek drainage. Getty, Cities Service, and Chevron have formed a joint venture called the GCC Joint Venture, the purpose of which is to develop a common water supply system that would allow each participant to divert and regulate water available under their respective, individual water rights for subsequent industrial use. Facilities associated with this system would extend from the intake in the Colorado River near De Beque through a main storage reservoir on Roan Creek, referred to as the Roan Creek reservoir. The Joint Venture was formed because it is the policy of the State of Colorado, as indicated by its statutes, to encourage joint facilities for the conveyance of water and to minimize the number of structures which are used for the conveyance of water on improved or occupied lands. In addition, such joint facilities for water would be more efficient, economical, and would in turn minimize the environmental impacts.

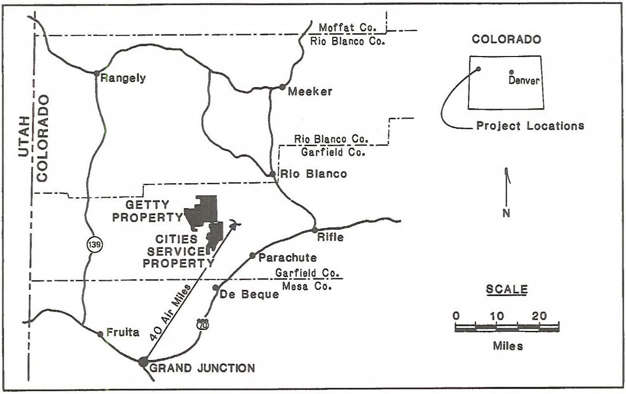


Figure 1.1-1 Getty and Cities Service Oil Shale Resource Property Areas.

The impacts of the GCC Joint Venture and the Chevron shale oil development were addressed in the Clear Creek Shale Oil Project (CCSOP) EIS (BLM 1983a). This EIS addresses the impacts of water withdrawal and use related to the development of Getty and Cities Service shale oil projects. This EIS also serves as the Technical Assistance Report to address the concerns of the U.S. Fish and Wildlife Service under the Fish and Wildlife Coordination Act of 1958. The appropriate information is provided in Sections 3.1.7, 3.2.7, 3.3.7, 4.1.7, 4.2.7, and 4.3.7.

1.2 Regulatory Actions Initiating The EIS

This EIS was initiated by a Section 404 permit application filed by the GCC Joint Venture, c/o Getty Oil Company, Los Angeles, California. The application, No. 8157, is a modification of an earlier application (No. 5917) submitted by Getty Oil Company in 1976. The application is for dredge and fill activities in the Colorado River and the Roan Creek drainage and will be evaluated pursuant to Section 404 of the Clean Water Act (33 USC 1344). Evaluation of the application will assume use of guidelines set forth by the Administrator, EPA, under authority of the Clean Water Act (40 CFR Part 230).

1.3 Other Required Authorizations and Technical Reviews

Numerous other federal, state, and local permits, authorizations, and technical reviews will be required to develop the Getty and Cities Service shale oil projects. The authorizations and reviewers listed below do not require prior preparation of an EIS, although some may rely on the EIS for a description of the full project and its impacts. In many instances very specific baseline and engineering data as well as impact analyses will be included in these permits or authorizations. References to these permit applications and associated data or impact analyses are made, where applicable, in Chapters 3.0 and 4.0.

1.3.1 Federal

Fish and Wildlife Service:

> A Biological Assessment has been prepared for the GCC-CCSOP as it relates to the aquatic environment. The USFWS will use this document to prepare a Biological Opinion relative to GCC-CCSOP water depletions on the Colorado River.
>
> The USFWS will also review the U.S. Army Corps of Engineers 404 Permit under authority of the Endangered Species Act and the Fish and Wildlife Coordination Act of 1958.

Environmental Protection Agency:

> The EPA will: (1) review for completeness and adequacy the Prevention of Significant Deterioration Permit (PSD) governing the effects of project construction and operation on existing air quality; (2) review plans for spent shale disposal, handling of any toxic and hazardous wastes, and noise control plans; and (3) issue permits and monitor compliance in these matters as applicable.

Bureau of Land Management:

> The BLM will issue various land use authorizations (land exchanges, land purchases, rights-of-way, leases) governing use and management of public lands administered by the BLM.

1.3.2 State of Colorado

Mined Land Reclamation Board:

> The Board will review the regular mining permit governing the construction, operation, and reclamation of mining operations.

Division of Water Resources:

The Division will review water well permits; approve plans and specification for all dams that are in excess of 10 feet in height, or have a water surface at the high waterline in excess of 20 acres, or have the capacity of more than 1,000 acre feet.

Division 5 Water Court:

The Court adjudicates Colorado water rights, augmentation plans, and change of use applications.

Division of Mines:

The Division will review permits for the use of underground diesel engine equipment, and the use and storage of explosives.

Water Quality Control Division:

The Division will review National Pollutant Discharge Elimination System (NPDES) permits governing the discharge of pollutants into the waters of the state.

The Division will issue 401 Certificates governing the effects of dredged or fill material on water quality.

Air Pollution Control Division:

The Division will review state air quality control permits.

Department of Highways:

The Department will review permits governing oversized vehicles.

State Historic Preservation Office:

The Office will review and provide clearances regarding cultural resources.

1.3.3 Local Jurisdictions

Mesa and Garfield counties administer various regulations governing land use in the unincorporated areas of the county. Such permits could be required for various project-related development activities.

Various municipalities also administer regulations governing land uses within municipal boundaries. Such permits could be required for various project-related development activities.

1.4 Purpose and Need

Every regulatory permit application has both an applicant's purpose and need and a public purpose and need. The purpose and need for the Getty and Cities Service shale oil projects is primarily to satisfy national energy requirements. The U.S. Congress and various Presidential Administrations have recognized the need for alternative forms of energy development. Synthetic fuels (e.g., shale oil) are a prime example of such alternative energy development. The western United States, and particularly the Green River Basin in Colorado, Utah, and Wyoming is rich in oil shale reserves and has been the focus of potential development activity. Getty and Cities Service have acquired lands and related resources for development of these oil shale reserves, and the purpose of this EIS is to analyze the environmental impacts of this development.

Other forms of alternative energy development (notably solar, geothermal, wind, and biomass technologies) have been promoted by various parties, including the U.S. Government, and are in various stages of development and commercialization. Government and private economic forces have strongly encouraged the testing and potential use of shale oil. Oil shale has been shown to be one of the most feasible synthetic fuel alternatives from an economic and technical perspective. Shale oil can replace conventional crude oil, and contains a larger proportion of growth for petroleum products such as jet and diesel fuel. This alternative energy technology is perhaps closer to commercialization than some of the others mentioned. This EIS is an example of the progress of two of these shale oil projects.

There are numerous other secondary public purposes and needs for the preparation of this EIS. As noted previously, the primary purpose of the EIS is to assess the impacts of granting a 404 Permit to the GCC Joint Venture for water development activities on the Colorado River and in the Roan Creek basin. This EIS will assess the impacts of that water use, notably development of the oil shale properties and related facilities. The public need for the shale oil beyond that primary need for energy sources noted above is also reflected in the economic benefits to localities in northwestern Colorado, the State of Colorado in general, and the nation. The jobs, income, expenditures, and general economic growth and development of this region, resulting from the proposed developments, would satisfy the economic needs of Colorado and the United States. These benefits are not without costs in terms of environmental impacts, however. Nearly every type of resource development involves environmental impacts (beneficial and adverse), but they usually promote economic and social growth. The purpose of this EIS is to compare and contrast those impacts for purposes of disclosure to agency reviewers, special interest groups, and the general public.

The purposes and needs for the Getty Project and the Cities Service Project are discussed separately below.

1.4.1 Getty

The purpose of the proposed Getty shale oil project is to produce shale oil in an environmentally and economically acceptable manner.

The Energy Security Act of 1980 states "The Congress finds and declares that ... the achievement of energy security for the United States is essential to the health of the national economy, the well being of our citizens, and the maintenance of national security". Since enactment of this legislation, domestic crude production has continued to lag behind consumption, although consumption decreased during the early 1980's. The 1983 National Energy Policy Plan sees a continued lag in domestic energy production, with oil imports growing to approximately 5-6 million barrels per day by the year 2000.

To augment conventional oil and gas, Getty and other domestic energy companies have committed significant resources to the development of alternate fuels, such as tar sands, oil shale, and oil from diatomacious earth. It is Getty's belief that, in the long run, development of alternate energy sources will contribute to the achievement of energy independence and security of the United States.

Development of an oil shale industry should provide western Colorado and the national interest with benefits far outweighing the costs. The infusion of new revenue to the area will enable controlled growth of Western Slope communities, with old and new residents benefitting from the resulting improvements in quality of life, services, and facilities.

While development of an oil shale industry is not expected to close the domestic energy gap during this century, it has been suggested that this industry could reduce domestic vulnerability to a recurrence of the foreign crude oil supply disruptions of the 1970's. The resulting production capability could also act as a moderating influence on cartel-induced rapid energy price escalations. An oil shale production level of 500,000 barrels per day would also reduce our balance of payments deficit by over $5 billion annually, even assuming the currently depressed foreign crude price of $30 dollars per barrel.

1.4.2 Cities Service

The purpose of the proposed Cities Service shale oil project is to produce shale oil in an environmentally and economically acceptable manner.

The Energy Security Act of 1980 states "The Congress finds and declares that ... the achievement of energy security for the United States is essential to the health of the national economy, the well being of our citizens, and the maintenance of national security". Since enactment of this legislation, domestic crude production has continued to lag consumption, although consumption decreased during the early 1980's. The 1983 National Energy Policy Plan sees a continued lag in domestic energy production, with oil imports growing to approximately 5-6 million barrels per day by the year 2000.

To augment conventional oil and gas, Cities Service and other domestic energy companies have committed significant resources to the development of alternate fuels, such as tar sands and oil shale. It is the belief of Cities Service that, in the long run, development of alternate energy sources will contribute to the achievement of energy security for the United States.

The Canadian Syncrude Project, in which Cities Service was a developing and long-term participant, and the Suncor Tar Sand Project are ventures that have proven that synthetic fuels can be developed in an environmentally sound, economically feasible, and socially responsible manner. The billions of dollars invested by private, public, and governmental interests in these ventures have provided the northern Alberta region with significant growth, as well as an enhanced quality of life for its residents. Looking beyond the local economies, development of the tar sands industry has benefitted Canada's national interest. During 1983, combined synthetic crude production from the Canadian Syncrude Project and Suncor Project is projected to exceed 55 million barrels, thereby reducing Canada's balance of payments deficit by over $1.6 billion.

Development of an oil shale industry should provide Western Colorado and the national interest with benefits far outweighing the costs. The infusion of new revenue to the area will enable controlled growth of Western Slope communities, with old and new residents benefitting from the resulting improvements in quality of life, services, and facilities.

While development of an oil shale industry is not expected to close the domestic energy gap during this century, it has been suggested that this industry could reduce domestic vulnerability to foreign crude oil supply disruptions, as experienced in the 1970's. The resulting production capability could also act as a moderating influence on a cartel-induced rapid energy price escalations. An oil shale production level of 500,000 barrels per day would also reduce the U.S. balance of payments deficit by over $5 billion annually, even assuming the currently depressed foreign crude price of $30 per barrel.

2.0

Proposed Action and Alternatives

2.0 Proposed Actions and Alternatives

2.1 Introduction

This section presents descriptions and impact comparisons of the proposed actions and alternatives for the Getty shale oil project and the Cities Service shale oil project (in separate subsections). In order to provide a basis for choice among varying alternatives by the Corps and the public, impact comparisons are presented for each discipline, based on the information provided in Chapter 3.0 — Affected Environment, and Chapter 4.0 — Environmental Consequences. In accordance with Council of Environmental Quality (CEQ) regulations (40 CFR 1502.14[a-f]) and appropriate Corps regulations (33 CFR 230.26), this chapter addresses the following:

- Alternatives eliminated from detailed study and the reasons for elimination (Section 2.2.2 - Getty project; Section 2.2.3 - Cities Service project)
- Description of the proposed action and reasonable alternatives (Section 2.3.1 - Getty project; Section 2.3.2 - Cities Service project)
- The No Action alternative for each project (Section 2.4.3.1.9 - Getty project; Section 2.4.3.2.11-Cities Service project)
- A comparison of the environmental impacts of the alternatives considered in detail including the proposed actions (Section 2.4.3.1 - Getty project; Section 2.4.3.2 - Cities Service project)

2.2 Selection of Alternatives for Detailed Discussion

2.2.1 Introduction

The Corps, in accordance with 40 CFR 1501.1(e) and 33 CFR 230.26, identified the proposed action for the Getty and Cities Service projects, as well as the full range of alternatives to each proposed action. The alternatives considered or eliminated for each project are presented on the following pages.

2.2.2 Getty Project

The alternatives considered for the Getty project encompassed a wide range of realistic options. Evaluation of alternatives included production capacity, mining techniques, retort technology, and siting options. Table 2.2-1 presents the full range of alternatives considered and the reason for their inclusion or elimination from detailed study in the EIS. In general, alternatives were selected on the basis of relative efficiency, technical and economical feasibility, and minimal environmental impact. Alternatives were eliminated because of relative inefficiency, technical and economical problems, and major potential environmental impacts.

2.2.3 Cities Service Project

In arriving at project alternatives for the Cities Service Project, a wide range of options were investigated. Table 2.2-2 presents alternatives by categories (e.g., mine type, retort technology, transport corridors) considered and the reason for inclusion or elimination from detailed study in the EIS. Alternatives were included based on current planning, relative efficiency, technical and economical feasibility, and minimization of environmental impact. The basis for elimination of alternatives included relative inefficiency, technical and economic problems, and major potential environmental impacts.

Table 2.2-1 ALTERNATIVES CONSIDERED OR ELIMINATED FROM DETAILED STUDY FOR THE GETTY SHALE OIL PROJECT

Alternative Category	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion or Elimination (Alternative Type)[a]
Production Rate	100,000 bpd	Included	Current design basis. Most economical and efficient production rate, sufficient resource for project life. (2)
	50,000 bpd	Included	May reduce overall impacts; may extend life of operation. (2)
Mining Method	Underground	Included	Allows the selection of rich oil shale layer for processing. (2)
	Surface	Eliminated	Uneconomical due to high ratio of overburden to reasonable grade oil shale resource. (4)
Retort Type	Surface	Included	The surface retorting technology has been demonstrated and has a high probability of technical and economic feasibility. (2)
	Modified In-Situ (MIS)	Eliminated	Technology less developed than surface retorting methods. (4)
Surface Retort Technology	Union B	Included	Technology developed commercially by Union Oil. (2)
	Lurgi	Included	Technology developed and demonstrated with numerous tests. Would process shale fines. (2)
Upgrading	Hydrotreating	Included	The hydrotreating of the shale oil results in a pipeline-compatible product. (2)
	Refinery	Eliminated	Sufficient refining capacity is available off-site within economic pipeline distance. (4)
Water Source	Surface	Included	It is an adequate supply (adjudicated) to meet project needs. (1)
	Underground	Eliminated	It is not a sufficient supply to meet project needs. (1)
Power Source	Purchase	Included	Most feasible in terms of efficiency and cost. (2)
	Cogeneration	Included	Feasible use of byproduct energy. (2)
Product Transport Methods	Pipeline	Included	Proven procedure for transport of oil products. (2)
	Railroad	Eliminated	Logistics of transport of shale oil by railroad not proven, nor is it anticipated to be economical. (2)
	Truck	Eliminated	Logistics of transport of shale oil by truck not acceptable. (2)
Product Pipeline Route	La Sal	Included	Most feasible method of transport, approved project. (2)
	Rangely	Included	Pipeline route established and previously analyzed. (2)
	Gary	Eliminated	Insufficient capacity for anticipated project needs. (4)
Retort Site	Mesa	Included	Acceptable from an air quality impact standpoint. (2)
	Valley	Eliminated	Projected unacceptable air quality impacts. (2)
Upgrading Site	Mesa (Retort Site)	Included	Acceptable from an air quality impact standpoint; potential energy savings. (2)
	Remote Location	Eliminated	Unacceptable logistics to move raw oil shale. (4)

Table 2.2-1 ALTERNATIVES CONSIDERED OR ELIMINATED FROM DETAILED STUDY FOR THE GETTY SHALE OIL PROJECT (concluded)

Alternative Category	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion or Elimination (Alternative Type)[a]
Spent Shale Disposal	Wiesse Creek	Included	Close to retort sites; potential energy savings; environmentally acceptable. (2)
	Tom, Buck, Doe Gulches	Included	Areas available for disposal. (2)
	Underground Disposal	Included	Concept feasible but subject to technical and economic problems. (4)
Retort Additions Site	Mid Property	Included	Potential energy savings if associated with second mine production inclines. (2)
	Initial Site	Eliminated	Economic constraint due to distance from ore production and spent shale disposal. (4)
Access Road	Getty Property	Included	No landownership concerns; standard procedure. (2)
	Other's property	Eliminated	Unacceptable anticipated logistics problems. (4)
Water Supply System	GCC Joint Venture, Roan Creek Diversion and Reservoir, Tom Creek Reservoir	Included	Acceptable on an economical and technical basis; in advance stage of planning. (1)
	GCC Joint Venture, Roan Creek Diversion, Tom Creek Reservoir, and West Fork Parachute Creek Reservoir	Included	Acceptable on an economical and technical basis; allows potential for emergency water supply. (1)
	Ruedi Reservoir and Colorado River Diversion	Eliminated	Unacceptable source on an economic basis. (4)
	Una Reservoir and Colorado River Diversion	Eliminated	Unacceptable source on an economic basis. (4)
Transmission Line Corridor	Roan and Parachute Creeks	Included	Increased reliability due to looped system. (2)
	Big Salt Wash Corridor	Included	Route previously established and analyzed. (2)

[a] Alternative type as defined by Corps of Engineers regulations in 33 CFR 230.26, Appendix B, paragraph 11b(5).
The definitions of alternative type are summarized below:
(1) Within the capability of the applicant and within the jurisdiction of the Corps of Engineers
(2) Within the capability of the applicant, but outside the jurisdiction of the Corps of Engineers
(3) A reasonably foreseeable alternative, beyond the capability of the applicant but within the jurisdiction of the Corps of Engineers
(4) A reasonably foreseeable alternative, beyond the capability of the applicant and outside the jurisdiction of the Corps of Engineers

Table 2.2-2 ALTERNATIVES CONSIDERED OR ELIMINATED FROM DETAILED STUDY FOR THE CITIES SERVICE SHALE OIL PROJECT

Alternative Category	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion or Elimination (Alternative Type)[a]
Production Rate	100,000 bpd	Included	Current design basis. Most economical and efficient production rate. (2)
	50,000 bpd	Included	May reduce overall impacts; may extend life of operation. (2)
Mining Method	Underground/Modified In Situ (MIS)	Included	The combination of underground and MIS mining includes the ability to select rich oil shale and maximize resource recovery. (2)
	Surface	Eliminated	Uneconomical due to high ratio of overburden to reasonable grade oil shale resource. (4)
	Underground	Included	Viable means of resource extraction. (2)
Retort Type	Surface/Modified In Situ (MIS)	Included	The combination of surface and MIS technologies has been tested and demonstrated by Occidental Petroleum. (2)
	Modified In Situ (MIS)	Eliminated	Use of a single technology results in the waste of the oil shale resource. (2)
	Surface	Included	Surface retorting technology has been developed and demonstrated. (2)
Surface Retort Technology	Union B	Included	Technology developed commercially by Union Oil. (2)
	Lurgi	Included	Technology developed and demonstrated with numerous tests; would process shale fines. (2)
Upgrading	Hydrotreating	Included	The hydrotreating of the shale oil results in a pipeline-compatible product. (2)
	Refinery	Eliminated	Sufficient refining capacity is available off-site within reasonable pipeline distance. (2)
	Coking	Eliminated	Results in lower syncrude yield. (2)
	None	Eliminated	The resulting raw syncrude unacceptable for pipeline transport. (4)
Water Source	Surface	Included	It is an adequate supply (adjudicated) to meet project needs. (1)
	Underground	Eliminated	It is not a sufficient supply to meet project needs. (3)
Power Source	Purchase	Included	Most feasible in terms of efficiency and cost. (2)
	Cogeneration	Included	Feasible use of by-product energy. (2)
	Cogeneration/Construction	Eliminated	Uneconomical due to lack of system integration. (4)
Product Transport Methods	Pipeline	Included	Proven procedure for transport of oil products. (2)
	Railroad	Eliminated	Logistics of transport of shale oil by railroad not proven, nor is it anticipated to be economical. (4)
	Truck	Eliminated	Logistics of transport of shale oil by truck not acceptable. (4)
Product Pipeline Route	La Sal	Included	Most feasible method of transport, approved project. (2)
	Rangely	Included	Pipeline route established and previously analyzed. (2)
	Gary	Eliminated	Insufficient capacity for anticipated project needs. (4)
	SOPS (south)	Eliminated	SOPS pipeline project is in an indefinite state of development. (4)

Table 2.2-2 ALTERNATIVES CONSIDERED OR ELIMINATED FROM DETAILED STUDY FOR THE CITIES SERVICE SHALE OIL PROJECT (concluded)

Alternative Category	Alternative Considered	Included/Eliminated for Detailed Analysis	Reason for Inclusion or Elimination (Alternative Type)[a]
Retort Site	Mesa	Included	Acceptable from an air quality impact standpoint. (2)
	Valley	Eliminated	Projected unacceptable air quality impacts. (4)
Upgrading Site	Mesa	Included	Acceptable from an air quality impact standpoint. (2)
	Valley	Eliminated	Projected unacceptable air quality impacts. (4)
	Remote Location	Eliminated	No site available. (4)
Spent Shale Disposal	Conn/Cascade Creeks	Included	Sufficient area and volume, minimize environmental impacts. (2)
	Mesa/Canyon	Included	Viable sites for deposition of spent shale. (2)
	Mesa	Eliminated	Insufficient area to handle anticipated volume. (4)
	Underground	Eliminated	Method subject to technical and economic problems. (4)
Access Road	On Cities Property	Included	No landownership concerns; standard procedure. (2)
	Rail Access/Road	Included	Feasible method of transport. (2)
	Other private property	Eliminated	Unacceptable logistics. (4)
	Northern Route	Eliminated	Unacceptable commuting distance and lack of existing road. (4)
Water Supply System	GCC Joint Venture	Included	Acceptable on an economical and technical basis; in advance stage of planning. (1)
	Larkin Ditch	Included	Acceptable means of obtaining water supply. (1)
	Green Mountain Reservoir	Eliminated	Supply indefinite and unacceptable current economics. (4)
	Ruedi Reservoir	Eliminated	Supply indefinite and unacceptable current economics. (4)
	Una Reservoir	Eliminated	Supply indefinite and unacceptable current economics. (4)
	Conn/Cascade Creeks	Eliminated	Insufficient supply. (4)
Supplemental Energy	Natural Gas	Included	Existing supply available in the region. (2)
	Coal	Eliminated	Unacceptable due to complexity of requirements for design and operation. (4)
Fines Processing	Storage	Included	The option of future resource recovery retained. (2)
	Retort	Included	Oil may be recovered from fines by implementation of a differing retort technology. (2)
Underground Mine Technology	Room-and-Pillar	Included	Technology has been developed and proven for oil shale. (2)
	Block Caving	Eliminated	Technology not developed for oil shale mining. (4)
	Stoping	Eliminated	Technology not developed for oil shale mining. (4)
Transmission Route	Loop to De Beque and Parachute Creek	Included	Looped system provides reliability. (2)
	Radial to De Beque	Eliminated	Supply not of adequate reliability. (4)
	Radial to Parachute Creek	Eliminated	Supply not of adequate reliability. (4)

[a] Alternative type as defined by Corps of Engineers regulations in 33 CFR 230.26, Appendix B, paragraph 11b (5).
The definitions of alternative type are summarized below:
(1) Within the capability of the applicant and within the jurisdiction of the Corps of Engineers
(2) Within the capability of the applicant but outside of the jurisdiction of the Corps of Engineers
(3) A reasonably foreseeable alternative, beyond the capability of the applicant, but within the jurisdiction of the Corps of Engineers
(4) A reasonably foreseeable alternative, beyond the capability of the applicant, and outside the jurisdiction of the Corps of Engineers

2.3 Description of Proposed Actions and Alternatives

2.3.1 Getty Project

2.3.1.1 Introduction and Overview

Getty Oil Company (Getty) owns properties adjacent to Clear and Roan creeks in Mesa and Garfield counties, Colorado (Figure 2.3-1). If economically justified, Getty proposes to develop the oil shale resource to ultimately produce 100,000 barrels per day (bpd) of shale oil for a period of approximately 30 years. The major components of the proposed operation include:

- An underground mine ultimately producing 150,000 tons per day (tpd) of shale
- Twelve retorting modules located in two areas on the mesa
- Four upgrading modules located on the mesa, each ultimately producing 25,000 bpd of shale oil
- Spent shale disposal in Wiesse Creek
- Support facilities, including a syncrude pipeline, electric transmission line, access road, railroad, and water supply system

A detailed description of the Getty proposed project is presented in Section 2.3.1.2.

Alternative facility sites and process methodologies were considered. Those alternatives considered can be categorized into the following major components.

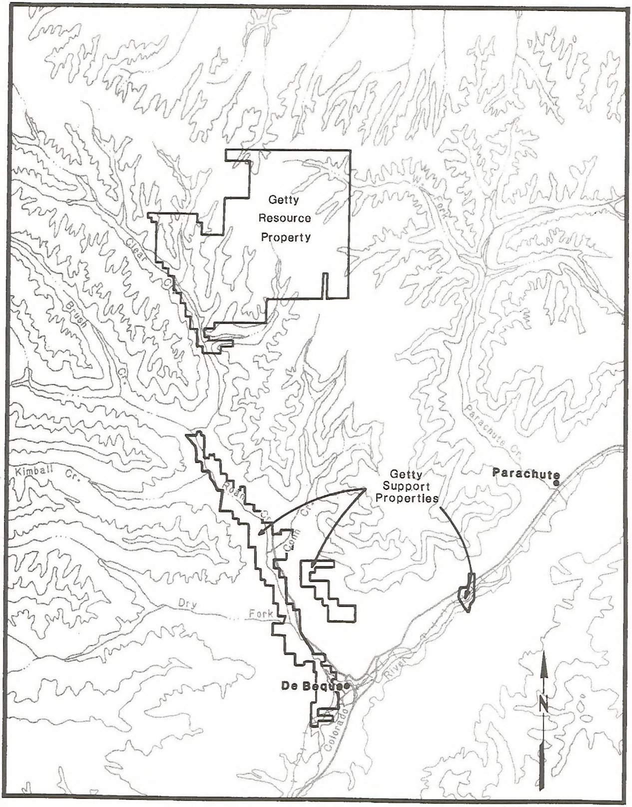
- Production rate alternatives — production of 50,000 bpd versus 100,000 bpd
- Surface retort technology — use of the Lurgi process instead of the Union B process.
- Support facilities — various alternatives regarding pipeline routes, spent shale disposal, water supply systems, and transmission line corridors.

2.3.1.2 Description of Proposed Action

2.3.1.2.1 Project Overview. The Getty properties are located primarily in Range 97W, Township 5S within Garfield County, and consist of 20,880 acres of oil shale resource land and 11,600 acres of valley support land for a total of 32,480 acres. The support lands extend from the Colorado River south of De Beque northward up the Roan Creek valley to Clear Creek, and includes a portion of Clear Creek canyon adjacent to the resource property.

The Getty oil shale property would be developed using conventional room-and-pillar underground mining techniques, combined with surface retorting and shale oil upgrading. The project would be developed with an initial capacity of 50,000 bpd followed by a 50,000-bpd addition for an ultimate capacity production rate of 100,000 bpd of upgraded shale oil. The expected production lifetime is 30 years (Figure 2.3-2), with construction commencing as early as 1987; production as early as 1991. As currently envisioned, manpower requirements (construction and operations personnel) would peak at about 7,000 when the additional production capacity is nearly complete. Peak construction manpower is estimated at 5,000, and the operational manpower ultimately at 3,000. A schedule of manpower requirements is shown in Table 2.3-1.

Certain components of Getty's proposed action could affect public lands in terms of land exchanges, land purchases, or rights-of-way. Those potentially affected public lands are presented in Table 2.3-2. The listing was determined by overlaying federal ownership boundaries on a map depicting project features as those shown in Figure 2.3-3. It must be noted that this listing is the most current estimate of all public lands potentially affected. In all likelihood, the amount of public lands actually impacted would be less.



SCALE 1:250,000

Figure 2.3-1 Oil Shale Resource Property, Getty Oil Company.

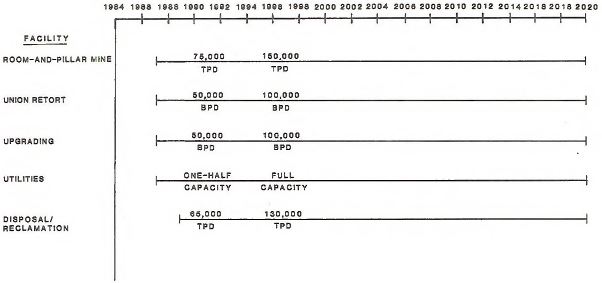


Figure 2.3-2 Getty Shale Oil Project Development Schedule.

Table 2.3-1 GETTY PROJECT WORKFORCE

Year	Construction	Operation	Total
1987	100		100
1988	1,300		1,300
1989	2,500	300	2,800
1990	3,700	1,000	4,700
1991	5,000	1,600	6,600
1992	2,500	1,600	4,100
1993	2,500	1,600	4,100
1994	3,700	1,900	5,600
1995	5,000	2,200	7,200
1996	1,300	2,600	3,900
1997-2020		2,900	2,900

Source: Getty (1983b).

Table 2.3-2 PUBLIC LANDS POTENTIALLY AFFECTED BY THE GETTY SHALE OIL PROJECT[a,b]

Township	Section	Quarter-Quarter Section		Project Feature-Use[c,d]
R97W, T5S	Section 36	NW 1/4	NW 1/4	Mining
		SW 1/4	NW 1/4	Mining
		NW 1/4	SW 1/4	Mining
		SW 1/4	SW 1/4	Mining
R97W, T6S	Section 3	NW 1/4	NW 1/4	Mining
		NE 1/4	NW 1/4	Mining
		NW 1/4	NE 1/4	Mining
	Section 4	NW 1/4	NW 1/4	Mining
		NE 1/4	NW 1/4	Mining
		NW 1/4	NE 1/4	Mining
		NE 1/4	NE 1/4	Mining
R97W, T7S	Section 19	SW 1/4	NW 1/4	Road/Utility Corridor
		SE 1/4	NW 1/4	Road/Utility Corridor
		SW 1/4	NE 1/4	Road/Utility Corridor
		NW 1/4	SW 1/4	Road/Utility Corridor
		NE 1/4	SW 1/4	Road/Utility Corridor
		SW 1/4	SW 1/4	Road/Utility Corridor
		NW 1/4	SE 1/4	Road/Utility Corridor
		SE 1/4	SE 1/4	Road/Utility Corridor
	Section 30	NW 1/4	SE 1/4	Road/Utility Corridor
		SW 1/4	SE 1/4	Road/Utility Corridor
	Section 31	NW 1/4	NW 1/4	Reservoir
		SE 1/4	NW 1/4	Reservoir
		NW 1/4	NE 1/4	Road/Utility Corridor
		NE 1/4	NE 1/4	Road/Utility Corridor
		SW 1/4	NE 1/4	Road/Utility Corridor
		SE 1/4	NE 1/4	Road/Utility Corridor
		NE 1/4	SW 1/4	Reservoir
		NW 1/4	SE 1/4	Reservoir
		SW 1/4	SE 1/4	Reservoir
		SE 1/4	SE 1/4	Reservoir
	Section 32	SE 1/4	NE 1/4	Road/Utility Corridor
		NW 1/4	SW 1/4	Road/Utility Corridor
		SW 1/4	SW 1/4	Road/Utility Corridor
		NW 1/4	SE 1/4	Road/Utility Corridor
		NE 1/4	SE 1/4	Road/Utility Corridor
	Section 33	NW 1/4	SW 1/4	Road/Utility Corridor
R97W, T8S	Section 5	NW 1/4	NW 1/4	Reservoir
		NE 1/4	NW 1/4	Reservoir
		SW 1/4	NW 1/4	Road/Utility Corridor

Table 2.3-2 PUBLIC LANDS POTENTIALLY AFFECTED BY THE GETTY SHALE OIL PROJECT[a,b] (continued)

Township	Section	Quarter-Quarter Section		Project Feature-Use[c,d]
R97W, T8S		SE 1/4	NW 1/4	Road/UtilityCorridor
		NW 1/4	NE 1/4	Road/Utility Corridor
		SW 1/4	NE 1/4	Road/Utility Corridor
		NW 1/4	SW 1/4	Road/Utility Corridor
		NE 1/4	SW 1/4	Road/Utility Corridor
	Section 6	NW 1/4	NE 1/4	Reservoir
		NE 1/4	NE 1/4	Reservoir
		SW 1/4	NE 1/4	Reservoir
		SE 1/4	NE 1/4	Reservoir
		SW 1/4	SW 1/4	Reservoir
		NW 1/4	SE 1/4	Reservoir
		NE 1/4	SE 1/4	Reservoir
		SE 1/4	SE 1/4	Reservoir
	Section 8	SW 1/4	SW 1/4	Road/Utility Corridor
	Section 17	NE 1/4	SE 1/4	Road/Utility Corridor
	Section 21	SE 1/4	NW 1/4	Road/Utility Corridor
	Section 27	NE 1/4	NW 1/4	Road/Utility Corridor
R98W, T6S	Section 4	SW 1/4	SE 1/4	Road/Utility Corridor
	Section 22	NW 1/4	NW 1/4	Road/Utility Corridor
		SW 1/4	NW 1/4	Road/Utility Corridor
		NE 1/4	SW 1/4	Road/Utility Corridor
	Section 27	NE 1/4	NW 1/4	Road/Utility Corridor
		SE 1/4	NW 1/4	Road/Utility Corridor
		NE 1/4	SW 1/4	Road/Utility Corridor
	Section 33	NE 1/4	SE 1/4	Road/Utility Corridor
	Section 34	NW 1/4	NW 1/4	Road/Utility Corridor
R98W, T7S	Section 3	NW 1/4	NW 1/4	Road/Utility Corridor
		NE 1/4	SW 1/4	Road/Utility Corridor
		SW 1/4	SE 1/4	Road/Utility Corridor
	Section 10	SE 1/4	NE 1/4	Road/Utility Corridor
	Section 11	NW 1/4	SW 1/4	Road/Utility Corridor
	Section 13	NW 1/4	SW 1/4	Road/Utility Corridor
		SE 1/4	SW 1/4	Road/Utility Corridor
		SW 1/4	SE 1/4	Road/Utility Corridor
	Section 14	NE 1/4	SE 1/4	Road/Utility Corridor
	Section 24	NW 1/4	NE 1/4	Road/Utility Corridor
		SW 1/4	NE 1/4	Road/Utility Corridor
		SE 1/4	NE 1/4	Road/Utility Corridor
	Section 36	SE 1/4	NW 1/4	Reservoir
		NE 1/4	SW 1/4	Reservoir
		SW 1/4	SE 1/4	Reservoir
R98W, T8S	Section 1	NE 1/4	NE 1/4	Reservoir
		SW 1/4	NE 1/4	Reservoir
		SE 1/4	NE 1/4	Reservoir

Table 2.3-2 PUBLIC LANDS POTENTIALLY AFFECTED BY THE GETTY SHALE OIL PROJECT[a,b] (concluded)

Township	Section	Quarter-Quarter Section		Project Feature-Use[c,d]
R98W, T8S (cont.)		NW 1/4	SE 1/4	Reservoir
		NE 1/4	SE 1/4	Reservoir
		SW 1/4	SE 1/4	Reservoir
		SE 1/4	SE 1/4	Reservoir

[a] No federal lands were identified north of the Getty property where the interconnection to the LaSal pipeline would occur.
[b] Baseline studies covering these areas include: GCC (1981a,b,c,d,e,f; 1982a,b,c,d,e,f).
[c] Roan Creek corridor is different than that shown in the CCSOP EIS (BLM 1983a).
[d] The lands potentially affected by the GCC reservoir were calculated considering the maximum (175,000 ac-ft) reservoir size.

2.3.1.2.2 Facility Sites and Processes. Major elements of the project include an underground room-and-pillar mine, retorting and upgrading facilities, raw shale transporting systems, a retorted (spent) shale disposal system, and a water supply system. The general arrangement of the proposed project facilities is shown in Figure 2.3-3. The detailed plot plans are shown as Figure 2.3-4.

Support facilities include a product syncrude pipeline, a natural gas pipeline, electric transmission loop, access road, railroad, and a water pipeline. A product (syncrude) intertie pipeline is planned from the upgrader modules to the La Sal pipeline. Road and rail access is planned up the Roan Creek and Clear Creek valleys. Total daily electric power requirements for 100,000 bpd-production would be approximately 210 MW (Table 2.3-3). Water usage would average approximately 17,000 gpm (Table 2.3-4). Fuel utilized within the proposed project would include high-Btu gas, upgraded shale oil, natural gas, and diesel fuel. Total quantities of fuel use would be 6,750 MM Btu/hr (Table 2.3-5).

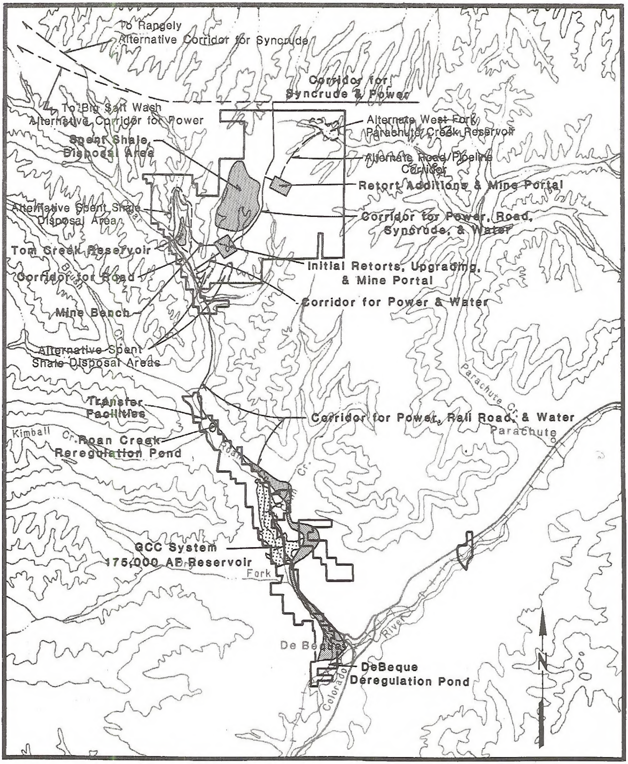
The water management plan is based on zero discharge, with all the process wastewater streams being treated and reused. Offsite water would be clarified to provide cooling tower makeup and treated to provide potable water. Sanitary wastewater would be treated biologically, and process wastewater would be separated into oily water and sour water. Oily water would be treated in an API separator; sour water would be stripped of ammonia and acid gas.

Details on each of the components of the project are presented in the following sections.

Mining

The oil shale resource (Mahogany Zone) is about 100 feet thick centered at approximately 7,500 feet above mean sea level (MSL). Underground mining is planned to extract the oil shale from a horizon 60-feet thick. The mining operation would cover the surface equivalent of approximately 13,800 acres and would progress as shown on Figure 2.3-5. The surface disturbances associated with the underground mine would comprise approximately 50 acres.

The main features of the underground mine would be the mine bench, vertical shafts, entry decline, adits, production panels, service facilities, and ventilation system. The mine bench would be constructed to provide horizontal access to the Mahogany Zone on the east wall of Tom Creek canyon. A decline would be sited to the west of the initial surface processing site to provide access to either the raw shale stockpile or the feed preparation plant. A vertical shaft would be constructed at the retort additions site which could provide connection to the first 50,000-bpd mine. Production panels would be approximately 1,000 feet wide and 2,000 feet long, situated on both sides of the entry drifts.



LEGEND

SCALE 1:250,000

——— **Proposed Action Configuration**

– – – – Alternative to Proposed Action

Figure 2.3-3 General Arrangement of Proposed Project Facilities, Getty Shale Oil Project.

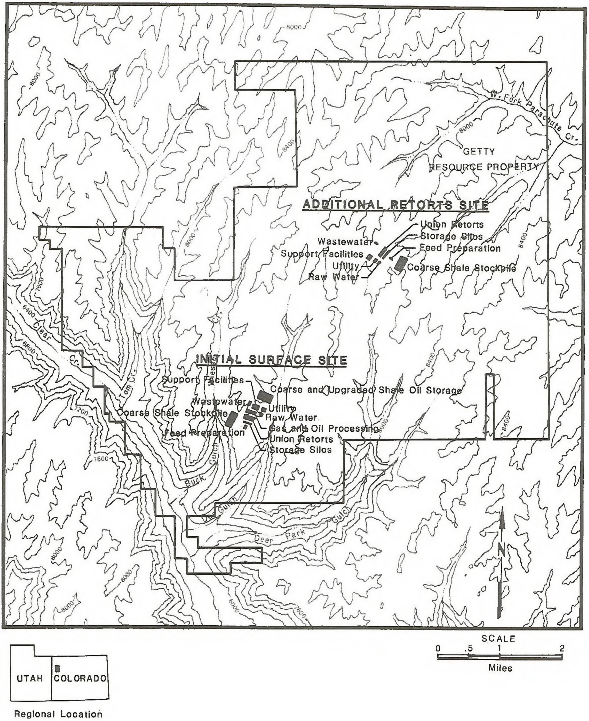


Figure 2.3-4 Plot Plan for Initial Surface Site and Additional Retorts Site, Getty Shale Oil Project.

Table 2.3-3 GETTY PROJECT POWER USE

Purpose	Quantity (MW)
Mining, Crushing, and Conveying	80
Union Retort	70
Upgrading	30
Raw Water Supply	10
Miscellaneous[a]	20
TOTAL	210

Source: Getty (1983b).

[a] Includes utility and support services.

Table 2.3-4 GETTY PROJECT WATER CONSUMPTION

Purpose	Quantity (gpm)
Spent Shale Cooling	6,500
Spent Shale Moisturizing	2,000
Upgrading	2,000
Reclamation	1,500
Power Generation	1,500
Community	1,500
Miscellaneous[a]	2,000
TOTAL	17,000

Source: Getty (1983b).

[a] Includes mine, crushing facilities, shale conveyor, potable water, service water, and treatment losses.

Table 2.3-5 GETTY PROJECT FUEL CONSUMPTION

Combuster	Quantity (MM Btu/hr)	Fuel Type
Recycle Gas Heater	3,000	High-Btu Gas/Natural Gas
Reboiler	300	High-Btu Gas/Natural Gas
Boiler	1,000	High-Btu Gas/Natural Gas
Reformer Heater	2,000	Shale Oil
Hydrotreater Heater	200	Shale Oil
Tail Gas Incinerator	50	High-Btu Gas/Natural Gas
Mobile Equipment	200	Diesel Fuel
TOTAL	6,750	

Source: Getty (1983b).

Mine development on the Getty property is expected to produce approximately 200,000 tons of waste rock. In addition, 1,310,000 tons of quality oil shale would be mined during the development stage, crushed, and stored for later use during startup of the surface facilities.

Mine service facilities would include dewatering, refueling, vehicle and equipment storage, warehousing, and personnel services. Mine safety facilities would also be included.

One of several objectives of the mining plan is to maximize oil shale resource recovery. The planned resource recovery within the proposed mining height is about 75 percent within the panels or about 60 percent overall. The support pillars would be approximately 60 feet high by 60 feet square. This mine plan is the state-of-the-art for oil shale room and pillar mining. The mining recovery percentage and the pillar sizes would depend on the depth of the overburden over the panels in all areas of the planned mine. In other words, where the overburden is the greatest, the mining recovery would be the lowest. Surface subsidence is a possibility but the probability of occurrance is, by design, relatively low. As mining progresses the stability of the pillars and mined openings would be closely monitored by the rock mechanics program. This data along with the mining experience gained during the mine development and initial years of operation would be employed to optimize the mining plan, mine stability, and the resource recovery. A conceptual diagram of underground mining is presented in Figure 2.3-6.

The mine ventilation system would be sized to control dust levels to meet Mine Safety and Health Administration standards. Within the mine, wet supression and deposition in the exhaust system would control particulate emissions from blasting, mining, and transfer operations. Surface material handling of dry, high-volume material would include dust control systems at transfer points, screening, and crushing operations. Particulate emissions from disposal and stockpile areas would be suppressed by dust control methods and minimizing the area exposed to wind erosion. The water management plan would be based on zero discharge to surface streams.

Feed Preparation and Handling

The raw shale will be hauled to the mine bench. Primary crushing of shale would be conducted on the mine bench with conveying to a feed preparation plant located near the initial surface plant site.

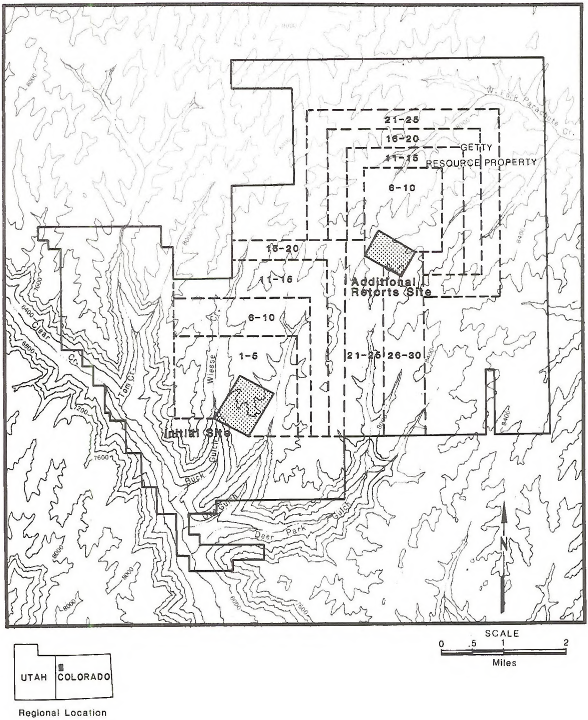


Figure 2.3-5 Mine Progression (years), Getty Shale Oil Project.

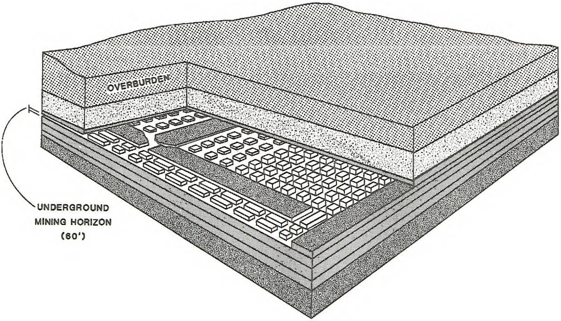


Figure 2.3-6 Conceptual Diagram of Underground Mining, Getty Shale Oil Project.

The main features of raw shale handling would be the primary crusher, conveyor system, coarse ore stockpile, and feed preparation plant. The primary crusher would produce raw shale of less than 12 inches in size. From the primary crusher, raw shale would be conveyed to either the stockpile or the feed preparation plant. The ore stockpile would contain approximately 1,000,000 tons and would be used to compensate for surges in either mine or retort operation. The feed preparation plant would perform secondary crushing and screen-out fines less than two inches in size, prior to conveying ore to the storage silo serving each Union B retort. The fines would be disposed of with the spent shale, unless the quantity justifies the addition of a fine shale feed retort. In the event that retorting of fines proves to be economical, the likely choice of retorting processes would be the Lurgi technology. Because of the uncertainty of the need for fines retorting, it is not a part of the proposed action. The Lurgi process is evaluated as an alternative in Section 2.4.

Retorting

Retorting facilities would utilize Union B retorts. The Union B retort process is a continuous, underfed, counter-current process (Figure 2.3-7). In the process, shale is fed through the bottom of the inverted cone vessel by a rock pump. Hot gases enter the top of the retort and pass down through the rising bed, causing kerogen pyrolysis. The shale oil and gas flow down through the bed. The oil accumulates in a pool at the bottom, which seals the retort and acts as a settling basin for entrained shale fines. The shale oil and gas are withdrawn from the bottom and top of the pool, respectively. The gases are split into three streams. One is reheated and reinjected to induce additional kerogen pyrolysis; one is used as fuel in the reheating furnace; and one is the net product. The shale is discharged from the top of the retort and falls into a water bath in the spent shale cooler. The rock pump is mounted on a moveable carriage and is immersed in the shale oil pool. The pump consists of two hydraulic assemblies that act in sequence. While the cylinder of one assembly is filling with spent shale, the other is charging a batch of raw shale into the bottom of the retort. When this operation is completed, the carriage moves until the full cylinder is under the retort entrance, and the process is reversed.

The raw shale oil resulting from this process has approximately 2 percent by weight nitrogen, and 0.8 percent by weight sulfur. The material balance for the Union B retort process is shown in Figure 2.3-8.

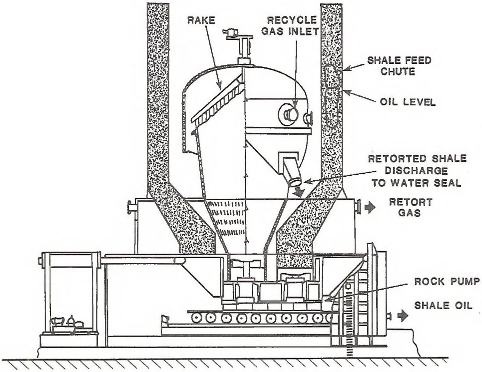


Figure 2.3-7 Conceptual Diagram of the Union Oil "B" Retorting System.

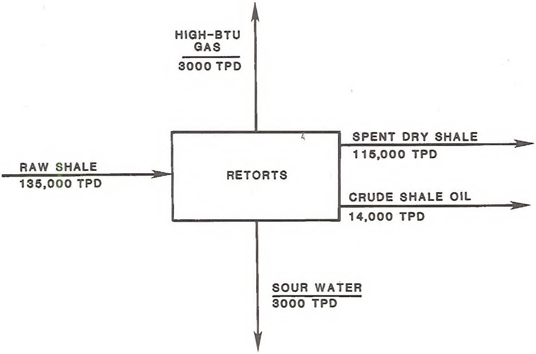


Figure 2.3-8 Union Retort Material Balance, Getty Shale Oil Project.

Emissions of primary pollutants are shown in Table 4.2-6. Union Oil Company (1982a) reports that the combustion source emissions occur for sulfur dioxide, nitrogen dioxide, carbon monoxide, nonmethane hydrocarbons, particulates, and sulfuric acid mist. All other regulated pollutants are either not emitted from the retort process, or are estimated to be below regulated levels considering the total facility operations (Union Oil Company 1982a).

Upgrading facilities would be located on the mesa, and would occupy approximately 30 acres (Figure 2.3-4). The retort and upgrading plants would be connected by a pipeline running through the middle of the site.

The upgrading process takes blended and filtered raw shale oil and catalytically hydrotreats it to remove nitrogen, sulfur, and metal compounds. The nitrogen content would be reduced to approximately 1,000 ppm and sulfur content to approximately 10 ppm. A portion of the upgraded shale oil is used directly for fuel. A flow diagram of the upgrading process is shown in Figure 2.3-9. On-site storage would include 1,500,000 barrels (each) for raw and upgraded shale oil.

Off-gas and sour water from the hydrotreaters are sent to gas cleaning and sour water treatment, respectively. Hydrogen for hydrotreating is furnished from the hydrogen plant by steam reforming retort gas and hydrogen purification. The gas cleaning plant recovers oil, removes acid gas for sulfur recovery, and provides treated fuel gas. Sour water is processed to recover ammonia, stripped of acid gas, and is reused. Acid gas is treated to recover elemental sulfur.

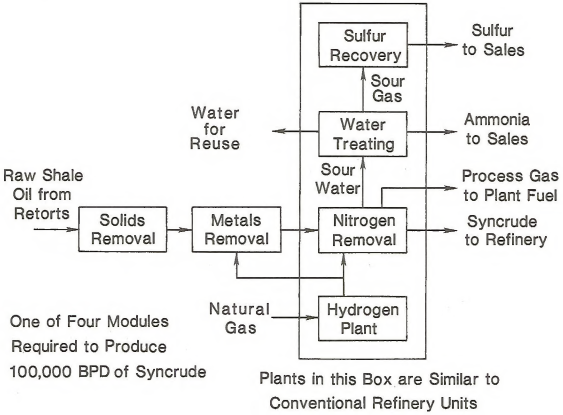


Figure 2.3-9 Flow Diagram of Upgrading Process, Getty Shale Oil Project.

Approximately 500 tpd of ammonia and 400 tpd of sulfur would be recovered in the sour water and sulfur recovery plants, respectively. Approximately ten days of on-site storage would be provided. Both by-products would be trucked to a transfer station in the Roan Creek valley and loaded into rail cars for transport to markets.

Spent Shale and Waste Rock Disposal

At the ultimate production rate of 100,000 bpd, approximately 130,000 tons of spent shale would be generated per day. The total amount of spent shale generated for the project life would amount to approximately 1,300 million tons, and would be deposited in the Wiesse Creek and Short Gulch watershed (Figure 2.3-3). As previously mentioned, approximately 200,000 tons of waste rock would be produced during mine development. This waste rock would also be deposited in Wiesse Creek.

Prior to the disposal of shale, topsoil would be removed and stockpiled. The retorted shale would be pre-moistened to approximately 16 percent by weight and transported to the Wiesse Creek gulch and Short Gulch areas by conveyor. Deposition of shale would proceed from the bottom of the gulches to the head of the gulches. Considering various engineering criteria, this is the most suitable method of progression, as shown in Figure 2.3-10. However, deposition from the head to the bottom of the gulches is also being considered. After topsoil has been removed and stockpiled (measured normal to slopes) a compacted blanket of retorted shale 10 feet in thickness would be placed over areas where topsoil has been removed. This compacted Zone I material would be an impermeable lining over which less compacted lifts of retorted shale, (Zone II and Zone IV material) would be placed. The Zone I lining would extend up the canyon walls before lifts of Zone IV materials are placed. From a prepared berm, the conveyor would feed mobile equipment which spreads and compacts the Zone IV moderately compacted spent shale in lifts of 50 feet at the toe of the pile. The Zone II material would be placed at a 15 percent slope. When a lift is completed, a new berm is prepared and the conveyor is moved. This process is repeated until the top level is reached. Benches would be incorporated into the pile faces to facilitate runoff water control and reclamation. Zone III material would be utilized for revegetation and reclamation. Detailed spent shale pile designs and the detailed reclamation plans will be developed for the mining and reclamation permit.

Surface runoff from the disposal area would be collected in a dam below the toe of the pile and evaporated or used for dust and moisture control within the pile. Retention dams would be located on the south end of Wiesse Creek and Short Gulch basins, below the disposal area. The dam on Wiesse Creek would be approximately 450 feet long with a maximum height of 96 feet, and the pool behind the dam would have an area of 14 acres. The dam on Short Gulch would be approximately 400 feet long with a maximum height of 81 feet and the pool behind the dam would have an area of approximately 14 acres. The reservoir bottom would be sealed to prevent seepage into groundwater. This system would be designed as a zero discharge operation.

An underdrain system below and above the shale liner may be utilized to collect any leachate. The detailed design of this system would be developed for the reclamation permit.

As previously stated, the disposal area would ultimately extend to the heads of the two drainages. During and after the construction of the disposal area, the runoff from above the disposal area would be directed around the site to a sediment pond where the water would have adequate residence time to settle out any sediment, The water remaining in these ponds could be used in the commercial oil shale operation or may be discharged to natural drainages. Flow from some of the major springs in the Wiesse Creek basin would be collected in pipes and diverted to the makeup water system.

The spent shale consists of 23 to 31 percent silt and clay size material, and 44 to 62 percent gravel size material. The material classifies as poorly graded gravel-sand-silt mixtures. Specific gravity ranges from 2.52 to 2.59 which is on the low side for coarse-grained soils. Contrary to typical experience with soils, the addition of moisture to the retorted shale material does not increase the density to a significant degree. The material is classified in the low end of the semi-pervious range with coefficients of permeability of 2.6 feet/year and 4.6 feet/year. The density increase in high lift which are not compacted is very significant to a depth of about 200 feet. Below a depth of approximately 600 feet, changes in density are very small and would likely have little effect on pile design. Material strength is more dependent on material gradation and confining pressure than on initial placement density.

The engineering design includes several features to ensure pile stability. A Zone I heavily compacted layer would minimize water infiltration. Exposed slopes of 3.6:1 would minimize erosion and runoff, and provide for reclamation surfaces. When the near-final surface elevations and configurations are reached, another Zone I

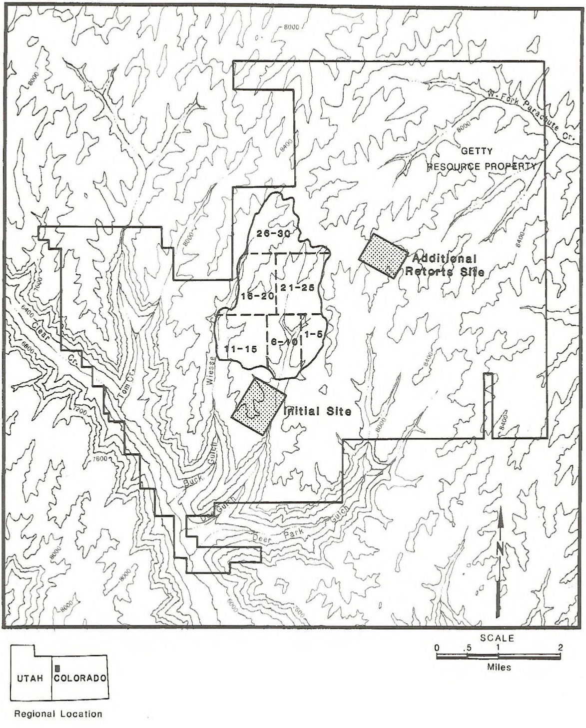


Figure 2.3-10 Spent Shale Disposal Progression (years), Getty Shale Oil Project.

blanket would be placed followed by a reclamation zone of retorted shale. Surface area would become available for revegetation in increments to allow for evaluation of reclaimed areas and adjustments where necessary. No more than 200 acres of retorted material would be exposed at one time. The ultimate areal extent of the spent shale disposal area would be approximately 2,312 acres.

Settlement of the retorted shale pile would occur both within the natural subsoil material beneath the pile and within the retorted shale pile itself. The amount of such settlement, and the time period during which settlement occurs, is dependent on many factors.

Settlement of the subsoil beneath the pile depends on the amount of retorted shale placed, moisture conditions, characteristics of the subsoil beneath the placed shale, and depth to bedrock. The rate of settlement depends on the relative amount of retorted shale placed in any time period, the time involved for structural readjustment of the subsoil, and the subsoil permeability. Preliminary studies for the Union Oil Company indicate that with a 1,000-feet high pile overlying about 100 feet of natural subsoils, the subsoils could settle from 5 to 15 feet. Since the subsoils in the area are generally granular (sand and gravel), their settlement would occur concurrently with pile construction and should be complete at completion of the pile.

The settlement of the retorted shale itself depends on the physical characteristics of the shale, moisture conditions, and placement methods. Preliminary studies for the Union Oil Company indicate that total pile settlement for a 1,000-feet pile constructed primarily of Zone IV materials could be 80 to 100 feet. Since the retorted shale materials are generally granular in nature, most of this settlement should occur as the pile is being constructed. As the pile settles, the materials within the pile become more dense and are able to support greater heights of retorted shale without increased settlement.

As a result of these design measures, it is anticipated that the basal liner and cap would have adequate strength and impermeability to ensure a low likelihood of leachate migration from the spent shale pile.

Reclamation

The reclamation activities for the proposed project would be conducted in two components: (1) reclamation of the shale disposal area, and (2) reclamation of other disturbed areas.

Spent Shale Disposal Area Reclamation. Retorted shale from the Union B process has loamy texture, is high in soluble salts, has a moderate pH, and is low in available phosphorous and nitrogen. Other mineral nutrients are low to adequate and within the range found in Colorado soils. The major problems encountered in establishing vegetation on retorted shale are the shale's low fertility, high sodium adsorption ratio, and high soluble salt content.

The amount of subsoil and topsoil to be placed upon the shale disposal area will be precisely determined during the permit application process reviewed by the Colorado Mined Land Reclamation Division. As parts of other reclamation testing programs, researchers have successfully produced vegetative cover on various soil and subsoil combinations, including growing plants directly on spent shale from a variety of retorting processes. Union Oil Company has conducted tests with bare retorted shale and 12 inches of soil coverage or 6 inches of soil coverage over retorted shale from the Union B process. Their 6-year analysis indicated the highest plant cover values with the 6-inch soil cover. Although the soil-covered shale tests had better initial coverage, later stages of development of all tests were similar. The current plan for reclamation of the spent shale on the Getty property would involve placing the spent shale with unretorted waste shale rock followed by soil, soil amendments, and seeding as necessary. The depths of these layers would be determined by availability of materials and the appropriate permit requirements.

The final configuration of the spent shale disposal pile is shown in Figure 2.3-11. The faces of the pile would be formed in lifts of 50 feet with the final slope of these faces approximately 3.6:1 (28 percent). The top of the pile would be gently sloped from north to south at an approximate 4 percent grade. As final contours of the faces of the disposal pile are realized, these areas would receive the final reclamation treatment including grading, subsoil and topsoil cover, and seeding. This activity primarily would involve the benches constructed to form sequential lifts of spent shale. Active waste disposal areas would be minimized to the extent possible and additional interim reclamation procedures would be employed, as required, to control erosion.

Disturbed Areas Reclamation. Construction of the processing and support facilities for the Getty project would require local topographic modifications to provide level areas for construction. After decommissioning, those areas would be reclaimed according to the specific conditions of the Colorado Mined Land Reclamation permit. Although the exact conditions of the permit cannot be accurately predicted at this time considering the current state of oil shale reclamation, the following procedures are anticipated. Surface disturbance areas would be graded and disced to break up the surface. Available topsoil would be redistributed, and appropriate seed mixtures and plantings would be placed. Monitoring plans are expected to evaluate the success of returning the various areas to a condition suitable for the planned post-mining land use.

Major pieces of equipment, structures, and foundations would be decommissioned per the requirements of the reclamation permit. Embankments, waste piles, and other disturbed areas would be reclaimed, as described above.

Erosion control would be accomplished using the appropriate type of control method for the situation at hand. Depending on the material to be controlled and the time requirement associated with the control, physical and chemical barriers such as riprap, mulches, netting, coagulants, and emusifiers may be used. More permanent control would be accomplished through soil preparation and revegetation efforts. Control of suspended solids resulting from erosion would be exercised by collection of runoff from eroding areas in sediment ponds.

Specific seed mixtures for short-term stabilization, long-term stabilization, and permanent revegetation efforts would be included in the specific reclamation procedures proposed as part of the permit application to the Colorado Division of Mined Land Reclamation. A seed mixture, as presented in Table 2.3-6, is considered to be representative of the mixture expected to accomplish reclamation goals.

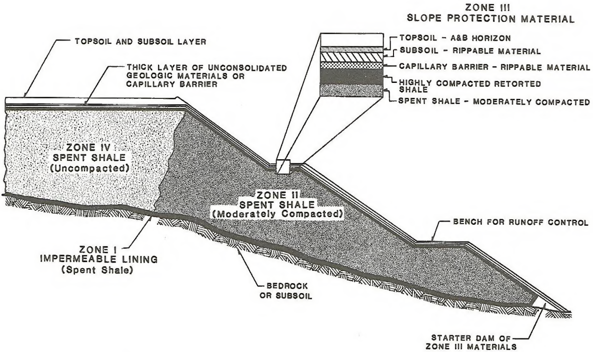


Figure 2.3-11 Spent Shale Cross-section, Getty Shale Oil Project.

Table 2.3-6 GETTY PROJECT PROPOSED SEED MIXTURE[a]

Scientific Name	Common Name		Pounds PLS/Acre[b]
Xeric Site			
Agropyron inerme	Beardless bluebunch wheatgrass		1.0
Agropyron tricophorum	Pubescent wheatgrass		2.0
Elymus junceus	Russian wildrye .		1.0
Agropyron riparium	Streambank wheatgrass		1.0
Agropyron smithii	Western wheatgrass		2.0
Agropyron desertorum	Crested wheatgrass		1.0
Festuca ovina	Hard fescue		2.0
Sporobolus airoides	Alkali sacaton		0.1
Sporobolus cryptandrus	Sand dropseed		0.1
Melilotus officinalis	Yellow sweet clover		0.5
Artemesia tridentata vaseyana	Mountain big sagebrush		0.1
Purshia tridentata	Bitterbrush		0.5
Hedysarum boreale	Utah sweetvetch		0.1
Kochia prostrata	Summer cypress		0.5
		TOTAL	11.9
Shrub Seedling Mixture			Seedlings/Acre
Prunus virginiana	Chokecherry		100
Rosa woodsii	Woods Rose		50
Symphoricarpos oreophilus	Snowberry		150
Amelanchier alnifolia	Serviceberry		50
Quercus gambelii	Gambels Oak		100
		TOTAL	450

[a] Seed mixtures are those to be used for permanent reclamation
[b] PLS = Pure Live Seed - equivalent to 60 seeds/square foot

2.3.1.2.3 Support Facilities. In order for the project to be constructed and operated, provisions must be made for the supply of personnel, equipment, water, and electricity to the site, as well as provision for the removal of product and waste. The various access corridors shown in Figure 2.3-3 constitute the current plan for support facilities. Details of any of these support facilities would be addressed in the appropriate land use (e.g., Right-of-Way) applications made to the appropriate agencies.

Transportation Systems

Getty's plans for transporting workers, major materials, and by-products is based on development of a new railroad line from De Beque, up Roan Creek Valley, to a transfer facility located at approximately the confluence of Roan and Clear creeks. The plans for the transfer facility are indefinite at this time. The general location of the transfer facility is shown in Figure 2.3-3; the specific location would be dictated by grade limitations and the constriction of Clear Creek canyon above the location.

Extending from the transfer facility would be a light-rail transportation system to a point below the Tom Creek reservoir site. Construction and operating workers would be transported from De Beque to Clear Creek canyon below the oil shale property via this light-rail transportation system. From Clear Creek canyon, workers would utilize elevators and escalators to access the main plant site.

Also connecting the transfer facility would be the main access road to be constructed in Roan Creek valley, which would extend up Clear Creek canyon and up Tom Creek canyon to the plateau. The road would be designed as a two-lane paved road, and would provide a safe traveling surface by improving the existing county and private road. The road grade would be limited to 8 percent. The total length of the route from De Beque to the plant site would be approximately 20 miles.

Materials delivered to the transfer facility by train would be transferred to trucks for delivery to the main plant site on the plateau. Likewise, by-products and materials leaving the site would be transported down the access road to the transfer facility, where they would be loaded into rail cars for shipment to their final destination. In some cases, trucks could proceed directly to their final destination. Table 2.3-7 summarizes the transportation requirements of the proposed project.

Access would be limited to the site at Getty's southern property boundary in Clear Creek canyon by a security gate and guard. Only authorized personnel would have access to the site.

Water Sources and Supply Systems

The primary source of water for the proposed project would be the Colorado River near De Beque. Getty owns water rights to 56 cfs with appropriation and adjudication dates of 1951 and 1966, respectively. Getty, Cities Service, and Chevron have formed the GCC Joint Venture, the purpose of which is to develop a common water supply system that will allow each participant to divert and regulate water available under their respective individual water rights for subsequent industrial use. The GCC water supply system is described in in the CCSOP EIS (BLM 1983a).

Getty's proposed water supply system includes a diversion structure on the Colorado River, and a dam and reservoir on Roan Creek near its confluence with Dry Fork.

The intake structure would be near the north bank of the Colorado River approximately 600 feet downstream of the confluence with Roan Creek. A system of low head pumps and short discharge lines would deliver water to adjacent sedimentation ponds. The ultimate capacity of the system would be 442.25 cubic feet per second. A 23,000-foot-long water pipeline system with a high head pumping plant is planned along the Roan Creek valley floor to the Dry Fork storage site. The length of the dam crest would be about 4,000 feet with a maximum height of 225 feet. The area of the reservoir would be about 2,600 acres, with an ultimate capacity of 175,000 acre-feet. Getty would install separate facilities to withdraw its water form the reservoir and to pump the water up Clear Creek canyon to the plant site along the corridor.

Four Getty facilities would be required to deliver water from the GCC reservoir to the plant site. A pumping plant from the reservoir, connected to a 24-inch pipeline (nominal capacity of 14,000 gpd), would deliver water to a small regulation reservoir near the confluence of Roan and Clear creeks. A diversion dam on Roan Creek and a short pipeline would also deliver water to this regulation reservoir. A pumping plant near the small regulation reservoir, connected to a pipeline, would deliver water to a second regulation reservoir on Tom Creek. From that point, water would be delivered to the plant site area.

Transmission Lines

The power requirements for the project are presented in Table 2.3-3. The corridors extend from De Beque up Roan and Clear creek valleys, over to Davis Point on Parachute Creek, down-valley to the town of Parachute and back to De Beque. This transmission line loop would be designed to provide reliable service.

A 345-kV capacity transmission line is anticipated for the Getty project. This same line would serve the proposed Cities Service project. Depending on the ultimate power requirements of the projects and the ultimate number of other project loads in the area, more than one line could be required. Rights-of-way requirements for a single 345-kV transmission line would be 150 feet.

Table 2.3-7 TRANSPORTATION REQUIREMENTS - GETTY SHALE OIL PROJECT

Transportation Item	Number or Quantity	Mode	Required No. of Round Trips/Day[a]
Work Force	7,000 persons[b]	Train (70 cars)	3
	3,000 persons[c]	Train (30 cars)	3
Catalysts	2,000 tons/yr	Truck	0.3
Explosives[d]	75 tons/day	Truck	7
Byproducts			
Ammonia	400 tons/day	Truck	10
Sulfur	400 tons/day	Truck	10
Diesel Fuel	17,000 gal/day	Truck	2
Chemicals, Solids & Misc.	80 tons/day	Truck	3

[a] Train round trips from De Beque to Transfer Station is approximately 17 miles. Truck round trip from the Transfer Station in the Roan Creek valley to the plant is approximately 16 miles.
[b] Peak construction (combined with operation) transportation requirements occurs in year 1995.
[c] Peak operating transportation requirements occur in year 1997.
[d] Explosive ingredients (dry-ammonia nitrate) would be delivered to the Transfer Station via railroad tank car. Trucks would be used to transport the ingredients to the site. Final explosive preparation would be done on-site (i.e., mixing ammonia nitrate with fuel oil). Shipments to the site would not be an explosive hazard.

The type of structure that would be utilized will depend on the conductor size and terrain limitations. Wood H-frame design, lattice steel towers, and steel poles are all possible alternatives. The wood H-frame structure requires more structures per mile of line length, as compared to steel towers or poles, but the latter typically require more land disturbance during construction of each structure.

Product Pipeline

Getty proposes to connect its syncrude pipeline with the La Sal pipeline, which was originally planned to transport syncrude from the Colony Oil Shale Project to existing refineries. Although the construction of the La Sal pipeline has been delayed, it remains a viable link for product transport. The pipeline would be 16 inches in diameter, and would have a nominal operating capacity of 100,000 bpd.

Waste Disposal

At this time it is uncertain (due to regulatory conditions) whether mining wastes will be classified as hazardous. However, some potentially hazardous waste could be generated by the retorting and upgrading processes and include catalysts and by-products. Due to these uncertainties, the types and quantities of any waste is indeterminant. Any hazardous waste would be handled by a qualified and licensed contractor, and disposed of off-site in a licensed facility. If on-site disposal is utilized, a waste disposal management plan would be developed and filed with the appropriate agencies.

Nonhazardous wastes generated by the proposed project would include paper and metal wastes, wood and plastic products, and miscellaneous items (fines, concrete, etc.). The proposed plan is to dispose of these wastes in the spent shale pile. If another on-site or off-site location is utilized, a waste management plan would be developed and filed with the appropriate agencies.

2.3.1.3 Alternatives to the Proposed Action

This section presents descriptions of alternatives to the various components of the proposed action. A wide range of options were investigated. Table 2.2-1 (Section 2.2-1) presents the alternative categories which have been considered and the various options in each category. Each alternative selected for detailed discussion is described below. For some categories, there were no alternatives included for detailed discussion. These include mining method, retort type, upgrading, water source, product transport methods, retort sites, upgrading site, retort additions site, and access road. Table 2.2-1 presents summaries of the reasons for elimination of alternatives by category.

2.3.1.3.1 Alternatives Considered for Detailed Study

Production Rate

The only alternative to the preferred 100,000-bpd production rate is a 50,000-bpd rate. This alternative would still utilize room-and-pillar underground mining and surface retorting, but at a reduced level. The project life would be doubled. The net consumption per year of water and power would be less than the 100,000-bpd alternative. Air and water emissions would also be less on an annual basis. Overall resource recovery and process efficiency is also expected to be less because of the loss of the economies of scale. The 50,000 bpd alternative will involve only the initial surface site, with one-half of the retort modules (6), and with one-half of the upgrading facilities and mine capacity.

Retort Technology

Use of Lurgi retorting technology alternative would be reasonable, based upon Getty experience in processing diatomite. The key elements of the Lurgi retort process are illustrated in Figure 2.3-12. Shale fines are fed to a horizontal mechanical screw mixer where heating is accomplished by mixing with recycled shale. The retorted oil is discharged from the mixer with the gas. The gas is quenched in a heavy oil scrubber which is designed to contain most of the dust in the heavy oil fraction. The lighter oils are further quenched and water is separated. The heavy oil is dedusted by a dilution centrifuge process which returns the spent shale to the retort collection bin. Heat is supplied to the process by combusting the carbon on a mixture of recycled and freshly-processed shale in a fluidized bed lift pipe which discharges into a collection bin. The flue gas from the combustor passes through a heat exchanger to preheat combustion air and to generate steam. Relative to the Union retort, less high-Btu gas and more sour water are produced. Substantial quantities of flue gas dust must be collected while sulfur dioxide is emitted primarily from the lift pipe.

In general, spent shale from the Lurgi process is of a finer particle size and has a much greater tendency to cement. Also, because of differences in the Lurgi process, there is substantially less carbon remaining on the spent shale than that produced by the Union B retort. The final pile is generally much harder due to its cementation.

The Lurgi spent shale is expected to require more water than the Union B spent shale because its average particle size is much smaller. Hence, there is more surface area per unit weight and more water would be required to wet the surface of the particles for compaction.

Power Source

Getty may install an on-site power plant as an alternative to ensure reliability of power supply. The capacity of the power plant would be determined based upon critical loads, steam requirements, and the availability of fuel. The output of this cogeneration plant would be electricity and process steam, and the ratio of the two products would vary with plant design. The assumed fuel for cogeneration would be upgraded shale oil, which has minimal sulfur content. The cogeneration plant would be located at the initial surface site, close to the fuel supply.

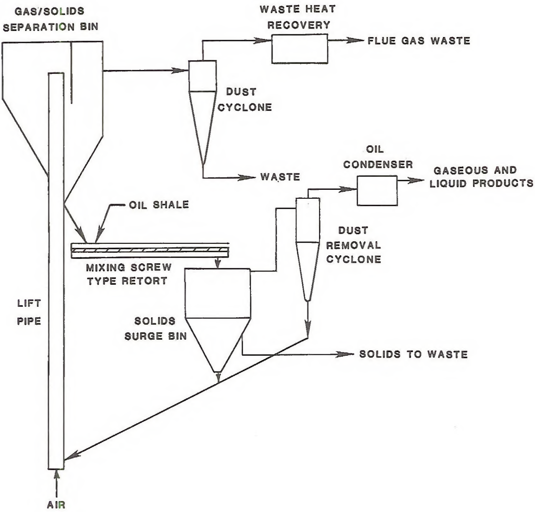


Figure 2.3-12 Lurgi-Ruhrgas Retort Process.

The thermal efficiency of the Union B process could be improved by utilizing the energy remaining in the spent shale. The Union Oil Company is currently developing a process that would use a spent shale combustor to gasify the residual coke and supply energy for process heating. Getty plans to monitor developments of this technology and evaluate its use when available.

Product Pipeline Route

The Rangely product pipeline alternative occupies the same corridor as described in the CCSOP EIS (BLM 1983a). It would connect to an existing pipeline in Rangely, supplying crude oil to Salt Lake City refineries. However, this pipeline has insufficient capacity for 100,000 bpd and available refining capacity in Salt Lake City is also inadequate to handle 100,000 bpd. A pipeline interconnection to the existing system at Rangely would require additional governmental approvals.

Spent Shale Disposal

Alternative spent shale disposal sites are in Tom, Buck, and Doe gulches. Shale disposal in these areas would require filling them to approximately the top of the cliffs (i.e., 7,600 feet). Conveyor length would be increased from the additional retorts site.

Because of the expansion of volume associated with spent shale, disposal of all of the spent shale in the underground mine would not be possible. In addition, disposal of spent shale underground would preclude possible future recovery of oil shale in the mine pillars. The logistics of underground disposal would also be more complex. Mine design and subsurface environmental conditions would delay the start of underground spent shale disposal to a time when side operations would not interfere with normal mining functions. This may be 5 to 10 years after the start of shale oil production. Additionally, in order to put the spent shale underground properly, it would still have to be cooled, perhaps even more than for surface disposal, because it would have to be handled underground by men and machinery. Hence, underground disposal could require more water than surface disposal.

However, approximately one-half of the total volume of spent shale could be disposed in the underground mine, thereby potentially reducing the total disturbed area for surface spent shale disposal and the depth of spent shale at the surface site(s).

If the Lurgi retort is utilized, the resulting spent shale would be deposited in the same areas, utilizing the same methods as in the proposed action and alternatives discussed herein.

Water Supply System

One water supply alternative has been developed. Others have been eliminated due to technical and economic reasons (Table 2.2-1). Both the proposed action and the 50,000-bpd alternative would include the GCC Joint Venture System (diversion dam, pumping plants, sedimentation and regulation ponds, pipeline, and storage dam).

To recall, the Getty proposed action (see Section 2.3.1.2.3) requires two facilities to deliver water from the GCC reservoir. A pumping plant at the reservoir and a pipeline along Roan and Clear creeks would deliver water to a regulation reservoir at the confluence of Roan and Clear creeks. From that location, another pumping plant and pipeline would deliver water to a second regulation reservoir on Tom Creek. A pumping plant at the Tom Creek reservoir and a pipeline would deliver water to the initial surface plant site and the retort additions site.

The alternative would require six facilities to deliver water from the GCC reservoir. A pumping plant at the GCC reservoir and a pipeline would deliver water to a small regulation reservoir near the confluence of Roan and Clear creeks. A diversion dam on Roan Creek and a short pipeline would also deliver water to this reservoir. A pumping plant at the Roan/Clear Creek regulation reservoir and a pipeline would deliver water to a regulation reservoir on Tom Creek. A pumping plant at Tom Creek reservoir and a pipeline would deliver water to the initial surface plant site and to a regulation reservoir on the West Fork of Parachute Creek. A pumping plant at the West Fork of Parachute Creek reservoir and a pipeline would deliver water to the retort additions site and under emergency conditions could deliver water to the initial surface and plant site. In summary, the alternative simply adds the West Fork Parachute Creek reservoir and related facilities to the proposed action, primarily to supplement water to the Getty retort additions site.

Power Supply

An alternative power supply route would be the Big Salt Wash transmission line corridor which would enable Getty to contract with either Colorado-Ute Electric Association or Public Service Company of Colorado. The route of this line is as described in the CCSOP EIS (BLM 1983a). The design details are as previously described for the transmission line.

2.3.2 Cities Service Project

2.3.2.1 Introduction and Overview

Cities Service plans to develop its oil shale properties in the upper Conn Creek area of Garfield County, Colorado (Figure 2.3-13). The proposed project would ultimately produce 100,000 barrels per day (bpd) of shale oil, and would have a minimum life of 25 years. Important components of the operation include:

- An underground mine ultimately producing 135,000 tons per day (tpd) of shale
- Ten retorting modules located on the Roan Plateau
- A total of 18 Vertical Modified In Situ (VMIS) retorts
- Four upgrading modules, one processing 10,000 bpd, and the other three producing 30,000 bpd each
- Spent shale disposal in Conn and Cascade Canyons
- Shale fines and waste rock disposal on the Roan Plateau
- Support facilities, including a product syncrude pipeline, a natural gas pipeline, electric transmission loop, access road, railroad spur, and water supply system.

A detailed description of the Cities Service proposed project is presented in Section 2.3.2.2.

The alternatives to the proposed action considered can be categorized into the following major components.

- Production rate alternatives - production of 50,000 bpd versus 100,000 bpd
- Method of mining - underground only
- Retort type - surface retorting only
- Retort technology - use of the Lurgi process instead of Union B process
- Support facilities - various alternatives regarding pipeline routes, shale disposal sites, and water supply systems

Discussion of these alternatives is presented in Section 2.3.2.3.

2.3.2.2 Description of Proposed Action

2.3.2.2.1 Project Overview. Cities Service properties are located primarily in Range 97W, Townships 6S and 7S. These holdings consist of 10,300 contiguous acres, with approximately 6,850 acres on the Roan Plateau and the remaining acreage located in canyon drainages. The acreage on the Roan Plateau contains the oil shale resource.

Cities Service would develop the oil shale property using conventional room-and-pillar underground mining techniques, VMIS retorting, surface retorting, and shale oil upgrading. Ultimate production capacity would be 100,000 bpd. The estimated project life depends on the precise implementation of the various stages, but is expected to be a minimum of 25 years (Figure 2.3-14). Initial production of approximately 10,000 bpd could commence in 1992 with the ultimate production of 100,000 bpd potentially achieved by 2010. Manpower requirements would peak at about 6,000 and would include construction and operations personnel. Peak construction manpower would be approximately 3,000 and ultimate operational manpower at capacity production would be approximately 4,000. A schedule of manpower requirements by year is shown in Table 2.3-8.

Certain components of the Cities Services proposed action could affect public lands in terms of land exchanges, land purchase, or rights-of-way. Those potentially affected public lands are presented in Table 2.3-9. The listing was determined by overlaying federal ownership boundaries on a map similar to Figure 2.3-15. It should be noted that this listing is the best current estimate of all public lands potentially affected. In all likelihood, the amount of public lands actually impacted would be less.

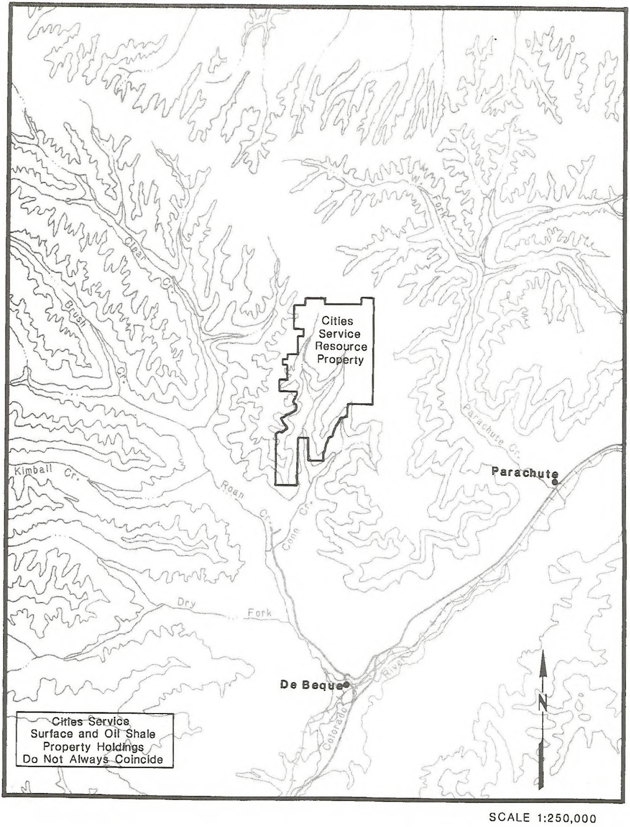


Figure 2.3-13 Oil Shale Resource Property, Cities Service.

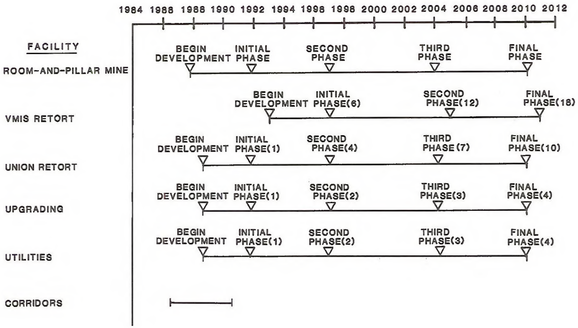


Figure 2.3-14 Cities Service Shale Oil Project Development Schedule.

Table 2.3-8 CITIES SERVICE PROJECT WORKFORCE

Year	Construction	Operation	Total
1986	400		400
1987	400		400
1988	600	100	700
1989	600	100	700
1990	1,700	100	1,800
1991	1,700	400	2,100
1992	--	500	500
1993	100	700	800
1994	400	700	1,100
1995	800	700	1,500
1996	2,100	1,000	3,100
1997	2,800	1,500	4,300
1998	--	1,800	1,800
1999	--	1,800	1,800
2000	100	1,800	1,900
2001	700	1,800	2,500
2002	900	1,800	2,700
2003	2,200	2,100	4,300
2004	3,100	2,600	5,700
2005	--	2,800	2,800
2006	100	2,800	2,900
2007	400	2,800	3,200
2008	1,800	2,900	4,700
2009	3,000	3,100	6,100
2010	600	3,500	4,100
2011[a]		3,700	3,700

Source: Cities Service (1983b).

[a] Steady-state operation until shutdown

2.3.2.2.2 Facility Sites and Processes. Major elements of the project include an underground room-and-pillar mine (a portion of which would accommodate VMIS processing), retorting and upgrading facilities, raw shale transporting systems, a retorted shale disposal system, and a water supply system. The general arrangement of the proposed project facilities is shown in Figure 2.3-15 and a Plot Plan for surface facilities is shown in Figure 2.3-16.

Table 2.3-9 PUBLIC LANDS POTENTIALLY AFFECTED BY THE CITIES SERVICE SHALE OIL PROJECT[a]

Township	Section	Quarter-Quarter Section		Project Feature - Use[b,c]
R96W, T5S	Section 6	Lots 3, 4, 5, 6		Road/Utility Corridor
	Section 18	Lot 4		Mining
R97W, T6S	Section 3	Lots 5, 6, 7, 8		Mining
		Lot 8		Road/Utility Corridor
	Section 4	Lots 5, 6, 7, 8		Mining
		Lots 5 and 8		Road/Utility Corridor
	Section 15	All SW 1/4		Mining
R97W, T7S	Section 4	NW 1/4	NW 1/4	Road/Utility Corridor
		NW 1/4	NW 1/4	Road/Utility Corridor
	Section 5	NW 1/4	NW 1/4	Road/Utility Corridor
		SW 1/4	NW 1/4	Road/Utility Corridor
		NW 1/4	SW 1/4	Road/Utility Corridor
		SW 1/4	SW 1/4	Road/Utility Corridor
	Section 8	NW 1/4	NW 1/4	Road/Utility Corridor
		NE 1/4	NW 1/4	Road/Utility Corridor
		SE 1/4	NW 1/4	Road/Utility Corridor
		SW 1/4	NW 1/4	Road/Utility Corridor
		NW 1/4	SW 1/4	Road/Utility Corridor
		NE 1/4	SW 1/4	Road/Utility Corridor
		SE 1/4	SW 1/4	Road/Utility Corridor
		SW 1/4	SW 1/4	Road/Utility Corridor
		SW 1/4	SE 1/4	Road/Utility Corridor
	Section 17	NW 1/4	NW 1/4	Road/Utility Corridor
		NE 1/4	NW 1/4	Road/Utility Corridor
		SW 1/4	NW 1/4	Road/Utility Corridor
		SE 1/4	NW 1/4	Road/Utility Corridor
		NW 1/4	SW 1/4	Road/Utility Corridor
		SW 1/4	SW 1/4	Road/Utility Corridor
		SE 1/4	SW 1/4	Road/Utility Corridor
		NW 1/4	NE 1/4	Road/Utility Corridor
		SW 1/4	NE 1/4	Road/Utility Corridor
		NW 1/4	SW 1/4	Road/Utility Corridor
	Section 18	SW 1/4	SE 1/4	Road/Utility Corridor
		NE 1/4	SE 1/4	Road/Utility Corridor
		SE 1/4	SE 1/4	Road/Utility Corridor
	Section 19	NW 1/4	NE 1/4	Road/Utility Corridor
		SW 1/4	NE 1/4	Road/Utility Corridor
		SE 1/4	NE 1/4	Road/Utility Corridor
		NE 1/4	NE 1/4	Road/Utility Corridor
		NW 1/4	SW 1/4	Road/Utility Corridor
		NE 1/4	SW 1/4	Road/Utility Corridor
		SE 1/4	Sw 1/4	Road/Utility Corridor
		SW 1/4	SW 1/4	Road/Utility Corridor

Table 2.3-9 PUBLIC LANDS POTENTIALLY AFFECTED BY THE CITIES SERVICE SHALE OIL PROJECT[a] (continued)

Township	Section	Quarter-Quarter Section		Project Feature - Use[b,c]
R97, T7S		NW 1/4	SE 1/4	Road/Utility Corridor
		SE 1/4	SE 1/4	Road/Utility Corridor
	Section 20	NW 1/4	NW 1/4	Road/Utility Corridor
		SW 1/4	NW 1/4	Road/Utility Corridor
	Section 30	NW 1/4	SE 1/4	Road/Utility Corridor
		SW 1/4	SE 1/4	Road/Utility Corridor
		SW 1/4	SW 1/4	Road/Utility Corridor
	Section 31	NW 1/4	NW 1/4	Reservoir
		SE 1/4	NW 1/4	Reservoir
		NE 1/4	NW 1/4	Road/Utility Corridor
		NW 1/4	NE 1/4	Road/Utility Corridor
		NE 1/4	NE 1/4	Road/Utility Corridor
		SW 1/4	NE 1/4	Road/Utility Corridor
		SE 1/4	NE 1/4	Road/Utility Corridor
		NE 1/4	SW 1/4	Reservoir
		NW 1/4	SE 1/4	Reservoir
		SW 1/4	SE 1/4	Reservoir
		SE 1/4	SE 1/4	Reservoir
	Section 32	SE 1/4	NE 1/4	Road/Utility Corridor
		NW 1/4	SW 1/4	Road/Utility Corridor
		SW 1/4	SW 1/4	Road/Utility Corridor
		NW 1/4	SE 1/4	Road/Utility Corridor
		NE 1/4	SE 1/4	Road/Utility Corridor
	Section 33	NW 1/4	SW 1/4	Road/Utility Corridor
	Section 36	SW 1/4	NW 1/4	Reservoir
		NE 1/4	SW 1/4	Reservoir
		SE 1/4	SW 1/4	Reservoir
		SW 1/4	SE 1/4	Reservoir
R97W, T8S	Section 1	NE 1/4	NE 1/4	Reservoir
		SW 1/4	NE 1/4	Reservoir
		SE 1/4	NE 1/4	Reservoir
		NE 1/4	SW 1/4	Reservoir
		SE 1/4	SW 1/4	Reservoir
		SW 1/4	SW 1/4	Reservoir
		NW 1/4	NW 1/4	Reservoir
	Section 5	NW 1/4	NW 1/4	Reservoir
		NE 1/4	NW 1/4	Reservoir and Road/ Utility Corridor
		SW 1/4	NW 1/4	Road/Utility Corridor
		SE 1/4	NW 1/4	Road/Utility Corridor
		NW 1/4	NE 1/4	Road/Utility Corridor
		SW 1/4	NE 1/4	Road/Utility Corridor
		NW 1/4	SW 1/4	Reservoir and Road/ Utility Corridor
		NE 1/4	SW 1/4	Road/Utility Corridor

Table 2.3-9 PUBLIC LANDS POTENTIALLY AFFECTED BY THE CITIES SERVICE SHALE OIL PROJECT[a] (concluded)

Township	Section	Quarter-Quarter Section		Project Feature - Use[b,c]
R97W, T8S		SW 1/4	SW 1/4	Road/Utility Corridor
	Section 6	NW 1/4	NE 1/4	Reservoir
		NE 1/4	NE 1/4	Reservoir
		SW 1/4	NE 1/4	Reservoir
		SE 1/4	NE 1/4	Reservoir
		SW 1/4	SW 1/4	Reservoir
		NW 1/4	SE 1/4	Reservoir
		NE 1/4	SE 1/4	Reservoir
		SE 1/4	SE 1/4	Reservoir
	Section 7	NE 1/4	NE 1/4	Road/Utility Corridor
		SE 1/4	NE 1/4	Road/Utility Corridor
		NE 1/4	SE 1/4	Road/Utility Corridor
		SE 1/4	SE 1/4	Road/Utility Corridor
	Section 8	SW 1/4	SW 1/4	Road/Utility Corridor
	Section 17	NE 1/4	SE 1/4	Road/Utility Corridor
	Section 21	SE 1/4	NW 1/4	Road/Utility Corridor
	Section 27	NE 1/4	NW 1/4	Road/Utility Corridor

[a] Baseline studies covering those areas include: GCC (1981a,b,c,d,e,f; 1982a, b,c,d,e,f).
[b] Roan Creek corridor is different than that shown in the CCSOP EIS (BLM 1983a).
[c] The lands potentially affected by the GCC reservoir were calculated considering the maximum (175,000 ac-ft) reservoir size.

Support facilities include a product syncrude pipeline, a natural gas pipeline, electric transmission loop, access road, railroad spur, and a water supply system. The syncrude pipeline would tie to the proposed La Sal pipeline for syncrude transport. Natural gas would be supplied from the existing Rocky Mountain Natural Gas line. Road and potential rail access would be up the Roan Creek and Conn Creek valleys. Current plans call for the unloading of material and equipment at De Beque for subsequent road transport to the project site. Rail access is also being considered for access to the project. Total daily electric power requirements would be approximately 160 MW (Table 2.3-10). Water requirements for processing average approximately 12,500 gpm daily. Total water usage for the project would be approximately 17,500 gpm daily after inclusion of community and power generation requirements (Table 2.3-11). Fuel utilized would include high- and medium-Btu gas, natural gas, and diesel fuel. Total quantities of fuel use would be 11,100 MM Btu/hr (Table 2.3-12).

The water management plan is based on zero discharge to surface water. All the process wastewater streams would be treated and reused. Offsite water would be mixed with clarified water to provide cooling tower makeup, chlorinated to provide potable water, and treated by carbon filter, reverse osmosis, and demineralizer to provide boiler feedwater. Mine water would be filtered and clarified. Sanitary wastewater would be treated biologically. Process wastewater would be separated into oily water and sour water. Oily water would be treated in an API separator. Sour water would be stripped of ammonia and acid gas. Storm water would be recycled to the feedwater treatment system.

Details on each of the components of the project are presented in the following section.

Mining

Extraction of the oil shale resource on the Cities Service property would involve an underground room-and-pillar mine and VMIS processing.

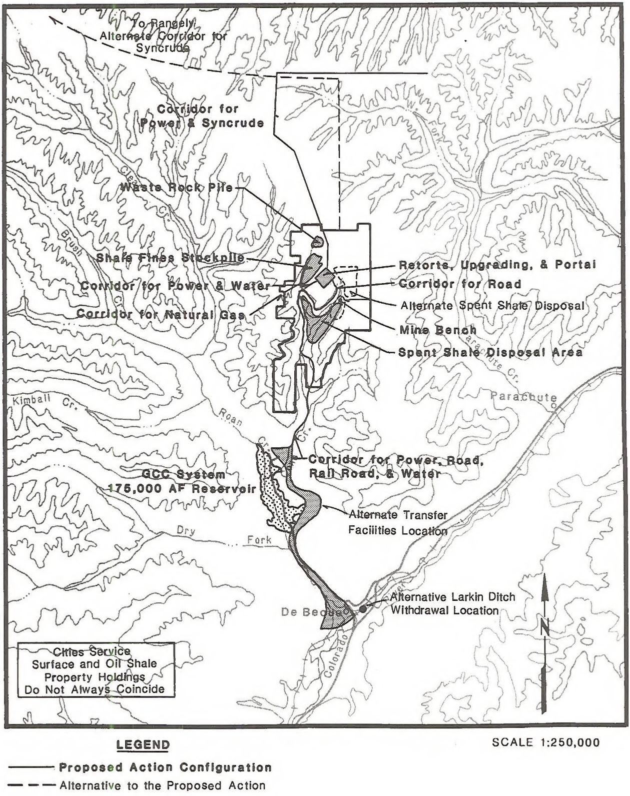


Figure 2.3-15 General Arrangement of the Proposed Project Facilities, Cities Service Shale Oil Project.

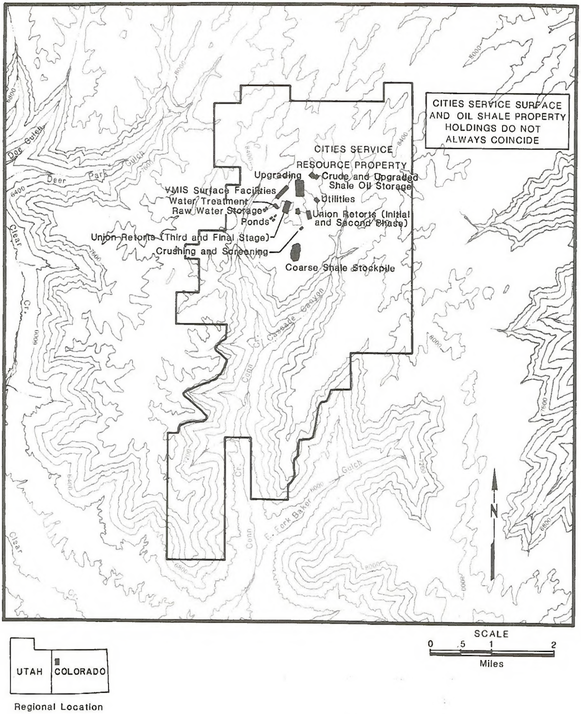


Figure 2.3-16 Plot Plan for Surface Facilities, Cities Service Shale Oil Project.

Table 2.3-10 CITIES SERVICE SHALE OIL PROJECT POWER USE

Purpose	Quantity (MW)
Mining and Underground Processing	30
Materials Handling	20
VMIS Surface Facilities	10
Above Ground Retorting	40
Upgrading	40
Raw Water Supply	10
Miscellaneous[a]	10
TOTAL	160

Source: Cities Service (1983b).

[a] Includes utility and support services

Table 2.3-11 CITIES SERVICE SHALE OIL PROJECT WATER CONSUMPTION

	Quantity	
Purpose	(gpm)	(cfs)
Process Plant	12,500	28
Community[a]	3,000	7
Power[b]	2,000	4
TOTAL	17,500	39

Source: Cities Service (1983b).

[a] Allowance for total population impact of project.
[b] Allowance for generation of project power requirements.

Table 2.3-12 CITIES SERVICE SHALE OIL PROJECT FUEL CONSUMPTION

Combuster	Quantity (MM Btu/hr)	Fuel Type
Recycle Gas Heater	2,400	High-Btu Gas[a]
Reboiler	200	High-Btu Gas[a]
Boiler	300	Natural Gas
Reformer Heater	200 1,600	High-Btu Gas[a] Medium-Btu Gas[b]
Hydrotreater Heater	500	High-Btu Gas[a]
MIS Boiler	1,900 300	Low-Btu Gas[c] High-Btu Gas[a]
Mobile Equipment	100	Diesel Fuel
Hydrogen Feedstock	3,000	Natural Gas
TOTAL	11,100	

Source: Cities Service (1983b).

[a] From treated Union retort make gas
[b] From hydrogen purification
[c] From treated VMIS make gas

The in-place oil shale resource of the Conn Creek property is estimated at 3.2 billion barrels utilizing a 15 gpt cut-off grade. The mineable oil shale for the 15 gpt and higher grade lies in a zone approximately 300 feet thick. Within this zone is the higher grade Mahogany Zone 100-feet thick, and is centered at an elevation of about 7,500 feet above mean sea level (msl). The underground room-and-pillar mining technique would be used to recover the shale from an interval of 65 feet of the Mahogany Zone. The proposed VMIS process would recover the shale oil from the leaner portions of the 300-foot oil shale interval.

The underground mine would cover the surface equivalent of approximately 5,700 acres, and would extend to the limits shown on Figure 2.3-17. The surface disturbances associated with the underground mine would comprise approximately 50 acres.

The main features of the underground mine are the mine bench, declines, entry drifts, room-and-pillar and VMIS production panels, primary crushing facilites, service facilities, and the ventilation system. The mine bench would be constructed to provide horizontal access to the Mahogany Zone on the northern wall of Cascade Canyon. A decline for conveying oil shale from the mine to the plant would be sited at the surface processing site. This decline would also provide access for equipment and personnel. Another decline would be sited to the north of the surface processing site to convey waste rock from underground to the waste rock disposal site. Cross drifts would be situated in each entry to allow truck travel between production panels and crusher stations. The production panels would be approximately 800 feet wide and 3,200 feet long, situated on both sides of the entry drifts. As currently envisioned, the mining pillars would be 60 feet square by 65 feet high, allowing approximately 60 percent removal of the resource in the 65-foot zone. One of several objectives of the mining plan is to maximize oil shale resource recovery. The proposed mine plan is the state-of-the art for oil shale room and pillar mining. The mining recovery percentage and the pillar sizes would depend on the depth of the overburden over the panels in all areas of the planned mine. In other words where the overburden is the greatest, the mining recovery would be the lowest. Surface subsidence is a possibility but the probability of occurrance is, by design, relatively low. As mining progresses the stability of the pillars and mined openings would be closely monitored by the rock mechanics program. This data along with the mining experience gained during the mine development and initial years of operation would be employed to optimize the mining plan, mine stability, and the resource recovery.

A conceptual diagram of the underground mining operations is presented as Figure 2.3-18. At ultimate production capacity approximately 135,000 tpd of oil shale, having an average grade of 29 gpt, would be mined. Over the life of the project, approximately 4,600,000 cubic yards of waste rock and 41,200,000 cubic yards of shale fines would be generated from mine development, production mining, and VMIS retort void development. The waste rock would consist primarily of raw, low-grade oil shale. Some of this material could be used as a capillary barrier for reclamation of the retorted shale pile.

Shale fines from the Cities Service mine would consist of particles less than 1/8 inch in nominal diameter. These particles would have the general characteristics of raw oil shale with a Fischer Assay of 29 gpt.

Within the mine, wet suppression and deposition in the exhaust system would control particulate emissions from blasting, mining, transfer operations, and primary crushing. Surface material handling of dry, high-volume material would include baghouses at transfer points, screening, and secondary crushing operations. Particulate emissions from disposal and stockpile areas would be suppressed by wetting and minimizing the area exposed to wind erosion.

Feed Preparation and Handling

The mined oil shale would be crushed within the mine to a coarse size and then would be transported by conveyor to either the stockpile or the feed preparation plant. A reclaim conveyor would move ore from the stockpile to the feed preparation plant. The ore stockpile would contain approximately 2,000,000 tons, and would be used to compensate for an imbalance between the mine and retort operation. At the feed preparation plant, secondary crushing would occur and fines less than 1/8 inch in size would be separated. The sized ore would then be conveyed to the storage silos serving each Union B retort. The fine ore (‹1/8 inch) would be tranported to the fines stockpile. Ore below the economic cut-off grade that is produced from development operations outside the Mahogany Zone would be removed to the waste disposal area. In the event that retorting of fines proves to be economical, the likely choice of retorting process would be the Lurgi technology. Because of the uncertainty of the need for fines retorting, it is not a part of the proposed action. The Lurgi process is evaluated as an alternative in Section 2.4.

Retorting

Retorting facilities would utilize the Union B retorts and the VMIS process. The Union B retort process is a continuous, underfeed, countercurrent process. In the process, shale is fed through the bottom of the inverted cone vessel by a rock pump (Figure 2.3-19). Hot gases enter the top of the retort and pass down through the rising bed, causing kerogen pyrolysis. The shale oil and gas flow down through the bed. The oil accumulates in a pool at the bottom, which seals the retort and acts as a settling basin for entrained shale fines. The shale oil and gas are withdrawn from the bottom and top of the pool, respectively. The gases are split into two streams. Recycle gas is reheated and reinjected to induce additional kerogen pyrolysis. The remaining gas is processed to recover liquid hydrocarbons and reduce sulfur content to below 100 ppm. The gas is then suitable for use as a fuel, with most of the fuel gas being used within the retort area. The remainder would be released to the fuel gas system.

The raw shale oil would have approximately 2 percent by weight nitrogen and and 0.8 percent by weight sulfur. The material balance for the Union B retorting process is shown in Figure 2.3-20.

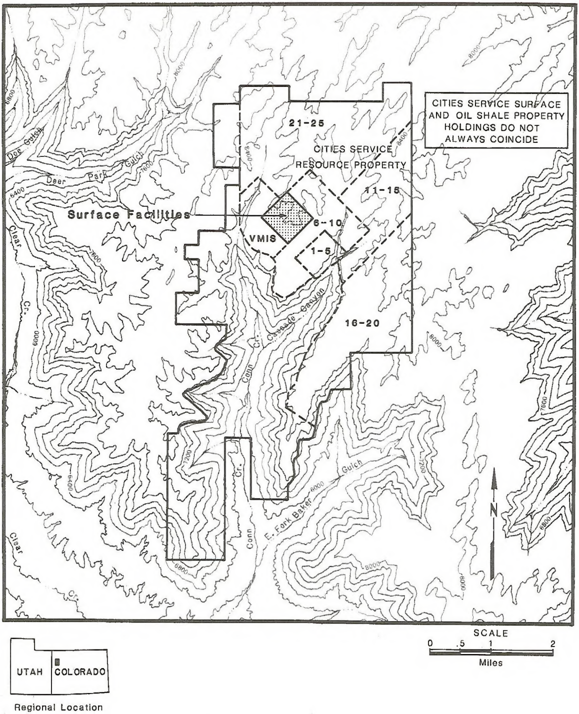


Figure 2.3-17 Mine Progression (years), Cities Service Shale Oil Project.

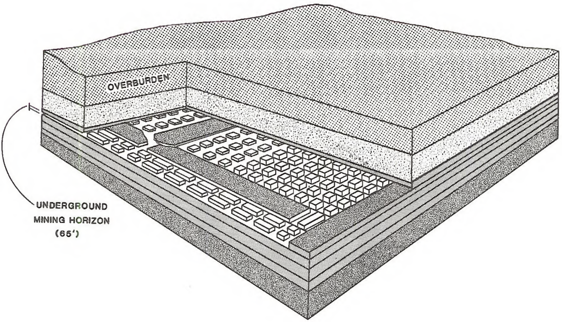


Figure 2.3-18 Conceptual Diagram of Underground Mining, Cities Service Shale Oil Project.

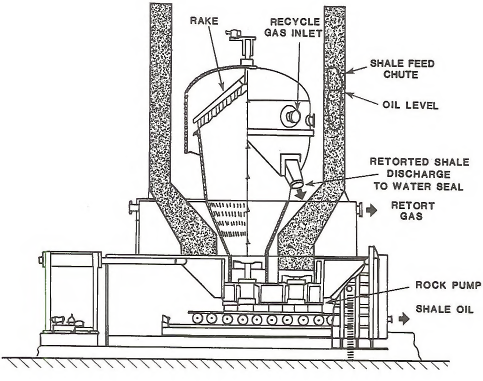


Figure 2.3-19 Conceptual Diagram of the Union Oil "B" Retorting System.

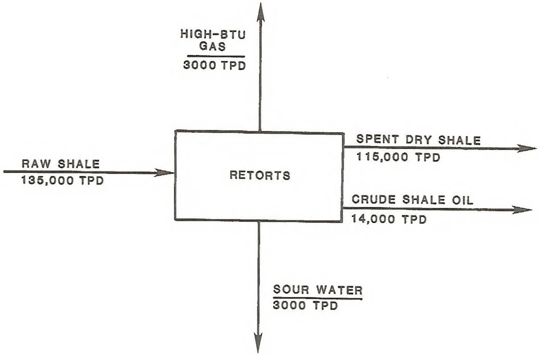


Figure 2.3-20 Union Oil "B" Retort Material Balance, Cities Service Shale Oil Project.

Emissions of primary pollutants for the above ground retorting portion of the project are shown in Table 4.3-6. The combustion source emissions for sulfur dioxide, nitrogen dioxide, carbon monoxide, nonmethane hydrocarbons, particulates, and sulfuric acid mist are based on information provided by Union Oil Company and, in general, are the best available control technology. All other regulated pollutants are either not emitted from the retort process or are estimated to be below EPA recommended levels.

The VMIS process consists of retorting a rubblized column of broken shale that has been formed by expansion of the oil shale into a previously mined-out void volume (Figure 2.3-21). This is accomplished in three steps. First, approximately 20 percent of the retort volume is mined and taken to the surface for retorting. Second, vertical holes are drilled from the mined-out rooms into the shale column to be rubblized. The holes are then loaded with explosives and detonated with appropriate time delays. The resulting broken shale would fill both the volume of the previously mined-out void and the volume of the shale column. Finally, prior to retorting, connections would be made at the top for air addition, and bottom for oil and gas withdrawal. At this stage, the oil shale is ready for in-situ retorting.

Retorting would be intiated by heating the top of the rubblized shale column with hot inert gas followed by admitting air to initiate combustion. Several hours after commencement, the inert gas flow is stopped and the air flow is maintained utilizing the carbonaceous residue in the retorted shale as fuel. In this vertical retorting process, the hot gases from the combustion zone move downward to pyrolyze the kerogen in the shale below that zone and produce gases, water vapor, and shale oil mist which condense at the bottom of the rubblized column. The raw shale oil would have approximately 1.5 percent by weight nitrogen and 0.7 percent by weight sulfur.

The VMIS off-gas has a very low heating value and it would be treated by a Flue Gas Desulfurization (FGD) system. Process heaters would burn either a treated fuel gas or natural gas. A Unisulf recovery unit would remove sulfur from the off-gas prior to combustion. Floating roof storage tanks would control hydrocarbon emissions from raw and upgraded shale oil storage The material balance for the VMIS process are shown in Figure 2.3-22.

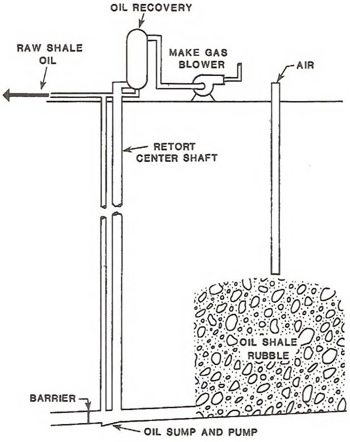


Figure 2.3-21 Conceptual Diagram of the VMIS Retort Process, Cities Service Shale Oil Project.

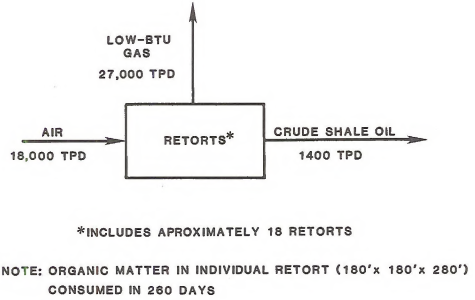


Figure 2.3-22 VMIS Retort Material Balance, Cities Service Shale Oil Project.

The expected emissions for all primary pollutants from the VMIS retorting process are given in Table 4.3-14. In addition to the primary air pollutants, there may be other criteria pollutants emitted from the VMIS retorts. Cathedral Bluffs Shale Oil Company has estimated the maximum emission rates for these pollutants from the MIS retort, and most are below the recommended rates. Table 4.3-14 lists these rates, along with de minimis values. Some criteria pollutants, such as asbestos, beryllium, and vinyl chloride have neither been found in the core samples taken from Tract C-b, nor are they formed during oil shale processing. Nonvolatile pollutants are emitted as the constituents of the raw and processed shale particulates, and the control of these particulates also provides the control of such pollutants. The mobilization of volatile pollutants, such as mercury, is temperature dependent. Since the waste streams released from the plant would be below the boiling point of mercury, release of mercury vapors is not anticipated. Any released mercury would be as a nonvolatile constituent of the particulates (EPA 1983).

Upgrading

Upgrading facilities would be located on the Roan Plateau, and would occupy approximately 30 acres (Figure 2.3-15). The retort and upgrading plants would be connected by a pipeline running through the middle of the site.

The upgrading process takes blended and filtered raw shale oil from both the Union B retorts and the VMIS processes, and catalytically hydrotreats it to remove nitrogen, sulfur, and metal compounds. The nitrogen content would be reduced to approximately 1,000 ppm and sulfur content to approximately 10 ppm. Natural gas would be used as the feedstock to a steam-methane reforming unit to produce hydrogen required for hydrotreating. A flow diagram of the upgrading process is shown in Figure 2.3-23. On-site storage would include 500,000 barrels for raw shale oil, and 750,000 barrels for synthetic crude oil.

Off-gas and sour water from the hydrotreaters would be sent to gas cleaning and sour water treatment, respectively. Hydrogen required for hydrotreating is furnished from the hydrogen plant by steam reforming natural gas followed by hydrogen purification. The gas cleaning plant recovers oil, removes acid gas for sulfur recovery, and provides treated fuel gas. Acid gas would be treated in the Unisulf unit to recover elemental sulfur.

Approximately 300 tpd of ammonia and 200 tpd of liquid sulfur would be recovered in the sour water and sulfur recovery plants, respectively. Approximately 10 days of on-site storage would be provided. Both by-products would be trucked to a terminal at De Beque for rail transport to market. The total amount of truck traffic is approximately 15 round-trips per day.

Spent Shale and Waste Rock Disposal

At the ultimate production rate of 100,000 bpd, approximately 115,000 tpd of spent shale would be generated (dry weight basis). The total amount of spent shale generated for the project life would be disposed of in Cascade and Conn Creek canyons (Figure 2.3-15). Prior to the disposal of shale in these areas, topsoil would be removed and stockpiled.

The spent shale would be moistened to approximately 15 percent by weight and transported to the disposal areas by conveyor. Deposition of the shale would begin in the lower portion of Conn Creek, and proceed in the northerly direction as indicated on Figure 2.3-24. Considering various engineering criteria, this is the most suitable method of progression. However, deposition from the head to the bottom of the gulches is also being considered.

After topsoil has been removed and stockpiled, a 10-foot thick (measured normal to slopes) layer of retorted shale would be placed and compacted. This highly compacted Zone I material would be an impermeable lining over which less compacted lifts of retorted shale, (Zone II material) would be placed. The Zone I lining would be extended up the canyon walls before lifts of Zone IV materials are placed. The continued placement and compaction of Zone I liner would precede the placement of Zone IV material. The toe of the pile would be constructed by placing moderately compacted Zone II material at 15 percent slopes, and benches would be incorporated as necessary into the pile faces to facilitate runoff water control and reclamation. Any runoff water would be collected in a dam below the toe of the pile and evaporated or be used for dust and moisture control within the pile. Reclamation and revegetation of the pile would be accomplished using Zone III material. Surface water stream flows from Conn and Cascade creeks would be diverted around the pile in lined culverts used during pile development and after completion. Peak streamflow during flooding would be contained in an upstream header dam. An underdrain system below and above the shale liner could be utilized to collect any lechate. While these methods are felt to be best at this time, specific drainage methodologies would be addressed in the applicable mining and reclamation permits.

The spent shale consists of 23 to 31 percent silt and clay size material and 44 to 62 percent gravel size material. The material classifies as poorly graded gravel-sand-silt mixtures. Contrary to typical experience with soils, the addition of moisture to the retorted shale material does not increase the density to a significant degree. The material would be classified in the low end of the semi-pervious range with coefficients of permeability of 2.6 feet/year and 4.6 feet/year after compaction. The density increase in high lifts which are not compacted would be very significant to a depth of about 200 feet. For depths greater than 200 feet, changes in density would be very small, would become even smaller as depth increases, and would likely have little effect on pile design. Material strength would be more dependent on material gradation and confining pressure than on initial placement density.

The engineering design includes several features to ensure pile stability as shown in Figure 2.3-25. A Zone I heavily compacted layer would minimize water filtration. Exposed slopes of 3.5:1 would minimize erosion and runoff, and provide for reclamation surfaces. When the near-final surface elevations and configurations are reached, another Zone I blanket would be placed followed by a reclamation zone of retorted shale. Surface area would become available for revegetation in increments over the life of the project. This would enable evaluation and adjustment of reclamation techniques where necessary. It is planned no more than 20 acres of uncompacted retorted material would be exposed at one time. The ultimate areal extent of the spent shale disposal pile is approximately 687 acres.

Settlement of the retorted shale pile would occur both within the natural subsoil material beneath the pile, and within the retorted shale pile itself. The amount of such settlement, and the time period during which settlement occurs, is dependent on many factors.

Settlement of the subsoil beneath the pile depends on the amount of retorted shale placed, moisture conditions, characteristics of the subsoil beneath the placed shale, and depth to bedrock. The rate of settlement depends on the relative amount of retorted shale placed during any time period, the time involved for structural readjustment of the subsoil, and the subsoil permeability. Preliminary studies for the Union Oil Company (1982b) indicate that with a pile 1,000-feet high overlying about 100 feet of natural subsoils, the subsoils would settle from 5 to 15 feet. Since the subsoils in the area are generally granular (sand and gravel), their settlement would occur concurrently with pile construction and should be complete at completion of the pile.

The settlement of the retorted shale itself depends on the physical characteristics of the shale, moisture conditions, and placement methods. Preliminary studies for the Union Oil Company (1982b) indicate that total pile settlement for a 1,000-foot pile constructed primarily of Zone II materials could be 80 to 100 feet. Since the retorted shale materials are generally granular in nature, most of this settlement should occur as the pile is being constructed. As the pile settles, the materials within the pile become more dense and are able to support greater heights of retorted shale without increased settlement.

As a result of these design measures, it is anticipated that the basal liner and cap would have adequate strength and impermeability to ensure a low likelihood of leachate migration from the spent shale pile.

Waste rock from mining operations would be disposed on the plateau. Fine ore from crushing operations, which is unsuitable for processing in the Union B retort, would be stockpiled on the plateau for future recovery. Reclamation measures would be implemented on the fines stockpile so that no more than one acre would be exposed at any one time. The ultimate areal extent of the disposal site would be approximately 73 acres.

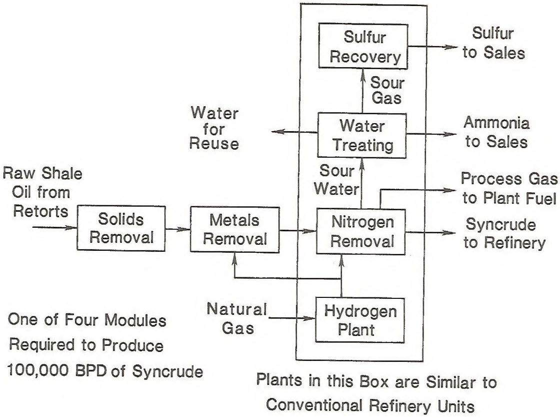


Figure 2.3-23 Flow Diagram of Upgrading Process, Cities Service Shale Oil Project.

Reclamation

The reclamation activities for the proposed project can be categorized into two areas: (1) reclamation of the shale disposal site, and (2) reclamation of other disturbed areas.

Shale Disposal Area Reclamation. Retorted shale from the Union B process has a loamy texture, is high in soluble salts, has a moderate pH, and is low in available phosphorous and nitrogen. Other mineral nutrients are low to adequate and within the range found in Colorado soils. The major problems encountered in establishing vegetation on retorted shale are the shale's low fertility, high sodium adsorption ratio, and high soluble salt content.

The amount of subsoil and topsoil to be placed will be precisely determined during preparation of the permit application for the Mined Land Reclamation permit for the Cities project. As parts of other testing programs, various researchers have successfully produced vegetative cover on various soil and subsoil combinations including growing plants directly on spent shale from a variety of retorting processes. Union Oil Company has conducted tests using 6 inches and 12 inches of soil coverage over retorted shale from the Union B process. The analysis, conducted over 6 years, indicated the highest plant cover values with the 6-inch soil cover. Although the soil-covered shale tests had better initial coverage, later stages of development of all tests were similar. The current plan for reclamation of the Cities Service property would involve covering spent shale with unretorted waste shale rock followed by soil, soil amendments, and seeding as necessary. The depths of these layers would be determined by further testing and by the appropriate permit requirements.

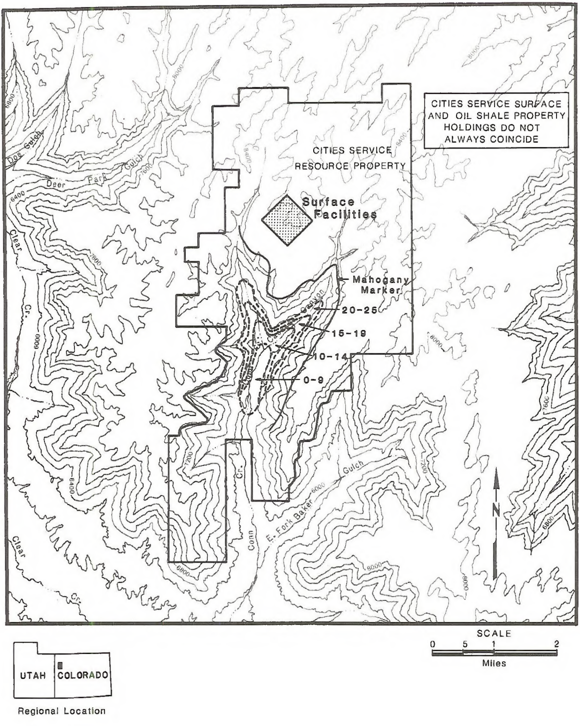


Figure 2.3-24 Spent Shale Disposal Progression (years), Cities Service Shale Oil Project.

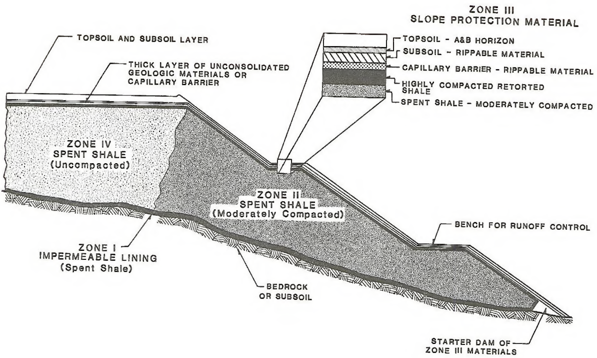


Figure 2.3-25 Spent Shale Cross-section, Cities Service Shale Oil Project.

The spent shale disposal pile for Cities Service project would be confined within Conn and Cascade canyons. It will occupy the general area indicated in Figure 2.3-15. The disposal pile would be constructed in lifts of varying thickness to a final contour as follows. The top of the pile would be gradually sloped along the long axes of the canyons at about 7 percent and sloped downward toward the northwest across the canyons at about 4 percent.

Other Disturbed Areas Reclamation. Construction of the processing and support facilities for Cities Service project would require local topographic modifications to provide level areas for construction. After decommissioning, those areas would be reclaimed according to the specific conditions of the Colorado Mined Land Reclamation permit. Although the exact conditions of this permit cannot be accurately predicted at this time the following procedures are anticipated. Surface disturbance areas would be graded and disced to break up the surface. Topsoil would be redistributed and appropriate seed mixtures and plantings would be placed. Monitoring plans are expected to evaluate the success of returning the various areas to a condition suitable for the planned post-mining land use.

Major pieces of equipment, structures, and foundations would be decommissioned per the requirements of the reclamation permit. Embankments, waste piles, and other disturbed areas would be reclaimed as described above.

Erosion control for the Cities Service project would be accomplished using the appropriate type of control method for the situation at hand. Depending on the material to be controlled and the time requirement associated with the control, physical and chemical barriers such as riprap, mulches, netting, coagulants, and emulsifiers could be used. More permanent control would be accomplished through soil preparation and revegetation efforts. Control of suspended solids resulting from erosion will be exercised by collection of runoff from eroding areas in sediment ponds.

Specific seed mixtures for short-term stabilization, long-term stabilization, and permanent revegetation efforts would be included in the specific reclamation procedures proposed as part of the reclamation permit application. The seed mixture presented in Table 2.3-13 is considered to be representative of the mixture expected to accomplish reclamation goals.

2.3.2.2.3 Support Facilities. In order for the project to be constructed and operated, provisions must be made for the supply of personnel, equipment, water, natural gas, and electricity to the site, as well as provision for the removal of shale oil, by-products, and waste. The various corridors shown in Figure 2.3-15 constitute the plan for support facilities.

Transportation Systems

Cities Services' plan for transporting of workers, major materials, and by-products is based on utilization of buses, trucks, and a rail. The workers and major equipment would utilize the existing transportation system for access to De Beque. Facilities would be constructed near De Beque to allow transfer of workers and equipment to buses and trucks, respectively. Buses would then transport workers to the project site via the new highway corridor identified in Figure 2.3-15. By-products form the project would be trucked from the plant site to De Beque for transfer to railroad cars and/or directly to the final by-product destination. Table 2.3-14 summarizes the transportation requirements. The general location of the transfer facilities was shown previously on Figure 2.3-15.

Access would be limited to the site at Cities Service's southern property boundary by a security gate and guard. Only authorized personnel would have access to the site.

Road access to the plateau would be along the existing Roan Creek road, up Conn Creek, and above the west side of the spent shale disposal area (Figure 2.3-16). The road would be upgraded to a two-lane paved road, and designed to provide a safe traveling surface. The road grade would be limited to a maximum of 8 percent. The total length of the route from De Beque to the plant site would be approximately 20 miles.

Water Sources and Supply Systems

The primary source of water would be the Colorado River near De Beque. Cities owns water rights sufficient to support a 100,000 bpd shale oil facility. Getty, Cities Service, and Chevron have formed the GCC Joint Venture, the purpose of which is to develop a common water supply system that will allow each participant to utilize their respective individual water rights for subsequent industrial use. A diversion structure is planned in the Colorado River, and a dam and reservoir near the confluence of Dry Fork and Roan Creeks. The intake structure is proposed to be located near the right bank of the Colorado River approximately 600 feet downstream of the confluence with Roan Creek. A system of low head pumps and short discharge lines would deliver water to adjacent sedimentation ponds. The ultimate withdrawal capacity of the GCC system from the river would be 442.24 cubic feet per second. A 23,000-foot long water pipeline, with a high head pumping plant, is planned along the Roan Creek valley floor, to the Dry Fork storage site. The length of the dam crest is expected to be about 4,000 feet with a maximum height of 225 feet. The area of the reservoir would be about 2,600 acres, with an ultimate capacity of 175,000 acre-feet. Cities Service would install separate facilities to withdraw its water from the reservoir and to pump the water up Conn Creek canyon to the plant to the plant site along the previously discussed corridor. These facilities include a 24-inch (approximate diameter) pipeline and would have a nominal operating capacity of 12,500 gpm.

Natural Gas

There is an existing natural gas pipeline adjacent to Cities Service property. A connection would be established (via a 6-inch approximate diameter pipeline connection) to provide supplemental fuel to the project. Normal operating requirements would be 86,000,000 standard cubic feet per day.

Table 2.3-13 CITIES SERVICE PROJECT PROPOSED SEED MIXTURE[a]

Scientific Name	Common Name		Pounds PLS/Acre[b]
Xeric Site			
Agropyron inerme	Beardless bluebunch wheatgrass		1.0
Agropyron tricophorum	Pubescent wheatgrass		2.0
Elymus junceus	Russian wildrye		1.0
Agropyron riparium	Streambank wheatgrass		1.0
Agropyron smithii	Western wheatgrass		2.0
Agropyron desertorum	Crested wheatgrass		1.0
Festuca ovina	Hard fescue		2.0
Sporobolus airoides	Alkali sacaton		0.1
Sporobolus cryptandrus	Sand dropseed		0.1
Melilotus officinalis	Yellow sweet clover		0.5
Artemesia tridentata vaseyana	Mountain big sagebrush		0.1
Purshia tridentata	Bitterbrush		0.5
Hedysarum boreale	Utah sweetvetch		0.1
Kochia prostrata	Summer cypress		0.5
		TOTAL	11.9
Shrub Seedling Mixture			Seedlings/Acre
Prunus virginiana	Chokecherry		100
Rosa woodsii	Woods Rose		50
Symphoricarpos oreophilus	Snowberry		150
Amelanchier alnifolia	Serviceberry		50
Quercus gambelii	Gambels Oak		100
		TOTAL	450

[a] Seed mixtures are those to be used for permanent reclamation
[b] PLS = Pure Live Seed - equivalent to 60 seeds/square foot

Table 2.3-14 TRANSPORTATION REQUIREMENTS - CITIES SERVICE SHALE OIL PROJECT

Transportation Item	Number or Quantity	Mode	Required No. of Round Trips/Day[a]
Work Force	5,328 people[b]	Buses	122
	3,368 people[c]	Buses	68
Catalysts	2,000 tons/yr (delivered and waste)	Truck	0.3
Byproducts			
Ammonia	300 tons/day	Truck	6
Sulfur	200 tons/day	Truck	4
Diesel Fuel	17,000 gal/day	Truck	2
Chemicals, Solids & Misc.	60 tons/day	Truck	3

[a] Approximately 40 miles per round trip. Assume 42 minutes for each one-way trip.
[b] Peak bus transportation requirement is expected to occur in 2004. Construction and operations shifts will be staggered to minimize the number of buses required.

[c] Bus transportation requirement for only operating personnel is expected to peak in 2011.

Transmission Lines

The power requirements for the project are presented in Table 2.3-10. A transmission loop is planned that would extend from De Beque, up Roan and Conn creeks, over to Parachute Creek, down the valley to the town of Parachute, and back to De Beque. This transmission line loop would be designed to provide reliable service.

Capacity of the proposed transmission line that would support the Cities Service project is likely to be 345 kV. This same line would serve the Getty project. Depending on the ultimate power requirements of the projects and the ultimate number of other project loads in the area, more than one line may be required. Rights-of-way requirements for a single 345-kV transmission line would be 150 feet wide.

The type of structure that would be utilized will depend on the conductor size and terrain limitations. Wood H-frame design, lattice steel towers, and steel poles are all possible alternatives. The wood H-frame structure requires more structures per mile of line, as compared to steel towers or poles, but the latter types usually require more land disturbance during construction of each structure.

Product Pipeline

The syncrude pipeline would connect to the La Sal pipeline, originally planned to transport syncrude from the Colony Oil Shale Project to existing refineries. Although the construction of the La Sal pipeline has been delayed, it would remain a viable link for product transport. The Cities Service connecting pipeline would be approximately 16 inches in diameter and would have a nominal operating capacity of 100,000 bpd.

Waste Disposal

At this time it is uncertain due to regulatory conditions whether mining wastes will be classified as hazardous. However, some potentially hazardous wastes would be generated by the retorting and upgrading processes. These include catalysts and by-products. Due to the regulatory uncertainties, the types and quantities of any waste is also indeterminant. Any hazardous waste would be handled by a qualified and licensed contractor, and disposed of off-site in a licensed facility. If on-site disposal is utilized, a waste disposal management plan would be developed and filed with the appropriate agencies.

Non-hazardous waste generated by the proposed project would include paper and metal wastes, plastic products, and miscellaneous items (fines, concrete, etc.) The proposed plan is to dispose of these wastes in the spent shale pile. If another on-site or off-site location is utilized, a waste management plan would be developed and filed with the appropriate agencies.

Non-hazardous waste generated by the proposed project would include paper and metal wastes, plastic products, and miscellaneous items (such as shale fines and concrete). The proposed plan is to dispose of these wastes in the spent shale pile. If another on-site or off-site location is utilized, a waste management plan would be developed and filed with the appropriate agencies.

2.3.2.3 Alternatives to the Proposed Action

This section describes alternatives to the various components of the Cities Service proposed action. A wide range of options were investigated. Table 2.2-2 (Section 2.2) presents the alternative categories which have been considered and the various options in each category. Each alternative selected for detailed discussion is described below. For some categories, there were no alternatives included for detailed discussion; these include upgrading, water source, product transport methods, retort sites, upgrading site, supplemental energy systems, underground mine technology, and transmission routes. Table 2.2-2 may be reviewed concerning reasons for elimination of these alternatives from detailed study.

2.3.2.3.1 Alternatives Considered

Production Rate

The only alternative to the proposed 100,000-bpd production rate is the 50,000 bpd rate. This alternative would still utilize room-and-pillar underground mining and surface retorting, but at a reduced level. The project life would be doubled. The amount of VMIS retorting would be the same as the 100,000-bpd alternative because it represents the minimum commercial sizes. The net consumption per year of water and power would be less than the 100,000-bpd alternative. Air emissions and water discharges would also be less on an annual basis. Overall process efficiency is expected to be less because of the loss of the economies of scale.

Mining Method

All underground mining (no VMIS) was considered as an alternative. Resource recovery for this alternative would not be as efficient as the underground/VMIS combination.

Retort Type

An alternative to the combination of surface and VMIS retorting is to use surface retorting only. Using surface retort technology only may result in some loss of shale oil resource.

Surface Retort Technology

The Lurgi retorting process was the only alternative to the Union B process that was considered. Other processes were considered, but were rejected based on their developmental status.

The key elements of the Lurgi retort process are illustrated in Figure 2.3-26. Shale fines are fed to a horizontal mechanical screw mixer where heating is accomplished by mixing with recycled shale. The retort oil is discharged from the mixer with the gas. The gas is quenched in a heavy oil scrubber which is designed to contain most of the dust in the heavy oil fraction. The lighter oils are further quenched and water is separated. The heavy oil is dedusted by a dilution centrifuge process which returns the spent shale to the retort collection bin. Heat is supplied to the process by combusting the carbon on a mixture of recycled and freshly-processed shale in a fluidized bed lift pipe which discharges to a collection bin. The flue gas from the combustor passes through a heat exchanger to preheat combustion air and to generate steam. A high-Btu gas byproduct is produced. Substantial quantities of flue gas dust must be collected and disposed of with the spent shale.

In general, spent shale from the Lurgi process is of a finer particle size and has a much greater tendency to cement. Also, because of differences in the Lurgi process, there is substantially less carbon remaining on the spent shale than that produced by the Union B retort. The final pile is generally much harder due to the cementation.

The Lurgi spent shale is expected to require more water than the Union B spent shale because its average particle size is much smaller. Hence, there is more surface area per unit weight and more water would be required to wet the surface of the particle for compaction.

The thermal efficiency of the Union B process could be improved by utilizing the energy remaining in the spent shale. The Union Oil Company (1982a) is currently developing a process that would use a spent shale combustor to gasify the residual coke and supply energy for process heating. Cities Service plans to monitor development of this technology and evaluate its use when available.

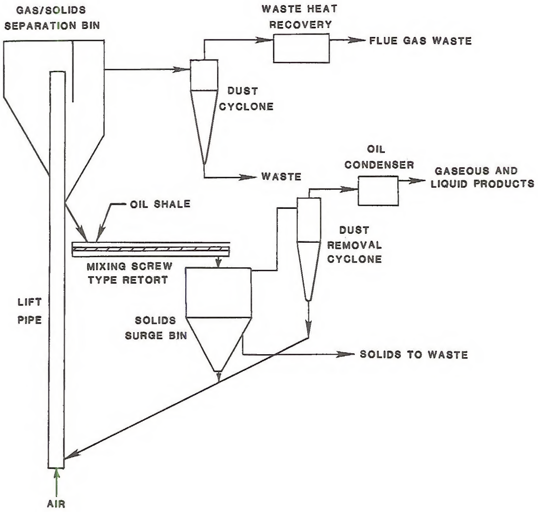


Figure 2.3-26 Lurgi-Ruhrgas Retort Process.

Power Source

Cities Service may install an on-site cogeneration plant as an alternative to ensure reliability of power supply. The capacity of the plant would be determined based upon critical loads, steam requirements, and the availability of fuel. The output of a cogeneration plant is electricity and process steam, and the ratio of the two products varies with plant design. The assumed fuel for cogeneration is low-Btu gas. It is estimated that a maximum of 1 scf per hour of natural gas may be required additionally to supplement the fuel balance.

Railroad Transportation

A railroad may be used to transport workers to Cities Service property in the Conn Creek valley. This rail transportation would be utilized by workers from De Beque to an unloading/parking area located east of the GCC Reservoir site near the access road. From the unloading/parking area, workers would be transported by buses to the main plant site area on the plateau. Materials, fuel, and supplies would be transported by truck from De Beque or their origin, to the property. Likewise, by-products would be transported by truck from the project site to their destination or a secondary transportation system. Table 2.3-15 summarizes the transportation requirements under the railroad alternative.

Table 2.3-15 TRANSPORTATION REQUIREMENTS - RAILROAD ALTERNATIVE CITIES SERVICE SHALE OIL PROJECT

Transported Item	Number or Quantity	Mode	Required No. of Round Trips/Day[a]
Work Force	5,328 people[b]	Train (53 cars)	3
	3,368 people[c]	Train (34 cars)	3
Catalyst	2,000 tons/yr	Truck	0.3
Explosives[d]	75 tons/day	Truck	7
By-products			
Ammonia	300 tons/day	Truck	8
Sulfur	200 tons/day	Truck	5
Diesel Fuel	17,000 gal/day	Truck	2
Chemicals, Solids & Misc.	60 tons/day	Truck	3

[a] Train round trip from De Beque to the unloading/parking are is approximately 11 miles. Truck round trip from the unloading/parking area in Conn Creek canyon to the plant is approximately 9 miles.
[b] Peak construction (combined with operation) transportation requirements occur in the year 2004.
[c] Peak operating transportation requirements occur in the year 2011.
[d] Explosive ingredients (dry ammonia nitrate) would be delivered to the plant site by truck. Final explosive preparation would be done on-site (i.e., mixing ammonia nitrate with fuel oil). Shipments to the site would not be an explosive hazard.

Product Pipeline Route

The Rangely product pipeline alternative occupies the same corridor as described in the CCSOP EIS (BLM 1983a). It would connect to an existing pipeline in Rangely, supplying crude oil to Salt Lake City refineries. However, the pipeline has insufficient capacity for 100,000 bpd, and excess refining capacity in Salt Lake City is also inadequate to handle an additional 100,000 bpd.

The North product pipeline and power corridor is also a practical alternative. It would be the shortest distance from Cities Service property to the La Sal corridor, but would generate increased construction impacts compared to the proposed action since it crosses several drainages enroute to Parachute Creek. This corridor is also less desirable from the standpoint of the opportunity for joint usage with others, such as the Getty project.

Spent Shale Disposal

Alternative spent shale disposal areas within Cities Service property boundaries include upper Cascade Canyon in connection with plateau property above this canyon, all within the Cascade Creek drainage area.

If the Lurgi retort is utilized, the resulting spent shale would be deposited in the same areas, utilizing the same methods as in the proposed action and alternatives described herein.

Water Supply System

Cities Service's proposed water supply system would be that of the GCC Joint Venture. An alternative would be the development of a water withdrawal system at the Larkin Ditch diversion, just east of De Beque, which would pump water to the GCC Roan Credek reservoir for eventual use on the Conn Creek property. The amount of water withdrawn and the withdrawal schedule would be as for the proposed action.

The Larkin Ditch is an existing, permitted structure which currently supplies water for agricultural purposes. The intake for the Larkin Ditch is located on the south bank of the Colorado River about 1,000 feet upstream of the De Beque highway bridge. The ditch then flows generally in a southward direction.

Cities Service's alternate action is to install a low head pumping station at the point shown on Figure 2.3-15, which would remove water from the ditch and pump it to a sedimentation pond located on the south side of the river. The pump station and sedimentation pond would be designed to withstand a 100-year flood.

The water sedimentation pond would be pumped to storage via the GCC corridor. The pipeline from the sedimentation pond to the GCC corridor would be routed via the De Beque highway bridge, and then parallel to the railroad track on the north side of the river. Storage would be assumed to be at the proposed GCC reservoir site.

Other alternative water supplies have been eliminated due to technical and economic reasons (Table 2.2-1).

Fines Processing

Cities Service's preferred option regarding fines is to store them in an environmentally acceptable manner, rather than attempting to process them. Processing of the fines for oil extraction is an alternative and would utilize the Lurgi technology.

2.4 Comparison of Alternatives Including the Proposed Action(s)

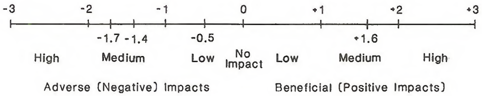
2.4.1 Introduction

The impacts of the proposed action(s) and alternatives for each of the Getty and Cities Service shale oil projects on specific segments of the environment (e.g., air, wildlife, ground water resources) are presented, compared, and contrasted in this section. These summaries and comparisons are derived from the detailed impact assessments in Chapter 4.0.

2.4.2 Methodology

Project alternatives were analyzed in consideration of their impacts to appropriate disciplines (i.e., specific segments of the environment). For example, an alternative oil shale retorting technology may not have wildlife impact differences, but usually will have varying air quality impacts. Conversely, an alternative corridor route usually has wildlife implications, but may show negligible impact differences concerning air quality.

Results of the impact assessments for each alternative on a discipline-specific basis were summarized and documented in project files on impact analysis matrix forms, and rated on a numerical scale of +3 to −3. Impact ratings are graduated to tenths, and were determined based upon the diagram shown below.



As an example, one pipeline corridor might rate −1.4 for wildlife, while another might compare at −1.7. Both would be considered to have medium adverse impacts, with one corridor rated slightly more adverse than the other.

It is important to note that these numerical impact ratings are subjective and based on best professional judgement. They are presented here to display the relative impacts between various alternative project components. The numbers presented in each table should not be construed as having any statistical significance.

Because of the complexity of the socioeconomic impacts, the numerical impact rating approach could not be used. Rather, socioeconomic impacts are presented in detail in tables of absolute numbers (e.g., population, employment, income) in Sections 4.2.13 and 4.3.13.

2.4.3 Impact Comparisons

2.4.3.1 Getty

The proposed action for the Getty project for which impact assessment was undertaken includes the following major project components.

- **Underground room-and-pillar mine** (capacity of 150,000 tpd to produce 100,000 bpd of shale oil)
- **Twelve Union B retorts**
- **Four shale oil upgrading modules**
- **Mine bench with mine portals** at the 2 retort sites
- **Associated surface facilities**
- **Disposal of 130,000 tpd spent shale** from the Union B process, including co-disposal of shale fines, in Wiesse Gulch
- **A water supply system** consisting of the GCC Joint Venture (intake on Colorado River, storage reservoir in Roan Creek, and associated facilities), plus pumping plants, pipelines, and regulation reservoirs at the Roan Creek/Clear Creek confluence and in Tom Gulch, with a pipeline to the mesa plant site up Buck Gulch. (Note: The GCC Joint Venture Roan Creek reservoir is addressed in the CCSOP EIS - BLM 1983a.)
- **Purchased power** from off-site sources
- **Tom Gulch road corridor**
- **Buck Gulch water and power corridor**
- **Mesa-top multi-use corridors**
- **Common corridor (with Cities Service);** north from the additional retort site to the La Sal pipeline connection
- **La Sal power and syncrude corridor** (previously addressed in the CCSOP EIS - BLM 1983a)
- **Roan Creek/Clear Creek (Tom Gulch to De Beque) multi-use corridor** (previously addressed in the CCSOP EIS - BLM 1983a)

Alternatives to Getty's proposed action for which impact comparisons are made are as follows:

- Production rate
  - **50,000 bpd** (only one plant site to be developed)
- Retort technology
  - **Lurgi**
- Spent shale disposal sites
  - **Tom Gulch**
  - **Buck Gulch/Doe Gulch**
  - **Underground mine/Buck and Doe Gulch combination**
- Spent shale disposal type
  - **Lurgi**

- Shale fines
  - Processing on-site

- Corridors
  - **Rangely product pipeline** (addressed in the CCSOP EIS - BLM 1983a)
  - **Big Salt Wash transmission line** (addressed in the CCSOP EIS - BLM 1983a)

- Power generation
  - **Cogeneration** on-site

- Water supply
  - **West Fork Parachute Creek Reservoir,** pumping plant, and pipeline added to proposed action to provide supplementary water to additional retort site

Maps and detailed discussions of the above proposed action and alternative components are given in Section 2.3.1.

2.4.3.1.1 Production Rate. As noted above, one Getty alternative is to produce shale oil at the rate of 50,000 bpd. It is assumed that approximately 75,000 tpd of oil shale would be mined, with spent shale disposal at the rate of 65,000 tpd. Mine life would be approximately doubled (to 60 years) with total mining and disposal volumes approximately the same over a longer period.

Appropriate impact comparisons by discipline are shown in Table 2.4-1, with brief written explanations given below.

Topography. The proposed 100,000-bpd production rate would result in a greater adverse impact to topography than the alternative production rate of 50,000 bpd, due to the construction of an additional retort and upgrading facility. The reduced production rate (50,000 bpd) would result in the reduction of the area to be disturbed.

Geology. No significant differences in the potential impacts to geological resources are expected as a result of the proposed or alternative actions. Both production rates and associated underground mines could result in the subsidence of the land surface, and both would utilize the same eventual volume of oil shale resource.

Paleontology. The 50,000-bpd alternative would reduce the proportion of the project area to be disturbed. This reduction in the proportion of disturbed area would result in reduced potential impacts to paleontological resources in the project area.

Surface Water. Compared to the 100,000-bpd production rate, production at 50,000 bpd would produce smaller amounts of spent shale on a daily basis. Surface water disturbances over the short-term would, therefore, be less for 50,000 bpd than the proposed action due to the reduction in the spent shale. Therefore, the 50,000-bpd production rate would have less adverse impacts on the surface water system.

Ground Water. Impacts to ground water would include potential dewatering of bedrock aquifers and discharge of mine inflows to the hydrologic system. Neither of these impacts are anticipated to be significant due to the fact that large mine inflows are not expected; data suggest that the mining interval may not be connected to overlying water-bearing strata. Prudent operation of a discharge handling system should mitigate potential impacts associated with encountered inflows. Impacts associated with the 50,000-bpd alternative would be similar, but on a reduced scale.

Table 2.4-1 IMPACT COMPARISONS FOR PRODUCTION RATE ALTERNATIVES, GETTY SHALE OIL PROJECT

Discipline[a]	100,000 bpd (Proposed Action)	50,000 bpd (Alternative)
Topography	−0.3	−0.1
Geology	−0.3	−0.3
Paleontology	−0.3	−0.1
Surface Water	−1.0	−0.0
Ground Water	−0.8	−0.4
Soils	−1.3	−1.2
Aquatic Ecology	−0.1	−0.1
Vegetation	−2.2	−2.0
Wildlife	−1.6	−1.5
Air Quality	−2.0	−1.2
Noise	−0.6	−0.5
Cultural Resources	−0.5	−0.3
Land Use	−1.2	−1.0
Recreation	−1.0	−0.7
Wilderness	−1.0	−0.8
Visual Resources	−1.2	−1.0
Socioeconomics[b]	--	--
Transportation	−1.7	−1.1
Energy	+2.0	+1.7

[a] Only pertinent disciplines for impact assessment are shown.
[b] Socioeconomic impacts are not rated numerically. See the socioeconomics discussion within this section.

Soils. The moderate adverse soils impacts resulting from the 100,000-bpd production rate are slightly greater than the 50,000-bpd rate. This is largely a result of the surface disturbance for the proposed action being larger than the alternative: 6,333 versus 6,097 acres (assuming the additional retorts and mine portals are the only difference). Incremental soil losses (the difference in soil loss between undisturbed and disturbed land conditions over a 30-year project life) for the 100,000- and 50,000-bpd production rates would be 234,040 tons and 223,490 tons, respectively. Prime farmland loss for both production rates would be the same (1,324 acres). Incremental soil loss would be 49 and 48 percent greater than naturally occurring soil in the proposed action and alternative, respectively.

Aquatic Ecology. The development of the Getty project and production at 100,000 bpd would have a slight negative impact on aquatic ecology. (The impact rating does not include impacts previously addressed in the CCSOP EIS, including development of the GCC Joint Venture Roan Creek reservoir and water withdrawal from the Colorado River.) There would be a loss of intermittent stream reaches due to physical covering, a risk of introduction of toxic substances to the surface water from the shale stockpile and accidental spillage along the corridors, and possible pipeline breakages. The proposed reservoirs, however, would offset some of these negative impacts by providing a net increase in aquatic habitat. The ratings for the 100,000-bpd and 50,000-bpd alternatives are based on the same water withdrawal and storage facilities. All other facility sitings are the same regardless of production rate. Therefore, there would be no difference between the proposed and alternative production rates.

Vegetation. The 100,000-bpd project would have slightly higher adverse impacts (both are high adverse) on vegetation than the 50,000-bpd alternative. This is due primarily to increased acreages that would be affected by the additional retort facilities and larger spent shale pile necessary for the 100,000-bpd alternative. Indirect impacts to vegetation resulting from increased urbanization would be similar among alternatives. Impacts on special interest plants (threatened or candidate plant species) would be similar for both production alternatives. These impacts would result from direct disturbance to known plant populations or their habitat. These disturbance areas would occur on private land owned by the Operator.

Wildlife. The types of wildlife impacts associated with each of the production rate alternatives are expected to be similar (i.e., there would be loss or disturbance of wildlife habitats and individuals in the affected areas). However, in comparison with the proposed action, approximately 230 fewer acres of habitats on the plateau would be affected under the 50,000-bpd alternative. This difference in acreage is attributed to the elimination of the additional retort site. No difference in anticipated impacts to sensitive wildlife habitats is expected. The medium adverse indirect impacts of the production alternatives to wildlife are also expected to be similar.

Air Quality/Meteorology. See the discussion of the various alternatives under Retort Technology, Section 2.4.3.1.2.

Noise. The variation between Getty's production rate alternatives regarding noise levels would be minimal. The full production alternatives would have the most adverse impacts, but these are only slightly higher than the reduced production alternatives. Transportation alternatives noise impacts would vary insignificantly between production alternatives.

Cultural Resources. Potential impacts on cultural resources (given the existing federal and state cultural resource regulations) would be insignificant. Surface disturbances related to the construction of the 100,000-bpd action would be relatively greater (in a low adverse context) than the 50,000 bpd alternative. Areas previously unsurveyed will be subject to study. Actual determination of impacts and mitigation measures will be developed acording to agency requirements.

Land Use. Construction and operation of the mine, retorts, and ancillary facilities would significantly impact existing land uses on the site and have significant secondary effects on land uses off-site. Lands which are now utilized as agricultural land or rangeland would become predominately industrial, commercial, and residential. Direct impacts are slightly higher (relatively) in an adverse sense for the 100,000-bpd alternative than for the 50,000-bpd alternative, due to slightly more total disturbance to rangeland for the proposed action.

Recreation. Indirect and adverse impacts to recreational facilities and opportunities in the region could occur due to an increase in human population during the construction phase of the project. Slightly beneficial impacts could be expected during the operational and residual phases, because new recreational facilities would be built during construction, providing more facilities during operation and post-operation phases for the reduced number of workers.

Wilderness. Low adverse impacts to wilderness could occur due to increased demand for wilderness use. Impacts could be relatively higher (yet still low adverse) during the construction phase of the 100,000-bpd project, when more workers would be involved.

Visual Resources. Due to the reduced size of facilities required for a 50,000 bpd alternative, a 50,000 bpd alternative would have less visual impacts than a 100,000 bpd alternative. However, since a 50,000 bpd alternative would require many of the same types of surface facilities and corridors, overall impacts for both alternatives would remain low to medium adverse.

Socioeconomics. The 100,000 bpd production rate has two distinct 5-year construction cycles, peaking at 5,000 construction workers in 1991 and again in 1995. Once the second cycle is complete, long-term operations employment stabilizes at 2,900. The 50,000 bpd alternative would duplicate the first construction cycle described above, but operations employment would then stabilize at 1,600 workers and there would be no further construction. Thus, the peak impact of the two production scenarios which occur during construction are very similar, except that they are repeated in the 100,000-bpd scenario. In the long-term, however, because most of the socioeconomic impacts are proportioned to employment, the impacts of a 50,000-bpd production level would only be about one-half the impact of the 100,000-bpd scenario.

Transportation. Transportation impacts throughout the construction, operations, and residual phases would be greater for the 100,000-bpd production rate than for the 50,000-bpd alternative, due to the greater need for worker, material, and product transport. At the 100,000-bpd production rate, greatest adverse impacts would occur to the roadway systems. Depending on the timing of the proposed project's construction, traffic slowdowns could occur on roadways within the area. Airports and railroads could experience minor adverse impacts from the 50,000- and 100,000-bpd production rates. Overall pipeline capacity would be increased under both alternatives, thereby creating a low beneficial impact following project shutdown.

Energy. Energy use during construction would constitute a low adverse impact. During project operation, however, a moderate net beneficial impact would result due to the production of shale oil. The 100,000-bpd production rate would, on the basis of output/input ratio, have a slightly greater beneficial impact.

2.4.3.1.2 Retort Technology. This alternative would employ the Lurgi technology (as previously described in Section 2.3.1) instead of the Union B retorts for surface retorting of the oil shale at 100,000 bpd. Appropriate impact comparisons by discipline are shown in Table 2.4-2, with brief written explanations given below.

Surface Water. The alternative Lurgi retort would process finer raw shale and, therefore, generate smaller particle size spent shale material compared to the proposed Union retort technology. Surface water impacts would be relatively greater using Lurgi retort due to (1) higher water consumption for spent shale moistening, and (2) more sour water generation.

Ground Water. Impacts could occur to ground water from the production of retort waste water and spent shale. Disposal of these by-products could result in the generation of leachate containing organic and inorganic components. Additionally, the Union B process cannot process raw shale fines, necessitating their disposal with the retort by-products (spent shale). Utilization of the Lurgi retorts would allow processing of the fines, negating disposal-related impacts. However, design and installation of the drainage system is necessary to restrict runoff waters from contacting/saturating any temporary storage piles for the Lurgi technology.

Air Quality. The full production Lurgi alternative is predicted to have the highest (relative adverse) impact rating due to TSP and NO_2 impacts, estimated at 80 and 76 percent of the national standard. The proposed action is slightly less adverse, because the highest air quality impact predicted is 73 percent of the NO_2 standard. Also, the SO_2 PSD Class I increment in Flat Tops wilderness is predicted to be 80 percent consumed. Modeling indicates that the proposed action is predicted to double the allowable PSD Class II increment for 24-hr TSP in a small area near the property line. The 50,00-bpd Lurgi alternative has less impact then the above two alternatives because the TSP impacts are predicted to be 60 percent of the 24-hr TSP national ambient standard. This alternative consumes the TSP 24-hr Class II increment by more than one and one-half times. The impact rating for the 50,000-bpd Union B alternative is most favorable of the process technology alternatives. Predicted TSP annual 24-hr concentrations are only 36 and 37 percent of the national ambient standards.

Noise. The variation between Getty process technologies concerning noise impacts would be minimal. Transportation alternative noise impacts would also vary insignificantly between process technologies.

Energy. The energy impacts of the proposed Union B and alternative Lurgi surface retort technologies would be moderately beneficial. The processing of the oil shale would require consumption of energy, but the shale oil produced would more than offset the energy consumption. There is a difference in energy efficiencies between the Union B and Lurgi retorting technologies. The Lurgi technology utilizes raw shale fines and the carbon on the spent shale is burned to produce energy. Therefore, the Lurgi technology is rated as being more beneficial to the overall energy balance.

2.4.3.1.3 Spent Shale Disposal Sites. As alternatives to the Weisse Gulch disposal site (proposed action), Getty would dispose of spent shale in either (1) Tom Gulch, (2) Buck/Doe gulches, or (3) underground in the mine and in Buck/Doe gulches. The Tom Gulch alternative would not allow for a regulation reservoir in Tom Gulch, as shown for the proposed action under water supply for Getty (see Section 2.4.3.1.6). Impact comparisons for the spent shale sites (proposed action and alternatives) are described below and presented in Table 2.4-3.

Table 2.4-2 IMPACT COMPARISONS FOR RETORT TECHNOLOGY ALTERNATIVES, GETTY SHALE OIL PROJECT

Discipline[a]	Union B (Proposed Action)	Lurgi (Alternative)
Surface Water	−0.3	−0.5
Ground Water	−0.8	−0.6
Air Quality	−2.0 (−1.2)[b]	−2.2 (−1.9)[b]
Noise	−0.6 (−0.5)[b]	−0.6 (−0.5)[b]
Energy	+1.2	+1.4

[a] Only pertinent disciplines for impact assessment are shown.
[b] Ratings in parentheses refer to the 50,000 bpd alternative.

Table 2.4-3 IMPACT COMPARISONS FOR SPENT SHALE DISPOSAL SITE ALTERNATIVES, GETTY SHALE OIL PROJECT

Discipline[a]	Weisse Gulch (Proposed Action)	Tom Gulch (Alternative)	Buck/Doe Gulches (Alternative)	Underground/ Buck-Doe Combination (Alternative)
Topography	−0.5	−0.8	−0.8	−0.3
Geology	−0.3	−0.5	−0.5	−0.1
Paleontology	−0.2	−0.2	−0.2	−0.1
Surface Water	−1.0	−1.5	−1.7	−0.7
Ground Water	−1.5	−2.0	−2.0	−1.0
Aquatic Ecology	−0.3	−0.3	−0.3	−0.2
Soils	−0.1	−0.2	−0.3	−0.3
Vegetation	−1.5	−1.3[b]	−1.3[b]	−1.3
Wildlife	−1.0	−2.5	−2.5	−2.5
Air Quality	−1.5	−0.9	−0.9	−0.9
Noise	−0.3	−0.3	−0.4	−0.3
Cultural Resources	−0.5	−0.2	−0.1	−0.3
Land Use	−1.0	−1.0	−0.8	−0.5
Visual Resources	−1.1	−1.5	−1.5	−1.0
Transportation	−0.1	−0.2	−0.2	−0.1
Energy	−0.2	−0.3	−0.3	−0.4

[a] Only pertinent disciplines for impact assessment are shown.
[b] Impact ratings shown individually are based on the combined analyses by the USFWS. The combination of Tom Gulch and Buck/Doe Gulches is treated in Tables 4.2-5 and 4.3-5.

Topography. The proposed action of placing spent shale in Wiesse Gulch, located on the plateau, would have relatively less adverse impacts on topography than the alternative sites of Tom, Buck, and Doe gulches. The alternative with the least topographic impacts would be the combined disposal of spent shale underground and in Wiesse Gulch, since it would decrease the volume of material to be placed on the surface.

Geology. The principal impact on geological resources as a result of the disposal of spent shale on the surface is the potential for geologic hazards. The disposal of spent shale at the surface could result in its exposure to weathering and erosional processes. Proper construction, maintenance, and reclamation would be required to limit the instability of the piles. Disposal in flatter areas would have fewer adverse impacts (all are low adverse) than steep slopes.

Paleontology. The disposal of spent shale on the surface could bury potential paleontological resources and limit access to collection sites. The combined surface/underground mine disposal of spent shale would have the least impact to paleontological resources, since the potential for sites to be buried would be slightly less due to reduced volumes.

Surface Water. The alternative spent shale disposal site in Buck and Doe gulches would have the greatest relative surface water impacts (medium adverse) compared to surface/underground mine combination and proposed action (Wiesse Gulch) disposal due to the proximity of Buck and Doe gulches to the Clear Creek drainage. Disposal of approximately one-half of the spent shale in the underground mine would have the least relative impacts due to reduction of surface area disturbance. The alternative disposal site in Tom Creek would have greater impacts than the proposed Wiesse Gulch disposal.

Ground Water. Impacts of spent shale disposal could be the most critical effects to ground water from the proposed development. Most important is the potential degradation of ground water resources due to leachate migration. The magnitude of such potential impacts is dependent upon the effectiveness of the disposal area liner system for prevention of leachate migration, and the proximity of the disposal area to important sources of ground water. The proposed Wiesse Gulch site provides the best (i.e., topographically, the flattest) site for liner construction and is also the furthest from alluvial aquifers. The Tom Gulch and Buck/Doe gulch areas, however, are typified by steep valley sides which would create difficult liner construction conditions, and are situated adjacent to the Clear Creek alluvial aquifer. As such, they pose a higher relative potential for ground water contamination. The combined underground/surface disposal would potentially result in the fewest ground water impacts because underground dipsosal presents the least opportunity for leachate migration to either alluvial or bedrock aquifers.

Aquatic Ecology. The proposed and alternative spent shale disposal sites would be located in intermittent tributaries of Clear Creek. The construction and operational impacts would be low adverse for all actions. The potential impacts include elimination of intermittent drainages, increased sedimentation in Clear Creek, and addition of toxic substances to Clear Creek via spent shale leachates. The surface/underground mine combination, which would have less surface disposal volume, would involve slightly less adverse impacts.

Soils. All four spent shale disposal scenarios would have low adverse impacts. The proposed action (Wiesse Gulch) is estimated to have the least, and Buck/Doe gulches and underground/Buck-Doe gulch combination the greatest relative impacts. There would be no prime farmland losses in any localities and calculated incremental soil losses are (−) 1,210, 16,070, 29,500, and 29,500 for Wiesse Gulch, Tom Gulch, Buck/Doe gulches, and underground/Buck-Doe gulches, respectively. Assuming reclamation goals would be achieved, these range from a 29 percent decrease to a 112 percent increase over naturally occuring soil loss for the least adverse and most adverse scenarios, respectively. These impact ratings do not reflect the eventual soil erosion rates which would occur when topsoil is eroded away, which could be 5 to 10 times the disturbed erosion rates shown previously (Table 4.2-1).

Vegetation. All alternative spent shale disposal sites would have medium adverse impacts on vegetation. In terms of affected acreage, disposal of spent shale in Wiesse Gulch would have the greatest adverse impact on vegetation. However, Wiesse Gulch disposal would affect fewer plant populations of special interest than disposal in Tom Creek canyon, Buck Gulch, or Doe Gulch.

Wildlife. Of the disposal alternatives considered, the Wiesse Creek Gulch disposal area would have the lowest adverse impact to wildlife. The disposal of spent shale in Tom, Buck, and Doe gulches would have high adverse impacts because of the expected loss of not only elk winter range, winter concentration area, and critical habitat, but also observed nest sites for Cooper's hawk, red-tailed hawk, and golden eagle. The impacts of combined surface/underground mine disposal are expected to be similar in nature, but reduced in extent (Tom Gulch would not be affected) compared with impacts which could occur under the Tom/Buck/Doe gulch disposal alternative. Because of the types of wildlife features affected by the Tom/Buck/Doe gulch alternative and the combination underground mine/surface disposal alternative, both were considered to have equally significant adverse impacts to wildlife.

Air Quality. Impact analyses for spent shale alternatives involved previous modeling and professional judgment. The air quality impact differences among the alternatives are minor when compared to the maximum concentrations from the retorting and upgrading processes. Wiesse Gulch rates higher relative (medium) adverse impacts than the alternative disposal sites.

Noise. Daily minor changes to the acoustic environment would result from the spent shale alternatives for the Getty project. Use of Doe or Buck Gulch, however, could result in elevated noise levels at sensitive receptors in the Clear Creek canyon.

Cultural Resources. Potential impacts on cultural resources (given the existing federal and state cultural resource regulations) would be insignificant. Given the areal extent and diverse topography of the Wiesse Creek gulch area, there is a relatively higher potential to impact cultural resources here than with any of the alternative areas. The underground alternative would certainly lessen the potential for impacts in the Wiesse Creek area, while the Tom gulch alternative and Buck/Doe alternatives are rated as having even less potential for impact due to the presence of steep-walled canyons. Areas previously unsurveyed will be subject to study. Actual determination of impacts and mitigation measures will be developed according to agency requirements.

Land Use. Low to medium adverse impacts to land use would occur from construction of all spent shale disposal alternatives. Rangeland would be also lost as a result of all alternatives. The Wiesse Gulch spent shale pile would affect the greatest amount of rangeland among all alternatives. The Tom Gulch canyon disposal site would be the only alternative to affect agricultural land.

Visual Resources. Disposal of spent shale in Wiesse Creek gulch would have less relative adverse impacts than disposal in either Tom Gulch or Buck/Doe gulches. The Wiesse Creek site is on the plateau and in an area of moderate scenic quality. Disposal of spent shale in either of the gulches would impact areas of high scenic quality. Return of some spent shale to the underground mine would reduce overall visual impacts as compared to all surface disposal. Since some disposal would be required on the surface, adverse impacts would remain for all alternatives until final reclamation, however.

Transportation. Spent shale disposal at any of the alternative sites would have minimal impacts to the transportation system, since conveyors and/or haul roads would be used. A very low adverse impact was assessed for spent shale disposal since some ancillary transportation (e.g., materials or equipment) could be needed to support the shale disposal process.

Energy. Disposal of spent shale in either the Wiesse Creek (proposed action) or alternate shale disposal sites would result in minimal energy consumption because of the proximity of the retorts. Use of underground disposal (in conjunction with surface disposal) may result in slightly higher relative adverse impacts, due to the dual nature of the disposal areas.

2.4.3.1.4 Spent Shale Disposal Types. Some impact differences would also occur as a result of the type of spent shale disposed whether it be from the Union B or Lurgi retort technology. Each has some different characteristics, as explained below by pertinent discipline and shown in Table 2.4-4. It is assumed that the spent shale types are disposed in identical sites.

Geology. The type of spent shale produced by the proposed (Union B) and alternative (Lurgi) retort could impact existing site geology as a geologic hazard. The spent shale particles produced by Lurgi retorting are known to cement together more easily when compared to the spent shale produced by the Union B retorts. The increased potential for cementation of the Lurgi-produced particles should increase the stability of the spent shale fines and reduce erosion of the pile by sheet waste.

Surface Water. The alternative Lurgi retort process would generate smaller particle size spent shale material, compared to the Union B retort technology. Surface water impacts would be relatively greater using Lurgi, due to (1) higher water consumption for spent shale moistening, and (2) more sour water generation.

Table 2.4-4 IMPACT COMPARISONS FOR SPENT SHALE DISPOSAL TYPE ALTERNATIVES, GETTY SHALE OIL PROJECT

Discipline[a]	Union B Retorted Spent Shale (Proposed Action)	Lurgi Retorted Spent Shale (Alternative)
Geology	−1.5	−1.0
Surface Water	−0.3	−0.5
Ground Water	−1.8	−1.5
Soils	NA[b]	NA[b]
Air Quality	−1.5	−1.4

[a] Only pertinent disciplines for impact comparisons are shown.
[b] See soils note in text for justification of non-applicability.

Ground Water. Disposal of spent shale generated by the Lurgi process could result in less ground water impacts than would be associated with Union B retorts. Reduced impacts could occur if the disposal pile were to become cemented or solidified upon application of moisture as existing data indicate (Bates 1983). This phenomenom could be enhanced due to the fine particle size of retorted shale associated with the Lurgi process when compared to the Union B process. If additional structural stability is achieved by this cementing, the potential for erosion and concomitant leachate generation would be reduced.

Soils. The impacts resulting from disposal of either type of spent shale are the same because the type of spent shale deposited would not affect the soil resource. The impacts result from the spent shale disposal sites rather than from the type of spent shale deposited. If water erosion occurs from the spent shale pile prior to overburden and topsoil replacement, spent shale would be lost, not soil. It is expected that the sedimentation basin would capture this eroded spent shale. Upon completing overburden and topsoil replacement activities on the spent shale piles, water and wind erosion would undoubtedly occur. Whether the pile is Lurgi or Union B spent shale beneath the topsoil it would not affect the topsoil topsoil erosion rate.

Air Quality. The air quality impacts were analyzed with different process stack emission rates but no differences in spent shale disposal emission rates between Union B and Lurgi retorting alternatives. However, the spent shale emission for Lurgi would be less due to the propensity of this Lurgi material to solidify. Both spent shale alternatives rate a medium adverse impact.

2.4.3.1.5 Shale Fines. The oil shale fines (pieces less than 1/8-in. in diameter after crushing) could be disposed of with the spent shale (proposed action) or, as an alternative, stockpiled and processed on-site for additional shale oil extraction. The impacts of these two options are compared below and in Table 2.4-5 for appropriate disciplines.

Surface Water. Low to medium adverse impacts to surface water would be associated with each alternative. On-site disposal could cause surface runoff and erosion from the stockpile, and migration of leachate to surface drainages. Retorting on-site would have slightly higher relative adverse impacts since some stockpiling is assumed and processed shale fines could contain residues of reagents from retorting which could contaminate surface water.

Ground Water. Low adverse ground water impacts are anticipated from either scheme for raw shale fines. The proposed disposal of fines with the spent shale would allow for longer term exposure to drainage waters, whereas processing in the alternative Lurgi retort, with continual accumulation/removal, would decrease this exposure time. Conversely, disposal with the spent shale would allow for timely reclamation by revegetation, thereby decreasing the opportunity for infiltration of precipitation. In either case, design and operation of proper handling and drainage control plans can reduce any hydrologic impacts.

Table 2.4-5 IMPACT COMPARISONS FOR SHALE FINES ALTERNATIVES, GETTY SHALE OIL PROJECT

Discipline[a]	On-site Disposal with Spent Shale (Proposed Action)	Processed On-site (Alternative)
Surface Water	−0.5	−1.0
Ground Water	−0.8	−0.7
Air Quality	−1.5	−1.6
Visual Resources	−0.9	−0.7
Energy	−0.3	+0.3

[a] Only pertinent disciplines for impact comparisons are shown.

Air Quality. Shale fines processig as opposed to disposal with the spent shale would probably have similar TSP impacts. Air quality impacts would be slightly increased by screening, crushing, and processing of the fines.

Visual Resources. Disposal of shale fines would have an adverse visual impact until processing and/or reclamation of the spent shale/shale fines area. Processing without storage would eliminate the storage area impact; an additional impact would occur, however, due to the need for additional process facilities.

Energy. Disposal of shale fines on-site (proposed action) would result in low adverse impacts because of the energy consumed in the transport of shale fines and the energy lost by non-recovery of the shale oil within these fines. Conversely, the alternative of retorting these fines would have a net low beneficial impact, due to the recovery of the additional shale oil.

2.4.3.1.6 Corridors. Alternatives to the La Sal corridor (proposed action) for product pipelines and transmission lines include (1) Rangely and (2) Big Salt Wash. All three alignments and their impacts have been previously addressed in the CCSOP EIS (BLM 1983a). Rangely B and Big Salt Wash (Echo Lake) are assumed for purposes here, and the numerical impact analyses from the CCSOP EIS are reprinted in Table 2.4-6. Summaries of the CCSOP EIS impact comparison discussions are presented below. The Roan Creek multi-use corridor was previously addressed in detail in the CCSOP EIS and is not reassessed here.

Topography. The potential impacts to topography by the proposed action (La Sal) and the alternatives (Rangely and Bid Salt Wash) are not significantly different. Surficial disturbances caused by construction of the pipeline could be reduced with proper reclamation.

Geology. No significant impacts are anticipated for any of the alternatives. Longer alignments (Big Salt Wash) and their stream crossings, with potential impacts on sand and gravel resources, would have slightly higher relative adverse impacts.

Paleontology. Excavations associated with the construction of the pipeline could destroy potential paleontological resources. There is little significant difference in the magnitude of potential impacts between the proposed and alternative actions with the differences dependent on alignment (potential resource areas crossed) and length. Impacts to paleontological resources could be reduced as a result of the development and implementation of a mitigation program.

Surface Water. The alternative Rangely syncrude pipeline corridor would have similar, but slightly higher relative surface water impacts compared to the proposed La Sal pipeline corridor. Impacts for the Rangely corridor would occur on the White River system, while the proposed La Sal corridor would have impacts on Roan Creek and Parachute Creek drainage systems. Big Salt Wash (in that drainage primarily) would have slighty higher relative adverse impacts (of medium magnitude) because of length and drainages crossed.

Table 2.4-6 IMPACT COMPARISONS FOR CORRIDOR ALTERNATIVES, GETTY SHALE OIL PROJECT

Discipline[a]	La Sal[b] (Proposed Action)	Rangely B[b] (Alternative)	Big Salt Wash[b] (Alternative)
Topography	−0.5	−0.5	−0.5
Geology	−0.2	−0.2	−0.8
Paleontology	−0.5	−1.1	−1.0
Surface Water	−0.8	−1.1	−1.5
Ground Water	−0.5	−0.5	−0.6
Aquatic Ecology	−0.8	−1.1	−1.5
Soils	−0.1	−0.1	−0.8
Vegetation	−0.8	−1.1	−1.0
Wildlife	−0.8	−1.0	−1.5
Cultural Resources	−0.2	−0.5	−0.3
Land Use	−0.3	−1.1	−0.2
Recreation	+1.0	+1.0	+1.2
Visual Resources	−0.5	−0.7	−0.7
Transportation	+0.8	+0.9	+0.6
Energy	−0.5	−0.6	−0.6

[a] Only pertinent disciplines for impact assessment are shown.
[b] Source of impact ratings is CCSOP EIS (BLM 1983a).

Ground Water. Impacts to ground water resulting from any of the alternative corridor construction activities are expected to be minor and limited to potential localized and temporary increases in dissolved solids associated with construction activities. Accidental spills of fuel or other contaminants may also occur during the construction phase. Adverse ground water impacts would be slightly greater for the Big Salt Wash corridor than for the others given the length of the former.

Aquatic Ecology. Potential impacts to aquatic ecology would be related to sedimentation during construction and water quality changes resulting from pipeline breaks or leaks. Impacts for all routes were considered low to medium adverse. Impacts would be directly related to pipeline length and proximity to surface waters. The Big Salt Wash corridor would have the highest (medium adverse) impacts of the corridors from the Getty site. Rangely B and La Sal would have slightly less adverse impacts.

Soils. It is expected that low adverse soils impacts would occur due to development of the Big Salt Wash alternative, and lower relative impacts in the other two corridors. Mainly because the disturbance area of the Big Salt Wash corridor is the largest, so too the soil loss is expected to be the greatest; about 78,000 tons versus 10,700 and 11,500 tons in the Rangely and La Sal corridors, respectively. Furthermore, the Big Salt Wash corridor would cause a loss of prime farmland (approximately 20 acres) while use of the others would not.

Vegetation. Construction of corridors would generally result in low to meduim adverse impacts to vegetation and special interest plant species. Impacts to vegetation would depend on the length and revegetation potential of the proposed corridors. Impacts resulting from the La Sal and Rangely B corridors are addressed in the CCSOP EIS (BLM 1983a). These impacts would be low to medium adverse due to affected agricultural productivity and unavoidable impacts to special interest plants. The impacts of the Big Salt Wash corridor are not significant and are also rated low to medium adverse.

Wildlife. Wildlife would be affected by both short- and long-term impacts to habitats associated with construction and operation of the corridors. The degree of impact would be directly related to the length of the corridor. The La Sal pipeline would have the lowest relative impact to wildlife and the Big Salt Wash the highest. In general, the three pipeline corridors would have low to medium adverse wildlife impacts (BLM 1983a).

Cultural Resources. Potential impacts of corridors on cultural resources (given the existing federal and state cultural resources regulations) would be insignificant. La Sal and Big Salt Wash alternatives especially are considered to have an insignificant impact on cultural resources. Rangely B is rated slightly higher adverse impacts, due to greater potential for inadvertent disturbance. Areas previously unsurveyed will be subject to study. Actual determination of impacts and mitigation measures will be developed according to agency requirements.

Land Use. Low adverse effects on land use can be expected from constructon of the alternative corridors, except Rangely B. A small amount of rangeland would be lost for all alignments except for Rangely B, which would affect greater amounts of rangeland along its alignment and is rated medium adverse.

Recreation. Beneficial impacts on recreation would probably occur due to development of corridors. Lands which are currently unavailable for recreational use would be opened for possible off-road vehicle use and hunting. Access would probably be controlled during the life of the project so such recreational use would most likely follow project abandondment.

Visual Resources. Use of either the Big Salt Wash or Rangely B corridor instead of La Sal would have a greater visual impact due to their greater lengths.

Transportation. Transportation impacts would be low, yet beneficial, because of either (1) improvements to the existing pipeline system, (2) transmission line system, or (3) construction of new systems available for further transport needs. The relative beneficial impacts were assessed based upon the length and potential availability of the networks to future users. As such, the Rangely alternative would have slightly greater relative beneficial impacts of the three alternatives analyzed.

Energy. Energy impacts would be directly related to length and are, therefore, proportional to energy use. Longer corridors would result in higher adverse impacts due to the increased need for pumping. Impacts of product pipelines are all rated as low adverse impacts. The La Sal pipeline, because of its relatively shorter length, would have slightly lower adverse impacts when compared to the Rangely or Big Salt Wash alternatives.

2.4.3.1.7 Power Generation. An alternative to purchase of power from off-site sources is cogeneration of power on-site. Impact comparisons for pertinent disciplines concerning cogeneration versus off-site purchase of power are given below and in Table 2.4-7. In general, cogeneration of power would cause more site-specific environmental impacts.

Surface Water. The cogeneration of power would introduce additional surface watershed disturbance and water consumption. Surface water impacts would be slightly adverse compared to the proposed action (which has essentially no on-site impacts).

Air Quality. With cogeneration added to the project alternatives, the 24-hour TSP concentrations are predicted to consume or exceed the PSD Class II increment for the 100,000-bpd Union B and the 100,000- and 50,000-bpd Lurgi alternatives. The total concentration, when added to the background values, result in 50, 91, and 66 percent of the NAAQS of the respective alternatives. No other consumption or exceedance of the PSD increments or NAAQS occur. All SO_2 and TSP concentrations for the regulated averaging times in the Class I and Category I sensitive receptors are less than 1 $\mu g/m^3$. A Level I screening analysis of cogeneration with the proposed action indicates a dark plume against a bright sky caused by NO_x would be visible out to 40 miles from the facilities and a light plume against dark terrain caused by TSP would be visible out to 48 miles from the facility. This analysis indicates a potential for visibility degradation in Flat Top Wilderness and Colorado National Monument.

Noise. Cogeneration would add only slightly to the process facilities adverse noise impacts. The additional noise from cogeneration could be masked by the other facilities.

Table 2.4-7 IMPACT COMPARISONS FOR POWER GENERATION ALTERNATIVES, GETTY SHALE OIL PROJECT

Discipline[a]	Purchase Off-Site (Proposed Action)	Cogeneration On-Site (Alternative)
Surface Water	-0-	−0.5
Air Quality	-0-	−0.1[b]
Noise	-0-	−0.2
Visual Resources	-0-	−0.5
Energy	−0.8	+0.6

[a] Only pertinent disciplines for impact assessment are shown.
[b] Only minor adverse impacts to air quality would result if cogeneration were added to any alternatives.

Visual Resources. The visual impacts of purchasing power would relate to the transmission line serving the project which would be required regardless if power is generated on-site or not. Power generation on-site (cogeneration) would contribute to the adverse impacts due to the need to expand facilities on site.

Energy. Purchase of power from an outside grid would place additional demands on that grid, and would have an adverse impact. The precise location of the power within the grid and associated environmental impact cannot be precisely determined at this time. Considering that the current power grid appears to be adequate for the anticipated project uses, the impact is rated as low. Cogeneration would be a beneficial impact in that it would create additional power for use within the facility, thereby reducing the demand for imported power.

2.4.3.1.8 Water Supply. The proposed action GCC Joint Venture/Roan Creek-Clear Creek regulation reservoir/Tom Creek reservoir system, with related facilities, could be supplemented (as an alternative) by addition of the West Fork Parachute Creek reservoir, pumping plant, and pipeline, primarily to provide supplementary water to the retort additions site. Comparisons of the proposed action and the addition of this alternative reservoir site, with related facilities, are discussed below and presented in Table 2.4-8.

Topography. Impacts to topography include the inundation of valley bottomlands and topographic disturbance as a result of the construction of the impoundment structures. These impacts are not considered significant in the long-term.

Geology. Impacts to the existing geology result from the construction of impoundment structures. These structures are considered potential geologic hazards. There is no significant difference in the potential impact of either the proposed or alternative actions. Potential hazards could be reduced by the development and implementation of a detailed maintenance and inspection program.

Paleontology. Impacts to paleontological resources include the submersion of existing or potential fossil collecting sites. The alternative action would inundate a greater area, thus the higher relative (yet still low adverse) impact rating.

Surface Water. The alternative water supply system would affect stream flows of West Fork of Parachute Creek, in addition to those impacts for the proposed action water supply system. Both would be rated low adverse impacts.

Ground Water. Little or no ground water impacts would be anticipated for the proposed GCC Colorado River diversion schemes. Increases in downstream salinity resulting from diversion could slightly affect the alluvial ground water quality along the Colorado River as a result of recharge from river water of increased salinity. Depending on the relative quality of local alluvial ground water and the quality of diverted Colorado River water stored in the respective impoundments, there would be slight beneficial or adverse impacts associated with localized recharge to alluvial aquifers at proposed storage reservoirs in the Parachute Creek and Tom Gulch valleys.

Aquatic Ecology. The proposed action would result in increased sedimentation in Roan Creek below the diversion and reservoir during construction, and dewatering of lower Roan Creek during operation. The reservoir would result in a net gain of warm water fishery habitat, however. A reservoir in Tom Creek, an intermittent drainage, would also increase available habitat. The alternative action, which includes the addition of a reservoir in West Fork Parachute Creek, would be a greater beneficial impact than the proposed action since it would probably increase the useable habitat for the already existing brown trout population in that stream. Potential impacts regarding loss of fishery habitat and aquatic biota as a result of dewatering below the proposed West Fork of Parachute Creek reservoir cannot be predicted at this time; however, they are not expected to be significant.

Soils. The moderate adverse soil impacts of the two water supply systems are expected to be the same. Largely because of the slightly smaller disturbance area of the proposed action, its impacts are about 7 percent less in terms of incremental soil loss. Calculated incremental soil loss of the proposed action and alternative are 112,400 and 115,800 tons, respectively. Both would disrupt about 635 acres of prime farmland. Permanent and temporary prime farmland impacts (inundation) would occur in the reservoir areas. Temporary impacts would occur due to pipeline construction.

Vegetation. Aside from the GCC water storage and supply system analyzed previously (BLM 1983a), alternative reservoir sites would have low to medium adverse impacts on vegetation and special interest plant species. The reservoir in Tom Creek canyon could affect populations or habitats of four special interest plant species (see Section 4.2.6.1). The West Fork of Parachute Creek reservoir would affect no known populations or potential habitat for special interest plants.

Table 2.4-8 IMPACT COMPARISONS FOR WATER SUPPLY ALTERNATIVES, GETTY SHALE OIL PROJECT

Discipline[a]	GCC Joint Venture[b] and Two Other Regulation Reservoirs (Proposed Action)	GCC Joint Venture[b] and Three Other Regulation Reservoirs Including West Fork Parachute Creek (Alternative)
Topography	−0.1	−0.2
Geology	−0.3	−0.4
Paleontology	−0.1	−0.2
Surface Water	−0.5	−0.7
Ground Water	-0-	-0-
Aquatic Ecology	+1.0	+1.4
Soils	−1.3	−1.3
Vegetation	−1.0	−1.3
Wildlife	−0.4	−0.6
Cultural Resources	−0.2	−0.2
Land Use	+0.4	+0.5
Visual Resources	−0.7	−0.9

[a] Only pertinent disciplines for impact assessment are shown.

[b] Upper Dry Fork Reservoir impacts have been previously analyzed (BLM 1983a). Impact ratings shown are for additional regulation reservoirs.

Wildlife. The construction and operation of either water supply alternative would have low adverse impact to wildlife. The Tom Creek and Roan Creek reservoirs would inundate about 220 acres of wildlife habitat including winter range, winter concentration areas, and critical habitat for mule deer and elk. Although no known raptor nest locations would be directly lost, construction of the reservoirs would likely cause short-term disturbance to raptors which nest in relative close proximity. The addition of the West Fork of Parachute Creek reservoir to the water supply system would cause further elimination of about 280 acres of habitat, most of which is composed of the aspen and riparian cover types. It is unknown whether or not the reservoir would eliminate or disturb any raptor nests.

Cultural Resources. Potential impacts on cultural resources (given the existing federal and state cultural resource regulations and the previous surveys undertaken, especially in the Roan Creek drainage) would be insignificant. Areas previously unsurveyed will be subject to study. Actual determination of impacts and mitigation measures would be developed according to agency requirements. Mitigation measures would eliminate most if not all, adverse impacts to sites potentially eligible for the National Register of Historic Places.

Land Use. There would be a slight beneficial impact on land use values from development of the alternative reservoir sites. Development of reservoirs could result in opportunities for irrigation, other agricultural uses, or recreation following project decommissioning.

Visual Resources. The proposed action system would have low to medium adverse impacts during construction and operation, followed by low to medium beneficial visual impacts after project shutdown. These are balanced in the ratings shown. The addition of the West Fork of Parachute Creek reservoir would have a greater potential for initial adverse (and later beneficial) impacts due to the added facilities.

2.4.3.1.9 No Action Alternative - Getty. Consideration of the No Action alternative is required in any EIS, in accordance with regulations issued by the Council on Environmental Quality (CEQ 1978), and under the provisions of the National Environmental Policy Act of 1969. Under the No Action Alternative, the construction of the shale oil facility would not take place. No action would occur, due to (1) the denial of the 404 Permit by the Corps, or (2) a decision by Getty not to proceed with the project.

The implications of the No Action alternative are many. These include the following:

- Non-development of the oil shale resource, increasing U.S. dependence on foreign energy.
- Elimination of the economic and social benefits of the project to Colorado's Western Slope.
- Non-use of the water, which would be put to beneficial industrial, commercial, and domestic uses before leaving Colorado if the project were developed.
- No adverse environmental impacts to the immediate area's and region's air, surface and ground water, wildlife, vegetation, soils, and aquatic resources; the social and economic environment; cultural resources, land use, recreation and wilderness values; visual resources and noise; and the area's topography, paleontological, and geological resources.
- No beneficial impacts to the above components of the environment (e.g., beneficial impacts to transportation and land use due to reservoir, road, and pipeline construction for the project).

2.4.3.2 Cities Service

The proposed action for the Cities Service shale oil project for which impact assessment was undertaken includes the following major project components.

- **Underground room and pillar/vertical modified in situ (VMIS) mine** (capacity of 135,000 tpd to produce 100,000 bpd of shale oil; surface retorts to produce 90,000 bpd of shale oil, VMIS retorts to produce 10,000 bpd)
- **Ten Union B retorts**
- **A total of eighteen VMIS retorts** (180 feet square × 280 feet high)
- Four **shale oil upgrading modules**, one at 10,000 bpd and three at 30,000 bpd
- **One mine bench and mine portal**
- **Associated surface facilities, including shale fines storage on-site**
- **Disposal of 115,000 tpd of spent shale** from the Union B retorts in Conn and Cascade canyons
- **A water supply system** consisting of the GCC Joint Venture, with a connecting pipeline to the Cities Service property (GCC system addressed in the CCSOP EIS - BLM 1983a)
- **Purchased power** from off-site sources
- **Conn Creek multi-use corridor**
- **Mesa-top multi-use corridors**
- **Cities Service to Getty property power and transmission corridor** (to near the Getty additional retorts site)
- **Common corridor (with Getty)** north from near the additional Getty retorts site to the La Sal pipeline connection
- **La Sal power and syncrude corridor** (addressed in the CCSOP EIS-BLM 1983a)
- **Roan Creek (De Beque to Conn Creek confluence) multi-use corridor** (addressed in the CCSOP EIS-BLM 1983a)
- **Bus and Truck Transport** of workers and materials from De Beque up the Conn Creek road to the base of the plateau

Alternatives to the Cities Service proposed action for which impact comparisons are made are as follows.

- Production rate
  - **50,000 bpd** (reduced production to 40,000 bpd from room and pillar mine, 10,000 bpd VMIS)
- Retort technology
  - **Lurgi**
- Mine type
  - **All underground room and pillar mine** (no VMIS retorts)

- Shale fines
  - **Processing on-site**

- Spent shale disposal site
  - **Upper Cascade Canyon/plateau combination**

- Spent shale disposal type
  - **Lurgi**

- Corridors
  - **Rangely product pipeline** (addressed in CCSOP EIS-BLM 1983a)
  - **North product pipeline and transmission line** (directly north of Cities property on BLM and private lands to intertie with La Sal)

- Water supply
  - **Larkin Ditch** (existing intake on south side of Colorado River near De Beque, existing ditch, new sedimentation reservoir and pipeline across river to GCC property)

- Power Generation
  - **Cogeneration** of power on-site

- Transport
  - **Rail and truck transport** of workers and materials

Maps and detailed discussions of the above proposed action and alternatives are given in Section 2.3.2.

2.4.3.2.1 Production Rate. As noted above, one Cities Service alternative is to produce shale oil at a rate of 50,000 bpd. Approximately 68,000 tpd of oil shale would be mined, with spent shale disposal of approximately 58,000 tpd. The mine life would be approximately doubled, with ultimate disposal volumes approximately the same as the 100,000-bpd rate. Short-term impacts would be less, and long-term impacts approximately the same. Appropriate impact comparisons by discipline are summarized in Table 2.4-9. Brief written descriptions of impacts follow.

Topography. Impacts to topography include general surficial disturbance as a result of the construction of mine facilities. There are no significant impact differences to topography by utilization of the proposed or alternative action.

Paleontology. There are no significant impact differences to paleontological resources as the result of the proposed or alternative actions. Minor adverse impacts for both alternatives would be experienced as a result of disturbance or covering of potential fossil collection sites.

Surface Water. Compared to the proposed production rate, the 50,000-bpd production rate would produce smaller amounts of waste rock, shale fines, and spent shale on a daily basis. However, the final dimensions of the retorted shale disposal pile would be the same as the proposed action. Surface water disturbances over the short-term would be less for 50,000 bpd than for the proposed action, due to the reduction of storage areas for waste rock, shale fines, and spent shale. Therefore, the 50,000-bpd production rate would have less adverse impacts on the surface water system, over the short-term, but essentially the same as the proposed action over the life of the project.

Ground Water. Impacts associated with ground water for both production rates would include potential dewatering of bedrock aquifers and discharge of mine inflows to the hydrologic system. The magnitude of these impacts would be dependent upon the degree of increased rock fracturing or production of high TDS waters from the VMIS process, an integral component of both actions. Existing data indicate that prudent use of the VMIS process and associated water handling (or treatment if necessary) should keep impacts in the low to medium adverse range, with a slightly lower relative rating for the 50,000-bpd alternative.

Soils. The moderate adverse soil impacts are slightly higher for the 100,000-bpd rate. This is a result of slightly greater surface disturbance for the proposed action than the alternative. The erosion rate (averaged for wind and water) for both scenarios is about 5.88 tons per acre annually, a five-fold increase over naturally occuring erosion losses. About 1,300 acres in prime farmland losses are associated with either of the production rate scenarios.

Aquatic Ecology. The development of the Cities Service project at a production rate of 100,000 bpd would have a low adverse negative impact on aquatic ecology. (The impact rating does not include impacts previously addressed in the CCSOP EIS including development of the GCC Joint Venture Roan Creek reservoir and water withdrawal from the Colorado River.) These impacts include a loss of intermittent stream reaches due to physical covering, a risk of introduction of toxic substances to the surface water from spent shale stockpile and accidental spillage along corridors, and possible pipeline breakages. The ratings for the 100,000-bpd and 50,000-bpd alternatives are based on the same water withdrawal and storage facilities. All other facility sitings are the same regardless of production rate. Therefore, there would be no impact differences between the proposed and alternative production rates.

Vegetation. The proposed action would have slightly higher adverse impacts (both alternatives are rated high adverse) on vegetation resource values than the 50,000-bpd alternative. This is due primarily to the additional acreages that would be affected by the expanded retort facilities necessary for the 100,000 bpd alternative. Indirect impacts to vegetation resulting from increased urbanization (housing and support facilities for project workers) would be similar among alternatives. Impacts on special interest plants (threatened or candidate plant species) would be similar for both alternatives. These impacts would result from direct disturbance to known plant populations or their habitat. These disturbance areas would occur on private land owned by the Operator.

Widlife. The types of impacts associated with each of the production rate alternatives are expected to be similar (i.e., there will be loss or disturbance of wildlife habitats and individuals in the affected areas, as well as significant and adverse effects). Big game ranges, raptor nest sites, and sensitive habitats would all be affected. Fewer acres of wildlife habitat would be disturbed under the 50,000-bpd alternative, since retort facilities would be down-sized and a smaller spent shale pile would be reuqired. The extent of these changes are unknown. Indirect impacts of the production alternatives are expected to be similar. Both alternatives are rated high adverse wildlife impacts.

Air Quality. See the discussion in Section 2.4.3.2.2 (Retort Technology Alternatives).

Noise. The generation of noise for both alternatives would be similar. The full production alternatives would have the most adverse impact, but is only slightly higher than the reduced production alternatives. Transportation alternatives noise impacts would also vary insignificantly between the production rate alternatives.

Cultural Resources. Potential impacts on cultural resources (given the existing federal and state cultural resource regulations) would be insignificant. Surface disturbances related to the construction of the 100,000-bpd action would be relatively greater (in a low adverse sense) than the 50,000-bpd alternative. Areas previously unsurveyed will be subject to study. Actual determination of impacts and mitigation measures will be developed according to agency requirements.

Land Use. Construction and operation of the mine, retorts, and ancillary facilities would significantly impact existing land uses on the site and have significant secondary impacts on land uses off-site. Lands which are now utilized as agricultural land and rangeland would become predominately industrial, commercial, and residential. Direct impacts are slightly higher (relatively) in an adverse sense for the proposed action than for the 50,000-bpd alternative due to slightly more total disturbance to rangeland for the proposed action.

Recreation. Indirect and adverse impacts to recreational facilities and opportunities would occur due to an increase in human population during the construction phase of the project. Slightly beneficial impacts could be expected during the operational and residual phases, because new recreational facilities would be built during construction, providing more recreational facilities during operation and post-operation phases for the reduced number of workers.

Table 2.4-9 IMPACT COMPARISONS FOR PRODUCTION RATE ALTERNATIVES, CITIES SERVICE SHALE OIL PROJECT

Discipline[a]	100,000 bpd (Proposed Action)	50,000 bpd (Alternative)
Topography	−0.3	−0.3
Paleontology	−0.3	−0.3
Surface Water	−1.0	−0.8
Ground Water	−1.2	−1.0
Soils	−1.4	−1.3
Aquatic Ecology	−0.3	−0.3
Vegetation	−2.2	−2.0
Wildlife	−2.5	−2.5
Air Quality	−2.3	−1.7
Noise	−0.6	−0.5
Cultural Resources	−0.3	−0.2
Land Use	−2.0	−1.5
Recreation	−1.0	−0.7
Wilderness	−1.0	−0.8
Visual Resources	−1.2	−1.0
Socioeconomics[b]	--	--
Transportation	−1.2	−0.9
Energy	+2.0	+1.7

[a] Only pertinent disciplines for impact comparisons are shown.
[b] Socioeconomic impacts are not rated numerically. See the socioeconomics discussion within this section.

Wilderness. Low adverse impacts to recreation could occur due to increased demand for wilderness use. Impacts could be relatively higher (yet still low to medium adverse) during the construction-phase of the 100,000 bpd level, when more workers would be involved with the project.

Visual Resources. Due to the reduced size of facilities required for a 50,000-bpd alternative, it would have less visual impacts than a 100,000-bpd alternative. However, since the 50,000-bpd alternative would require many of the same types of surface facilities and corridors as the proposed action, impacts of both alternatives would remain low to medium adverse.

Socioeconomics. The 100,000-bpd proposal by Cities Service has four distinct construction cycles, each of approximately 6 years duration. After the first two cycles are completed in 1998, operations employment is 1,800 and production would be approximately 40,000 to 50,000 bpd (a nominal 50,000-bpd alternative). Thus, the impact analyses through 1998 are appropriate to either the 50,000-bpd or the 100,000-bpd scenarios. Subsequent to 1998, under the 50,000 bpd alternative, impacts would stabilize at levels similar to those of 1998. Under the 100,000-bpd scenario, impacts continue to increase in each subsequent construction cycle because similar construction forces are added to progressively larger numbers of operating workers.

Transportation. Transportation impacts throughout the construction operations and residual phases would be greater for the 100,000-bpd production rate than for the 50,000-bpd rate, due to the greater need for worker, material, and product transport. However, the duration of the impacts from the 50,000-bpd alternative would be doubted. At the 100,000-bpd production rate, the highest relative adverse impacts would occur to the roadway systems. Depending on the timing of the proposed action's construction, traffic slowdowns could occur on roadways within the area. Airports and railroads may experience low to medium adverse impacts from both the 50,000- and 100,000-bpd production rates. Overall regional pipeline capacity would be increased under both alternatives, causing low beneficial impacts.

Energy. Energy use during construction would constitute a low adverse impact. During project operation, a net beneficial impact would result due to the production of shale oil. The 100,000-bpd production rate would, on the basis of output/input ratio, have a slightly greater (medium to high) beneficial impact.

2.4.3.2.2 Retort Technology. This alternative would use the Lurgi technology (as previously described in Section 2.3.2) instead of the Union B retort for surface retorting of the oil shale. Appropriate impact comparisons by discipline are shown in Table 2.4-10, with brief written explanations given below. The 100,000 bpd proposed action production rate (90,000 bpd surface retort, 10,000 bpd VMIS) is assumed except as indicated. Other alternatives as modeled for air quality are discussed in that section.

Surface Water. The alternative Lurgi retort would process and, therefore, generate smaller particle size spent shale material compared to the proposed Union B retort technology. Surface water impacts could be increased due to: (1) higher water consumption for spent shale moistening, and (2) more sour water generation.

Ground Water. Impacts could occur from the production of retort waste water and spent shale. Disposal of these by-products could result in the generation of leachate high in dissolved solids, selected trace metals, and organic contaminants. Additionally, the Union B process cannot process raw shale fines, necessitating their disposal with the retort by-products. Utilization of the Lurgi retorts would allow processing of the fines negating disposal-related impacts. However, design and installation of a careful drainage system would be necessary to restrict runoff waters from contacting and saturating any temporary storage piles.

Air Quality. The air quality discussion presents only the most adverse or limiting values for health impacts. Additional detail is presented in Section 4.3.8. The most adverse air quality impact would come from the full-production alternatives for the proposed action and the Union B retorts. Both would consume 80 percent of the 24-hour NAAQS for TSP. Additionally, the project would require some redesign or additional land acquisition (approximately 0.1 square miles) to avoid violating PSD Class II increments. The land area of potential violation is near the shale fines storage area on the western property boundary. Of the other alternatives analyzed for the DEIS, the 90,000-bpd Lurgi/10,000-bpd VMIS would consume approximately 65 percent of the 24-hour TSP NAAQS, primarily due to shale disposal. This alternative and the proposed action would consume 60 percent of the 24-hour SO_2 Class I increment in Flattops Wilderness Area. A potential violation of the Class II 24-hour TSP increment could also occur with the 90,000-bpd Lurgi/10,000-bpd VMIS alternative. Refined analyses could prove that this would not occur. These analyses would be required for air quality permits prior to construction.

For the 100,000-bpd all Union B retorts alternative, the 24-hour TSP off-property concentration would cause one of the highest air quality impacts of all Cities Services' proposed alternatives, consuming 2.3 times the Class II increment. When added to the background concentration, the total impact represents 80 percent of the NAAQS. Forty percent of the SO_2 24-hour Class I increment would be consumed in Flat Tops. When added to background concentrations, the total annual TSP and NO_x concentrations would represent about 30 percent of the applicable limiting NAAQS. This impact is rated high adverse.

Table 2.4-10 IMPACT COMPARISONS FOR RETORT TECHNOLOGY ALTERNATIVES, CITIES SERVICE SHALE OIL PROJECT

Discipline[a]	Union B (Proposed Action)	Lurgi (Alternative)
Surface Water	−0.3	−0.5
Ground Water	−0.8	−0.6
Air Quality	−2.3 (−1.7)[b]	−1.9 (−1.4)[b]
Noise	−0.6 (−0.5)[b]	−0.6 (−0.5)[b]
Energy	+1.2	+1.4

[a] Only pertinent disciplines for impact comparisons are shown.
[b] Rating in parentheses is for the 50,000 bpd alternative, using the indicated technology at 40,000 bpd plus 10,000 bpd VMIS.

For the 100,000-bpd all Lurgi retorts alternative, the off-property PSD Class II 24-hour TSP concentration is predicted to be exceeded by 72 percent. The total 24-hour TSP concentration would represent 65 percent of the limiting NAAQS. Forty percent of the 24-hour TSP Class I increment would be consumed in Flat Tops and 32 percent of the 3-hour SO_2 Class I increments in Flat Tops would be consumed.

The full production/90,000-bpd Union B, 10,000-bpd VMIS alternative, with an additional Lurgi retort to process fines, replaces the fines stock pile with an additional retort. The 24-hour TSP Class II concentration would exceed the PDS increment by 22 percent. When added to the background levels, this results in a total concentration which would be 52 percent of the federal standard. The 3-hour SO_2 concentration in the Flat Tops Wilderness would be 32 percent of the PDS Class I increment.

The 40,000-bpd Union B/10,000-bpd VMIS alternative would consume approximately 59 percent of the 24-hour TSP NAAQS. This impact is primarily due to the shale fines storage and spent shale disposal.

For the Union B reduced production alternative, the PSD Class II 24-hour TSP increment would be exceeded by 16 percent. The total off-property TSP 24-hour concentration would be 50 percent of the NAAQS. No other increments are predicted to be exceeded.

For the of 50,000-bpd all Lurgi retorts alternative, no PSD Class I or Class II increments would be consumed. When added to the background concentrations, the background concentrations would represent 44 percent of the 24-hour TSP NAAQS and 30 percent of the annual TSP NAAQS.

The 40,000-bpd Lurgi/10,000-bpd VMIS alternative would also have its major adverse impacts from TSP. It is predicted to consume approximately 44 percent and 37 percent of the 24-hour and annual TSP NAAQS, respectively. A more complete description of the air quality impacts is contained in Appendix A and Sections 4.1.8, 4.2.8, and 4.3.8.

The 40,000-bpd Union B retorts/10,000 bpd VMIS alternative, with an additional Lurgi retort for fines, replaces the fines stockpile with an additional retort at a reduced production rate. No TSP or SO_2 Class I, Class II, or Category I increments are fully consumed, nor are the NAAQS exceeded. When added to the background concentrations, the 24-hour off-property TSP total concentration represents 38 percent of the NAAQS.

The 24-hour TSP concentrations are predicted to consume or exceed the PSD Class II increment for all full-production alternatives and for the reduced production split and all Union B retorts. These impacts would all occur in the same location as the original alternatives without cogeneration. When added to the background concentrations, the percent contribution of the 24-hour TSP NAAQS and impact ratings are identical to those listed for the proposed alternatives without cogeneration. All other total concentrations would be well below 30 percent of the NAAQS.

Noise. The variation between the Cities Services process technologies concerning noise impacts would be minimal. The full production alternatives would have the most adverse impacts, but are only slightly higher than the reduced producton alternatives. Noise impacts of the transportation alternatives would also vary insignificantly between process technologies.

Energy. The energy impacts of the proposed Union B surface retort technology are medium beneficial. Processing of the oil shale would require consumption of energy, but the shale oil produced would more than offset the energy consumption. There is a difference in energy efficiency between the Union B and Lurgi retorting technologies. The Lurgi technology utilizes raw shale fines and the carbon on the spent shale is burned to produce energy. Therefore, the Lurgi technology is rated as being more beneficial to the overall energy balance.

2.4.3.2.3 Mine Type. The combination underground room-and-pillar mine/VMIS process could be replaced by an all-underground room-and-pillar mine alternative. Union B retorts and 100,000-bpd production rates are assumed. Appropriate impact comparisons by discipline are shown in Table 2.4-11, with brief interpretations given below.

Table 2.4-11 IMPACT COMPARISONS FOR MINE TYPE ALTERNATIVES (WITH UNION B RETORTS), CITIES SERVICE SHALE OIL PROJECT

	100,000 bpd	
Discipline[a]	90,000 room-and-pillar; 10,000 VMIS (Proposed Action)	All underground room-and-pillar (Alternative)
Topography	−0.5	−0.2
Geology	−0.5	−0.3
Surface Water	−0.4	−0.2
Ground Water	−1.8	−0.8
Soils	−0.1	−0.1
Wildlife	−0.3	−0.1
Air Quality	−2.3 (−1.7)[b]	−2.3 (−1.6)[b]
Noise	−0.6 (−0.5)[b]	−0.6 (−0.5)[b]
Visual Resources	−0.9	−0.8
Energy	−0.7	−0.9

[a] Only pertinent disciplines for impact comparisons are shown.
[b] Impact rating in parentheses is for 50,000 bpd alternatives.

Topography. The underground mining of oil shale could result in the subsidence of the land surface. Underground disturbances associated with the VMIS process, including blasting and increased excavation, would increase the potential for subsidence. Impacts from the proposed action, therefore, could be higher in magnitude.

Geology. Geologic impacts include the possibility of land subsidence. Underground disturbances associated with the VMIS process, including blasting and increased excavation from the proposed action could be higher in magnitude than those from the alternative.

Surface Water. The alternative all-underground mine type would have less adverse surface water impacts compared to the proposed action, due to the volume reduction of spent shale generated.

Ground Water. Adverse ground water impacts resulting from the alternative all-underground mine without VMIS retorting should be less than for the proposed action. The increase in impact magnitude for the proposed action is due to the potential for dewatering of overlying aquifers, ground water contamination via contact with VMIS retort "rubble," and increased opportunity for mine inflows during this VMIS process.

Soils. Impacts associated with either of the two different mine types are low and adverse. The underground versus the VMIS method would probably disturb the same surface acreage in generally the same locations. Therefore, incremental soil loss would be approximately the same. There are no prime farmland impacts associated with either of the two alternatives.

Wildlife. The effects of the two mining alternatives on wildlife would be low adverse. The impacts would also be similar since the location and amount of surface disturbance associated with each are comparable. The VMIS alternative could have slightly greater adverse direct and indirect impacts on wildlife than the proposed action because of increased potential for subsidence, surface water impacts, and air quality impacts.

Air Quality. See discussion in Section 2.4.3.2.2 (Retort Technology Alternatives).

Noise. See discussion in Section 2.4.3.2.2. (Retort Technology Alternatives).

Visual Resources. The combination underground mine/VMIS would have slightly higher relative adverse visual impacts than underground mining alone. The greater impact is related to the surface facilities (oil recovery units and pipes) of the VMIS process. The visual impact of the underground mine would result from surface facilities at the mine adit.

Energy. Mining of oil shale would have a low adverse energy impacts due to the energy consumed in the extraction, crushing, and transport of oil shale. The combination of underground mining and VMIS would have relatively greater beneficial energy impacts because the combined method gives the best site-specific resource recovery.

2.4.3.2.4 Shale Fines. The oil shale fines (pieces less than 1/8 inch in diameter after crushing) could be stockpiled on-site (as in the proposed action) or, as an alternative, processed on-site for additional shale oil extraction. The impacts of these two options are compared below and in Table 2.4-12 for appropriate disciplines.

Surface Water. Low to medium adverse impacts to surface water would be associated with each alternative. On-site storage could cause surface runoff and erosion from the stockpile, and migration of leachate to surface drainages. Retorting on-site would have slightly higher adverse impacts since some stockpiling is assumed and processed shale fines could contain residues of reagents from retorting which could contaminate surface water.

Ground Water. Low adverse ground water impacts are anticipated from either schemes for raw shale fines. The proposed storage of fines in stockpiles would allow for longer term exposure to drainage waters, whereas processing in the alternative Lurgi retort, with continual accumulation/removal, would decrease this exposure time. Conversely, storage would allow for timely reclamation by revegetation, thereby decreasing the opportunity for infiltration of precipitation. In either case, design and operation of proper handling and drainage control plans can reduce any significant hydrologic impacts.

Air Quality. Shale fines processing as opposed to storage (both on-site) would reduce TSP impacts slightly. Reduced storage requirements would be offset by increased screening and crushing operations if processing occurred. Storing the shale fines on-site, as in the proposed action, would consume approximately 75 percent of the 24-hour TSP NAAQS, while processing these fines using the Lurgi alternatives would reduce the impact to approximatley 60 percent of the same standard.

Visual Resources. Storage of shale fines would have an adverse visual impact until processing and/or reclamation of the storage area. Processing, without storage, would eliminate most of this adverse impact. The impact would be offset due to the additional processing facilities required.

Energy. Storage of shale fines on-site (proposed action) would result in low adverse impacts because of the energy consumed in the transport of shale fines and the energy lost by non-recovery of the shale oil within these fines. Conversely, the alternative of retorting these fines would have a net low beneficial impact, due to the recovery of the additional shale oil.

2.4.3.2.5 Spent Shale Disposal Sites. As an alternative to the Conn Creek/Cascade Canyon site in the proposed action, Cities Service has determined that an alternative involving a combination site in Upper Cascade Canyon and a nearby location on the plateau would be feasible. These impact comparisons are given below and in Table 2.4-13. The 100,000-bpd production rate is assumed.

Topography. The disposal of spent shale in Conn Creek and Cascade Canyon would result in greater relative adverse impacts to topography than the combined disposal of spent shale on the plateau and in upper Cascade Canyon. The impact of spent shale disposal on topography is considered low adverse for both actions, with the alternative action having the lower impact, due to less relief changes.

Geology. Impacts to geology include the creation of potential geological hazards as a result of the construction of the spent shale piles. The alternative action is preferred, because of less steep slopes and its probable reduced size.

Table 2.4-12 IMPACT COMPARISONS FOR SHALE FINES ALTERNATIVES, CITIES SERVICE OIL PROJECT

Discipline[a]	On-site Disposal with Spent Shale (Proposed Action)	Processed On-site (Alternative)
Surface Water	−0.5	−1.0
Ground Water	−0.8	−0.7
Air Quality	−2.1	−1.7
Visual Resources	−0.9	−0.5
Energy	−0.3	+0.3

[a] Only pertinent disciplines for impact comparisons are shown.

Table 2.4-13 IMPACT COMPARISONS FOR SPENT SHALE DISPOSAL SITE ALTERNATIVES, CITIES SERVICE SHALE OIL PROJECT

Discipline[a]	Conn Creek/Cascade Canyon (Proposed Action)	Upper Cascade Canyon/Mesa (Alternative)
Topography	−1.0	−0.6
Geology	−0.8	−0.5
Paleontology	−0.2	−0.2
Surface Water	−1.0	−1.5
Ground Water	−2.0	−1.8
Soils	−0.6	−0.5
Aquatic Ecology	−0.5	−0.2
Vegetation	−2.2	−2.3
Wildlife	−1.1	−2.3
Air Quality	−1.5	−2.6
Noise	−0.3	−0.3
Cultural Resources	−0.1	−0.1
Land Use	−1.0	−1.5
Visual Resources	−1.5	−1.4
Transportation	−0.1	−0.2
Energy	−0.2	−0.2

[a] Only pertinent disciplines for impact comparisons are shown.

Paleontology. As a result of the construction of the spent shale disposal piles, potential paleontological resources would be buried and access restricted. Very low adverse impacts are expected. Neither action is preferred with regard to paleontological resources.

Surface Water. The alternative spent shale disposal area using upper Cascade Canyon and the plateau site would disturb more surface drainage area than the proposed action, including several springs which contribute to the stream flow of Conn Creek. In addition, spent shale disposal piles and embankments on the plateau are more susceptible to water erosion and potential leaching as a result of the two separate disposal areas. This alternative disposal site would have greater relative impacts (both are medium adverse) compared to the proposed action disposal site.

Ground Water. Potential ground water impacts from spent shale disposal could be significant, involving leachate generation and migration. The magnitude of these impacts is dependent upon both the effectiveness of the liner containment system and on the proximity to ground water aquifers. The proposed disposal area is situated largely within steep-walled canyons at the head of the Conn Creek alluvial valley, whereas more than over half of the alternative site occurs on flatter, upland areas further removed from alluvial aquifers. These factors indicate that the potential for contamination of important ground water sources could be greater for the proposed action site than for the alternative sites.

Soils. The proposed action is expected to have low adverse impacts on soils, but a relatively greater adverse impact than the alternative. The incremental soil loss for the proposed action is about 64,200 tons, as compared to 50,600 tons for the alternative. No prime farmland loss is expected for either. If revegetation of the spent shale pile slopes is successful, permanent erosion rates could be lower than predisturbance rates. The impact analyses do not reflect the eventual soil erosion rates which would occur when the topsoil material is eroded away. They could easily be 5 to 10 times the disturbance rates shown in Table 4.3-1.

Aquatic Ecology. Neither the proposed action nor the alternative sites would have significant impacts to aquatic ecology. There would be a slightly lower adverse impact associated with the alternative action since only one intermittent stream bed would be eliminated. The plateau site would have little or no adverse impacts.

Vegetation. The alternative spent shale disposal sites would have similar, high adverse impacts on vegetation. Disposal in Conn Creek and Cascade Canyon would affect significantly more special interest plant populations and habitat than disposal on the plateau and in upper Cascade Canyon. However, affected plant productivity is higher in the plateau/Cascade Canyon alternative than in the Conn Creek/Cascade Canyon proposed action.

Wildlife. The alternative shale disposal sites would have low to moderate adverse impacts to wildlife and habitats. Over 700 acres of wildlife habitat would be inundated if shale were disposed of in Cascade and Conn Creek canyons. Major impacts would be known to raptor nests locations and big game ranges. The disposal of shale in the alternative location would have a significant long-term impact on wildlife since over 1,500 acres of habitat would be eliminated, including raptor nest locations and sensitive habitats (aspen, Douglas-fir, riparian, and cliffs).

Air Quality. A moderate to high adverse impact rating is predicted for all of the 100,000-bpd alternatives at the alternative spent shale disposal site. The proposed action site shows medium adverse impacts from the modeling analyses.

Noise. Daily minor changes to the acoustic environment would result from both spent shale disposal alternatives. Noise adverse impacts would be low adverse and about equal.

Cultural Resources. Due to the steep canyon walls and narrow canyon bottom associated with these sites, potential impacts to cultural resources would be minimal. Areas previously unsurveyed would be subject to study. Actual determination of impacts and mitigation measures would be developed according to agency requirements. Mitigation measures would eliminate most, if not all, adverse impacts to sites potentially eligible for the National Register of Historic Places.

Land Use. Low to medium adverse impacts to land use would occur from construction of either spent shale disposal site. Rangeland would be lost as a result of both alternatives. The plateau/canyon spent shale pile would affect the greatest amount of rangeland and productivity among alternatives.

Visual Resources. Spent shale disposal within Conn Creek and Cascade Canyon would have a medium adverse impact since an area of high scenic quality would be impacted. Disposal on the plateau and in the canyon would have a slightly less relative impacts since a smaller area of high scenic quality would be affected.

Transportation. Spent shale disposal at either of the alternative sites would have minimal impacts to the regional transportation systems since private conveyors and/or haul roads would be used. A very low adverse impact was assessed for spent shale disposal since some ancillary transportation (e.g., materials) may be needed to support the shale disposal procedures. The plateau/canyon alternative involves a slightly greater transport distance.

Energy. Disposal of spent shale in either the Conn/Cascade Creeks location or the Mesa/Canyon alternative location would result in low adverse impacts. Only a minimal amount of energy would be consumed because of the proximity of these sites to the retorts.

2.4.3.2.6 Spent Shale Disposal Types. The Union B and Lurgi processes would produce spent shale with differing properties. These differences are discussed below and shown in Table 2.4-14.

Geology. The Union B spent shale and alternative (Lurgi) retorts could impact existing site geology as a geologic hazard. The spent shale particles produced by Lurgi retorting are known to cement together more easily when compared to the spent shale produced by the Union B retorts. The increased potential for cementation of the Lurgi-produced particles should increase the stability of the spent shale piles and reduce erosion of the pile by sheet waste.

Surface Water. The alternative Lurgi retort process would generate smaller particle size spent shale material, compared to the Union B retort technology. Surface water impacts would be relatively greater using Lurgi, due to (1) higher water consumption for spent shale moistening, and (2) more sour water generation.

Ground Water. Disposal of spent shale generated by the Lurgi process could result in less adverse ground water impacts than would be associated with the Union B retorts. Reduced impacts could occur if the disposal pile were to become cemented or solidifed upon application of moisture as existing data indicate (Bates 1983). If additional structural stability is achieved by this cementing, the potential for erosion and leachage generation would be reduced.

Soils. The impacts resulting from disposal of either type of spent shale would be the same because the type of spent shale deposited would not affect the soil resource. Hence, the impact rating reflects the spent shale disposal site rather than the type of spent shale deposited. If water erosion occurs from the spent shale pile prior to overburden and topsoil replacement, spent shale would be lost, not soil. It is expected that the sedimentation basin system would capture this eroded spent shale. Upon completing overburden and topsoil replacement activities on the spent shale piles, water and wind erosion would undoubtedly occur. The type of spent shale beneath the topsoil will not affect the topsoil erosion rate.

Air Quality. The maximum air quality impacts would result from the process stack releases. Nevertheless, TSP impacts, which fully consume the PSD Class II increment for 24-hr TSP, are predicted to occur along the west property line next to the spent shale disposal area. This rates a low to moderate adverse impact. The maximum emissions for the Lurgi disposal areas are 10 to 20 percent lower than the Union B spent shale disposal emissions.

2.4.3.2.7 Corridors. Alternative corridors for the Cities Service project are discussed below for product transport and transmission lines. These are the North corridor, directly north of the Cities property using BLM/private lands (but not using the Getty property), and the route northwest to Rangely. The Rangely route is described in the CCSOP EIS (BLM 1983a). The route designated Rangely B is assumed for purposes here, and its impact ratings in the CCSOP EIS are presented in Table 2.4-15. This table also presents impact comparison of the proposed action (Cities to common corridor with Getty to La Sal connection) and the North corridor alternative. Brief written interpretations for appropriate disciplines are presented below.

Topography. Topographic impacts would be the result of surficial disturbance due to excavation and construction. There is no significant difference in the potential impacts to topography as a result of the proposed or the alternative actions. In general, impacts to topography would be reduced by reclamation efforts.

Table 2.4-14 IMPACT COMPARISONS FOR SPENT SHALE DISPOSAL TYPE ALTERNATIVES, CITIES SERVICE SHALE OIL PROJECT

Discipline[a]	Union B Retorted Spent Shale (Proposed Action)	Lurgi Retorted Spent Shale (Alternative)
Geology	−1.5	−1.0
Surface Water	−0.3	−0.5
Ground Water	−1.9	−1.6
Soils	NA[b]	NA[b]
Air Quality	−1.1	−1.0

[a] Only pertinent disciplines for impact comparisons are shown.
[b] See soils note in text for justification of non-applicability.

Table 2.4-15 IMPACT COMPARISONS FOR CORRIDOR ALTERNATIVES, CITIES SERVICE SHALE OIL PROJECT

Discipline[a]	Cities Service to Common Corridor With Getty to La Sal Connection (Proposed Action)	Rangely B (Alternative)[b]	North Corridor (Alternative)
Topography	−0.5	−0.5	−0.5
Paleontology	−0.2	−1.1	−0.5
Surface Water	−0.3	−1.1	−0.5
Ground Water	−0.5	−0.5	−0.5
Soils	−0.1	−0.1	−0.2
Aquatic Ecology	-0-	−0.7	−0.5
Vegetation	−0.8	−1.1	−0.8
Wildlife	−0.8	−1.1	−0.2
Cultural Resources	−0.2	−0.5	−0.2
Land Use	−0.3	−1.1	−0.5
Recreation	+1.0	+1.0	+1.0
Visual Resources	−0.1	−0.7	−0.1
Transportation	+0.2	+0.9	+0.5
Energy	+0.3	−0.6	+0.3

[a] Only pertinent disciplines for impact comparisons are shown.
[b] Rating shown is from CCSOP EIS (BLM 1983a).

Paleontology. There is no significant difference in the potential impacts to paleontological resources as a result of the proposed common corridor or the alternative North corridor. Rangely B is rated as having moderate adverse impacts.

Surface Water. The Rangely pipeline corridor would have similar surface water impacts compared to the proposed La Sal pipeline corridor. Impacts of these two corridors assessed in BLM (1983a), would occur on different drainage systems. The North syncrude pipeline corridor would have greater impacts than the Cities-to-Getty common corridor pipeline corridor because it crosses several additional drainages enroute to Parachute Creek.

Ground Water. La Sal and Rangely corridors addressed in the CCSOP EIS (BLM 1983a) would have low adverse impacts to ground water. Similarly, the North corridor alternative is rated as low adverse. The corridor is largely on upland areas, with exposure only to a narrow reach of West Fork of Parachute Creek, where saturated alluvial deposits should be minimal.

Soils. It is estimated the North corridor alternative would have low adverse soils impacts, but the relative highest impacts of the three pipeline routes. Incremental soil loss is calculated at about 21,400, 11,500, and 10,700 tons for the North, La Sal, and Rangely corridors, respectively. No loss or disruption of prime farmland is expected.

Aquatic Ecology. The Cities Service to Getty common corridor would have no aquatic ecology impacts, because it crosses no permanent water. The North corridor crosses several minor drainages, and is expected to have low adverse impacts.

Vegetation. Low adverse impacts to vegetation would occur as a result of the Cities-to-Getty common power and syncrude corridor. A minimal amount of vegetation and plant productivity would be lost. No known populations of or favorable habitat for special interest plant species will be affected. The remainder of the La Sal pipeline route is addressed in BLM (1983a). The North corridor is also expected to have low adverse impacts.

Wildlife. The Cities-to-Getty power and syncrude corridor would have low adverse impacts to wildlife and wildlife habitat. A few known raptor nests (which occur in close proximity to the corridor) could be temporarily disturbed during construction. Almost 80 acres of aspen cover type would also be eliminated or disrupted by construction of this corridor. The North corridor would create similar impacts to wildlife including potential disturbance of raptor nesting locations and 147 acres of aspen habitat. The corridor would also intersect and cause short-term disturbance of about 50 acres of riparian habitat. The rating for the North corridor is the best estimate available; no site-specific surveys have been conducted along this route. The Rangely B pipeline would have a medium adverse impact to wildlife (see BLM 1983a).

Cultural Resources. Potential impacts on cultural resources (given the existing federal and state cultural resources regulations) would be low adverse. The Rangely corridor would have slightly more potential for cultural resources given existing studies. Areas previously unsurveyed will be subject to study. Actual determination of impacts and mitigation measures will be developed according to agency requirements.

Land Use. Low adverse impacts to land use can be expected from construction of the North corridor and the Cities-to-Getty common power and syncrude corridor. An insignificant amount of range would be lost. No agricultural lands would be affected.

Recreation. Low-to-medium beneficial impacts on recreation would probably occur due to development of all corridors. Lands which are currently unavailable for recreational use would be opened for possible off-road vehicle use and hunting. Access would be controlled during the life of the project; thus, such recreational use would probably follow project abandonment.

Visual Resources. The Cities-to-Getty common corridor to La Sal, and the North pipeline alternatives would have similar, very low adverse visual impacts. Both of these corridors would be on the Roan Plateau. The Rangely corridor would have a greater adverse visual impacts due to greater length and visibility of the corridor to the general poublic.

Transportation. Transportation impacts of the pipeline corridors would be low, yet beneficial, because of improvements to the existing pipeline system and because new systems would be available to transport other commodities. The relative beneficial impacts were assessed based upon the length and potential availability of the pipeline network to future users. As such, the Rangely product pipeline would have slightly greater beneficial impacts of the alternatives analyzed.

Energy. Energy impacts for the pipeline corridors would be directly related to length and therefore proportional to energy use. Longer corridors would result in higher adverse impacts due to the increased need for pumping. Impacts of product pipelines are rated as low adverse impacts. The La Sal pipeline, because of its relatively shorter length, would have slightly lower adverse impacts when compared to the Rangely alternative. The corridors constructed for power transmission (i.e., North corridor and the Cities-to-Getty corridor) are assessed as having low beneficial impacts due to expansion of the power distribution system.

2.4.3.2.8 Water Supply. The alternative to the GCC Joint Venture system (which is addressed in the CCSOP EIS - BLM 1983a) is the Larkin Ditch system. Larkin Ditch consists of a previously established (and permitted by the Corps) intake structure on the south side of the Colorado River near De Beque, with an existing irrigation ditch. Cities Service would construct a sedimentation pond and a pumping facility and pipeline across the river (a hanging pipeline on the De Beque highway bridge is assumed) should this alternative be constructed. The pipeline would then follow the GCC corridor and utilize the GCC reservoir site for storage. Therefore, the only difference between the preferred and alternative actions is the withdrawal point, sedimentation pond, and pipeline to the GCC reservoir. As a result, Table 2.4-16 shows only the *increment* of additional adverse impacts attributed to the additional Larkin Ditch components. The CCSOP EIS (BLM 1983a) ratings for the GCC Joint Venture system are also recalled, and both alternatives are discussed below.

Topography. The alternative action (Larkin Ditch) would cause slightly greater adverse impacts to topography than the proposed action, because of more inundation due to the sedimentation pond.

Geology. The alternative action would result in similar (low adverse) impacts to existing geology when compared with the proposed action.

Paleontology. The inundation of a portion of Roan Creek valley could restrict the access to potential paleontological resource sites. The alternative would result in similar impacts to paleontological resources, generally of a low adverse magnitude. The excavation and construction of a water pipeline in the Roan Creek valley could also impact potential paleontological resources.

Table 2.4-16 IMPACT COMPARISONS FOR WATER SUPPLY ALTERNATIVES, CITIES SERVICE SHALE OIL PROJECT

Discipline[a]	GCC Joint Venture System (Proposed Action)[b]	Larkin Ditch System (Alternative)[c]
Topography	−1.0	−0.1
Geology	−0.8	−0.1
Paleontology	−0.5	−0.1
Surface Water	−1.5	−0.5
Soils	−1.6	−0.1
Aquatic Ecology	−1.2	--[d]
Vegetation	−3.0[e]	−0.5
Wildlife	−2.1	−0.1
Cultural Resources	−0.4	−0.1
Land Use	+0.4	−0.5
Visual Resources	−0.9	−1.0

[a] Only pertinent disciplines for impact assessment are shown.
[b] Rating is shown from CCSOP EIS (BLM 1983a) for Upper Dry Fork reservoir site (BLM's final preferred alternative).
[c] Only the additional incremental impacts attributed to the Larkin Ditch components are shown.
[d] Aquatic ecology impacts of the Larkin Ditch alternative regarding the Colorado River have been primarily assessed in the 404 permit for that intake facility. These impacts will be reassessed in the future if construction activities cause an amended permit application to be filed. Additional diversion beyond that previously addressed for the GCC Joint Venture (see CCSOP EIS - BLM 1983a) will not occur as a result of the Larkin Ditch alternative.
[e] Considering impacts to threatened and endangered plant species. Mitigation of impacts has received commitment from GCC, however (BLM 1983a).

Surface Water. The alternative Larkin Ditch diversion could cause additional stream flow disruption on Colorado River compared to the proposed GCC diversion. In addition, a sedimentation basin to be located within the floodplain of the Colorado River could restrict some degree of flow conveyance during flood flow events.

Soils. The moderate adverse soil impacts of the Larkin Ditch water supply system are slightly more adverse than the proposed action, largely because it causes an additional loss of about 20 acres of prime farmland. The incremental soil loss is also slightly greater (690 tons) for the alternative as compared to the proposed action.

Aquatic Ecology. Aquatic ecology impacts of the Larkin Ditch alternative on the Colorado River were assessed in the 404 permit for that intake facility. These impacts will be reassessed in the future if construction activities cause an amended permit application to be filed. Additional diversion beyond that previously addressed for the GCC Joint Venture (BLM 1983a) would not occur as a result of this alternative.

Vegetation. The GCC water storage and supply alternative described in BLM (1983a) would have high adverse impacts to vegetation and special interest plant species. Additional disturbances associated with Larkin Ditch are expected to have low adverse impacts to vegetation.

Wildlife. The Larkin Ditch alternative would have slightly higher adverse impacts to wildlife when added to those of the GCC system. The GCC system would eliminate about 140 acres of riparian habitat and 1700 acres of mule deer winter range, winter concentration areas, and critical habitat. By comparison, the Larkin Ditch system would affect about 10 acres of riparian habitat.

Cultural Resources. Potential impact on cultural resources (given the existing federal and state cultural resources regulations) would be insignificant. The GCC Joint Venture system impacts are addressed in BLM (1983). Impacts of the Larkin Ditch alternative appear to be insignificant due to the existing impacts to the area. Areas previously unsurveyed will be subject to study. Actual determination of impacts and mitigation measures will be developed according to agency requirements. Mitigation measures would eliminate most, if not all, adverse impacts to sites potentially eligible for the National Register of Historic Places.

Land Use. The Larkin Ditch water supply alternative would have low adverse impacts, compared to slightly beneficial impacts for the GCC water supply system as presented in BLM (1983a). Construction of a sedimentation pond for the Larkin Ditch alternative would affect a cattle feed lot and an existing gravel pit.

Visual Resources. The proposed action water supply system presented in BLM (1983a) would have a low adverse to low beneficial impact, depending on operational characteristics. The Larkin Ditch alternative, although in an area already impacted, would have a similar low adverse visual impact due to its proximity to the I-70 corridor and the location of its pipeline.

2.3.4.2.9 Power Generation. An alternative purchasing power from off-site sources is cogeneration power on-site. Impact comparisons for pertinent disciplines concerning cogeneration versus off-site purchase of power are given below and in Table 2.4-17. In general, cogeneration of power would cause more site-specific environmental impacts. Off-site impacts of power purchase were not assessed except for energy.

Surface Water. The cogeneration of power would introduce additional surface watershed disturbance and water consumption. Surface water impacts would be slightly adverse compared to the proposed action (which has essentially no on-site impacts).

Air Quality. With cogeneration added to the project alternatives, the 24-hour TSP concentrations are predicted to consume or exceed the PSD Class II increment for the proposed action and the 100,000 and 50,000 bpd Lurgi alternatives. The total concentration, when added to the background values, result in 50, 91, and 66 percent of the NAAQS of the respective alternatives. No other consumption or exceedance of the PSD increments or NAAQS would occur. All SO_2 and TSP concentrations for the regulated averaging times in the Class I and

Category I sensitive receptors are less than 1 μg/m³. A Level I screening analysis of cogeneration with the proposed action indicates a NO_x-caused dark plume against a bright sky would be visible out to 40 miles from the facilities and a light plume against dark terrain caused by TSP would be visible out to 48 miles from the facility. This analysis indicates a potential for visibility degradation in the Flat Top Wilderness and Colorado National Monument.

Noise. Cogeneration would add only slightly to the process facilities adverse noise impacts. The additional noise from cogeneration could be masked by the other facilities.

Visual Resources. The visual impacts of purchasing power would relate to the transmission line serving the project, which would be required regardless of whether or not power is generated on-site. Power generation on-site (cogeneration) would contribute to the adverse impacts due to the need to expand facilities on-site.

Energy. Purchasing power from an outside grid would place additional demands on that grid, and would have an adverse impact. The precise location of the power within the grid and associated environmental impacts cannot be precisely determined at this time. Considering that the current power grid appears to be adequate for the anticipated project uses, the impact is rated as low. Cogeneration would be a beneficial impact in that it would create additional power for use within the facility, thereby reducing the demand for imported power.

Table 2.4-17 IMPACT COMPARISONS FOR POWER GENERATION ALTERNATIVES, CITIES SERVICE SHALE OIL PROJECT

Discipline[a]	Purchase Off-Site (Proposed Action)	Cogeneration On-Site (Alternative)
Surface Water	-0-	−0.5
Air Quality	-0-	−0.1
Noise	-0-	−0.2
Visual Resources	-0-	−0.5
Energy	−0.8	−0.6

[a] Only pertinent disciplines for impact assessment are shown.

2.4.3.2.10 Transport of Workers and Materials. As an alternative to the transport of workers and materials by vehicles (buses and trucks from De Beque up the Conn Creek road to the base of the mesa), Cities Service has proposed rail transport for workers. Impact comparisons for appropriate disciplines are shown in Table 2.4-18 and described below.

Wildlife. The use of rail instead of buses to transport workers would result in relatively lower adverse impacts to wildlife, since a significant reduction in the number of round-trips is expected. The nearly 200 bus round-trips per day would cause medium adverse impacts to wildlife, primarily as a result of roadkills and noise. The incidence of roadkills would diminish significantly if workers were transported by rail, since the number of required round-trips per day would be about six. Noise affects on wildlife would likely remain the same as the proposed action. Noise intensity from the rail system would probably be greater than that expected fom buses; however, the incidence and duration should be considerably less.

Air Quality. Significant air emission and, thus, air quality impacts are not expected from either of these transportation alternatives. Both rate very low adverse impacts.

Noise. Bus and truck noise for the Cities Services project could be perceptible to residences along this road segment. This rates a low adverse impact. Railroad noise, however, would be perceptible to residences along this corridor. Due to the low frequency, penetrating rumble characteric of trains, the noise levels may be objectionable to some of these individuals. This rates a higher relative (yet still low adverse) impact.

Visual Resources. The visual impact of trucking supplies to the project site from a De Beque railhead would result from the roadway previously addressed. Therefore, no additional impact would be expected. A railhead at the Conn Creek confluence would require construction of a railroad line up Roan Creek valley. A minor linear and form impact would result from construction of this line.

Transportation. Use of either the vehicular transportation system or the rail system would not significantly affect the overall transportation characteristics of the area. The vehicular transportation system is rated as a very low adverse impact because it could cause some traffic congestion and subsequent traffic problems (e.g., accidents). This adverse aspect of the vehicular transportation system is somewhat offset by the improved transportation network up the Roan Creek valley. The rail system is rated as a very low beneficial impact because of the improved transportation system. Problems of traffic congestion are not anticipated with the rail system.

Energy. Both alternatives are rated as low adverse impacts because of the consuption of energy to operate the transportation systems. Rail transportation is more efficient than vehicular transportation and is rated a lower relative adverse impact.

2.4.3.2.11 No Action Alternative - Cities Service. Consideration of the No Action alternative is required in any EIS in accordance with regulations issued by the Council on Environmental Quality (1978), and under provisions of the National Environmental Policy Act of 1969. Under the No Action Alternative, the construction of the shale oil facility would not take place. No action would occur, due to (1) the denial of the 404 Permit by the Corps, or (2) a decision by Cities Service not to proceed with the project.

The implications of the No Action alternative are many. These include the following:

- Non-development of the oil shale resource, increasing U.S. dependence on foreign energy sources.
- Elimination of the economic and social benefits of the project to Colorado's Western Slope.
- Non-use of the water, which would be put to beneficial industrial, commercial, and domestic uses before leaving Colorado if the project were developed.
- No adverse environmental impacts to the immediate area's and region's air, surface and ground water, wildlife, vegetation, soils, and aquatic resources; the social and economic environment; cultural resources, land use, recreation and wilderness values; visual resources and noise; and the area's topography, paleontology, and geology.
- No beneficial impacts to the above components of the environment (e.g., beneficial impacts to transportation and land use due to reservoir, road, and pipeline construction for the project).

Table 2.4-18 IMPACT COMPARISONS FOR TRANSPORTATION ALTERNATIVES, CITIES SERVICE SHALE OIL PROJECT

Discipline[a]	Bus and Truck Transport (Proposed Action)	Rail Transport (Alternative)
Wildlife	−1.5	−0.7
Air Quality	−0.3	−0.1
Noise	−0.2	−0.5
Visual Resources	−0.1	−0.5
Transportation	−0.1	+0.1
Energy	−0.4	−0.1

[a] Only pertinent disciplines for impact assessment are shown.

3.0

Affected Environment

3.0 AFFECTED ENVIRONMENT

The existing environmental baseline conditions for the Getty and Cities Service shale oil project sites and the surrounding region are described in this chapter. Section 3.1 is a general environmental description of the Roan Plateau, the various river and creek valleys and gulches which dissect it, and adjacent areas. Section 3.1 also addresses the only facility common to the Getty and Cities Service projects — a 3-mile power and syncrude corridor on the north end of the Getty Property which both companies would use as part of their proposed actions (1) to transport their shale oil to the La Sal pipeline connection and (2) as a power corridor, also to the La Sal/Davis Point Loop.

Sections 3.2 and 3.3 address specific environmental conditions for the Getty and Cities Service project sites and corridors, respectively. Baseline characteristics of proposed project localities are generally addressed in each section in the following order.

- Mine
- Process Facilities
- Waste Rock Disposal (if applicable)
- Shale Fines Stockpile (if applicable)
- Spent Shale Disposal
- Corridors
- Water Supply Facilities

Sites included in the proposed action are always addressed first, followed by alternative sites.

Sections 3.2 and 3.3 will each address the following disciplines (or, as one may view them, components of the environment), in the following order.

- Topography, Geology, and Paleontology
- Surface Water
- Ground Water
- Aquatic Ecology
- Soils
- Vegetation
- Wildlife
- Air Quality and Meteorology
- Noise
- Cultural Resources
- Land Use, Recreation, and Wilderness
- Visual Resources
- Socioeconomics
- Transportation
- Energy

3.1 Common Environment/Facilities Description

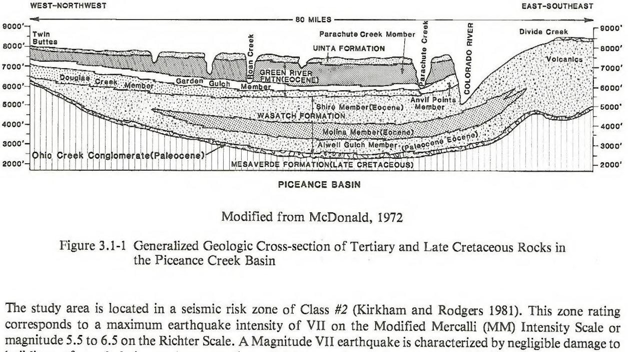
3.1.1 Topography, Geology, and Paleontology

The Getty and Cities Service shale oil projects areas are located within the Plateau Province of western Colorado. This physiographic province is characterized by a flat-lying, upland area (Roan Plateau) which has been deeply dissected by fluvial processes. This area consists of broad upland divides, steep valley side slopes, and flat valley floors. The topographic relief of the plateau area ranges from several thousands of feet (1,000-3,000 feet) for the deeply dissected principal drainages to hundreds of feet (100-1,000 feet) for their upland tributaries.

The principal drainages for the general area include Clear Creek, Roan Creek, and Parachute Creek, which generally flow from north-northwest to south-southeast. Roan Creek and Parachute Creek are direct tributaries of the Colorado River. The drainage pattern of the general area is of a dendritic type (leaf pattern), and is of a coarse texture (drainage densities less than 5.0 miles/square mile).

The type and distribution of the plateau's landforms is influenced by the stratigraphy and structural geology of the plateau. In general, the Roan Plateau consists of a thick, nearly horizontal sequence of sedimentary rocks which were deposited during the Eocene Epoch (53.8 - 47 million years ago) (Newman 1980). In the region, three major formations are exposed. These include the Wasatch Formation (Shire Member), Green River Formation (Douglas Creek Member, Garden Gulch Member, Anvil Points Member, and Parachute Creek Member), and Uinta Formation. Geologic mapping of the area has been accomplished by the U.S. Geological Survey (Hail 1978, 1982). A generalized geological cross-section is presented in Figure 3.1-1. A detailed discussion of basin stratigraphy is presented in Lucas and Kihm (1982), Newman (1980), and Hail (1978, 1982), and is summarized in Table 3.1-1. In general, these formations represent a transition from a fluvial depositional environment (Wasatch Formation) to a lacustrine depositional environment (Green River Formation), returning to a fluvial depositional environment (Uinta Formation). Of the members exposed, it is the Parachute Creek Member of the Green River Formation that is of economic interest. This member consists of oil shale, platy marlstones, and limestones (Lucas and Kihm 1982) with potential yields of oil ranging from 15 to 30 gallons per ton of oil shale (Donnell 1961).

Surficial deposits of Quarternary Age within the region include alluvial valley fill, alluvial fan deposits, landslide deposits, talus, and slope wash. Alluvial valley fill and fan deposits are concentrated in the areas of the valley floors and confluences of stream channels. Landslide deposits, talus, and slope wash originate on the valley sides and extend onto the valley floors.



Modified from McDonald, 1972

Figure 3.1-1 Generalized Geologic Cross-section of Tertiary and Late Cretaceous Rocks in the Piceance Creek Basin

The study area is located in a seismic risk zone of Class *#2* (Kirkham and Rodgers 1981). This zone rating corresponds to a maximum earthquake intensity of VII on the Modified Mercalli (MM) Intensity Scale or magnitude 5.5 to 6.5 on the Richter Scale. A Magnitude VII earthquake is characterized by negligible damage to buildings of good design and construction; slight to moderate damage to well-built ordinary structures; considerable damage to poorly built or badly designed structures.

Several potentially active faults have been identified on the northeastern flank of the Uncompahgre Uplift. Late-Cenozoic (Quaternary) movement has been associated with the Flume Canyon, Kodel's Canyon, and Redlands faults located about 3 miles south of Fruita, Colorado (BLM 1983a). Recent studies (McGuire, et al. 1982) have

Table 3.1-1 SUMMARY OF STRATIGRAPHY AND PALEONTOLOGY OF THE STUDY AREA

System	Series	Geologic Unit	Thickness[a] (feet)	Physical Character	Paleontological Resources
Quaternary	Holocene and Recent	Alluvium	0-140	Sand gravel and clay partly fill major valleys as much as 140 feet generally less than half a mile wide. Beds of clay may be as thick as 70 feet; generally thickest near the center of valleys. Sand and gravel contain stringers of clay near mouths of small tributaries to major streams.	No known paleontological resource
Tertiary	Eocene	Uinta Formation	0-850	Intertonguing and gradational bed of sandstone, siltstone, and marlstone contains pyroclastic rock and a few conglomerate lenses. Forms surface rock over most of the area, thins appreciably westward.	Fossil vertebrates and invertebrates, plant and leaf debris. Within study area, a partial skull of *Uintatherium* was discovered in this formation. Class Ib paleontological resource.
Tertiary	Eocene	Parachute Creek Member (Green River Formation)	950-1,280	Kerogenaceous dolomitic marlstone (oil shale) and shale contains thin pyroclastic beds fractured to depths of at least 1,800 feet. Abundant saline minerals in deeper parts of the basin. The member can be divided into 3 zones - high resistivity, low resistivity, or leached and Mahogany (oldest to youngest) which can be correlated throughout basin by use of geophysical logs.	Extensive fossil fauna including: fishes, turtles, crocodilians, birds, bats, and insects. Flora include leaves, branches, seeds, pollen, and flowers. Of the three members comprising the Green River Formation, the Parachute Creek Member represents the most important paleontological resource of the formation. Class Ib paleontological resource.
Tertiary	Eocene	Douglas Creek Member (Green River Formation)	640-720	Gray, brownish gray, and greenish gray claystone, variably silty and dolomitic; also considerable dolomitic shale and marlstone. Grades into the Parachute Creek Member in the eastern portion of the study area.	Locally, Douglas Creek Member overlies the Garden Gulch as a result of a facies change. East of study area Garden Gulch overlies Douglas Creek.
Tertiary	Eocene	Garden Gulch Member (Green River Formation)	680-730	Papery and flaky marlstone and shale contains some beds of oil shale and locally thin beds of marlstone.	
Tertiary	Eocene	Anvil Points Member (Green River Formation)	300-400	Sandstone, siltstone, and silty claystone; some papery fissile kerogen-rich shale. Sandstone is fine grained to medium grained, medium to massive bedding. Grades into Gulch, Douglas Creek, and lower part of the Parachute Creek Member in the southeastern portion of the study area.	
Tertiary	Eocene	Wasatch Formation	200-5,000	Clay, shale lenticular sandstone locally beds of conglomerate and limestone. Beds of clay and shale are the main constituents of the formation. Contains gypsum.	Extensive fossil vertebrate fauna. Major areas of collecting southwest and northwest of the study area. Class Ib paleontological Resource.

Source: Coffin et al. (1971); Hail (1978); Lucas and Kihm (1982).

[a] Thickness as identified by Hail (1978) in the property area.

located a prominent lineament in the Central Piceance Basin. This lineament is inferred as a causative strcture for a 6.5 magnitude earthquake which affected an area of approximately 193,050 square miles on November 7, 1982.

The paleontological resources of the region are diverse and have been previously discussed in detail by Lucas and Kihm (1982). In the region, the Wasatch, Green River, and Uinta Formations are all fossil-bearing. Fossil types range from numerous vertebrates in the Wasatch Formation to fishes and insects in the Green River Formation. A summary of typical fossil assemblages by formation is also presented in Table 3.1-1.

Common to the proposed development of the Getty and Cities Service projects are the La Sal syncrude pipeline and the GCC Roan Creek water supply reservoir and corridor. These have been previously addressed in the Clear Creek Shale Oil Project EIS (BLM 1983a). However, another common corridor not presently addressed is a 2-mile link on the Getty property with the La Sal pipeline located north of the project area. This corridor is underlain by the nearly flat-lying Uinta Formation and portions of the Green River Formation intertongued with the Uinta. Portions of the corridor are covered by alluvial, colluvial, and eolian (wind-blown) deposits. Geologic hazards, such as faults and landslides, are not present along the syncrude pipeline corridors near the project area (BLM 1983a).

The Roan Creek water supply reservoir and associated power, transport, and water corridors are underlain by the sediments of the Wasatch Formation and are covered by a fill of valley alluvium and a veneer of mass-wasting deposits (BLM 1983a). Potential geologic hazards in the corridor may include slope instabilities in talus and landslide deposits, rockfall and debris avalanching along steep valley slopes and debris flows on alluvial fan deposits. No significant mineral resources have been identified in the Roan Creek corridor, although sand and gravel may be utilized on local basis (BLM 1983a).

3.1.2 Surface Water

Resource properties for the Getty and Cities oil shale projects are located in the Roan Creek and Parachute Creek drainages. Both drainages flow south and drain into the Colorado River. In Colorado, this river is the principal drainage on the west side of the Continental Divide. The project sites are approximately 12 to 15 miles from the Colorado River, north of the Town of De Beque. The Colorado River at the USGS gaging station (09093700) near De Beque is at an elevation of 4,940 feet. Based on stream flow data collected at the gaging station (which is about 5 miles above the confluence of Roan Creek, and 7 miles from the Parachute Creek confluence), the Colorado River had a peak flow of 32,200 cubic feet per second (cfs) during June 1983 (USGS 1983), and a minimum daily flow of 916 cfs on 22 December 1977. The average discharge for 15 years of record (1966-1981) is about 3,511 cfs. The maximum flows on the Colorado River system generally occur during the months of May and June, in response to runoff from snowmelt. The minimum flows usually occur during the winter months, when the majority of the flow is comprised of ground water drainage. Low flows also occur late in the summer as a result of irrigation demand, especially in the Grand Valley near Grand near Grand Junction (Getty 1983a; Cities Service 1983a).

Dissolved and suspended solids concentrations have been recognized as the most prevalent water quality problems in the Colorado River Basin. The average annual flow weighted salinity (total dissolved solids or TDS) concentration of the Colorado River at the De Beque gaging station is estimated to be 418 mg/l (milligrams per liter), based on water quality data from 1973 to 1980. The projected salinity level for the Colorado River at Imperial Dam during 1982 was about 825 mg/l (CRBSCF 1981). Suspended sediment concentrations for the Colorado River at the gaging station vary wildly from 2 mg/l to 2,090 mg/l (CDM 1983i). Monthly average concentrations range from 9.4 mg/l in November to 595.0 mg/l during May of 1975. The annual discharge of suspended sediment for water years 1975 and 1976 were 996,700 tons and 331,990 tons, respectively. Assuming that sediment has an average unit weight of 70 pounds per cubic foot, mean annual sediment yield was estimated to be approximately 0.09 acre-feet/square mile (ac-ft/sq mi) in 1975 and 0.03 ac-ft/sq mi in 1976 for the upper Colorado River basin.

Roan Creek

Roan Creek, which is a tributary of the Colorado River at De Beque, is composed of several named creeks, including Conn Creek. The drainage area of Roan Creek at the Colorado River confluence is about 515 square miles. The source of water for Roan Creek, a perennial stream, is snowmelt, rainfall, and numerous springs and seeps. The orientation of the basin trends from the northwest to southeast. Topography can be divided into three zones; plateau, canyon/valley walls, and valley floor. The plateaus make up about 40 percent of the drainage area, most of which is above 7,000 feet in elevation. The canyon/valley walls comprise another 40 percent of the area and the valley floors, at or below 5,000 feet elevation, account for the remainder of the area.

The gradient of Roan Creek near the confluence with Conn Creek is 0.37 percent. The Roan Creek channel is relatively unstable with significant meandering, braiding, and lateral gravel/sand bars. Stream banks are often undercut and highly erodible. Sparse riparian vegetation and some shrubs and grasses help to stabilize the channel. Roan Creek carries a very high sediment load during periods of moderate to high flow (BLM 1983a). Roan Creek has been historically identified as a high sediment yield area with annual erosion rate of approximately 1.0 ac-ft/sq mi; the mainstems of Roan Creek, Conn Creek, and Clear Creek have estimated sediment yields ranging from 1.1 to 2.1 ac-ft/sq mi (CDM 1983i).

Stream flow in Roan Creek at USGS station 09095000 has averaged 42.2 cfs for 21 years of record. Flows ranged from 3.2 cfs (25 November 1963) to 2,765 cfs (May 1983; Getty 1983d). Stream flow varies seasonally with the high flow season occuring from April to July (BLM 1983a). Runoff, based on a drainage area of 321 square miles, is 1.8 inches per year. At times it has been reported that the creek is dry.

The prime water use in the Roan Creek basin is for irrigation. Irrigation ditches (about 87 diversions have been identified) are used to irrigate approximately 4,020 acres of land (Getty 1983a; Cities Service 1983a). The flow in the creek is insufficient to meet the crop consumptive use, except at times of high snowmelt or precipitation runoff.

Roan Creek and its tributaries extending upstream from the confluence with Clear Creek have been recommended by the Colorado Department of Health for water supply, irrigation, and cold water biota classification (CDOH 1982). Roan Creek (between the Clear Creek and Colorado River confluences) meets the criteria necessary for classification for irrigation and warm water biota usage. Regarding water quality, Roan Creek has high sulfate concentration due to the presence of the Wasatch Formation, which contains an abundant quantity of calcium sulfate. Average annual sulfate concentration in 1982 was about 252 mg/l for Roan Creek, downstream of Kimball Creek, thereby exceeding the 250 mg/l specified by Colorado Water Quality Standards (CDOH 1982).

Parachute Creek

Parachute Creek drains an area of approximately 200 square miles of the Roan plateau. It flows into the Colorado River at an elevation of approximately 5,090 feet at the Town of Parachute. The drainage basin characteristics of Parachute Creek are similar to Roan Creek. Tributaries include Davis Gulch, Middle Fork, East Fork, West Fork, and East Middle Fork of Parachute Creek. There are numerous springs, gulches, and arroyos along the stream course. Stream flow during the low flow period depends mainly on springs which emerge near or in the creek bed. Based on flow data for the Colorada River from above and below the town of Parachute, Parachute Creek contributes approximately 1 percent of the total flow of the Colorado River. Parachute Creek, at the USGS gaging station 09093500 (approximately 1.4 miles upstream of the confluence with the Colorado River), has a mean daily discharge of 31.0 cfs for the 19 years (period of record 1921-1927, 1948-1954, 1974-1980 Getty 1983a; Cities Service 1983a).

Water quality of the Parachute Creek drainage, including tributaries, generally shows increasing concentrations for most parameters in the downstream direction. No specific parameters obtained during a 1983 study exceeded any numeric stream standards (CDOH 1982). Mean concentration of total dissolved solids collected in 1983 for the Parachute Creek drainage basin ranged from 310 mg/l to 422 mg/l (Getty 1983a; Cities Service 1983a).

3.1.3 Ground Water

3.1.3.1 Regional Setting

Ground Water Occurrence

The Getty and Cities oil shale properties are located on the southern flank of the Piceance Structural Basin. This northwest-trending trough is the dominant structural feature of the region, although faulting and folding do occur. The Crystal Creek Anticline and Clear Creek Syncline are examples of such localized structures, both of which occur at or proximal to the sites.

The principal bedrock aquifers in the Piceance Basin area occur within the Green River Formation. The overlying Uinta Formation, to a lesser degree, may store and transmit ground water, while the underlying Wasatch Formation is typically devoid of significant aquifers. Alluvial deposits within the stream valleys of major drainages (e.g., Piceance, Yellow, Roan, and Parachute creeks) also carry significant quantities of ground water.

The Uinta Formation crops out on ridge tops in the area, representing the youngest strata. Ground water generally occurs under fracture-controlled (secondary) permeability, rather than interstitial porous spaces of the rock matrix (primary permeability). Well yields as high has 100 gallons per minute (gpm) have been reported from the Uinta Formation (Weeks et al. 1974), but such conditions are more prevalent towards the center of the basin, rather than near the margins. Transmissivities for Uinta strata follow a similar trend, with values of 20,000 gallons per day per foot (gpd/ft) encountered in the basin interior, but only 3,000 gpd/ft or less along the flanks (Coffin et al. 1971). Furthermore, along the southern boundary of the basin, the Uinta has been deeply incised by stream drainages, creating a drained condition with less potential to retain ground water.

The underlying Green River Formation is generally divided into three members in the Piceance Basin. These are (in ascending order): the Douglas Creek, Garden Gulch, and Parachute Creek members. Oil shale horizons and ground water occurrence are largely restricted to the latter member. The Parachute Creek Member is divided into upper and lower units, with the kerogen-rich Mahogany Zone in between. Similarly, ground water occurs in two distinct zones corresponding the upper and lower Parachute Creek Members, referred to as the upper and lower aquifers, respectively. The upper aquifer includes the Uinta Formation over much of the region, and the Mahogany Zone is regarded as a relatively impermeable barrier between the upper and lower aquifers. Permeability within both aquifers is largely controlled by the presence of fractures and solution cavities. Leached zones (voids and solution collapse breccia formed by dissolution of soluble minerals) have been identified within the upper and lower Parachute Creek Members, and provide the most permeable zones within the respective aquifers. Well yields as high as 1,000 gpm or more have been reported for each aquifer throughout the Piceance Basin. Data from the southern portion of the basin, however, indicate that the lower aquifer is largely absent in this area, owing to a lack of fractures and solution features.

Recharge to the upper aquifer occurs throughout the basin largely through the infiltration of precipitation and snowmelt. Recharge to the lower aquifer is limited, occurring by infiltration in outcrop areas and some downward movement from the upper aquifer via fractured zones. Ground water flow in the Piceance Basin is generally towards the basin center, although local variations on this trend occur, particularly along basin margins (Coffin et al. 1971). In general, bedrock aquifers beneath the Getty and Cities Service properties are hydrogeologically isolated from the remainder of the basin. More detailed site-specific data to be collected during mine permitting studies will allow further delineation of hydrogeologic conditions, including potentiometric surfaces and their relationship to regional trends.

Alluvial aquifers beneath principal stream valleys of the Piceance Basin are generally less than 0.5 mile in width, and range in thickness from 0 to 140 feet (Coffin et al. 1971). Saturated thicknesses as high as 100 feet have been reported for the Piceance Creek drainage. Well yields as high as 2,000 gpm have been reported, but long-term maintenance of these rates may be restricted by the limited lateral extent of the valley bottom deposits. Recharge to the alluvial aquifers occurs via discharge from bedrock aquifers and infiltration of precipitation and streamflow.

Ground Water Quality

The water quality of alluvial and bedrock aquifers is quite variable. Water quality in bedrock aquifers is dependant on lithology, depth, and location within the Piceance Basin, whereas water quality of the alluvial aquifer is largely a function of the lithochemistry of the deposits.

Concentrations of total dissolved solids (TDS) exhibit a general increase with depth and with increasing distance from recharge areas. As a result, higher TDS values are typically associated with the lower aquifer (as opposed to the upper aquifer), and occur more towards the center of the basin. TDS concentrations range from 250 mg/l in the upper aquifer near the basin margin to up to 50,000 mg/l or more in the lower aquifer near the basin center (Coffin et al. 1971). Bedrock ground water is generally a sodium bicarbonate type, although appreciable concentrations of calcium, magnesium, chloride, and sulfate may also occur. Additional water quality data to facilitate comparison with site-specific conditions will be necessary during the mine permitting process.

Water quality in the alluvial aquifers is similarly variable with general down-gradient increases in TDS (Weeks et al. 1974). TDS values range from 250 mg/l to as high as 25,000 mg/l. The latter concentration typically occur in lower reaches of drainages where strata of lower Green River or Wasatch Formations are exposed (Coffin et al. 1971). In general, the alluvial water quality is largely a function of the dissolution of minerals within the alluvial deposits, recharge conditions associated with streamflow or adjacent bedrock strata, and irrigation return flow. Alluvial ground water ranges in water type from calcium/magnesium-bicarbonate to sodium-bi-carbonate.

3.1.3.2 Common Project Facilities

The proposed common corridor within the Getty property crosses upland and valley areas. The upland areas are underlain by Uinta and Green River Formation strata, whereas valley areas include the upper reaches of the West Fork (and Wet Fork tributary) of Parachute Creek. Hydrostratigraphic units in these environments, therefore, include fractured/leached marlstones of the upper Parachute Creek Member of the Green River Formation, and alluvial deposits within the drainage valleys.

Site-specific data are limited to a survey of springs in the corridor area (Getty 1983a). These data are suggestive of several probable characteristics of the hydrogeologic environment:

- Uinta and upper Parachute Creek members are at least partially saturated, with various points of spring discharge at or near their contact.
- Discharge from these bedrock strata probably provides for some saturation of alluvial deposits.
- Based on topographic and surficial geologic data, the alluvial deposits are likely thin and unstratified, and do not represent a significant aquifer.
- Based on limited conductivity and pH data, the water quality of discharging springs appears to be typically good.

All of the springs emanating from bedrock strata along or near the corridor discharge into the Wet Fork of the West Fork of Parachute Creek. In this manner, bedrock aquifers serve as a recharge mechanism for alluvial deposits in the West Fork, as well as potential contributors to base stream flow in that drainage.

Ground water characteristics of the Roan Creek reservoir site are addressed in BLM (1983a). To summarize, the Roan Creek water supply reservoir and associated corridor is underlain by alluvial and other unconsolidated deposits. The deposits, in turn, are underlain by bedrock strata of the Wasatch Formation. Bedrock of the Wasatch Formation is generally not considered a significant source of ground water, although some lenticular sandstone aquifers may occur in the Shire Member. The Roan Creek valley contains alluvial deposits that can be classified as an aquifer. No site-specific data are available on this aquifer, but existing water use, including nine wells in the vicinity (BLM 1983a), indicates that at least some of the sediments are sufficiently permeable and saturated so as to allow ground water extraction for domestic, stock, and irrigation use.

3.1.4 Aquatic Ecology

3.1.4.1 Regional Setting

The Getty and Cities Service properties are located in Garfield County, north of De Beque, Colorado. All of the Cities Service property and the majority of the Getty property lie within the upper Colorado River drainage basin.

The mainstem of the Colorado River has received much attention recently as a result of the proposed regional energy development. From De Beque Canyon to the Colorado-Utah border the river is generally turbid, carrying high dissolved salt concentrations and heavy sediment loads. Irrigation return flow greatly adds to the turbidity and salt content to the stream (Kidd 1977). The mainstem of the Colorado River, from the confluence with the Roaring Fork River to immediately below the confluence with Parachute Creek, is designated as suitable for Class 1 cold water biota. The river from immediately below Parachute Creek to immediately above the confluence of the Gunnison River is designated for Class 1 warm water biota (CDOH 1983a). The cold water reach, along with the headwaters of many Colorado River tributatries, support trout fisheries. The reach below Parachute Creek primarily supports channel catfish and members of the sucker and minnow families. Sunfish, including largemouth bass, are locally common in flooded pond and gravel pit areas (Holden and Stalnaker 1975). In addition, three federally-listed endangered species are native to the Colorado River within this region: Colorado squawfish (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), and bonytail chub (*Gila elegans*). The razorback sucker (*Xyrauchen texanus*), listed as an endangered species by the State of Colorado and expected to be proposed for federal threatened status in the near future, is native to this area.

Three drainages within the Colorado River system are particularly important because of their direct association with oil shale development. These include the Roan, Parachute, and, to a lesser degree, Piceance Creek drainages.

The Roan Creek drainage is characterized as having a low to medium fishery potential (EPA 1979). The flow fluctuates highly and is dependent upon spring runoff, storm events, and irrigation practices of the area. At times it has been reported that lower Roan Creek is dry. The system generally carries high suspended and dissolved solid loads, especially during periods of moderate to high flow. Water quality deteriorates with distance from the headwaters (Cities Service 1983a; Woodling 1977). The stream channel is unstable, with eroding, undercut banks. The substrate at the headwaters consists of cobble and gravel and becomes generally silt- and gravel-dominated near the mouth (Cities Service 1983a).

Six species of fish occur within the Roan Creek basin. These include: rainbow trout, cutthroat trout, brook trout, bluehead suckers, speckled dace, and mottled sculpin (ERT 1981). No state or federally-listed threatened or endangered species occur within the drainage. The Colorado River cutthroat (*Salmo clarkii pleuriticus*), a candidate endangered species, occurs in upper Carr Creek (Grody 1983). The trout populations are generally limited to the upper reaches of Willow Creek, East and West Fork of Willow, and Clear Creek. However, a sparse number do occur in the mainstem of Roan Creek above the Roan-Clear Creek confluence (CDOW 1983a). Below this point, the water quality degrades and only the warm water species occur. Many of the tributaries of the Roan drainage are intermittent, lacking sufficient water to support a viable fishery (Cities Service 1983a).

Fishery potential of the Parachute Creek and West Fork Parachute Creek are also low to moderate (EPA 1979). The Parachute Creek drainage supports a fishery similar in composition to the Roan Creek drainage. Four species occur including brown, rainbow and cutthroat trout, bluehead sucker, and speckled dace. The candidate species, Colorado cutthroat, occurs only in the upper reaches of East Fork and in Northwater Creek and Trapper Creek, tributaries of East Middle Fork (BLM 1975). These streams are not expected to be impacted by either the Getty or the Cities Service projects.

Piceance Creek is a tributary to the White River in the Green River system. The White River in the vicinity of Piceance Creek is designated for Class 1 warm water aquatic life (CDOH 1983). The species composition is similar to that of the Colorado River. Piceance Creek, from the Emily Oldland diversion dam to the confluence with the White River, is designated for Class 2 warm water biota (CDOH 1983). The mainstem of Willow Creek to its confluence with the Piceance Creek is suitable as a Class 1 cold water stream, as are many of the tributaries within the White River drainage. Relatively pure Colorado River cutthroat trout populations are reported to occur in Willow Creek, as well as other tributaries of the White River, including East Fork, Lake Creek, and Soldier Creek, all tributaries of Douglas Creek (BLM 1983a).

3.1.4.2 Common Project Facilities

A proposed common facility includes a 3-mile section of syncrude pipeline. The pipeline corridor runs north-south and is situated in the northern portion of the Getty property. The pipeline is generally located in the Parachute drainage, crossing the upper canyon areas of Wet Creek and West Fork of Parachute Creek. No permanent water is crossed by or adjacent to the proposed pipeline.

3.1.5 Soils

Soil characteristics in western Colorado are generally affected by parent material and source rock, position on the landscape, elevation, precipitation, temperature, aspect, vegetation, and slope. Due to strong variation in all of these influences, the soils in western Colorado exhibit great diversity. The Getty and Cities Service project sites occur on three broad physiographic types: upland plateau, canyon valleys, and low semi-arid lands. Geographically, these positions are the Roan Plateau, the Roan Creek valley (and its tributaries), and the Colorado River valley including the Grand Valley. General soil characteristics of these physiographic types are summarized in Table 3.1-2.

The upland plateau areas are rolling to steep. Sandstone and marlstone comprise the principal bedrock and source of soil parent material of the plateau area (Cashion 1967). These sedimentary units, being relatively weak and permeable with uniform lithology, produce rough terrain with a dendritic stream pattern.

The climate on the plateau is relatively cool and moist. The mean annual air temperature is 36 to 40 °F. For elevations around 8,000 feet, the Soil Conservation Service reported precipitation ranging from 18 to 22 inches (SCS unpublished). Due to moisture conditions and the short growing season (usually less than 90 days), none of the plateau is recognized as prime farmland by the SCS (1979a, 1980).

Soils on the plateau are shallow to deep and have developed on easily weathered sedimentary materials that usually produce loamy soils predominantly derived from the Uinta formation. Most of the soils are heavily vegetated, neutral to slightly acid, and have thick, dark, surface horizons. Northwater and Rhone soils occur on north-facing slopes and are deep, with many channery fragments in the subsoil. Irigul and Dateman soils are very channery, shallow to bedrock, and occur on ridge crests and south-facing slopes. Pachic Cryoborolls, which occur on bottomlands of narrow plateau valleys, are deep, dark colored, and generally loamy (CDM 1983b; SCS unpublished).

Climate in the canyon valleys is influenced by topographic features such as slope, aspect, and elevation. The north-facing slopes are colder and more moist than the south-facing slopes because of less exposure to the sun. This affects vegetational growth and soil development. The mean annual precipitation ranges from 12 to 18 inches. The average annual air temperature ranges from 36 to 52 °F and the frost free season is 80 to 150 days (SCS unpublished).

The canyon valleys consist of high, steep rock walls (Green River and Wasatch Formations), colluvial (talus) side slopes, and valley bottoms. The valley bottoms consist of alluvial and colluvial materials which slope gently upward from the edge of the drainage to the base of the steeply sloping rock walls. Also included in the alluvial bottom are numerous, small, coalescing, alluvial fans at the mouths of lateral tributaries.

The dominant soils in the canyon valley are Gunsone Variant, Sunup, Panitchen, Youngston, Nihill, and Dominguez. The Gunsone Variant and Sunup soils commonly occupy steeper sloping areas, while Panitchen, Youngston, and Dominguez occur in gently sloping valley bottoms. Nihill soils occupy both steeply and gently

Table 3.1-2 GENERAL SOIL CHARACTERISTICS OF THE THREE PHYSIOGRAPHIC TYPES OCCURRING WITHIN THE GETTY AND CITIES SERVICE PROJECT AREAS

Physiographic Type	Depth	Drainage	Dominant Parent Material	Source Rock Formation	Dominant Surface Horizon Color	Particle Size Class[a]	Water Holding Capacity (in.)	Permeability
Upland Plateaus	Shallow to Deep	Well to Excessive	Alluvium Residuum Colluvium	Uinta	Dark	Loamy[b], Loamy-Skeletal	Low, High[b]	Moderate to Rapid
Canyon Valleys								
Steep Sideslopes	Deep	Somewhat Excessive	Colluvium	Green River	Light	Loamy[c] Skeletal	Low, Moderate[b]	Moderately Rapid or Slow
Bottomlands	Deep	Well[c]	Colluvium Alluvium	Wasatch/ Green River	Light	Clayey[b], Loamy[b], Loamy-Skeletal	Moderate[c]	Moderate to Rapid
Low Semi-Arid Lands	Shallow to Deep	Well and Poorly	Residuum Colluvium Alluvium	Wasatch	Light	Loamy, Clayey	Low to High	Slow to Moderate

Physiographic Type	pH	Saline (>8 mmhos/ cm)	Sodic (SAR >13)	Range in Elev. (ft.)	Growing Season (days)	Mean Soil Temp. (°F)	Mean Annual Precip. (in.)	Estimated Acres of Prime Farmland
Upland Plateaus	6.1 to 7.3	No	No	6,800 to 8,500	45 to 95	36 to 42	18 to 25	0
Canyon Valleys								
Steep Sideslopes	7.9 to 8.4	Yes[b]	Yes[b]	5,800 to 7,200	95[d]	40 to 46	12 to 26	0
Bottomlands	7.4 to 7.8	No	No	5,000 to 6,500	95 to 150	42 to 52	11 to 16	5,000
Low Semi-Arid Lands	7.4 to 9.4	Yes[b]	Yes[b]	4,000 to 6,400	130 to 170	50 to 54	7 to 12	60,000

Source: BLM (1983a); SCS (1979a,b unpublished).

[a] Skeletal = greater than 35 percent by volume rock fragments
[b] In some areas
[c] Commonly
[d] Approximation

sloping areas. If irrigation water is supplied, Panitchen and Youngston soils are considered prime farmlands (SCS 1983). More specific characteristics and interpretations of canyon valley and upland plateau soils are presented in Table 3.1-3.

Soil erosion rates are generally higher for canyon valley than plateau, due to slope, texture of the soil surface, and /or vegetation cover differences.

SCS prime farmland maps (SCS 1979a, 1979b) in this part of Colorado are based on old, broad soil maps. Due to the completion of more detailed soil mapping by the SCS in the past year (SCS unpublished), and an updated evaluation of prime farmland was performed. This evaluation consisted of overlaying land use maps and delineating areas of current irrigation onto the detailed soil maps. Those soil map units classified by the SCS (1983) as "prime if irrigated", were considered as prime farmland if they were currently under irrigation. From this analysis, lower stretches of the Roan Creek valley do have areas designated by the SCS as prime farmland.

3.1.6 Vegetation

The Getty and Cities Service shale oil projects are located at the southern margin of the Roan Plateau and include the Parachute Creek and Roan Creek watersheds. The vegetation of the area is typical of the Great Basin and Rocky Mountains and is representative of much of the semiarid landscape of western Colorado and eastern Utah (Kuchler 1975). Plant species which occur in the area are derived at lower elevations from the desert flora of the southwest and from the Rocky Mountain flora at higher elevations.

The gently rolling Roan Plateau has been deeply dissected by numerous permanent and ephemeral watercourses which are tributary to the Colorado River. The plateaus, deep canyons, and broad valley bottoms of the region are dominated by a variety of mixed (evergreen and deciduous) desert shrublands. Below an elevation of 8,000 feet, forest vegetation is restricted to riparian areas, north-facing slopes, and leeward slope positions with persistent spring snow. Composition of vegetation varies through distinct responses of plants to a regional relief of 4,500 feet, landforms ranging from cliffs to nearly level valley bottoms, complex sedimentary geology and soil development, climatic variation controlled by topography and elevation, and the historical impact of domestic and wildlife grazing use.

As elsewhere in Colorado, change in vegetation along the altitude gradient provides useful information on local ecosystems. With the exceptions of grasslands and riparian woodlands, the major regional vegetation types fall within four climatic zones (Graham 1937). An outline of the vegetation zones is presented in Table 3.1-4.

Differences exist between north- and south-facing slopes in the amount of sunlight received, soil development, and capacity to retain moisture. Due to these differences, the vegetation typical of each zone occurs at higher elevations on south-facing slopes and at lower elevations on north-facing slopes.

Total plant cover, shrub density, and plant productivity generally increase with elevation due to increased precipitation (CDM 1983a). Because of limited accessibility and seasonal use, the plateau vegetation has a lower livestock utilization than vegetation of the valleys. Except for irrigated pasture and hayland, the valley plant communities generally have lower plant cover values and productivity values than plateau communities, but because of accessibility are moderately to heavily grazed by livestock. Consequently, the range condition of the plateau is better than that for the valleys.

Eight special concern plant species are known to occur within the Getty and Cities Service project areas. These species occur within the mixed desert shrub zone or on the cliffs or talus slopes of the Roan Plateau. The names and status of these plants are summarized in Table 3.1-5.

For all of the candidate threatened or endangered plants, the USFWS (1980) has stated that listing is probably appropriate. Of the candidate species identified by the USFWS in their 1980 Notice of Review, sufficient biological information (for listing) was thought to be available for two Category 1 species, De Beque phacelia (*Phacelia submutica*) and Sevier blazing-star (*Mentzelia argillosa*). Additional biological information was sought by USFWS for three other species (Category 2).

Table 3.1-3 SELECTED SOIL CHARACTERISTICS AND INTERPRETATIONS FOR THE GETTY AND CITIES SERVICE RESOURCE PROPERTIES

Soil	Characteristics[a]						Interpretations					
	Depth	Drainage	Particle Size Class	Avail. Water Holding Capacity	Permeability	pH	Saline (>8 mmhos/cm)	Sodic (SAR >13)	Water Erosion Rate tons/ac/yr	Wind Erosion Rate tons/ac/yr	Estimated Topsoil Stripping depth - ft	Acres of Prime Farmland
PLATEAU SOILS												
Pachic Cryborolls	deep	well	loamy	low	moderately rapid	6.0 – 7.8	No	No	0.8	1	6.0	0
Dateman	moderately deep	well	loamy-skeletal	low	moderate	6.0 – 7.8	No	No	2.9	1	1.0	0
Irigul	shallow	well	loamy-skeletal	very low	moderate	6.0 – 7.8	No	No	1.6	1	0.5	0
Rhone	deep	well	loamy	moderate	moderately slow	6.0 – 7.8	No	No	0.8	1	5.0	0
Starman	shallow	well	loamy-skeletal	very low	moderate	7.4 – 9.0	No	No			0.0	0
Adel	deep	well	loamy	moderate	moderate	6.0 – 7.4	No	No	3.5	1	5.0	0
Northwater	deep	well	loamy-skeletal	moderate	moderate	6.8 – 7.8	No	No	3.3	1	3.0	0
Unnamed	moderately deep	well	loamy-skeletal	low	moderate	6.0 – 7.4	No	No	0.5	1	2.0	0
CANYON VALLEY SOILS												
Gunsone Variant	deep	well	loamy	moderate	slow	7.9 – 8.4	No	No	6.5	1	5.0	0
Panitchen	deep	well	loamy	high	moderate	7.9 – 9.0	No[b]	No	0.1	1	0.0	884[c]
Sunup	shallow	well	loamy-skeletal	very low	moderate	7.4 – 9.0	No	No	3.2	1	0.5	0
Youngston	deep	well	loamy	high	moderate	7.4 – 9.0	No[b]	No			5.0	440[c]
Grobutte	deep	well	loamy-skeletal	low	moderately rapid	7.9 – 8.4	No	No			0.0	0
Nihill	deep	well	loamy-skeletal	low	moderately rapid	7.4 – 8.4			6.1	1	0.5	0
Utso Variant	deep	well	loamy-skeletal	low	moderately rapid	6.6 – 8.4	No	No			0.5	0
Dominguez	deep	well	clayey	moderate	slow	7.4 – 9.0	No[b]	No	0.9	1	0.0	0

Source: SCS (unpublished).

[a] Skeletal = greater than 35 percent by volume rock fragments (mineral fragments greater than 2 mm).
[b] Typically, but may be saline in lower horizons in some areas.
[c] These numbers reflect acres of prime farmland in areas that are common to both projects.

Only federally listed species are protected under the Endangered Species Act of 1973. However, the USFWS has stated its intent to avoid impacts to candidate plant species (USFWS 1980). The additional Colorado Natural Heritage Inventory (CNHI) "plant species of special concern" which occur in the region are either endemic to Colorado or endemic to western Colorado and portions of eastern Utah. The CNHI-listed species do not have legal status and may not be under consideration by the USFWS for protection.

Uinta Basin hookless cactus (*Sclerocactus glaucus*) is known from 21 localities in 5 counties in Colorado. De Beque phacelia has been located in 11 areas in Garfield and Mesa counties in Colorado. Uinta Basin hookless cactus and De Beque phacelia are restricted, in the project sphere of influence, to the GCC reservoir and corridor. These plants have been addressed in detail in BLM (1983a) and in the Clear Creek Shale Oil Project Biological Assessment (Woodward-Clyde 1983).

Table 3.1-4 VEGETATION ZONES IN WEST-CENTRAL COLORADO

Vegetation Zone	Altitude Range
MIXED DESERT SHRUB	4,500-5,500 feet
JUNIPER PINYON	5,500-7,000 feet
SUBMONTANE SHRUB	7,000-8,000 feet
MONTANE	Above 8,000 feet

Source: Graham (1937); BLM (1983a).

Table 3.1-5 PLANT SPECIES WITH FEDERAL OR STATE STATUS

Scientific Name	Status	Common Name
Endemic Desert Plants		
Sclerocactus glaucus	Threatened	Uinta Basin Hookless Cactus
Phacelia submutica	Candidate Category 1	DeBeque Phacelia
Endemic Plants of Moist Cliffs		
Aquilegia barnebyi	Candidate Category 2	Barneby Columbine
Sullivantia hapemanii var. *purpusii*	CNHI list	Sullivantia
Endemic Plants of Talus Slopes		
Astragalus lutosus	Candidate Category 2	Dragon Milkvetch
Festuca dasyclada	Candidate Category 2	Fescue
Mentzelia argillosa	Candidate Category 1	Sevier Blazing Star
Thalictrum heliophilum	CNHI list	Sunloving Meadow Rue

Source: CDNR (1982); USFWS (1980).

3.1.7 Wildlife

3.1.7.1 Regional Setting

The Getty and Cities Service project areas lie within the southern portion of the Piceance Basin, a geographic area characterized by strong topographic relief and narrow stream valley corridors (Burke and Vlachos 1974). Semi-arid vegetation characteristically lines the valley floors and canyon walls, while mixed mountain shrubland, aspen, and Douglas-fir forests cover the Roan Plateau. The occurrence and distribution of wildife species are strongly influenced by vegetational and climatic features of the area and the availability of water. Wildlife species in the region are representative of those associated with the Colorado Plateau and Rocky Mountain provinces as described by Bailey (1980).

Four big game species occur within the region: mountain lion, black bear, elk, and mule deer. Mountain lions are relatively abundant in the northwestern part of the state, including the area north of the Colorado River and west of Rifle and Meeker (Armstrong 1972). Mountain lion habitat is essentially the same as that of mule deer, its principal prey (Mackie et al. 1982). Lions also tend to prefer rocky cliffs, ledges, or other areas that provide cover (Mackie et al. 1982). Game Management Unit (GMU) 31 which includes the project areas, has a population of approximately 15 mountain lions and yields a relatively large number of animals during hunting season compared with that harvested in adjacent GMU's (Cities Service 1983a; Getty 1983a).

Black bears are found in timbered and brush-covered portions of the region between 6,000 and 9,000 feet (Bissell 1978; ERT 1981). Prime black bear habitat is characterized by relatively inaccessible terrain, thick understory vegetation, and abundant sources of food in the form of shrub or tree-borne soft or hard mast (Pelton 1982). McKean and Neil (1974) estimate that, in 1972, GMU 31 supported a bear population of 4 to 15 animals. About 500 bears are estimated to occur in Garfield County (Cities Service 1983a; Getty 1983a). During the 1979 to 1981 period, Garfield County was among the most productive counties in Colorado for bear hunters (CDOW 1980, 1981, 1982a).

Elk are common migratory residents of the Piceance Basin. Within the last 20 years, the number of elk in the basin has increased, and the species range has expanded to include the upper elevations of the basin. Preferred habitats are those which are in close proximity to timber, water, and broken terrain. Elk calving grounds occur throughout the shrublands and forests of the Roan Plateau (ERT 1981; Gumber 1982). An estimate of the 1982 post- season population density of elk in Data Analysis Unit (DAU) E-10, which includes the project areas, is 2,609 individuals per 2,394,240 acres (Cities Service 1983a; Getty 1983a).

The mule deer is the most abundant big game mammal in the Piceance Basin and Colorado River valley. In fact, the Piceance deer herd is the largest migratory population known in the United States. During the summer, deer utilize a variety of habitat types throughout the plateau and valley portions of the basin. However, during winter, mule deer concentrate in lower elevation sagebrush, juniper, riparian, and agricultural habitats. It appears that deer move from the plateau to lower elevation winter ranges via canyons wherever topography permits their passage (Ellenberger et al. 1982). The CDOW estimates that about 8,907 deer are in DAU 41, which includes the project areas (Cities Service 1983a; Getty 1983a). The estimate is based on a 1982 post-hunting survey of the 618,240-acre unit (Cities Service 1983a; Getty 1983a; Morris 1983). Game harvest statistics for the state show that of the deer taken statewide, between 0.7 and 0.9 percent are from GMU 31 (CDOW 1980, 1981, 1982a).

Numerous mammalian predators, furbearers, small game, and nongame species occur throughout the Piceance Basin. The most common predator species in the region are the coyote, badger, striped skunk, long-tailed weasel, and bobcat (CDM 1983d). Coyote, skunk, and weasel are generally found in all habitats; whereas bobcat prefer rough, broken terrain and rimrock. Badger are typically found in valley shrubland and agricultural areas. Other predators in the region include red fox, gray fox, and ermine. A variety of rabbit and rodent species occur in the Colorado plateau and constitute an important prey base for carnivores and raptors (CDM 1983d). Cottontails and jackrabbits are numerous and occupy shrubland habitats at various elevations. Large rodents such as porcupine, marmot, and muskrat are also prevalent and inhabitat woodlands, rock outcrops, and perennial water sources, respectively. Beaver are also known to occur in perennial streams of the plateau (BLM 1983a). The ubiquitous deer mouse is the predominant small mammal species in the region. Chipmunks, ground squirrels, shrews, and bats are also common and may be found in a variety of habitats.

As many as 223 species of birds may occur in the 2,740 square mile-latilong area which includes the Getty and Cities Service properties (CDM 1983d). Many species of raptors, which include hawks, vultures, eagles, and owls, are found in the Piceance Basin and Colorado River valley. Notable among the raptors which occur in the region are the federally endangered peregrine falcon and bald eagle, and regionally rare osprey and goshawk. Common residents or visitors include prairie falcon, red-tailed hawk, American kestrel, and golden eagle. Important nesting locations for raptors include aspen woodlands, conifer forests, and cliff faces. Prairie falcons and golden eagles are the most common cliff nesters in the region (Enderson 1977).

Upland gamebird species of the region include sage grouse, blue grouse, chukar, and mourning dove. Mourning dove, a summer resident, is the most widely distributed of these species and may be found in a variety of habitats. Sage grouse is intimately associated with sage year-round and use it as a source of escape cover, food, and nesting sites, and for breeding (Cities Service 1983a; Getty 1983a). Blue grouse usually occur in coniferous and aspen woodlands at elevations greater than 6,700 feet. Chukar, an introduced species, inhabits rocky slopes, cliffs, or rock outcrops that are partially covered with sage and cheatgrass.

With the exception of the major river drainages, limited habitat for waterfowl and shorebirds is available in the region. Species such as mallard, common merganser, green-winged teal, killdeer, and spotted sandpiper typically breed in the valley and upland portions of the plateau where riparian and wetland areas afford suitable habitat. Other species including herons, egrets, and geese are most likely to occur along major water courses.

Passerine (songbird) species constitute the major portion of the avifauna community in the plateau region. Burke and Vlachos (1974) report that 128 species of songbirds, including warblers, jays, robins, and crows, may be expected to occur. Recent studies (ERT 1981; CDM 1983d) have shown that most songbirds in the region are closely associated with shrubland habitats of the valleys and plateau. However, conifer, aspen, and riparian habitats also support a highly diverse songbird community with the highest observed diversity and abundance in the aspen cover type (ERT 1981; CDM 1983d).

Amphibians and reptiles are common to the region and include various species of frogs, toads, lizards, and snakes. Most of these species are primarily insectivorous or predatory on other vertebrates (Burke and Vlachos 1974). Amphibians are generally restricted to riparian habitats and ponds; whereas, reptiles are distributed throughout wet and dryland habitats of the region.

Threatened and Endangered Species

Three federally listed endangered wildlife species are known or likely to occur within the region: the peregrine falcon, bald eagle, and black-footed ferret. The peregrine falcon is a rare breeder and winter visitor to northwestern Colorado and may occasionally be present as a migrant (Kingery and Graul 1978). The CDOW (1978) has designated certain areas within this section of the state (including portions of the Colorado River and its tributaries) as essential hunting and nesting habitat for peregrines. Only seven active nest sites are known in the region (Craig 1981, 1983). Nests typically occur in large holes or recesses in cliff faces (Snow 1972). Key peregrine hunting areas are those in which small to moderately-sized prey (songbirds, woodpeckers, and doves are examples of primary prey species) are concentrated or especially vulnerable to predation. Such habitats include riparian areas, wetlands, and pastureland (CDOW 1978).

In western Colorado, the bald eagle is a rare nester, but a locally common winter resident along major rivers. Approximately 200 bald eagles winter annually along major rivers in northwestern Colorado, primarily the Colorado, White, Yampa, and Little Snake rivers (CDOW 1978; Woodward-Clyde 1983). Eagles tend to concentrate where water remains ice-free and where suitable perches and viable fishery are available (Fisher et al. 1981; Lytle et al. 1982). Two major winter concentration areas for bald eagle occur along the Colorado River: one between De Beque and Parachute and the other from the Colorado-Utah stateline west through Westwater Canyon, Utah (Fisher et al. 1981).

The black-footed ferret is a highly specialized carnivore whose distribution in northwest Colorado formerly included the Yampa, White, Gunnison, and Colorado River valleys (CDOW 1978). This species has never been abundant, and few specimens or recorded sightings of individuals exist (Armstrong 1972; CDOW 1978). Historically the distribution of ferret in northwestern Colorado has been coextensive with the distribution of the white-tailed prairie dog, its principal prey item (Torres 1973).

The federally endangered whooping crane and state-endangered sandhill crane migrate through the western half of Colorado (CDOW 1978). Breeding grounds for the sandhill crane are primarily located along the Yampa and White River drainages. The primary concentration area for migrating whooping and sandhill cranes is in the San Luis Valley of south-central Colorado.

Sensitive Habitats

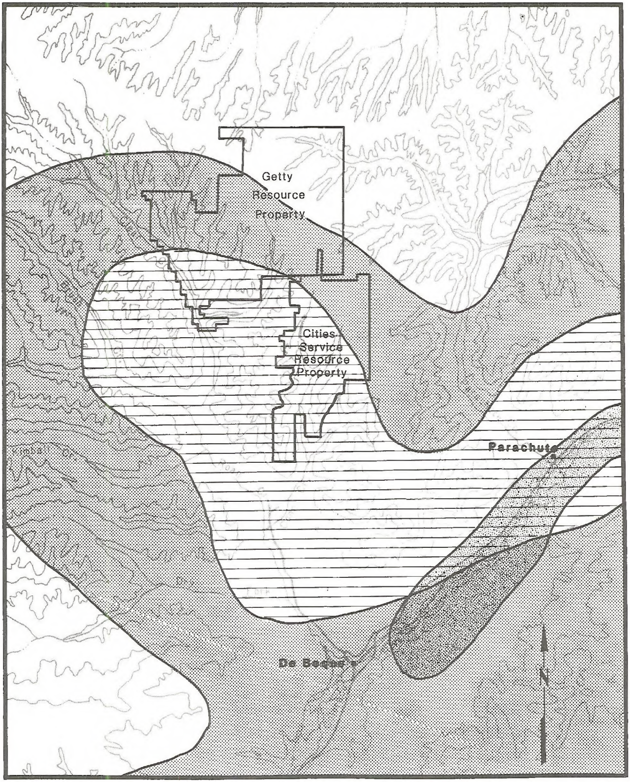
Although no critical habitats for threatened and endangered species have been designated within the region by the Secretary of Interior, sensitive habitats do occur within the region. These habitats provide nesting, foraging, and other seasonal requirements for important wildlife species and therefore represent areas of high sensitivity to disturbance. Locations of several of these areas in relation to the Getty and Cities projects are shown in Figures 3.1-2 and 3.1-3. Essential habitat for the peregrine falcon, illustrated in Figure 3.1-2, represents an area designated by the CDOW (1978) as "absolutely necessary for the maintenance or recovery" of this species. Other sensitive habitats within the area include bald eagle winter concentration areas as well as elk and mule deer winter range (WR), winter concentration areas (WCA), and critical habitat (CH).

In addition to the sensitive areas previously described, four habitats within the region are of special importance to wildlife because of their limited distribution and high value as sources of food and cover for wildlife. These habitats include aspen woodlands, aquatic habitats, riparian woodlands, and cliffs. None of these types are unique to the region; however, their pattern of distribution is an important determinant of the abundance and diversity of wildlife in the region.

3.1.7.2 Common Project Facilities

Wildlife habitats along the common corridor are primarily plateau mixed shrublands interspersed with stands of sage and aspen. Some bare rock areas are also in the corridor. No site-specific data on wildlife species occurrence are available; however, based on regional information as well as baseline data from adjacent properties — Clear Creek (ERT 1981) and Pacific (CDM 1983d) — a variety of wildlife species are likely to occur in or traverse this particular area. Several big game species including mule deer, elk, mountain lion, and black bear, are potentially present. CDOW (1983) has identified critical habitat for elk in the northern portion of the corridor (Figure 3.1-3). White-tailed jackrabbits, porcupine, weasel, coyote, and several species of mice and ground squirrels are also likely to occur in the area.

Raptors and songbirds are the major components of the avifauna community. Typical raptor species include red-tailed hawk, golden eagle, and Cooper's hawk. Cooper's hawk and red-tailed hawk nests occur within 0.5 to 0.75 miles of the corridor. Songbird species which occur in the area are closely associated with the shrubland habitats. Sage and blue grouse may be found in the sagebrush and mixed shrublands, respectively. It is unknown whether or not display or brooding grounds for these gamebirds occur along the corridor. Northern sagebrush lizard, prairie rattlesnake, wandering garter snake, and Woodhouse's toad are a few of the reptile and amphibian species which may occur in plateau shrublands and deciduous forests in the vicinity of the corridor.



LEGEND

SCALE 1:250,000

Bald Eagle High Use Area

Peregrine Falcon Nesting Habitat

Peregrine Falcon Hunting Habitat

Figure 3.1-2 Essential Habitat for the Peregrine Falcon and Bald Eagle Winter Concentration Areas.

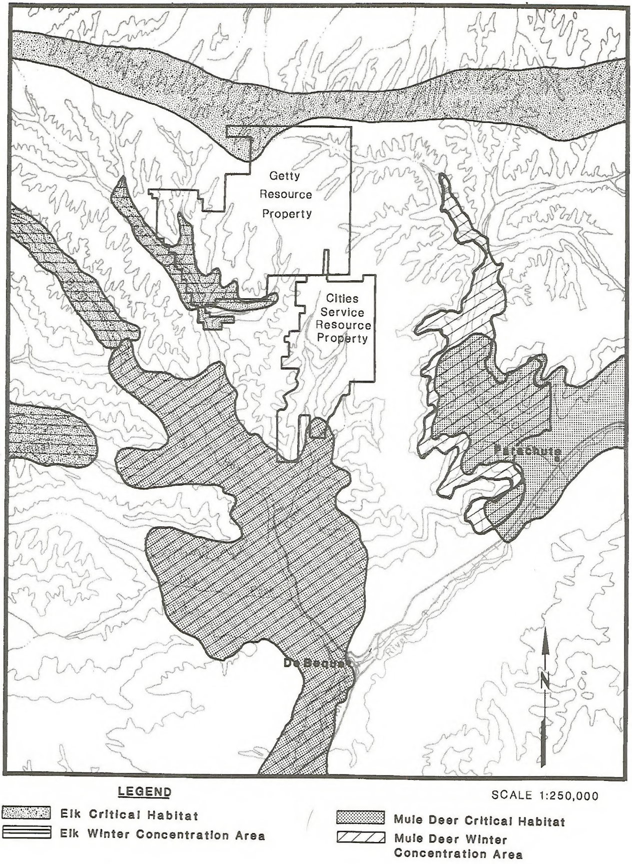


Figure 3.1-3 Big Game Critical Habitat and Winter Concentration Areas.

3.1.8 Air Quality/Meteorology

Climatology

The Getty and Cities Servies shale oil projects are located in the Piceance Basin of northwestern Colorado, specifically on the plateau separating the Roan Creek and Parachute Creek drainages. The project sites, along with pertinent meteorological monitoring sites, air basin boundaries, and the sensitive PSD Class I and Colorado Category I areas, are shown on Figure 3.1-4.

The climate of this area has been classified mountainous and highland, semiarid steppe (Trewartha 1968). These climate types are associated with abundant sunshine, low precipitation, low relative humidity, and large diurnal and seasonal fluctuations.

The meteorological conditions which would affect the dispersion potential of the air emissions from the Getty and Cities Service project areas are, in turn, governed by local topography and synoptic (large scale weather patterns) flow regimes.

The two project areas are located in the mid-latitude belt of the prevailing westerlies. Nevertheless, interaction of low pressure cells and storm tracks which are usually steered north and south along the Continental Divide cause the synoptic, prevailing winds, when unaffected by terrain, to be from the south to southwest at 10-14 mph (Meyer 1975). Figure 3.1-5 illustrates the wind roses from the 10- and 58-meter level measured at the Chevron Clear Creek mesa site (BLM 1983a) and the 10- and 60-meter wind roses composited from Pacific project meteorology and air quality reports (CDM 1983f,g,h). As noted in Figure 3.1-4, these sites are the closest available meteorological and air quality sites to the proposed project.

As can be seen from the data, synoptic flow dominates the air flow on the mesa, while different plateau locations exhibit variability primarily in average wind speed. In the absence of strong prevailing winds, wind movement within the canyons and valleys is extremely complex. Even without actual monitored data for these deep valleys, canyons and gulches, it is possible to describe the predominant flows in a general sense.

In the area, available data (BLM 1983a; CDM 1983f,g,h; Getty 1983a; Cities Service 1983a) suggests that there is a daily exchange of downslope and upslope flows oriented along the valley axis, which are controlled by surface heating and cooling. The downslope flows which last longer occur during the evening, night, and early morning hours, while the upslope flows occur during mid-day (specifically, the warmest part of the day).

Within the Cities Service and Getty project areas, the respective baseline reports (Getty 1983a; Cities Service 1983a) indicate average monthly temperatures range from 10° to 60°F, with diurnal variations of 30°F. In the valleys, canyons, and gulches, average monthly temperatures range from about 20° to 70°F with diurnal variations ranging 30° in winter months and up to 40°F in the summer months. Temperatures on the Chevron property were reported to range from −5° to 82°F, with monthly average ranging 25° to 63°F (BLM 1983a). The 9-month data set measured on the Pacific Property plateau similarly evinces ambient temperatures ranging from −2° to 75°F with the monthly average ranging from 23°F to 61°F over the winter, spring, and summer quarters.

Grand Junction sunshine data (NOAA 1978), which should correlate reasonably well with the project sites, indicate 140 clear days a year from sunrise to sunset.

Precipitation near the project areas is strongly influenced by variation in elevation. Annual precipitation on the plateaus is about 20 inches (USGS 1973). Baseline studies (Getty 1983a; Cities Service 1983a) report that average annual precipitation for areas less than 6,000 feet in elevation is about 12 inches, 6,000 to 7,000 feet is 14 inches, 7,000 to 8,000 feet is about 18 inches, and greater than 8,000 feet is 21 inches. This data suggests an average increase of about 4 inches with a 1,000 feet increase in elevation. Thunderstorms occur about 35 days each year (BLM 1983a) with the highest probability of occurence in August. Summer storms are brief and highly localized with average intensity decreasing sharply with area. Hail occurs rarely. Snow pack data (BLM 1983a) indicate that snow pack begins in early December, and remains until thaw in early April.

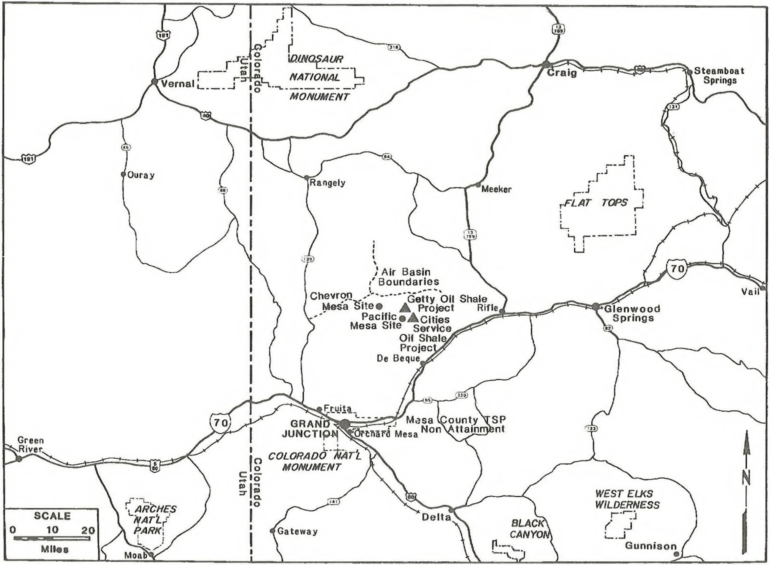


Figure 3.1-4 Locations of Meteorological Monitoring Stations, Air Basins and PSD Class 1 and Colorado Category 1 Areas.

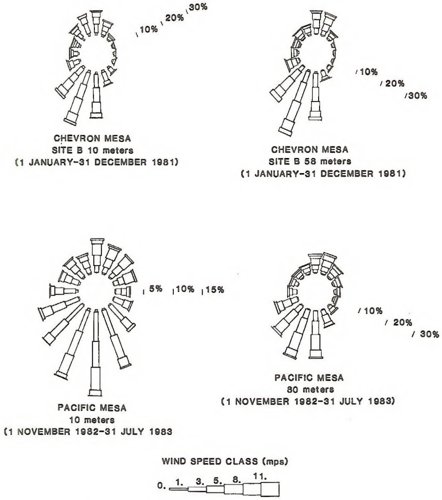


Figure 3.1-5 Wind Speed and Direction Wind Roses Measured on Chevron Clear Creek Mesa and Pacific Project Mesa.

Relative humidity is assumed to be similar to Grand Junction data (NOAA 1978) which is very low (about 30 to 40 percent) during spring through fall, and relatively higher (50 to 80 percent) during winter. Humidity is expected to be slightly drier in the project area due to less evapotransipiration associated with agriculture, coupled with increased elevation.

Evaporation data from the Chevron property (BLM 1983a) totaled 16 inches for the summer of 1981.

Atmospheric stabilities, which are indicators of the capability of the atmosphere to disperse or dilute air pollutants, are available from the 1-year Chevron property data set and the 9-month Pacific set. These are presented in Table 3.1-6.

Adverse meteorological conditions that result in elevated concentrations of air pollutants typically occur when dispersion potential is low, as when atmospheric stability indicates very stable air. These conditions will generally result in the maximum ground level concentration.

Table 3.1-6 REGIONAL DISTRIBUTION OF ATMOSPHERIC STABILITIES

		Chevron Property[a] Annual Stability Percentage	Pacific Property[b] Stability Percentages		
Stability Classification	Pasquill-Gifford Stability Classification	10-m Sigma Theta	Sigma Theta (10-m)	Sigma Theta (60-m)	Delta T (10-60 m)
Extremely Unstable	A	17	6	3	7
Moderately Unstable	B	5	7	4	2
Slightly Unstable	C	8	12	8	2
Neutral	D	34	51	57	29
Slightly Stable	E	16	22	24	52
Moderate to Extremely Stable	F	20	21	4	3

[a] Source: BLM (1983a).
[b] Source: CDM (1983f,g,h).

Air Quality

Sensitive receptors are points in the area of significant impacts that are not within the project boundary, but may be subjected to significant increases in pollutant concentration levels. These receptors are "sensitive" to increases in pollutant levels either from a desire to maintain the area as pristine or clean (PSD Class I and Colorado Category I areas), or due to already elevated levels of air pollutants (non-attainment areas), or due to locations of potential high concentrations (e.g., project boundaries accessible to the public). The sensitive PSD Class I and Colorado Category I areas important to these projects are located on Figure 3.1-4 and include the Flat Tops Wilderness, the Black Canyon of the Gunnison Wilderness, the West Elk Wilderness, Arches National Monument, Colorado National Monument, and Dinosaur National Monument. The Mesa County total suspended particulates (TSP) Nonattainment area is also an area of concern due to the existing high levels of TSP.

The criteria pollutants include sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), total suspended particulates (TSP), and lead (Pb). They are those pollutants for which a primary and or secondary National Ambient Air Quality Standard (NAAQS) has been set by the United States Congress (Clean Air Act 1977). These standards allow comparison of the predicted concentration of these pollutants from proposed facilities in order to evaluate the impact of the facilities on public health and welfare. Quoting from the Clean Air Act, Section 109 (b)(1), the NAAQS *"shall be ambient air quality standards the attainment and maintenance of which in the judgement of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health."* In addition, Section 109 (b)(2) states that the NAAQS *"shall provide a level of air quality, the attainment and maintenance of which in the judgement of the Administrator, based on such criteria, is requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of such air pollutant in the ambient air."* These standards, which are listed in Table 3.1-7, are designed to provide protection with an adequate margin of safety for public health and welfare. Therefore, comparisons are made throughout this EIS to these individual standards, which consequently are used as a guide for determining impacts. In addition to the primary and secondary standards, the EPA has promulgated a program to Prevent Significant Deterioration (PSD) of existing air quality through the use of increments. These increments establish the maximum increase in pollutant concentration allowed above a baseline level. The only pollutants Congress specifically regulated with the incremental approach were

Table 3.1-7 NATIONAL AMBIENT AIR QUALITY STANDARDS AND PSD CLASS I AND CLASS II INCREMENTS

	Primary Standard		Secondary Standard		PSD Increment	
Averaging Period	($\mu g/m^3$)	(ppm)	($\mu g/m^3$)	(ppm)	Class I	Class II
Sulfur Dioxide						
Annual Arithmetic	80	0.03	None	None	2	20
24-Hour[a]	365	0.14	None	None	5	91
3-Hour[a]	None	None	1,300	0.5	25	512
Particulate Matter						
Annual Geometric	75	--	60[b]	--	5	19
24-Hour	260	--	150	--	10	37
Carbon Monoxide						
8-Hour[a]	10,000	9	10,000	9		
1-Hour[a]	40,000	35[c]	40,000	35		
Ozone						
1-Hour[d]	235	0.12	235	0.12		
Nitrogen Dioxide						
Annual Arithmetic	100	0.05	100	0.05		
Lead						
Calendar Quarter	1.5	--	1.5	--		
Hydrocarbons						
3-Hour (6-9 a.m.)	160	0.24[e]	160	0.24		

Source: Clean Air Act (1977).

[a] Not to be exceeded more than once per year.
[b] The secondary standard of 60 $\mu g/m^3$ is a guide to be used in assessing implementation plans to achieve 24-hour standard.
[c] Revision to 28,630 $\mu g/m^3$ and 25 ppm proposed 8/18/80.
[d] Standard attained when the expected number of days per calendar year with maximum hourly average concentrations above 235 $\mu g/m^3$ or 0.12 ppm is equal to one or less.
[e] Hydrocarbon 3-hour standard used only as a guide to develop plans for achieving ozone standard.

SO_2 and TSP. Violation of an increment would impose a restriction to growth for the affected area. It does not necessarily indicate an adverse health impact. The increments for these two pollutants are also given in Table 3.1-7.

Table 3.1-8 presents background air quality for the Clear Creek (BLM 1983a) and Pacific projects (CDM 1983h) compared to federal and state standards. These values should be representative of the Getty and Cities Service project areas. The following discusses the existing conditions of the criteria pollutants.

Sulfur Dioxide (SO_2). Recorded concentrations of SO_2 at the Chevron Cottonwood Station have been very low, which is expected since there are very few industrial sources of SO_2 in the area. The mean annual concentration for the period is about 1 microgram/cubic meter ($\mu g/m^3$) with 3-hour and 24-hour peaks of 17 $\mu g/m^3$ and 14 $\mu g/m^3$, respectively.

Total Suspended Particulate (TSP). The annual geometric mean for TSP for the Chevron Mesa Station is 15 $\mu g/cm^3$. The 24-hour peak concentration is 34 $\mu g/m^3$. The Pacific Project annual TSP geometric mean is 21 $\mu g/m^3$ and the 24-hr maximum is 26 $\mu g/m^3$.

Table 3.1-8 SUMMARY OF REGIONAL BACKGROUND CONCENTRATIONS AND AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	Concentrations ($\mu g/m^3$) Chevron	Pacific	National Standards[a] ($\mu g/m^3$) Primary	Secondary
SO_2	Annual	1	--	80	--
	24-Hour	14	--	365	--
	3-Hour	17	--	--	1,300
TSP	Annual Geometric Mean	15[b]	21	75	60
	24-Hour	34[b]	26	260	150
NO_2	Annual	4	--	100	100
CO	8-Hour	2,500	--	10,000	10,000
	1-Hour	3,000	--	40,000	40,000
O_3	1-Hour	180[b]	--	235	235

Source: BLM (1983a); CDM (1983h).

[a] Colorado standards are the same as the federal standards
[b] Concentration measured at Chevron's mesa station

Nitrogen Dioxide (NO_2). The annual arithmetic mean for January 1981 through December 1981 for NO_2 at the Cottonwood Station is 4 $\mu g/m^3$ and is assumed to be representative of the background.

Carbon Monoxide (CO). The maximum 1-hour and 8-hour values for CO measured at the Chevron Cottonwood Station are 3,000 $\mu g/m^3$ and 2,500 $\mu g/m^3$, respectively.

Ozone (O_3). Ozone data has been gathered at the Chevron Cottonwood and Mesa Stations. A maximum 1-hour concentration of 190 $\mu g/m^3$ has been measured at the Chevron Cottonwood Station and 180 $\mu g/m^3$ has been the maximum measured at the Chevron Mesa Station. The mean for the sampling period is 110 $\mu g/m^3$ at the Cottonwood Creek site, and 84 $\mu g/m^3$ at the Mesa Station (Chevron 1983).

Lead (Pb). No known measurements of lead exist in the vicinity of the project sites. Ambient concentrations of lead should be very low on the properties because of its rural location and corresponding lack of automobiles and industrial sources (BLM 1983a).

Air Quality Related Values

A PSD permit addressing the mining, retorting, and upgrading facilities will be required for both projects. This permit will also require an assessment of impacts to air quality related values such as acid deposition, visibility, and impacts to soils and vegetation. The existing Class I area near the project areas which could be affected is the Flat Tops Wilderness Area in the White River National Forest (43 miles to the northeast). The US Forest Service has recommended (USFS 1981) that a long-term visibility monitoring program be conducted in the Flat Tops Wilderness Area to measure current conditions and predict future emissions of those pollutants that have a potential to degrade visibility. No visibility monitoring program has been conducted by either operator.

The U.S. Forest Service has identified sensitive, poorly buffered, high mountain lakes in the Flat Tops Wilderness Area (Haddow 1982). These lakes are Ned Wilson, Oyster, and Upper Island, and may be sensitive to acid rain impacts due to their poor buffering capacity. Little baseline data is available on current deposition rates.

3.1.9 Noise

Ambient noise is defined as the level of sound associated with a given environment resulting from composite sounds from many sources near and far. Typical sources of ambient noise in western Colorado include automobiles, trucks, airplanes, heavy equipment, wildlife activity, wind (rustling brush or leaves), and flowing water.

The ambient noise level on the Chevron property (BLM 1983a), which should be representative of the Getty and Cities Service properties, is about 40 decibels (dBA). This estimate is based on representative levels according to population densities (U.S. Department of Commerce 1977) and noise level measurements in rural western Colorado (Gulf Oil Corporation - Standard Oil Company 1977). Existing traffic noise levels were determined based on road segments shown in Figure 3.1-6 and traffic volumes from the Clear Creek Oil Shale Project EIS. The calculated noise levels 50 feet from the roadways presented in Table 3.1-9 are based on peak traffic hour volumes of autos and heavy trucks. Railroad and heavy equipment noises are generally nonexistent on Cities Service and Getty sites at this time.

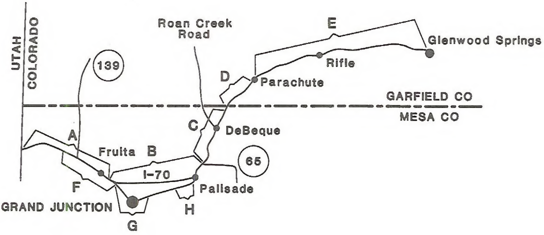


Figure 3.1-6 Regional Road Segments Evaluated for Noise Impacts.

Table 3.1-9 BASELINE TRAFFIC NOISE LEVELS (Leq) EXISTING AND PROJECTED

	Decibel Level (dBA) at 50 feet								
Road[a] Segment	1980	1985	1990	1995	2001	2005	2010	2015	2070
A	74	75	76	76	77	77	78	79	81
B	76	77	77	78	79	79	79	80	83
C	76	77	77	78	79	79	79	80	83
D	76	77	77	79	79	79	80	80	83
E	76	77	77	78	79	79	80	80	83
F	72	73	73	74	75	75	75	76	79
G	82	83	83	83	84	84	85	85	87
H	76	77	78	79	79	79	79	79	83
RCR[b]	46	46	47	47	47	47	48	48	49

[a] See Figure 3.1-6 for locations of road setments
[b] RCR: Roan Creek Road from De Beque to Roan Creek Community Center.

3.1.10 Cultural Resources

3.1.10.1 Archaeology

A characterization of the archaeological setting of the region can be drawn from numerous sources. Notably, the reader is referred to BLM (1983a) concerning references on the archaeological (and historical) background. The region has been inhabited by nomadic groups for the past 10,000 years. Subsistence practices focused on hunting and gathering of available resources on a seasonal basis. Evidence of the earliest inhabitants in the region (i.e., Paleo-Indian tradition cultures) is sparse and is limited to isolated findings of characteristic projectile points.

These earliest cultures survived mainly on the hunting of big game. With a change to warmer and drier climatic conditions at the end of the Pleistocene epoch (approximately 8,000 years ago) came a shift in aboriginal lifestyles. The subsequent Archaic tradition cultures exploited a wider range of available resources, particularly small animals and wild plants.

The appearance of the Fremont culture (A.D. 450) marked the introduction of a horticultural lifestyle into the region as evidenced by the use of cultivated plants, pottery, and above-ground masonry or adobe architecture. Around A.D. 1200, the Fremont culture is no longer evident in the region, presumably due to the decrease in effective moisture. The shift from Fremont peoples to protohistoric groups, represented by Numic-speaking groups, represents an economic shift from the horticultural lifestyle to an exploitative pattern resembling the Archaic lifestyle. The Numic-speaking groups are assumed to be the ancesters of the Ute Indians, who were the inhabitants of the region at the time of Euro-American settlement.

3.1.10.2 History

The history of the region can be described in terms of five major influences in the area: early exploration, the fur trade, Anglo-Ute conflicts, the cattle and mining industries, and Euro-American settlement.

The Dominguez-Escalante expedition in 1776 marks the arrival of the Euro- American presence in the region; this expedition traveled from Sante Fe, New Mexico, up Roan Creek to Douglas Creek. Later expeditions to the area were conducted by John C. Fremont in 1845 and John Wesley Powell in 1868.

Fur trading began during the period of exploration and continued into the 1830s. Two forts, Fort Robidoux and Fort Davy Crockett, were built in the region during the 1830s to centralize the fur trade. Both were abandoned with the demise of the fur trade industry in the early 1840s.

Anglo-Ute conflicts resulted as Euro-American settlers moved into traditional Indian lands. Between 1863 and 1881, a series of treaties were negotiated which resulted in the removal of the Utes from western Colorado and the opening of the area to Euro-American settlement. With the opening of northwest Colorado to white settlement, homesteading began in the region. Settlement along Roan Creek began in 1890, with the incorporation of the town of DeBeque (later spelled De Beque) named after Dr. Wallace A.E. DeBeque who had settled in the area in 1884.

Cattle were initially brought into the region as early as 1843 and became an organized industry in 1868. The construction of the JQS Cattle Trail in 1885 introduced large numbers of cattle to the Roan Plateau. As settlement of the area occurred, sheep and cattle ranching, agriculture, and fruit growing became dominant economic forces.

Mining efforts in the region began in the 1900s and were related to coal mining and oil shale exploration. An early oil shale boom occurred in the region between 1915 and 1925. Numerous attempts to develop oil shale have occurred in the region since that time.

3.1.11 Land Use, Recreation, Wilderness

Land Use

Land uses in northwestern Colorado vary from urban development to rangeland. The region is predominantly rural, and includes sparsely populated towns such as Meeker, Rangely, Rifle, De Beque, Parachute, Palisade, Fruita, and Mack. Grand Junction is the most urban and densely populated city within the study area, and is the main economic center within the region.

Agriculture and ranching are the dominant land uses in the region (BLM 1982a). Agricultural production from irrigated croplands primarily consists of grains, vegetables, and fruits. Dry croplands are for the most part used for hay production or pasture. The crops grown in Garfield County include winter wheat, spring wheat, corn, barley, oats, hay, rye, fruits, and vegetables. Irrigated land in the De Beque area is used for hay production. The projected value of all crops in Garfield County for 1982 is estimated to approach $32 million dollars (USDA 1982).

Rivers provided early settlers with a reliable source of water. Consequently, agricultural lands are mainly confined to the valley bottoms. Within Garfield and Mesa counties, approximately 170,500 acres of agricultural land occurs (SCS 1979a,b). Of this total, approximately 63,500 acres are designated prime farmland.

Cattle and sheep graze the areas on or adjacent to the Getty and Cities Service properties from June through September at stocking rates ranging from 10-20 acres/cow (BLM 1983a). The number of cattle and calves reported from Garfield County in 1983 was 102,000. The total number of sheep and hogs was 51,000 and 10,000, respectively (USDA 1982).

Recreation

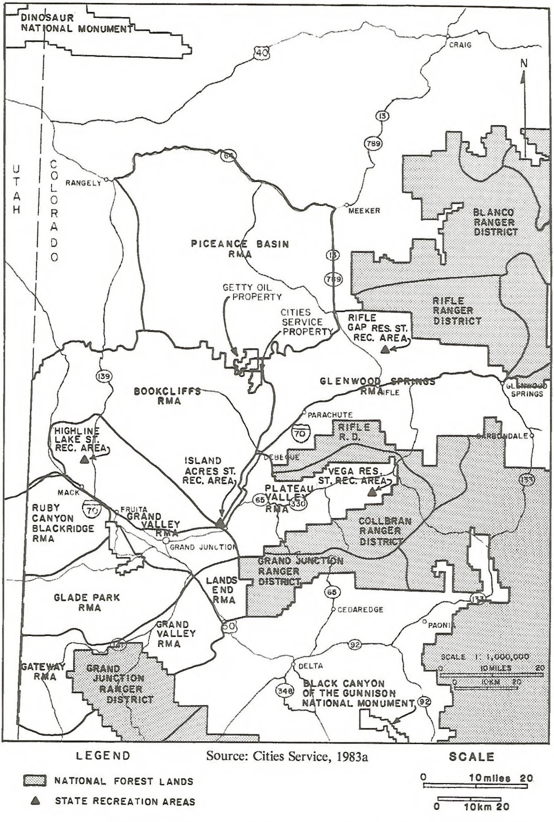
Diverse recreational opportunities are available within 50 miles of the Getty/Cities Service project areas. Interstate 70, the major transportation corridor in the region, allows for transport to, and spontaneous recreational use of, regional recreational resources (BLM 1983b).

The hunting of deer and elk is the most important recreational use of the mountainous terrain in the region. Nearby areas contain one of the largest mule deer herds in the West, in addition to large numbers of elk. Hunters from all over the country come to this area in the autumn, making an important contribution to the regional economy (BLM 1983a). Fishing for warm-water species and trout is a common activity in the mountain streams, although fishing experiences are not of the same quality as in other portions of the state (BLM 1980). Rafting on the Colorado River is an important recreational activity. Off-road vehicle (ORV) use of some back-country areas, and the Book Cliffs area is common. Other recreation opportunities in the region include hiking, camping, skiing, nature study, and sightseeing.

Recreational facilities within the Grand Valley urban area consist of parks and community centers, and private facilities such as athletic and health clubs (BLM 1983a). Municipalities within the Grand Valley are experiencing increased demand for recreational facilities. Many towns have developed recreation master plans and are developing new parks and recreation centers.

Lands with recreational value are divided into regions by the Colorado Division of Parks and Outdoor Recreation (CDPOR), into Recreation Management Areas (RMAs) by the BLM, and into Forest Service Districts by the USFS. Recreational lands in northwest Colorado, including National Monuments, National Forest Areas, Colorado State Recreation Areas, and BLM RMAs are shown in Figure 3.1-7.

The project sites and surrounding areas of Mesa and Garfield counties are included in CDPOR Region II. On a percentage basis, Region II ranks second in the state in total activity days for developed camping and snowmobiling. The five top activites in this region include bicycling, developed camping, picnicing, swimming, and fishing. Swimming ranks as the highest need in the region, followed closely by bicycling, four-wheeling, and lake boating (BLM 1980).



Source: Cities Service, 1983a

Figure 3.1-7 Recreational Areas in the Vicinity of the Getty and Cities Service Shale Oil Projects

Included in Region II are the State Recreation Areas of Highline Reservoir, Rifle Gap/Falls, Vega, and Island Acres (Figure 3.1-7). The Colorado National Monument is located immediately southwest of Grand Junction. National forests located within a 50-mile radius include the White River, Gunnison, Uncomphagre, and Grand Mesa National Forests (Figure 3.1-7).

BLM intensive RMAs located in the Grand Junction Resource Area are the Grand Valley and Ruby Canyon/Black Ridge RMAs (BLM 1979). Also included is one extensive RMA, which is divided into six areas: Book Cliffs, Plateau Creek Valley, Lands End, Dominguez, Glade Park, and Gateway. The Piceance Basin extensive RMA (located in the White River Resource Area) and the Glenwood Springs extensive RMA (Glenwood Springs Resource Area) are also located in the region.

Detailed descriptions of these RMAs can be found in BLM (1983a), Getty (1983a), and Cities Service (1983a). The location of each RMA is shown in Figure 3.1-7.

Wilderness

The Flat Tops Wilderness Area, 9 wilderness study areas (BLM 1980), and 1 Further Study Unit occur within a 50-mile radius of the Getty/Cities Service projects. The wilderness study areas (WSAs) were designated by the BLM in 1980, after a review to assure that they possess sufficient wilderness values to qualify. These WSAs are listed in Table 3.1-10, and are depicted in Figure 3.1-8. Descriptions of all WSAs can be found in BLM (1980) and BLM (1983a). The BLM is reconsidering the Futher Study Unit, South Shale Ridge, as a WSA.

Table 3.1-10 DESIGNATED WILDERNESS STUDY AREAS (WSAs) WITHIN A 50-MILE RADIUS OF THE GETTY/CITIES SERVICE PROJECTS

Black Mountain	Dominguez Canyon
Windy Gulch	Black Ridge Canyons
Oil Spring Mountain	Black Ridge Canyons West
Cross Mountain	Adobe Badlands
Little Book Cliffs Wilderness Area	

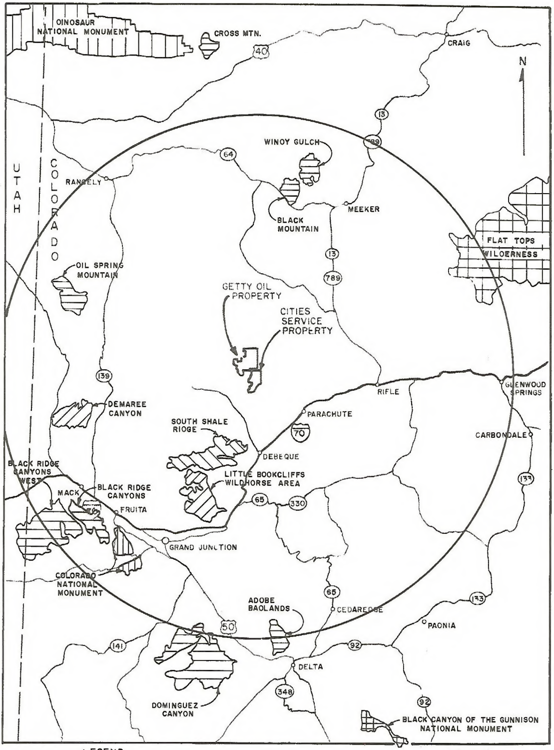
The 235,230-acre Flat Tops Wilderness Area became part of the National Wilderness Preservation System in 1975 (BLM 1983a). The Flat Tops Wilderness is located approximately 50 miles northeast of the Getty/Cities Service project areas. Descriptions of the Flat Tops Wilderness can be found in USFS (1978) and BLM (1983a).

3.1.12 Visual Resources

Regional Setting

The proposed Getty and Cities Service shale oil projects are located within the Colorado River Plateau Physiographic Province. This area is characterized by broad, open, irrigated valleys adjacent to arid, sparsely vegetated cliffs. The cliffs rise to brush-covered, gently rolling plateaus. With the exception of drainage bottoms, water is scarce. Color is dominated by the gray-green of sagebrush, green of mountain brush, and the yellows and tans of the exposed cliff faces. Line in the plateau areas and valley bottoms is horizontal and curving. Line in the cliff areas is straight, vertical and horizontal (BLM 1983a).

The dominant landscape features in the project area include the Book Cliffs to the west and southwest, the Roan Plateau and Roan Cliffs in the center, Cathedral Bluffs to the northeast, and the Colorado River drainage to the south and southeast. Canyons cut by Parachute Creek, Roan Creek, and associated tributary drainages are also dominant landscape features (BLM 1983a).



LEGEND
- = DESIGNATEO WILOERNESS AREA (USFS , NPS)
- = WILOERNESS STUDY AREA (BLM)
- = AREA ADMINISTRATIVELY ENDORSED AS SUITABLE (NPS)
- = WILDERNESS STUDY AREA (UNOER APPEAL), (BLM)
- = NON-RECOMMENOEO WILOERNESS STUDY AREA (UNOER APPEAL), (BLM)

SCALE
0 10miles 20
0 10km 20

Source: Cities Service, 1983a

Figure 3.1-8 Wilderness Areas Within 50 Miles of the Getty and Cities Service Shale Oil Projects

Cultural modifications are, for the most part, restricted to the valley bottoms or areas immediately adjacent to the bottoms. These include the communities of De Beque, Battlement Mesa, and Parachute; ranches, farms, orchards, and associated activities; general access roads and Interstate Highway 70; and the Denver and Rio Grande Western Railroad. Ranch and jeep roads, fences, and stock tanks occur on the plateaus, but do not dominate the landscape. Oil shale mining and associated facilities within the Parachute Creek drainage have become significant visual features in that area (BLM 1983a).

Common Project Facilities

The proposed common product pipeline would lie on the Roan Plateau. The area is characterized by gently rolling brush-covered terrain that forms the headwaters of area drainages and canyons. The greens of vegetation exhibit the primary color of the area. Line is curvilinear and horizontal. Water is absent. Access to the area is limited and overall visual sensitivity is low.

3.1.13 Socioeconomics

Socioeconomic baseline conditions have been compiled by Mountain West Research-Southwest Inc. (MWSW 1983) and are summarized herein. The socioeconomic study area includes Garfield and Mesa counties; existing conditions for the study area apply equally to the Getty and Cities Services projects. The study area description, which follows, includes current conditions of the area economy, population, housing, public facilities and services, governmental fiscal conditions, and the social structure.

Socioeconomic baseline conditions, as reported below, were compiled using methods, data files, computer programs, and local review processes that were the outcome of work initially undertaken by the Cumulative Impact Task Force (CITF). That work has subsequently been augmented in EISs prepared for the Chevron, Mobil, Pacific, and Union shale oil projects. The description of the regional environment that follows is based directly on those sources.

3.1.13.1 Economics

Employment

Employment trends for Garfield and Mesa counties during the period 1976-1981 are shown in Tables 3.1-11 and 3.1-12. Garfield County recorded the largest increase in jobs in the construction, retail trade, and state and local government sectors. The latter two sectors are particularly important in the Glenwood Springs area, which serves as the County Seat and tourist and recreation center of the Garfield County economy. Proportionally, the largest gains were in wholesale trade; construction; finance, insurance, and real estate; and transportation and public utilities. Mesa County, with its market center located in Grand Junction, serves as the major urban service center for the Western Slope region. Since 1975, the highest growth rates have been in the mining sector, due to the fact that several major energy companies established offices in Grand Junction. This effect probably peaked between 1980 and early 1982, and declined after that time when the Occidental project was curtailed and the Colony project shut down.

Unemployment in Garfield County generally has been about one percentage point above the state rate. Mesa County, on the other hand, has followed closely the state averages. In the last half of 1982, there was a sharp rise in unemployment rates for both counties: Garfield County rose to 8.0 percent and Mesa County to 6.7 percent. The state rate for the same period was 4.8 percent. The main reason for this increase in unemployment was the shutdown of the oil shale-related work (MWSW 1983). The unemployment rate can be expected to drop over time as the labor force is reduced through out-migration, as workers find other jobs, and as the national and local economies recover and new employment is created.

Income

Per capita income figures for Garfield and Mesa counties have historically been lower than the state and national averages. This trend was reversed in 1980 when Garfield County per capita income rose to $10,055, exceeding the

Table 3.1-11 EMPLOYMENT BY TYPE AND BROAD INDUSTRIAL SOURCES FOR GARFIELD COUNTY, 1976-1981[a]

Employment by Place of Work	1976	1977	1978	1979	1980	1981	Average Annual Growth % 1976-1981
Total Employment[b]	8,477	8,787	9,502	10,049	10,762	12,765	8.5
Number of Proprietors	1,520	1,651	1,761	1,915	1,974	2,007	5.7
Farm Proprietors	415	403	396	386	388	395	−1.0
Nonfarm Proprietors	1,105	1,248	1,365	1,529	1,586	1,612	7.8
Total Wage and Salary Employment	6,957	7,136	7,741	8,134	8,788	10,758	9.1
Farm	182	205	205	161	215	211	3.0
Nonfarm	6,775	6,931	7,536	7,973	8,573	10,547	9.3
Private	5,273	5,373	5,831	5,999	6,486	8,192	9.2
Ag. Serv., For., Fish., and Other[c]	(L)	(L)	58	60	63	(D)	--
Mining	501	536	530	99	93	124	−24.4
Construction	651	629	734	849	906	1,565	19.2
Manufacturing	220	167	161	202	208	239	1.7
Nondurable goods	74	81	83	83	86	96	5.3
Durable goods	146	86	78	119	122	143	−0.4
Transportation and Public Utilities	520	543	547	659	807	978	13.5
Wholesale Trade	129	154	199	239	234	(D)[d]	16.1[d]
Retail Trade	1,621	1,754	1,843	2,012	2,048	2,319	7.4
Finance, Insurance, and Real Estate	257	262	303	315	400	541	16.1
Services	1,338	1,287	1,456	1,564	1,727	2,104	9.5
Government and Government Enterprises	1,502	1,558	1,705	1,974	2,087	2,355	9.4
Federal, Civilian	177	159	184	196	194	207	3.2
Federal, Military	74	60	61	64	67	71	−0.8
State and Local	1,251	1,339	1,460	1,714	1,826	2,077	10.7

Source: Bureau of Economic Analysis (1983).

[a] Estimates based on 72 SIC.
[b] Consists of wage and salary jobs (full- and part-time) plus number of proprietors.
[c] Includes number of jobs held by U.S. residents working for international organizations in the U.S. Primary source for private, nonfarm employment: ES-202 covered wages - Colorado Division of Employment.
(D) Not shown to avoid disclosure of confidential data. Data are included in totals.
(L) Less than 10 wage and salary jobs.
[d] 1976-1980, figures not available for 1981.

state average of $10,033. For the same year, Mesa County (at $8,512) was considerably lower. The figures for 1981 show an increase of 21.4 percent in personal income for Garfield County to $12,209. The Mesa County increase was to $9,821, a 15.4 percent rise.

3.1.13.2 Population

Census figures for 1970, 1977, and 1980 for Garfield and Mesa counties are shown in Table 3.1-13. A rapid increase in the growth rate is evident; for the entire decade the Garfield County population was up by 51.9 percent while Mesa County increased by almost as much (49.9 percent), in contrast to the national increase of 11.4 percent.

The most dramatic growth in the study area took place during the period 1977 to 1980 when the annual growth rate for Garfield County was 6.2 percent. For the period 1970 to 1977 the rate was 3.5 percent. The Mesa County annual rate of increase for 1970 to 1977 was 3.0 percent, and for the period 1977 to 1980 it was 6.8 percent. The annual increase for Colorado as a whole during the period 1970 to 1977 was 2.5 percent; for 1977 to 1980 it was 3.3 percent.

Table 3.1-12 EMPLOYMENT BY TYPE AND BROAD INDUSTRIAL SOURCES FOR MESA COUNTY, 1976-1981[a]

Employment by Place of Work	1976	1977	1978	1979	1980	1981	Average Annual Growth % 1976-1981
Total Employment[b]	28,590	31,562	33,987	36,269	38,340	41,951	8.0
Number of Proprietors	4,172	4,572	4,782	5,025	5,176	5,263	4.8
Farm Proprietors	1,397	1,354	1,329	1,295	1,304	1,327	−1.0
Nonfarm Proprietors	2,775	3,218	3,453	3,730	3,872	3,936	7.2
Total Wage and Salary Employment	24,418	26,990	29,205	31,244	33,164	36,688	8.5
Farm	504	562	562	444	592	581	2.9
Nonfarm	23,914	26,428	28,643	30,800	32,572	36,107	8.6
Private	18,803	21,407	23,513	25,441	27,078	30,413	10.1
Ag. Serv., For., Fish., and Other[c]	95	108	82	90	116	132	6.8
Mining	950	1,095	1,251	1,729	2,357	2,710	23.3
Construction	1,835	2,269	2,671	2,862	2,740	3,589	14.4
Manufacturing	2,378	2,565	2,595	2,639	2,627	2,654	2.2
Nondurable goods	631	699	658	645	712	815	5.3
Durable goods	1,747	1,866	1,937	1,994	1,915	1,839	1.0
Transportation and Public Utilities	1,693	1,812	2,069	2,274	2,339	(D)[d]	8.4[d]
Wholesale Trade	1,254	1,424	1,436	1,581	1,592	(D)[d]	6.1[d]
Retail Trade	4,764	5,530	6,027	6,394	6,738	7,758	10.2
Finance, Insurance, and Real Estate	849	947	1,094	1,209	1,344	1,561	13.0
Services	4,985	5,657	6,288	6,663	7,225	7,832	9.5
Government and Government Enterprises	5,111	5,021	5,130	5,359	5,494	5,694	2.2
Federal, Civilian	828	900	853	996	1,048	1,074	5.3
Federal, Military	262	205	212	224	241	254	−0.6
State and Local	4,021	3,916	3,965	4,139	4,205	4,366	1.7

Source: Bureau of Economic Analysis (1983).

[a] Estimates based on 72 SIC.
[b] Consists of wage and salary jobs (full- and part-time) plus number of proprietors.
[c] Includes number of jobs held by U.S. residents working for international organizations in the U.S. Primary source for private, nonfarm employment: ES-202 covered wages - Colorado Division of Employment.
[d] 1976-1980, figures not available for 1981.
(D) Not shown to avoid disclosure of confidential data. Data are included in totals.

Some communities within the study area grew faster than others during the 1977 to 1980 period. Rifle increased by 43.2 percent and Carbondale grew by 26.8 percent. The unincorporated areas of Garfield County were up by 18.9 percent. Palisade with an increase of 49.4 percent exhibited the largest rate of increase for any incorporated community in Mesa County. Fruita also displayed a strong growth pattern, up by 20.7 percent. The unincorporated areas of Mesa County grew by 29 percent, increasing their share of the county population from 56.1 percent in 1977 to 59.4 percent at the time of the 1980 Census.

The increase in population has also meant a decrease in the median age for the study area. As might be expected, the proportion of elderly in the population has declined. Similarly, the school age population (5 to 18) also declined from almost 25 percent in 1970 to just over 20 percent in 1980. The decline in the proportion of school age population and the elderly means that the major growth due to in-migration was in the adult, working ages.

3.1.13.3 Housing

The study area recorded a dramatic increase in the number of housing units in the period between 1970 and 1980. The 1970 and 1980 Census data show about a 70 percent increase in the housing stock, partly due to population

Table 3.1-13 POPULATION IN GARFIELD AND MESA COUNTIES, 1970-1983

Place	Pop. 1970[a] Census	Pop. 1977[b] Census	Avg. Annual Growth Rate 1970-77 (%)	Pop. 1980[a] Census	Avg. Annual Growth Rate 1970-80 (%)	Avg. Annual Growth Rate 1977-80 (%)	Pop.[c] 1981	Pop.[c] 1982	Pop.[c] 1983	Avg. Annual Growth Rate 1980-83 (%)
Garfield County	14,821	18,800	3.5	22,514	4.3	6.2	27,054	29,160	27,521	6.9
Carbondale	726	1,644	12.4	2,084	11.1	8.2	2,278	2,313	2,344	4.0
Glenwood Springs	4,106	4,091	--	4,637	1.2	4.3	4,935	4,978	5,000	2.5
Grand Valley (Parachute)	270	377	4.9	338	2.3	−3.4	834	1,119	855	36.2
New Castle	499	543	1.2	563	1.2	1.2	623	670	644	4.6
Rifle	2,150	2,244	0.6	3,215	4.1	12.7	4,861	5,290	4,959	15.5
Silt	434	859	10.2	923	7.8	2.4	1,102	1,161	1,113	6.4
Unincorporated[d]	6,636	9,042	4.5	10,754	4.9	6.0	12,421	13,629	12,606	5.4
Mesa County	54,374	66,848	3.0	81,530	4.1	6.8	86,084	86,955	84,847	1.3
Collbran	255	293	3.8	344	4.3	5.5	348	344	344	--
De Beque	155	264	7.9	279	6.1	1.9	344	371	341	6.9
Fruita	1,822	2,328	3.6	2,810	4.4	6.5	2,994	3,021	2,950	1.6
Grand Junction	20,170	25,398	3.3	28,144	3.4	3.5	30,029	30,314	29,364	1.4
Palisade	874	1,038	2.5	1,551	5.9	14.3	1,784	1,817	1,729	3.7
Unincorporated	31,128	37,527	2.7	48,402	4.5	8.9	50,585	51,088	50,119	1.2
State of Colorado	2,209,596	2,625,308	2.5	2,889,964	2.7	3.3				

Source: BMML (1982); Mountain West Research - Southwest, Inc. (1983).

[a] Colorado State Demographers Office (1981).
[b] U.S. Bureau of Census (1979).
[c] PAS estimates; does not reflect actual data for 1981-1983.
[d] Includes Battlement Mesa.

increases influenced by in-migration and partly by the decline in average household size. Data are displayed in Table 3.1-14. Garfield County housing stock increased by 69 percent for the decade, while the figure for Mesa County was 72 percent.

The greatest period of increase came in the period 1977 to 1980. The 8,815 units constructed during this time amounted to about half the total production for the decade, notably 51.6 percent of the total for Mesa County and 49.6 precent for Garfield County.

Building activity in the housing industry increased at an even faster rate during 1980 and 1981. The study area added 5,871 units during the 18-month period from April 1980 to October 1981. This is about a third as many units as were built during the entire decade of the 1970s.

As part of the growth in the study area, the value of housing units has increased at rates much greater than for the state as a whole. In current dollars, the increase for the state was 273 percent for the period 1970 to 1980. In Garfield County the increase was 407 percent, while it was 346 percent in Mesa County. As would be expected, the increases in rents for the study area were also greater than the state average. While the state increase was 132 percent for the decade of the 1970s, it was 241 percent for Garfield County and 203 percent for Mesa County (BLM 1983a).

The abrupt termination of oil shale project construction in mid-1982 had immediate and significant effects on the housing industry and on property values. Housing starts dropped sharply, rents fell, vacancy rates increased, property values declined in all categories, and sales of developed and undeveloped real estate decreased markedly (DRI 1983).

Table 3.1-14 TOTAL HOUSING UNITS IN GARFIELD AND MESA COUNTIES, 1970-1980, AND ESTIMATED BUILDING ACTIVITY, APRIL 1980-OCTOBER 1981

			1970 - 1980 Increase		April 1980 - October 1981			
Place	1970	1980	Number	Percent	Single	MultiFamily	Mobile	Total
Garfield County	5,537	9,345	3,808	68.8	312	1,229	643	2,184
Carbondale	264	830	566	214.4	6	46	--	52
Glenwood Springs	1,574	2,160	586	37.2	42	47	--	89
Parachute (Grand Valley)	120	144	24	20.0	2	207	39	248
New Castle	200	255	55	27.5	2	24	1	27
Rifle	803	1,370	567	70.6	57	541	265	863
Silt	155	357	202	130.3	23	14	8	45
Unincorporated	2,421	4,229	1,808	74.7	180	350	330	860
					(14%)	(56%)	(30%)	(100%)
Mesa County	18,982	32,573	13,591	71.6	1,654	1,173	860	3,687
Collbran	113	159	46	40.7	5	2	8	15
Clifton Area					370	336	232	938
De Beque	82	136	54	65.9	2	4	6	12
Fruita	635	1,025	390	61.4	69	18	27	114
Grand Junction	7,626	12,706	5,080	66.6	1,022	779	435	2,236
Palisade	351	657	306	87.2	17	22	23	62
Unincorporated	10,175	17,890	7,715	75.8	169	12	129	310
					(45%)	(32%)	(23%)	(100%)
TOTAL	24,519	41,918	17,399	71.0	1,966	2,402	1,503	5,871
					(33%)	(41%)	(26%)	(100%)
State of Colorado	757,070	1,194,253	437,183	57.7				

Source: U.S. Bureau of the Census (1971, 1981); Colorado West Area Council of Governments (1982); BMML (1982)

3.1.13.4 Public Facilities and Services

Due to the growth which has occurred, local governments in the two-county area have taken action to accommodate and serve new residents. In many instances, public facilities and services have reached capacity, and expansion has begun, plans and finances have been established, construction has started or been scheduled, and programs have been instituted. Recent cutbacks in oil shale projects, however, have created some hesitation on the part of county and municipal governments to significantly expand public facilities and services.

Garfield County, with a 1980 population of 22,514, is a rural area. However, certain portions of the county have grown rapidly in the last several years. The City of Rifle and the new development of Battlement Mesa, an unincorporated planned unit development, are two instances of locales witnessing significant growth. Rifle recently adopted a comprehensive plan, revised land use codes, and adopted a capital improvements program. Rifle has water and sewer capacity for approximately 5,000 additional people.

Battlement Mesa, lying adjacent to the town of Parachute, has water and sewer capacity for a population of nearly 25,000. Recreation and other amenities have been developed by Battlement Mesa, but the community relies on Garfield County for other services such as police protection, social services, road maintenance, and medical facilities.

Mesa County, larger and more urbanized than Garfield County, employs a county administrator, in addition to planners, engineers, and other specialists to provide a variety of government services. Mesa County has addressed many of its capital needs with proceeds from a recent $35 million bond issue. Water and sewer systems have excess capacity or are planned for expansion. Substantial capacity for accomodating growth exists in Mesa County.

The Grand Junction area offers the most comprehensive range of public and private services in the study area. The communities of Grand Junction, Palisade, and Fruita all have systems in place and have developed policies to guide expansion. Excess capacity exists in the water and sewer systems, and plans to expand to meet future demand. Water capacity here is planned for 250,000 people; wastewater for 135,000.

De Beque, the community closest to the two projects, has a population estimated at 350 people. As a community, it has a limited infrastructure and, subsequently, minimal ability to expand.

The school districts within the area potentially affected include Garfield County School Districts RE-2 (Rifle area) and #16 (Parachute/Battlement Mesa area), Mesa County Valley School District #51 (Grand Junction area), and Mesa County Joint District #49 (De Beque area). Enrollment figures for the period 1976 to 1982 are shown in Table 3.1-15. All of these districts have been experiencing and accomodating some growth during the last 10 years.

The Garfield County schools experienced the most rapid growth, and they were required to make major expenditures for new facilities. Impact payments from the oil shale developers and from public funds have made it possible for these two districts to provide for major expansion. The impact payments to Mesa County schools have been small in comparison; Joint District #49 received $80,000, District #50 received approximately $100,000, and District #51 received approximately $400,000 (BMML 1982).

3.1.13.5 Local Finances

The fiscal condition of the various jurisdictions has been greatly influenced by the oil shale development that took place between 1979 and 1982. The results were different for the counties than for the municipalities. Garfield and Mesa counties appear to be in good condition. Garfield County's assessed valuation and other tax bases have been strong, and their expenditures have been well within its capabilities. Mesa County has reorganized its tax base to include a county-wide 2 percent sales tax that should generate additional revenues.

Table 3.1-15 SCHOOL ENROLLMENTS BY DISTRICT, GARFIELD AND MESA COUNTIES

School District	Serving	1976	1977	1978	1979	1980	1981	1982	1980 Student/ Teacher Ratio
Garfield County									
RE-16	Parachute/ Battlement Mesa	176	165	173	179	202	434	628	18.5
RE-2	Rifle, New Castle, Silt	1,466	1,467	1,467	1,601	1,916	2,200	2,359	18.1
Mesa County									
District #51	Grand Junction, Fruita, Palisade	13,293	13,653	14,126	14,621	15,075	15,630	16,188	19.1
District #50	Collbran, Mesa, Plateau City, Molina	284	288	322	342	375	393	421	18.1
Joint District #49	De Beque, Roan Creek Valley	145	132	117	119	113	122	165	9.1

Source: BMML (1982); BLM (1983a).

Generally, the municipalities have greater demands for services, and lack the tax base to fund their services and facilities. Some communities need growth to support existing service levels. Grand Junction, however, has had good fiscal management, and its financial practices appear sound (BMML 1982). The smaller communities vary widely in their current fiscal conditions, and have all taken a variety of measures (within their limited resources) to deal with existing conditions.

Additional insight into existing fiscal conditions of local jurisdictions can be gained from the impact discussion in Sections 4.2.13 and 4.3.13.

3.1.13.6 Social Structure

Two social structures are described within the study area: one in south central Garfield County, and the other in the Grand Junction metropolitan region of Mesa County (Mobil 1982). Since these areas are adjacent to each other and share a common past as well as extensive ongoing interaction, there are many similarities. At the same time, the Garfield County area is disinct, most notably as a rural setting in contrast to the more urban setting of Grand Junction.

Garfield County

Five significant groups were identified as important, long-term units in the social structure of south central Garfield County. These groups are: (1) Agricultural, (2) Business and Professional, (3) Elderly, (4) the other Long-time Residents, and (5) Newcomers. These groups are profiled in Table 3.1-16. Natives and in-migrants who have lived in the area for a long time make up the membership of the first four groups. Most of these people have lived in the area for at least a decade or more, and are therefore well integrated into the indigenous social structure. Additions to these groups can occur, for example, when new people join the business and professional community in Rifle. These additions to existing groups are considered to be distinct from establishment of the newcomers group, which has not been assimilated into the established social groups and which constitutes a new entity in the social structure.

Table 3.1-16 SOUTH-CENTRAL GARFIELD COUNTY SOCIAL STRUCTURE

Groups	Size	Occupation/ Livelihood	Demographic Characteristics	Geographical Location	Ownership	Development Attitudes	Interaction
Agriculturalists	350-400	Farmers, ranchers, orchardists. Some part-time with other jobs.	Long-time residents, somewhat older.	Rural	Land, homes, and agricultural property.	Conservative, many support agricultural conservation.	Family ties, support local business, very active in politics.
Business & Professional	1,400-1,800	Business owners, managers, professionals, executives	Average profile	Center is Rifle and surrounding areas.	Homes, business, and investment property.	Support economic growth and development.	Business ties and civic groups; active political group.
Elderly	800	Mostly retired. Some still active in business and work.	Elderly, somewhat greater percent female.	Family homes, concentrated near Rifle.	Homeowners, many rent.	Conservative, support traditions, and growth that benefits families.	Family, church, some political involvement, limited business.
Other Long-Time Residents	6,000-8,000	Mainly wage and salary workers.	Average profile	Rifle, other towns, unincorporated.	Homeowners, renters.	Jobs and pay are important; support for outdoor recreation.	Work, family, school, church, community ties.
Newcomers	2,500-3,500	Mainly wage and salary.	Working age, 25-50, in-migrants, slightly more males; smaller household sizes.	Concentrated in and around Rifle and Battlement Mesa.	Renters, some owners.	Jobs attract them, also amenities of area.	Work, family, other newcomers. Formal contacts with communities, many out-of-area contacts.

Source: Mountain West Research - Southwest, Inc. (1983).

Garfield County has a long history of out-migration prior to the oil shale boom. Although the population has grown since 1940, it has done so at a very slow rate (less than natural increase). For the four indigenous groups, the social, political, and economic ties are strong ones. Shared values, a common background, and kin and friendship ties have all helped to create a cohesive community in an essentially rural area. The influx of newcomers, largely oil shale project construction workers, created a new group which was not easily assimilated into the existing social structure. Therefore, they constituted a new group in the social structure. Those newcomers who came to take advantage of the increased business and professional opportunities, on the other hand, were assimilated quite easily. Their interests, values, and social skills fit well with the established social structure.

Mesa County

As might be expected of adjacent areas, there are a number of similarities between Mesa and Garfield counties. The historical experiences were, in large part, regional in their sphere of influence, thus accounting for a similarity between the groups in both areas. At the same time, the Grand Junction vicinity has many urban characteristics and its place as the trade and service center for the Western Slope has been instrumental in the creation of numerous distinctive characteristics in the social structure. Therefore, while the types of groups are similar, their composition and interaction patterns are quite different.

Six groups are described for Mesa County: (1) Agriculturalists, (2) Business and Professional, (3) Elderly, (4) Hispanic, (5) Other Long-time Residents, and (6) Newcomers. A summary presentation of group characteristics is shown in Table 3.1-17.

In summary, the Mesa County social structure is concentrated in Grand Junction, which is a major urban trade and service center serving the entire Western Slope. The business and professional group, in addition to their obvious economic control, seems to be the most socially and politically influential. In many ways, they are also the most open to newcomers and they have cooperated with the growth of the energy sector. Of the other groups, the agriculturalists and the elderly seem to be least affected by in-migration of new people, although they have changed in a number of ways in response to other aspects of rapid growth. For example, housing for the elderly has been a concern. The other long-time residents and the Hispanics have absorbed much of the impact of new growth, as both construction workers and other wage and salary personnel have moved into the county. Those newcomers who have come as permanent residents, buying homes and settling their families, have been most fully integrated. The temporary and transient newcomers have remained on the outside. Although growth has brought with it a number of tensions and demands, the social structure has demonstrated great flexibility in dealing with large-scale change.

3.1.14 Transportation

3.1.14.1 General Transportation Characteristics

Highways, air and rail transportation, and pipeline facilties exist within the region. The major transportation facilities are shown on Figure 3.1-9.

Grand Junction, Rifle, Battlement Mesa, and Glenwood Springs offer the closest major population concentrations with established community infrastructures. Prior experience with other oil shale project evaluations (e.g., Colony, Union Oil, Chevron) indicates that operational workers will commute from these areas.

3.1.14.2 Roadways

Major roadways within the area are shown in Figure 3.1-6. The road network consists of federal, state, county, and city roads all of which are maintained by the appropriate road departments. The major transportation link between Glenwood Springs and Grand Junction is I-70. The highway is four-lane, except through De Beque Canyon where it is two-lane. The De Beque Canyon segment is scheduled to be completed between 1988 and 1990.

Table 3.1-17 MESA COUNTY SOCIAL STRUCTURE

Groups	Size	Occupation/ Livelihood	Demographic Characteristics	Geographical Location	Property Ownership	Development Attitudes	Interaction
Agriculturalists	2,500	Farmers, ranchers, orchardists. Some part-time with other jobs.	Long-time residents, somewhat older.	Rural	Land, homes, and agricultural property.	Conservative, many support agricultural conservation.	Family ties, politically active, support local business.
Business & Professional	12,000	Business owners, managers, professionals, executives.	Average profile	Urban, suburban concentrated in Grand Junction area.	Homes, business, and investment property.	Support economic growth and development. Also small but noticeable environmental support.	Business ties and civic groups; most active political group.
Elderly	8,700	Mostly retired. Some still active in business and Work.	65 + years of age; somewhat greater percent female.	Urban, some suburban.	Homeowners, many rent.	Conservative, support traditions, and growth that benefits families.	Family, church, some political involvement, limited business.
Hispanics	5,700	Mainly wage and salary with some business and professionals.	Average profile.	Concentrated in Grand Junction and Fruita.	Owners and renters.	Support jobs and public services.	Family, ethnic identification, school, church. Some political activity.
Other Long-time Residents	40,000-45,000	Mainly wage and salary workers.	Average profile.	Urban and suburban some in unincorporated areas.	Owners and renters.	Jobs and pay are important; support for outdoor recreation.	Work, family, school, church.
Newcomers	12,000	Mainly wage and salary.	Working age, 25-50 in-migrants slightly more males; smaller household	Suburban, some urban.	Renters, some home owners.	Jobs attract them, also amenities of area.	Work, family, other newcomers. Formal contacts with communities, many out-of-area contacts.

Source: Mountain West Research - Southwest, Inc. (1983).

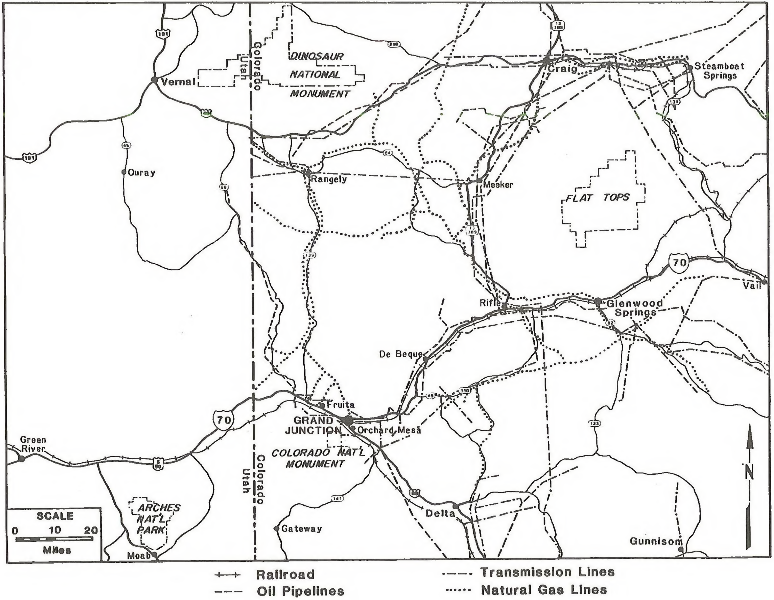


Figure 3.1-9 Project Area Transportation Network.

Highway use and capacity for selected road segments (Figure 3.1-6) are shown on Table 3.1-18. The table shows, by road segment, average daily traffic (ADT), peak hourly traffic (PHT), and road capacity (CAP). Average daily traffic is the average number of vehicles using the given highway section in one day. Peak hour traffic is the 30th highest amount of traffic that can be expected in an hour for the year, and approximates above average rush hour traffic. Road capacity is based on the design of the roadway. The approximate traffic conditions on the road during high use are indicated by the PHT capacity ratio. If this ratio approaches 0.85, occasional traffic slowdowns will occur. If the rate is at or over 1.0, the traffic speed will be reduced (BLM 1983a). From review of Table 3.1-18, it appears that only Segment G will experience any level of service reduction through the year 2010. This trend is consistent with data collected in 1980.

U.S. Highways 6, 24, and 50 are the other major highways in the project area. State Highway 139 runs from I-70 (out of Loma) north over Douglas Pass to Rangely. In 1978, ADT for SH 139 was 1,250 vehicles. State Highway 13 runs from 1-70 (out of Rifle) north to Rio Blanco and Meeker (Figure 3.1-6).

Accident rates for the I-70 road segments analyzed varied from 60 to 198 for the year 1981. Traffic fatalities varied from one to four, depending on the road segment. Table 3.1-19 shows accident rates by highway segments on I-70. Accident rates are projected through year 2010.

County road mileage accounts for approximately 2,529 miles in Garfield and Mesa counties. Garfield County's system consists of 929 miles, 409 miles of which are considered primary thoroughfares. Mesa County has approximately 1,600 miles of county-maintained roads, of which approximately 500 miles are paved. Communities within the area have varying mileages of streets and roadways. Grand Junction leads the urbanized areas, having approximately 150 miles of streets within the city limits.

The Roan Creek road would provide access to the Getty and Cities Service projects. The road is initially paved and up to 30 feet in width. As it proceeds northward, the road surface becomes a graded dirt road. Accurate traffic counts are not available for the Roan Creek road, but estimates of average daily traffic 150 to 250 vehicles (Bolby 1983).

3.1.14.3 Airports

Walker Field Airport, located in Grand Junction and run by a public airport authority, serves northwestern Colorado and eastern Utah. Expansion of the passenger terminal and air field has recently been completed (December 1982) to accomodate increases in air traffic. Total operations in 1981 increased 14.5 percent over 1980; general aviation operations increased 13.7 percent; air carrier and air taxi increased 18.5 percent. This trend has, however, changed somewhat in recent years with total operations in 1982 decreasing 22 percent over 1981, and general aviation decreasing 22 percent for the first six months of 1983. Howver, air carrier traffic increased 50 percent during the first half of 1983.

The Garfield County Airport is located in Rifle, Colorado, and until recently (October 1983), has had one commercial flight in and out each day. This service was offered by Aspen Airways and provided connections with Rifle, Aspen, and Denver. As of October 1983, this service has been discontinued. The airport also provides service to private operations. Room for airport expansion is available.

3.1.14.3 Railroads

The Denver and Rio Grande Western Railroad Company serves the project area with freight trains to and from Denver and Salt Lake City. Schedules vary depending on demand. Amtrak serves the area with daily passenger trains with routes between Denver and Salt Lake City. Existing rail traffic is approximately 25 trains per day; the rail line has a capacity of 48 trains per day.

3.1.14.4 Pipelines

Currently, no shale oil pipelines exist within the project area. Existing oil pipelines do pass near Craig, Colorado and north of Highway 40 in Moffat County, as well as one which passes west of the properties and runs into

Table 3.1-18 TRAFFIC VOLUMES ON AFFECTED HIGHWAY SEGMENTS[a]

Year	Road[b] Segment	Segment Length	ADT[c]	PHT[d]	CAP[e]	PHT Capacity Ratio
1980	A	29.6	3,600	400	3,400	.12
	B	19.4	5,200	660	3,500	.19
	C	17.0	5,450	750	3,450	.22
	D	8.9	5,400	750	3,450	.22
	E	42.4	6,100	850	3,500	.24
	F[f]	15.1	3,750	500	950	.53
	G[f]	4.3	21,150	2,350	2,000	1.18
	H[f]	8.4	4,800	600	1,400	.43
1995	A	29.6	5,750	750	3,400	.22
	B	19.4	7,600	1,050	3,500	.30
	C	17.0	8,300	1,150	3,450	.33
	D	8.9	8,250	1,150	3,450	.33
	E	42.4	9,300	1,300	3,500	.37
	F	15.1	5,750	750	950	.79
	G	4.3	27,350	3,050	2,000	1.53
	H	8.4	6,900	850	1,400	.61
2003	A	29.6	6,900	900	3,400	.26
	B	19.4	8,850	1,250	3,500	.36
	C	17.0	9,800	1,350	3,450	.39
	D	8.9	9,750	1,350	3,450	.39
	E	42.4	11,000	1,550	3,500	.44
	F	15.1	6,750	900	950	.95
	G	4.3	30,600	3,450	2,000	1.73
	H	8.4	8,000	1,000	1,400	.71

Year	Road[b] Segment	Segment Length	ADT[c]	PHT[d]	CAP[e]	PHT Capacity Ratio
2010	A	29.6	7,900	1,000	3,400	.29
	B	19.4	9,950	1,400	3,500	.40
	C	17.0	11,150	1,550	3,450	.45
	D	8.9	11,050	1,550	3,450	.45
	E	42.4	12,500	1,750	3,500	.50
	F	15.1	7,700	1,000	950	1.05
	G	4.3	33,500	3,700	2,000	1.85
	H	8.4	9,000	1,100	1,405	.79

Source: Colorado Department of Highways (1982).

[a] Updated data are available for average daily traffic volumes for the project area. These data show increases in traffic volumes, however, corresponding data are not available for accident rates. These data sets may be available for the DEIS and FEIS.
[b] See Figure 3.1-6 for locations of road segments.
[c] ADT = Average Daily Traffic. Projections include anticipated increases in population without project.
[d] PHT = Peak Hourly Traffic.
[e] CAP = Capacity of highways and roads at level of service "C". This is typical level of service for rural areas.
[f] Segments F to H are State Highway 6 in and near Grand Junction.

Table 3.1-19 ACCIDENT RATES ON AFFECTED HIGHWAY SEGMENTS (1981)

Year	Road[a] Segment	Segment Length	Accident Rates			
			PDO[b]	INJ[c]	FAT[d]	Total
1981	A	29.6	32	25	3	60
	B	19.4	44	15	3	62
	C	17.0	56	11	1	68
	D	8.9	40	22	0	62
	E	42.4	130	64	4	198
	F	15.1	39	22	1	62
	G	4.3	375	88	1	464
	H	8.4	37	16	0	53
1995	A	29.6	51	40	5	96
	B	19.4	64	22	4	90
	C	17.0	85	17	2	104
	D	8.9	61	34	2	97
	E	42.4	198	98	6	302
	F	15.1	60	34	2	96
	G	4.3	484	114	1	599
	H	8.4	53	23	1	77
2003	A	29.6	61	48	6	115
	B	19.4	75	26	5	106
	C	17.0	101	20	2	123
	D	8.9	72	40	2	114
	E	42.4	234	115	7	356
	F	15.1	70	40	2	112
	G	4.3	542	127	1	670
	H	8.4	62	27	2	91
2010	A	29.6	70	55	7	132
	B	19.4	84	29	6	119
	C	17.0	115	23	2	140
	D	8.9	82	45	2	129
	E	42.4	266	131	8	405
	F	15.1	80	45	2	127
	G	4.3	594	139	2	735
	H	8.4	69	30	2	101

Source: BLM (1983a).

[a] See Figure 3.1-6 for locations of road segments.
[b] PDO = Property damage accidents only.
[c] INJ = Injury producing accidents.
[d] FAT = Fatality producing accidents.

Utah. The capacities of these pipelines are adequate to transport existing volumes of oil. Various shale oil pipelines are planned but have not been built. Natural gas pipelines exist throughout the project area and are operated by the Western Slope Gas Company, a subsidiary of Public Service Company of Colorado. Other pipelines transport oil and water in the area; however, no major pipelines traverse project sites (BLM 1983a).

3.1.15 Energy

Electric power in Garfield and Mesa Counties is provided by Public Service Company of Colorado, headquartered in Denver, and by rural power systems that are part of the Colorado-Ute Electrical Association. The Public Service distribution system includes Rifle, Parachute, and Silt in Garfield County, and Grand Junction and De Beque in Mesa County. Other areas are served by Grand Valley Rural Power, Holy Cross Electric Association, and Delta-Montrose Rural Power; these three distribution systems buy power from Colorado-Ute. The generating capacity available to the Western Slope from hydroelectric and fossil fuel steam-generating plants is shown in Table 3.1-20. Natural gas is supplied by Public Service and the Rocky Mountain Natural Gas Company.

Electric transmission lines serving the area include a 69-kv line to Parachute and Rifle, a 69-kv line from the Cameo and Shoshone electric generating plants, and a 230-kv line traversing the area south of the Colorado River. Numerous natural gas pipelines run throughout the region and are operated by the Western Slope Gas Company, a subsidiary of Public Service Company of Colorado. Other pipelines for transport of oil and water occur within the region.

Energy sources within the area include coal, oil shale, oil and gas, and uranium.

Table 3.1-20 POWER GENERATING FACILITIES IN PROJECT AREA

Plant	Location	Type of Unit	Net Generating[a] Capacity
Cameo	Cameo, CO	Coal-Steam Turbine	66,000 kW
Palisade	Palisade, CO	Hydro-Turbine Generator	3,000 kW
Shoshone	Near Glenwood Springs, CO	Hydro-Turbine Generator	14,400 kW
Fruita	Fruita, CO	Natural Gas/Oil Combustion Turbine	18,650 kW
Lower Molina	Near Colbran, CO	Hydro-Turbine Generator	4,860 kW[b]
Upper Molina	Near Colbran, CO	Hydro-Turbine Generator	4,860 kW[b]
Hayden	Hayden, CO	Coal-Steam Turbine	2 Units: 184,000 kW 261,000 kW
Nucla Station	Nucla, CO	Coal-Steam Turbine	36,000 kW[b]
Bullock Station	Montrose, CO	Coal-Steam Turbine	12,000 kW[b]
Morrow Point	Near Montrose, CO	Hydro-Turbine Generator	120,000 kW[b]
Crystal	Near Montrose, CO	Hydro-Turbine Generator	28,000 kW[b]
Craig	Craig, CO	Coal-Steam Turbine	800,000 kW

Source: Electrical World (1982).

[a] kW - Kilowatt (1,000 watts)
[b] These units are either peaking or intermediate units.

3.2 Getty Project

3.2.1 Topography, Geology, and Paleontology

The Getty oil shale resource property is located on the Roan Plateau, which consists of a rugged, intricately dissected plateau with broad tabular upland tracts between deep stream valleys. The plateau property ranges from 8,000 feet to 8,700 feet in elevation. The lower portion of the plateau property lies to the southwest. Elevation increases to a ridgeline in the northeast which generally divides surface water drainage between Clear Creek and the west fork of Parachute Creek. A small portion of the property (far northwest) drains to east Willow Creek. Slope gradient in the plateau upland areas ranges from 3-4 percent for slopes oriented to the northeast, while the slopes oriented to the principal upland drainages have gradients of 20-30 percent (Getty 1983a).

Facilities to be located on the plateau would include the initial retorts, oil shale upgrading, mine portal, additional retorts, and mine portal, spent shale disposal area, and an access, transport, power corridor. Facilities located above 7,800 feet on the plateau would be underlain by the Uinta Formation. Development below this elevation in the upland valley of Short Gulch would be on the Parachute Creek Member of the Green River Formation. Both of these formations are essentially flat-lying in the Getty property area. Although no major faults have been mapped in the area (Hail 1978), a significant number of joint fractures have been identified in the Uinta and Green River Formations (Verbeek and Grout 1983).

Linking the facilities on the plateau with the Roan Creek corridor would be a transportation, water supply, and power corridor which would traverse the steeply-sloping Roan Cliffs. The Roan Cliffs have an average slope gradient ranging from 30 percent to nearly vertical (Getty 1983a). In general, these cliffs are oriented to the southwest, paralleling the valley of Clear Creek with topographic relief ranging from 1,000-1,500 feet. These cliffs consist of the Green River Formation, with the Parachute Creek Member being a significant cliff former. The proposed transportation corridor would traverse these cliffs in the canyon of Tom Creek, while the power and water corridor would be in the canyon of Buck Gulch. As evidenced by the significant amount of talus deposited on the valley walls of these canyons, rockfall is the predominant mass-wasting process in this area. The predominance of rockfall is the result of the significant amount of joint fracturing in the Green River Formation.

Below the plateau and the Roan Cliffs are the canyons of Buck Gulch, Doe Gulch, Tom Creek, and Clear Creek. These canyon bottoms are generally flat and narrow with elevations ranging from 6,000 feet in Clear Creek below Tom Creek, to approximately 5,400 feet at the confluence of Roan and Clear Creeks. The slope gradient in these canyons ranges from 1 to 2 percent (Getty 1983a). These canyons consist of Quaternary Age alluvium veneered with talus and landslide deposits (Hail 1978). The alluvium in these canyons represents a fill deposited in the bottom lands eroded from the Garden Gulch and Douglas Creek Members of the Green River Formation. Facilities proposed for development here would include transportation, power and water supply corridors, and water supply reservoirs. The side slopes of these valleys consist of rockfall, landslide, and slopewash deposits which, in some locations, impinge upon the valley floor near the corridors and in the area that would be inundated by the Tom Creek Reservoir. The affected geologic environment of the Roan Creek corridor is discussed in BLM (1983a).

The paleontological resources of the Getty property and the neighboring Piceance Creek Basin were reviewed by Lucas and Kihm (1982). Paleontological resources of the Getty property include the Eocene age Green River and Uinta Formations (Getty 1983a). The most common fossils in the Green River Formation in the Piceance Creek Basin are plants and insects. These fossils have been extensively studied because of their excellent preservation. A juvenile crocodilian was recently reported from the Douglas Creek Member of the Green River Formation just southwest of the study area. Prior to this the reported fossil fauna was limited to a few insects and gastropods from the Green River Formation. The Lucas and Kihm (1982) survey augmented the insect and gastropod fauna, but only found small amounts of vertebrate fossil material in the Green River Formation within the study area (Getty 1983a). Lucas and Kihm (1982) also classified each of the geologic formations within the study area with regard to their importance as a paleontological resource. The Green River Formation is considered to have demonstrated high potential for producing scientifically significant paleontologic resources.

Very few fossil vertebrates or invertebrates were known from the Uinta Formation in the study area previous to the Lucas and Kihm survey. Their study found numerous localities in the Uinta Formation in the study are along with the discovery of the partial skull of the vertebrate *Uintatherium*, a significant paleontological find. The Uinta Formation, as with the Green River Formation, is considered to have demonstrated high potential for producing scientifically significant paleontologic resources.

3.2.2 Surface Water

Watershed Characteristics

The Getty oil shale property site lies on the Roan Plateau. The surface water drainages within the property include portions of Parachute Creek, Roan Creek, their tributaries (Tom Creek, Doe Gulch, Buck Gulch, and Deer Park Gulch), and East Willow Creek. Only 5 percent (1,160 acres) of the property drains into the East Willow Creek, a tributary of Piceance Creek which flows into the White River drainage system. The project site is about 15 miles from the Colorado River and over 30 miles from the White River. The watersheds within the property are characterized by large, undulating areas on the plateau draining into relatively steep canyons and valley areas. About 88 percent of the property is located on the plateau, 10 percent in the canyons, and 2 percent in the valley area. The maximum elevation on the property is about 8,700 feet. About 80 percent of the property has elevations above 7,000 feet. Stream channel slopes range from 200 to 400 feet per mile on the plateau, from 400 to 500 feet per mile in the canyons, and from 30 to 80 feet per mile in the valleys.

Stream Flows

In the vicinity of the property area, there are eight stream gaging stations in the Roan Creek and West Fork Parachute Creek watersheds. These stream gaging stations and streamflow records are summarized in Table 3.2-1. Water balance of the property area (Table 3.2-2) indicates that the total net runoff from the property is about 3,890 ac-ft per year (1.82 inches of runoff per year). Runoff contributions for the drainages are 220 ac-ft, 1,960 ac-ft, and 1,710 ac-ft for East Willow Creek, West Fork Parachute Creek, and Clear Creek, respectively.

Water Quality

Clear Creek and Roan Creek downstream from its confluence with Clear Creek meet the classification criteria necessary for irrigation and usage by warm water biota. Water quality of the Roan Creek drainage and its tributaries is a mixed bicarbonate type with a relatively high pH value. Magnesium, calcium, and sodium are the dominant cations, and bicarbonate is the dominant anion. Elevated soil erosion in the Roan Creek drainage system results in increased suspended solids and dissolved solids in the stream. In addition, stream waters of Roan Creek show high concentrations of sulfate (Table 3.2-3) due to the dissolution of calcium sulfate present in the Wasatch Formation. Concentrations of iron and manganese frequently exceed the EPA Primary Drinking Water Quality Standards. Water quality of the streamflows in Deer Park Gulch and lower Clear Creek shows a high concentration of total coliform. This is primarily due to intensive livestock grazing activities in the lower portions of the stream valley. All other trace metals and organic compounds are either below the laboratory detection limits or the regulatory standards.

In general, the water quality of Clear Creek appears better than the water quality of Roan Creek. Water quality of Deer Park Gulch, Doe Gulch, and Buck Gulch shows lower concentrations of TDS, major anions and cations than Clear Creek. Total suspended solids showed high concentrations during high flow periods, compared with other sampling periods. Concentrations of total dissolved solids, and major anions and cations increased from upstream to downstream (CDM 1983i).

Water quality of West Fork Parachute Creek is similar to Deer Park Gulch and better than Clear Creek, as shown in Table 3.2-3. The headwaters of West Fork Parachute Creek have been classified by the Colorado Water Quality Control Commission as coldwater aquatic life Class 1 and agricultural use. Water quality of West Fork Parachute Creek is influenced by the geology, soils, and agriculture in the headwater areas. The nature of geologic formations and the overlaying soil contribute to alkalinity, TDS, and total suspended solids (CWACG 1977).

Table 3.2-1 STREAM GAGING STATIONS - GETTY SHALE OIL RESOURCE PROPERTY

Gaging Station	Period of Record[a]	Drainage Area (sq mi)	Annual Discharge (ac-ft/yr)	Unit Runoff (in./yr)	Peak Daily Flow (cfs)	Minimum Daily Flow (cfs)
Roan Creek near De Beque (USGS 09095000)	Apr 1921 - Sep 1926 Oct 1962 - Sep 1972 Oct 1974 - Sep 1981	321.0	30,600	1.8	2,020[b]	3.2
Roan Creek (Colony)	Jul 1971 - Sep 1982	378.0	36,784	1.8	1,160	2.4
Clear Creek (Getty)	Aug 1969 - Sep 1982	101.5	14,016	2.6	588	3.6
West Fork Parachute Creek (Getty)	Oct 1969 - Sep 1982	8.4	1,194	2.7	24	0.3
Buck Gulch (Getty)	Jul 1981 - Sep 1982	4.5	63	0.3	1.1	0
Tom Creek (Getty)	Jul 1981 - Sep 1982	12.8	355	0.5	9.0	0
Doe Gulch (Getty)	Jul 1981 - Sep 1982	5.0	60	0.2	1.1	0
Deer Park Gulch (Getty)	Jul 1981 - Sep 1982	13.1	293	0.4	3.1	0

Source: Getty (1983a).

[a] All gages are in operation at current time.
[b] Instantaneous peak flow.

3.2.3 Ground Water

Ground Water Occurrence

The hydrogeologic environment of the Getty resource property is dominated by sandstone and marlstone strata of the Uinta Formation at the surface, and the underlying marlstones of the upper Parachute Creek Member of the Green River Formation. The spent shale disposal area, syncrude corridor, and additional retort facilities are underlain by the Uinta Formation, whereas the initial retort and upgrading facilities in Short Gulch are underlain by the upper Parachute Creek Member. The water and power corridor would traverse alluvial deposits in the valleys of Clear Creek and Buck Gulch before crossing Uinta and upper Parachute Creek strata atop the Roan Cliffs. Site-specific information for these hydrostratigraphic units are lacking, but their probable characteristics can be inferred from data available from adjacent oil shale properties.

The Uinta Formation in this sector of the Piceance Basin is typified by interbedded sandstones and marlstones. Bedding is often discontinuous and lenticular and not traceable for any distance. Permeability conditions are controlled by primary (interstitial openings in the rock matrix) and secondary (fracture) systems. Data from the Pacific property to the south indicate that primary and secondary permeability decreases with depth (CDM 1983e). The occurence of ground water within the Uinta Formation is highly variable. Information from the Chevron property indicates the Uinta Formation is well drained and largely unsaturated (BLM 1983a). Drill hole/monitor well data and spring discharges on the Pacific property are indicative of at least partially saturated conditions (CDM 1983e). Similarly, exploratory drill holes on the Getty property encountered cascading water from the Uinta interval, suggesting saturated zones are present (Getty 1983a). The occurrence of numerous springs throughout the Getty property, emanating from at or near the Uinta/upper Parachute Creek contact confirms the probability of partially saturated conditions within Uinta strata. Based on single well test data from the Pacific property, the hydraulic conductivity of Uinta Formation ranges from 5.4×10^{-4} to 2.4×10^{-2} feet/day (CDM 1983e). This variability is due to the lateral and vertical differences in lithology and fracture intensity.

Table 3.2-2 WATER BALANCE - GETTY SHALE OIL RESOURCE PROPERTY

Watershed	Area (Acres)	Annual Precipitation (in.)	Irrigation and Run-in (in.)	Evapo-transpiration (in.)	Surface Runoff and Deep Percolation (in.)	Annual Precipitation (ac-ft)	Irrigation and Run-in (ac-ft)	Evapo-transpiration (ac-ft)	Surface Runoff and Deep Percolation (ac-ft)
East Willow Creek[a]	1,160	20.80	0	18.50	2.30	2,010	0	1,790	220
West Fork Parachute Creek	9,680	20.99	0	18.56	2.43	16,930	0	14,970	1,960
Clear Creek	14,910	19.21	0.27	17.83	1.65	23,860	340	22,150	2,050
TOTAL	25,750					42,800	340	38,910	4,230
EUD[b]		19.95	0.15	18.13	1.97				

Net Excess = Surface Runoff and Deep Percolation - Irrigation and Run-in
= 4,230 − 340 = 3,890 ac-ft
= 1.82 inches

Source: Getty (1983a).

[a] Tributary to Piceance Creek.
[b] EUD = Equivalent Uniform Depth.

Ground water also occurs in strata of the underlying Parachute Creek Member. Flow beneath the Chevron property is confined to thin, sandy siltstone layers above and below the Mahogany Oil Shale Zone, known as the A and B grooves, respectively. The predominant water-bearing interval beneath the Pacific property, however, is a zone of fractured and leached marlstones above (and hydraulically isolated from) the A groove. The occurrence of this water-bearing leached zone within the upper Parachute Creek Member is more typical within the Piceance Basin, than is its absence on the Chevron property (Coffin et al. 1971; Weeks et al. 1974). Testing data from the Pacific property show the leach zone to be more permeable than the Uinta Formation, with hydraulic conductivities ranging form 4.0×10^{-2} to 1.7×10^{-1} feet/day (CDM 1983e). Hydraulic conductivities for the A and B grooves on the Chevron property had ranges of 2.0×10^{-2} to 5.5×10^{-2} feet/day and 8.0×10^{-4} to 3.0×10^{-2} feet/day, respectively (BLM 1983a).

Table 3.2-3 SUMMARY OF AVERAGE WATER QUALITY DATA FOR DRAINAGES IN THE VICINITY OF THE GETTY PROPERTY

Parameter[a]	Roan Creek	Upper Clear Creek	Lower Clear Creek	Deer Park Gulch	Doe Gulch	Buck Gulch	West Fork[b] Parachute Creek
Temperature (°C)	10.0	10.0	9.6	20.0	20.2	18.5	--
Dissolved Oxygen	9.5	9.0	9.2	7.5	8.0	7.6	7.3
pH	7.9	8.0	7.3	8.8	8.9	8.8	8.1
Conductivity (umhos/cm)	795	505	576	515	495	517	576
Alluminum	0.45	0.58	<0.5	<0.5	<0.5	<0.5	0.019
Ammonia	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.231
Arsenic	0.006	0.006	0.005	0.007	0.006	<0.005	0.001
Barium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bicarbonate	463	355	420	235	250	280	--
Boron	0.3	0.3	0.3	0.15	0.25	0.15	0.117
Cadmium	0.007	<0.005	0.006	0.0075	0.005	0.006	--
Calcium	89.0	56.5	64.0	34.0	30.5	36.5	55.4
Carbonate	3.0	4.0	0.0	14.5	15.5	12	--
Chloride	9.2	8.5	10.2	3	3.5	3.0	5.9
Chromium	0.014	0.016	0.012	0.015	0.012	0.008	0.0
Copper	0.011	0.012	0.0065	0.009	0.008	0.009	0.004
Fluoride	0.65	0.72	0.92	0.35	0.35	0.35	0.241
Hardness	508	298	350	220	215	235	251
Iron	3.61	3.25	1.2	1.05	0.56	0.33	0.195
Lead	0.0065	0.009	0.008	0.016	0.007	0.007	0.003
Magnesium	65.0	34.0	42.0	29.5	31.5	30.5	35.8
Manganese	0.121	0.072	0.039	0.027	0.013	0.022	0.015
Mercury	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0004
Molybdenum	0.016	0.01	0.019	0.013	0.011	0.008	0.001
Nickel	0.02	0.02	0.025	0.07	0.02	0.02	0.002
Nitrate	0.65	0.59	1.20	0.15	0.05	0.05	0.726
Total Phosphate	0.31	0.21	0.09	0.10	0.1	0.08	0.081
Potassium	3.4	2.4	2.8	1.4	2.1	1.15	1.69
Selenium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.001
Sodium	101.0	60.5	69.0	47.5	51.0	50.5	50.7
Total Coliform[c]	--	--	492	44,125	--	--	--
Sulfate	252.0	83.0	116.0	80.0	77.0	63.5	70.0
TDS	751.5	572	512	338	348	345.5	393
TSS	136.0	153.0	75.0	48.0	29.5	38.0	45.9
TOC	10.2	7.8	9.5	8	8.5	9.5	4.9
Zinc	0.028	0.023	0.015	0.022	0.016	0.017	0.031

Source: CDM (1983i).

[a] All units in mg/l or otherwise noted.
[b] Source: Getty (1983a).
[c] Unit in mpn/100 ml.

The leach zone on the Pacific property is bounded above and below by relatively impermeable (unfractured) marlstones, although the intertonguing of Uinta/upper Parachute Creek strata at the northern end of the Pacific property and onto the Getty property (Hail 1978; Verbeek and Grout 1983) may allow for some downward ground water flow. On all properties, declining head with depth was observed, indicating potential for some downward flow.

The Mahogany Zone is not considered a significant water-bearing interval beneath the Getty property (Getty 1983a), nor any of the adjacent oil shale properties. Data from the adjacent Pacific property, including rock cores and hydraulic testing, show the Mahogany Zone to be relatively unfractured and flow permeability a hydraulic conductivity of less than 0.020 ft/day (7×10^{-6} cm/sec; CDM 1983e). Furthermore, with the exception of the B groove, no strata below the Mahogany Zone are considered significant sources of ground water (Getty 1983a; CDM 1983e; BLM 1983a).

Existing data do not allow precise determination of the direction of ground water flow within these bedrock strata. A potentiometric map, however, constructed for the Getty property (Getty 1983a) based on composite head in open drill holes exhibits an estimated flow gradient to the southwest, corresponding to the structural dip of the Crystal Creek Anticline. A similar southwesterly ground water flow direction was apparent for the leach zone interval beneath the Pacific property, whereas flow in the Uinta Formation roughly corresponded to the topographic surface (i.e., away from topographic highs). These characteristics may also be indigenous, to the Getty property, with some modification of geologic structure. Although ground water flow direction on the Getty property and adjacent areas is dissimilar to that described elsewhere in the Piceance Basin, such a variance can be explained by the location of these sites on the margin of the basin.

Alluvial aquifers within the boundaries of the Getty property include valley fill deposits along Clear Creek and in Tom, Buck, and Doe gulches. The alluvial aquifer in Clear Creek has been addressed in BLM (1983a), and is presently being evaluated as a result of Chevron's proposed augmentation plan (5th District Water Court). Little or no data are available as to the extent, lithologic character, and degree of saturation in the latter three gulches. Based on their topographic expression, and data available for Deer Park Gulch on the Pacific property to the south, several general conditions can be inferred:

- Ground water probably occurs under unconfined conditions within the colluvial and alluvial sediments of the valley bottom
- Ground water levels may fluctuate seasonally
- The valley bottom aquifers are recharged by infiltrating streamflow and by springs discharging from bedrock strata along and atop the Roan Cliffs
- Ground water flow probably parallels surface topography (i.e., down gulch to Clear Creek canyon)

Based on available data, unconsolidated deposits in drainages on the plateau, including Weisse and Short gulches, appear to be too thin and laterally restricted to be considered significant sources of ground water.

Water Quality

The water quality of the bedrock aquifers is generally good, based on spring discharge data on the Getty property and additional ground water quality data from the adjacent Chevron, Pacific, and Cities Service Properties. TDS values for all springs and upper Parachute Creek wells are uniformly in the range of 400 to 800 mg/l (Getty 1983a). Sodium bicarbonate waters predominate, although locally high calcium and sulfate concentrations occur. Based on data from the Pacific property, however, the Uinta Formation displays greater viability in water chemistry, particularly in the northern sector adjacent to the Getty property. High concentrations of calcium (greater than 500 mg/l in several instances) were observed, with TDS values as high as 1,800 mg/l (CDM 1983e). Little or no bicarbonate was encountered, owing to pH values in excess of 10.3. It is important to note that spring discharges from the Uinta Formation on the Pacific property, with TDS values consistantly below 500 mg/l. The significant difference between dissolved constituents from Uinta wells and springs is suggests that springs may be a near-surface phenomenom in the area (CDM 1983e). Fracture controlled permeability in near-surface areas allow discharge quantities as high as 240 gpm on the Getty property, whereas the low hydraulic conductivities discussed previously suggest a longer residence time for the "interior", unweathered strata.

Alluvial water quality is generally good, based on data from the adjacent Chevron and Pacific properties. Ranges in TDS concentrations are 550 to 730 mg/l and 310 to 570 mg/l for Clear Creek and Deer Park Gulch, respectively (CDM 1983e; BLM 1983a). Water type is generally mixed cation and anion, with variable concentrations of sodium, calcium, bicarbonate, and sulfate.

Ground Water Use

An inventory of existing water rights indicates that no registered ground water wells occur on the Getty resource property. Five registered wells for stock, domestic, and irrigation use are situated within three miles of the property boundary. Well depths range from 4 to 350 feet, with yields ranging from 5 to 50 gpm (Getty 1983a).

Four appropriated springs occur on the Getty property, and three more within 3 miles of the property boundary. Appropriated flows range from 0.05 to 0.5 cfs (0.4 to 3.7 gpm; Getty 1983a). Further details regarding existing well and spring use are provided in the above referenced baseline reports.

3.2.4 Aquatic Ecology

The primary surface water drainages of the Getty property include Clear Creek and its associated tributaries (Roan Creek drainage), West Fork of Parachute Creek (Parachute Creek drainage), and East Willow Creek (Piceance Creek drainage). These streams are, in general, poor fishery habitats having little or no recreational value.

Clear Creek, the major drainage of the Getty project area, is located on the southwest border of the resource property. The reach adjacent to the property area, from Sheep Gulch to the confluence with Roan Creek, is characterized as a poor fishery habitat, especially during periods of moderate to high flow. The banks are unstable and eroding. The stream channel is deeply cut, having a generally consistent width and depth throughout. There are few pools, little cover, and the substrate consists primarily of shale and silt. Mottled sculpin is the only fish species which occurs in this reach, although an occasional trout is planted by the local ranchers. The trout migrate out during high flows (ERT 1981).

The tributaries of Clear Creek originating within the project area include Camp Gulch, Crystal Creek, Doe Creek, Pearl Creek, Potts Creek, Weisse Creek, and the East Fork, West Fork, and mainstem of Short Gulch; tributaries in Roan Creek valley include Bush, Deer Park, Doe and Sheep gulches, and Tom Creek. Most of these surface waters are intermittent. The biological communities are limited to benthic invertebrates and lower life forms. No fishery exists in these drainages (Engineering-Science 1983b).

The West Fork Parachute Creek is located within the northeast portion of the property. The stream is characterized as having a low to moderate fishery potential (EPA 1979). The flows are extremely variable and dependent upon snowmelt, storm events, and spring sources (Engineering-Science 1983a). The stream is perennial below its confluence with Wet Creek. The water quality is generally good with the exception of high concentrations of aluminum. The substrate consists primarily of sand. Deeply undercut stream banks and pools with depths exceeding 4 feet provide cover and holding waters for fish, especially during periods of low flows. A trout fishery, primarily dominated by brown trout, was established through a stocking program within an impoundment in the uppermost reach of Parachute Creek within the Getty property. The most recent stocking occurred in 1979. No fish were present in the drainage prior to initiation of the stocking program. Trout were collected within the impoundment in 1982 (Engineering Science 1983c). However, since that time, the dam has been breached leaving barren flats. Most of the trout have been washed out, although some remain in pool areas of the upper West Fork of Parachute Creek (Seeley 1983).

Other surface waters within the Parachute drainage which originate on the Getty property include Bear Run, Wet Fork, Willow Creek, and Wolf Creek. These streams are intermittent or provide insufficient flow for the maintenance of a fishery (Engineering-Science 1983a).

The East Fork of Willow Creek, in the Piceance Creek drainage, is a perennial stream which drains the northern 5 percent of the Getty property. Within the property area, the stream has an average width of 2 feet, depth of 4 inches, and the substrate consists of cobble and gravel. The aquatic biota is limited to benthic invertebrates and lower forms. No fishery exists due to lack of sufficient flow (Engineering-Science 1983a; 1983b).

No state or federally-listed threatened or endangered species occur within the project area.

3.2.5 Soils

Soils located on the Getty property and part of the Getty proposed action are on the canyon valley and upland plateau physiographic types. Detailed discussions of these soils are given in Section 3.1.5 and Table 3.1-3. There are 1,324 acres of prime farmland in the project area.

3.2.6 Vegetation

The vegetation of the Getty resource property consists of mixed desert shrublands and riparian woodlands in Tom Creek canyon and Buck and Doe gulches. Mixed shrublands and aspen and Douglas-fir woodlands occur on the plateau (Getty 1983a).

The predominant vegetation type on the property is mixed shrubland, which covers approximately 58 percent of the area. Aspen woodland, the second most abundant type, covers 20 percent of the property. Plateau sagebrush shrubland occupies about 16 percent of the area, occurring in drainages and valley bottoms. The remaining vegetation types are less abundant.

Barren talus slopes and cliffs, the most important habitats for special concern plant species, cover about 6 percent of the resource property. Five special concern plant species are reported from the Getty property (Getty 1983a) in these habitats. Barneby columbine (*Aquilegia barnebyi*) and Sullivantia (*Sullivantia hapemanii* var. *purpusii*) occur together near waterfalls, plunge pools, and seeps in the upper reaches of Tom Creek canyon and Buck and Doe gulches (see Section 3.1.6 for definition of status categories).

Barren talus slopes in Tom Creek canyon and Buck and Doe gulches support abundant populations of dragon milkvetch (*Astragalus lutosus*), Sevier blazing-star, and sunloving meadow-rue (*Thalictrum heliophilum*). Although these talus slopes provide potential habitat for sedge fescue (*Festuca dasyclada*), no individuals were observed.

3.2.7 Wildlife

Baseline investigations indicate that approximately 74 species of mammals, 233 species of birds, 19 species of reptiles, and 8 species of amphibians have been observed or are likely to occur in the Getty oil shale project area and vicinity (Getty 1983a). Major wildlife habitats are distributed between the plateau and valley portions of the project area. Aspen, rimrock, plateau mixed shrub, and plateau grass/sage are habitats which occur at an elevation greater than 7,800 feet (Getty 1983a). Principal habitats of the valley and canyon walls (less than 7,800 feet) include valley wet slope shrubland, valley dry slope shrubland, scree slope, valley sagebrush shrubland, conifer, agricultural land, and riparian areas (Getty 1983a). Although each of these habitats may provide the necessary food, cover, breeding, or nesting sites for a variety of animals, most wildlife species occur in close association with aquatic or riparian habitats (BLM 1983a). This close association may be attributed to the general lack of rivers, streams, ponds, and reservoirs in the region (ERT 1981). Following is a discussion of important mammals, birds, reptiles, and amphibians which occur in the project area.

Mammals

Four big game species occur within the project area: mountain lion, black bear, elk, and mule deer. Comprehensive inventories for mountain lion have not been conducted in the Roan Creek area (Ellenberger 1982). However, lion sightings have been reported in the Conn, Roan, and Clear creek drainages (Gumber 1982; CDM 1983d). The Tom, Buck, and Doe creek drainages and adjacent areas provide excellent habitat for mountain lion because of high topographic diversity, dense vegetation cover, and abundance of prey species in conjuction with lack of disturbance (Getty 1983a). Since mule deer constitute the primary prey of mountain lion, the distribution of lion in the project area is likely to be coextensive with this species (BLM 1983a).

Recent sightings of black bear in Clear Creek (ERT 1981) and Conn Creek canyons (Getty 1983a) indicate the widespread occurrence of this species in the vicinity of the Getty project area. Bear sign was observed in mixed shrubland habitat in the southwestern portion of the Getty property (Getty 1983a). The aspen and douglas-fir habitats of the project area also provide good habitat for bear due to the availability of cover and important dietary components such as succulent forbs, berries, and mast (Getty 1983a). Other important food items such as snowberry and serviceberry are available in densely vegetated canyons, hillsides, and riparian areas.

Although present in the project area and vicinity year-round, elk are migratory within their range, moving into higher elevations during the growing season and returning to the lower wintering grounds via traditional migration routes (BLM 1983a). According to CDOW (1983), elk winter range, winter concentration areas, and critical habitat all lie within the canyon floors of Clear Creek in the vicinity of the project area and in Tom Creek (Figure 3.1-3). Tom Creek and upper Clear Creek canyon are critical areas for elk survival during the winter because of the shelter and browse which they provide. The CDOW (1983) has also identified Tom Creek canyon as a corridor for migrating elk. There is no estimate for elk density specific to the 32,480-acre project area. During a January 1982 aerial survey of the Clear Creek drainage, 121 elk were counted by CDOW (1982b). An estimated 200-250 elk frequent Clear Creek canyon winter range (Ellenberger et al. 1982).

Mule deer are also migratory residents of the project area, frequenting the plateau shrublands during the summer, and the valley shrubland and riparian habitats in winter. The CDOW has designated the southern portion of the project area along the Clear Creek drainage as winter range for deer (CDOW 1983). Habitats in this winter range area are primarily valley shrubland, riparian woodland, and agricultural (Getty 1983a). Winter concentration areas and critical habitat also occur in the lower portion of the Clear Creek canyon and in the Roan Creek valley (Figure 3.1-3). Recent surveys of areas adjacent to the Getty property indicate that the west-facing tributaries of Clear Creek (e.g., Deer Park and Doe gulches) provide important sources of preferred winter browse for deer (CDM 1983d). No deer population estimate is available for the project area. However, 202 deer were recently observed during winter in lower Clear Creek canyon (CDM 1983d).

Other mammals which commonly occur in the Getty project area and vicinity include cottontails, jackrabbits, porcupine, chipmunks, coyote, bobcat, and weasel (ERT 1981; CDM 1983d; Getty 1983a).

Birds

The vegetation and topographic diversity of the Getty project area attracts a large variety of gamebirds, raptors, and non-raptor species. Upland gamebirds of the project area include blue grouse, sage grouse, chukar, and mourning dove (Getty 1983a). Display grounds for blue grouse are likely to occur in Douglas-fir woodland and adjacent plateau shrublands (CDM 1983d). Although none were directly observed, strutting grounds for sage grouse may also be present on the property. Two leks within close proximity to the project area have been identified by CDOW (Getty 1983a). However, the location and level of lek use is highly variable on an annual basis in the region (Gumbar 1982). Preferred habitat for chukar occurs in the canyon floors and adjacent walls of Tom and Clear creeks (Getty 1983a).

A variety of raptors inhabit the Getty project area. Red-tailed hawks are the most prevalent; however, turkey vulture, Cooper's hawk, Swainson's hawk, golden eagle, and American kestrel have also been observed (Getty 1983a). Four active red-tailed hawk nests and two active Cooper's hawk nests were found on the plateau portion of the project area. An active Cooper's hawk nest was seen in Buck Canyon, and the cliffs above Tom Creek had three inactive golden eagle nests. Several other unidentified raptor nests were found on the plateau and along the cliff faces.

Numerous species of waterfowl, shorebirds, and songbirds are likely to occur as residents or transients in the project area (Getty 1983a). Among the occasional migrants or residents are several bird species of high federal interest, including the sandhill crane, western bluebird, Scott's oriole, Williamson's sapsucker, black swift and Lewis' woodpecker (Getty 1983a). Recent studies have failed to locate any of these species in the vicinity of the project area (ERT 1981; CDM 1983d; Getty 1983a).

Reptiles and Amphibians

Frogs and toads are the most common amphibians in the vicinity of the project area and are highly dependent on the availability of water as a source of food and for reproduction (ERT 1981; CDM 1983d). Important habitats include riparian areas, ditches, intermittent streams, and ponds of the plateau and valley floor (CDM 1983d). By contrast, the reptilian species, such as lizards and snakes, rely heavily on the availability of shrub-dominated habitats and rock outcrops (CDM 1983d). Among the reptile and amphibian species which occur in the project area are the short-horned lizard, northern plateau lizard, midget-faded rattlesnake, and tiger salamander (Getty 1983a).

Threatened and Endangered Species

Three wildlife species federally listed as endangered were evaluated to determine their potential for occurrence in the Getty project area (Getty 1983a). These species are the black-footed ferret, peregrine falcon, and bald eagle. A detailed assessment of their occurrence in the project area is presented in the Biological Assessment for the Getty and Cities Service properties (Beck 1983a), a summary of which is contained in Appendix B. Applicable information from the report is summarized below.

Neither black-footed ferret nor white-tailed prairie dogs, principal prey of black-footed ferrets, were observed in the project area. Although two white-tailed prairie dogs were sighted near the confluence of Roan and Conn creeks, a survey of habitats in the vicinity of the sighting failed to locate any prairie dog colonies (Beck 1983a). No prairie dog colonies are known to occur in the Roan Creek valley (Lambeth 1983).

Potential nesting habitat for peregrine falcon occurs in the cliff faces of the Getty project area (Figure 3.1-2). In addition, riparian habitat, which attracts a variety of prey species, is present in the valley floor of Tom Creek and Clear Creek canyons. The recent sighting of a peregrine falcon in Scott Gulch, 2 miles south of the Getty property, confirms the likelihood that this species occurs in the Roan Creek and Clear Creek valleys and vicinity; however, no active eyries are known in this area (CDM 1983d).

Bald eagles are commonly observed during winter in riparian habitats along the Colorado River in close proximity to De Beque (Figure 3.1-2; BLM 1983a). Eagles were recently sighted in the Roan Creek valley within 1.5 miles of the Roan Creek and Conn Creek confluence (CDM 1983d). Although bald eagles have not been observed in the Getty project area, they are known to frequent the valley habitats along Roan Creek probably in pursuit of alternative prey such as waterfowl, carrion, or small mammals (Fisher et al. 1981).

The Getty project area lies within the migration corridor of the federally endangered whooping crane and state endangered sandhill crane. Since key staging areas for these species generally occur along large rivers where small grain crops are available as food (CDOW 1978), occurrence of sandhill or whooping crane in the vicinity of the project area is unlikely.

Fifteen species listed as species of special concern by the Colorado Natural Heritage Inventory (CNHI 1983) are likely to occur in the project area and vicinity. None of these species were directly observed in the project area; however, two species the great blue heron and western yellowbelly racer have been observed in the Roan Creek valley (Getty 1983a).

3.2.8 Air Quality/Meteorology

The affected air quality and meteorology environment representative of the Getty property is fully discussed in Section 3.1.8. Existing features unique to the Getty property include the complex flow regimes in the deep gulches. As discussed in Section 3.1.8, no actual monitored meteorological data exists. However, flows driven by temperature gradients should result in up- and down-valley regimes. The affected valleys and their orientation (downvalley) are Tom Creek canyon, running north to south; Buck Gulch, running northeast to southwest; Doe Gulch, running north-northeast to south-southwest; and Clear Creek canyon, running north-northwest to south-southeast.

3.2.9 Noise

The affected noise environment representative of the Getty project area is discussed in Section 3.1.9.

3.2.10 Cultural Resources

The cultural resource investigations for the Getty project were conducted by a team of Nickens and Associates of Montrose, Colorado, during July 1983 (Getty 1983a). Prior to conducting field investigations, a review of pertinent regional literature and site records was performed (Class I inventory). Records checks and literature reviews were conducted at the BLM White River Resource Area office and the BLM Grand Junction Resource Area office and district offices; the Office of the State Archaeologist; the Colorado State Historic Preservation Office; and the Garfield County and Mesa County courthouses.

The Class I inventory resulted in documentation of 34 sites (18 prehistoric and 16 historic) and 16 isolated finds (14 prehistoric and 2 historic) previously identified for the project area. The prehistoric sites are primarily either lithic scatters or campsites. Historic sites are mainly homesteads.

Field investigation consisted of a random sample (Class II inventory) survey of portions of the Getty property. A total of 9.1 percent of the sample units was intensively surveyed; all were within likely areas of impact. The Class II inventory identified one historic site (a corral) and one prehistoric isolated artifact (a chert flake). Neither is considered eligible for nomination to the National Register of Historic Places (NRHP), and no further work is deemed necessary (Nickens 1983).

In summary, the results of the survey indicate a low prehistoric site density. Historic sites are more common in the area and can be related to ranching activities.

3.2.11 Land Use, Recreation, Wilderness

Land Use

The Getty resource property consists of 20,880 acres of privately owned land. The predominant land use is rangeland (Getty 1983a). Stocking rates for cattle average 10-20 acres/cow (BLM 1983a). There is only limited agricultural use of the resource property, at the mouth of Tom Creek canyon.

Recreation and Wilderness

Mule deer and elk, important to the region's economy as game species, are located on the site and are hunted in autumn. Access is limited, however. Although numerous recreation and wilderness areas are located in the region (Section 3.1.11), none occur within the Getty resource property.

3.2.12 Visual Resources

The Getty Oil project area lies within four landscape character types: Plateau, Cliff and Canyon Floor, Arid Foothill, and Valley Floodplain. The following site descriptions include landscape characterization, scenic quality, and sensitivity evaluations for the project area. Descriptions are based on Getty (1983a) and BLM (1983a).

The mines, plants, spent shale disposal, and associated service and utility corridors would be located within the Plateau landscape character type. This type, which represents the highest elevation of the project area (greater than 7,600 feet), represents the majority of the Getty property area. The type is characterized by mountain brush and grass covered, gently sloping and rolling, spherical shaped landforms. Line is horizontal and curvilinear; texture is insignificant. Color is dominated by the grays and greens of vegetation and is affected by the seasons. Exposed landform is yellow, tan, and brown. Cultural modifications such as jeep roads, fence lines, and cattle trails occur, but do not affect scenic quality. Overall scenic quality is considered moderate (Getty 1983a). Access by the general public to the plateau area is limited and thus site sensitivity is low.

Access corridors from Clear Creek canyon to the plant sites would traverse the Cliff and Canyon Floor landscape character type. This type is characterized by steep to near vertical massive cliffs and talus slopes rising nearly 2,000 feet to the plateau. In the project area, this type includes Clear Creek and Tom Creek canyons and Deer Park, Doe, and Buck gulches. Line is vertical as exhibited by debris avalanche runs, and horizontal as a result of exposed shale beds. Color is dominated by the yellows, tans, browns, and (in some areas) reds of exposed soil and landform. Vegetation is sparse. The canyon floor imparts horizontal curvilinear lines and exhibits the greens and yellows of riparian vegetation. Public access to Clear Creek canyon is limited, thus the area is considered low sensitivity. Cultural modifications are limited to an access road and powerline on the canyon floor. Due to the massive nature and striking contrast of the landform, the character type is rated high scenic quality.

The Roan Creek portion of the project area is comprised of the Arid Foothill and Valley Bottom landscape character types. The Arid Foothill character type is comprised of moderate to steep, brush-covered slopes with horizontal and curving line. Color varies with slope and aspect and includes the grays and greens of vegetation and the browns and grays of exposed soil. Cultural modifications exist as roads, powerlines, and ranch structures. Scenic quality is considered moderate to low. In the project area, the type can be observed by the general public; thus sensitivity is moderate to high.

The Valley Bottom character type is comprised of gently rolling arid terrain adjacent to broad flat irrigated pasture. During summer the dark greens of the valley bottom contrasts sharply the browns of the adjacent terrain. Cultural modifications occur throughout as roads, fence lines, ranches, fields, and other associated agricultural activities. The majority of the modifications impart straight lines to the landscape. Due to the pastoral nature of the type, scenic quality is moderate. Sensitivity is moderate to high since the type is visible to the general public.

3.2.13 Socioeconomics

The Getty property includes over 32,000 acres in the Roan Creek and Clear Creek area, north and northwest of De Beque. The property will be utilized for access to the oil shale resource, and for development of a water storage system, including pumping stations, pipelines, and a reservoir. The water storage system would be undertaken by the GCC joint venture, comprised of Getty, Cities Service, and Chevron Shale Oil Company. The environmental impacts, including socioeconomics, have been addressed in BLM (1983a).

The Getty oil shale resource site is located in the Clear Creek drainage and accounts for about 20,880 acres of their holdings. Currently there are no permanent residents or other structures on the resource property. There are a number of grazing leases and the only continuous socioeconomic activity on the property is associated with the raising of livestock. There are some dirt roads that allow access for the ranchers; certain portions require a 4-wheel drive vehicle.

3.2.14 Transportation

The major transportation networks for the Getty project area and the relative capacity of these networks are described in Section 3.1.14.

Physical barriers restrict site access from the north, therefore the Roan Creek road (County Road 45) would provide access to the Getty properties from De Beque. Approximately one-half of the road is paved, and ranges from 18 to 30 feet in width. The remainder is a graded dirt road which narrows from 22 feet in width to 10 to 14 feet in width at the northernmost extreme. The average daily traffic is estimated at 150 to 250 vehicles.

The existing Roan Creek road would not be fully adequate for the proposed project, and improvements would be required. A new road would also be constructed to tie the project plant into the Roan Creek road. Details of the new road were given in the Project Description (Section 2.3.1).

3.2.15 Energy

The energy systems and resources in the area of the proposed action are as described in Section 3.1.15. Various electrical transmission lines travel north up Roan Creek and Parachute Creek valleys to serve local residents and industrial customers. These lines are adequate to serve current needs, but would have to be expanded to provide enough power for the proposed operations.

A natural gas pipeline, owned by Rocky Mountain Natural Gas Company, runs north-south and lies approximately 3 miles east of the site. The pipeline would potentially be a source of gas supply to the proposed projects.

No water pipelines lie within the immediate area of the proposed project at this time.

3.3 Cities Service Project

3.3.1 Topography, Geology, Paleontology

The Cities Service resource property is located on the Roan Plateau, which consists of a rugged, intricately dissected plateau with broad tabular upland tracts between deep stream valleys. The plateau property ranges from 8,000 feet to 8,400 feet in elevation. In general, elevation increases on the plateau from the southwest to the northeast. A major portion of the Cities Service property lies south and west of a ridge line which divides the property from southeast to northwest. This ridge line divides the surface water drainage between Conn Creek and Parachute Creek with a small portion of the property draining to Clear Creek via Deer Park Gulch. Slope gradient in the plateau upland areas ranges from 4-5 percent in the plateau drainages, to 20-30 percent for plateau slopes oriented perpendicular to principal stream drainages (Cities Service 1983a).

Facilities to be located on the plateau would include the waste rock pile, shale fines stockpile, spent shale disposal area (alternative), retorts, upgrading, mine portal, and various corridors. Facilities to be located above 8,100 feet on the plateau would be underlain by the Uinta Formation. Those facilities located below 8,100 feet but above the canyon cliffs are underlain by the Parachute Creek Member of the Green River Formation (Cities Service 1983a). Both of these formations are essentially flat-lying in the Cities Service property area. Although no major faults have been mapped in the area (Hail 1978, 1982), a significant amount of joint fractures have been identified in the Uinta and Green River Formations (Verbeek and Grout 1983).

Facilities located within the canyons below the plateau include the spent shale disposal site and the transportation, water, and power corridors. Slope gradients in the canyon of Conn Creek range from 30 percent to nearly vertical (Cities Service 1983a). Lower gradient slopes in the canyon are comprised of the Garden Gulch Member, while the steep, nearly vertical cliffs are formed by the Parachute Creek Member of the Green River Formation (Hail 1982). Below these cliffs, partially covering the Garden Gulch Member, are lobes of rockfall and landslide deposits. Most of these mass-wasting features are located below the path of the proposed corridor and impinge upon the proposed spent shale disposal pile.

Below the plateau and canyon slopes are the valley bottom lands of Conn Creek. Slope gradients within the canyon drainage range from 1-2 percent (Cities Service 1983a). The valley bottomlands are comprised of alluvial fan, stream laid alluvium, and talus and landslide deposits (Hail 1982). Facilities located in the canyon bottomlands include the spent shale disposal area and the lower portion of the transportation, water, and power corridors. The affected geologic environment of the lower Roan Creek corridor and reservoir are described in BLM (1983a).

The paleontological resources of the Cities Service property and the neighboring Piceance Creek Basin are presented in Lucas and Kihm (1982). For the property, these include the Eocene age Green River and Uinta formations (Cities Service 1983a). The most common fossils in the Green River Formation in the Piceance Creek Basin are plants and insects. These fossils have been extensively studied because of their excellent preservation. A juvenile crocodilion was recently reported from the Douglas Creek Member of the Green River Formation just southwest of the study area. Prior to this, the reported fossil fauna has been limited to a few insects and gastropods from the Green River Formation in. The Lucas and Kihm (1982) survey augmented the insect and gastropod fauna, but only found small amounts of vertebrate fossil material in the Green River Formation within the study area (Cities Service 1983a). Lucas and Kihm (1982) also classified each of the geologic formations within the study area with regard to their importance as a paleontological resource. The Green River Formation is considered to have demonstrated high potential for producing scientifically significant paleontologic resources.

Very few fossil vertebrates or invertebrates were known from the Uinta Formation in the study area, prior to the Lucas and Kihm (1982) survey. Their study found numerous localities in the Uinta Formation in the study area along with the discovery of the partial skull of the vertebrate*Uintatherium,* a significant paleontological find. The Uinta Formation, as with the Green River Formation, is considered to have demonstrated high potential for producing scientifically signifcant paleontologic resources.

3.3.2 Surface Water

The Cities Service oil shale resource property lies in the Roan Creek and Parachute Creek drainage basins. The surface waters which drain from the property include Conn Creek and its tributaries, and small portions of drainages to Parachute Creek and Clear Creek. The project site is about 15 miles from the Colorado River, north of the town of De Beque. Approximately 12 percent (1,236 acres) of the property drains into the Parachute Creek drainage, 4 percent drains to the west into Clear Creek via Deer Park Gulch, and 84 percent drains to the southwest into the Conn Creek drainage.

The topography is characterized by undulating plateaus, generally at elevations of about 7,000 feet. These plateaus are cut by canyons and steep-sided valleys which comprise the remainder of the property area. The valley floors are relatively narrow and only occupy about 13 percent of the property area. The highest elevation on the property is 8,698 feet.

Conn Creek is the major drainage on the property. It flows in a generally southward direction to its confluence with Roan Creek at about 5,200 feet elevation. The main course of the stream lies in Conn Gulch with tributaries joining the main channel from Cascade Canyon, Baker Gulch, and Bowdish Gulch. The drainage area of Conn Creek, upstream of East Fork Baker Gulch is about 17.0 sq. mi. The upper portion of Conn Creek has an average channel slope of 7.5 percent and extends in a stream length of about 7.0 miles (CDM 1983i). Land use in the vicinity of Conn Creek is primarily agricultural rangeland. Conn Creek is an important source of water for stock, either directly from the stream or from small impoundments. The stream is also used for irrigation of several hay meadows near the confluence of the East Fork of Baker Gulch. Vegetation along the course of Conn Creek is primarily characterized as riparian, and is variable in density and composition. Sediment yield from the watershed is estimated to be about 2.0 ac-ft/sq mi of drainage area (CDM 1983i).

Stream Flow

Sources of streamflow for Conn Creek are snowmelt, rainfall, springs, and seeps. Streamflow data (from 1970 to 1983) for Conn Creek are available at two gaging stations: one located upstream of the East Fork of Baker Gulch confluence, the other at the mouth of Roan Creek. The months of May and June provide 45 percent of the annual runoff, while the remainder of annual runoff is evenly distributed among the other months (Table 3.3-1). The annual average flows are 2.03 cfs and 2.84 cfs for upper Conn Creek and lower Conn Creek, respectively (Cities Service 1983a). Stream flows in the lower Conn Creek may be affected by irrigation diversions. The stream bed of Conn Creek has been observed to be dry during the summer at the two gaging stations, and the low flow characteristics of this stream are such that low flows may be very consistent for many consecutive days.

The water balance analysis for the Cities Service property indicates that most of the precipitation is consumed by evapotranspiration, and only approximately 7.0 to 9.0 percent of the precipitation resulted in surface runoff (Cities Service 1983a). The water balance shows that total net runoff from the Cities Service property is about 1.81 inches per year (1,713 ac-ft per year).

Water Quality

The water quality of Conn Creek is a mixed bicarbonate type (CDM 1983i). Water quality of lower Conn Creek showed high concentrations of sulfate, compared with water of upper Conn Creek (Tables 3.3-2 and 3.3-3). The pH values generally are greater than 7.0, indicating alkaline conditons. Water quality of Conn Creek does not show any seasonal trends. However, certain parameters, including total suspended solids (TSS), TDS, sulfate, nitrate, and hardness, have higher concentrations (for lower Conn Creek) during the summer thunderstorm season. Concentrations of most constituents increased from upstream to downstream. The water quality of upper Conn Creek is generally similar to the water quality of Clear Creek, but better than the water quality of Roan Creek.

Concentrations of TDS, sulfate, iron, and manganese in lower Conn Creek very often exceed the EPA drinking water quality standards. Also, the concentrations of fecal coliform for lower Conn Creek often exceed 100 mpn/ml (the water quality standard established by the Colorado Department of Health) during the period from March through September (Chevron 1981). This is primarily due to intensive livestock grazing activities in the lower Conn Creek drainage basin.

Table 3.3-1 AVERAGE DAILY FLOWS FOR THE LOWER CONN CREEK STATION FOR WATER YEARS 1971 TO 1982

Months	Average Daily Flow (cfs)	% of Annual Total
October	2.2	5.4
November	2.3	5.6
December	2.2	5.4
January	2.1	5.2
February	2.1	5.2
March	2.0	4.9
April	2.0	4.9
May	13.9	34.2
June	4.8	11.8
July	2.5	6.1
August	2.5	6.1
September	2.1	5.2
Annual Total	(2455.0 ac-ft)	100

Source: Cities Service (1983a).

3.3.3 Ground Water

Ground Water Occurrence

The hydrogeologic environment of the Cities Service resource property is dominated by sandstone and marlstone strata of the Uinta Formation at the surface, and underlying marlstones of the upper Parachute Creek Member of the Green River Formation.

Proposed retort and upgrading facilities, waste rock pile, and majority of shale fines pile would be situated on the Uinta Formation, whereas, the spent shale disposal area would be located in Conn Creek and Cascade Canyon, incised into Green River Formation strata. The alternative spent shale disposal areas would encompass areas underlain by Uinta and Upper Parachute Creek strata on the plateau. The water and power corridor would traverse alluvial deposits of Conn Creek, as well as the aforementioned bedrock units on and above the Roan Cliffs. Detailed site-specific information for these hydrostratigraphic units is somewhat limited. However, their probable characteristics can be inferred from data available from adjacent oil shale properties.

The Uinta Formation in this sector of the Piceance Basin is typified by interbedded sandstones and marlstones. Bedding is often discontinuous and lenticular, such that no one strata can be correlated for any distance. Permeability conditions are controlled by primary (intersticial openings in the rock matrix) and secondary (fracture) systems. Data from the Pacific property to the south indicate that primary and secondary permeability decreases with depth (CDM 1983e). Ground water conditions resulting from this lithology are similarly variable. Whereas, data from the Chevron property indicate the Uinta Formation to be well drained and unsaturated (BLM 1983a). Drill hole/monitor well data and spring discharge on the Cities Service and Pacific properties are indicative of at least partially saturated conditions (CDM 1983e).

Table 3.3-2 WATER QUALITY RECORDS FOR UPPER CONN CREEK AT STATION UCC

Field Measurement[a]				
Date Sampled	5/25/82	8/18/82	11/3/82	2/22/83
Time Sampled	0943	0845	1438	1430
Discharge (cfs)	1.28	1.16	0.97	0.82
Temperature (°C)	7.5	11.0	9.2	11.1
Dissolved Oxygen	10.1	9.05	7.5	8.3
Salinity (‰)	0.0	0.2	0.0	0.2
pH	8.3	8.1	7.1	8.2
Specific Conductance (micromhos/cm)	460	710	700	680
Laboratory Analysis[a]				
Aluminum	0.5	0.5	0.2	0.5
Ammonia	0.2	0.2	-	0.2
Arsenic	0.005	0.005	0.005	0.005
Barium	0.2	0.2	-	0.2
Bicarbonate	340	490	490	350
Boron	0.1	0.3	0.3	0.2
Cadmium	0.005	0.005	0.009	0.005
Calcium	62	85	84	73
Carbonate	0	0	0	0
Chloride	4	8	11	9
Chromium	0.010	0.011	0.006	0.005
Copper	0.006	0.010	0.005	0.005
Fluoride	0.4	0.8	0.8	0.6
Hardness	330	440	430	400
Iron	2.5	0.48	0.19	1.0
Lead	0.010	0.005	0.005	0.005
Magnesium	35.0	54.0	57.0	51.0
Manganese	0.054	0.025	0.015	0.045
Mercury	0.0001	0.0001	-	0.0001
Molybdenum	0.018	0.03	0.02	0.018
Nickel	0.02	0.02	0.02	0.02
Nitrate	1.1	1.1	1.0	1.0
Total Phosphate	0.13	0.06	0.03	0.12
Potassium	2.0	3.2	2.9	4.8
Selenium	0.005	0.005	0.005	0.005
Sodium	53	70	65	63
Sulfate	104	150	160	160
TDS	452	640	640	620
TSS	86	24	10	52
TOC	6	8	7	15
Zinc	0.02	0.016	0.009	0.006
Alkalinity	-	-	-	360

Source: CDM (1983i).

[a] Units in mg/l unless otherwise noted.

Table 3.3-3 WATER QUALITY RECORDS FOR LOWER CONN CREEK AT STATION LCC

Field Measurement[a]				
Date Sampled	5/25/82	8/18/82	11/3/82	2/22/83
Time Sampled	1035	0945	1255	1310
Discharge (cfs)	0.60	1.08	1.3	1.77
Temperature (°C)	11.0	13.0	6.1	8.0
Dissolved Oxygen	9.2	8.7	8.6	8.35
Salinity (‰)	0.5	0.5	0.0	0.5
pH	8.3	8.3	7.2	8.5
Specific Conductance (micromhos/cm)	1,000	1,160	760	810
Laboratory Analysis[a]				
Aluminum	0.5	0.7	0.9	0.8
Ammonia	0.2	0.2	-	0.2
Arsenic	0.005	0.005	0.005	0.005
Barium	0.2	0.2	-	0.2
Bicarbonate	460.0	530.0	480.0	470.0
Boron	0.2	0.3	0.3	0.2
Cadmium	0.005	0.005	0.01	0.007
Calcium	83.0	120.0	90.0	100.0
Carbonate	0	0	0	0
Chloride	14.0	16.0	10.0	10.0
Chromium	0.021	0.036	0.011	0.01
Copper	0.007	0.010	0.008	0.007
Fluoride	0.5	0.8	0.7	0.6
Hardness	570	650	480	560
Iron	0.29	4.2	1.0	3.2
Lead	0.058	0.005	0.005	0.005
Magnesium	80.0	88.0	70.0	69.0
Manganese	0.021	0.11	0.034	0.11
Mercury	0.0001	0.0001	-	0.0001
Molybdenum	0.036	0.031	0.019	0.022
Nickel	0.02	0.02	0.02	0.02
Nitrate	1.0	1.7	1.0	1.2
Total Phosphate	0.02	0.11	0.05	0.11
Potassium	3.2	7.0	3.6	4.2
Selenium	0.008	0.005	0.008	0.005
Sodium	120	130	89	90
Sulfate	369	370	240	270
TDS	941	1,000	780	820
TSS	8	240	72	200
TOC	7	7	7	15
Zinc	0.073	0.030	0.013	0.015
Alkalinity	-	-	-	390

Source: CDM (1983i).

[a] Unit in mg/l unless otherwise noted.

The occurrence of numerous springs throughout the Cities Service property, emanating at or below the Uinta/upper Parachute Creek contact, confirms the probablility of partially saturated conditions within Uinta strata. Based on single well test data from the Cities Service and Pacific properties, the hydraulic conductivity of Uinta Formation ranges from 5.4×10^{-4} to 2.4×10^{-2} feet/day (CDM 1983e). This variability is undoubtedly due to the lateral and vertical differences in lithology and fracture conditions.

Ground water also occurs in strata of the underlying Parachute Creek Member. Flow beneath the Chevron property is confined to thin, sandy siltstone layers above and below the Mahogany Oil Shale Zone known as the A and B grooves, respectively. The predominant water-bearing interval beneath the Pacific and Cities Service properties, however, is a zone of fractured and leached marlstones above (and hydraulically isolated from) the A groove. The occurrence of this water-bearing leached zone within the upper Parachute Creek member is more typical within the Piceance Basin than is its absence on the Chevron property (Coffin et al. 1971; Weeks et al. 1974). Testing data from the Pacific and Cities Service properties show the leach zone to be more permeable than the Uinta Formation, with hydraulic conductivities ranging from 4.0×10^{-2} to 1.7×10^{-1} ft/day (CDM 1983e). Hydraulic conductivities for the A and B grooves on the Chevron property had ranges of 2.0×10^{-2} to 5.5×10^{-2}feet/day and 8.0×10^{-4} to 3.0×10^{-2} feet/day, respectively (BLM 1983a).

The leach zone on the Pacific and Cities Service properties is bounded above and below by relatively impermeable (unfractured) marlstones, although the intertongueing of Uinta/upper Parachute Creek Strata at the northern end of the Pacific property and onto the Cities Service property (Hail 1978; Verbeek and Grout 1983) may allow for some downward ground water flow. Declining head with depth has been encountered on the Pacific, Chevron, Getty, and Cities Service properties, allowing the downward flow gradient, provided that vertical fracture conduits exist. Data from the Pacific property indicate that such fractures are confined to the aforementioned areas, where Uinta and upper Parachute Creek strata are interbedded.

Spring discharge has been documented from 40 locations on and immediately adjacent to the Cities Service property (Cities Service 1983a). These springs emanate from just above or below the contact between Uinta and upper Parachute Creek strata. As such, they are indicative of infiltrating ground water that moves downward through the Uinta Formation, discharging at the base of this unit or upper sections of the upper Parachute Creek. These discharge points are typically near the heads of the numerous ephemeral/intermittent streams drawing from the plateau, where erosion has allowed incision through the overlying bedrock strata.

The Mahogany Zone is not considered a significant water-bearing interval beneath the Cities Service property (Cities Service 1983a), nor any of the other adjacent oil shale properties. Data from the adjacent Pacific property, including rock cores and hydraulic testing, show the Mahogany Zone to be relatively unfractured and of low permeability, with a hydraulic conductivity of less than 0.020 ft/day (7×10^{-6} cm/sec; CDM 1982e). Furthermore, with the exception of the B groove, no strata below the Mahogany Zone are considered significant sources of ground water (Cities Service 1983a; CDM 1983e; BLM 1983a). A single spring emanates from the contact between the Douglas Creek Member of the Green River Formation and the underlying Wasatch Formation. This spring is located at the extreme southern end of the Cities Service property, with a measured discharge of less than 3 gpm (Cities Service 1983a). No other seeps or springs have been observed emanating from, at, or below the Mahogany Zone on the Cities Service or any of the adjacent properties (Cities Service 1983a; BLM 1983a; Chevron 1983).

Existing data do not allow a precise determination of the direction of ground water flow within the bedrock aquifers. Based on well and springs data from the Cities Service, Pacific, and Getty properties, flow in the Uinta Formation appears to be from topographically high areas to points of spring discharge in the drainage bottoms along the periphery of the mesa. As noted previously, some water may percolate downward through the Uinta and into the upper Parachute Creek Member below. Data from the Pacific and Getty properties indicated in a general southwesterly ground water gradient, but is not clear if such a trend can be inferred for the Cities Service property as well.

Valley fill deposits along Conn Creek in the extreme southern sector of the Cities Service property represent the only significant alluvial aquifer. Unconsolidated deposits of alluvial and colluvial origin occur in the upland reaches of Conn Creek and Cascade Canyon atop the plateau. Both are generally narrow and shallow in extent, based on topographic evidence. They may, however, provide a recharge mechanism for the lower valley fill on Conn Creek by the transmission of water discharged from bedrock springs. A single alluvial monitor well at the southern property boundary exhibited 50 feet of valley fill alluvium adjacent to Conn Creek. Thirty-nine feet of saturated thickness was encountered. Although no data are available, it is reasonable to assume that ground water flow in the Conn Creek alluvial aquifer likely parallels surface flow.

Water Quality

Based on spring and well data from the Cities Service and adjacent properties, the water quality of the bedrock aquifers is generally good. TDS values for all springs and wells completed in upper Parachute Creek strata are uniformly in the 300 to 800 mg/l range. Spring discharge on the Cities Service property is comparable to that on the Pacific property (CDM 1983e), but slightly lower in TDS concentrations than exhibited on the Getty property (Getty 1983a). Sodium bicarbonate waters predominate, although locally high calcium and sulfate concentrations occur. Calcium often occurs as the dominant cation in Cities Service springs where TDS concentrations are low (in the 300 mg/l range; Cities Service 1983a). Springs and upper Parachute Creek wells typically have pH values in the 6.9 to 8.4 range.

Based on monitor well data on the Cities Service and Pacific properties, significant variation in water chemistry may occur within the Uinta Formation. TDS values as high as 1,800 mg/l were encountered in two wells (1 Cities Service, 1 Pacific; CDM 1983e). Little or no bicarbonate was encountered, owing to pH values above 10.3. Given the relatively good quality of identified Uinta spring discharge, it is apparent that isolated high TDS zones exist within the Uinta strata. Fracture controlled permeabilities in the near-surface areas allow spring discharge as high as 35 gpm with good quality water, whereas the low hydraulic conductivities observed at well locations may allow for greater dissolution of calcium carbonate strata, with little opportunity for movement or discharge from these more isolated zones.

Based on data from a single monitor well, TDS concentrations in the Conn Creek alluvial aquifer are noticeably higher than other valley systems such as Clear Creek. TDS values of 1,200 mg/l were recorded during all four quarters of a sampling program conducted during 1982-1983 (CDM 1983e). Ground water was of a sodium bicarbonate type, with appreciable concentrations of calcium, magnesium, and particularly sulfate as well. Similar water quality was apparent from an adjacent well, completed in the underlying Wasatch Formation (CDM 1983e), indicating that saline facies within these bedrock strata may contribute to the high dissolved solids concentration in the alluvial aquifer. The presence of a high TDS (greater than 4,000 mg/l) spring emanating from the Douglas Creek Member/Wasatch interface about 1.8 miles from the above noted wells appears to confirm this theory (Cities Service 1983a).

Ground Water Use

No registered wells or springs occur within 2 miles of the Cities Service property (Cities Service 1983a), indicating negligible ground water use. The nearest registered springs occur on the Getty property to the northwest, and the nearest ground water well occurs in the lower reaches of Conn Creek. This well is 100 feet deep, and is registered for domestic supply use (Cities Service 1983a). Further details regarding well and spring use are provided in the above referenced baseline report.

3.3.4 Aquatic Ecology

The surface waters draining the Cities Service resource property include Conn Creek and its tributaries, Cascade Creek, East Fork and Bowdish Gulch (Roan Creek drainage); and four tributaries to Parachute Creek, McKay Gulch, Corral Gulch, House Log Gulch, and Little Creek. None of these waters are suitable for maintenance of a fishery, although benthic invertebrates are found in most (Cities Service 1983a).

The aquatic habitat of Conn Creek is characteristic of small intermittent western Colorado streams. The flow is dependent on snowmelt, storms, springs, and irrigation practices. The average stream width is 3 feet and average depth is 2 inches with few pools and little cover (Cities Service 1983a). The substrate is composed of cobble and gravel at the headwaters and is silt, sand, and gravel at the mouth. Due to the lack of flow and habitat, no viable fishery is present in Conn Creek. Ranchers occasionally place trout in a pool in lower Conn Creek; however, these fish move out during high flow (Cities Service 1983a).

The tributaries to Conn Creek, including Cascade Creek, East Fork, and Bowdish Gulch are intermittent with insufficient flow to support a fishery (Cities Service 1983a). The major water uses of Conn Creek are irrigation and stock watering. There is no indication of recreational use of the area (Cities Service 1983a).

The surface waters within the Parachute drainage which have their origin on the Cities Service resource property include McKay, Corral and House Log gulches, and Little Creek. The average depth of the four streams ranges from 0.5 inch at McKay Gulch to 1.5 inches at Little Creek and their average widths ranged from 14.5 inches at McKay Gulch to 2 feet at Corral Gulch (Cities Service 1983a). Flows are dependent upon runoff and spring sources. None are of sufficient size to support a fishery.

3.3.5 Soils

The soils located on the Cities Service property are on the same upland plateau and canyon valley physiographic types as are in the Getty property. Detailed discussions of these soils are give in Section 3.1.5 and Table 3.1-3. There are approximately 1,324 acres of prime farmland in the project area.

3.3.6 Vegetation

The vegetation of the Cities Service resource property consists of mixed desert shrublands and riparian woodlands in Conn Creek and Cascade canyons and mixed shrublands and aspen and Douglas-fir woodlands on the plateau (Cities Service 1983a).

The predominant vegetation type on the Cities Service property is mixed shrubland which covers approximately 42 percent of the area. Aspen woodland is the second most abundant type covering about 38 percent of the area. Plateau sagebrush shrubland (Cities Service 1983a) occupies about 18 percent of the area.

Barren talus slopes and cliffs, the most important habitats for special concern plant species, cover about 2 percent of the resource property. Six special concern plant species are reported from the Cities Service property in these habitats (Cities Service 1983a). Barneby columbine (*Aquilegia barnebyi*) and sullivantia (*Sullivantia hapemanii* var. *purpusii*) occur in the upper reaches of Conn Creek and Cascade canyons.

Barren talus slopes in Conn Creek and Cascade canyons support large populations of dragon milkvetch (*Astragalus lutosus*), sedge fescue (*Festuca dasyclada*), Sevier blazing-star (*Mentzelia argillosa*), and sunloving meadow-rue (*Thalictrum heliophilum*).

3.3.7 Wildlife

Baseline investigations indicate that approximately 74 species of mammals, 233 species of birds, 19 species of reptiles, and 8 species of amphibians have been observed or are likely to occur in the Cities Service project area and vicinity (Cities Service 1983a). Major wildlife habitats are distributed between the plateau and valley portions of the project area. Aspen, rimrock, plateau mixed shrub, and plateau grass/sage are habitats which occur at an elevation greater than 7,800 feet (Cities Service 1983a). Principal habitats of the valleys are canyon walls (less than 7,800 feet in elevation), valley wet slope shrubland, valley dry slope shrubland, scree slope, valley sagebrush shrubland, conifer, agricultural land, and riparian areas (Cities Service 1983a). Although each of these habitats may provide the necessary food, cover, breeding, or nesting sites for a variety of animals, most wildlife species occur in close association with aquatic or riparian habitats (BLM 1983a). The close association may be attributed to the general lack of rivers, streams, ponds, and reservoirs in the region (ERT 1981). Following is a discussion of important mammals, birds, reptiles, and amphibians which occur in the project area.

Mammals

Four big game species occur within the project area: mountain lion, black bear, elk, and mule deer. Comprehensive mountain lion inventories have not been conducted in the Roan Creek area (Ellenberger 1982). However, lion sightings have been reported in the Conn, Roan, and Clear Creek drainages (Gumber 1982; CDM 1983d). Lion tracks and a recent kill were found in aspen groves in the Conn Creek drainage on Cities Service property (Cities Service 1983b). The Conn and Cascade creek drainages and neighboring areas provide excellent habitat for mountain lion because of high topographic diversity, dense vegetation cover, and abundance of prey species in conjunction with the lack of disturbance. Since mule deer constitute the primary prey of mountain lion, the distribution of lions in the project area is coextensive with this species (BLM 1983a).

Recent sightings of black bear in Clear Creek (ERT 1981) and Conn Creek canyons (Cities Service 1983a) indicate the widespread occurrence of this species in the vicinity of the Cities Service project area. Gumber (1982) estimates that the Conn Creek drainage may support five bears. A single yearling black bear was observed on the west rim of Conn Canyon during June 1983 (Beck 1983b). The aspen and Douglas-fir habitats of the project area provide good habitat for bears due to the availability of cover and important dietary components, such as succulent forbs, berries, and mast (Cities Service 1983a). Other important food items, such as snowberry and serviceberry are available in densely vegetated canyons, hillsides and riparian areas.

Although present year-round in the project area and vicinity, elk are migratory within their range, moving into higher elevations during the growing season and returning to the lower wintering grounds via traditional migration routes (BLM 1983a). According to the CDOW (1983), Conn and Cascade canyons as well as portions of the plateau constitute winter range for elk. This winter range is comprised of a mixture of upland and valley shrubland, conifer, and riparian habitats. The valleys serve as corridors for elk that migrate from the plateau to lower elevations. No critical habitat, severe winter range, or calving areas for elk occur in the project area. There is no estimate for elk density specific to the 10,300 acre project area. However, CDOW estimates that 200-250 elk winter in the Clear Creek drainage (Ellenberger et al. 1982).

Mule deer are also migratory residents of the project area, inhabiting the plateau shrublands during the summer and the valley shrubland and riparian habitats in winter. Winter range, winter concentration areas, and critical habitat for mule deer all occur in the canyon bottoms of lower Conn Creek (Figure 3.1-3; Cities Service 1983a). Habitats within these areas include plateau mixed shrubland, sagebrush, riparian areas, and agricultural land. Migration corridors for deer also exist in lower Conn Creek canyon (CDOW 1983). Aerial surveys of the Roan Creek drainage in winter 1981 indicated a minimium of 603 deer in the valley (CDOW 1981). During a winter 1982 survey of the Conn Creek area, 236 deer were observed on the east-facing uplands above the creek, and moderate numbers were sighted in the riparian bottomland and sagebrush types near the head of Conn Creek (CDM 1983d). No deer population estimate is available for the project area.

Other mammals which commonly occur in the Cities Service project area and vicinity include cottontails, jackrabbits, porcupine, chipmunks, coyote, bobcat, and weasel (ERT 1981; CDM 1983d; Cities Service 1983a).

Birds

The vegetational and topographic diversity of the Cities Service project area attracts a large variety of gamebirds, raptors, and non-raptor species. Upland gamebirds of the project area include blue grouse, sage grouse, chukar, and mourning dove (Cities Service 1983a). Display grounds for blue grouse are likely to occur in Douglas-fir woodland and adjacent plateau shrublands (CDM 1983d). Only one sage grouse lek, located near Long Point, has been identified on site, however, suitable habitats for strutting grounds are available in other portions of the project area (Cities Service 1983a). The location and level of use of leks is highly variable on an annual basis in the region (Gumber 1982). Preferred habitat for chukar occurs in the canyon floors and adjacent walls of Conn and Cascade canyons.

A variety of raptors inhabitat the Cities Service project area. Red-tailed hawks are the most prevalent; however, turkey vulture, Cooper's hawk, Swainson's hawk, golden eagle, and American kestrel have also been observed (Cities Service 1983a). Active nests observed on the plateau were those of red-tailed hawk and Cooper's hawk. Active cliff nests of golden eagles and kestrels were also identified along the canyon walls of Conn and Cascade creeks.

Numerous species of waterfowl, shorebirds, and songbirds are likely to occur as residents or transients in the project area (Cities Service 1983a). Among the occasional migrants or residents are several species of high federal interest including sandhill crane, western bluebird, Scott's oriole, Williamson's sapsucker, black swift, and Lewis' woodpecker (Cities Service 1983a). Recent studies have failed to locate any of these species in the vicinity of the project area (ERT 1981; CDM 1983d; Cities Service 1983a).

Reptiles and Amphibians

Frogs and toads are the most common amphibians in the vicinity of the project area and are highly dependent on the availability of water as a source of food and for reproduction (ERT 1981; CDM 1983d). Important habitats include riparian areas, ditches, intermittent streams, and ponds of the plateau and valley floor (CDM 1983d). By contrast, the reptilian species such as lizards and snakes, rely heavily on the availability of shrub-dominated habitats and rock outcrops (CDM 1983d). Among the reptile and amphibian species which occur in the project area are the short-horned lizard, northern plateau lizard, midget-faded rattlesnake, and tiger salamander (Cities Service 1983a).

Threatened and Endangered Species

Three wildlife species federally listed as endangered were evaluated to determine their potential for occurrence in the Cities Service project area. These species are the black-footed ferret, peregrine falcon, and bald eagle. A detailed assessment of their occurrence in the project area is presented in the Biological Assessment for the Getty and Cities properties (Beck 1983a), a summary of which is contained in Appendix B. Applicable information from this report is summarized below.

No black-footed ferret or white-tailed prairie dogs, its principal prey, were observed in the project area. Although two white-tailed prairie dogs were sighted near the confluence of Roan and Conn creeks, a survey of habitats in the vicinity of the sighting failed to locate any prairie dog colonies. No prairie dog colonies are known to occur in the Roan Creek valley (Lambeth 1983).

Potential nesting habitat for peregrine falcon occurs in the cliff faces of the Cities Service project area (Figure 3.1-2). In addition, riparian habitat, which attracts a variety of prey species, is present in the floor of Conn Creek and Cascade Canyon. The recent sighting (CDM 1983d) of a peregrine falcon in Scott Gulch, 2 miles west of the Cities Service property, confirms the likelihood that this species occurs in the Roan Creek and Clear Creek valleys and vicinity. However, no active eyries are known in this area.

Bald eagles are commonly observed during winter in riparian habitats along the Colorado River in close proximity to De Beque (Figure 3.1-2; BLM 1983a). Eagles were recently sighted in the Roan Creek valley within 1.5 miles of the Roan Creek and Conn Creek confluence (CDM 1983d). Although bald eagles have not been observed in the Cities project area, they are known to frequent the valley habitats along Roan Creek in pursuit of alternative prey, such as waterfowl, carrion, or small mammals (Fisher et al. 1981.)

The Cities Service project area lies within the migration corridor of the federally endangered whooping crane and state endangered sandhill crane. Since key staging areas for these species generally occur along large rivers where small grain crops are available as food (CDOW 1978), occurrence of sandhill or whooping crane in the vicinity of the project area is unlikely.

Fifteen species listed as species of special concern by the Colorado Natural Heritage Inventory (CNHI 1983) are likely to occur in the project area and vicinity. Although none has been directly observed in the project area, two species — the great blue heron and western yellow belly racer — have been sighted in the Roan Creek valley (Cities Service 1983a).

3.3.8 Air Quality/Meteorology

The affected air quality and meteorological environment representative of the Cities Service property would be that described in Section 3.1.8. Additionally, there are complex flow regimes in the deep gulches on the Cities Service property. As discussed in Section 3.1.8, no actual monitored meteorological data exists, however, flows driven by temperature gradients should result in up- and down-valley regimes. The affected valleys and their orientations (downvalley) are Conn Creek canyon, running north-northwest to south-southeast; and Cascade Canyon, running north-northeast to south-southwest.

3.3.9 Noise

The affected noise environment representative of the Cities Service project area is discussed in Section 3.1.9.

3.3.10 Cultural Resources

Cultural resource studies for the Cities Service property were performed by a team from Nickens and Associates, Montrose, Colorado (Cities Service 1983a). Prior to conducting field investigations, a review of pertinent regional literature and site records was performed (Class I inventory). Records checks and literature reviews were conducted at the BLM White River Resource Area office and the BLM Grand Junction Resource Area and District offices; the Office of the State Archaeologist; the Colorado State Historic Preservation Office; and the Garfield County and Mesa County courthouses.

The Class I inventory identified no previously recorded sites in the area. Field investigation consisted of a random sample survey (Class II inventory) of portions of the Cities Service property. A total of 13.5 percent of the sample units was intensively surveyed; all were within likely areas of impact. The Class II inventory identified two sites, one a multicomponent site (historic/prehistoric) and a historic site. The multicomponent site included a small scatter of lithic (stone) tools, historic structures, and a corral. The researcher noted that this was a significant site, potentially eligible to the National Register of Historic Places (NRHP), and recommended avoidance and testing if the site is to be impacted. The other historic site includes a cabin, corrals, and a stock pond. It is not considered significant, and is ineligible for nomination to the NRHP (Nickens 1983).

In summary, the results of the survey indicate a low prehistoric site density, while historic sites are a more common occurrence.

3.3.11 Land Use, Recreation, Wilderness

Land Use

Cities Service has 10,300 continguous acres of private land. The resource portion consists of approximately 6,850 acres. Rangeland for cattle is the predominant land use (Cities Service 1983a). Corridors not previously considered by the BLM (1983a) are also primarily rangeland. Stocking rate for cattle averages 10-20 acres/cow (BLM 1983a). There are 120 acres of agricultural land (hay fields) along Conn Creek near the resource property (Cities Service 1983a).

Recreation and Wilderness

Mule deer and elk, important to the region's economy as game species, are located on the site and are hunted in autumn. Access is limited, however. Although numerous recreation and wilderness areas are located in the region (Section 3.1.11), none occur within the Cities Service resource property.

3.3.12 Visual Resources

The Cities Service project area lies within four landscape character types: Plateau, Cliff and Canyon Floor, Foothill, and Valley Bottom. The following site descriptions include landscape characterization, scenic quality, and sensitivity evaluations for the project area. Descriptions are based on Cities (1983a) and BLM (1983a).

The mine, plant, spent shale, shale fines, waste rock, and associated service and utility corridors would be located within the Plateau landscape character type. This type, which represents the highest elevation of the project area (greater than 7,600 feet), represents approximately 50 percent of the Cities Service property area. The type is characterized by mountain brush and grass covered, gently sloping and rolling, spherical-shaped land form. Line is horizontal and curvilinear, texture is insignificant. Color is dominated by the grays and greens of vegetation and is affected by the seasons. Exposed landform is yellow, tan, and brown and is affected by the season. Cultural modifications exist as jeep roads and fence lines; these do not affect scenic quality. Overall scenic quality is considered moderate (Cities Service 1983a). Access by the general public to the plateau area is limited and thus sensitivity is low.

The access corridor from the Roan Creek valley to the plant site would traverse the Cliff and Canyon landscape character type. Within the property area this type essentially comprises the narrow-walled Conn Creek canyon and drainage which makes up the southern portion of the property. The Cliff and Canyon type is characterized by steep to near vertical massive cliffs and talus slopes rising nearly 2,000 feet from the canyon floor. Line is vertical as exhibited by debris avalanche runs and horizontal as a result of exposed shale beds. Color is exhibited by the yellows, tans, browns, and (in some areas) reds of exposed soil and landforms. Vegetation is sparse. The canyon floor imparts horizontal curvilinear line and exhibits the greens and yellows of riparian vegetation. Public access to the northern portion of Conn Creek canyon is limited, therefore sensitivity is low. The southern portion of the canyon can be observed from the Roan Creek valley; thus, this portion of the canyon is rated moderate sensitivity. The canyon itself is rated high scenic quality.

The southern portion of the proposed Conn Creek and Roan Creek corridors lies within the Arid Foothill and Valley Bottom landscape character types. The Arid Foothill character type is comprised of moderate to steep brush covered slopes with horizontal and curving lines. Color varies with slope and aspect and includes the grays and greens of vegetation and the brown and grays of exposed soil. Cultural modification exists as roads, powerlines, and ranch structures. Scenic quality is considered moderate to low. In the project area, the type can be observed by the general public and sensitivity is moderate to high.

The Valley Bottom character type is comprised of gently rolling arid terrain adjacent to broad, flat irrigated pasture. During summer the dark greens of the valley bottom contrast sharply with the browns of the adjacent terrain. Cultural modifications occur throughout as roads, fence lines, ranches, fields, and other associated agricultural activities. The majority of the modifications impart straight lines to the landscape. Due to the pastoral nature of the type, scenic quality is moderate. Sensitivity is moderate to high since the type is visible to the general public.

3.3.13 Socioeconomics

The Cities Service oil shale site is located on Conn Creek, almost directly north of De Beque. Access to the property is by way of the Roan Creek road. The property was acquired by Cities Service in 1951, and consists of 10,300 acres. Cities Service has a joint venture interest in the water storage system for oil shale development which would be constructed in the Roan Creek valley. The description and impacts of the water storage system are included in BLM (1983a).

The Conn Creek resource site is used for livestock grazing, and this is the only economic activity currently taking place on the property. There are no permanent residents or structures. Access is by dirt road and off-road vehicles.

3.3.14 Transportation

The major transportation networks and their relative capacities for the Cities Service project area are described in Section 3.1.14.

Physical barriers restrict access from the north, therefore the Roan Creek road would provide the main access to the Cities Service property to a point approximately 10 miles north of De Beque. At that point, access to the Cities property is currently via a dirt road, heading east and then north.

The Roan Creek road is paved to the point where it intersects the dirt road, and ranges from 18 to 30 feet in width. The average daily traffic is estimated to be 150 to 250 vehicles (Bolby 1983). The connecting dirt road ranges from 10 to 14 feet, narrowing at its northern most extents. The road is primarily used for local ranching operations with minimal daily traffic.

3.3.15 Energy

The energy systems and resources in the area of Cities Service's proposed project are as described in Section 3.1.15. Various electrical transmission lines run north, up from Roan Creek and Parachute Creek valleys, to serve local residents and industrial customers. These lines are adequate to serve current needs, but would have to be upgraded to provide enough power for the proposed action.

A natural gas pipeline, owned by Rocky Mountain Natural Gas Company, runs north-south and lies 2 miles west of the site. The pipeline would be a source of gas supply to the proposed project.

No water pipelines lie within the immediate area of the proposed project at this time.

4.0

Environmental Consequences

4.0 Environmental Consequences

Environmental impacts of the proposed actions and alternatives of the Getty and Cities Service shale oil projects are evaluated in this chapter. Section 4.1 presents discussions of the general impacts to each component of the environment (discipline) from oil shale development which are common to both projects. Impacts are discussed generally in Section 4.1 in order that they need not be repeated in the Getty (4.2) and Cities Service (4.3) impact discussions.

Sections 4.2 and 4.3 address specific environmental impacts for the Getty and Cities Service project sites and corridors, respectively. Following the format of Chapter 3.0, impacts of proposed project features are generally addressed in this order in each section.

- Mine
- Process Facilities
- Waste Rock Disposal (if applicable)
- Shale Fines Stockpile (if applicable)
- Spent Shale Disposal
- Corridors
- Water Supply Facilities

Sites included in the proposed action are always addressed first, followed by alternative sites.

Sections 4.2 and 4.3 will address the following disciplines (or, as one may view them, components of the environment) in the following order.

- Topography, Geology, and Paleontology
- Surface Water
- Ground Water
- Aquatic Ecology
- Soils
- Vegetation
- Wildlife
- Air Quality and Meteorology
- Land Use, Recreation, and Wilderness
- Visual Resources
- Socioeconomics
- Transportation
- Energy

4.1 Common Impacts

4.1.1 Topography, Geology, and Paleontology

4.1.1.1 General Impacts

Impacts to topography, geology, and paleontology could include surficial disturbance, man-induced geologic hazards, and the partial destruction of potential paleontological resources. Surficial disturbance would be the result of the development of mine facilities, corridors, and spent shale disposal sites. Recontouring and successful reclamation of these disturbed areas would reduce the potential impacts to existing topography.

Man-induced geological hazards would result from the construction of transportation corridors, impoundment structures, and spent shale disposal sites. Proper engineering design and site maintenance is necessary to limit construction/mining related geologic hazards. It is possible tha paleontological resources could be disturbed during the construction of mine facilities and corridors.

Discussions of site specific impacts to topography, geology, and paleontological resources for the Getty and Cities Service properties are provided in Sections 4.2.1 and 4.3.1, respectively. Cumulative impacts to the region from these properties and other oil shale projects are discussed in Section 4.4.

4.1.1.2 Common Project Facilities

Common facilities and corridors to the Getty and Cities Service oil shale projects include the common product transport corridor on the north end of the Getty property, La Sal syncrude pipeline, Roan Creek water supply reservoir and corridor. Potential impacts of the development of the La Sal syncrude pipeline and the Roan Creek reservoir and associated corridor have been previously discussed (BLM 1983a).

The common product transport corridor consists of a 3-mile pipeline which would link the project sites with the La Sal syncrude pipeline. Potential environmental impacts as a result of corridor development would include increased soil erosion and the disturbance of potential paleontological resources. Increased soil erosion and possible gully development would be restricted to areas directly disturbed by construction activities. The magnitude of these impacts would also decrease as reclamation of the disturbed area proceeded. As a result of site reclamation and re-contouring, local topography and geology would not be significantly impacted on a long-term basis by the proposed pipeline.

Depending upon the depth of pipeline excavation, potential paleontological resources of the Uinta formation could be disturbed. Considering the small size of the area disturbed by the pipeline relative to the project site, any potential impacts to paleontological resources would not be expected to be significant.

4.1.2 Surface Water

4.1.2.1 General Impacts

General surface water impacts resulting from oil shale development would include watershed disturbance, stream flow and water quality changes, and surface water uses. Construction of power and syncrude lines could temporarily disturb surface water drainages, and cause increases in total suspended and dissolved solids and stream sedimentation. In addition, accidental spills and leakage from the syncrude pipeline could affect West Fork of Parachute Creek including a stock pond located in proximity to the syncrude pipeline.

Spent shale disposal for both projects could cause potential water quality impacts to Roan Creek due to leachates and surface runoff from the spent shale piles. However, these impacts should be minimized with proper design and construction practices. Runoff and sedimentation reservoirs could reduce stream flows, especially during low flow periods. Construction of the access road, retort, upgrading facilities, and other site development activities could disturb watershed causing potential increases in soil erosion and flood flows.

4.1.2.2 Common Project Facilities

The facilities that could be used by both projects include the GCC water supply system and reservoir on Roan Creek, intake facilities at the Colorado River, a water pipeline along Roan Creek, and the La Sal corridor for power and syncrude lines. Surface water impacts associated with those facilites are addressed in the CCSOP EIS (BLM 1983a). The only other common facility for the Getty and Cities Service projects is a short (approximately 3 miles) power and syncrude corridor on the Getty Property to the proposed LaSal corridor. This corridor transects the headwaters of the West Fork of Parachute Creek.

4.1.3 Ground Water

Impacts to regional ground water systems associated with oil shale development on the southern edge of the Piceance Basin could include removal and/or dewatering of aquifers within or proximal to the underground mines, local modification of ground water flow, and potential subsidence and fracturing of strata overlying the underground mines. In general, these adverse impacts could be of medium magnitude in terms of the local environment, but low with respect to the region. This projected lower regional impact is predicted on the apparent relative hydrogeologic isolation of these project sites from the majority of the Piceance Basin. Discussions of local ground water impacts associated with the individual Getty and Cities Service properties are provided in Sections 4.2.3 and 4.3.3, respectively. Cumulative impacts to the region from these properties and others are discussed in Section 4.4.

Impacts to ground water resulting from common facilities would be limited. The Roan Creek reservoir and associated water transmission/road corridors are addressed in the CCSOP EIS (BLM 1983a). To recall, net ground water impacts would be negligible from the Roan Creek reservoir, and potential impacts along the Roan Creek road corridor would be largely restricted to uncontrolled spills or leaks from the transport of hazardous contaminants. Similarly, the common transport corridor on the Getty property should have low adverse impacts, given the upland terrain; impacts would be limited to accidental spills resulting from pipeline breakage. The national average annual accident rate associated with pipeline breakage is about 0.001 accidents per mile of pipeline (BLM 1981). Based on a common pipeline distance of approximately 8 miles, the average pipeline leakage frequency would be on the order of once every 125 years — negligible for these properties.

4.1.4 Aquatic Ecology

Primary and secondary impacts to aquatic organisms would occur during the construction and operation of the Getty and Cities Service shale oil projects. These impacts would, in general, be insignificant since the drainages within the project areas are mostly intermittent and the fishery resources extremely limited.

Primary impacts which would occur during construction include stream habitat degradation and stream flow alteration. The construction of the mine benches, roads, power and water corridors, plant facilities, and dams would increase runoff and erosion. This would add to the sediment and silt loads of the streams and could result in reduced stream cover due to removal of riparian vegetation. The extent of the impact is not quantifiable, but would be dependent upon the amount of surface area disturbance, proximity to the streams, timing of construction, and the value of the aquatic habitat disturbed. These impacts are generally short-term and would occur only during the construction phase. Long-term impacts would only occur in those streams for which the facilities would hinder the natural flushing of the stream bed.

The operations phase of the projects, especially that of the water resource facilities and spent shale disposal sites, could result in relatively higher adverse aquatic ecology impacts. Impacts which generally occur as a result of this type of development include alteration of flow and loss of stream miles due to the physical inundation of the stream beds. Degradation of the stream habitat could result due to heavy corridor use, which would contribute dust and windblown materials from vehicles to nearby surface waters. Toxic substances could enter the streams via runoff containing chemicals used for road maintenance, leachates from spent shale disposal, and pipeline breakage.

Secondary aquatic ecology impacts would result mainly from project-related population growth. These include the addition of point and nonpoint pollution sources, and increases in fishing pressure and in recreational and consumptive uses of regional water resources.

The common syncrude pipeline corridor crosses the uppermost portion of the West Fork of Parachute Creek drainage, a reach which is commonly dry. Construction of the pipeline would have no impact on the stream. During operation, pipeline breakage could result in the introduction of toxic substances to the stream. However, breakage in this area is very unlikely since pipeline failure rates are extremely low, about 0.001 accidents per mile per year (BLM 1981). The potential impact due to spillage would be greatest during high runoff periods (spring) and could result in the contamination and death of aquatic organisms within the West Fork of Parachute Creek. Depending on the magnitude of the spill, the main stem of Parachute Creek could also be adversely affected. It is doubtful that the contamination could ever reach the Colorado River. During low-flow periods, impacts due to pipeline breakage would be less severe since containment of the crude oil may be achieved within the drainage above the perennial waters of the West Fork of Parachute Creek.

The duration of the impact is dependent upon volume of crude oil spilled and cleanup methods employed. Since oil absorbs to particulates, the substrate, especially in pool areas, could become highly contaminated and unsuitable to support a diverse invertebrate community or to provide habitat for spawning.

In a related sense, although spillage would cause major adverse impacts within the impoundment, development of a reservoir in West Fork of Parachute Creek (an alternative action for Getty) would mitigate impacts throughout the draiange. The reservoir would act as a holding pond for crude leakage, thus protecting the main stem of Parachute Creek from toxic substances.

Impacts related to the development of the Roan Creek reservoir, the power loop, the multi-use corridor in Roan and Clear creeks, and the common syncrude pipeline to the LaSal connection and Rangely are addressed in the CCSOP EIS (BLM 1983a).

4.1.5 Soils

Construction, operation, and post-operational activities associated with the development of the Getty and Cities Service shale oil projects would result in generally adverse impacts to the soil resource. Such impacts include increased erosion rates and soil loss, temporary or permanent loss of prime farmland, decreased soil quality, and temporary changes in soil (agricultural) productivity. Impacts to the soil resource would generally be a function of the acreage of disturbance; hence, the greater the disturbed area, the more adverse the impact.

Project development would accelerate wind and water erosion. Accelerated wind erosion during construction and operation phases would result from loss of vegetation, breaking down of soil aggregates into sizes more susceptible to detachment and transportation, soil dessication, and changes in surface texture. Accelerated water erosion would be caused by loss of vegetation, increase in slope, changes in surface texture and structure, smoothing of the surface soil horizon, or failure to implement water erosion control measures. Erosion would increase during construction, and decrease during operation as reclamation occurs. Erosion rates would eventually diminish to predisturbance levels for most areas of the projects.

Physical and chemical characteristics of the soils would be changed during disturbance related to contruction. In implementing the proposed reclamation plan, it is anticipated that the texture and chemical characteristics of a given profile would become more homogeneous as a result of excavation and replacement activities. Specifically, segregated and stockpiled topsoil would become more homogeneous. Subsoil material would be mixed with overburden and probably take on its physical and chemical characteristics. Runoff would increase significantly during disturbance, due to loss of vegetation, compaction, and road construction. Soil drainage would remain roughly the same during disturbance and after reclamation. The available water-holding capacity of the soil could either increase or decrease depending upon specific textural changes. The infiltration and percolation of the soil would temporarily increase in backfilled areas and probably decrease in compacted areas. These changes would occur as a result of differences in porosity, pore geometry, and pore size distribution. Although some of these impacts would be positive, the overall impact to the physical and chemical characteristics of the soils would be slightly adverse.

In compliance with Mined Land Reclamation Board guidelines, it is anticipated that nearly all available topsoil would be stripped and stockpiled during construction. Stockpiled topsoil would lose its potential productivity after about a year due to reduced fertility. This results from decreased microbial activity (and oxygen levels) below the surface of the stockpile.

With the disposal of spent shale in canyons and valleys, a future significant adverse impact is created when, in time, erosion uncovers the spent shale. Research has generally failed to show this type of material to be capable of supporting plant life without continued irrigation and soil amendment applications.

Prime farmland would be lost due to disturbances such as construction of paved roads or reservoirs (i.e., disturbances which would generally be regarded as permanent). In other instances, such as pipeline installation, prime farmland areas would be temporarily disturbed.

Incremental soil loss (tons of soil lost to erosion under disturbed conditions minus soil lost under undisturbed conditions over a 30-year project life) for the power and syncrude corridor common to both projects is estimated at 1,650 tons or a 39 percent increase over undisturbed soil loss. Incremental water erosion losses are estimated as being twice wind erosion losses. These losses are based on calculations using the Universal Soil Loss Equation (SCS 1982). Loss of prime farmland is not anticipated in the common corridor.

4.1.6 Vegetation

Construction of oil shale retort and upgrade facilities, spent shale disposal sites, and corridors would directly affect vegetation through removal or through partial destruction by off-road construction equipment and vehicles. Vegetation resource values potentially affected by oil shale development include plant productivity, nutrient cycling, microclimate influences, habitat, ecosystem structure, erosion control, and aesthetics.

The extent of vegetation removal would vary widely among the projects and project activities. The length of time between vegetation removal and revegetation also varies among oil shale project activities. Construction of roadways, railroads, and reservoirs as permanent facilities would result in residual impacts on productivity and all other vegetation resource values. Disturbance areas associated with pipeline burial, transmission tower construction, and slopes adjacent to access routes would be revegetated in the short term. Revegetation of areas disturbed by mine and plant site facilities would occur over the long term. Spent shale disposal areas would undergo long-term revegetation, likely followed by degeneration of the vegetation as spent shale is gradually uncovered by natural processes of erosion. Ongoing research in spent shale revegetation indicates that even weathered spent shale may be incapable of supporting native or desirable vegetation without continued inputs of water and soil amendments (Redente and Cook 1981).

Although the projects should operate within air pollution guidelines, fumigation by stack gases and coating by fugitive dust could adversely affect plant productivity and viability on-site.

Secondary impacts associated with human population growth and activity could significantly affect vegetation resource values as a result of urban expansion, accidental range and forest fires, and increased off-road vehicle (ORV) use.

Of special concern are direct and secondary effects on candidate and listed threatened or endangered plant species. The Getty and Cities Service projects would adversely affect populations of protected plant species (see Sections 4.2.6 and 4.3.6). Uinta Basin hookless cactus and De Beque phacelia occur in the vicinity of the proposed GCC reservoir and Roan Creek corridor north of De Beque. Impacts to these plants have been addressed in the CCSOP EIS (BLM 1983a) and in the CCSOP Biological Assessment (Woodward-Clyde 1983). In the Roan Creek corridors, additional impacts to these plant species could occur as a result of the Getty and Cities Service projects.

The Getty and Cities Service common power and syncrude corridor would be located on the plateau and would crosse habitats unsuitable for any rare plant species. This corridor would not impact any known localities of special interest plant species. Furthermore, impacts to other vegetation resource values are insignificant.

4.1.7 Wildlife

This section of the EIS serves, in part, as a Technical Assistance Report to address the concerns of the U.S. Fish and Wildlife Service (USFWS) under the Fish and Wildlife Coordination Act of 1958.

4.1.7.1 General Impacts

Construction and operation of oil shale production projects generally cause the direct loss of wildlife habitat. Reduction in quality of habitat would also occur attributable to the alteration of topography and vegetation cover as well as increased soil erosion, dust, noise, fumes, and human activity. The loss and modification of habitat would result in reduced wildlife species abundance. Redistribution of local populations would occur, as individuals are forced to move into habitats adjacent to disturbed areas. Due to generally restricted habitat requirements, low reproductive rates, and low tolerance to human disturbance, raptors and big game would be adversely affected by the proposed projects. Over the life of the projects, wildlife would be susceptible to toxic contamination through oil and chemical spills, increased mortality as a result of interaction with transmission lines and greater traffic volume on roads, and obstructions to movement by pipelines and roads. Project-induced growth in human population would increase the likelihood of illegal hunting, off-road vehicle (ORV) use, and accidental forest and range fires on a local and regional level.

Development of the Getty and Cities Service projects would cause reduction in the carrying capacity of big game in the region as a result of direct habitat loss. The value of the disturbed areas to big game may be partially restored through reclamation and revegetation with native plants; however, reduction in big game use and productivity in these areas is likely to be long-term in its effect. Processed shale disposal would preclude use of some plateau shrubland and woodland habitats by big game over the long-term. In addition, the value of reclaimed disposal piles to big game would likely remain low due to reduced topographic relief, vegetation diversity, and availability of water. Reduction in the size of winter ranges and critical habitats, as a result of the Getty and Cities Service projects, could cause increased competition among big game species. This effect could be significant, especially since the areal extent of these ranges in the region is limited and forage availability is highly variable. Interference with known migration corridors for deer and elk is also anticipated. Increased vehicular and rail traffic in access corridors would likely increase the incidences of big game road kills above existing levels.

The quantity and quality of black bear and mountain lion habitat would also be reduced by the projects. However, because these species have relatively large home ranges, high mobility, and low population densities, potential impacts should be minor.

Densities of most mammalian predators and furbearers in the project areas would decrease in response to localized reductions in numbers of prey, such as rodents, reptiles, and amphibians. Construction and operation of the projects would also cause short-term reduction in populations of small game species, such as jackrabbits and cottontails, in the affected areas.

Local reduction in upland gamebird populations within each of the project areas would also occur as a result of surface disturbance. Sage grouse and blue grouse densities would decrease in those plateau shrubland and woodland habitats affected by project activities. Chukar would be displaced from canyon habitats disturbed by construction of access roads, transmission lines, and pipelines.

Raptor species would be directly affected by project activities through alteration of potential cliff nesting sites, disturbance from human activity, increased noise levels, and local reduction in prey populations. Increased mortality could occur as a result of electrocution from transmission lines. Raptors potentially affected by the projects include species of high federal interest: golden eagle, Cooper's hawk, and prairie falcon. The Getty and Cities Service projects could also reduce potential nesting and feeding habitat for the endangered peregrine falcon. Construction of roads and mine benches across cliff faces could eliminate potential nest sites, and noise and dust generated by project activities would make available potential nesting locations less attractive. Important peregrine falcon feeding habitats, such as riparian and agricultural areas, could also be altered by project activities, making those habitats less attractive to prey species.

Sensitive wildlife habitats potentially affected by the projects include aspen, riparian, Douglas-fir, and cliffs. All of these habitats would be directly impacted through removal of vegetation during construction, corridor development, or processed shale disposal. The alteration of riparian communities would adversely affect those species which depend on this habitat as a source of food and water.

The disposal of processed shale on the plateau portions of the project areas would increase the likelihood of wildlife exposure to trace and toxic elements in forage and water.

Wildlife impacts specific to the Getty and Cities Service projects are discussed in Sections 4.2.7 and 4.3.7, respectively.

4.1.7.2 Common Project Facilities

Construction of the common corridor for syncrude and power would cause the short-term disturbance of approximately 160 acres of wildlife habitat. Most wildlife species would temporarily disperse from the immediately affected area and reinvade once construction has ceased and the area has been reclaimed. No known raptor nests would be directly lost during construction. However, two currently active red-tailed hawk and Cooper's hawk nests, both located within 0.5 mile of the corridor, may be temporarily disturbed by construction activities. Approximately 18 acres of critical habitat for elk could be temporarily disturbed at the north end of the corridor, where it intersects the La Sal pipeline (Table C-1, Appendix C).

Operation of the syncrude pipeline above ground should have no adverse effect on wildlife or wildlife habitat except in the event that the pipeline leaks or breakage should occur. The rate at which such an event could occur along this pipeline segment is about 0.001 accidents per mile per year (BLM 1981). Important wildlife resources, such as forage and water in the vicinity of the spill and downstream from it, would be significantly adversely affected. Relatively nonmobile animals, such as small mammals, would be directly lost through contamination of habitat. Use of the affected area by wildlife would cease over the short-term at least until the area could be cleaned up and important resources (e.g., forage, cover) have regenerated.

4.1.8 Air Quality/Meteorology

Air quality would be generally impacted by the addition of dust or total suspended particulates (TSP), carbon monoxide (CO), sulfur oxides (SO_2), nitrogen oxides (NO_x), and hydrocarbons (HC) from construction activities, plant operations, and the increased population anticipated from development of the Getty and Cities Service shale oil projects.

The ambient concentrations of various pollutants which would result from the proposed facilities would depend upon a variety of factors, including wind speed and direction, mixing heights, temperature lapse rates, local topography, precipitation, emission rates, emission source characteristics, and other complex factors which tend to vary substantially even during brief periods. Computer models were used to simulate environmental conditions and predict ambient concentrations. Descriptions of the models and the assumptions used in defining air quality impacts of the project are presented in Appendix A. These air quality impact studies were conducted using U.S. Environmental Protection Agency (EPA) accepted methods. These models which apply mathematical algorithms are the Industrial Source Complex (ISC) short-term and long-term models. The models apply Gaussian concepts involving homogeneous and constant flow. These concepts emphasize consistency and objectivity to obtain estimates that tend to over-predict potential impacts. The models and the development of input data result in an accuracy generally within a factor of two. Additional studies were conducted using the EPA models VALLEY and PTPLU.

The modeling studies predicted the impacts upon the air quality of plant operations on the area in the vicinity of the proposed Getty and Cities Service facilities. Because the rate of emissions resulting from project activities would vary, the detailed modeling studies assume potential worst case or maximum emissions. Construction impacts were considered in a qualitative sense and deemed to be of a temporary nature, with minor adverse impact. The syncrude product pipeline and powerline corridor were excluded from the analyses since significant air emissions are not expected from these areas.

4.1.9 Noise

The acoustic environment would be generally impacted from construction activities, plant operations, and increased traffic levels (direct and secondary) due to the Cities Service and Getty shale oil projects. This analysis assumes that three basic types of noise sources would be representative of the proposed actions and each project alternative. These sources are: traffic, railroad, and process equipment. Only major sources are considered in this assessment, as lesser sources would be masked by major souces and not contribute significantly to the overall noise level.

The road segments, the corresponding traffic noise impacts, and railroad impacts relative to the Getty and Cities Service projects are evaluated in the CCSOP EIS (BLM 1983a). Elevated noise levels due to process equipment have been modeled using a standard flat world, distance attenuation CDM proprietary model NIM (Noise Impact Model) developed from BLM (1982b) and the U.S. Office of Naval Research (1977) guidelines. The attenuation factors account for the general variety of vegetation and terrain. Attenuation due to high density of taller vegetation or forest canopies is not considered, nor does the model offer additional attenuation due to terrain affects. It should be remembered when predicting noise exposure from a particular source using the available techniques, that the results tend to be conservative (to overpredict levels of exposure), typically up to several decibels (dB). The noise levels for the process equipment are estimated based on the proposed activities and mining equipment noise levels quoted in the respective Project Descriptions (Getty 1983b; Cities 1983b).

Construction noise is not treated as a source for analysis in this assessment. Noise generated during the construction phase is difficult to estimate and highly dependent on equipment used, work schedule, and duration. Major noise sources and corresponding untreated equipment noise levels during construction are shown in Table 4.1-1. All construction operations are assumed to be in compliance with the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA) regulations of occupational exposure. For this reason, and also because of the short duration relative to the project lifetime and the remote nature of the project, construction noise is anticipated not to have a significant environmental impact away from the project area.

Table 4.1-1 CONSTRUCTION NOISE LEVELS FROM TYPICAL EQUIPMENT WITHOUT NOISE CONTROLS

Equipment	At Operator Position	At 50 Feet
Earth-Moving Equipment	80 - 105 dBA	75 - 95 dBA
Drilling	95 - 112 dBA	80 - 97 dBA
Blasting	90 - 140 dB[a]	135 dBA

Source: BLM (1983a).
[a] Peak Sound Pressure Levels

Project equipment is also not treated on an individual alternative basis. The specific location of process eqiupment is not critical from a noise standpoint due to the size and remote nature of the project. Based on the large areas required to construct Getty and Cities Service facilities, and similarities of noise emissions for various process equipment, the noise impacts would be approximately equivalent for all full-production alternatives.

4.1.10 Cultural Resources

Cultural resource surveys must be conducted in all federally-owned areas prior to any construction activity to determine if sites eligible for the National Register of Historic Places (NRHP) are present. Determinations of eligibility and effect on public lands (BLM-administered in this area) are completed by the Bureau of Land Management in consultation with the Colorado State Historic Preservation Officer. Determinations by the above two parties of no adverse and adverse effect are sent to the Advisory Council on Historic Preservation for comment. The above is done in accordance with the Advisory Council Regulations, 36 CFR 800.

Impacts to significant cultural resource sites from oil shale development on federal property are therefore subject to mitigation under existing laws and regulations. Indirect impacts could occur, however, due to accidental disturbance, vandalism, or unauthorized collecting (e.g., of arrowheads). Significant sites located on private land are the responsibility of the landowner.

Impacts to prehistoric and historic sites located within or near the Roan Creek reservoir, the corridor to De Beque, and related facilities and the La Sal pipeline corridor are addressed in BLM (1983a).

A common pipeline and power corridor located on the north end of the Getty property would be used by both projects. A Class II sample study of the Getty property conducted by Nickens (1983) identified one isolated chert flake in the vicinity of this corridor. Further cultural resource surveys conducted along the corridor may identify additional resources.

4.1.11 Land Use, Recreation, and Wilderness

Land Use

Primary impacts to land use would occur during construction and operation of oil shale operations. The main land use concerns related to such operations are loss of crop production, reduction of grazing area, and short-term land use changes at surface facility sites. The reduced crop production and cattle grazing capacity would be significant to the local economy, but could be insignificant when viewed from a regional perspective. Because of the limited quantities of land presently cultivated within the resource areas of either project (approximately 260 acres), impacts to agricultural productivity would be insignificant even when viewed from the local perspective.

Indirect land use impacts could be significant. New residences would be built and additional community facilities would be developed to sustain increased population. New patterns of urbanization would occur on developable land in communities which are now primarily rural in nature. Furthermore, since much of this development would take place within communities which are predominantly located within valleys, it is likely that expansion of these communities would encroach upon irrigated cropland. The resulting loss of cropland acreage from urban development would likely be more substantial than direct impact of construction and operation of the oil shale facilities.

Oil shale development could reduce the amount of water available for irrigation, converting agricultural lands under irrigation to nonirrigated agricultural, residential, industrial, or commercial land. At present the anticipated amount of water lost to other industrial uses is unknown.

Industrialization could have other, more subtle effects on agricultural land use patterns within the region. The projected increase in energy development activity could cause an increase in demand for labor, thereby making it difficult for agricultural enterprises to compete directly for the existing labor, land, and water, which could lead to changing land values and eventually lead to indirect land displacement.

Recreation

The primary impact of oil shale development on recreation would be increased numbers of people participating in, and demanding, recreational opportunities. Developed recreation sites within the region from Glenwood

Springs to Grand Junction would receive additional use. Overuse of facilities could lead to increased maintenance and repair costs. Municipal facilities, in particular, would be inadequate to meet local needs. While increases in local tax bases would occur, there could be a lag time between need and availability of funds.

The majority of non-local construction workers and operations workers would be located in the proposed single status camp north of De Beque, or in the Parachute/Battlement Mesa area (see Tables 4.2-20 and 4.3-22). Municipal facilities located in and near the area (Glenwood Springs, Silt, Rifle, and Parachute/Battlement Mesa) and outdoor recreation facilities such as the Naval Oil Shale Reserve Extensive Recreation Management Area (ERMA), Rifle ERMA, and Plateau Valley ERMA would experience increased numbers of visitor days (see Section 3.1.11). Impacts on municipal facilities would be greater than on the regional outdoor facilities. This would be particularly evident in the smaller, more rural communities (e.g., De Beque, Parachute) where facilities are currently inadequate or nonexistent. The larger communities such as Grand Junction and Glenwood Springs would be better able to absorb additional residents, though they too would need to upgrade existing municipal facilities.

Big game hunting in the area would be significantly affected by construction of project facilities and corridors which would remove many acres of wildlife habitat. However, at the same time other hunting areas would be made more accessible by additional roads and corridors.

Water-related recreational activities (fishing, boating, swimming) would not be expected to be affected by development. Even though new reservoirs would be created for the project, these would be unavailable for recreational use (BLM 1983a).

Overall, impacts to the recreation areas and facilities in the region would be substantial, particularly to municipal recreational facilities. Impacts could be greatest during the construction phase, when population size would be changing abruptly. Potentially impacted communities would be required to determine whether or not to construct the necessary facilities to provide adequate capacity for short-term population peaks. Although not economically sound, construction of these new facilities could lessen social problems being experienced in smaller, expanding communities.

Wilderness

The primary impact of oil shale development on western slope wilderness areas would be the increased demand placed upon these areas, particularly due to increased populace during peak construction. Areas under wilderness study which would be impacted include those contained in Table 3.1-10.

The Flat Tops Wilderness Area and Colorado National Monument could be expected to experience increased use; however, these areas can absorb some increased activity. Wilderness areas could record increased numbers of visitor days and perhaps increased maintenance and repair costs. The BLM is aware of these potential impacts and will monitor visitor days and corresponding effects on the environment.

4.1.12 Visual Resources

Visual resource impacts result from a contrast introduced into the existing form, line, color, or texture of a landscape due to a landscape alteration. The degree of impact is directly related to the amount of contrast created. For the purpose of this EIS, visual impacts are defined as either significant or insignificant. Significant impacts result from any project activity that (1) produces an adverse contrast that cannot be reduced (mitigated) through siting, design, or reclamation for the life of the project or longer, or (2) produces an impact that can be reduced but would still be adversely perceived by the general public. Insignificant impacts result from those activities that (1) may initially be perceived as adverse by the public, but the degree of impact can be reduced through mitigation, (2) will only be slightly adverse through use of design or siting, or (3) will not be noticeable following completion of short-term reclamation.

Construction and operation of surface facilities related to the mine, process, retort, and upgrade facilities and spent shale and waste rock disposal areas are expected to result in significant visual impacts. In addition those portions of the access roads and utility corridors that would traverse the steep faces of the cliffs are also expected to result in a significant visual impact. Through proper siting, design, and reclamation, the remaining portions of access roads, pipelines, and utility corridors are expected to result in insignificant impacts. Depending on operational characteristics, reservoirs are expected to have a low beneficial to adverse impact.

4.1.13 Socioeconomics

Regional socioeconomic impacts would be experienced from development of either the Getty or Cities Service projects, with both projects, or cumulatively in combination with several other oil shale projects in the region. Impacts associated with development of either the Getty or Cities Service project are discussed in sections 4.2.13 and 4.3.13, respectively. Cumulative impacts of each project along with other potential regional oil shale and other development are likewise discussed in sections 4.4.1.13 and 4.4.2.13.

4.1.14 Transportation

Transportation impacts for both projects would be the greatest to the road systems, particularly I-70. The increase in vehicular travel would result from an influx of workers for the construction and operation of the oil shale facilities. Certain road segments would experience traffic slowdowns and increased accident rates, particularly during years of peak employment (project construction). Airports and railroad systems would also experience increased use.

Improvements of the Roan Creek road and construction of the product transport pipelines would provide a beneficial impact in that improved facilities would be available for use by others when each of the projects is decommissioned.

Data utilized in determining anticipated vehicular traffic levels were obtained from the Colorado Department of Highways as supported by the population growth predictions presented in the socioeconomic impact assessment (Sections 4.2.13 and 4.3.13). The analysis of the relative transportation impacts was performed using a technique developed by the BLM (BLM 1982c).

4.1.15 Energy

The impacts of both projects to the region would be beneficial because of the production of shale oil. While construction and operation of the mining and retorting facilities would consume energy, the shale oil produced during operations would increase the energy available to the nation and the net energy gains would outweigh the consumptive loss. At a rate of 100,000 bpd, each project would produce approximately 2.0 percent of the oil imported into the United States during 1981 (BLM 1983c).

An analysis was conducted to determine the net energy yield from construction and operation of Getty's and Cities Service's shale oil facilities. Net energy yield is defined as the useable energy which results after all direct and indirect energy inputs and outputs to the oil shale facility are considered. In both cases, it was determined that the production of shale oil would result in a positive energy impact. Construction of both projects would cause a short-term net energy loss; however, resulting shale oil production would more than compensate for this loss.

The net energy analysis was conducted using methodology developed in the Energy Analysis Handbook for Oil Shale Development (BLM 1982d). This methodology isolates each major operation, or module, in the entire energy flow from raw shale in the ground to synthetic crude oil entering a major pipeline system. Each module is then evaluated to determine and quantify all of its energy inputs and outputs.

The energy inputs are divided into two major categories, namely principal and external energy inputs. Principal energy input is the energy to be processed (i.e., raw shale), while external energy input is the energy consumed in operating the process and constucting the processing system itself (including the production of raw materials such as steel).

The energy outputs are also divided into two major categories; energy production and energy loss. Energy production is the energy delivered from the process (e.g., synthetic crude oil), while energy loss is the energy unavailable for further use as a result of the process. The latter can include losses, uncovered resources in extraction, and internally consumed energy.

4.2 Getty Project Impacts

4.2.1 Topography, Geology, and Paleontology

4.2.1.1 Proposed Action

The mine facilities proposed for the Getty project would include two underground room and pillar mines, the Tom Creek mine bench (with associated surface facilities), primary crushers, mine portals, and vents. Considering that the majority of the proposed mine facilities would be located underground and that the facilities located above ground would represent a small portion of the total surface area, topographic impacts are considered insignificant.

An important geologic consideration of the proposed mining plan would be the potential effect of land subsidence. The proposed underground mine includes several drifts paralleled by production panels measuring 1,000 feet wide and 2,000 feet long. The room-and-pillar mining plan consists of pillars 60 feet square by 60 feet high allowing approximately 75 percent removal of the oil shale resource. Within the proposed mine tract the thickness of overburden ranges from 400 to 900 feet with a mining thickness of 60 feet. The amount of subsidence that generally occurs as a result of underground mining is controlled by the thickness of the material removed, the depth and area of the mine workings, and the nature of the surrounding ground (Blyth and de Freitas 1974). Based upon the results of previous investigations in the region, subsidence at the proposed mine site could be 1 foot or less (BLM 1983a). The amount of subsidence would be dependent on natural undisturbed overburden and surface loading such as construction of the spent shale disposal site. Due to the limited amount of subsidence that is expected, its impact on existing geology and topography is not considered significant. As a result of mine facility development, the paleontological resources of a portion of the Uinta and Green River Formation located on the mine property could be disturbed and or destroyed.

The proposed process facilities would include a raw shale stock pile, secondary feed preparation, two retort sites, and two upgrading sites. Associated with the facilites would be various roads, parking areas, and power lines. Of these facilities, the raw shale stockpile would represent the largest potential disturbance. The raw shale stock pile would contain approximately 1,000,000 tons of ore. As with each of the other proposed process facility components, surficial disturbances would occur. Considering the limited size of the proposed facilities, and including the conceptual reclamation plan of re-contouring, topsoiling and seeding of disturbed areas, the potential impact to topography and geology is considered insignificant. Excavations at the process facilities sites could impact the paleontological resources of the underlying Uinta Formation.

The proposed spent shale disposal site would be be located in the headwater area of Wiesse Creek. Disposal techniques are described in Section 2.3.1. Potential impacts to the existing topography would be dependent upon the proposed reclamation plan. Based upon the given production information, the pile of spent shale would have an approximate volume of 1.3×10^{-7} cubic feet which would transform the topographic lows of Wiesse and Short creeks into topographic highs. As a result of this transformation, several geological hazards must be considered. Surface stability or susceptibility to erosion could be dependent on the success of the reclamation program (see Section 2.3.1). Susceptibility to mass-wasting processes (landslides) would be dependent on several design considerations, including methods for fill placement and adequate surface and subsurface drainage to prevent saturation of fill materials. In review of the conceptual information provided, no significant geological impacts would be expected.

Impacts to paleontological resources are not expected to be significant due to the limited exposure of the Uinta Formation in the area of the disposal site. A detailed field paleontological survey would be required to support this evaluation.

The proposed corridors for the Getty project would include corridors for product transport, utility, roads, railroad, and water. These corridors would be located on the plateau, valley slopes, and valley bottom lands. The road, utility, railroad, and water corridors proposed for Clear and Roan creeks have been previously addressed (BLM 1983a).

Potential impacts resulting from the construction of the road, power, and water corridors along the valley site slopes could be significant to paleontological resources. These corridors would cross Class 1b paleontologic resources (Green River Formation) as previously identified by Lucas and Kihm (1982).

The proposed water supply system would include the GCC Roan Creek reservoir, Tom Creek reservoir, Clear Creek/Roan Creek confluence reservoir, intermediate pumping facilities, and connecting water pipelines. The Roan Creek reservoir and Roan Creek corridor have been previously described (BLM 1983a). The Tom Creek reservoir would be located on Quaternary age alluvium, alluvial fan, and talus deposits. These unconsolidated deposits are underlain by the Parachute Creek and Douglas Creek Members of the Green River Formation. The construction of the reservoir would inundate a portion of the valley floor of Tom Creek, thus changing the topography of the lowlands. At the proposed dam site, no active faults have been mapped (Hail 1978). Also, the seismic hazard potential of this area is considered moderate (seismic risk zone #2; Kirkham and Rogers 1981). Inundation of the valley would prevent removal of fossils from the Green River Formation but would not significantly damage the potential paleontological resources of this area.

4.2.1.2 Alternatives

The proposed production rate alternative is 50,000 bpd and the retort alternative is the Lurgi process. The production rate alternative would result in a reduction of surface area disturbed during the project. The use of Lurgi-type retorts could result in a reduction of the potential geologic hazards associated with the spent shale piles. Spent shale from the Lurgi process has better cementing properties than the Union B-type spent shale (Bates 1983). The cohesiveness of the Lurgi-type spent shale may reduce the erosion of the spent shale piles by sheet wash and mass-wasting processes.

Proposed alternatives to spent shale disposal in Wiesse Creek would include disposal in Tom Gulch, Buck Gulch and Doe Gulch, and/or by backfilling the underground mine. Disposal of spent shale in Tom Creek and Buck and Doe Gulches would require filling the gulches to approximately the top of the cliffs (i.e., 7,600 feet). Disposal in the alternative site would generate several impacts. Since the canyon lands are to be filled with spent shale, the impact to topography is obviously significant. As a result of this valley infilling, berms will need to be constructed at the toe of the piles to limit erosion by runoff or mass-wasting processes. An embankment structure located at the toe of the disposal pile would be needed to prevent mass movement of the spent shale. Also, since the spent shale piles would cover outcrops of the Green River Formation, potential paleontological resources exposed or near the surface would be buried.

The alternative of underground spent shale disposal combined with surface disposal on the plateau would result in lesser impacts to topography, geology, and paleontological resources. First, underground spent shale disposal would reduce the amount of material (approximately 50 percent) that would need to be placed on the surface. Secondly, underground disposal may allow for increased resource recovery by decreasing the size of pillars (Earnest et al. 1977). Lastly, backfilling of spent shale may reduce the magnitude of subsidence as a result of mining.

No significant changes in impacts to topography, geology or paleontological resources are envisioned if the Rangely or Big Salt Wash corridors are developed. These corridors have been previously described in the CCSOP EIS (BLM 1983a).

No significant changes in impacts to topography, geology, or paleontological resources are foreseen as the result of cogeneration of energy at the mine property.

A proposed water supply alternative would be the construction of an additional reservoir on the plateau in the drainage of the West Fork of Parachute Creek. The development of this reservoir would result in the inundation of the valley bottom lands in the West Fork of Parachute Creek. Inundation of this portion of the plateau would limit access to exposures of the Uinta and Green River Formation, thus restricting paleontologic resource surveys. No major geological hazards have been mapped in the potential area of development. Overall, the impacts of constructing the West Fork Parachute Creek reservoir are not considered significant.

4.2.1.3 Solid and Hazardous Wastes and Toxic Pollutants

The disposal of solid wastes at the project site, and the disposal of hazardous and toxic wastes in an existing facility off-site should not significantly impact topography, geology, or paleontology.

4.2.1.4 Secondary Impacts

The population and economic growth associated with development of the Getty project would result in the expansion of existing residential centers and possible development of new areas. Topography could be impacted locally by construction-related activities for roads, houses, and other structures to support the growing population. Geologic impacts include the use of locally derived mineral resources, such as sand and gravel, or coal. The exploitation of these resources locally is considered a beneficial use. Paleontological resources could also be impacted by construction-related activities for buildings and roads. Regrading activities and excavations could expose or bury fossil collection localities.

4.2.2 Surface Water

4.2.2.1 Proposed Action

The proposed underground mine is not expected to affect the surface water regime. Surface facilities (including mine benches, primary crushers, mine portals, equipment repairs, and storage areas) could have impacts, however. The proposed bench and mine portal are to be located on the east wall of Tom Creek. Surface water impacts resulting from these facilities would be limited to minor runoff and sedimentation increases in Tom Creek during construction and operation stages.

The initial plant site would be located in the upper drainages of Doe and Buck gulches. The main process facilities at the initial surface plant site would include the ore stockpile, feed preparation plant, Union retorts, upgrading, gas and oil processing, wastewater treatment, utility, and other support facilities. Facilites at the additional plant site, to be located in the headwaters of West Fork of Parachute Creek, would not include the upgrading and the gas and oil processing. Construction of the processing and support facilities (earthworks and site grading) would disturb the surface drainage basin and contribute higher sediment load in the streams. During operations, runoff water from the plant site could have high concentrations of calcium, bicarbonate, and sulfate (BLM 1983a) causing water quality impacts on the receiving streams.

The impacts on the stream water quality would be minimal provided that appropriate runoff diversion and sediment control plans are developed for areas around the two plant sites. Wastewater generated from the process plants would be treated in a wastewater treatment system only if, and as necessary, to be suitable for reuse for spent shale conditioning. Potential surface water impacts could result from the accidental spills of wastewater from the storage pond. Appropriate spill prevention and mitigation measures should minimize the impacts.

Spent shale and shale fines from the feed preparation plant would be disposed in Wiesse Creek and Short Gulch watersheds as shown in Figure 2.3-3. Shale fines would be retorted if generated in sufficient quantity to justify the retort. The project would generate approximately 1,300 million tons of spent shale, plus a relatively small quantity of shale fines. The disposal site would cover a total area of approximately 2,310 acres. The design of the spent shale pile includes plans to control erosion, surface runoff, and slope stability. Revegetation plans would be implemented such that no more than 200 acres of retorted material could be exposed at one time. Retention dams would be located on the south end of Wiesse Creek and Short Gulch basins, downstream of the disposal area. The retained water would be utilized in the shale disposal operation. Potential impacts on watershed drainages prior to revegetation would include soil erosion and degradation of water quality due to surface runoff from the spent shale pile. The water quality of runoff from the exposed retorted material could have elevated concentrations of selenium, molybdenum, arsenic, copper, zinc, manganese, iron, and boron (EPA 1977). Field runoff and leaching tests have shown that anionic species such as boron, fluoride, molybdenum, and selenium could be leached from retorted shales by percolating water.

Long-term surface water impacts would include potential water quality degradation due to leachate from the spent shale pile, sediment deposition and salt loading contributed by surface runoff from the spent shale pile, and stream flow reduction of Wiesse Creek due to interruption of several major springs in the Wiesse Creek basin.

Various corridors are proposed for the project development in the Roan Creek and Parachute Creek basins. These corridors would contain access roads, railroad spurs, transmission lines, and water and syncrude pipelines. Surface drainages that would be disturbed by these corridors either during construction or operations include Roan Creek, Clear Creek, Tom Creek, Buck Gulch, Short Gulch, and West Fork of Parachute Creek. Surface water impacts of soil erosion/sedimentation and stream flow disruption would be expected during the construction stage, especially at the intersections of corridor crossings and stream drainageways. In addition, accidental spills from the syncrude pipeline could affect waters in the West Fork of Parachute Creek.

Water supply for the Getty shale oil development would come from the GCC Roan Creek reservoir. Pipelines would be required to deliver water from the Roan Creek reservoir to the plant site. The water supply system would include a pumping plant at the Roan Creek reservoir, a small regulation reservoir and pumping plant near the confluence of Roan and Clear Creeks, a regulation reservoir and pumping plant on Tom Creek, and a water pipeline up Buck Gulch connecting those reservoirs to the plant sites. Construction of these two regulation reservoirs could interrupt streamflows in Tom, Clear, and Roan creeks. Minor stream channel configuration changes could also occur upstream and downstream of the reservoir sites.

4.2.2.2 Alternatives

The 50,000-bpd production rate alternative would produce a smaller daily amount of waste rock, shale fines, and spent shale. Therefore, surface water disturbance would be less in the short-term than the proposed 100,000-bpd production rate due to the reduction of storage areas for waste rock and spent shale. Total project water requirements would also be reduced; however, the water consumption rate for per barrel shale oil production would be higher. Except for the syncrude pipeline, no impacts on West Fork of Parachute Creek are anticipated due to the elimination of the retort additions site.

Three alternative spent shale disposal sites (Tom Creek; Buck and Doe gulches; and underground mine/Buck and Doe gulch combination) have been evaluated. Watershed disturbances for these alternatives would generally be reduced due to the decrease in affected drainage area. However, the Tom Creek disposal site would eliminate the water supply regulation reservoir on Tom Creek. Potential water quality impacts for this alternative on Clear Creek and Tom Creek are much greater than the Wiesse Gulch spent shale disposal site. The alternative Buck and Doe gulch disposal sites are also close to the Clear Creek drainage. Leachate and surface runoff from this spent shale pile could directly impact the Clear Creek drainage. Disposal of approximately one-half of the spent shale in the underground mine would reduce surface water impacts, due to less surface disturbance and less total volume of spent shale on the surface to contribute to potential shale leaching impacts.

The Rangely alternative product pipeline corridor is discussed in the CCSOP EIS (BLM 1983a). Surface water impacts of the alternative would be similar to the proposed La Sal pipeline corridor, but would occur on different drainages. The alternative Big Salt Wash transmission line corridor is also addressed in BLM (1983a). Surface water impacts for this alternative corridor would be slightly greater than the proposed De Beque transmission loop, due to its longer route and its crossing of more surface drainages.

The West Fork of Parachute Creek alternative reservoir would have similar impacts as the proposed project, but would affect stream flows of West Fork of Parachute Creek.

The Lurgi alternative process technology would generate spent shale of a smaller particle size compared to the proposed Union retort technology. It would therefore require more water for spent shale moistening. In addition, more sour water would be produced by Lurgi process compared to the Union retort process. Surface drainages downstream of the spent shale and plant site could be subject to higher water quality impacts.

4.2.2.3 Solid/Hazardous Wastes Disposal

All nonhazardous solid waste would be disposed in the spent shale disposal area. No additional surface water impacts are anticipated beyond those previously mentioned. Some hazardous waste could be generated by the retorting and upgrading process. Hazardous waste disposal would be off-site in a licensed facility. There would be no surface water impacts in the vicinity of the Getty property, but cumulative impacts could occur elsewhere (see Section 4.4).

4.2.2.4 Secondary Impacts

Secondary impacts to surface water would result from increased population in the region. These impacts could include increased water consumption, potential water contamination from wastewater and solid wastes, and increased suspended solids in streams due to development activities adjacent to the streams.

4.2.3 Ground Water

4.2.3.1 Proposed Action

Underground mining on the Getty property would remove a 60-foot thick horizon within the Mahogany Zone. Direct disturbance of the subsurface associated with oil shale extraction would be limited to this zone and immediate over- and underlying strata. As discussed in Section 3.2.3, water-bearing intervals identified beneath the Getty property occur above this mining interval. The potential for ground water inflow into the mine workings is, therefore, predicted on the degree of interconnected fractures between the oil shale horizon and overlying leached interval in the Upper Parachute Creek Member of the Green River Formation.

Existing data are not adequate to precisely evaluate the potential for this interconnection. Data from the adjacent Chevron property, however, indicate that relatively insignificant inflows of approximately 1 gpm can be anticipated during mining from strata immediately adjacent to the mine interval. Total inflows estimated for the underground portion of the Chevron property are in the range of 100 to 1,500 gpm (BLM 1983a). Data from the Pacific and Cities properties to the south and east indicate the apparent presence of a thick zone of relatively impermeable strata separating the mining zone from the Upper Parachute Creek/Uinta aquifer. If this intervening zone remains relatively unfractured beneath the proposed mine area, inflows from overlying strata should be minimal. Similarly, limited inflows would reduce the potential for potentiometric impacts (i.e., lowering or aquifer water levels) resulting from the underground mine. The low hydraulic conductivities for the Mahogany and the Upper Parachute Creek zones would restrict the potential for any decline in potentiometric levels from propagating outside the property boundaries, where existing ground water use has been identified.

The effect of ground water flow from underground mining should also be minor. Vertical gradients have been identified on most adjacent properties. Such a gradient may be steepened if fracturing allows inflow from the overlying aquifer. Flow within the Uinta Formation and appurtenant spring discharge points should not be significantly affected by the proposed underground mine.

Further fracturing of overlying strata could occur if subsidence results from the eventual abandonment of underground workings. Such potential subsidence was estimated to be only 1 foot over a 10-year period (BLM 1983a). Given the relative similarity in both mining zone and overburden thickness between the Getty and Chevron sites, such an estimate should be considered generally reliable for the Getty property. If subsidence fractures intersect the overlying Upper Parachute Creek aquifer, increased inflows to the underground workings could occur. The magnitude and duration of any potential increase in flows cannot be predicted accurately.

Water quality impacts associated with the underground mine should similarly be minor. The quality of existing ground water in the Mahogany Zone and Upper Parachute Creek Members is generally good. Ground water inflow to the mine would be discharged in such a manner so as to minimize contact with soluble mined spent shale materials, restricting the potential for infiltration of higher TDS waters.

Impacts associated with process facilities including the raw shale stockpile, secondary feed preparation, retorting and upgrading, and associated surface disturbances should be minor. Only the stockpiling of raw shale could pose a significant potential for ground water contamination. Such contamination would be minimized by two factors: (1) storage would be a transient phenomenon, with continual removal and addition of materials; consequently, the limited exposure of raw shale involved with stockpiling and conveyance to feed preparation should restrict generation of leachate; and (2) drainage design around the stockpiles could minimize the potential for infiltration or off-site migration of any leachate that might be generated.

Prudent operation and maintenance of the remaining facilities should restrict the potential for contamination by infiltration of accidental spills.

Disposal of spent shale in Wiesse Gulch drainage could potentially be a source of leachate which, in turn, could infiltrate into the ground water regime. Getty has designed the disposal process so as to minimize this potential. Critical to the design are construction of a compacted spent shale liner and efficient reclamation of the surface area.

Generation of leachate within the disposal area would require saturation of the spent shale by surface water runoff, direct precipitation, or ground water via spring discharge. Surface water runoff would be contained by retention dams within Short and Wiesse gulches below the disposal area. Each retention pond would be sealed or lined so as to limit seepage into ground water. Retained water would be used for moisturizing spent shale prior to disposal. Direct infiltration of precipitation would be minimized by construction of a compacted spent shale blanket 10-feet thick on top of the disposal area. This blanket would be advanced and revegetated in a timely fashion, such that no more than 200 acres of retorted shale are exposed at any one time. Despite these precautions, some saturation of the spent shale could occur from accumulation of runoff/precipitation during periods when the pile is exposed. A liner of compacted shale 10-feet thick would be constructed on the ground surface (stripped of topsoil) beneath the disposal area to minimize the potential for leachate infiltration. The precise permeability of this underlining is not available, but typical values for hydraulic conductivity of the expected spent shale in uncompacted form are 7.1×10^{-3} to 1.3×10^{-2} feet/day (2.5×10^{-6} to 4.6×10^{-6} cm/sec; Getty 1983b).

Existing data indicate that 12 or more springs emanate within the proposed disposal area. These springs exhibit a total maximum discharge of over 200 gpm. Continued flow from these springs could jeopardize the long-term stability of the compacted shale underliner and pose a significant potential for leachate generation and off-site migration. For this reason, spring flows would be collected in pipes and diverted to the make-up water systems by the operator. Furthermore, because the compacted shale underliner would encompass a sizeable portion of the apparent recharge area for these springs, it is probable that spring flow will decrease as construction of the disposal area proceeds.

The spent shale pile would be designed to minimize the potential for failure, thereby reducing the potential to endanger the stability of the under- or overliners. Design features would include interior and exterior slopes engineered to provide an adequate factor of safety. Additional design features, including maintenance after closure, are not presently available, but will be developed in detail during the permitting process.

Prevention of leachate generation and migration would require careful maintenance of both the liner system and the spring piping system. Long-term weathering of the under- and overliners could result in leakage. If leaks develop, leachage could be transmitted (1) directly into the Uinta Formation via infiltration, (2) into the alluvial aquifer systems below the mesa via surface runoff, or (3) into the surface water system. Higher concentrations of sulfate, cationic salts, ammonia, cyanide, other trace ions, and organic compounds could be introduced into the hydrologic system, as a result. Additional organic compounds may be present from the co-disposal of wastewater from the upgrading plant. Permitting under applicable RCRA and TSCA standards would be necessary.

No significant ground water impacts are anticipated to occur from the construction of product transport, utility, road, railroad, and water corridors. Increases in TDS concentrations could occur during construction via infiltration of waters draining the disturbed areas. Such infiltration would be more prevalent along the

Roan/Clear Creek alluvial areas than on upland areas (e.g., syncrude pipeline, access roads) underlain by bedrock. Any increase in TDS concentrations so occurring, however, would be short-term in nature.

4.2.3.2 Alternatives

Ground water impacts associated with a 50,000-bpd production rate would be essentially the same as those described for the 100,000-bpd proposed action. Surface and underground disturbance would occur at a reduced rate, however, thereby potentially decreasing the magnitude of any impacts.

Impacts associated with process facilities integral to the Lurgi process would be the same as those discussed for the proposed project. However, spent shale disposal from the Lurgi process, may result in slightly less potential for leachate generation/migration than for the Union B process. The tendency of Lurgi spent shale to solidify upon moisturizing may reduce the erosion potential and leaching (Bates 1983). This lesser potential is necessarily predicated on effective, timely revegetation of Lurgi-derived spent shale piles.

Disposal of spent shale in Tom, Buck, and Doe gulches would require the same engineering/construction precautions as described for the proposed action (Wiesse Gulch). Disposal in Tom Gulch would require reevaluation of the project water supply, given that this site is a component (regulation reservoir) of the proposed and alternative water supply systems.

From a design perspective, liner construction (and therefore reliability) could be more difficult in the alternative gulches. Alluvial deposits are apparently broader and thicker than in Wiesse Gulch, providing a foundation which is not as stable as Uinta strata underlying much of the Wiesse Gulch area.

Impacts to the ground water regime from disposal in these gulches should be minimal, provided that the liner system described for the proposed project is constructed and operates properly. As described previously, failure of the liner system could result in release of leachate to the ground and surface water environments. The potential for contamination of bedrock aquifers (e.g., the Uinta/Upper Parachute Creek Member) is significantly less than for the Wiesse Gulch site. Conversely, leachate leakage in these alternative sites would allow direct infiltration into the valley bottom alluvial aquifers of each gulch. In so doing, there would be potential for more rapid migration into either the alluvial aquifer or surface drainage of Clear Creek.

No significant ground water impacts are anticipated for the Rangely and Big Salt Wash corridors described in BLM (1983a). As described for the proposed project, potential increases in ground water TDS concentrations resulting from drainage (and infiltration) of distrubed areas should be short-term in duration and minor in magnitude.

No significant ground water impacts are anticipated from the co-generation of power on site.

Development of an alternative water supply which includes a regulation reservoir on the West Fork of Parachute Creek should have no significant ground water impacts. Reservoir construction on West Fork of Parachute Creek would alter the recharge/discharge relationship at this location; two springs discharging from the Upper Parachute Creek Member would be inundated. Any such alteration should not be considered adverse.

4.2.3.3 Solid/Hazardous Wastes and Toxic Pollutants

Nonhazardous wastes would be disposed of in the spent shale disposal area. As such, no impacts to the ground water regime are anticipated provided that the integrity of the liner material is not endangered. Hazardous waste would be disposed of in a presently unspecified, off-site, licensed facility; no ground water impacts are anticipated.

Toxic pollutants could be generated during the Union B retort processes. It is assumed that retort waters could be utilized to provide remoisturization of the spent shale, thereby introducing such trace metals as arsenic and lithium and various organic constituents. Impacts associated with this disposal would, therefore, be predicated on the effectiveness of the liner system to prevent production and migration of leachate. Leakage from the spent shale disposal pile could allow contamination of ground water below Wiesse Gulch. Additionally, airborne pollutants may settle in the area soils, also providing potential ground water contamination if leached and transported by infiltrating precipitation. Further discussion of potential airborne contaminants is provided in Section 4.2.8.

4.2.3.4 Secondary Impacts

Secondary impacts associated with population growth should be limited to: (1) depletion of ground water resources if such a source is required for domestic/municipal supply, and (2) short-term increases in dissolved solids concentration if runoff from disturbed areas (e.g., housing construction) is allowed to infiltrate. Although no ground water use is proposed for the Getty project itself, concomitant industrial development could create such a demand. Furthermore, waste disposal areas required to support population increases could create localized areas of ground water contamination if they are not properly designed, constructed, and maintained.

4.2.4 Aquatic Ecology

4.2.4.1 Proposed Action

Impacts as a result of the development and operation of the Getty shale oil project would be minimal since the drainages potentially affected are intermittent or have a low to moderate fishery value. The drainages potentially affected by the proposed action project include those which would be:

- Altered by the water resources development: Tom Creek, Roan Creek, Clear Creek
- Crossed by or adjacent to corridors: Tom Creek, Clear Creek, Buck Gulch, and Short Gulch
- Within the spent shale disposal site: Weisse Creek and Short Gulch
- Affected by the development of the retort facilities and the mine portal: Doe Gulch

The most significant impacts of the proposed action would result from the development and operation of the water supply system. The system includes use of the GCC Roan Creek reservoir in conjunction with a diversion dam on Roan Creek, a 5 acre-foot regulation reservoir near the confluence of Roan and Clear creeks, an 8,000 acre-foot regulation reservoir in Tom Creek, and connecting pipelines. Impacts related to the diversion of water from the Colorado River as a result of the development of the GCC Roan Creek reservoir have been addressed in the CCSOP EIS (BLM 1983a). During the construction phase of the regulation reservoir there would be increased sedimentation in Clear and Roan creeks. This would not be a significant impact since the aquatic habitat of the affected reaches is only marginal. In addition, the mottled sculpin and bluehead suckers, the only resident species of these reaches, are very tolerant of high dissolved and suspended solid concentrations. The reservoirs would inundate a 2-mile reach of Tom Creek and approximately 3.5 stream miles in Clear and Roan creeks. This would be a slight beneficial impact, since the reservoirs would create additional aquatic habitat, probably suitable for the introduction of a warm water fishery.

Minor impacts to the aquatic ecology could occur as a result of spent shale disposal within Wiesse Gulch. There would be no loss of aquatic habitat; however, a remote possibility exists of toxic leachates from the spent shale reaching Clear Creek via the intermittent streams of Weisse Creek, and Short and Doe gulches. Since the spent shale disposal site is approximately 2 miles from the perennial waters of Clear Creek, the potential for toxic substance contamination is minimal, assuming proper containment techniques would be used.

The construction the Tom Creek reservoir and use of corridors Buck Gulch and Short Gulch and other drainages adjacent to Clear Creek would have little or no impact on the aquatic ecology. Increased sedimentation would occur in Clear, Roan, and Tom creek reservoirs during the construction phase. However, since these waters are only marginal aquatic habitats, the impact would not be significant.

Secondary impacts related to corridor usage, including addition of windblown and runoff substances, would also occur, but the impact is likely to be insignificant.

Sedimentation in Clear Creek via Doe Gulch could also occur as a result of development of the plant facilities and mine portal. Again, this would be a minor adverse impact, since Doe Gulch is intermittent and the receiving water, Clear Creek, is not a significant fishery habitat.

4.2.4.2 Alternatives

An alternative to the Getty water supply system includes the contruction of a 4,658 acre-foot regulation reservoir on West Fork of Parachute Creek. The reservoir would inundate approximately 2 miles of stream including 1.5 miles of West Fork of Parachute Creek from just above the Wet Creek confluence to the Getty property, and the lower 0.5 miles of Wet Fork. Dewatering of lower West Fork of Parachute Creek would occur as a result of dam construction and operation. This would probably result in adverse impacts to the aquatic habitat and biota below the dam.

The reservoir would have a low beneficial impact since it would provide additional warm and possibly cold water fishery habitat in a reach which has a low to moderate fishery habitat value and which was previously impounded, stocked with several trout species, and maintained a viable brown trout population (Seely 1983; Engineering Science 1983c).

The reservoir would also serve to mitigate possible impacts related to breakage of the syncrude pipeline located in the West Fork Parachute Creek drainage (see Section 4.1.4).

4.2.4.3 Solid/Hazardous Wastes and Toxic Pollutants

Impact to aquatic resources could result from transportation accidents to an off-site facility. Severity of potential impacts would be dependent on the magnitude of the spill and proximity to water bodies.

4.2.4.4 Secondary Impacts

The most significant secondary impacts would be those resulting from increased fishing pressure and water consumption caused by project-induced population growth. Increased municipal/domestic water consumption pressure would impact those surface waters which are already heavily utilized, such as Carr Creek and the Aspinall (Curecanti) Unit dams on the Gunnison River. Other secondary impacts would result from increases in point and nonpoint discharges associated with sewage treatment plants, housing developments, construction, and other activities necessary to support the increased population.

Fishes in the Colorado River, including the rare species, would be affected by the commercial extraction of gravel from the Colorado River floodplain. Such extraction, for construction at the plant sites as well as for homes and service structures for the employees of Getty, could be extensive. Gravel pits have been identified as prime habitat for predacious exotic species, and their proliferation could be detrimental to the native species, especially the rare forms (Valdez et al. 1982).

4.2.5 Soils

4.2.5.1 Proposed Action

Direct impacts to the soil from the Getty project include incremental soil loss due to accelerated erosion and loss of prime farmland acreage. The calculated incremental soil loss for the life of the operation is approximately 244,100 tons. Due to the topsoil salvage program, most of the soil loss is expected to be less valuable subsoils. The greatest contributing area of incremental soil loss would be the Clear Creek corridor (91,000 tons) which is primarily a function of the relatively large disturbance associated with the many components of this corridor. Losses of 1,324 acres of prime farmland are expected to occur in the Roan Creek corridor.

The erosion rates (weighted averages) and soil and prime farmland losses anticipated for each disturbance area are presented in Table 4.2-1. The rates are based on the successful achievement of the conceptual reclamation plan described in Section 2.3.1. If reclamation goals are not achieved, more adverse erosion rates and losses should be expected.

Acid-precursor pollutants (SO_2 and NO_x) would be emitted from the retorting facilites. In the canyon valleys and low, semi-arid lands, soils are well buffered, with the pH ranging from 6.8 to 9.0; these would probably not be impacted. At higher elevations (Roan Plateau), soils range in pH from 5.5 to 7.8 and they receive greater precipitation (18 to 22 inches), making them more susceptible to acid rain impacts. However, due to the neutral pH range of the Uinta formation (soil parent material source rock) more than slight changes to the soil are not expected. More importantly, these slight changes would not affect the vegetative productivity of the soil.

4.2.5.2 Alternatives

As with the proposed action, prime farmland acreage loss and incremental soil loss (changes in the erosion rates) would be the major impacts associated with the alternatives. These losses are quantified and shown in Table 4.2-1. The Lurgi retort alternative would have impacts essentially similar to the Union B process.

4.2.5.3 Solid/Hazardous Wastes and Toxic Pollutants

Solid/hazardous materials would be handled by a hazardous waste disposal company and stored off-site in facilities designed to prevent contamination to the surrounding environment. A contingency plan for accidental spills would likely be implemented. Therefore, no impacts to the soil resulting from transportation of solid hazardous wastes and toxic pollutants are expected.

4.2.5.4 Secondary Impacts

Anticipated secondary impacts include prime farmland and erosional losses resulting from accelerated urban (residential, industrial, and commercial) developments. Prime farmland and accelerated topsoil and subsoil erosion losses due to urban growth have been occurring for many decades in the Colorado River valley from Glenwood Springs to Fruita and would likely continue as a result of the proposed action. Urban growth onto prime farmland would occur as a result of this project, primarily because prime farmland is also well-suited for urban development. Assuming that secondary impacts of urban development occurs partially on prime farmland, the amount permanently lost to such development from the project is estimated at 1,000 acres. Loss of soil through erosion at urban development areas may exceed direct incremental soil loss of the project.

4.2.6 Vegetation

4.2.6.1 Proposed Action

Vegetation and Productivity

Direct impacts to vegetation resource values by the Getty proposed action are summarized in Table 4.2-2. Vegetation disturbance and removal required for construction of project facilities, spent shale disposal, reservoirs, and corridors would affect approximately 3,835 acres of native vegetation and 8 acres of agricultural land (pasture). If project decommissioning and reclamation includes all disturbance sites except reservoirs, then approximately 6 percent of the potentially affected area, or 228 acres, would be residually affected by vegetation removal. However, spent shale cannot be successfully revegetated without a continued input of water and fertilizer (Redente and Cook 1981). These inputs would not be provided following project decommissioning. Therefore, as the topsoil erodes away and spent shale becomes the soil parent material, approximately 2,096 additional acres could be residually affected.

Table 4.2-1 APPROXIMATE PRIME FARMLAND AND SOIL LOSS COMPARISONS OF THE GETTY PROPOSED ACTION AND ALTERNATIVES[a]

	Water Erosion Rates (weighted average)		Wind Erosion Rates (weighted average)				
	Undisturbed (tons/ac/yr)	Disturbed (tons/ac/yr)	Undisturbed (tons/ac/yr)	Disturbed (tons/ac/yr)	Temp. or Perm. Prime Farmland Loss (acres)	Incremental Soil Loss (acres)	Percent Increase Over Undisturbed Soil Loss
Proposed Action							
Retorts, Upgrade, and Mine Area	2.8	6.1	0.1	2.5	0	13,360	46
Additional Retorts and Mine Area	1.9	5.9	0.1	2.5	0	10,560	74
Spent Shale Disposal - Wiesse Gulch	3.5	1.8	0.1	1.7	0	−1,210[b]	−1[b]
Tom Creek Reservoir	4.4	3.6	0.1	9.9	0	7,770	33
GCC Reservoir	1.6	2.4	0.1	10.0	463	89,880	14
Roan Creek/Clear Creek (Rail, Road, Water Power) Corridor	1.7	3.8	0.1	9.8	861	90,960	107
Buck Gulch (Power, Water) Corridor	4.3	7.1	0.1	8.4	0	5,300	75
Syncrude, Power, Water, Road Corridor	1.7	6.4	0.1	2.5	0	6,880	66
LaSal Pipeline	2.1[c]	22.6[c]	0.1[c]	0.5[c]	0	11,470	95
Mine Bench and Road	3.9	4.4	0.1	4.7	0	7,560	22
Common Power and Syncrude Corridor	1.8	6.5	0.1	2.6	0	1,640	39
TOTAL					1,324	234,040	49
Alternatives							
Tom Gulch Spent Shale	4.1	2.2	0.1	5.5	0	16,070	112
Buck and Doe Gulch Spent Shale	4.4	4.1	0.1	7.5	0	29,470	27
West Fork Parachute Creek Reservoir	.89	2.6	0.1	2.5	0	3,380	69
Rangely Corridor	2.6[c]	14.9[c]	0.1[c]	0.5[c]	0	10,740	47
Big Salt Wash Corridor	1.2[c]	10.5[c]	4.0[c]	17.3[c]	21	78,010	72

[a] The Universal Soil Loss and Wind Erosion equations were used to calculate erosion rates and incremental soil loss. Although these equations were developed for use in mid-western cropland areas, modifications by the SCS facilitate calculations with a reasonable amount of accuracy in semi-arid and mountainous areas; at least equal to the accuracy of the soil survey data used in these calculations.

[b] Disturbed condition soil loss is less than undisturbed condition.

[c] Description of impacts obtained from the CCSOP EIS (BLM 1983a).

Table 4.2-2 DIRECT IMPACTS OF THE GETTY PROPOSED ACTION ON VEGETATION AND RESOURCE VALUES[a]

	Acreages of Affected Vegetation Types[b]													Wetlands				Affected Annual Production[c]	
Project Components	AG	AW	BL	BLH	DF	DS	GL	GR	OB	PJ	PS	US	VSB	P	R	RW	Total Potentially Affected Acreage	TOP	AUM
Mine and Process Facilities											327.0	22.5	123.0		6.0		478.5	140.4	66.8
Wiesse Gulch Processed Shale Disposal							10.5				1,474.5	147.0	394.5	7.5	61.5		2,095.5	625.1	300.8
Tom Creek Regulation Reservoir	6.0						9.0				16.5	99.0	27.0		43.5	16.5	217.5	126.5	116.3
De Beque Siltation Pond													9.0	1.5			10.5	2.4	1.0
Roan Creek/Clear Creek Regulation Reservoir[d]													30.0			15.0	45.0	13.0	5.6
Tom Creek Canyon Access Road	1.5						10.5		18.0		39.0	216.0	13.5		25.5	1.5	325.5	131.4	71.7
Buck Gulch Power and Water Corridor						7.5					55.5	37.5	12.0				112.5	36.5	17.8
Getty Property Multiple-Use Corridor									16.5		183.0	21.0	103.5		7.5		331.5	93.5	44.0
Getty/Cities Service Common Power and Syncrude Corridor		24.0						6.0			75.0	90.0	27.0		4.5		226.5	80.8	40.9
TOTAL	7.5	24.0	0.0	0.0	0.0	7.5	30.0	6.0	34.5	0.0	2,170.5	633.0	739.5	9.0	148.5	33.0	3,843.0	1,249.6	664.9
Percent of Total	0.2	0.6	0.0	0.0	0.0	0.2	0.8	0.2	0.9	0.0	56.6	16.5	19.2	0.2	3.9	0.9			

[a] Acreage values determined by USFWS.

[b] AG = Agricultural; AW = Aspen Woodland; BL = Barren Land; BLH = Barren Land/Herbaceous; DF = Douglas-fir Woodland; DS = Dry-slope Shrubland; GL = Grassland; GR = Greasewood Shrubland; OB = Oak-Brush Shrubland; P = Palustrine Wetland; PJ = Pinyon-Juniper Woodland; PS = Plateau Sagebrush Shrubland; R = Riverine Wetland; RW = Riparian Woodland; US = Upland Shrubland; VSB = Valley Sagebrush Shrubland

[c] TOP = Thousands of Pounds. AUM = Animal Unit Months

[d] Reservoir location undetermined - assume 45 acres total disturbance. Estimates are worst-case assumptions.

Most of the vegetation of the affected area has moderate to high revegetation potential. However, desert shrublands (in canyon bottoms), barren areas, Douglas-fir woodlands, and riparian area covering 5 percent (204 acres) of the affected area, have low revegetation potential. Reestablishment of vegetation in these areas would be relatively difficult and costly.

Impacts to vegetation productivity during project construction and operation could be locally significant to some ranching operations. Affected productivity is summarized in Table 4.2-2. Available data suggest that up to 665 Animal Unit Months (AUMs) could be lost annually by direct removal of vegetation. Operational impacts to vegetation from fumigation by gaseous stack emissions and coating of plants by fugitive dust and particulate emissions could also lower productivity.

In terms of affected acreage, the single most significant project impact to vegetation would be the disposal of spent shale in Wiesse Gulch. This action would remove 2,096 acres of native vegetation, constituting 54 percent of the total affected acreage. Although the spent shale pile would be revegetated during the operation of the project, permanent revegetation success is unlikely due to the characteristics of spent shale as a soil parent material.

Threatened and Endangered Plant Species

Detailed descriptions of potential project impacts to threatened and endangered plant species are presented in a Biological Assessment prepared for the Getty and Cities Service projects (Beck 1983a). The following discussion represents a summary of the information presented in the Biological Assessment.

Table 4.2-3 summarizes the names, status, and potential impacts of the Getty Project on special interest plant species. These species occur on barren talus slopes or moist cliffs in the canyons and gulches on the Getty property. Project effects on these plants would result from the construction of corridors in Tom Creek canyon and Buck Gulch, and potentially from placement of a regulation reservoir at Tom Creek canyon. Such actions could impact known populations of, or favorable habitat for, Barneby columbine, dragon milkvetch, sedge fescue, Sevier blazing-star, sullivantia, and sunloving meadow-rue. Spent shale disposal in Wiesse Gulch could reduce or eliminate surface water flows into Buck Gulch and Doe Gulch, thus affecting populations of barneby columbine and sullivantia which occur in the vicinity of waterfalls at the head of the gulches.

Aside from processed shale disposal, no project facilities proposed for the mesa would affect these plant species. Construction of Getty project facilities within the proposed Roan Creek corridor could affect three known populations of Uinta Basin hookless cactus (Beck 1983a) and one population of De Beque phacelia.

4.2.6.2 Alternatives

Impacts of alternative facilities on vegetation are summarized in Table 4.2-4. Potentially affected acreages and annual production values would be less for the various alternatives than for similar components of the proposed project.

Disposal of spent shale in Tom Creek canyon, or Buck and Doe gulches, would eliminate several plant populations and their habitat (Table 4.2-4). However, these areas would be partially disturbed by construction of other facilities which are part of the proposed action.

The underground spent shale disposal alternative would deposit 50 percent of the shale underground (in the mine) and 50 percent in Buck and Doe gulches. Therefore, impacts would result to populations of Barneby columbine, sullivantia, sunloving meadow-rue, Sevier blazing-star, and dragon milkvetch.

None of the other project alternatives have significant effects on special interest plants.

Table 4.2-3 RELATIONSHIPS OF THE GETTY PROPOSED ACTION COMPONENTS WITH RARE PLANT SPECIES

			Facility Site[b,c]								
Plant Species	Common Name	Status[a]	M	PF	WG	TCR	RCR	TCA	BG	GM	GC
Aquilegia barnebyi	Barneby columbine	Category 2			X				O		
Astragalus lutosus	Dragon milkvetch	Category 2				O		X	O		
Festuca dasyclada	Sedge fescue	Category 2				O		O	O		
Mentzelia argillosa	Sevier blazing-star	Category 1				O		X	O		
Phacelia submutica	DeBeque phacelia	Category 1									
Sclerocactus glaucus	Uinta Basin hookless cactus	Threatened									
Sullivantia hapemanii v. *purpusii*	Sullivantia	CNHI[d] Species of Concern			X				O		
Thalictrum heliophilum	Sunloving meadow-rue	CNHI[d] Species of Concern				O		X	O		

[a] Status based on USFWS (1980) and CDNR (1982). See Section 3.1.6 for explanation of status categories.
[b] Facility Sites:
M = Underground Mine and Related Facilities
PF = Process Facilities
WG = Wiesse Gulch Spent Shale Disposal
TCR = Tom Creek Reservoir
RCR = Roan Creek/Clear Creek Reservoir
TCA = Tom Creek Canyon Access Road
BG = Buck Gulch Corridor
GM = Getty Property Multiple-Use Corridor
GC = Getty/Cities Service Common Power and Syncrude Corridor
[c] Occurrence: X = Verified Population Affected
O = Possibly Present, Based Upon Habitat Suitability
[d] CNHI = Colorado Natural Heritage Inventory.

4.2.6.3 Solid/Hazardous Wastes and Toxic Pollutants

Solid wastes would be disposed in the spent shale storage area; therefore, adverse impacts to vegetation and productivity from solid waste disposal would be insignificant. Hazardous wastes and toxic pollutants would be sent to an unspecified off-site licensed disposal facility, thus minimizing impacts to vegetation in a site-specific sense, but contributing to impacts elsewhere in a cumulative sense (see Section 4.4).

4.2.6.4 Secondary Impacts

Secondary impacts to vegetation resulting from the Getty project would occur, but are spatially less predictable than direct project effects. Human population growth and activity could significantly affect vegetation due to new patterns of urbanization, accidental range and forest fires, and increased off-road vehicle use. Approximately 3,369 acres of land could be affected by project-induced population growth (Section 4.2.11). Some of this growth could affect populations of threatened or endangered species, particularly in the De Beque area. Changes in patterns of grazing land use could have either positive or adverse effects on threatened plant populations.

Table 4.2-4 IMPACTS OF GETTY FACILITY SITING ALTERNATIVES UPON VEGETATION ACREAGE, PRODUCTIVITY, REVEGETATION POTENTIAL, AND PLANT SPECIES OF SPECIAL INTEREST

Project Component	Potentially[a] Affected Acreage	Affected Annual Production[b]		Duration of[c] Impacts	Revegetation Potential	Potentially Affected Plant Species of Special Concern
		TOP	AUM			
Mine and Process facilities at 50,000 bpd	292.5	89.3	43.1	R	Moderate to High	Same as Proposed Action
Tom Creek Canyon/Buck Gulch/Doe Gulch Spent Shale Disposal	1,327.5	419.2	208.8	R	Low	*Aquilegia barnebyi* *Astragalus lutosus* *Festuca dasyclada* *Mentzelia argillosa* *Sullivantia hapemanii* var. *purpusii* *Thalictrum heliophilum*
Underground Spent Shale Disposal[d]	624.0	196.9	98.0	R	Low	*Aquilegia barnebyi* *Astragalus lutosus* *Mentzelia argillosa* *Sullivantia hapemanii* var. *purpusii* *Thalictrum heliophilum*
West Fork Parachute Creek Reservoir and Corridor	532.5	615.1	614.0	R	N/A	None

[a] Acreage values determined by USFWS.
[b] TOP = Thousands of Pounds AUM = Animal Unit Months
[c] R = Residual
[d] Assume 50% shale disposal underground; 50% in Buck and Doe Gulches. Acreages and production values are for 50% disposal in Buck and Doe Gulches.

4.2.7 Wildlife

This section of the EIS serves in part, as a Technical Assistance Report to address the concerns of the U.S. Fish and Wildlife Service (USFWS) under the Fish and Wildlife Coordination Act of 1958.

Following is a description of direct impacts of the Getty proposed action and alternatives on wildlife. This discussion is based on the results of a wildlife impact analysis performed by the USFWS and Colorado Division of Wildlife (CDOW). Sources of information for the analysis included the baseline report for the Getty project (Getty 1983a) and wildlife data in the USFWS/CDOW computer data base. Project impact analyses were accomplished by use of a modified USFWS Geographic Information System (GIS; Porter et al. 1979; USFWS 1981). GIS is a computer-based overlay system designed to provide a relately rapid impact evaluation capability. Wildlife values (wildlife range or habitat acreage weighted by species abundance, sensitivity, or other critical limiting factors) were compared with project development acreage (weighted by intensity and type of potential disturbances). The results of this analysis are given in Appendix C (Tables C-1, C-3, and C-5) and summarized in this report.

4.2.7.1 Proposed Action

Construction and operation of the proposed action would directly affect about 4,100 acres of wildlife habitat within the project area. An additional 16,480 acres of habitat within 0.5 miles of the project features would be potentially disturbed (Table C-3, Appendix C). Of these acres directly affected by the proposed action, an estimated 1,800 acres are big game winter range (WR), winter concentration area (WCA), and critical habitat (CH). Active nest locations for Cooper's hawk and red-tailed hawk would be impacted as well as known cliff nesting sites (currently inactive) for the golden eagle. Sensitive habitats affected by the proposed action include aspen woodland and riparian areas (Table C-3, Appendix C). Wildlife impacts associated with each project feature are summarized below.

Development and operation of the underground mine would have a low adverse effect on wildlife species or habitats in the project area. Disturbance of some cliff and plateau shrubland habitats could occur during construction of the two mine benches, portals, vents, and associated surface facilities.

The construction of processing facilities would directly affect plateau mixed shrubland habitat, the primary habitat on site. Some aspen stands would also be lost at the second retort addition. An active red-tailed hawk nest located in an aspen stand at the north end of the second retorting facility site may become disturbed or directly lost.

The disposal of spent shale in Wiesse Gulch would cause the direct loss of plateau mixed shrubland, sagebrush, and aspen habitats. In addition, one active Cooper's hawk nest and one active red-tailed hawk nest would be eliminated through disposal activities. Three inactive nests two buteo and one accipitrine would also be directly lost.

The placement of a syncrude pipeline and transmission line across the Getty property would cause the short-term disturbance of plateau shrubland and aspen habitats which lie in the corridor. One known, active red-tailed hawk nest would probably be lost or disturbed. The proposed utility and water corridor, which traverses Buck Gulch, would disturb dry slope shrubland and barren rock habitats of the gulch. This area has been classified by the CDOW (1983b) as a migration corridor for mule deer. Elk winter range, winter concentration area, and critical habitats would also be affected by this corridor (Table 4.2-5). However, disturbance of these big game areas should be short-term in duration. The proposed access road from the Clear Creek road up Tom Gulch to the initial retorting and upgrading facilities would affect riparian, dry shrubland, cliff, conifer, and plateau shrubland habitats. In addition, the road corridor would traverse elk CH and a Tom Creek migration route. As a result, the incidence of big game roadkills, particularly elk, could increase as a result of increased vehicular traffic. Although no known raptor nests lie in the road corridor, several buteo (active and inactive) and golden eagle (inactive) nests occur in relative close proximity. Construction and use of the road could cause these nests to become permanently abandoned.

The establishment of a reservoir in Tom Creek gulch would cause the inundation of riparian and valley shrubland habitats. Portions of WCA and CH for elk would be permanently lost (Table 4.2-5). Habitats for a variety of small game and nongame species would also be eliminated. The Roan Creek-Clear Creek reservoir would inundate valley riparian and shrubland habitats and affect portions of mule deer WCA and CH. The open water habitat created by the reservoirs could attract increased numbers of waterfowl and shorebirds to the project area during migration and winter periods. Fluctuating water levels in the reservoirs as a result of inflow and withdrawal could result in open, ice-free water throughout the winter. However, these positive aspects of the reservoirs are likely to be offset by the destruction of habitat and loss of individuals that are also expected to occur.

The wildlife habitats affected by the proposed GCC settling pond are unknown but are most likely to be a combination of agricultural, valley grassland, and sagebrush types. Fifty-five acres of mule deer WR, WCA, and CH would also be affected (Table 4.2-5).

Riparian communities potentially affected by construction and operation of the proposed action include those located in Tom Gulch and in the vicinity of the GCC settling pond. Approximately 20 acres of riparian habitat, including a 0.5 buffer, would be directly impacted at these localities (Table C-1, Appendix C). The effects on wildlife could include loss of breeding and nesting areas, escape cover, and preferred food and water sources, and are not deemed significant considering the total area involved. No threatened or endangered wildlife species would be affected by loss of riparian habitat at these locations.

4.2.7.2 Alternatives

No significant difference in wildlife impacts is anticipated for the Lurgi alternative. About 230 fewer acres of wildlife habitat on the plateau would be disturbed under the 50,000-bpd alternative since the second retort addition site would be eliminated (see Key, Appendix C).

Disposal of spent shale in Tom, Buck, and Doe gulches would have a significant long-term effect on wildlife. Almost 640 fewer acres of wildlife habitat would be permanently lost compared with that expected under the proposed action. However, the disposal of spent shale at these alternate locations would inundate a relatively large area of cliff and dry shrubland habitat, thereby causing a long-term reduction in the availability of these habitats to cliff nesters (e.g., golden eagles), as well as to a variety of other wildlife species. A narrow band of riparian habitat in Tom Gulch would also be covered by spent shale. In addition, one active Cooper's hawk nest in Buck Gulch and several buteo and golden eagle nest sites (inactive) in Tom Gulch would be permanently lost. Almost 600 acres of Elk WCA and CH and over 1,500 acres of WR, which also occur in these gulches, would be directly lost through disposal activities (Table 4.2-5). Disposal of spent shale in the underground mine in combination with Buck and Doe gulches would result in wildlife impacts similar to those discussed above.

The addition of the West Fork of Parachute Creek reservoir (plus a connecting pipeline) to the water supply system would entail the loss of additional riparian, aspen, and shrubland habitats on the plateau. Active red-tailed hawk and Cooper's hawk nests in the vicinity of the corridor and reservoir will likely be disturbed during construction activities. The impacts of the Big Salt Wash and Rangely corridors on wildlife and wildlife habitats were addressed in the CCSOP EIS (1983).

Of the alternatives considered, the West Fork of Parachute Creek reservoir and pipeline corridor is the only one which would adversely affect riparian habitat in the project area. Approximately 100 acres would be directly impacted, and an additional 66 acres of riparian habitat within 0.5 miles of the corridor could be disturbed (Table C-1, Appendix C). Impacts to terrestrial wildlife are expected to be similar to those which would result from disturbance of riparian habitat under the proposed action. No threatened or endangered wildlife species would be affected by disturbance or elimination of riparian habitat in the alternative reservoir and corridor location.

Table 4.2-5 SUMMARY OF ESTIMATED POTENTIALLY AFFECTED ACREAGES OF BIG GAME WINTER RANGE (WR), WINTER CONCENTRATION AREA (WCA), AND CRITICAL HABITAT (CH) FOR MAJOR FACILITIES ASSOCIATED WITH THE GETTY PROPOSED ACTION AND ALTERNATIVES

	Potentially Affected Acreages[a]					
	Mule Deer			Elk		
Alternative/Components	WR	WCA	CH	WR	WCA	CH
Proposed Action (100,000 bpd)						
Mine Bench and Plant Site	0.0	0.0	0.0	94.5	0.0	0.0
Additional Retort Site	0.0	0.0	0.0	0.0	0.0	0.0
Spent Shale Disposal	0.0	0.0	0.0	0.0	0.0	0.0
Corridors						
Power, Road, Syncrude, Water (Mesa)	0.0	0.0	0.0	0.0	0.0	0.0
Power and Water (Buck Gulch)	0.0	0.0	0.0	124.5	84.0	84.0
Road (Tom Gulch)	0.0	0.0	0.0	337.5	118.5	118.5
Power, Rail, Road, Water (Roan Creek, Clear Creek)	3,015.0	2,428.5	2,326.5	249.0	147.0	147.0
Water Supply						
GCC Joint Venture and Two Other Regulation Reservoirs	1,803.0	1,803.0	1,803.0	174.0	174.0	174.0
GCC Settling Pond	55.5	55.5	55.5	0.0	0.0	0.0
	4,873.5	4,287.0	4,185.0	979.5	523.5	523.5
Alternatives						
Proposed Action (50,000 bpd)	4,873.5	4,287.0	4,185.0	979.5	523.5	523.5
Spent Shale Disposal (Tom, Buck, Doe Gulches)	1.5	0.0	0.0	1,563.0	582.0	582.0
Corridors						
Rangely B	1,464.0[b]	0.0[b]	1,638.0[b]	2,856.0[b]	0.0[b]	1,008.0[b]
Big Salt Wash	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
West Fork Parachute Creek	0.0	0.0	0.0	0.0	0.0	0.0
Water Supply						
West Fork Parachute Creek Res., Tom Creek Res., Roan Creek/ Clear Creek Res., and GCC Joint Venture Facilities	1,803.0	1,803.0	1,803.0	174.0	174.0	174.0

Source: USFWS (1983); See Appendix C, Table C-1.

[a] The acreages shown in the table for each big game species and range type are *not* mutually exclusive values (i.e., considerable overlap in ranges exists within *and* between each species).
[b] Source: Lockhart et al. (1983).

4.2.7.3 Solid/Hazardous Wastes and Toxic Pollutants

Getty has proposed to use engineering measures which should reduce the likelihood of surface and ground water contamination through contact with spent shale and upward migration of trace and toxic elements into the plant rooting zone. These preventive measures include use of an impermeable liner, capillary barrier, benching, adequate topsoiling, and revegetation of the pile (see Section 2.3.1). Therefore, spent shale disposal in Wiesse Creek should not result in uptake or bioaccumulation of toxic elements in plants and herbivores. Runoff retention reservoirs below the disposal area could contain elevated concentrations of heavy metals (see Surface Water, Section 4.2.2). Getty plans to pump the water in the retention reservoirs back to the shale disposal site. Hence, exposure of wildlife species to metals in the reservoirs should be minimal and short-term in duration.

4.2.7.4 Secondary Impacts

Indirect loss of wildlife and wildlife habitat would result from secondary impacts of the proposed project. A long-term reduction of wildlife densities from road kills and poaching could occur throughout the region. Direct loss of wildlife due to poaching could be locally significant, especially for deer and elk, where concentration areas are accessible. Direct regional impacts on wildlife habitat would result from housing and community infrastructure development. The magnitude of long-term reduction in the regional carrying capacity for many species would be minimized if such habitat losses are concentrated in areas of existing community development. Indirect impacts to wildlife would occur as a result of increased levels of noise, harassment by domestic pets, and human activity (including ORV use) in the area of secondary impact. A simultaneous increase in the demand for consumptive and nonconsumptive wildlife-related recreation would occur throughout the area.

4.2.8 Air Quality/Meteorology

4.2.8.1 Proposed Action

This section considers the combined air quality impacts due to Getty's proposed action with the mine, retorting and upgrading facilities located on the plateau above Doe and Buck gulches.

Emissions

The air quality impact analysis of the proposed Getty project considers stack and fugitive releases of SO_2, TSP, NO_x and CO in addition to emissions of other regulated and/or potentially hazardous pollutants. A 100,000-bpd production rate was utilized. TSP emissions anticipated from mining and shale handling activities include a wide variety of source types. The exact location of sources could move across wide areas in a day-to-day progression. The year 2010, or 21 to 25 years into the project, was chosen to define the area source locations of the rock storage and spent shale areas and the point source locations of the mine activities and processing plants. This year should represent maximum emission potentials due to full production.

The emission rates and stack height information associated with the retorting, upgrading, and mining facilities are presented in Table 4.2-6. Sources with identical stack parameters and in the same vicinity were grouped to form composite sources with combined emissions. These composite sources for the upgrading, retorting and mining facilities were assigned geographical coordinates corresponding to the geometric mid-point of the individual sources of each source sub-group. Constant year-round emissions corresponding to retorting for a 100,000-bpd oil shale facility were assumed for the modeling analysis. Further details of the modeling analysis are provided in the Appendix A. The emission source modeling configuration was derived from the plot plans and emission rates detailed in the Getty project description (Getty 1983b).

Air Quality

Table 4.2-7 lists the predicted maximum air quality impacts of the plateau top facilities for the proposed action. The table lists each appropriate pollutant, averaging time, and receptor location for the predicted maximum concentrations in the PSD Class II areas, the PSD Class I areas (Flat Tops Wilderness, Arches National

Table 4.2-6 TOTAL MINING, RETORTING, AND UPGRADING STACK EMISSIONS AND STACK DATA - GETTY PROPOSED ACTION (100,000 bpd)

Facility	Stack Height (m)	No. of Stacks	SO_2[a] (g/sec)	TSP[a] (g/sec)	NO_x[a] (g/sec)	CO[a] (g/sec)	HC[a] (g/sec)
Retorting and Upgrading Emissions							
Recycle Gas Heater	76	12	58	2	74	6	1
Reboiler	61	6	5	0	7	1	<1
Boiler	61	4	19	1	34	25	1
Reformer Heater	23	4	2	1	37	3	1
Hydrotreator	53	4	2	0	7	1	0
Tail Gas Incinerator	6	2	1	0	0	0	0
Mining and Material Handling Emissions							
Mining	NA[b]	NA	3	6	52	159	3
Raw Shale Handling	NA	NA	0	24	0	0	0
Spent Shale Handling	NA	NA	0	1	0	0	0
Disposal/Reclamation	NA	NA	1	7	17	3	1
Miscellaneous	NA	NA	0	0	0	0	20
TOTAL EMISSIONS			91	42	228	198	27

Source: Getty (1983b).

[a] Total for all stacks.
[b] NA - Not Applicable.

Monument, the Black Canyon of the Gunnison Wilderness, and West Elk Wilderness), the Colorado Category I areas (Colorado National Monument and Dinosaur National Monument) and the Mesa County TSP non-attainment area.

For the proposed action, the PSD Class II 24-hour TSP increment may be consumed or exceeded by 1 microgram per cubic meter ($\mu g/m^3$). This predicted impact is located along the west central property line and is largely due to the close proximity of the disposal area to this property line. No other Class II increments or NAAQS are predicted to be exceeded by the proposed action.

The 24-hour SO_2 impact at the southwest corner of the Flat Tops Wilderness boundary, which is about 42 miles away, is predicted to be 80 percent of the PSD Class I increment. Transport of significant quantities of SO_2 and TSP for the other regulated averaging times would not likely occur due to the distances to Flat Tops and other sensitive areas (about 87 miles to Arches National Monument, 76 miles to the Black Canyon of the Gunnison Wilderness, 71 miles to the West Elk Wilderness, 40 miles to the Colorado National Monument, and 58 miles to Dinosaur National Monument) and the low probability of occurrence of meteorological conditions that would effectively transport pollutants to these areas.

An analysis of ozone impacts from the Getty proposed action has been conducted. Since ozone is a regional pollutant, the analysis presented in the CCSOP EIS (BLM 1983a) should be representative of the Getty location. Optimum ozone production typically occurs when the ratio of HC to NO_x is between 7 to 1 and 12 to 1 (EPA 1977). The ratio for the Getty proposed action is only 0.12 to 1. The Chevron study (BLM 1983a) indicates emissions of HC and NO_x from oil shale facilities at a ratio of 0.3 to 1, would have a minimal impact on ambient ozone concentration, with a range of predicted ozone concentrations for all scenarios less than 0.01 ppm. This would represent a concentration of less than 8 percent of the federal standard. The contribution from the Getty project would be within this range.

Table 4.2-7 MAXIMUM AIR QUALITY IMPACTS SUMMARY - GETTY PROPOSED ACTION (100,000 bpd)

			Predicted PSD Class I[b] Concentrations ($\mu g/m^3$)				Category I[b] Conc. ($\mu g/m^3$)			Predicted Class II Conc. ($\mu g/m^3$)			Standards ($\mu g/m^3$)[b]			
Pollu-tant	Averaging Time	Background[a] Conc. ($\mu g/m^3$)	FLAT	ARCH	BACA	WELK	COLO	DINO	MESA	Receptor Location	Conc.	Total Conc.	Class I Incre.[c]	Class II Incre.	Limit. NAAQS	SIL
SO_2	Annual	1	<1	<1	<1	<1	<1	<1		W-Cen Prop. Line	7	8	2	20	80	1
	24-Hour	14	4	<1	<1	<1	2	1		2.4 km off NW Cor.	29	43	5	91	365	5
	3-Hour	17	13	3	6	5	13	7		NW Cor. Prop. Line	85	102	25	512	1,300	25
TSP	Annual	5	<1	<1	<1	<1	<1	<1	<1	W-Cen Prop. Line	8	13	5	19	60	1
	24-Hour	34	<1	<1	<1	<1	<1	<1	<1	W-Cen Prop. Line	38[d]	72	10	37	150	5
NO_2	Annual	4								W-Cen Prop. Line	69	73			100	1
CO	8-Hour	2,500								W-Cen Prop. Line	1,981	4,481			10,000	500
	1-Hour	3,000								W-Cen Prop. Line	17,417	20,417			40,000	2,000

[a] Background concentrations are representative of facility area. The actual background concentration in other impact areas may be lower.
[b] FLAT = Flat Tops Wilderness west boundary; ARCH = Arches National Monument east boundary; BACA = Black Canyon of the Gunnison National Monument west boundary; WELK = West Elk Wilderness west boundary; COLO = Colorado National Monument north boundary; DINO = Dinosaur National Monument east boundary; MESA = Mesa County TSP Nonattainment Area; SIL = Significant Impact Level
[c] Colorado Category I increments are the same as PSD Class I increments for SO_2 only.
[d] Equal to or exceeds PSD increments.

Visibility

An EPA Level-1 visibility screening analysis (Latimer and Ireson 1980) was performed to determine the possibility of any significant impacts occurring in the Class I and Colorado Category I areas. The Level-1 visibility screening analysis is a simple, straightforward calculation designed to identify those emission sources that have little potential of adversely affecting visibility. If a source passes this screening test, it would not likely cause significant visibility impairment, and further analysis of potential visibility impairment would not be necessary. The Level-1 analysis input requirements are the minimum distance of the emission source from the nearest Class I area boundary; total TSP, SO_2, and NO_x emission rates; and typical worst case meteorology. The meteorology used for this analysis is that suggested by Latimer and Ireson (1980) which is moderate atmospheric stability (F) and light winds. This analysis indicates that significant impacts can not be ruled out within 37 miles where TSP-caused plume blight against dark terrain might occur. All of the above Class I and Category I areas are beyond 37 miles and therefore no visibility impacts are anticipated in these areas.

Atmospheric Deposition

Acid deposition is considered as one of the Air Quality Related Value (AQRV's) for federally designated Class I areas which are within close proximity of a facility. Acid deposition is a regional phenomenon generally associated with emissions generated by large cities and major industrial sources. Even so, it has been documented in a high-altitude Rocky Mountain setting where no direct connection has been made to major emissions sources (Lewis and Grant 1980). Additional studies and analyses have been done by Lewis and Grant of CSU, Turk of U.S. Geological Survey (Turk 1982), and Fox of the U.S. Forest Service (Fox 1981). Most of these studies of western acid deposition indicate it is unlikely, but still unknown, whether significant contributions to adverse impacts are possible from an individual source.

Potential deposition of sulfur and nitrogen in Class I and Category I areas was modeled using the deposition results from the ISC long-term model and the annual meteorological data set collected at Chevron's Clear Creek mesa station. The analysis assumes the following:

- The estimated worst-case single concentration is representative of deposition to the entire wilderness area.
- All sulfur compounds were assumed to be SO_2 and nitrogen compounds were assumed to be NO_x.
- Dry deposition velocity of NO_x and SO_2 was assumed to be 1 centimeter per second (cm/sec).
- Complete mixing in lakes could occur due to snowmelt or runoff.

Wet deposition rates were estimated from precipitation statistics for the Class I and Category I areas. Assuming an annual average mixing depth of 8,200 to 8,500 feet (Holzworth 1972) and the complete removal of pollutants during the 1-hour precipitation event on each of the event days (Department of Commerce 1968), the effective annual-average wet deposition velocity of 0.8 cm/sec was calculated for Flat Tops, Black Canyon, and West Elk Wilder ness areas, and 1.0 cm/sec for Arches, Colorado and Dinosaur National Monuments. Applying these values to the concentrations of SO_2 and NO_x in the wilderness area resulted in the prediction of wet deposition rates to be 80 and 100 percent of the dry deposition rates in these respective areas. Table 4.2-8 presents the annual dry and wet deposition rates resulting from Getty's proposed action. The total nitrogen and sulfur deposition was conservatively estimated to range from 3 to 48 mg/m^2 over an annual period for the sensitive receptors.

The conservative deposition rates are not expected to alter the pH of lakes with good buffering capabilities but may slightly lower the level of poorly buffered lakes with pH values of about 7 or less. U.S. and Canadian scientists have agreed that wet sulfate deposition of 2 g/m^2/yr and dry sulfate deposition of 1.3 g/m^2/yr has not produced any recorded damage in most vulnerable areas (Roberts 1983). The sulfur deposition calculated represents a small percentage of this threshold value. Although no similar threshold value has been proposed for judging nitrate deposition, the threshold impact value would be expected to be about the same as for sulfate

Table 4.2-8 MAXIMUM ANNUAL ELEMENTAL DEPOSITION RATES ($mg/m^2/yr$) IN SENSITIVE AREAS - GETTY PROPOSED ACTION (100,000 bpd)

	Flat Tops		Arches		Black Canyon		West Elk		Colorado		Dinosaur	
Constituent	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Nitrogen	32	26	2	2	4	3	4	3	28	28	14	14
Sulfur	16	13	1	1	2	2	2	2	13	13	7	7

deposition. Again, the calculated nitrogen values are only a small percentage of this threshold value. It is not currently known what effect, if any, these shifts would have on sensitive biota of Class I and Category I areas. In general, as aquatic systems acidify, the physiological stress is likely to progressively alter biological population structures. At the acidification levels reported, elimination of certain phyto- and zooplankton species is possible (reducing diversity), but a significant change in total biomass is unlikely.

4.2.8.2 Alternatives

This section considers the air quality impact of the proposed alternatives and subalternatives to the Getty project. These alternatives and subalternatives include the following:

- Reduced production rate at 50,000 bpd using Union B retorts
- Full production rate at 100,000 bpd using Lurgi retorts
- Reduced production rate at 50,000 bpd using Lurgi retorts
- On-site cogeneration
- Underground spent shale disposal
- Tom, Buck, and Doe gulch spent shale disposal

The emission rates in grams per second (g/s) were provided by Getty (1983c). The emissions inventory for each alternative is presented in Table 4.2-9. The emissions included all emissions from the alternative oil shale facility except for cogeneration. Cogeneration has been treated as a separate point source subalternative that could be added to any of the primary alternatives.

As for the proposed action, these emission rates were modeled using the ISC air quality model to analyze the short-term and annual concentration of TSP, SO_2, NO_x, and CO. Table 4.2-10 summarizes the significant results of these analyses. Ozone impacts would be small for all alternatives since the ratio of hydrocarbons to oxides of nitrogen emissions would be well below optimum ozone production ratios (see Section 4.2.8.1). Table 4.2-11 presents the acid deposition analyses conducted for the sensitive receptor areas. The acid deposition analysis was performed using the same methodology used for the proposed action. Table 4.2-12 presents the air quality impacts summary for the subalternatives of spent shale disposal and cogeneration. Level-1 visibility screening analyses were performed for all alternatives and are below.

50,000 bpd - Union B Retorts

For the Union B reduced-production rate alternative, 56 percent of the PSD Class II 24-hour TSP increment would be consumed. This impact would be located along the west central property line (Sleepy Ridge) where the maximum TSP concentration for the proposed action occurred. This value, when added to background, is about

Table 4.2-9 SUMMARY OF EMISSION RATES (g/sec) - GETTY PROJECT ALTERNATIVES[a]

	50,000 bpd Union B				100,000 bpd Lurgi				50,000 bpd Lurgi				Cogeneration			
Facility	TSP	SO_2	NO_2	CO	TSP	SO_2	NO_2	CO	TSP	SO_2	NO_2	CO	TSP	SO_2	NO_2	CO
Retorting and Upgrading Emissions																
Recycle Gas Heater	1	29	37	3	-	-	-	-	-	-	-	-				
Reboiler	0	3	4	<1	-	-	-	-	-	-	-	-				
Boiler	<1	10	17	13	1	19	34	25	<1	10	17	13				
Reformer Heater	<1	1	18	2	1	2	37	3	<1	1	19	2				
Hydroheater	0	1	4	<1	0	2	7	1	0	1	4	<1				
Tail Gas Incinerator	0	<1	0	0	0	1	0	0	0	<1	0	0				
Lurgi Retorts	-	-	-	-	180	70	520	100	90	35	260	50				
Mining and Material Handling																
Processing Area	8	0	0	-	15	-	-	-	8	-	-	-				
Mining	3	2	26	80	6	3	52	159	3	2	26	80				
Raw Shale Handling	5	0	0	0	63	-	-	-	33	-	-	-				
Spent Shale Handling	4	0	0	0	1	0	0	0	<1	0	0	0				
Disposal	4	<1	9	2	8	1	17	3	4	<1	9	2				
TOTAL EMISSIONS	21	46	114	99	274	98	667	291	137	49	334	146	30	1	80	6

[a] For the underground disposal subalternative, the disposal/reclamation emissions are reduced 50 percent while the mining emissions increase by this amount. The Buck, Tom, and Doe gulches disposal subalternative emissions are the same as above.

one-third of the federal standard. About 40 percent of the 24-hr and 3-hr PSD Class I SO_2 increments in the Flat Tops Wilderness would also be consumed. In addition, impacts of about 40 percent of the NO_2 annual and CO 8-hr and 1-hr national standards are predicted to occur. This alternative rates a low adverse impact.

A Level-1 visibility screening analysis indicated that a plume blight cannot be ruled out within a distance of 24 miles. All of the Class I and Category I areas are well beyond this distance and therefore no visibility impacts are expected in these areas due to this alternative.

Acid deposition was analyzed for the 50,000-bpd reduced-production rate alternative using the methodology outlined in Sections 4.2.8.1. The results presented in Table 4.2-11 are well below threshold limits (Roberts 1983). Therefore, significant impacts associated with these acidification levels are not expected.

100,000 bpd - Lurgi Retorts

For the Lurgi alternative at 100,000 bpd, the 24-hr TSP concentration is predicted to more than double the PSD Class II increment at the off-property Sleepy Ridge location. When added to the background levels this impact represents 80 percent of the NAAQS. No other Class II increment or NAAQS are predicted to be exceeded by this alternative. This alternative rates a medium adverse impact.

The 24-hr SO_2 impact at the southwest corner at the Flat Tops Wilderness boundary is predicted to be 80 percent of the PSD Class I increment.

The 24-hr TSP concentration at the north boundary of the Mesa County TSP Non-Attainment area is predicted to be 3 $\mu g/m^3$, which is only 75 percent of the EPA significant impact level.

Table 4.2-10 SUMMARY OF MAXIMUM AIR QUALITY IMPACTS[a] - GETTY PROJECT ALTERNATIVES

	50,000-bpd Union B								100,000-bpd Lurgi							
Sensitive Areas	TSP Annual	TSP 24hr	SO_2 Annual	SO_2 24hr	SO_2 3hr	NO_2 Annual	CO 8hr	CO 1hr	TSP Annual	TSP 24hr	SO_2 Annual	SO_2 24hr	SO_2 3hr	NO_2 Annual	CO 8hr	CO 1hr
Class I Areas																
Flat Tops Wilderness	0	<1	0	2	8				<1	4	<1	3	9			
Arches National Park	0	0	0	<1	2				<1	1	0	<1	3			
Black Canyon of the Gunnison Wilderness	0	0	0	<1	3				<1	1	0	<1	3			
West Elks Wilderness	0	0	0	<1	3				<1	1	0	<1	2			
Category I Areas																
Dinosaur National Monument	0	0	<1	1	6				<1	2	<1					
Colorado National Monument	0	0	0	1	7				<1	2	<1	1	6			
Mesa County TSP Non-Attainment Area	0	0							<1	3						
Class II Areas																
Background	15	34	1	14	17	4	2,500	3,000	15	34	1	14	17	4	2,500	3,000
Maximum Conc.	5	21	5	18	70	34	1,940	17,300	12	85[b]	6	18	60	72	1,971	17,363
Total Conc.	20	55	6	32	87	38	4,440	20,300	27	119	7	19	74	76	4,471	20,363
PSD Increments																
Class 1	5	10	2	5	25				5	10	2	5	25			
Class II	19	37	20	91	512				19	37	20	91	512			
Limiting NAAQS	60	150	80	365	1,300	100	10,000	40,000	60	150	80	365	1,300	100	10,000	40,000
Significant Impact Level	1	5	1	5	25	1	500	2,000	1	5	1	5	25	1	500	2,000

Table 4.2-10 SUMMARY OF MAXIMUM AIR QUALITY IMPACTS[a] - GETTY PROJECT ALTERNATIVES (continued)

	50,000-bpd Lurgi							
Sensitive Areas	TSP Annual	TSP 24hr	SO_2 Annual	SO_2 24hr	SO_2 3hr	NO_2 Annual	CO 8hr	CO 1hr
Class 1 Areas								
Flat Tops Wilderness	<1	2	<1	2	6			
Arches National Park	<1	<1	<1	<1	2			
Black Canyon of the Gunnison Wilderness	<1	<1	<1	<1	2			
West Elks Wilderness	<1	<1	<1	<1	1			
Category 1 Areas								
Dinosaur National Monument	<1	<1	<1	<1	2			
Colorado National Monument	<1	1	<1	1	3			
Mesa County TSP Non-Attainment Area	<1	1						
Class II Areas								
Background	15	34	1	14	17	4	2,500	3,000
Maximum Conc.	11	65[b]	4	15	51	44	1,940	17,318
Total Conc.	29	99	5	29	68	48	4,440	20,318
PSD Increments								
Class 1	5	10	2	5	25			
Class II	19	37	20	91	512			
Limiting NAAQS	60	150	80	365	1,300	100	10,000	40,000
Significant Impact Level	1	5	1	5	25	1	500	2,000

[a] All values $\mu g/m^3$.
[b] May consume or exceed PSD increment.

Table 4.2-11 MAXIMUM ANNUAL ELEMENTAL DEPOSITION RATES IN SENSITIVE AREAS[a] - GETTY PROJECT ALTERNATIVES

	Flat Tops		Arches		Black Canyon		West Elk		Colorado		Dinosaur	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Proposed Action 100,000 bpd												
Nitrogen	15	12	1	1	2	2	2	1	15	15	7	7
Sulfur	8	6	1	1	1	1	1	1	7	7	4	4
Lurgi Retorts 100,000 bpd												
Nitrogen	153	122	8	8	20	16	16	13	129	129	64	64
Sulfur	22	18	1	1	3	2	2	2	19	19	9	9
Lurgi Retort 50,000 bpd												
Nitrogen	71	57	4	4	9	7	8	6.3	72	72	34	34
Sulfur	5	4	1	1	1	1	1	1	10	10	5	5
Cogeneration with Proposed Action 100,000 bpd												
Nitrogen	50	40	3	3	7	6	6	5	45	45	22	22
Sulfur	16	13	1	1	2	2	2	2	14	14	7	7

[a] All values $\mu g/m^3$.

A Level-1 visibility screening analysis indicates that a NO_x-caused dark plume against a bright sky would be visible within a distance of 59 miles from the facility, while a light plume against dark terrain caused by TSP would be visible within a distance of 85 miles. This analysis indicates a potential for visibility degradation in Flat Tops Wilderness, Black Canyon of the Gunnison Wilderness, West Elk Wilderness, Colorado National Monument, and Dinosaur National Monument due to a full-production Lurgi alternative.

The maximum total acid deposition presented in Table 4.2-11 would be less than 10 percent of threshold values presented earlier. Therefore, impacts to biota are unlikely.

50,000 bpd - Lurgi Retorts

The second highest 24-hr TSP concentration that would occur off the Getty property due to a reduced-production Lurgi alternative would be almost 2 times the Class II PSD increment. When added to the background concentration this value would be two-thirds of the NAAQS. No other PSD increments or NAAQS are predicted to be exceeded.

A Level-1 visibility screening analysis indicated that a NO_x-caused dark plume against a bright sky would be visible to a distance of 40 miles from the facility, while a TSP-caused light plume against dark terrain would be visible to a distance of 62 miles. This analysis indicates a potential for visibility degradation in Flat Top Wilderness and Colorado National Monument.

The maximum total acid deposition presented in Table 4.2-11 is less than 10 percent of threshold values presented earlier (Roberts 1983). Therefore, impacts to biota are unlikely.

Underground Disposal

Table 4.2-12 presents the modeling results of the underground disposal subalternatives. The 24-hr TSP concentrations are predicted to consume or exceed the PSD Class II increment for the full-production proposed

Table 4.2-12 SUMMARY OF OFF-PROPERTY CLASS II AIR QUALITY IMPACTS - GETTY PROJECT SPENT SHALE AND COGENERATION ALTERNATIVES[a]

	Underground Disposal						Gulch Disposal					
	Annual TSP	24-Hr TSP	Annual SO_2	24-Hr SO_2	3-Hr SO_2	Annual NO_2	Annual TSP	24-Hr TSP	Annual SO_2	24-Hr SO_2	3-Hr SO_2	Annual NO_2
Background Conc.	15	34	1	14	17	4	15	34	1	14	17	4
Proposed Action 100,000 bpd												
Maximum	5	37[b]	6	33	87	50	6	28	6	36	91	49
Total	39	52	7	47	104	54	21	62	7	50	118	53
Proposed Action 50,000 bpd												
Maximum	4	27	4	20	72	25	5	15	4	22	74	25
Total	38	42	5	34	89	29	20	59	5	46	91	29
Lurgi Retorts 100,000 bpd												
Maximum	11	82[b]	5	22	78	53	14	74[b]	4	20	88	49
Total	45	97	6	36	95	57	29	108	5	34	105	53
Lurgi Retorts 50,000 bpd												
Maximum	10	67[b]	3	18	66	27	12	56[b]	3	17	75	25
Total	44	82	4	32	83	31	27	90	4	31	92	29
Limiting NAAQS	60	150	80	365	1,300	100	60	150	80	365	1,300	100
PSD Class II Increments	19	37	20	91	512		19	37	20	91	512	

Table 4.2-12 SUMMARY OF OFF-PROPERTY CLASS II AIR QUALITY IMPACTS - GETTY PROJECT SPENT SHALE AND COGENERATION ALTERNATIVES[a] (continued)

	Cogeneration					
	Annual TSP	24-Hr TSP	Annual SO_2	24-Hr SO_2	3-Hr SO_2	Annual NO_2
Background Conc.	15	34	1	14	17	4
Proposed Action 100,000 bpd						
Maximum	8	40[b]	2	5	25	73
Total	23	74	3	19	42	78
Proposed Action 50,000 bpd						
Maximum	5	23	5	18	70	34
Total	20	57	6	32	87	38
Lurgi Retorts 100,000 bpd						
Maximum	12	87[b]	6	18	60	72
Total	27	121	7	29	77	76
Lurgi Retorts 50,000 bpd						
Maximum	11	67[b]	4	15	51	44
Total	26	101	5	29	68	48
Limiting NAAQS	60	150	80	365	1,300	100
PSD Class II Increments	19	37	20	91	512	

[a] All values $\mu g/m^3$.
[b] PSD increment may be consumed or exceeded.

action and the 100,000- and 50,000-bpd Lurgi alternatives. The total concentrations when added to the background values results in values of 33, 66, and 44 percent of the NAAQS for the respective three alternatives. No other consumption or exceedences of PSD increment or NAAQS would occur. Visibility and acid deposition values and air quality impacts in the Class I and Category I areas would be the same as the alternative impacts discussed earlier.

Gulch Disposal

Table 4.2-12 presents the modeling results of the alternative Tom, Doe, and Buck gulch spent shale disposal areas. The 24-hr TSP concentrations are predicted to consume or exceed the PSD Class II increment for 100,000-and 50,000-bpd Lurgi alternatives. When added to the background values, this would result in 72 and 60 percent of the NAAQS for the 100,000-bpd and 50,000-bpd alternatives, respectively. Visibility and acid deposition values and air quality impacts in the Class I and Category I areas would be the same as the alternative impacts discussed earlier.

Cogeneration

Table 4.2-12 presents the modeling results of the cogeneration alternative. The 24-hr TSP concentrations are predicted to consume or exceed the PSD Class II increment for the 100,000-bpd proposed action and the 100,000 and 50,000-bpd Lurgi alternatives. The total concentrations when added to the background values result in 50, 81, and 66 percent of the NAAQS of the respective alternatives. No significant consumption or exceedance of PSD increments or NAAQS would occur over other alternatives without cogeneration. All SO^2 and TSP concentrations for the regulated averaging times in the Class I and Category I sensitive receptors are less than 1 $\mu g/m^3$. A Level-1 screening analysis of cogeneration with the proposed action indicated a NO_x-caused dark plume against a bright sky would be visible out to 40 miles from the facility and a TSP-caused light plume against dark terrain would be visible out to 48 miles from the facility. This analysis indicates a potential for visibility degradation in the Flat Top Wilderness and Colorado National Monument. Acid deposition values are presented in Table 4.2-11 and are below the threshold values (Roberts 1983).

4.2.8.3 Solid/Hazardous Wastes and Toxic Pollutants

None of the non-criteria pollutants typically found in combustor off-gas are expected to be emitted above de minimis values by the Union B retort process. This conclusion is based upon a review of the Union Oil Company's PSD permit application (Union Oil Company 1982a) and a review of EPA's document entitled Trace Elements Associated with Oil Shale Processing (EPA 1977). An additional analysis for combustor off-gas trace elements has been supplied by Getty (1983c) and is presented in Table 4.2-13. Based on the analysis of potentially toxic pollutants that might be emitted from the proposed project, all ranges of emissions for the identified toxics are minor and are below EPA de minimis levels.

Only limited data are available concerning the emissions of potentially toxic substances. However as noted in the Uinta Basin Synfuels Development Final EIS (BLM 1983b), the risk is very small even for a 1,000,000-bpd oil shale industry. This risk calculation addressed project workers, the existing population, and people moving into the area.

4.2.8.4 Secondary Impacts

This section presents the estimated air quality impacts from secondary growth emission sources associated with the construction and operation of Getty's mining, upgrading, and retorting facilities. The secondary growth sources included in the analysis are increased space heating requirements and increased motor vehicle traffic in the De Beque area.

The emission estimates from increased space heating and transportation requirements are presented in Table 4.2-14. Space heating emissions were calculated by assuming each new household was a consumer of natural gas and used 115,000 standard cubic feet of gas per customer year (BLM 1983b). Emission factors for natural gas

Table 4.2-13 TRACE ELEMENTS IN UNION B RETORT OFF-GAS[a] - GETTY PROJECT

Element	Form	Concentration in Off-Gas (μg/SCM)	Toxicity Range[b] (TLV) (μg/m³)	Annual Emmision[c] Rate (Ton/Year)	De Minimis Value (Ton/Year)
Arsenic	Gas	15	500 to 2,000	0.25	--
	Particulate[d]	0.4			
		15.4			
Mercury	Gas	2.2	100 to 500	0.01	0.1
	Particulate	0.15			
		2.35			
Iron	Gas	120.0	--	0.44	--
	Particulate	6.0			
		126.0			
Chromium	Gas	90.0	500 to 2,000	0.32	--
	Particulate	2.0			
		92.0			
Zinc	Gas	40.0	500 to 150,000	0.14	--
	Particulate	0.5			
		40.5			

Source: Getty (1983b).

[a] Assumes net gas production of 500 SCM/ton shale (Harak et al. 1974).
[b] Source: Cowherd et al. (1977).
[c] Assumes volume flow rate of 100 m³/sec.
[d] Gaseous forms are defined as those not collected by a 0.5μ neopore filter.

Table 4.2-14 MAXIMUM ANNUAL SECONDARY EMISSION RATES IN DE BEQUE - GETTY PROJECT

Source Type	SO_2 (ton/yr)	TSP (ton/yr)	NO_x (ton/yr)	CO (ton/yr)	HC (ton/yr)
Space Heating (6,895 Units)	0.2	22	32	8	3
Transportation (13,790 Vehicles)	42	109	1,459	5,436	857
TOTAL EMISSIONS	42.2	131	1,491	5,442	860

combustion were derived from EPA's compilation of emission factors (EPA 1977). Vehicle exhaust emissions were calculated from national average emission factors. It was assumed that each household operated an average of two vehicles and each vehicle averaged 12,000 miles traveled per year. The highest emissions are expected in 1995. The air quality impacts of the 1995 projected emissions were estimated with the highly conservative screening technique outlined below.

A worst-case episode was considered to estimate the highest short-term concentrations possible in De Beque from the projected 1995 secondary emissions. The scenario assumes all motor vehicle emissions from 3 pm one day until 9 am the next morning are trapped over the De Beque area. In addition, continuous space heating emissions are added to the vehicle emissions. The meteorological conditions assumed are a regional high pressure stagnation condition, with zero ventilation. Thus, pollutants emitted during the 18-hour period are assumed to accumulate over the town, and then fumigated down to the ground and fill a well-mixed box surrounding De Beque. A 32-square-mile area surrounding De Beque was assumed for the well-mixed region. To add to the conservatism, the vertical extent of the mixed region was taken as only 650 feet. The worst-case short-term concentrations were then calculated as the total amount of pollutant mass released during the period divided by the volume of the well mixed box.

The uniform hourly concentration estimates calculated using the above worst-case dispersion episode are 3, 9, 105, 384, and 61 $\mu g/m^3$ for SO_2, TSP, NO_x, CO, and HC respectively. Except for NO_x, these concentrations are at the level of background concentrations, and are insignificant.

Extrapolating the NO_x concentration to an annual average using a factor of 0.2 as recommended (EPA 1970) results in a concentration of 22 $\mu g/m^3$, or only 22 percent of the annual NO_2 NAAQS.

4.2.9 Noise

4.2.9.1 Proposed Action

The Getty project has been designed using engineering noise controls where required and whenever practical. Only nominal noise controls were assumed in estimating facility sound pressure levels. Some equipment could require additional noise controls such as acoustical enclosures, mufflers, or special designs to reduce noise to acceptable working conditions. Getty (1983c) has stated that these items will be addressed as required.

The facility equipment noise inventory for the Getty proposed action is presented in Table 4.2-15. The predicted noise level on the access roads segments on and off property were assumed to be 86 dBA at 10 feet. This assumes one medium to heavy duty utility truck (service or supply) on the access road segments at all times. Two spent shale trucks were assumed in the spent shale area, resulting in a sound pressure level (SPL) of 108 dBA, while one spent shale truck was placed in all of the haul road segments with a resulting SPL of 105 dBA.

Based on the untreated noise levels, calculation of the facilities noise sources spreading indicate operational noise would not have a significant impact away from the project. The radius of this additional noise from the center of the Getty property to the day/night noise level (Ldn) 55 dBA contour is about 7 miles. This results in a total affected area of about 94,000 acres. No known sensitive receptors for residential or public land uses were identified from recent 1:50,000 scale USGS topographical map.

Employees would be mass-transported from De Beque to the transfer station at the Roan Creek Community Center. Three trains per day would transfer about 7,000 people during 1995, when peak transportation requirements occur due to construction and operation (BLM 1983a). Three trains per day were analyzed in the CCSOP EIS. The results of this analysis are presented in Table 4.2-16. Due to the low frequency, penetrating rumble of the trains, the higher noise levels shown in Table 4.2-16 may be objectionable to some individuals.

About 32 trucks per day would utilize the road from De Beque to Getty's plant site (Getty 1983b). The CCSOP EIS (BLM 1983a) predicts, without any new oil shale projects during Getty's peak traffic year of 1995, a noise level along this segment of 47 dBA at 50 feet. The additional truck traffic analyzed alone would result in an equivalent noise level of 60 dBA at 50 feet. For perspective, typical houshold noise levels are in the range of 45 to 65 dBA (EPA 1978b). The average individual would probably not be able to detect the increase in traffic noise indoors, based on the equivalent sound level. Nevertheless, noise variation due to traffic from the Getty project would be perceptible, but should not be obtrusive.

Table 4.2-15 EQUIPMENT NOISE LEVELS - GETTY PROPOSED ACTION

Description	Sound Pressure Level (dBA)	Distance (m)
Above Ground Retorting		
Union B Retorts	85	119
Retort Gas Plant	89	54
Sulfur Recovery	80	54
Upgrading		
Naphtha Hydrotreator	82	55
Hydrogen Plant	90	69
Whole Oil Hydrotreater	81	92
Gas Plant	82	27
Sulfur Recovery	79	45
Material Handling		
Spent Shale Disposal Truck	105	3

Source: Getty (1983c).

Table 4.2-16 RAILROAD NOISE IMPACT - GETTY PROPOSED ACTION

Railroad Segment	Trains per Day	Distance to 50 dBA Contour (feet)	Area of Impact (acres)	Sensitive Receptors	Noise Level at Receptor (dBA) Outdoor	Noise Level at Receptor (dBA) Indoor
De Beque to Roan Creek Comm. Center	3	3,700	13,360	1 House	70-75	55-60
				7 Houses	65-70	50-55
				6 Houses and Roan Creek Comm. Center	60-65	45-50
				8 Houses	55-60	40-45
				3 Houses	50-55	35-40

Source: BLM (1983c).

The noise levels associated with the proposed action is considered a low adverse impact. It must be noted, however, that noise impact is highly specific to individuals. Many people living in the remote areas of western Colorado are there primarily because it is remote, and may very likely view any increase in noise as a medium adverse impact. Additional adverse effects would be observed by persons seeking recreational activities (e.g., hunting or hiking) near the Getty facilities. Potential impacts associated with noise include possible minor physiological reactions, behavioral interferences with work, sleep or hearing, as well as subjective effects including irritation and annoyance. Increased noise levels could also affect animals living on or near proposed facilties and transportation corridors. Effects on animals could be of short-term duration due to the potential for adaptation.

4.2.9.2 Alternatives

All process technology alternatives for full production (100,000 bpd) alternatives including facilities and transportation corridors should not vary significantly from the proposed action. As mentioned in Section 4.1.9, specific location of the process equipment is not critical from a noise standpoint. Based on the large areas required for the plant and the remote site locations, process equipment noise impact would be approximately equivalent for all Getty full-production alternatives.

The facility equipment noise inventory for the Getty project 50,000-bpd alternatives are presented in Table 4.2-17. The noise levels of mobile equipment were assumed to be the same as for the proposed action.

Based on these untreated noise levels calculations of the facility, noise source spreading indicates operational noise would not have a significant impact. The radius of this additional noise from the center of the facility to the 55 dBA contour is about 6 miles, which results in a total of 63,000 acres affected. Again, no known sensitive receptors were identified on 1:50,000 scale USGS topographic maps.

Employees would be mass transported from De Beque to the transfer station at the Roan Creek Community Center. Assuming 3 shifts a day would result in three trains a day. This analysis for railroad noise would be the same as presented for the proposed action. Other transportation/traffic noise impacts would not increase above the proposed action traffic noise levels.

The noise levels associated with the reduced production rate alternatives would rate as a low adverse impact. It must be noted however that noise impact is highly specific to individuals.

The use of cogeneration as an additional power supply is also an alternative to Getty's proposed action. This addition would add another source of noise. Typical power plant noise generation has been supplied by Getty (1983b) and are presented in Table 4.2-18. The addition of these sources should not greatly expand the radius of acreage affected presented for all alternatives.

4.2.9.3 Solid/Hazardous Wastes and Toxic Pollutants

On-site disposal of hazardous wastes would not create additional noise impacts. The noise impacts of transportation of any wastes off-site have been considered in the calculations for the proposed action and alternatives.

Table 4.2-17 EQUIPMENT NOISE LEVELS - GETTY 50,000 BPD ALTERNATIVES

Description	Sound Pressure Level (dBA)	Distance (m)
Above Ground Retorting		
Union B Retorts	82	119
Retort Gas Plant	86	54
Sulfur Recovery	77	54
Upgrading		
Naphtha Hydrotreator	79	55
Hydrogen Plant	77	69
Whole Oil Hydrotreater	78	92
Gas Plant	79	27
Sulfur Recovery	76	45

Source: Getty (1983c).

4.2.9.4 Secondary Impacts

Secondary noise impacts related to increased population in the region is not quantifiable, but some general statements can be made. Noise impacts related to traffic increases (the major secondary noise source) should be diffuse and of low adverse impact. Additional railroad and construction noises would occur in the region to accompany the increased populations. Most of these impacts should be of short duration and temporary, although major project construction (e.g., a shopping center) or frequent train traffic could cause local temporary adverse impacts of some importance.

Table 4.2-18 TYPICAL POWER PLANT NOISE GENERATORS AND THE RANGE OF LEVELS PRODUCED - GETTY PROJECT

Equipment	Noise Levels (dBA)
Boiler Feed Pumps	85 - 100
Forced Draft Fans	85 - 110
Induced Draft Fans	77 - 97
Condenser Rooms Below Turbine Generators	83 - 100
Pressure-Reducing Stations	82 - 109
Turbine-Generators	83 - 100
Auxiliary Exciters	88 - 93
D-C Generators	93 - 103
Demineralizers	85 - 101
Flue Dust Exhausters	85 - 103
Noise in Control Rooms	56 - 74

Source: Getty (1983c).

4.2.10 Cultural Resources

4.2.10.1 Proposed Action

Construction of the Getty underground room and pillar mine (100,000 bpd) would not affect cultural resources due to the nature of mine construction. Portions of the mine facilities and processing areas were part of a Class II sample study area. Actual survey in the facilities area has yet to be conducted. Cultural resources were not located during a sample survey of portions of the retort and mine portal area. The potential for locating cultural resources exists given the presence of suitable conditions for site locations such as proximity to water (permanent, intermittant, or springs), gently sloping terrain, ridge top areas, and access to canyons leading to major permanent drainages.

A Class II survey of a portion of the raw shale stock pile area resulted in the location of site 5GF 1174, a cattle corral. This site has been recommended as not eligible to the National Register of Historic Places. Sample survey areas in the vicinity of the shale disposal area indentified no cultural resources. Although the area appears to have a low occurrence of cultural resources, it is likely, given the existence of favorable topographical conditions, that cultural resources exist within the disposal area.

The LaSal pipeline is addressed in the CCSOP EIS (BLM 1983a). A class II sample survey in the vicinity indicates the presence of little or no cultural resources.

While site densities are low for the areas in question, it is assumed that cultural resources do exist in the all unstudied areas based on the presence of topographic situations favorable to site location. Should pre-construction cultural resource surveys identify sites, the actual determination of impacts and appropriate mitigation measures will be developed according to agency standards.

4.2.10.2 Alternatives

Construction of the Getty underground room and pillar mine at the 50,000-bpd production rate would not impact any cultural resources. Use of additional retorts would likely increase the potential for impacts to cultural resources due to increased surface disturbance. Site sample surveys identified no cultural resources. The presence of springs near the retort addition area suggests a higher potential for cultural resources, either visible on the surface or buried.

Construction of the spent shale disposal alternatives would have less potential to impact cultural resources than the proposed action, due to the placement of alternatives in steep-walled canyon area where the likelihood of site location is lower than in more opened, level terrain. Potential impacts to cultural resources with the Rangely pipeline corridor alternative and the Big Salt Wash transmission line corridor are addressed in the CCSOP EIS (BLM 1983a).

Construction of the West Fork of Parachute Creek reservoir and a related transport corridor has potential for cultural resource impacts due to the location of the alternative along a major drainage with access to the Piceance Basin and Clear Creek.

It is likely that cultural resources exist in unstudied areas, particularly where topographic conditions are favorable for site location. Actual determination of impacts and mitigation measures are dependent upon the identification of sites during pre-construction surveys.

4.2.11 Land Use, Recreation, and Wilderness

4.2.11.1 Proposed Action

Land Use

The Getty resource property consists of 20,880 acres of predominately rangeland (Getty 1983a). The primary land use impacted by Getty's proposed action would be the loss of approximately 3,836 acres of rangeland from construction of mine facilities, process facilities, spent shale disposal in Wiesse Gulch, and the Tom Creek reservoir. No prime farmland and only a limited amount of agricultural land would be affected; therefore, impacts to agricultural lands are insignificant. In addition to activities analyzed in the CCSOP EIS (BLM 1983a), approximately 1,041 acres of rangeland and 2 acres of agricultural land would be disturbed by the construction of the Roan Creek/Clear Creek reservoir and various project corridors (product transport, utility, access, railroad, and water). These lands would essentially be lost as a resource for up to 33 years. Eventually the majority of this affected acreage would be returned to its original use.

Another land use impact resulting from placement of corridors could be the alteration of livestock movement patterns. Corridors could present physical barriers to livestock, and thus certain rangeland parcels could be used more or less intensely.

Because the proposed action should not significantly affect any agricultural lands, and because of the regional abundance of rangeland, direct land use impacts resulting from the proposed action are considered to be insignificant.

Table 2.3-2 lists the BLM-administered public land to be considered for land exchange, purchase, lease, or rights-of-way approval for the Getty project. These public lands could be subject to impacts due to corridor routing or construction of reservoirs in the parcels. None of the public lands cited are located in Recreation Management Areas or Wilderness Study Areas.

Potential impacts to public lands would generally be the same as those described for private lands throughout Section 4.2. In general, project activities within public land parcels would result in the loss of rangeland and vegetation resources. Wildlife habitat and wildlife use patterns in the immediate vicinity of the corridors and reservoirs could be expected to change. Sensitive wildlife habitat such as aspen stands, Douglas-fir stands, riparian areas, and cliffs, as well as big game winter range, could potentially be affected. Minimal effects to threatened or endangered wildlife and plants on public lands is expected.

Impacts to public lands would be detailed in a use application by Getty for BLM analysis of land-action alternatives (land exchange, land purchase, or Right-of-Way approval).

Recreation

The primary impact of the Getty proposed action on recreation would be increased numbers of people requiring recreational opportunities in the region. A detailed discussion of these regional impacts is presented in Section 4.1.11. Project-specific recreational impacts would be the removal of up to 3,843 acres of big game habitat. However, hunting in this area is limited by access. Thus, this adverse impact could be ameliorated by the fact that other areas, which could be relatively inaccessible at present, would be made more accessible by the construction of new corridors and access roads. Although such access could open up additional areas to hunting, it could also lead to an unpredictable increase in the incidence of poaching, trespassing, and off-road vehicle use. Access through corridors would be strictly controlled, thus the impacts would be minimized.

Wilderness

As a result of the proposed action, wilderness areas and wilderness study areas in the region could experience increased use. These effects are discussed in Section 4.1.11.

4.2.11.2 Alternatives

Land Use

The alternatives to the proposed action would yield less adverse impacts to land use than the proposed action. The 50,000-bpd alternative would affect less rangeland than the 100,000-bpd proposed action by eliminating the second retorting facility site (186 acres) and possibly requiring less surface area for spent shale disposal.

The alternative spent shale disposal sites in Tom Creek canyon, Buck Gulch, and Doe Gulch would have lesser land use impacts to rangeland than the proposed action (disposal in Wiesse Gulch) due to the fewer total acres disturbed. Land use impacts would be further minimized by the alternative of placing approximately 50 percent of the spent shale underground which would thus affect even less surface area. However, the small parcel of farmland found in the mouth of Tom Creek canyon would be more severely impacted if this area were used for retorted shale disposal as well as access roads.

The alternative West Fork of Parachute Creek reservoir and water pipeline corridor would affect approximately 532 acres of rangeland, an insignificant land use impact. Likewise, the Lurgi retort alternative, the Douglas Pass transmission corridor alternative, and on-site power generation alternative would have insignificant land use impacts in contrast to the proposed action.

Recreation and Wilderness

Direct impacts to wilderness areas and recreational impacts would be nearly identical to those described for the proposed action (Section 4.2.11.1). No notable changes are predicted.

4.2.11.3 Solid/Hazardous Wastes and Toxic Pollutants

Land use, recreation, and wilderness impacts resulting from the disposal of solid and hazardous wastes and toxic pollutants would be insignificant. Solid wastes would be disposed with spent shale on-site. Therefore, land use impacts of solid waste disposal would be the same as those associated with spent shale disposal. Hazardous wastes and toxic pollutants would be sent to an unspecified off-site licensed disposal facility, thus minimizing impacts on the site, but contributing in a cumulative sense to impacts elsewhere (see Section 4.4).

4.2.11.4 Secondary Impacts

Land Use

Indirect impacts to agricultural lands resulting from increased population growth could be as significant as direct project impacts. A population increase of up to 17,000 individuals is predicted (Sections 4.1.13 and 4.2.13). Using the BLM (1982a) figure of 0.22 acres affected per individual, approximately 3,740 acres of land could be affected by project-induced growth. The percentage of this total acreage that is presently cropland is unknown. However, as noted in Section 4.1.11, population-induced land use changes are most likely to impact areas which are also best suited for agriculture.

Project development could also reduce the amount of water available for irrigation. Essentially, Colorado River water potentially available for agricultural uses would be committed to industrial purposes. In addition, water obtained under Getty's water rights is presently used for irrigation purposes. Some of this water would be used for industrial purposes, further reducing the amount of irrigated farmland in the area.

Recreation and Wilderness

Secondary impacts to recreation and wilderness are the same as those described in Sections 4.1.11 and 4.2.11.1.

4.2.12 Visual Resources

4.2.12.1 Proposed Action

Assuming subsidence or caving of the room and pillar mine would not affect surface features, the visual impact of the mine would result from development of its surface facilities. For the Getty project, these facilities would be contiguous with process facilities. Impacts are therefore described below.

Clearing of the site area for construction of mine and process facilties would create a color (exposure of subsurface materials) and form (planar) impact. The mine, process, and support facility buildings would introduce box-like forms. Tanks, pipelines, and retort/upgrade facility structures would introduce linear and cylindrical forms. Conveyors, access roads, surface pipes and transmission lines would introduce linear forms. Exposed raw shale stockpiles would introduce form and color impacts. The colors of the surface facilities would contrast with the surrounding landscape. The impact of all facilities is expected to be significant for the life of the project. Following completion of reclamation activities at project closure, the long-term impact is expected to be insignificant to nondiscernable. All activities would not be observed from an existing public roadway, community, or recreational center. No important vista or visual feature would be affected by the site.

Disposal of spent shale at Wiesse Gulch would introduce a significant form and color impact to the plateau area. Although portions of the disposal area would be reclaimed as disposal activities advance on the plateau, the overall visual impact is expected to remain significant for the life of the project. Following completion of reclamation activities, the color impact would be eliminated. The form of the site would be permanently altered, but the form change is not expected to be a significant long-term impact. The site is not visible from an existing public roadway, community, or recreation center. No important vista or visual feature would be affected by the site.

Impacts of the GCC water system have been addressed in BLM (1983a). However, the Getty project includes two additional reservoirs which require further analysis: the Roan Creek reservoir at the confluence of Roan and Clear Creeks and the Tom Creek reservoir. These reservoirs would have positive or negative impacts depending on operational characteristics. When filled, the reservoirs would have a beneficial impact since they would contribute to overall visual quality. During operations when water is withdrawn, the exposure of banks and the reservoir bottom would have an adverse visual impact. This impact is considered to be insignificant, however. The Roan Creek/Clear Creek reservoir site could be observed by the general public. The Tom Creek reservoir site would be in an area currently of limited access.

The product transport corridor traverses gently rolling terrain. Assuming proper mitigation, the linear impact of constructing this corridor is expected to be insignificant.

Those portions of utility and water supply pipeline corridors that traverse flat to rolling terrain are not expected to have significant linear impacts, assuming proper reclamation. Those portions of the corridors that traverse cliff faces would have a significant visual impact due to line and color contrasts and the difficulty of reclaiming the cliff faces.

Although the proposed access road follows the contour of Tom Creek gulch as it rises from Clear Creek canyon, road construction is expected to have a significant visual impact. The road and cut and fill activities would introduce significant form, line, and color impacts to the cliff area. Due to reclamation difficulties, these impacts are expected to remain following project closure.

The railroad is expected to have a linear impact that would complement existing line on the valley floor. Impact is therefore expected to be insignificant.

4.2.12.2 Alternatives

The 50,000-bpd alternative involves mine and process facilities at one site only. Therefore, overall visual resource impacts of the facility sites are expected to be reduced by one-half. The impact to the developed site would remain significant, however.

Differing surface process alternatives are not expected to affect visual resources. Overall impact for each is expected to remain significant.

Disposal of spent shale in either Tom Gulch, Buck Gulch, or Doe Gulch would have a greater adverse visual resource impact than in Wiesse Gulch due to the higher scenic quality of the Canyon character type. Spent shale disposal in the gulches would create a greater color and form contrast than on the plateau.

Use of the Big Salt Wash corridor for a transmission line would have less visual impacts since the corridor would not involve traversing steep cliff faces. Assuming proper siting and reclamation, the impact is expected to be insignificant. This corridor and the Rangely Corridor have been previously assessed (BLM 1983a).

Power generation facilities on site for cogeneration would introduce additional form, line, and color impacts on the plateau. This impact would contribute to the already existing significant impact due to mine and process facilities on the plateau.

Impacts due to the Parachute Creek reservoir would be similar to those of the Tom Creek reservoir.

4.2.12.3 Solid/Hazardous Wastes and Toxic Pollutants

Solid non-hazardous materials would be disposed in the spent shale areas. Disposal of such would not appreciably affect visual resources beyond that of the spent shale previously addressed. Disposal of hazardous materials will be done at a licensed off-site facility, thus not affecting visual resources of the project area.

4.2.12.4 Secondary Impacts

Secondary impacts due to employee housing, community and commercial facilities, powerlines, and roads would have a significant impact on the Roan Creek and Colorado River valleys (De Beque, Parachute, and Battlement Mesa areas). The rural and agrarian setting of the valleys would be altered to that of a more urban environment. Degree of impact would depend on the architecture, layout, and landscaping of the new communities.

4.2.13 Socioeconomics

The study area analyzed for evaluation of Getty project impacts includes Garfield and Mesa counties; the time-period covered is from the present through construction to full operation at 100,000 bpd. Because construction is incremental, inferences can also be drawn from the analysis relevant to production at the alternative 50,000-bpd rate. Allocations of probable effects are made to the study area as a whole and to the significant jurisdictions and communities. Projections are made for the "no action" and for the "with the Getty project" alternatives. Impacts are defined as the difference betweeen these two scenarios. The quantified projections are based upon output from the Planning and Assessment System (PAS) and FisPlan (MWR 1982; CITF 1982). The major subject areas covered are: economic, demographic, housing, public facilities and services, fiscal, and social impacts. The following impact discussions are summarized from a detailed technical report prepared by Mountain West Research-Southwest, Inc. (MWSW 1983), which is herein incorporated by reference.

4.2.13.1 Direct Project Employment, Wages, and Purchases

For this analysis the Getty project is scheduled to begin in 1987 and reach full (100,000 bpd) operation by 1997. Information on employment, wages, and local purchases was supplied by Getty and is presented in Table 4.2-19.

Construction is expected to take 9 years with peak employment of 5,000 occurring twice, in 1991 and 1995. Operation employment begins at 300 in 1989 and rises rapidly to 1,600 by 1991. Full operation employment is estimated at 2,900, a figure which is reached in 1997 and maintained through the remainder of the projection period. Total employment (construction plus operation) peaks twice, in 1991 at 6,600 and in 1995 at 7,200.

A 50,000-bpd alternative would eliminate the second construction cycle shown in Table 4.2-19. Thus, under a 50,000-bpd alternative, the employment requirements would be the same as for the 100,000-bpd alternative through 1991. After that, the construction workforce would be 0 and operations employment would stabilize at 1,600, about 55 percent of the operating employment of the 100,000-bpd scenario. In general, therefore, a 50,000 bpd alternative analysis would be as presented in Section 4.2.13.9 (i.e., the 1987-1991 impacts indicate construction period impacts for a 50,000 bpd alternative). Operations impacts can be approximated as one-half of those shown for the 100,000-bpd scenario.

Wages are calculated, using CITF standard rates, at $34,400 annually for construction workers and $32,600 annually for operation workers (in 1982 dollars). The pattern of wages paid follows the pattern of employment; peak years are 1991 and 1995 when the annual amounts total $224 million and $243 million, respectively. Annual wages paid during full operation are estimated to be $94.5 million.

Local purchase estimates are benchmarked to employment. Construction purchases are estimated at $49,000 per man year of employment; for operations the figure is $20,000. Like employment and wages, purchases peak in 1991 and 1995; the respective estimates are $277 million and $289 million. Annual local purchases during full scale operation are estimated at $58 million.

4.2.13.2 Residential Allocation of Work Force

Table 4.2-20 shows the residential allocation of the direct basic employment. This includes the construction and operation work forces. The construction work force is divided into the local and nonlocal components; 35 percent of the construction employment is estimated to come from the local study area and 65 percent is estimated to come from outside the study area. About 62 percent of the local construction workers are expected to come from Garfield County with the remaining portion residing in Mesa County. For the nonlocal workers, over 80 percent are expected to reside in Garfield County during the work week and just under 20 percent are assigned to Mesa County. The Getty single-status camp is expected to provide housing for 49 percent of the non-local workers. Battlement Mesa would house the next largest proportion, about 23 percent. In Mesa County, the Grand Junction area would account for the greatest proportion of the county total, 28 percent of the local and 14 percent of the nonlocal construction workers.

Table 4.2-19 GETTY PROJECT EMPLOYMENT, WAGES, AND LOCAL PURCHASES

	Employment			Total Wages[a]			Local Purchases[a]		
Year	Construction	Operation	Total	Construction	Operation	Total	Construction	Operation	Total
1987	100	--	100	3,440	--	3,440	4,900	--	4,900
1988	1,300	--	1,300	44,720	--	44,720	63,700	--	63,700
1989	2,500	300	2,800	86,000	9,780	95,780	122,500	6,000	128,500
1990	3,700	1,000	4,700	127,280	32,600	159,880	181,600	20,000	201,600
1991	5,000	1,600	6,600	172,000	52,160	224,160	245,000	32,000	277,000
1992	2,500	1,600	4,100	86,000	52,160	138,160	122,500	32,000	154,500
1993	2,500	1,600	4,100	86,000	52,160	138,160	122,500	32,000	154,500
1994	3,700	1,900	5,600	127,280	61,940	189,220	181,600	38,000	219,600
1995	5,000	2,200	7,200	172,000	71,720	243,720	245,000	44,000	289,000
1996	1,300	2,600	3,900	44,720	84,760	129,480	63,700	52,000	115,700
1997	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000
1998	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000
1999	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000
2000	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000
2001	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000
2002	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000
2003	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000
2004	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000
2005	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000
2006	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000
2007	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000
2008	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000
2009	--	2,900	2,900	--	94,540	94,540	--	58,000	58,000

Source: Getty (1983b).

[a] Thousands of 1982 dollars.

Table 4.2-20 RESIDENTIAL ALLOCATION OF GETTY PROJECT WORK FORCE

	Construction[a]		Operation
Place	Local	Non Local	Local
Garfield County	.620	.806	.620
Battlement Mesa	.450	.230	.450
Parachute Area	.050	.025	.050
Rifle Area	.120	.061	.120
Getty Single Status Camp	--	.490	--
Mesa County	.380	.194	.380
De Beque	.050	.025	.050
Grand Junction Area	.280	.143	.280
Palisade	.030	.016	.030
Fruita	.020	.010	.020

Source: CITF (1983); Getty (1983b); and Mountain West Research - Southwest, Inc. (1983).

[a] The local construction work force comprises 35 percent and the non local 65 percent of the total construction employment.

During operations, 62 percent of the work force is estimated to reside in Garfield County with 45 percent assigned to Battlement Mesa. Mesa County is projected to be the residential location of 38 percent with 28 percent in the Grand Junction area.

The allocation of workers was made by Mountain West Research-Southwest based upon information contained in descriptions made by other oil shale proposals and the location of the Getty resource site.

4.2.13.3 Study Area Employment and Income

In order to account for all the employment and income effects in the study area, two categories of economic activity are defined basic and non-basic. Basic employment and income are created by demand from outside the study area, such as that resulting from the Getty project. As the basic income is spent and respent in the study area, additional jobs and income are created which are called non-basic. The ratio of basic to non-basic employment and income depends upon the ability of the local areas to provide the required goods and services. The Planning and Assessment System (PAS) has determined the basic and non-basic ratios for each economic sector by county. The model allows the analyst to estimate the size, duration, and location (by economic sector) of the non-basic response to significant changes in basic income.

The "no action" alternative (without the Getty project) incorporated a number of assumptions about future growth in the study area. The Basic Activity System (BAS) file used for the Getty projections is the CITF version as of May 1983, with an updating of the labor force participation rates to conform to data from the 4th count tapes, 1980 U.S. Census. Except for the modification to the labor force participation rates, this baseline description is the same as the one used for the Mobil and Pacific projects (Higgins 1983; Taylor 1983). Assumptions were made for basic employment in Garfield and Mesa counties for each of the economic sectors, agriculture, services, etc. In addition, information for specific types of activity was included. These included activities for conventional oil and gas, coal, uranium, water projects, utilities such as electric power generation, and their associated facilities. The only oil shale project in "no action" baseline projections was Union I at 10,000 bpd. The guidelines for including projects was conservative; that is, only projects in progress or projects for which firm commitments have been made were included.

Local purchases, which affect basic and non-basic employment and income, were provided by Getty. The economic sector distribution was estimated by Mountain West Research based upon information contained in documents on other oil shale projects in the same area. The spatial distribution used assumptions formulated by the CITF. These assumptions were incorporated in the PAS model programming.

Employment

The employment impacts are defined as the difference between the projections for the "no action" and the "with the Getty project" alternatives. This includes basic and non-basic jobs. In Table 4.2-21, total employment is shown for Garfield County, Mesa County, and the two-county study area.

Peak study area employment impacts are projected for 1991 and 1995. In 1991 the employment for the "no action" alternative is projected to be 53,895; for the "with project" alternative it would be 66,046. The impacts are estimated at 12,150 or 22.5 percent more than the "no action" alternative. During operation the employment impact would be about 6,000 or approximately 10 percent greater than for the "no action" case.

The impacts for Garfield County would be more significant than for Mesa County. This would occur because Garfield County would receive about half the employment, but it has a smaller employment base so the percentage of increase with the project would be substantially greater.

Mesa County accounts for slightly more of the construction period employment impacts and almost as much as the operations period employment impacts as Garfield County does. At peak employment in 1991 and 1995, the employment impacts for Mesa County are 6,442 and 6,860. The figure during operation is about 2,900. However, these impacts are a much smaller proportion of the "no action" alternative baseline figures. The increase is about 16 percent in 1991, 16 percent in 1995, and 6 percent during operation. The location of most of the employment impacts would be in the Grand Junction area, the service and trade center for the study area.

Table 4.2-21 SUMMARY OF EMPLOYMENT IMPACTS BY COUNTY FOR THE GETTY PROJECT

	Garfield County				Total Garfield & Mesa				Mesa County			
			Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	11,306	11,306	0	0	47,908	47,908	0	0	36,602	36,602	0	0
1981	13,401	13,401	0	0	52,277	52,277	0	0	38,876	38,876	0	0
1982	14,890	14,890	0	0	54,683	54,683	0	0	39,793	39,793	0	0
1983	14,016	14,016	0	0	53,227	53,227	0	0	39,211	39,211	0	0
1984	12,663	12,663	0	0	51,053	51,053	0	0	38,390	38,390	0	0
1985	12,630	12,630	0	0	51,296	51,296	0	0	38,666	38,666	0	0
1986	12,470	12,470	0	0	51,727	51,727	0	0	39,257	39,257	0	0
1987	12,592	12,519	73	0	52,728	52,569	159	0	40,136	40,050	86	0
1988	13,570	12,602	967	7	55,473	53,374	2,098	3	41,903	40,772	1,131	2
1989	14,954	12,691	2,262	17	58,843	54,035	4,808	8	43,890	41,344	2,545	6
1990	16,751	12,783	3,968	31	62,512	54,030	8,481	15	45,760	41,247	4,513	10
1991	18,564	12,856	5,708	44	66,046	53,895	12,150	22	47,482	41,039	6,442	15
1992	17,039	12,929	4,110	31	62,863	54,450	8,413	15	45,825	41,521	4,303	10
1993	16,852	13,005	3,846	29	62,840	54,936	7,903	14	45,988	41,931	4,056	9
1994	18,070	13,082	4,987	38	65,552	55,239	10,313	18	47,483	42,157	5,325	12
1995	19,553	13,161	6,391	48	68,874	55,622	13,252	23	49,321	42,461	6,860	16
1996	17,482	13,244	4,237	32	64,470	56,033	8,436	15	46,988	42,789	4,198	9
1997	16,527	13,329	3,197	24	62,678	56,453	6,224	11	46,151	43,125	3,026	7
1998	16,482	13,419	3,062	22	62,838	56,879	5,958	10	46,356	43,460	2,896	6
1999	16,562	13,507	3,054	22	63,263	57,322	5,940	10	46,701	43,815	2,886	6
2000	16,657	13,600	3,057	22	63,686	57,738	5,947	10	47,029	44,139	2,890	6
2001	16,752	13,691	3,061	22	63,931	57,975	5,956	10	47,179	44,284	2,894	6
2002	16,849	13,783	3,065	22	64,164	58,199	5,964	10	47,315	44,415	2,899	6
2003	16,949	13,879	3,069	22	64,403	58,428	5,974	10	47,454	44,549	2,904	6
2004	17,053	13,979	3,073	22	64,652	58,668	5,984	10	47,600	44,689	2,910	6
2005	17,161	14,083	3,078	21	64,913	58,919	5,994	10	47,753	44,836	2,916	6
2006	17,273	14,191	3,082	21	65,186	59,182	6,004	10	47,913	44,991	2,921	6
2007	17,391	14,304	3,086	21	65,471	59,457	6,014	10	48,081	45,153	2,927	6
2008	17,514	14,423	3,091	21	65,771	59,746	6,024	10	48,258	45,324	2,933	6
2009	17,641	14,546	3,094	21	66,082	60,048	6,034	10	48,441	45,502	2,939	6

Source: Mountain West Research - Southwest, Inc. (1983).

[a] Percentages less than 1.0 are reported as 0.

Income

The labor income impacts are displayed in Table 4.2-22. As in the case of employment, the impacts are calculated as the difference between the "no action" and the "with the Getty Project" alternatives. The overall pattern of the income impacts is quite similar to that shown for the employment impacts. The variations that are noticeable are due to differential pay rates between economic sectors. In particular, the pay rates for the construction and mining sectors are significantly higher than those paid in the trade and service sectors, and higher than the averages paid for the "no action" alternative. As a result, the proportional impacts for income are somewhat higher than those recorded for the employment impacts. This holds true for the study area as a whole because the wage rates for the project workers are substantially higher than the average for the two counties. A similar result also applies to certain communities where the lower paying non-basic jobs are concentrated.

Table 4.2-22 SUMMARY OF LABOR INCOME IMPACTS BY COUNTY FOR THE GETTY PROJECT

(in thousands of 1982 dollars)

	Garfield County				Total Garfield & Mesa				Mesa County			
			Impact				Impact				Impact	
Year	With Project	No Action	Difference	%[a]	With Project	No Action	Difference	%[a]	With Project	No Action	Difference	%[a]
1980	167,126	167,126	0	0	746,134	746,134	0	0	597,008	579,008	0	0
1981	230,084	230,084	0	0	864,981	864,981	0	0	634,898	634,898	0	0
1982	256,627	256,627	0	0	902,228	902,228	0	0	645,601	645,601	0	0
1983	238,076	238,076	0	0	871,400	871,400	0	0	633,325	633,325	0	0
1984	210,779	210,779	0	0	829,511	829,511	0	0	618,731	618,731	0	0
1985	210,587	210,587	0	0	835,045	835,045	0	0	624,458	624,458	0	0
1986	206,232	206,232	0	0	841,615	841,615	0	0	635,383	635,383	0	0
1987	208,559	206,873	1,685	0	860,667	857,369	3,298	0	652,108	650,496	1,612	0
1988	230,538	208,153	22,384	10	915,849	872,324	43,525	5	685,311	664,170	21,141	3
1989	261,955	209,519	52,435	25	984,349	883,548	100,800	11	722,394	674,029	48,365	7
1990	304,001	210,933	93,068	44	1,063,025	883,674	179,351	20	759,024	672,741	86,283	12
1991	345,704	211,968	133,735	63	1,138,567	881,367	257,200	29	792,863	669,399	123,464	18
1992	307,768	212,985	94,783	44	1,068,511	890,020	178,491	20	760,742	677,035	83,706	12
1993	304,745	214,049	90,695	42	1,068,532	897,633	170,899	19	763,788	683,584	80,203	11
1994	333,463	215,124	118,339	55	1,125,794	901,532	223,261	24	792,331	687,409	104,922	15
1995	366,869	216,228	150,641	69	1,193,444	908,644	284,799	31	826,574	692,416	134,158	19
1996	317,848	217,384	100,463	46	1,100,761	915,165	185,595	20	782,913	697,781	85,131	12
1997	298,698	218,559	80,138	36	1,067,325	921,835	145,489	15	768,627	703,276	65,350	9
1998	297,866	219,822	78,043	35	1,069,564	928,598	140,966	15	771,699	708,775	62,923	8
1999	298,876	221,040	77,836	35	1,076,317	935,608	140,708	15	777,442	714,569	62,872	8
2000	302,243	222,329	77,914	35	1,083,099	942,261	140,837	14	782,856	719,932	62,923	8
2001	301,548	223,574	77,974	34	1,084,426	943,528	140,897	14	782,878	719,954	62,923	8
2002	302,878	224,844	78,034	34	1,085,761	944,804	140,956	14	782,882	719,960	62,922	8
2003	304,252	226,153	78,098	34	1,087,129	946,108	141,021	14	782,877	719,955	62,922	8
2004	305,678	227,513	78,165	34	1,088,550	947,462	141,087	14	782,872	719,949	62,922	8
2005	307,166	228,935	78,230	34	1,090,031	948,878	141,152	14	782,866	719,943	62,922	8
2006	308,719	230,423	78,296	34	1,091,580	950,362	141,217	14	782,860	719,938	62,922	8
2007	310,340	231,977	78,363	33	1,093,195	951,911	141,284	14	781,856	719,934	62,921	8
2008	312,036	233,606	78,430	33	1,094,877	953,535	141,352	14	782,851	719,929	62,921	8
2009	313,791	135,300	78,491	33	1,096,639	955,226	141,412	14	782,848	719,926	62,921	8

Source: Mountain West Research - Southwest, Inc. (1983).

[a] Percentages less than 1.0 are reported as 0.

4.2.13.4 Population

Changes in population are brought about by births, deaths and migration. Projections of births and deaths are made using rates of change, which in this case were developed in cooperation with the CITF and reviewed by local officials. A natural increase or decrease results from the application of these rates to the population base of the study area. Migration, which includes consideration of employment on nonemployment components, accounts for population change due to people moving into or out of the area. Project-related in-migration is directly tied to the employment effects and conditions in the local labor force. Diminished out-migration due to the ability of local residents to obtain jobs in the study area, instead of moving, also contributes to a positive population impact. In addition to accounting for the workers, members of their households who move with them must also be included in population figures.

The distribution of population impacts to communities takes into account the location of the jobs, the commuting patterns of workers, and the available housing for households. Direct basic workers are allocated as shown in Table 4.2-20. Indirect basic employment is created by the local purchases made on behalf of the project, and these jobs are located at various work sites depending upon the goods or services that are purchased. Non-basic work is located in the market and trade centers. A commuter matrix was used to identify the residential locations of the indirect basic and the non-basic workers.

The population projections for the "no action" and the "with Getty" alternatives are shown in Table 4.2-23. The data show the figures for the study area, for the two counties, and for the significant jurisdictions. Also shown are the impacts, defined as the difference between the "no Action" and the "with Getty" alternatives.

The population increase for the study area between 1980 and 2009 with the "no action" alternative would be 20,563, an 0.5 percent average annual rate of increase. Garfield County showed rapid increases for 1981 and 1982 during the recent oil shale development period, with a pattern of decline until 1986 and slow annual increases after that year. The population projection for 2009 is 29,420 with the "no action" alternative, slightly lower than the figure of 29,478 which was recorded for 1982. This is, for all practical purposes, a no-growth scenario.

The "no action" projections for Mesa County estimate only small annual rates of increase, about 0.3 percent for the period 1982 to 2009. The total population would be 95,186, a numerical increase of about 7,700 for the 28-year period.

The population impacts for the entire study area with the Getty project are estimated to be 17,419 at peak construction in 1995, a 14 percent increase over the "no action" case. The impacts would be over 12,000 or about 10 percent during operation. This is a significant increase for the "with Getty" project alternative, the average annual rate of change between 1982 and 2009 is about triple that of the "no action" alternative.

4.2.13.5 Housing

The housing demand (the total number of housing units required at any point in time) is tied to the population increases that have been forecast with the Getty project. Housing supply is provided by utilization of the existing capacity and by the construction of new units. The infrastructure of services to the housing sector is important in determining the location of new housing; the availability of water, wastewater treatment, utilities, streets, roads and highways, schools and other public services, all play important roles. The current housing conditions are described in Section 3.1.13.4. The private sector response to housing demand resulting from the oil shale projects began during the late 1970's and then terminated in mid- 1982 produced an excess capacity in the study area (DRI 1983). In particular, there was the development of Battlement Mesa as a major population center designed for housing people associated with oil shale projects in the area. Given the current surplus of housing accommodations and readily developable property (i.e., Battlement Mesa), the demand created by any major new project would make a positive contribution to the housing sector of the local economy.

The housing demand forecast for the study area communities does not include the Single Status Camp which is expected to house about 49 percent of the non-local workers during the construction period. This means the camp would accommodate almost 1,600 workers at peak construction, and these people are not distributed to the local communities as population who would create housing demand.

The future housing demand is derived from the population impacts. The total number of people, the age structure, and the household size determine the total number of households requiring housing units. The mix of units (single family, multifamily, and mobile homes) is estimated from past experience, distribution of the demand both geographically and over time, and descriptions of the development potential. Table 4.2-24 presents a summary of housing demand for the "no action" and the "with Getty" alternatives. The first two columns show demand for the two alternatives. The impact columns show the difference between the housing demand for the two alternatives and the percent of increased demand "with Getty" as compared to the "no action" case.

The housing demand impacts for the study area are expected to peak in 1995 at 6,895 units, an increase of 12 percent over the "no action" alternative. During operation, the demand impact is forecast to range between 5,332 and 5,134, a proportional increase of 9 to 10 percent. The housing mix is expected to gradually shift for the "no action" and the "with Getty" alternatives with the single family proportion declining from about 65.4 percent in 1983 to 60.9 percent by the year 2009. Mobile homes would hold a constant percent in 1983 to 24.7 percent in 2009. The average annual rate of change for the projection period would be almost a third higher for the "with Getty" alternative (1.3 percent) as compared to the "no action" case (1.0 percent).

Table 4.2-23 SUMMARY OF POPULATION IMPACTS BY JURISDICTION FOR THE GETTY PROJECT

	Garfield County				Carbondale				Glenwood Springs				New Castle			
			Impact				Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	22,514	22,514	0	0	1,997	1,997	0	0	4,637	4,637	0	0	563	563	0	0
1981	27,054	27,054	0	0	2,317	2,317	0	0	5,082	5,082	0	0	623	623	0	0
1982	29,478	29,478	0	0	2,381	2,381	0	0	5,165	5,165	0	0	677	677	0	0
1983	28,081	28,081	0	0	2,431	2,431	0	0	5,214	5,214	0	0	656	656	0	0
1984	27,132	27,132	0	0	2,468	2,468	0	0	5,237	5,237	0	0	647	647	0	0
1985	27,380	27,380	0	0	2,502	2,502	0	0	5,276	5,276	0	0	653	653	0	0
1986	27,176	27,176	0	0	2,516	2,516	0	0	5,288	5,288	0	0	652	652	0	0
1987	27,413	27,294	119	0	2,545	2,540	4	0	5,319	5,310	8	0	642	619	23	3
1988	28,229	27,456	773	2	2,572	2,565	6	0	5,347	5,335	11	0	646	622	24	3
1989	29,651	27,610	2,040	7	2,640	2,589	50	1	5,428	5,359	69	1	659	625	33	5
1990	32,959	27,755	5,204	18	2,812	2,611	200	7	5,650	5,380	270	5	695	628	66	10
1991	35,735	27,883	7,852	28	2,945	2,632	313	11	5,812	5,398	414	7	722	630	91	14
1992	34,470	27,998	6,472	23	2,956	2,651	305	11	5,808	5,413	395	7	722	632	89	14
1993	34,587	28,101	6,485	23	2,972	2,668	304	11	5,817	5,426	390	7	723	634	89	14
1994	35,321	28,191	7,130	25	2,987	2,683	303	11	5,824	5,437	386	7	724	635	89	14
1995	36,933	28,268	8,664	30	3,050	2,697	353	13	5,895	5,444	450	8	737	636	100	15
1996	34,989	28,290	6,698	23	3,056	2,705	351	13	5,886	5,445	440	8	736	636	99	15
1997	34,829	28,326	6,503	23	3,098	2,714	384	14	5,975	5,447	528	9	746	636	109	17
1998	34,640	28,374	6,266	22	3,077	2,725	352	12	5,941	5,449	492	9	740	637	103	16
1999	34,736	28,415	6,320	22	3,091	2,734	356	13	5,949	5,450	498	9	741	637	104	16
2000	34,813	28,454	6,358	22	3,102	2,743	359	13	5,954	5,451	503	9	742	637	105	16
2001	34,895	28,493	6,402	22	3,113	2,751	362	13	5,960	5,452	507	9	744	638	106	16
2002	34,974	28,532	6,441	22	3,124	2,759	364	13	5,965	5,453	512	9	745	638	106	16
2003	35,050	28,572	6,478	22	3,134	2,767	366	13	5,970	5,454	515	9	746	638	107	16
2004	35,123	28,611	6,512	22	3,143	2,775	368	13	5,974	5,456	518	9	747	639	108	16
2005	35,193	28,650	6,544	22	3,152	2,782	370	13	5,977	5,456	520	9	748	639	108	17
2006	35,262	28,687	6,574	22	3,161	2,790	371	13	5,981	5,458	523	9	749	639	109	17
2007	35,328	28,722	6,605	23	3,169	2,797	372	13	5,983	5,458	524	9	749	640	109	17
2008	35,388	28,962	6,425	22	3,177	2,829	348	12	5,984	5,512	472	8	750	650	100	15
2009	35,443	29,420	6,022	20	3,183	2,887	296	10	5,985	5,623	361	6	751	669	81	12

Table 4.2-23 SUMMARY OF POPULATION IMPACTS BY JURISDICTION FOR THE GETTY PROJECT (continued)

	Parachute				Rifle				Silt				Battlement Mesa AA			
			Impact				Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	331	331	0	0	3,215	3,215	0	0	923	923	0	0	416	416	0	0
1981	779	779	0	0	4,618	4,618	0	0	1,115	1,115	0	0	853	853	0	0
1982	1,071	1,071	0	0	5,112	5,112	0	0	1,185	1,185	0	0	1,733	1,733	0	0
1983	837	837	0	0	4,850	4,850	0	0	1,149	1,149	0	0	831	831	0	0
1984	586	586	0	0	4,444	4,444	0	0	1,123	1,123	0	0	820	820	0	0
1985	588	588	0	0	4,483	4,483	0	0	1,131	1,131	0	0	830	830	0	0
1986	575	575	0	0	4,460	4,460	0	0	1,127	1,127	0	0	601	601	0	0
1987	582	578	3	0	4,504	4,486	18	0	1,134	1,133	1	0	639	599	40	6
1988	621	581	39	6	4,656	4,512	143	3	1,141	1,139	2	0	1,101	598	502	84
1989	685	585	100	17	4,948	4,537	410	9	1,160	1,144	15	1	1,790	597	1,192	199
1990	828	587	240	41	5,669	4,561	1,108	24	1,212	1,150	61	5	3,280	397	2,683	449
1991	952	590	361	61	6,276	4,582	1,693	37	1,251	1,155	96	8	4,605	597	4,008	671
1992	880	593	287	48	6,033	4,602	1,431	31	1,252	1,159	93	8	3,669	596	3,072	515
1993	884	595	289	48	6,057	4,620	1,436	31	1,256	1,163	92	8	3,691	596	3,095	518
1994	924	597	326	54	6,199	4,635	1,564	33	1,259	1,167	92	7	4,173	596	3,576	599
1995	1,002	600	401	66	6,550	4,649	1,900	40	1,278	1,170	107	9	5,030	596	4,343	743
1996	893	601	292	48	6,178	4,655	1,522	32	1,278	1,172	106	9	3,621	595	3,026	508
1997	867	603	263	43	6,117	4,662	1,454	31	1,296	1,174	122	10	3,150	594	2,556	430
1998	866	605	260	43	6,066	4,672	1,394	29	1,290	1,176	113	9	3,119	594	2,525	424
1999	870	607	262	43	6,087	4,680	1,406	30	1,293	1,178	115	9	3,133	594	2,539	427
2000	873	609	263	43	6,104	4,689	1,414	30	1,296	1,180	116	9	3,146	594	2,551	428
2001	877	612	265	43	6,122	4,698	1,424	30	1,299	1,182	117	9	3,160	595	2,564	430
2002	881	614	266	43	6,139	4,706	1,432	30	1,302	1,184	118	10	3,174	596	2,578	432
2003	884	616	268	43	6,157	4,716	1,441	30	1,305	1,186	118	10	3,189	597	2,591	434
2004	888	619	269	43	6,174	4,725	1,448	30	1,307	1,188	119	10	3,204	598	2,605	435
2005	892	621	270	43	6,190	4,734	1,455	30	1,310	1,190	119	10	3,220	599	2,620	436
2006	896	624	272	43	6,207	4,744	1,462	30	1,312	1,192	120	10	3,236	601	2,634	438
2007	900	626	273	43	6,223	4,753	1,470	30	1,315	1,194	120	10	3,252	602	2,650	439
2008	904	634	269	42	6,238	4,802	1,435	29	1,317	1,208	108	9	3,270	607	2,663	438
2009	908	647	260	40	6,252	4,894	1,357	27	1,318	1,236	82	6	3,288	615	2,673	434

Table 4.2-23 SUMMARY OF POPULATION IMPACTS BY JURISDICTION FOR THE GETTY PROJECT (continued)

	Mesa County				Grand Junction				Palisade				Fruita			
			Impact				Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	81,530	81,530	0	0	28,143	28,143	0	0	1,551	1,551	0	0	2,810	2,810	0	0
1981	86,100	86,100	0	0	29,915	29,915	0	0	1,751	1,751	0	0	2,990	2,990	0	0
1982	87,479	87,479	0	0	30,349	30,349	0	0	1,825	1,825	0	0	3,059	3,059	0	0
1983	87,936	87,936	0	0	30,554	30,554	0	0	1,776	1,776	0	0	3,077	3,077	0	0
1984	88,494	88,494	0	0	30,778	30,778	0	0	1,734	1,734	0	0	3,072	3,072	0	0
1985	88,631	88,631	0	0	30,995	30,995	0	0	1,746	1,746	0	0	3,060	3,060	0	0
1986	89,621	89,621	0	0	31,441	31,441	0	0	1,764	1,764	0	0	3,074	3,074	0	0
1987	90,682	90,652	29	0	31,871	31,856	14	0	1,784	1,781	2	0	3,112	3,111	1	0
1988	91,896	91,507	388	0	32,377	32,187	189	0	1,830	1,795	34	1	3,163	3,141	21	0
1989	93,049	92,302	747	0	32,861	32,496	365	1	1,876	1,808	67	3	3,212	3,170	41	1
1990	96,188	92,131	4,057	4	34,092	32,331	1,761	5	2,017	1,800	216	12	3,334	3,168	166	5
1991	98,818	91,355	7,463	8	35,110	31,884	3,226	10	2,141	1,782	359	20	3,436	3,153	283	9
1992	98,683	91,850	6,832	7	34,970	32,059	2,911	9	2,085	1,787	297	16	3,418	3,171	246	7
1993	99,249	92,303	6,945	7	35,174	32,215	2,958	9	2,095	1,793	302	16	3,440	3,189	250	7
1994	100,126	92,232	7,894	8	35,535	32,116	3,419	10	2,136	1,792	343	19	3,481	3,201	279	8
1995	100,989	92,234	8,755	9	35,895	32,147	3,747	11	2,179	1,785	394	22	3,522	3,206	316	9
1996	100,312	92,550	7,762	8	35,507	32,252	3,255	10	2,088	1,788	300	16	3,479	3,221	258	8
1997	98,328	92,829	5,499	5	34,665	32,344	2,320	7	1,997	1,790	207	11	3,409	3,234	174	5
1998	98,640	93,077	5,562	6	34,771	32,425	2,346	7	2,001	1,792	209	11	3,424	3,247	176	5
1999	98,916	93,296	5,619	6	34,865	32,495	2,370	7	2,005	1,793	211	11	3,438	3,259	178	5
2000	99,162	93,492	5,669	6	34,949	32,558	2,391	7	2,008	1,795	213	11	3,451	3,271	180	5
2001	99,392	93,679	5,713	6	35,026	32,616	2,410	7	2,010	1,796	214	12	3,463	3,282	181	5
2002	99,615	93,862	5,753	6	35,102	32,674	2,427	7	2,013	1,796	216	12	3,476	3,293	182	5
2003	99,834	94,045	5,788	6	35,175	32,732	2,443	7	2,015	1,798	217	12	3,488	3,305	183	5
2004	100,054	94,233	5,821	6	35,249	32,791	2,458	7	2,018	1,799	219	12	3,501	3,316	184	5
2005	100,276	94,424	5,851	6	35,325	32,852	2,472	7	2,021	1,800	220	12	3,514	3,328	185	5
2006	100,500	94,618	5,881	6	35,400	32,914	2,486	7	2,024	1,802	222	12	3,526	3,340	186	5
2007	100,724	94,813	5,910	6	35,477	32,977	2,500	7	2,027	1,803	223	12	3,539	3,352	187	5
2008	100,944	95,004	5,939	6	35,552	33,038	2,514	7	2,030	1,805	225	12	3,552	3,364	188	5
2009	101,155	95,186	5,969	6	35,624	33,096	2,527	7	2,033	1,806	226	12	3,565	3,376	188	5

Table 4.2-23 SUMMARY OF POPULATION IMPACTS BY JURISDICTION FOR THE GETTY PROJECT (concluded)

	De Beque				Collbran				Total Garfield and Mesa Counties			
			Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	279	279	0	0	342	342	0	0	104,044	104,044	0	0
1981	313	313	0	0	352	352	0	0	113,154	113,154	0	0
1982	349	349	0	0	352	352	0	0	116,956	116,956	0	0
1983	318	318	0	0	352	352	0	0	116,017	116,017	0	0
1984	321	321	0	0	352	352	0	0	115,626	115,626	0	0
1985	323	323	0	0	352	352	0	0	116,011	116,011	0	0
1986	325	325	0	0	352	352	0	0	116,797	116,797	0	0
1987	328	327	1	0	352	352	0	0	118,095	117,946	149	0
1988	349	328	21	6	352	352	0	0	120,125	118,964	1,161	1
1989	370	330	40	12	352	352	0	0	122,700	119,912	2,788	2
1990	482	331	150	45	357	352	5	1	129,147	119,885	9,262	7
1991	584	332	252	75	361	351	9	2	134,553	119,238	15,315	12
1992	547	333	213	64	361	351	9	2	133,153	119,848	13,304	11
1993	551	335	216	64	361	351	10	2	133,835	120,404	13,431	11
1994	574	336	238	71	360	350	10	2	135,447	120,423	15,024	12
1995	598	335	263	78	360	349	11	3	137,922	120,502	17,419	14
1996	541	336	205	61	360	348	11	3	135,301	120,840	14,460	12
1997	504	336	167	49	354	347	7	2	133,157	121,155	12,002	9
1998	506	337	169	50	354	347	7	2	133,280	121,451	11,829	9
1999	508	337	171	50	353	346	7	2	133,651	121,711	11,940	9
2000	510	338	172	51	352	345	7	2	133,974	121,947	12,027	9
2001	512	338	174	51	352	344	7	2	134,287	122,172	12,115	9
2002	514	338	175	51	351	343	7	2	134,589	122,394	12,195	10
2003	515	338	176	52	350	343	7	2	134,884	122,617	12,267	10
2004	517	339	178	52	349	342	7	2	135,177	122,843	12,333	10
2005	518	339	179	52	349	341	7	2	135,469	123,074	12,395	10
2006	520	339	180	53	348	340	7	2	135,762	123,306	12,456	10
2007	522	339	182	53	347	340	7	2	136,051	123,536	12,515	10
2008	523	340	183	54	347	339	7	2	136,332	123,967	12,365	10
2009	525	340	184	54	346	338	7	2	136,598	124,607	11,991	9

Source: Mountain West Research - Southwest, Inc. (1983).

[a] Percentages less than 1.0 are reported as 0.

Table 4.2-24 SUMMARY OF CHANGES IN HOUSING DEMAND FOR THE GETTY PROJECT

Year	Garfield County				Carbondale				Glenwood Springs				New Castle			
			Impact				Impact				Impact				Impact	
	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	9,360	9,360	0	0	787	787	0	0	2,046	2,046	0	0	249	249	0	0
1981	11,578	11,578	0	0	932	932	0	0	2,237	2,237	0	0	276	276	0	0
1982	12,809	12,809	0	0	976	976	0	0	2,288	2,288	0	0	298	298	0	0
1983	12,423	12,423	0	0	1,015	1,015	0	0	2,332	2,332	0	0	295	295	0	0
1984	11,723	11,723	0	0	1,048	1,048	0	0	2,363	2,363	0	0	295	295	0	0
1985	11,951	11,951	0	0	1,078	1,078	0	0	2,396	2,396	0	0	300	300	0	0
1986	12,031	12,031	0	0	1,098	1,098	0	0	2,418	2,418	0	0	302	302	0	0
1987	12,242	12,200	41	0	1,125	1,123	2	0	2,445	2,442	3	0	301	291	10	3
1988	12,606	12,382	223	1	1,149	1,146	2	0	2,472	2,467	4	0	305	295	10	3
1989	13,215	12,567	648	5	1,191	1,170	21	1	2,521	2,492	29	1	314	299	15	5
1990	14,593	12,746	1,846	14	1,279	1,192	86	7	2,631	2,517	114	4	333	303	30	10
1991	15,769	12,923	2,845	22	1,352	1,215	137	11	2,719	2,541	177	7	350	307	42	14
1992	15,559	13,088	2,471	18	1,373	1,235	137	11	2,737	2,563	173	6	354	311	43	13
1993	15,737	13,243	2,494	18	1,395	1,255	139	11	2,758	2,584	174	6	358	314	43	13
1994	16,081	13,388	2,692	20	1,415	1,273	142	11	2,778	2,602	176	6	362	318	44	13
1995	16,771	13,524	3,246	24	1,457	1,290	166	12	2,826	2,620	206	7	372	321	50	15
1996	16,377	13,654	2,722	19	1,476	1,307	169	13	2,844	2,637	206	7	376	325	51	15
1997	16,693	13,775	2,917	21	1,521	1,322	199	15	2,926	2,652	273	10	387	328	59	18
1998	16,733	13,891	2,842	20	1,524	1,337	186	14	2,926	2,666	259	9	388	331	57	17
1999	16,897	14,004	2,893	20	1,541	1,351	189	14	2,943	2,679	264	9	392	334	58	17
2000	17,046	14,105	2,941	20	1,556	1,364	192	14	2,959	2,690	268	10	395	337	58	17
2001	17,193	14,199	2,993	21	1,571	1,376	195	14	2,974	2,701	273	10	399	339	59	17
2002	17,327	14,289	3,038	21	1,585	1,387	198	14	2,987	2,710	276	10	402	342	60	17
2003	17,445	14,363	3,082	21	1,597	1,397	200	14	2,998	2,717	280	10	405	344	61	17
2004	17,560	14,433	3,127	21	1,608	1,405	202	14	3,008	2,723	284	10	408	346	62	17
2005	17,682	14,508	3,174	21	1,620	1,415	205	14	3,018	2,730	288	10	411	348	62	18
2006	17,792	14,573	3,219	22	1,631	1,423	207	14	3,027	2,736	291	10	413	350	63	18
2007	17,882	14,623	3,258	22	1,639	1,430	209	14	3,033	2,739	294	10	415	351	64	18
2008	17,952	14,744	3,208	21	1,646	1,445	200	13	3,036	2,761	274	10	417	356	60	17
2009	18,004	14,939	3,065	20	1,650	1,470	180	12	3,036	2,803	232	8	418	366	52	14

Table 4.2-24 SUMMARY OF CHANGES IN HOUSING DEMAND FOR THE GETTY PROJECT (concluded)

	Parachute				Rifle				Silt				Battlement Mesa AA			
			Impact				Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	142	142	0	0	1,290	1,290	0	0	355	355	0	0	154	154	0	0
1981	333	333	0	0	1,857	1,857	0	0	434	434	0	0	289	289	0	0
1982	458	458	0	0	2,065	2,065	0	0	467	467	0	0	570	570	0	0
1983	354	354	0	0	1,990	1,990	0	0	460	460	0	0	274	274	0	0
1984	243	243	0	0	1,855	1,855	0	0	456	456	0	0	269	269	0	0
1985	247	247	0	0	1,893	1,893	0	0	464	464	0	0	271	271	0	0
1986	245	245	0	0	1,909	1,909	0	0	468	468	0	0	205	205	0	0
1987	250	248	1	0	1,947	1,941	6	0	475	474	0	0	218	207	10	5
1988	265	252	12	5	2,016	1,972	43	2	482	481	0	0	341	209	132	63
1989	291	256	35	13	2,143	2,005	138	6	494	488	6	1	543	211	331	156
1990	354	259	94	36	2,452	2,036	415	20	520	494	25	5	1,042	214	828	386
1991	408	263	144	55	2,717	2,068	648	31	541	500	40	8	1,479	216	1,263	583
1992	387	266	120	45	2,674	2,098	575	27	547	506	40	8	1,227	218	1,008	460
1993	391	269	122	45	2,710	2,127	582	27	553	512	41	8	1,238	221	1,017	459
1994	408	273	134	49	2,780	2,155	625	29	559	517	42	8	1,370	224	1,146	512
1995	440	276	164	59	2,937	2,181	755	34	571	522	49	9	1,634	226	1,408	622
1996	408	279	129	46	2,857	2,207	650	29	577	526	50	9	1,259	228	1,030	450
1997	407	282	124	44	2,902	2,231	670	30	593	531	62	11	1,156	231	925	400
1998	410	285	124	43	2,906	2,255	651	28	594	535	59	11	1,160	233	926	396
1999	416	289	127	43	2,941	2,278	662	29	599	539	60	11	1,181	236	944	399
2000	421	292	129	44	2,973	2,300	673	29	604	543	61	11	1,201	239	962	402
2001	426	295	131	44	3,005	2,320	685	29	608	546	62	11	1,221	241	979	405
2002	431	298	133	44	3,035	2,340	695	29	612	550	62	11	1,241	244	997	408
2003	436	300	135	45	3,062	2,357	705	29	616	552	63	11	1,260	246	1,013	410
2004	441	303	137	45	3,089	2,373	715	30	620	555	64	11	1,280	249	1,031	413
2005	446	306	139	45	3,117	2,391	726	30	623	558	65	11	1,301	252	1,049	416
2006	451	309	142	45	3,142	2,406	736	30	627	561	65	11	1,322	254	1,067	419
2007	455	311	144	46	3,164	2,419	745	30	629	563	66	11	1,341	257	1,084	421
2008	459	316	143	45	3,183	2,446	736	30	631	569	62	10	1,359	260	1,099	422
2009	463	323	140	43	3,197	2,488	709	28	633	581	52	9	1,376	264	1,112	420

Source: Mountain West Research - Southwest, Inc. (1983).

[a] Percentages less than 1.0 are reported as 0.

Garfield County is forecasted to increase its housing stock at an average annual rate of 1.1 percent for the "no action" alternative and 1.8 percent with the Getty project. The estimates made with the PAS model outputs indicate that the Mesa County demand was for about 35,754 housing units in 1983, and this would increase to 45,414 units for the "no action" alternative by 2009, and 48,362 units for the "with Getty" case.

The total increase in housing units due to the Getty project could be over 6,000 for the entire projection period. The housing sector in the study area recently demonstrated that it is capable of meeting this level of demand. An important factor in projecting future housing demand is that Battlement Mesa has developed the infrastructure to accommodate significant new housing. Other communities have also taken steps to upgrade their ability to provide support for housing development.

4.2.13.6 Education

Education impacts are reported for five school districts in the study area: Garfield County District No. RE-2 which serves Rifle, New Castle, Silt, and the surrounding area; Garfield County District No. RE-16 which serves the Parachute and Battlement Mesa area; Mesa County Joint District #49 which serves De Beque and the surrounding rural portions of Mesa and Garfield Counties including the Roan Creek valley; Plateau Valley School District #50 which serves Collbran, Mesa, Plateau City, and Molina; and Mesa County Valley School District #51 which serves Grand Junction, Fruita, Palisade, and the surrounding unincorporated areas.

The projections of school age population for each of these districts is displayed in Table 4.2-25 for the "no action" and the "with Getty" alternatives. The projections for these five districts estimate a slight increase from 1983 to 1995 with a gradual decline in school age population for the "no action" alternative over the rest of the projection period.

The additional school age children that would result from the Getty project would mean significant impacts for the school districts. The RE-16 and Mesa County District #51 would exceed their enrollment capacity and would require major investments in new facilities. The other three districts would be expected to experience only minor impacts that could be handled within their current capacities. Joint District #49 would have the value of the project added to its property tax base and this could provide a major source of funds for schools. During recent oil shale development, the Oil Shale Trust Fund and the developers made major contributions to the construction of new facilities for RE-6, most noticeably at Battlement Mesa.

4.2.13.7 Public Facilities, Services, and Fiscal

This section presents descriptions of the direction (positive or negative), magnitude, duration, and overall pattern of the impacts on public facilities, services, and fiscal conditions. As is the case for other areas, the most important data are those that can show a difference between the "no action" and the "with Getty" alternatives. These differences, or impacts, are based upon projections that use the same assumptions about the tax base, tax rates, levels of service, and demand for facilities. This process does not attempt to predict future local political and governmental decisions; rather, it attempts to maintain the same basic assumptions for each alternative, apply the same methods for making projections, and to isolate the impacts that are produced when the "with project" effects are compared to the "no action" effects.

Table 4.2-26 presents the fiscal impacts as the difference in the cumulative balance between the two alternatives for each significant jurisdiction. The "no action" and "with project" columns present the net difference between the revenues and expenditures for each governmental unit or fund. If the net balance is positive, revenues were forecasted to exceed expenditures and if the net balance is negative, expenditures were forecasted to exceed revenues. These net balances are accumulated annually to show a running total for the projection period. Impacts are the difference between the two columns for each alternative. It is possible for both the "no action" and the "with Getty" balances to be negative and the impact be positive. This can happen if the negative balance of the "with Getty" alternative is smaller than the projected for the "no action" case. The display of fiscal balances in this format makes it possible to show the total fiscal balance for the projection period and the general pattern of annual fiscal impacts.

Table 4.2-25 SUMMARY OF SCHOOL-AGE POPULATION WITH THE GETTY PROJECT

	Mesa County Joint District #49 (De Beque)				Garfield County School District RE-2				Garfield County School District RE-16				Plateau Valley School District #50			
			Impact				Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	124	124	0	0	2,117	2,117	0	0	321	321	0	0	500	500	0	0
1981	133	133	0	0	2,461	2,461	0	0	555	555	0	0	453	453	0	0
1982	136	136	0	0	2,624	2,624	0	0	859	859	0	0	436	436	0	0
1983	120	120	0	0	2,538	2,538	0	0	534	534	0	0	408	408	0	0
1984	118	118	0	0	2,450	2,450	0	0	456	456	0	0	391	391	0	0
1985	101	101	0	0	2,512	2,512	0	0	475	475	0	0	381	381	0	0
1986	99	99	0	0	2,526	2,526	0	0	419	419	0	0	373	373	0	0
1987	99	99	0	0	2,558	2,547	11	0	440	429	11	2	367	367	0	0
1988	99	98	1	1	2,618	2,575	42	1	580	434	145	33	363	363	0	0
1989	99	97	2	2	2,712	2,598	114	4	771	438	333	76	358	358	0	0
1990	120	96	23	24	2,916	2,611	305	11	1,161	437	724	165	360	353	7	2
1991	138	95	43	45	3,081	2,615	465	17	1,517	433	1,083	249	361	347	14	4
1992	135	93	42	44	3,010	2,611	399	15	1,245	427	818	191	357	342	15	4
1993	136	93	43	46	3,010	2,612	397	15	1,276	420	855	203	356	340	15	4
1994	138	92	45	49	3,041	2,611	429	16	1,436	414	1,022	247	354	337	17	5
1995	139	87	52	59	3,105	2,586	519	20	1,683	404	1,279	316	352	323	29	9
1996	136	86	50	58	2,974	2,547	427	16	1,275	391	884	226	350	320	30	9
1997	130	84	45	53	2,955	2,507	447	17	1,180	378	802	212	341	316	24	7
1998	129	82	46	56	2,885	2,457	428	17	1,186	365	821	225	337	312	25	8
1999	127	80	46	58	2,808	2,378	429	18	1,183	347	836	241	332	306	25	8
2000	125	78	46	59	2,736	2,307	428	18	1,173	331	842	254	326	299	26	8
2001	122	75	46	61	2,662	2,235	426	19	1,156	316	839	265	318	292	26	9
2002	119	73	46	63	2,588	2,166	422	19	1,132	302	830	274	311	284	26	9
2003	116	70	45	64	2,517	2,101	416	19	1,103	289	814	281	304	277	26	9
2004	113	68	44	65	2,450	2,043	406	19	1,072	278	793	285	297	270	26	9
2005	110	66	44	66	2,387	1,991	395	19	1,039	268	771	287	290	264	26	9
2006	108	64	43	66	2,331	1,948	382	19	1,008	260	747	286	285	259	25	9
2007	105	63	42	67	2,283	1,915	368	19	978	253	724	285	280	255	25	9
2008	104	62	41	67	2,245	1,904	340	17	951	251	699	278	276	252	24	9
2009	102	61	41	67	2,214	1,917	297	15	928	252	675	267	273	249	23	9

Table 4.2-25 SUMMARY OF SCHOOL-AGE POPULATION WITH THE GETTY PROJECT (concluded)

	Mesa County Valley School District #51			
			Impact	
Year	With Project	No Action	Number	%[a]
1980	17,659	17,659	0	0
1981	18,164	18,164	0	0
1982	18,072	18,072	0	0
1983	17,834	17,834	0	0
1984	17,789	17,789	0	0
1985	17,896	17,896	0	0
1986	18,215	18,215	0	0
1987	18,615	18,607	0	0
1988	19,065	18,969	95	0
1989	19,476	19,293	183	1
1990	20,200	19,336	863	4
1991	20,767	19,185	1,581	8
1992	20,722	19,277	1,444	7
1993	20,934	19,438	1,495	7
1994	21,147	19,414	1,733	8
1995	21,318	19,376	1,941	10
1996	21,084	19,353	1,731	8
1997	20,523	19,240	1,282	6
1998	20,372	19,046	1,325	7
1999	20,127	18,786	1,358	7
2000	19,742	18,359	1,382	7
2001	19,310	17,914	1,396	7
2002	18,855	17,456	1,398	8
2003	18,391	17,005	1,386	8
2004	17,939	16,575	1,364	8
2005	17,512	16,178	1,333	8
2006	17,127	15,830	1,297	8
2007	16,795	15,538	1,256	8
2008	16,519	15,304	1,215	7
2009	16,302	15,127	1,174	7

Source: Mountain West Research - Southwest, Inc. (1983).

[a] Percentages less than 1.0 are reported as 0.

Study Area

The sum of the Getty project fiscal impacts for all the jurisdictions over the entire projection period is shown as a positive fiscal balance of $455.2 million by the year 2009 (Table 4.2-26). This balance is produced by dramatic increases in the property taxes for Garfield County, by increased sales tax revenues which benefit Mesa County, and by severance taxes which are distributed to the local jurisdictions. The total fiscal gain is not equally distributed, however, and an analysis of more detailed data for various county and sub-county levels shows some negative impacts for certain years and/or for the entire projection period. These county and sub-county trends are discussed in more detail below.

Garfield County

The Getty project would increase the assessed valuation of Garfield County by $1.1 billion and at present property tax rates this would produce over $20 million per year in revenues. When this amount is added to the increased severance and sales taxes which the county would receive, the net fiscal impact for Garfield County by 2009 would be over $400 million, or over 88 percent of the total fiscal impacts for the entire study area. This net cumulative impact makes it clear that Garfield County would greatly benefit in terms of revenues from the project, much more so than any other public jurisdiction.

Table 4.2-26 CUMULATIVE NET FISCAL IMPACT WITH THE GETTY PROJECT[a]
(in thousands of 1982 dollars)

	TOTAL			
			Impact	
Year	With Project	No Action	$	%[a]
1982	-1,761	-1,745	-15	-0
1983	-14,458	-13,636	-821	-6
1984	-50,946	-50,038	-908	-1
1985	-75,648	-74,652	-995	-1
1986	-89,720	-88,604	-1,116	-1
1987	-97,581	-96,533	-1,048	-1
1988	-108,857	-107,408	-1,448	-1
1989	-106,962	-108,439	1,477	1
1990	-94,141	-110,165	16,024	14
1991	-72,187	-107,017	34,829	32
1992	-53,032	-100,234	47,202	47
1993	-27,389	-90,482	63,093	69
1994	4,826	-79,477	84,304	106
1995	42,921	-66,972	109,893	164
1996	81,896	-51,915	133,811	257
1997	121,334	-36,301	157,635	434
1998	161,840	-20,755	182,596	879
1999	202,283	-5,249	207,532	3,953
2000	242,692	10,263	232,428	2,264
2001	282,629	25,669	256,960	1,001
2002	324,613	42,756	281,856	659
2003	367,245	60,648	306,597	505
2004	410,233	78,789	331,444	420
2005	453,446	97,082	356,364	367
2006	496,792	115,515	381,277	330
2007	540,056	133,966	406,090	303
2008	582,921	152,584	430,336	282
2009	626,501	171,331	455,170	265

Source: Mountain West Research - Southwest, Inc. (1983).

[a] Percentages less than 1.0 are reported as 0.

Rifle

The net fiscal impact for the city of Rifle is projected to be $1.8 million by the year 2009. The main revenue source producing this positive balance is the severance tax which, however, does not produce positive annual effects until 1992. Prior to that time, the impacts are negative, which means that the expenditures required by the increased population would be greater than the added revenues. The Rifle Water Fund shows an increasing deficit due to the fact that its per capita expenditures are greater than its revenues so that it would lose money with each additional user. The opposite is true of the sanitation fund which is structured so that it would make money with each additional user. The fiscal impact for the Rifle General Fund shows a net cumulative balance of over $2 million by the year 2009.

Parachute

The town of Parachute shows impacts that are similar in their overall pattern to those of Rifle. The water fund is projected to run a deficit while the sanitation fund is projected to accumulate a surplus. The general fund shows negative impacts until the severance tax payments begin, and gradual annual surpluses after that point. The accumulated fiscal balance by 2009 is projected to be $404 thousand.

New Castle

The impacts for New Castle are projected to show an overall deficit of $109 thousand by the year 2009. A slight gain in the water fund is offset by losses that would be expected for the sanitation and general funds.

Silt

The fiscal impacts for Silt are shown as positive from 1987 to 2009. The net accumulated impact by the end of the projection period would be $199 thousand.

Mesa County

As the regional market center, Mesa County would realize significant revenues from the sales tax which has been recently restructured so the county collects 2 percent on most sales. The net impact for the entire projection period is $32.8 million, about 7 percent of the total fiscal gain for the study area.

Grand Junction

Each of the Mesa County communities shown in Table 4.2-27 are projected to show a net fiscal gain by the year 2009. The gain would be $12.6 million for Grand Junction with a $15 million positive balance in the general fund, somewhat offset by a $2.8 million loss for the water fund and a $10,000 deficit for the sanitation fund. The effect of the severance tax as well as the municipal sales taxes are shown in the general fund pattern. Deficits in the early years are offset by increased revenues after 1991.

Fruita

Fruita shows a surplus for each of its three funds: sanitation, water, and the general fund. The gains for the water and sanitation funds are quite small indicating that the costs of operating these enterprises are balanced by user fees. The general fund shows positive balances starting with the income from the severance taxes and gradually accumulating to $1.7 million for the projection period.

Palisade

Palisade shows short-term deficits for the general fund, but for the projection period, the estimates are that the town would experience an overall fiscal benefit of over $2.5 million. The majority of this effect is produced by the Palisade Utility Fund, which would accumulated to $1.5 million by the year 2009.

De Beque

The De Beque Utility Fund shows a growing deficit with the added population resulting from the Getty project. This means that the present costs to utility users do not cover costs and that the addition of more people will create larger deficits. The De Beque General Fund shows deficits in the early years, but annual fiscal gains once the severance tax payments begin. The net positive balance for the town by the end of the projection period would be slightly over $1 million.

Battlement Mesa

Battlement Mesa is not an incorporated municipality but rather a Planned Unit Development (PUD) operated by Battlement Mesa Inc. Therefore, it is not shown as a public entity that would experience fiscal impacts during the projection period. It may be that significant growth would produce pressure for the incorporation of the PUD in order to provide services or standard municipal government. On the other hand, the community could obtain adequate services from the county, where the tax base would be greatly expanded by the increased assessed valuation of the Getty Project. At this point, however, no fiscal impact projections have been made for Battlement Mesa, although as a community, it is expected to receive significant employment, population, housing, and other impacts.

Capital Expenditure

The FisPlan model was used to make projections of capital needs based on increases in population and housing. In many cases, capital spending would begin before the actual need is in place. This anticipation function is recognized in using FisPlan and it results in fiscal impacts prior to actual demand. As a result, some jurisdictions show fiscal impacts for as early as 1983. The capital facilities needs for the entire projection period are shown in Table 4.2-27. The expansion of capacities are made within the decision parameters reviewed and approved by the CITF.

The additional capital expenditures are shown as impacts for each jurisdiction. The largest capital needs are identified for Grand Junction where over $3 million for general governmental facilities and $1.2 million for the water system were estimated. The largest proportional increases are for utilities in De Beque, and the water funds in Rifle and Parachute. These are areas that would be expected to experience gains in population and housing and where the in-place facilities do not now have the capacity to meet the impact demand.

Summary

The estimated revenues produced by the Getty project would be expected to exceed required expenditures by a considerable amount, over $455 million for the study area over the entire projection period, 1982-2009. These fiscal benefits are not distributed equally among the local jurisdiction, so that Garfield County would realize about 88 percent of the total fiscal increase while Mesa County would receive only about 7 percent. Mesa County would serve, however, as the location for up to half the population and housing effects. Many jurisdictions would experience short-term deficits as expenditures would exceed revenues in the early years before taxes, especially the severance tax, come into effect. In some cases, long-term deficits would occur with funds where user fees do not cover the operating costs. New capital expenditures are expected to be required for almost all the jurisdictions, but in most cases they seem modest given the amounts and the time period covered by the projections. The largest proportional increases would be for water and/or utility services in Parachute, Rifle, and De Beque.

4.2.13.8 Social Structure

A profile of the current social structures in the study area was presented in Section 3.1.13.8, along with a rationale for the approach taken. The purpose of this section is to discuss the development of the significant functional groups and the social structure for the "no action" and the "with Getty" alternatives. There is no quantified data on the groups as such, so a qualitative distribution of project-related effects was made. This distribution is shown in Tables 4.2-28 and 4.2-29.

The changes forecast for the social structure are only those that are the result of effects specific to the study area itself. It is understood that in the past many changes to local social groups and their social structure have resulted from forces from ouside the area, sometimes from national or even international causes. Abrupt changes in technology, travel, or communications have transformed social life in the last decades and analogous changes may have similar effects on local social conditions in the future. These exogenous factors are beyond the scope of the analysis intended in this section. The focus of this EIS is on the study area itself and how it might be expected to respond to specific types of socioeconomic effects which have been considered important in social impact assessment literature.

Table 4.2-27 GETTY PROJECT CUMULATIVE TOTAL CAPITAL EXPENDITURES: 1983-2009

Jurisdiction	Expenditures ($000)		Impact	
	No Action	With Getty	$000	%
Mesa County All Funds	$27,628.85	$28,346.38	$ 717.53	2.60
Grand Junction				
General Fund	63,004.68	66,076.34	3,071.66	4.88
Water Fund	23,550.36	24,780.07	1,229.71	5.22
Grand Junction City/County				
Sanitation	9,206.10	9,221.32	15.22	.17
Fruita				
General Fund	7,904.02	7,938.74	34.72	.44
Water Fund	1,050.21	1,062.90	12.69	1.21
Sewer Fund	1,017.47	1,017.47	0	--
Palisade				
General Fund	0	221.10	221.10	--
Utility Fund	3,266.55	3,266.55	0	--
De Beque				
General Fund	428.24	574.54	146.30	34.16
Utility Fund	107.06	359.46	252.40	235.76
Garfield County				
All Funds	934.63	1,296.90	362.27	38.76
Rifle				
General Fund	684.11	854.26	170.15	24.87
Water Fund	64.24	239.37	175.13	272.62
Sewer Fund	0	33.31	33.31	--
Parachute				
General Fund	803.76	1,124.36	320.60	39.89
Water Fund	131.46	389.21	257.75	196.07
Sewer Fund	0	0	--	--

Source: Mountain West Research - Southwest, Inc. (1983).

Garfield County

The social structure of south-central Garfield County was divided into five significant functional groups: Agriculturalists, Business and Professional, Elderly, Other Long-Time Residents, and Newcomers. The Newcomers were primarily present, due to oil shale development that has occurred in the area. The other four groups were largely made up of natives and people who had been in the area for a long time. There is a small proportion of new business and professional people who arrived when oil shale development was strong and some have stayed on.

No Action Alternative. The projected growth rates for the "no action" alternative are quite small. In fact, the population projections estimate an annual average growth rate of only 0.2 percent for the period 1983 to 2009. This rate is less than natural increase (births minus deaths) and implies annual out-migration. A certain replacement function would occur in jobs, housing, and public facilities. In the social structure, there would be little change resulting from significant growth or decline in the economy or in the population. Over time, the Newcomers would either leave the area to obtain employment elsewhere or they would integrate into the social structure and become long-time residents. The social structure would contract to four significant functional groups.

Table 4.2-28 GETTY PROJECT EFFECTS ON GARFIELD COUNTY SOCIAL STRUCTURE

Group	Employment, Income, Purchases	Demographic	Housing, Land Use	Public Service Fiscal	Social (Intergroup)
Agriculturalists	Little or no effects	Little or no effects, although will become a smaller proportion of the total population.	Significant effects; rising property values due to increased demand for land.	Possible impacts from lower tax rates with addition of major project to county's assessed valuation; higher level of service.	Political and social position expected to diminish as they become a smaller segment of the social structure.
Business and Professional	Significant impacts due to project purchases and resulting nonbasic employment and income activity.	Moderate increase in size due to in-migration is expected, especially as a result of nonbasic employment. Geographical distribution of impacts to Rifle, Battlement Mesa, and Parachute.	Housing effects would come primarily from the business, response to increasing demand.	Will benefit from higher level of public facilities and services.	Social, political and economic position should be strengthened due to significant economic benefits group would realize. Also tend to be well organized and political, busines, and community affairs.
Elderly	Little or no effects.	Proportion of total population will decline, although actual numbers will not.	Some effects through increased housing costs for renters and rising housing values for owners.	Will benefit from access to higher level of public facilities and services.	Political and social power will decline as they become a smaller proportion of the population. May be anti-growth attitudes due to erosion of their lifestyle and value system.

Table 4.2-28 GETTY PROJECT EFFECTS ON GARFIELD COUNTY SOCIAL STRUCTURE

Group	Employment, Income, Purchases	Demographic	Housing, Land Use	Public Service Fiscal	Social (Intergroup)
Other Long-Time Residents	Significant effects from on-site employment and wages as well as nonbasic employment and income.	Little effect for the first decade; then group size would increase as newcomers become long-time residents.	Some effects through increased housing costs for renters and rising housing values for owners.	Increased service levels.	Moderate effects - position would be strengthened through increased employment, income and diminished out-migration. However, less well organized politically and socially than Business and professional group; numerous small subgroups, based on occupation, residential location, and ethnic or religious characteristics will form.
Newcomers	Significant impacts from on-site employment and wages as well as increased employment in nonbasic sector. Without the project this group would diminish or cease to exist.	Significant increase in size due to in migration for both on-site and nonbasic employment.	Substantial increase in demand for housing, especially rental units.	Will generate increased demand for public services.	Significant effects on social structure due to size and importance of group. Their integration could result in major readjustments in social structure due to their size, income and lifestyles, the working class people would become more important.

Source: Mountain West Research - Southwest, Inc. (1983).

"With Getty" Alternative. The discussion of social structure impacts is based upon a distribution of effects to groups and their likely response to the significance of these occurrences. These qualitative assessments are shown in Table 4.2-28.

The significant economic effects include employment, income, and purchases made on behalf of the Getty project. There would be few effects for the Agriculturalists and the Elderly. Significant effects would accrue to the other three groups. The Business and Professional group would benefit from the additional spending in the county, and they would provide some goods and services obtained by Getty's local purchases. The Other Long-Time Residents would be in a good position to be employed both directly for project work or through the purchases and non-basic effects. The Newcomers would be most affected since they would be in the area as a direct result of the increased employment. They would be especially important in filling the skilled jobs that are required for construction and operation.

Intergroup relations would be expected to change as a result of the project- related effects. The Agriculturalists could lose some of their political and social influence, as might the Elderly. Both groups would become a smaller proportion of the population, and both would become less important economically. The Business and Professional group would be expected to increase its political, economic, and social role. This group tends to be well organized, compared to the other groups, and would enjoy the advantages of a substantial new base for economic growth. The effects for the Other Long-Time Residents would be moderate, although they would be expected to play a major part in the interaction with the Newcomers. The role of the Newcomers would be a significant one as they would form a major new force in the social structure, one that would have to be integrated. The political role of the working class, mostly pertaining to the Newcomers and the Other Long-Term Residents, could become important.

Mesa County

Grand Junction is the market and service center for Mesa County and the study area as a whole. In this role, the city dominates the social structure of the Grand Valley. Because of its central position, the city has many ties with the surrounding rural communities and areas, a fact that has been important in shaping its functional social groups and its social structure. The current social structure incorporates a relatively large population and it has a history of assimilating rapid growth. The following six groups were identified as significant functional units in the social structure: Agriculturalists, Business and Professional, Elderly, Hispanics, Other Long-Time Residents, and Newcomers.

No Action Alternative. Although the Mesa County projected growth rate is twice as great as that expected for Garfield County for the "no action" alternative, it is still less than half of 1 percent, a very small rate of increase. As was the case with Garfield County, this rate is actually less than natural increase and implies the out-migration of natives who would not be able to get jobs in the study area. Under these conditions, the social structure would be expected to be quite stable. The Newcomers would become a smaller group and they might cease to exist at all. For the most part, the relationships between the groups would be expected to continue along current lines with only minor adjustments for the no-growth conditions. The population projections suggest a very stable population, economic and income picture, one which also implies little change in the social structure.

"With Getty" Alternative. The overall impacts on the Mesa County social structure are expected to be smaller than was the case for Garfield County. This is because the size and strength of the functional groups is much greater and the level of change due to the socioeconomic effects is a smaller proportion of the total. For example, at peak construction in 1995 the population impacts on Garfield County would be about 30 percent, but in Mesa County they would be only 9 percent. The employment impacts would reach 16 percent for Mesa County compared to 48 percent for Garfield County. These are important levels of impact, but the changes implied for Mesa County are much smaller than those distributed to Garfield County. The qualitative distribution of these impacts by group is shown in Table 4.2-29.

Little change would be expected in the intergroup patterns due to the Getty project. The Other Long-Time residents would stabilize and increase somewhat due to the employment. They would also develop ties with the Newcomers who would be expected to be from about the same class. The Newcomers would have to become integrated into the community, but these could very well be fairly formal ties such as their day-to-day market interactions. As voters, the combined numbers of the Other Long-Time Residents and the Newcomers might make them politically more important. However, this would depend upon how active the two groups would become in local public issues.

Table 4.2-29 GETTY PROJECT EFFECTS ON MESA COUNTY SOCIAL STRUCTURE

Group	Employment, Income, Purchases	Demographic	Housing, Land Use	Public Service Fiscal	Social (Intergroup)
Agriculturists	Little or no effects.	Little or no effects. would become slightly smaller proportion of the growing population.	Will be affected by the additional demand for land (residential, commercial, and industrial), especially the orchardists east of Grand Junction.	Little or no effects.	Little or no effects.
Business and Professional	Low to moderate impact on employment caused by nonbasic employment. Moderate benefits will occur from increasing spending due to higher overall income and project purchases.	Low to moderate increase.	Housing effects would come primarily from the business response to increasing demand.	Low to moderate effects.	Little or no effect - they would remain the dominate group in social structure.
Elderly	Little or no effect	Little or no effects, although would become a slightly smaller proportion of population due to overall growth.	Some effects through increased housing costs for renters and rising housing values for owners.	Little or no fiscal impacts.	Little or no effects.

Table 4.2-29 GETTY PROJECT EFFECTS ON MESA COUNTY SOCIAL STRUCTURE

Group	Employment, Income, Purchases	Demographic	Housing, Land Use	Public Service Fiscal	Social (Intergroup)
Hispanics	Some effects through nonbasic employment and income created by project purchases.	Little or no effects, although would become a slightly smaller proportion of population due to overall growth.	Some effects through increased housing costs for renters.	Little or no effects.	Little or no effects.
Other Long-Time Residents	Some effects through nonbasic employment and income created by project purchases.	Little or no effect in the short term; eventually, the group's size will increase as members of the newcomers group become long-time residents.	Some effects through increased housing costs for renters and rising housing values for owners.	Little or no effects.	Group would stabilize due to increased employment and declining out-migration.
Newcomers	Moderate impacts on employment and income, primarily from non-basic activity generated by the project.	Low to moderate increase in numbers due to in-migration for jobs.	Increase in population would create greater demand for housing.	Population and housing increase would generate greater demand on facilities and services.	Eventually, size would diminish as operation work force stabilizes and newcomers become integrated into long-time residents.

Source: Mountain West Research - Southwest, Inc. (1983).

4.2.13.9 50,000-bpd Production Rate Alternative

Getty's project includes development to 100,000 bpd in two major increments of 50,000 bpd each. Construction of the initial 50,000-bpd increment would take approximately 5 years. Data through 1991 in Table 4.2-19, therefore provide an indication of the employment requirements to develop a 50,000-bpd alternative. Subsequent to 1991, construction employment would rapidly approach zero and operations employment would stabilize at 1,600 workers, if only a 50,000-bpd project were to be built.

In general terms, the socioeconomic impact implications for the 50,000-bpd alternative follow directly from these assumptions. The impacts through the first 5 years of the project are the same under the 50,000-bpd and 100,000-bpd alternatives. Under the 50,000-bpd alternative, however, the second 5-year construction cycle (1992-1996), which is of the same magnitude as the first cycle, is eliminated. Instead, by 1993 the project would stabilize with an operating workforce of 1,600, which is slightly more than half (55 percent) of the 100,000-bpd work force.

The construction period socioeconomic impacts for the 50,000-bpd alternative can be anticipated, therefore, by reviewing the impact data through 1991 in the previous sections. Since the operations period effects are generally proportional to the size of the direct workforce, the operations period impacts of the 50,000-bpd alternative can be inferred to be on the order of 55 percent of the impacts shown under the 100,000-bpd alternative after all construction is over in 1997.

Since the peak impacts occur during the construction period, and the two construction cycles are of similar magnitude, the peak impacts of the two alternatives are very similar. These occur twice, however, in the 100,000-bpd scenario. In the operations phase, the impacts of the 50,000-bpd alternative differ from those of the 100,000-bpd alternative because there are only about half as many workers.

4.2.13.10 Summary—Socioeconomic Impact Conclusions

Employment

Employment impacts of a 100,000-bpd scenario would be significant, amounting to increases of 10 to 23 percent for the study area as a whole. For local jurisidiction they would often be much higher. Unemployment rates would be expected to drop during times of peak demand for workers. The employment effects would require significant in-migration in order to meet the needs of a larger work force. Similar results would be obtained for 50,000-bpd alternative. Peak impact would be 22 percent occurring in 1991, but the long-term impact would only result in about 3,000 total jobs, an increase of approximately 5 percent.

Income

The labor income impacts at the 100,000-bpd production rate would exceed $284 million at the peak year, a 31 percent increase over the "no action" alternative. During operation, labor income would be 14 percent higher with the Getty project. For the 50,000-bpd alternative, peak impacts would be similar ($257 million), but operating period impacts would only be approximately 7 percent higher than the "no action" alternative.

Purchases

Local purchases to support the project are projected to reach $289 million at peak construction and amount to $58 million annually during operation at 100,000 bpd. This would produce significant indirect basic and non-basic employment and income impacts. At 50,000-bpd production, purchases would peak at $277 million, but annual expenditures during operation would be closer to $30 million per year.

Demographic

Study area population impacts would be over 17,000 at peak construction, a 14 percent increase over the "no action" alternative. During operation, these impacts would be about 10 percent. These significant population impacts would be made up of in-migrants and diminished outmigration of local residents. At 50,000 bpd, peak impacts would be similar, but long-term impacts would only be about 5 percent of study population, or 6,000 persons.

Housing

Housing demand impacts would reach 6,895 units in 1995, and would be about 6,000 units during operation at 100,000 bpd. Battlement Mesa would be the location of the greatest proportional increases. At 50,000 bpd, peak impact would be at 5,826 units in 1991, and would level off at about 3000 units during operation.

Education

The school age population for the 100,000-bpd rate would increase by 3,820 at peak construction, 17 percent over the "no action" alternative. During operations, the figure would be about 2,000, or 13 percent higher. Additional school facilities would be required for RE-16 and District #51. The assessed valuation of Joint District #49 would be increased by $1.1 billion since the Getty project would be located within its boundaries. Again, peak impacts at 50,000 bpd would be very similar, but long-term impacts would only average about 1,000 students.

Public Facilities, Services, and Fiscal

The study area fiscal impacts are projected to be over $455 million at 100,000 bpd. Garfield County would receive most of this increase, about 88 percent, through the addition of the project improvements to the county's assessed valuation base. Other jurisdictions would obtain much smaller fiscal impacts, with the sales tax providing most of the positive results in Mesa County. The severance tax would make up the difference between expenditures and revenues for many towns although during the period before these taxes take full effect there could be short-term deficits. Some funds would accumulate net deficits with rising demand; this is most noticeable in water and other utility funds. New facilities would be required for most jurisidictions with the greatest dollar costs occurring in Grand Junction. At 50,000 bpd, total revenue flows would be more than half those shown above. The spatial distribution would be similar.

Social

Changes to the social groups and the social structure would be expected to take place in both counties. The groups with mainly natives or long-time residents would be strengthened due to the economic (jobs and income) and the demographic (diminished out-migration) impacts. Housing and public service impacts would be mixed for these groups. Relative to each other, the Business and Professional groups would be expected to gain the most while the Other Long-Time Residents and the Hispanics would be somewhat strengthened. The Agriculturalists and the Elderly would realize some positive benefits and, at the same time, their political and social positions would tend to diminish.

4.2.14 Transportation

4.2.14.1 Proposed Action

Road Systems

The development and operation of the proposed Getty project would not significantly impact Interstate Highway 70 over the road segments analyzed for the EIS (road segments A to E - see road segments as described in Section 3.1.14). Road segment C, near De Beque, would experience occasional traffic slowdowns during the peak employment year (1995). Segments F and G would experience occasional traffic slowdowns and a potential reduction in the level of service in 1995. There should be no speed reductions for I-70 during normal operations (year 2010), but there would be traffic speed reductions along road segments F and G. Table 4.2-30 presents the anticipated level of traffic and associated impacts for each road segment.

The Roan Creek road would be significantly impacted by construction and operation of the proposed project. The existing road is inadequate for the anticipated traffic demand and would have to be upgraded to accomodate the increase in traffic. Accidents along the road segments would also increase (Table 4.2-31). The impact of the proposed action would not, however, result in a significant increase of accidents over what is predicted to occur if no project is developed (Table 3.1-19, Section 3.1.14).

Table 4.2-30 TRAFFIC PROJECTIONS FOR ROAD SEGMENTS A-H, PROPOSED ACTION - GETTY OIL COMPANY

Year	Road Segment	Segment Length	ADT[a]	PHT[b]	CAP[c]	PHT/CAP[d] Ratio
1980	A	29.6	3,600	400	3,400	.12
	B	19.4	5,200	650	3,500	.19
	C	17.0	5,450	750	3,450	.22
	D	8.9	5,400	750	3,450	.22
	E	42.4	6,100	850	3,500	.24
	F	15.1	3,750	500	950	.53
	G	4.3	21,150	2,350	2,000	1.18
	H	8.4	4,800	600	1,400	.13
1995[e]	A	29.6	6,100	850	3,400	.25
	B	19.4	12,200	2,150	3,500	.61
	C	17.0	13,100	3,400	3,450	.99
	D	8.9	10,700	2,300	3,450	.67
	E	42.4	18,700	2,950	3,500	.84
	F	15.1	6,100	850	950	.89
	G	4.3	31,550	3,950	2,000	1.98
	H	8.4	7,350	950	1,400	.68
2010	A	29.6	8,100	1,050	3,400	.31
	B	19.4	12,700	2,000	3,500	.57
	C	17.0	13,150	2,450	3,450	.71
	D	8.9	12,050	2,000	3,450	.58
	E	42.4	18,750	2,800	3,500	.80
	F	15.1	7,900	1,050	950	1.11
	G	4.3	36,000	4,200	2,000	2.10
	H	8.4	9,250	1,150	1,400	.82

[a] ADT = Average Daily Traffic
[b] PHT = Peak Hourly Traffic
[c] CAP = Capacity at Level of Service "C"
[d] See text (Section 3.1.14) for explanation.
[e] Peak year of employment (construction and operation)

Accurate predictions of accident rates on the Roan Creek road are not possible due to lack of recent data on accidents. It is expected that accidents would increase in proportion to the increase in traffic.

Airports

Increases to air traffic at Walker Field would likely be proportional to the population increase. A similar level of increase is expected at the Garfield County airport, but would likely be limited largely to private aircraft. Considering that both of these airports are designed to handle air traffic beyond current levels (in anticipation of oil shale and the development in the region), the proposed action should have no significant impact on air service for the area.

Railroads

The only increase in rail traffic along the main rail lines would be due to material and product transport. Material transport would be most significant during construction, while by-product transport would occur during operation. Considering that the present rail system is below capacity (Section 2.3.1.14), and that the daily train traffic attributable to material or product transport is expected to be low, impacts to the existing rail system would be minor.

Table 4.2-31 PREDICTED NUMBER OF ACCIDENTS ON AFFECTED HIGHWAY SEGMENTS - GETTY PROPOSED ACTION

Year	Road[a] Segment	Segment Length	Predicted No. of Accidents (annual)[b] PDO[c]	INJ[d]	FAT[e]	TOTAL
1980	A	29.6	32	25	3	60
	B	19.4	44	15	3	62
	C	17.0	56	11	1	68
	D	8.9	40	22	0	62
	E	42.4	130	64	4	198
	F	15.1	39	22	1	62
	G	4.3	375	88	1	464
	H	8.4	37	16	0	53
1995[f]	A	29.6	54	42	5	101
	B	19.4	103	37	7	147
	C	17.0	135	26	2	163
	D	8.9	79	44	2	125
	E	42.4	399	196	12	607
	F	15.1	64	36	2	102
	G	4.3	585	131	2	718
	H	8.4	57	25	2	84
2010	A	29.6	72	56	7	135
	B	19.4	108	37	7	152
	C	17.0	135	27	2	164
	D	8.9	89	49	2	140
	E	42.4	400	197	12	609
	F	15.1	82	46	2	130
	G	4.3	638	150	2	790
	H	8.4	71	31	2	104

[a] See Figure 3.1-6 for location of road segments
[b] Numbers for 1995 and 2010 are total accidents. The incremental amount due to the proposed action can be derived by comparison to Table 3.1-15.
[c] PDO = Property damage accidents only
[d] INJ = Injury-producing accidents
[e] FAT = Fatality-producing accidents
[f] Peak year of employment (construction and operation)

A significant amount of train traffic up the Roan Creek valley to transport workers is proposed. However, this will be a private railroad and should not impact the Denver and Rio Grande Western line.

Pipelines

Additional pipelines would be built to transport shale oil and water (Section 2.3.1.14). Development of these pipelines would result in a net beneficial impact in that a new pipeline system would be in place for future transport of various commodities upon proper purging and refitting of the pipelines. Such commodities would potentially include all materials (e.g., oil, water) that are reasonably transported by pipelines.

4.2.14.2 Alternatives

The 50,000-bpd alternative is the only alternative that would have a significant impact on any of the transportation systems. Impacts to the transportation network, particularly the road system, would be proportionately less than at 100,000-bpd during operation. However, the duration of impacts would be approximately twice as long. Consistent with the socioeconomics analysis (Section 4.2.13), impacts to the road system are represented by the population estimates shown for the year 1995.

Other alternatives, such as alternative pipeline routes, would not have significantly different impacts than the proposed project.

4.2.14.3 Solid/Hazardous Wastes and Toxic Pollutants

Transport of wastes or toxic pollutants off-site could result in spills on roadways or along railroad lines. Considering the current industry standards for transport of such materials, such spills should be infrequent and would have, over the long-term, insignificant impacts. It is assumed that appropriate spill containment and control plans would be in place at the time of operations.

4.2.14.4 Secondary Impacts

Secondary impacts to transportation would occur due to induced population growth. Secondary effects were considered in the transportation impact analysis. As discussed above, most of the analyzed road segments would be able to handle the increased traffic without further improvements. Due to more road use, deterioration of road surface would likely occur more rapidly with project development. Road maintenance would need to be increased to alleviate these problems. A similar situation would occur for increased railroad traffic.

4.2.15 Energy

4.2.15.1 Proposed Action

Table 4.2-32 presents the net energy analysis for Getty production rates of 100,000 bpd and 50,000 bpd of shale oil. As currently designed (100,000 bpd), the proposed action would have a net energy gain of 148.0×10^{12} Btu and the energy output to input ratio would be 3.7:1.

These calculations include all energy requirements and consider mine facilities, process facilities, spent shale disposal, and the various support facilities (e.g., product transport, roads, railroads, water transport). Infrastructure energy due to increased population is also included.

Electrical generation requirements to produce 100,000 bpd of oil would be supplied from outside sources. Projections indicate that Colorado will be a net importer of electricity by 1991, but that currently existing or projected power supply in the project region would be sufficient for the project's electric power requirements.

4.2.15.2 Alternatives

The two alternatives that would have substantial impact on the energy balance of the proposed action would be the 50,000-bpd production rate alternative and co-generation.

The energy requirements needed to produce 50,000 bpd of shale oil are also presented in Table 4.2-32. These figures, as with the 100,000-bpd figures, include mining and processing facilities, spent shale disposal, ancillary support facilities, and infrastructure energy.

The 50,000-bpd alternative shows a net energy gain of 73.6×10^{12} Btu and an energy output to input ratio of 3.6:1. This ratio is slightly less favorable than the 100,000-bpd rate because the 100,000-bpd rate would extract a higher grade raw shale. Consequently, energy expenditures per unit of shale oil would be less.

Co-generation would reduce the amount of electrical energy that would have to be imported to the project site, hence resulting in less impact to the regional energy system.

Table 4.2-32 SUMMARY OF ENERGY BALANCE FOR THE GETTY PROJECT (1×10^{12} Btu/yr)

Energy Type	Proposed Action (100,000 bpd)	Alternative Production Rate (50,000 bpd)
Materials Energy[a]	3.2	1.6
Direct Electrical[a]	19.4	9.7
Fuels[b]	21.6	10.8
Infrastructure[a,c]	10.8	5.8
Total Energy Consumed	55.0	27.9
Total Energy Produced[d]	203.0	101.5
Ratio of Energy Produced-Energy Consumed	3.7:1	3.6:1

[a] Based on data in the Energy Analysis Handbook for oil shale development (BLM 1982d).
[b] Fuel consumption includes liquid and gaseous fuels.
[c] Based on average population numbers (see Section 3.2.13).
[d] Does not include the shale oil used in processing.

Current information on the 100 percent Lurgi retort alternative shows it to be the most thermally efficient alternative due to its ability to process fines and recover maximum energy from the spent shale. If this alternative is implemented, and these benefits prove to be commercially practical, the net energy balance would be somewhat more favorable for the 100,000-bpd and 50,000-bpd production rates. Overall energy recovery from the property would increase by approximately the quantity of shale oil recovered from the extra fines processed, together with the additional energy that would be recovered by the combustion of residual carbon on the spent shale. The overall increase in energy recovered would be in the order of 10 percent. The energy output to input ratio, however, would be increased by a lesser amount (Getty 1983e).

Other alternatives (e.g., spent shale disposal sites, corridor alternatvies, water supply alternatives) would not significantly alter the overall energy balance of the proposed action.

4.2.15.3 Solid/Hazardous Waste and Toxic Pollutants

Handling and disposal of solid wastes, hazardous wastes, and toxic pollutants would not have any impact on the net energy balance of the proposed action.

4.2.15.4 Secondary Impacts

The primary secondary impacts of the proposed action would be the additional energy required for the increased population due to implementation of the project. This additional energy was calculated in the net energy analysis and is shown in Table 4.2-32.

4.3 Cities Service Project Impacts

4.3.1 Topography, Geology, and Paleontology

4.3.1.1 Proposed Action

The proposed Cities Service project mine facilities would include an underground room and pillar mine and a series of vertical modified in situ (VMIS) retort units and a mine bench (which would include mine portal and vents). Considering that the majority of the proposed mine facilities would be located underground, and that the facilities located above ground would represent a small portion of the total project area, direct topographic impacts would be limited. The underground mine would consist of production panels measuring approximately 500 feet wide and 3,200 feet long situated on both sides of the entry drifts. Pillars would measure 60 feet square by 65 feet high, allowing approximately 60 percent removal of the resource. The VMIS retorts would require two void zones as well as an upper air level and a lower production level. The retort size would be 180 feet square feet by 280 feet high (Cities Service 1983b).

An indirect topographic impact due to oil shale mining could be the occurrence of land subsidence. Although specific data on potential mine subsidence is unavailable for the Cities Service site, generalizations can be presented based on previously published information. In general, the amount of land subsidence that would occur as a result of mining would be dependent on the thickness of the material removed, the depth and area of the mine workings, and the nature of the surrounding ground (Blyth and de Freitas 1974). Within the proposed mine tract, the mine zone is to be 65 feet thick with overburden thicknesses ranging from approximately 600 to 800 feet. Based on previous investigations in the area, subsidence at the proposed Cities Service mine site could be 1 foot or less (BLM 1983a). The amount of subsidence would vary at the site as overburden thickness varies and also with potential additional loading from surface facilities such as the shale fines stockpile and waste rock pile. Due to the limited amount of subsidence that is expected, impacts on existing geology and topography are not considered significant. As a result of mine facility development, the paleontological resources of a portion of the Uinta and Green River Formation located within the mine property could be disturbed and/or destroyed.

No detailed information is currently available on the contents, pile design, or reclamation plans for the waste rock disposal pile; however, Cities Service has committed to designs in compliance with all appropriate regulations. In general, such a disposal site would be graded to conform with existing project area topography and reclaimed so plant species may be established to limit erosion. If proper grading and reclamation is accomplished, impacts would be insignificant.

No detailed information is currently available on the contents, pile design or reclamation plans for the shale fines stockpile; again, all designs would be in compliance with applicable regulations. In general, such a disposal site would be graded to conform with existing project area topography and reclaimed so plant species may be established to limit erosion as a result of runoff and eolian processes. Impacts would be insignificant if grading/reclamation is properly conducted.

The proposed process facilities include the raw shale stockpile, secondary feed preparation, retorts, and upgrading. All of these facilities are to be located on the plateau. Direct impacts include surficial disturbances and the disturbance of paleontological resources during construction.

Spent shale would be disposed in Conn Creek and Cascade Canyon as described in Section 2.3.2. The surface disposal of spent shale in Conn Creek and Cascade Canyons potentially would create several impacts. Since canyon lands are to be filled with spent shale to near cliff level, the impact to topography is obviously significant. As a result of this valley infilling, diversion structures and berms would be installed, as necessary, to limit erosion by runoff or mass-wasting processes. An embankment structure located at the toe of the disposal pile and as described above would be constructed to prevent mass movement of the spent shale. A subsurface drainage collection system would also be constructed at the base of the spent shale piles to limit saturation of the spent shale. Also, since the spent shale piles would cover outcrops of the Green River Formation, potential paleontological resources exposed or near the surface would be buried.

The proposed project would include corridors for product transport, power, road, and water. Several possible corridors have been proposed, which include a general service corridor located in Conn Creek and several power, water, and product transport corrridors located on the plateau. General impacts of the plateau corridors would include topographic and paleontologic disturbances. These impacts would essentially be localized and can be mitigated. To reduce impacts to topography, proper reclamation methods should be applied after construction. Impacts to paleontological resources could be reduced by implementing a detailed paleontological survey in the study area before or concurrent with the construction of the corridors.

The proposed water supply sytem would include the use of the GCC reservoir and related facilities proposed for the Roan Creek valley and on the Colorado River. The potential impacts of the development of this water system on topography, geology, and paleontological resources has been previously described (BLM 1983a).

4.3.1.2 Alternatives

The production rate alternative is underground mining at 40,000 bpd with VMIS production at 10,000 bpd. It is not clear as to whether the extent of planned mining would remain the same as the proposed action, and thus impacts due to mining would not change.

No significant changes in impacts to topography, geology, or paleontological resources would occur as a result of reducing production from 100,000 bpd to 50,000 bpd.

Lurgi-type retorts represent an alternative technology to the proposed use of the Union B retorts. The use of the Lurgi-type retorts could result in a reduction of the potential geological hazards associated with the spent shale piles. Spent shale from the Lurgi process has better cementing properties than the Union B-type spent shale (Bates 1983). The cohesiveness of the Lurgi-type spent shale could reduce the erosion of the spent shale piles by sheet wash and mass-wasting processes.

Process facility alternatives would include a change in the type of retort to be used and the processing of shale fines on site. No significant change in impacts to topography, geology, and paleontological resources would occur as a result of a change in the type of retort employed. A significant reduction in the impact to topography would result due to the processing of shale fines on site. The processing of fines would eliminate the need for a shale fines disposal pile on the mesa, but would create spent shale of a finer particle size than the proposed action.

A spent shale disposal alternative would be a combined facility located in Cascade Canyon and the plateau. No significant reduction in impacts to topography, geology, or paleontological resources would occur as a result of the proposed alternative.

No significant reduction in impacts to topography, geology, or paleontological resources would occur as a result of the develoment of the Rangely or North corridor. The Rangely corridor is described in BLM (1983a).

An alternative to the development of the Cities Service portion of the GCC intake would be the construction of a diversion structure from the Larkin Ditch, a sedimentation basin, a pumping station, and a pipeline to the Cities Service site. Impacts to topography, geology, and paleontological resources from use of this alternative would be similar to those resulting from the proposed action. The Larkin diversion system, including the sedimentation basin and pump station, would be located within the 100-year floodplain, and therefore would require special design and construction considerations.

4.3.1.3 Solid and Hazardous Wastes and Toxic Pollutants

The disposal of solid wastes at the project site and the disposal of hazardous and/or toxic wastes in an existing facility off-site should not significantly impact topography, geology, or paleontological resources.

4.3.1.4 Secondary Impacts

The population and economic growth associated with development of the Cities Service project would result in the expansion of existing residential centers and possible development of new areas. Topography would be impacted locally by construction-related activities for roads, housing, and other structures to support the growing population. Geologic impacts would include the use of locally derived mineral resources, such as sand and gravel, or coal. The exploitation of these resources locally is considered to be a beneficial use. Paleontological resources would also be impacted by construction related activities for buildings and roads. Regrading activities and excavations could expose or bury fossil collection localities.

4.3.2 Surface Water

4.3.2.1 Proposed Action

The proposed Mahogany Zone underground mine would underly the upper Conn Creek drainage system in the Cities Service project area. The main surface features of the proposed underground mine would be the mine bench, primary crushing facilities, and services facilities. The mine bench area would be located on the upstream end of Cascade Canyon. Surface water impacts resulting from these facilities would be limited to minor increases in runoff and sedimentation in the upper Conn Creek drainage.

The waste rock would consist primarily of raw, low-grade oil shale. A total of 4.6×10^6 cubic yards of waste rock would be generated from mine development and production mining. The disposal site would be located at the headwaters of Conn Creek in the northern part of the Cities Service property. Surface water impacts associated with this waste rock disposal site should be minimal due to the installation of a downstream collection dam to impound runoff water from disposal pile. Three springs that have been identified would be covered by the waste rock pile. Suitable underdrain facilities would be provided to divert spring flows. These springs contribute to the stream flows of upper Conn Creek during base flow periods.

A total of 41.2×10^6 cubic yards of shale fines would be generated from the production mine consisting of particles less than 1/8-inch in nominal diameter. These particles would have the general characteristics of raw oil shale. The raw shale fines storage site would be located on the plateau in the headwaters of Conn Creek canyon, just south of waste rock disposal area. The shale fines storage pile would be susceptible to water erosion due to its fine grain characteristics. Surface runoff from the pile could also contain high concentrations of dissolved solids and organic carbon. Since the shale fines storage pile would be located upstream of the spent shale disposal area, all runoff from disturbed areas would be discharged into the spent shale disposal area. There would be no direct impacts on lower Conn Creek except the short segment of the stream channel, downstream of the shale fines storage pile.

The proposed plant site would be located on the ridge between upper Conn Creek and Cascade Canyon, upstream of the spent shale disposal area. The main processing facilities would include crushing and screening, retorts, upgrading, VMIS facilities, coarse shale stockpile, raw and upgraded shale oil storage, a water treatment plant, and utilities and service facilities. Surface water impacts associated with these facilities are mainly soil erosion and sedimentation. Surface runoff from the plant site could have high concentrations of certain constituents including suspended solids, oil and grease, and dissolved solids. Again, there would be no direct impacts on lower Conn Creek since all the sediment and runoff from the plant site would be controlled in the process wastewater treatment facilities.

The spent shale disposal site would be located within upper Conn Creek and Cascade Canyon. At ultimate capacity, approximately 500 million tons of spent shale would be generated and would cover approximately 800 acres of surface area. Runoff from the disposal area would be collected in a sedimentation dam below the spent shale pile. Surface flow from Conn and Cascade creeks would be diverted around the pile in lined culverts. Surface water impacts here would include soil erosion/sedimentation, and potential water quality degradation due to surface runoff potential leachate from the spent shale pile. In the unlikely event of dam failure of the downstream collection dam, the cumulative effects of surface runoff from upstream waste rock and shale fines piles and plant site could aggravate water quality impacts on lower Conn Creek. Field leaching tests have shown that anionic species such as boron, fluoride, molybdenum, and selenium can be leached out from the retorted shales by percolating water. Stream flows of Conn Creek could be reduced, especially during low flow periods, as the result of springs disruption, surface runoff interception by spent shale pile, and reduction of recharge area.

Various corridors for access roads, railroad spurs, water pipelines, natural gas pipelines, transmission lines, and syncrude pipelines are proposed for the project. Surface drainages that would be disturbed by these corridors during construction and operation include Roan Creek, Clear Creek, Conn Creek, and West Fork of Parachute Creek. Soil erosion/sedimentation, and streamflow disruption are expected at the intersection of corridor crossings and stream drainageways during the construction stage. In addition, accidental spills from the syncrude pipeline could also cause water quality degradation in the West Fork of Parachute Creek.

4.3.2.2 Alternatives

The alternative mining method would be an underground room-and-pillar mine without the VMIS mining process. Surface water impacts would be essentially the same as those of proposed action, due to the substitution of additional surface retorts for the eliminated VMIS surface facilities.

The 50,000-bpd production rate alternative would produce smaller amounts of waste rock, shale fines, and spent shale on a daily basis. Surface water disturbances over the short-term would be less than the proposed action, due to the reduction of storage areas for waste rocks, shale fines, and spent shale. Total project daily water requirement would also be reduced. However, overall impacts over the life of the project would be the same as the proposed action.

The Lurgi alternative process technology would generate smaller particle size spent shale material, compared to the proposed Union retort technology. It would therefore require more water for spent shale moistening. In addition, more sour water would be produced by the Lurgi process, as compared to the Union retort process. Surface drainages downstream of the spent shale disposal and plant site could be subject to higher water quality impacts.

The Cascade Canyon alternative spent shale disposal area would be used in conjunction with a mesa site above the canyon. This alternative would disturb more surface drainage area and several mesa springs which contribute to the stream flows of Conn Creek. In addition, spent shale disposal piles and embankments in Cascade Canyon would be more susceptible to water erosion and potential leaching.

Impacts of the alternative Rangely product pipeline corridor are addressed in the CCSOP EIS (BLM 1983a). Surface water impacts would be similar to the proposed LaSal pipeline corridor except that the impacts occur on a different drainage. The alternative North product pipeline corridor starts from the Cities Service property and runs directly north to the LaSal pipeline. The North corridor would generate increased construction impacts since it crosses several drainages of Parachute Creek. This corridor intersects the LaSal pipeline downstream of a stock pond in the headwaters of West Fork of Parachute Creek, which supports a wide variety of fish species. Accidental damage to the syncrude pipeline would, therefore, not cause direct water quality impacts on the stream flow and water in the stock pond.

The alternative water supply would involve the installation of a pumping structure off the Larkin Ditch (just east of De Beque) for pumping of water to the proposed GCC reservoir. This alternative would require construction of a pumping station at the ditch, a sedimentation basin, and a water pipeline. In addition, a sedimentation basin would be located within the floodplain of Colorado River. This basin could restrict river flow conveyance to a minor degree during flood flow events.

4.3.2.3 Solid/Hazardous Wastes Disposal

All nonhazardous solid waste would be disposed in the spent shale disposal area. No additional surface water impacts are anticipated. Some hazardous waste could be generated by the retorting and upgrading process. Hazardous waste disposal would be off-site in a licensed facility. There would be no surface water impacts in the vicinity of the Cities Service property.

4.3.2.4 Secondary Impacts

Secondary impacts to surface water would result form increased population in the region. These impacts could include increased water consumption, potential water contamination from wastewater and solid wastes, and increased suspended solids in streams due to development activities adjacent to the streams.

4.3.3 Ground Water

4.3.3.1 Proposed Action

Underground mining would remove a portion of the Mahogany Zone. Direct disturbance of subsurface strata would, therefore, be limited to this zone and immediate over- and underlying strata. As discussed in Section 3.3.3, water-bearing intervals identified beneath the Cities Service property occur above this mining interval. The potential for ground water inflow into the mine workings is, therefore, predicted on the degree of interconnected fractures between the oil shale horizon and overlying leached interval in the Upper Parachute Creek Member of the Green River Formation.

Existing data are not adequate to precisely evaluate the potential for this interconnection. Data from the adjacent Chevron property, however, indicate that relatively insignificant inflows of approximately 1 gpm can be anticipated during mining from strata immediately adjacent to the mine interval. Total inflows estimated for the underground portion of the Chevron property are in the range of 100 to 1,500 gpm (BLM 1983a). Limited data for the Cities Service property, and the Pacific property to the south, indicate the apparent presence of a thick zone of relatively impermeable strata separating the mining zone from the Upper Parachute Creek/Uinta Aquifer. If this intervening zone remains relatively unfractured beneath the proposed mine area, inflows from overlying strata should be minimal. Similarly, limited inflows would reduce the potential for potentiometric impacts (i.e., lowering of aquifer water levels) resulting from the underground mine. The low hydraulic conductivities for both the Mahogany and the Upper Parachute Creek zones would restrict the potential for any decline in potentiometric levels from propagating outside the property boundaries, where existing ground water use has been identified.

The effect of ground water flow from underground mining should also be minor. Vertical gradients have been identified on most adjacent properties. Such a gradient could be steepened somewhat if fracturing allows inflow from the overlying aquifer. Flow within the Uinta Formation and appurtenant spring discharge points should not be significantly affected by the proposed underground mine.

There is potential for increased ground water impacts associated with the VMIS underground retort. The use of explosives in the retorting process could propagate fractures outside of the immediate mined interval which extends above the Mahogany zone. It is possible that the overlying competent Upper Parachute Creek Member marlstones would be significantly affected; if less competent zones occur, however, they could exhibit some additional interconnection which could potentially increase the hydrologic interconnection between the mined interval and overlying aquifers. If such a phenomenon were to occur, increased inflows to the underground mine might result. These inflows would likely be exposed to rubblized shale and process gases. Concentrations of dissolved solids, including trace metal and organic constituents could, therefore, increase. Careful handling of such water would be required to ensure that contamination of off-site ground and surface water systems does not occur.

Further fracturing of overlying strata could occur if subsidence results from the eventual abandonment of underground workings. The degree of subsidence would be a function of the void space at the top of the rubblized zone. It is expected that little void space would be present and thus little subsidence will occur. If subsidence fractures intersect the overlying Upper Parachute Creek aquifer, increased inflows to the underground workings may occur. The magnitude and duration of any potential increase in flows cannot be predicted accurately.

Water quality impacts associated with the underground mine should similarly be minor. The quality of existing ground water in the Mahogany Zone and Upper Parachute Creek Members is generally good. Ground water inflow to the mine would be discharged in such a manner so as to minimize contact with soluble mined spent shale materials, restricting the potential for infiltration of higher TDS waters. As discussed previously, proper handling of mine inflows would be particularly critical in areas of VMIS retorting where exposure to rubblized shale and process gasses is more likely.

Waste rock disposal would occur at the upper end of an ephemeral draw in the headwaters of Conn Creek. The waste rock pile would be placed largely on sandstone and marlstone strata of the Uinta Formation at this location. One stream emanates from the Uinta strata approximately 600 feet downgradient (about 10 feet lower in elevation) from the toe of the waste rock pile.

Drainage control and pile underlining measures would be installed in compliance with appropriate regulations. Any precipitation and runoff in contact with the pile could increase the TDS levels for water draining the area. Runoff from the waste pile would probably drain into the spent shale disposal area and then into the collector dam below the spent shale pile. No design details are currently available for this dam, but it would potentially include a key/cutoff trench or similar feature to preclude seepage losses via alluvial underflow. Such design criteria would be addressed as a part of the permitting process. Some water could infiltrate, however, creating a localized recharge to the Uinta Formation of high(er) TDS water. Down-gradient spring discharge could, therefore, exhibit increases in TDS concentrations. High sodium, calcium, sulfate, and bicarbonate concentrations could accompany the higher TDS levels.

The shale fines stockpile would be situated down valley from the waste rock pile. Two springs occur above this location, providing up to 60 gpm (0.13 cfs) of surface flow or alluvial underflow. Ground water impacts associated with this storage would be similar to that discussed above for the waste rock disposal. The opportunity for exposure to precipitation/runoff should be somewhat more restricted by timely reclamation (revegetation) of the fines stockpile. No more than 1 acre of this pile would be exposed at any one time. Given the steeper drainage gradient within and below this pile, it is likely that most effluent would not infiltrate, but rather follow the drainage course into the spent shale disposal area.

Impacts associated with process facilities — including the raw shale stockpile, secondary feed preparation, retorting and upgrading, and associated surface disturbances — should be minor. Only the stockpiling of raw shale could pose a significant potential for ground water contamination. Such contamination would be minimized by two factors: (1) storage would be a transient phenomenon, with continual removal and addition of materials; consequently, the limited exposure of raw shale involved with stockpiling and conveyance to feed prep should restrict generation of leachate; and (2) drainage design around the stockpiles could minimize the potential for infiltration or off-site migration of any leachate that might be generated.

Prudent operation and maintenance of the remaining facilities should restrict the potential for contamination by infiltration of accidental spills.

The extent and magnitude of ground water impacts from disposal of spent shale would be dependent on the effectiveness and long-term stability of the liner system. The spent shale disposal area could potentially be a significant source of leachate which, in turn, could contaminate the alluvial aquifer of Conn Creek below the disposal area. Generation and migration of leachate from the disposal area would require both saturation of the spent shale and existence of a pathway by which leachate could leak.

Saturation of the spent shale pile could occur by surface water runoff, spring discharge above the pile, and direct precipitation. Cities Service proposes to control surface water flow, including that generated by spring discharge above the disposal pile by means of an impoundment downstream of the disposal site, and culverts diverting flow from above the disposal area. Assuming that all upstream flow is successfully diverted or retained in header dams as necessary, saturation of the spent shale should be limited to potential infiltration of precipitation and surface water runoff lateral to the disposal pile. Cities Service proposes to inhibit these waters from contact with the pile by construction of a compacted spent shale liner, 10 feet in thickness, to surround the area. Construction of the top blanket or overlining is to be accomplished in a timely manner such that no more than 20 acres of retorted material will be exposed at any one time.

Despite these precautions, some saturation of the spent shale would occur from accumulation of precipitation during periods when the pile is exposed. Construction of the underlining 10-feet which is intended to preclude infiltration of these waters from the spent shale pile into bedrock strata below. Given the topographic conditions, including steep 1:1 valley side slopes, it is unlikely that a fully impenetrable barrier could be constructed. It is, therefore, possible that leachate seepage below the liner could occur, and not be collected in the downstream impoundment. If such seepage occurs, it could follow fracture systems within the shallow bedrock beneath the disposal area, with potential infiltration into bedrock aquifer(s), or movement downward into the Conn Creek canyon alluvial aquifer.

The magnitude of potential leakage cannot be predicted at this time. Losses would be dependent upon the long-term reliability of the liner system. Weathering/erosion of liner material could occur on the surface and below, exacerbating pre-existing leachate production/migration. Additional design details, including such potential features as rock drains beneath the lining are not currently available. Appropriate design characteristics will be necessarily incorporated during the permitting process. If leachate migration does occur, studies reported in the CCSOP EIS (BLM 1983a) indicate that higher concentrations of sulfate, cationic salts, ammonia, cyanide, other trace ions, and organic compounds could be introduced to the hydrologic system. Additional organic compounds may be present from the codisposal of wastewater from the upgrading plant. Permitting under applicable RCRA and TSCA standards would be necessary.

No significant ground water impacts are anticipated to occur from the construction of product transport, utility, road, railroad, and water corridors. Increases in TDS concentrations could occur during construction via infiltration of waters draining the distrubed areas. Such infiltration would be more prevalent along the Roan/Conn Creek alluvial areas than on upland areas (e.g., syncrude pipeline, access roads) underlain by bedrock. Any increase in TDS concentrations so occurring, however, would be short-term in nature.

4.3.3.2 Alternatives

Utilization of an all underground room and pillar mine would result in similar impacts as those described for the proposed action, except on a reduced scale. The potential for creation of artificial fracturing during the VMIS process, and associated impacts would be eliminated.

Ground water impacts associated with a 50,000-bpd production rate would be essentially the same as those described for the 100,000-bpd proposed action. Surface and underground disturbance would occur at a reduced rate, however, thereby potentially decreasing the magnitude of any impacts, but increasing the duration.

Impacts associated with alternative retort technologies and appurtenant facilities should be similar to those described for the proposed action. However, spent shale derived from the Lurgi retorting process may cement more readily upon the potential for erosion and/or leachate generation may be reduced. Effective and timely revegetation of the pile would be necessary for this potential to be lessened.

Processing of shale fines on site should have a similar net impact as the proposed action. Whereas some increased exposure to runoff/spring discharge could occur from these temporary piles (the stockpiles in the proposed action are to be covered), such contact should be offset by reduced potential for saturation due to the constant addition and removal of fines to and from the pile(s).

Disposal of spent shale in the alternative areas could result in slightly less ground water impacts than for the proposed action. These potentially lessened impacts could result from two factors:

1. Over half of the alternative disposal area encompasses areas of flatter topographic relief, potentially enhancing the effectiveness and stability of the compacted underliner.

2. All disposal would occur within a single drainage system (Cascade Canyon) instead of two. Six of the 11 springs flowing into the proposed action site from above will not affect the alternative sites.

It is important to note that since the upper alternative disposal site would be on the plateau, leachate from this disposal site would have a greater potential for contamination of the Uinta/Upper Parachute Creek Member bedrock aquifer than exhibited at the proposed site. Furthermore, the location of the alternative site proximal to the topographic and ground water divide could allow some generated leachate to migrate into the West Fork of Parachute Creek, heretofore, largely unaffected. In general, contaminant migration into bedrock strata could be considered less significant (but still important) than contamination of alluvial deposits such as those within the Conn Creek canyon below the plateau. Ground water use in the area is more extensive in such unconsolidated aquifers. The precise impact potential rests necessarily more with the reliability of the protection system, including liners, that with specific locations.

No significant ground water impacts are anticipated for the Rangely and North corridors. As described for the proposed action, potential increases in ground water TDS concentrations resulting from drainage (and infiltration) of disturbed areas should be short-term in duration and minor in magnitude.

No significant ground water impacts are anticipated from the Larkin Ditch intake and pumping system.

Nonhazardous wastes would be disposed of in the spent shale disposal area. As such, no impacts to the ground water regime are anticipated provided that the integrity of the liner material is not endangered. Hazardous waste would be disposed of in an off-site, licensed facility; no significant ground water impacts are anticipated assuming appropriate regulatory standards are followed.

Toxic pollutants could be generated during the Union B retort and VMIS processes. It is assumed that retort waters would be utilized to provide remoisturization of the spent shale, thereby introducing such trace metals as arsenic and lithium and various organic constituents. Impacts associated with this disposal would, therefore, be predicated on the effectiveness of the liner system to prevent production and migration of leachate. Leakage from the spent shale disposal pile could allow contamination of ground water below Conn Creek and Cascade Canyon. Additionally, airborne pollutants could settle in the area soils, also providing potential ground water contamination if leached and transported by infiltrating precipitation. Further discussion of potential airborne contaminants is provided in Section 4.3.8.

4.3.3.4 Secondary Impacts

Secondary impacts associated with population growth should be limited to: (1) depletion of ground water resources if such a source is required for domestic/municipal supply, and (2) short-term increases in dissolved solids concentration if runoff from disturbed areas (e.g., housing construction) is allowed to infiltrate. Although no ground water use is proposed for the Cities Service project itself, concomitant industrial development could create such a demand. Furthermore, waste disposal areas required to support population increases could create localized areas of ground water contamination if they are not properly designed, constructed, and maintained.

4.3.4 Aquatic Ecology

4.3.4.1 Proposed Action

Impacts to aquatic ecology as a result of the development and operation of the Cities Service project would be minimal since the drainages affected are mostly intermittent and no fishery exists within the project area. Conn and Cascade creeks would be the streams that would receive impacts due to the proposed project. Impacts related to the diversion of water from the Colorado River as a result of the development of the GCC Roan Creek reservoir have been addressed in the CCSOP EIS (BLM 1983a).

The most significant impacts of the proposed action would be those associated with the development and operation of the spent shale disposal area located in upper Conn Creek and Cascade Canyon. The deposition of shale in the area would physically cover approximately 1 mile of Cascade Canyon and 2 miles of the Conn Creek drainage. The relocation of Conn Creek resulting from the construction and operation of the disposal site would be a minor adverse impact, since the drainage is intermittent and no fishery resource or habitat would be eliminated.

In the unlikely event of liner failure, toxic substances carried in spent shale leachates could contaminate Conn Creek and lower Roan Creek. The impact on Conn Creek would be insignificant since the stream is intermittent and no fishery exists. The extent of possible contamination of Roan Creek cannot be quantified at this time; however, assuming proper construction and containment techniques are employed, it is doubtful that lethal levels would occur.

In the unlikely case of a catastrophic event (i.e., dam breakage), the spent shale and its associated toxic elements would produce significant adverse impacts on Conn and Roan creeks. All aquatic habitat of Conn Creek would probably be destroyed and toxic substances would enter the proposed Roan Creek reservoir. The extent of the contamination of Roan Creek cannot be quantified at this time; however, total loss of aquatic life in the reservoir cannot be ruled out. Deterioration of the disposal site after project abandonment could result in similar impacts as those described above.

The construction of corridors, plant facilities, and the mine portal would affect Conn and Cascade creeks. The impacts would not be significantly greater than those caused by development of the spent shale disposal site. The waste rock and shale fines stock piles located in the headwaters of the Conn Creek drainage would also have no additional aquatic ecology impact.

4.3.4.2 Alternatives

The Larkin Ditch water intake alternatives would cause impacts to aquatic organisms. Additional withdrawals from the Colorado River beyond those addressed for the GCC water supply system would not occur as a result of the Larkin Ditch alternative (Goodwin 1983; see previous analysis in BLM 1983a).

4.3.4.3 Solid/Hazardous Wastes and Toxic Pollutants

Impact to aquatic resources could result from transportation accidents to an off-site facility. Severity of potential impacts would be dependent on the magnitude of the spill and proximity to water bodies.

4.3.4.4 Secondary Impacts

The most significant secondary impacts would be those resulting from increased fishing pressure and water consumption caused by project-induced population growth. Increased municipal/domestic water consumption pressure would impact those surface waters which are already heavily utilized, such as Carr Creek and the Aspinall (Curecanti) Unit dams on the Gunnison River. Other secondary impacts would result from increases in point and nonpoint discharges associated with sewage treatment plants, housing developments, construction, and other activities necessary to support the increased population.

Fishes in the Colorado River, including the rare species, would be affected by the commercial extraction of gravel from the Colorado River floodplain. Such extraction, for construction at the plant sites as well as for homes and service structures for the employees of Cities Service could be extensive. Gravel pits have been identified as prime habitat for predacious exotic species, and their proliferation could be detrimental to the native species, especially the rare forms (Valdez et al. 1982).

4.3.5 Soils

4.3.5.1 Proposed Action

The types of direct soil impacts of the Cities Service proposed action are those discussed in the common impacts section (4.1.5). Changes to the erosion rates (weighted averages) and prime farmland losses are presented in Table 4.3-1. The calculated incremental soil loss for surface disturbance areas is about 149,000 tons, a 47 percent increase over undisturbed soil loss. Due to the topsoil salvage program described in Section 2.3.1, most of the soil loss is expected to be less valuable subsoil. The greatest contributing area of incremental soil loss is the GCC reservoir having a calculated incremental soil loss of 89,900 tons. This soil loss is primarily a function of its surface disturbance (the largest of all components of the proposed action) and high wind erosion disturbance rate of 10 tons/acre/year. Most prime farmland loss or disturbance is expected to occur in the Roan Creek corridor or GCC reservoir, affecting up to 1,324 acres.

The erosion rate and soil and prime farmland losses anticipated are outlined in Table 4.3-1, and are based on the successful achievement of the conceptual reclamation plan described in Section 2.3.2. If reclamation goals are not achieved, more adverse erosion rates and increased soil loss should be expected.

Acid-precursor pollutants, SO_2 and NO_x, would be emitted from the retorting facilites. In the canyon valleys and low semi-arid lands, soils are relatively well buffered with the pH ranging from 6.8 to 9.0, hence would not be impacted. At higher elevations (the Roan Plateau), soils range in pH from 5.5 to 7.8, and they receive much greater precipitation (18 to 22 inches) making them more subject to acid rain impacts. However, due to the neutral pH range of the Uinta formation (soil parent material source rock), more than slight changes to the pH of the higher elevation soils is not expected. More importantly, these slight changes would probably not affect the vegetative productivity of the soil.

4.3.5.2 Alternatives

Prime farmland acreage loss, incremental soil loss, and erosion rates for the North power and syncrude corridor, Mesa/Cascade spent shale area, and Larkin Ditch alternatives are presented in Table 4.3-1. The mine type, retort type, and retort technologies have impacts similar to that of the proposed action.

4.3.5.3 Solid/Hazardous Wastes and Toxic Pollutants

Solid/hazardous materials would be handled by a hazardous waste disposal company and stored off-site in facilities designed to prevent contamination to the surrounding environment. A contingency plan for accidental spills would likely be implemented. Therefore, no impacts to the soil resulting from transportation of solid/hazardous wastes and toxic pollutants are expected.

4.3.5.4 Secondary Impacts

Anticipated secondary impacts include prime farmland and erosion losses resulting from accelerated urban (residential, industrial, and commercial) development. Prime farmland and accelerated topsoil and subsoil erosion losses, due to urban growth have been occurring for many decades in the Colorado River valley from Glenwood Springs to Fruita, and would continue as a result of the proposed action. Urban growth onto prime farmland would occur primarily because prime farmland is also well suited for urban development. Assuming that secondary impacts of urban development occur partially on prime farmland, the amount that would be permanently lost to such development as a result of this project is estimated at 1,000 acres. Loss of soil through erosion at urban development areas may exceed direct soil loss of the project.

Table 4.3-1 APPROXIMATE PRIME FARMLAND AND SOIL LOSS COMPARISONS OF THE CITIES SERVICE PROPOSED ACTION AND ALTERNATIVES[a]

	Water Erosion Rates (weighted average)		Wind Erosion Rates (weighted average)				
	Undisturbed (tons/ac/yr)	Disturbed (tons/ac/yr)	Undisturbed (tons/ac/yr)	Disturbed (tons/ac/yr)	Temp. or Perm. Prime Farmland Loss (acres)	Incremental Soil Loss (acres)	Percent Increase Over Undisturbed Soil Loss
Proposed Action							
Retorts, Upgrade and Mine Area	2.2	5.0	0.1	2.2	0	7,280	50
Conn & Cascade Canyon Spent Shale Disposal	3.4	4.0	0.1	11.7	0	64,220	83
Shale Fines Stockpile	1.8	7.5	0.1	2.5	0	23,050	10
Waste Rock Pile	1.3	5.7	0.1	2.5	0	4,230	113
GCC Reservoir	1.6	2.4	0.1	10.0	463	89,880	105
Power, Water Corridor	1.9	7.0	0.1	2.5	0	1,320	63
Conn Creek (Rail, Road, Power, Water) Corridor	3.7	5.2	0.1	10.0	861	57,000	50
Mesa-top (Syncrude, Power) Corridor	1.4	5.4	0.1	2.5	0	8,370	71
Natural Gas Pipeline	1.8	6.7	0.1	2.5	0	1,980	64
Mine Bench	3.9	4.6	0.1	9.0	0	12,400	40
LaSal Pipeline	2.1[b]	22.6[b]	0.1[b]	0.5[b]	0[b]	11,470[b]	95
Common Power & Syncrude Corridor	1.8	6.5	0.1	2.6	0	1,600	38
TOTAL					1,324	282,800	74
Alternatives							
Mesa/Cascade Spent Shale	4.1	3.1	0.1	10.4	0	50,570	28
Rangely Pipeline	2.6[b]	14.9[b]	0.1[b]	0.5[b]	0[b]	10,740	47
North Corridor	1.7	6.4	0.1	1.8	0	21,400	95
Larkin Ditch - Settling Pond	.14	1.3	0.1	12.0	46	670	549

[a] Erosion rate and soil loss calculations were made using the Universal Soil Loss and Wind Erosion Equations. Although these equations were developed for use in mid-western cropland areas, modifications by the SCS facilitate calculations with a reasonable amount of accuracy in semi-arid and mountainous areas, at least equal to the accuracy of the soil survey data used in these calculations.

[b] Description of impacts obtained from the CCSOP EIS (BLM 1983).

4.3.6 Vegetation

4.3.6.1 Proposed Action

Vegetation and Productivity

Direct impacts to vegetation and productivity of the Cities Service proposed action are summarized in Table 4.3-2. Vegetation disturbance and removal required for construction of project facilities, spent shale and waste rock disposal, reservoirs, and corridors would affect approximately 3,100 acres of native vegetation and 10 acres of agricultural land (pasture). If project decommissioning and reclamation includes all disturbance sites except roads and railroads, then approximately 27 percent of the potentially affected area, or 827 acres, would be residually affected by vegetation removal. However, processed shale cannot be successfully revegetated without continuing inputs of water and fertilizer (Redente and Cook 1981). Although the processed shale pile wwould be revegetated during the life of the project, these inputs would not be provided following project decommissioning. Therefore, as the topsoil erodes away and the processed shale becomes the soil parent material, 868 additional acres of vegetation could be permanently lost.

Most of the vegetation of the affected area has moderate to high revegetation potential. However, desert shrublands (in canyon bottoms), barren areas, Douglas-fir woodlands, and riparian areas covering 28 percent (884 acres) of the affected area, have low revegetation potential. Reestablishment of vegetation in these areas would be relatively difficult and costly.

Impacts to vegetation productivity during project construction and operation could be locally significant to some ranching operations. Affected productivity is summarized in Table 4.3-2. Available data suggest that up to 608 Animal Unit Months (AUMs) could be lost annually by direct removal of vegetation. Operational impacts to vegetation from fumigation by gaseous stack emissions and coating of plants by fugitive dust and particulate emissions could also decrease productivity.

In terms of affected acreage and productivity, the single most significant impact to vegetation would be the disposal of processed shale in Conn Creek and Cascade canyons. This action would remove 868 acres of native vegetation and would result in the loss of 117 AUMs annually. Although the processed shale pile would be revegetated during the operation of the project long-term revegetation success is unlikely due to the characteristics of processed shale as a soil parent material.

The Conn Creek multiple-use corridor would be the only Cities Service project action to directly affect agricultural lands. Approximately 10 acres of irrigated hayland, producing 158 AUMs annually, would be lost.

Threatened and Endangered Plant Species

Detailed descriptions of potential project impacts to plant species of special interest are presented in a Biological Assessment prepared for the Getty and Cities Service projects (Beck 1983a; see Appendix B). The following discussion represents a summary of the information presented in the Biological Assessment.

Table 4.3-3 summarizes the potential impacts of the Cities Service project on special interest plant species. Project effects on these plants primarily result from construction in the multiple-use corridors and from spent shale disposal in Conn Creek and Cascade Canyon. Such project actions could adversely impact known populations of Uinta Basin hookless cactus, Barneby columbine, dragon milkvetch, sedge fescue, Sevier blazing-star and sunloving meadow-rue. Construction of project facilities in the Roan Creek multiple-use corridor could affect two known populations of Uinta Basin hookless cactus and one known population of De Beque phacelia.

The raw shale fines stockpile and waste rock disposal pile, located on the plateau, would reduce surface water flow into Conn Creek canyon and, hence, may affect the Barneby columbine and sullivantia habitats located near the waterfall. The proposed mine bench and associated surface facilities could adversely impact known

Table 4.3-2 DIRECT IMPACTS OF THE CITIES SERVICE PROPOSED ACTION ON VEGETATION AND PRODUCTIVITY[a]

Project Components	Acreages of Affected Vegetation Types[b]													Wetlands			Total Potentially Affected Acreage	Affected Annual Production[c]	
	AG	AW	BL	BLH	DF	DS	GL	GR	OB	PJ	PS	US	VSB	P	R	RW		TOP	AUM
Mines and Process Facilities		10.5									153.0		31.5				195.0	63.3	31.2
Waste Rock Disposal Pile		4.5									43.5	3.0	33.0				84.0	24.3	11.6
Raw Shale Fines Stockpile		76.5							9.0		262.5		40.5		72.0		460.5	142.7	74.6
Conn/Cascade Canyon Spent Shale Disposal			6.0		12.0				4.5	3.0	103.5	519.0	127.5		93.0		868.5	240.3	117.3
Conn Creek Multiple-Use Corridor	10.5		3.0	4.5	7.5	28.5	6.0			75.0	90.0	123.0	91.5		9.0	4.5	453.0	240.7	211.9
Cities Natural Gas Corridor									15.0		34.5		10.5		1.5		61.5	18.7	9.1
Cities Property Multiple-Use Corridor		53.0	42.0						25.5		102.0	54.0	78.0		9.0		363.5	106.4	54.4
Cities Property Power and Water Corridor									16.5		40.5		7.5		6.0		70.5	20.7	10.2
Cities to Getty Power and Syncrude Corridor		27.0									171.0	1.5	127.5				327.0	96.7	46.7
Getty/Cities Service Common Power & Syncrude Corridor		24.0						6.0			75.0	90.0	27.0		4.5		226.5	80.8	40.9
TOTAL	10.5	195.5	51.0	4.5	19.5	28.5	6.0	6.0	70.5	78.0	1,075.5	790.5	574.5	0.0	195.0	4.5	3,110.0	1,034.6	607.9
Percent of Total																			

[a] Acreage values determined by USFWS.

[b] AG = Agricultural
AW = Aspen Woodland
BL = Barren Land
BLH = Barren Land/Herbaceous
OS = Oakbrush Shrubland
P = Palustrine Wetland
PJ = Pinyon-Juniper Woodland
PS = Plateau Sagebrush Shrubland
DF = Douglas-fir Woodland
DS = Dry-slope Shrubland
GL = Grassland
GR = Greasewood Shrubland
R = Riverine
RW = Riparian Woodland
US = Upland Shrubland
VSB = Valley Sagebrush Shrubland

[c] TOP = Thousands of Pounds
AUM = Animal Unit Months

Table 4.3-3 RELATIONSHIPS OF THE CITIES SERVICE PROPOSED ACTION COMPONENTS WITH RARE SPECIES

			Facility Site[b,c]									
Plant Species	Common Name	Status[a]	MF	PF	WP	RS	CS	CM	RM	NG	PW	PS
Aquilegia barnebyi	Barneby columbine	Category 2	X		X	X	X	X			X	
Astragalus lutosus	Dragon milkvetch	Category 2	O				X	X				
Festuca dasyclada	Sedge fescue	Category 2	X				O					
Mentzelia argillosa	Sevier blazing star	Category 1	O				X	X				
Phacelia submutica	DeBeque phacelia	Category 1							X			
Sclerocactus glaucus	Uinta Basin hookless cactus	Threatened						X	X			
Sullivantia hapemanii v. *purpusii*	Sullivantia	CNHI[d] Species of Concern	X		X	X	X	X				
Thalictrum heliophilum	Sunloving meadow-rue	CNHI[d] Species of Concern	O				X	X			X	

[a] Status based on USFWS (1980) and CDNR (1982). See Section 3.1.6 for explanation of status categories.
[b] Facility Sites:
MF = Mine Facilities
PF = Process Facilities
WP = Waste Rock Disposal Pile
RS = Raw Shale Fines Stockpile
CM = Conn Creek Multiple-Use Corridor
RM = Ronn Creek Multiple-Use Corridor
NG = Cities Natural Gas Corridor
PW = Cities Property Power and Water Corridor
PS = Cities to Getty Power and Syncrude Corridor
[c] Occurrence: X = Verified Population Affected
O = Possibly Present, Based Upon Habitat Suitability
[d] CNHI = Colorado Natural Heritage Inventory.

populations of, or favorable habitat for six more plant species. The Cities Service property power and water corridor passes near known localities of Barneby columbine and sullivantia in Conn Creek canyon. Construction of this corridor could further impact these species.

4.3.6.2 Alternatives

Impacts of alternative facilities on vegetation are summarized in Table 4.3-4. Potential adverse impacts of the various alternative actions on vegetation and productivity would be similar to impacts caused by components of the proposed action. The amount of vegetation disturbed due to the 50,000-bpd production rate alternative would be slightly less due to the smaller area required for physical facilities and surface retorts. The size of the spent shale and waste rock disposal piles produced over the long-term would abe similar among alternatives. Impacts to vegetation production resulting from the alternative Cities Service north power and syncrude corridor would be greater than those of the Cities Service to Getty power and syncrude corridor (proposed action).

Affected acreages of the alternative spent shale disposal sites are nearly twice the affected acreages of the proposed action shale disposal sites. Plant production lost by the alternative would be significantly higher than the proposed action due to generally greater production values for the plateau vegetation compared to vegetation in the canyons.

Table 4.3-4 IMPACTS OF CITIES SERVICE FACILITY SITING ALTERNATIVES UPON VEGETATION ACREAGE, PRODUCTIVITY, REVEGETATION POTENTIAL, AND PLANT SPECIES OF SPECIAL INTEREST

Project Component	Potentially[a] Affected Acreage	Affected Annual Production: TOP	Affected Annual Production: AUM	Duration of[b] Impacts	Revegetation Potential	Potentially Affected Plant Species of Special Concern
50,000 bpd Production Rate Alternative[c]	3,119.0	1,092.9	677.4	R	Moderate to High	*Aquilegia barnebyi* *Astragalus lutosus* *Festuca dasyclada* *Mentzelia argillosa* *Sclerocactus glaucus* *Phacelia submutica* *Sullivantia hapemanii* var. *purpusii* *Thalictrum heliophilum*
Spent Shale Disposal in Cascade Canyon & Mesa	1,674.0	531.2	282.5	R	Low to High	*Aquilegia barnebyi* *Astragalus lutosus* *Festuca dasyclada* *Mentzelia argillosa* *Sullivantia hapemanii* var. *purpusii* *Thalictrum heliophilum*
Cities North Power and Syncrude Corridor	920.5	257.5	125.2	S,R	Moderate to High	None
Larkin Ditch Water Supply Alternative	9.0	58.3	69.5	R	Low to Moderate	None

[a] Acreage values determined by USFWS.
[b] R = Residual; S = Short-term
[c] Assume total long-term disturbance equivalent to the proposed action at 100,000 bpd.

The Larkin Ditch water supply alternative is expected to have insignificant impacts on vegetation and productivity, since the intake structure and ditch are currently in existence. The small sedimentation reservoir (assumed to be about 10 acres in size) is also expected to have insignificant impacts. The GCC pipeline, corridor, and reservoir impacts have been previously identified (BLM 1983a).

Adverse impacts to plant species of special interest associated with project alternatives would be less significant than those for the proposed action. Fewer impacts to special interest plant species would result due to the disposal of spent shale in Cascade Canyon and on the plateau. Therefore, in the alternative spent shale configuration plant populations in Conn Creek canyon would only be affected by the Conn Creek multiple-use corridor and mesa-top shale fines stockpile. If the alternative of processing raw shale fines on site is selected, resulting in little or no reduction in surface water flow to Conn Creek, then populations of Barneby columbine and sullivantia occurring there would suffer little impact.

The effects of other project alternative on special interest plant species are similar to their counterparts in the proposed action (Section 4.3.6.1).

4.3.6.3 Solid/Hazardous Wastes and Toxic Pollutants

Solid wastes could be disposed in the spent shale storage area; therefore, adverse impacts to vegetation resource values from solid waste disposal are insignificant. Hazardous wastes and toxic pollutants would be sent to an unspecified off-site licensed disposal facility, thus minimizing impacts to vegetation in a site-specific sense, but contributing to impacts elsewhere in a cumulative sense (see Section 4.4).

4.3.6.4 Secondary Impacts

Secondary impacts to vegetation resulting from the Cities Service shale oil project would occur, but are less spatially predictable than direct project effects. Human population growth and activity could significantly affect vegetation due to new patterns of urbanization, accidental range and forest fires, and increased off-road vehicle use. Approximately 3,900 acres of land could be affected by project-induced population growth (Section 4.3.11). Some of this growth could affect populations of threatened or endangered species, particularly in the De Beque area. Changes in patterns of grazing land use could have either positive or adverse effects on threatened plant populations.

4.3.7 Wildlife

This section of the EIS serves, in part, as a Technical Assistance report to address the concerns of the U.S. Fish and Wildlife Service (USFWS) under the Fish and Wildlife Coordination Act of 1958.

Following is a description of direct impacts of the Cities Service proposed action and alternatives on wildlife. This discussion is based on the results of a wildlife impact analysis performed by the USFWS and Colorado Division of Wildlife (CDOW). Sources of information for the analysis included the baseline report for the Cities Service project (Cities Service 1983a) and wildlife data currently in the USFWS/CDOW computer data base. Project impact analyses were accomplished by use of a modified USFWS, Geographic Information System (GIS; Porter et al. 1979). GIS is a computer-based overlay system designed to provide a relatively fast impact evaluation capability. Wildlife values (wildlife range or habitat acreage weighted by species abundance, sensitivity, or other critical limiting factors) were compared with project development acreage (weighted by intensity and type of potential disturbances). The results of this analysis are given in Tables C-2, C-4, and C-6 in Appendix C and are summarized in this report. Further details concerning the impact analysis methodology are provided in the Technical Assistance Report for the Clear Creek Shale Oil Project (Lockhart et al. 1983).

4.3.7.1 Proposed Action

The proposed action would directly affect about 3,000 acres of wildlife habitat within the project area. An additional 23,550 acres of habitat within 0.5 miles of the project features would be potentially disturbed (Table

C-4, Appendix C). Of those acres directly affected by the proposed action are an estimated 2,020 acres of big game winter range (WR), winter concentration area (WCA), and critical habitat (CH). Active nest locations for Cooper's hawk, red-tailed hawk, and golden eagle would also be impacted. Sensitive habitats affected by the proposed action include aspen woodland, Douglas-fir, riparian areas, and cliffs (Table C-4, Appendix C). Wildlife impacts associated with each of the project features are summarized below.

Development and operation of the underground mine would have a low adverse effect on wildlife species or habitats in the project area. Disturbance of some cliff and plateau shrubland habitats could occur during construction of the mine bench, portal, vents, and associated surface facilities. The development of the waste rock disposal area, raw shale fines stockpile, and processing facilities would directly affect riparian, plateau shrubland, and aspen habitats. No known active raptor nests occur in these areas; however, several inactive buteo and accipitrine nests are present in the proposed shale fines stockpile and processing locations. Two active red-tailed hawk nests and one active Cooper's hawk nest occur in aspen stands within one-quarter mile of these facilities. It is likely that project-related activities within each of these areas would disturb the nests and cause their abandonment.

The disposal of spent shale in the Conn and Cascade Creek canyons would inundate some riparian, valley shrubland, conifer, and cliff habitats. The cliff faces in both of these valleys are known nesting locations for golden eagles, buteos, and kestrels. Although no nests would be directly eliminated by spent shale disposal, nests in the vicinity of the disposal pile could be abandoned. The disposal pile could also obstruct a known elk migration route which runs from the plateau portion of the project area to Conn Creek canyon.

The construction of an underground syncrude pipeline and a transmission line from the Cities Service processing area north to the common corridor (with Getty) would cause short-term disturbance to plateau shrubland and aspen habitats along this route. One active red-tailed hawk nest lies in this corridor and would most likely be eliminated or disturbed.

Some plateau shrubland habitat would be directly affected by placement of the natural gas pipeline and power/water lines for the western portion of the project area. The construction of the proposed access road and power and water corridors would affect valley shrubland, riparian, cliff, conifer, and plateau shrubland habitats in its path. The upper portion of this corridor would potentially affect known golden eagle, buteo, and kestrel nesting locations. The lower portion of the corridor (which also includes rail) would traverse mule deer winter range, winter concentration areas, critical habitats, and migration routes to Conn Creek canyon (Table 4.3-5). Elk winter range and migration routes in Conn Creek Canyon would also be affected by development of this corridor (Table 4.3-5). As a result of vehicular and rail traffic, the incidence of big game roadkills is likely to increase above present levels.

Riparian communities potentially affected by the proposed action include those located at the shale fines site, shale disposal site, and Conn Creek road corridor (Table C-2, Appendix C). Approximately 190 acres of riparian habitat would be directly impacted at these localities, and an additional 800 acres within 0.5 miles of these features would be potentially disturbed (Table C-4, Appendix C). The effect on wildlife would be potentially significant and could include loss of breeding and nesting areas, escape cover, and preferred food and water sources. No threatened or endangered wildlife species would be affected by loss of riparian habitat at these locations.

4.3.7.2 Alternatives

No significant difference in wildlife impacts is anticipated for either the 50,000-bpd alternative or Lurgi retort alternative. The processing of shale fines on site would reduce the extent of wildlife habitat affected by shale fines storage (i.e., approximately 420 fewer acres would be disturbed). However, increased air emissions and water quality impacts due to processing of the fines on site could adversely affect local and downstream wildlife habitats.

Table 4.3-5 SUMMARY OF ESTIMATED POTENTIALLY AFFECTED ACREAGES OF BIG GAME WINTER RANGE (WR), WINTER CONCENTRATION AREA (WCA), AND CRITICAL HABITAT (CH) FOR MAJOR FACILITIES ASSOCIATED WITH THE CITIES SERVICE PROPOSED ACTION AND ALTERNATIVES

	Potentially Affected Acreages[a]					
	Mule Deer			Elk		
Alternative/Components	WR	WCA	CH	WR	WCA	CH
Proposed Action (100,000 bpd)						
Mine Bench	0.0	0.0	0.0	0.0	0.0	0.0
Retort and Plant Site	0.0	0.0	0.0	0.0	0.0	0.0
Spent Shale Disposal	6.0	0.0	0.0	762.0	0.0	0.0
Waste Rock Pile	0.0	0.0	0.0	0.0	0.0	0.0
Shale Fines Stockpile	0.0	0.0	0.0	19.5	0.0	0.0
Corridors						
Power, Syncrude (Mesa)	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas (Mesa)	0.0	0.0	0.0	0.0	0.0	0.0
Power, Water (Mesa)	0.0	0.0	0.0	0.0	0.0	0.0
Road (Mesa)	0.0	0.0	0.0	141.0	0.0	0.0
Power, Rail, Road, Water (Conn Creek)	342.0	246.0	225.0	279.0	0.0	0.0
Power, Rail, Road, Water (Lower Roan Creek)	2,097.0	1,674.0	1,581.0	0.0	0.0	0.0
Water Supply						
GCC Joint Venture	1,758.0	1,758.0	1,758.0	0.0	0.0	0.0
	4,197.0	3,678.0	3,564.0	1,201.5	0.0	0.0
Alternatives						
Proposed Action (50,000 bpd)	4,197.0	3,678.0	3,564.0	1,201.5	0.0	0.0
Spent Shale Disposal (Mesa and Cascade Creek)	0.0	0.0	0.0	498.0	0.0	0.0
Corridors						
Rangely B	1,464.0[b]	0.0[b]	1,638.0[b]	2,856.0[b]	0.0[b]	1,008.0[b]
Power, Syncrude (North Corridor)	0.0	0.0	0.0	0.0	0.0	0.0
Water Supply						
Larkin Ditch	0.0	0.0	0.0	0.0	0.0	0.0

Source: USFWS (1983); See Appendix C, Table C-2.

[a] The acreages shown in the table for each big game species and range type are *not* mutually exclusive values (i.e., considerable overlap in ranges exists within *and* between each species).

[b] Source: Lockhart et al. (1983).

The disposal of spent shale in alternative locations would eliminate cliff, conifer, riparian, and shrubland habitat in Cascade Canyon; plateau shrublands and extensive stands of aspen would be permanently covered on the plateau. Known nesting locations for red-tailed hawks and buteos (active and inactive) would be eliminated at the plateau location. Golden eagle nesting sites in Cascade Canyon would also be inundated during shale disposal. Disposal of spent shale in Cascade Canyon would eliminate about 500 acres of elk winter range (Table 4.3-5) and would potentially interfere with a known elk migration route.

The development of the North corridor for power and syncrude could disturb aspen, riparian, and plateau shrubland habitats. It is unknown whether or not any raptor nests would be affected by this corridor.

The use of a railroad versus a fleet of buses to transport workers to the staging area in the Conn Creek valley would result in a significant reduction in the incidence of roadkills in the lower Roan Creek corridor. Approximately 200 bus round-trips would be necessary on a daily basis to transport workers; whereas only 6 round-trips by rail would be required to perform the same function. Noise generated by the rail system would be of equivalent or greater intensity as that expected in the proposed action; however, the incidence and duration of the noise should be considerably less.

The construction of additional facilities at the Larkin Ditch and nearby could disturb existing riparian habitat along the Colorado River. Wintering bald eagles are known to use the large, live cottonwoods along the river and in the vicinity of De Beque as roosts and perch sites. Construction of this facility would not affect these trees; however, it might affect use of the river by eagles in this area, particularly if construction activities occur during winter. The wildlife habitats affected by the proposed pipeline from the intake to the Roan Creek multiple-use corridor are unknown but are most likely to be a combination of agricultural, valley grassland, and sagebrush types. A white-tailed prairie dog colony occurs near Mount Low (Lambeth 1983) which is located in the general vicinity of the pipeline route to the Roan Creek multiple use corridor. However, because of the size of this colony and its isolation from larger prairie dog towns in the Grand Valley near Fruita, black-footed ferret may not occur in this area (Lambeth 1983). The impacts of the Rangely corridor on wildlife and wildlife habitats were addressed in BLM (1983).

The Cities Service alternatives which would directly affect riparian habitats include the alternate shale disposal site (136 acres of riparian habitat) and the North pipeline corridor (52 acres of riparian habitat). About 520 acres of riparian habitat within 0.5 miles of these project features would be potentially disturbed. Disturbance of these areas would create impacts to wildife similar to those described for affected riparian areas under the proposed action. Based on available information, no threatened or endangered wildife species would be affected by disturbance of riparian habitats associated with each of these alternatives.

4.3.7.3 Solid/Hazardous Wastes and Toxic Pollutants

Cities Service proposes to use engineering measures which should reduce the likelihood of surface and ground water contamination through contact with spent shale and upward migration of trace and toxic elements into the plant rooting zone. These preventive measures include use of an impermeable liner, capillary barrier, benching, adequate topsoiling, and revegetation of the pile (see Section 2.3.2.2). Therefore, spent shale disposal in Cascade and Conn Creek canyons should not result in uptake or bioaccumulation of toxic elements in plants or herbivores.

Runoff retention reservoirs below the disposal area could contain elevated concentrations of heavy metals (see Surface Water, Section 4.3.2). Cities Service plans to pump the water in the retention reservoirs back to the shale disposal site. Hence, exposure of wildlife species to metals in the reservoirs should be minimal and short-term in duration.

4.3.7.4 Secondary Impacts

Indirect loss of wildlife habitat would result from secondary impacts of the proposed project. A long-term reduction of wildlife densities from road kills and poaching could occur throughout the region. Direct loss of wildlife due to poaching could be locally significant, especially for deer and elk, where concentration areas are accessible. Direct regional impacts on wildlife habitat would result from housing and community infrastructure development. The magnitude of long-term reduction in the regional carrying capacity for many species would be minimized if such habitat losses are concentrated in areas of existing community development. Indirect impacts to wildlife would occur as a result of increased levels of noise, harassment of domestic pets, and human activity (including ORV use) in the area of secondary impact. A simultaneous increase in the demand for consumptive and nonconsumptive wildlife-related recreation would occur throughout the area.

4.3.8 Air Quality/Meteorology

4.3.8.1 Proposed Action

This section considers the combined air quality impacts due to Cities Service's proposed action with the mine, retorting and upgrading facilities located on the plateau above Deer Park Gulch.

Emissions

The air quality impact analysis of the proposed Cities Service project considered stack and fugitive releases of SO_2, TSP, NO_x and CO in addition to emissions of other regulated or potentially hazardous pollutants. The 100,000-bpd production rate was utilized. TSP emissions anticipated from mining and shale handling activities include a wide variety of source types. The exact location of sources could move across wide areas in a day to day progression. The year 2010, or 21 to 25 years into the project, was therefore chosen to define the area source locations of the rock storage and spent shale areas, and the point source locations of the mine activities and processing plants. This year represents a maximum emission year.

The emission rates and stack height information associated with the retorting, upgrading and mining facilities are presented in Table 4.3-6. Sources with identical stack parameters and in the same vicinity were grouped to form a composite source. These composite sources for the upgrading, retorting and mining facilities were assigned geographical coordinates corresponding to the geometric mid-point of the individual sources of each source sub-group. Constant year round emissions corresponding to retorting for a 100,000-bpd shale oil facility were assumed for the modeling analysis. Further details of the modeling analysis are provided in Appendix A. The emission source modeling configuration was derived from the plot plans and emission rates detailed in the project description (Cities Service 1983b).

Air Quality

Table 4.3-7 lists the predicted maximum air quality impacts of the plateau facilities. The table lists each appropriate pollutant, averaging time and receptor location for the predicted maximum concentration in the PSD Class II areas, the PSD Class I areas (Flat Tops Wilderness, Arches National Monument, the Black Canyon of the Gunnison Wilderness, and West Elk Wilderness), the Colorado Category I areas (Colorado National Monument and Dinosaur National Monument), and the Mesa County TSP nonattainment area.

For the proposed action, the PSD Class II 24-hour TSP increment could be consumed or exceeded by a factor of almost three. This predicted impact is located along the west central property line and is largely due to the close proximity of the fines stock pile area to this property line. No other Class II increments of NAAQS are predicted to be exceeded by the proposed action. In order for the project to receive an air quality construction permit, either the area of exceedance (approximately 0.1 square miles) would have to be acquired or the fines stockpile would have to be moved. Although the increment is predicted to be exceeded, the NAAQS is not. Health impacts would be moderately adverse due to TSP in this area.

The 24-hour SO_2 impact in the Flat Tops Wilderness, which is about 41 miles away, is predicted to be 40 percent of the PSD Class I increment. Transport of significant quantities of SO_2 and TSP for the other regulated averaging times would not be likely given the distances to these sensitive areas (about 87 miles to Arches National Monument, 71 miles to the Black Canyon of the Gunnison Wilderness, 66 miles to the West Elk Wilderness, 39 miles to the Colorado National Monument, and 63 miles to Dinosaur National Monument) and the low probability of the occurrence of meteorological conditions that would effectively transport pollutants to these areas.

All modeled CO impacts were well below EPA's levels of significant impacts in all Class II, Class I, and Category I areas.

An analysis of ozone impacts from the Cities Service proposed action has been conducted. Since ozone is a regional pollutant, the analysis presented in BLM (1983a) should be representative of the Cities Service location and emissions. Optimum ozone production typically occurs when the ratio of HC to NO_x is between 7 to 1 and 12 to 1 (EPA 1977). The ratio for the Cities Service proposed action is only 0.3 to 1. The Chevron study (BLM 1983a) indicates emissions of hydrocarbons and oxides of nitrogen from oil shale facilities, which have a similar ratio of 0.3 to 1, would have a minimal impact on ambient ozone concentration with a range of predicted ozone concentrations for all scenarios less than 0.01 ppm. This would be less than 8 percent of federal standards. Cities Services impact would fall in this range.

Table 4.3-6 TOTAL MINING, RETORTING, AND UPGRADING STACK EMISSIONS AND STACK DATA - CITIES SERVICE PROPOSED ACTION (100,000 bpd)

Facility	Stack Height (m)	No. of Stacks	SO_2[a] (g/sec)	TSP[a] (g/sec)	NO_x[a] (g/sec)	CO[a] (g/sec)	HC[a] (g/sec)
Retorting and Upgrading Emissions							
Recycle Gas Heater	76	10	26	<1	139	10	<1
Reboiler	61	10	2	<1	3	1	<1
FGD	122	3	35	<1	143	12	<1
Auxiliary Boiler	61	2	< 1	<1	6	1	<1
Reformer Heater	61	4	1	<1	126	9	<1
Whole Oil Heater	61	4	21	<1	9	2	<1
Naphtha Heater	61	4	2	<1	1	<1	<1
Tail Gas Incinerator	91	4	2	0	<1	<1	<1
Mining and Material Handling Emissions							
Mining	NA[b]	NA	2	4	25	33	2
Surface Material Handling	NA	NA	0	6	0	0	0
Disposal Reclamation	NA	NA	2	33	22	5	2
Miscellaneous	NA	NA	<1	<1	<1	<1	<1
TOTAL EMISSIONS			93	43	476	73	6

Source: Cities Service (1983c).

[a] Total for all stacks.
[b] Not applicable.

Visibility

A Level-1 visibility screening analysis (Latimer and Ireson 1980) was performed to determine whether any significant impacts would occur in Class I and Category I areas. The Level-1 visibility screening analysis is a simple, straightforward calculation designed to identify those emission sources that have little potential of adversely affecting visibility. If a source passes this screening test, it would not be likely to cause significant visibility impairment, and further analysis of potential visibility impairment would not be necessary. The Level-1

Table 4.3-7 MAXIMUM AIR QUALITY IMPACTS SUMMARY - CITIES SERVICE PROPOSED ACTION (100,000 bpd)

			Predicted PSD Class I[b] Concentrations ($\mu g/m^3$)				Category I[b] Conc. ($\mu g/m^3$)			Predicted Class II Conc. ($\mu g/m^3$)			Standards ($\mu g/m^3$)[b]			
Pollutant	Averaging Time	Background[a] Conc. ($\mu g/m^3$)	FLAT	ARCH	BACA	WELK	COLO	DINO	MESA	Receptor Location	Conc.	Total Conc.	Class I Incre.[c]	Class II Incre.	Limit. NAAQS	SIL
SO_2	Annual	1	<1	<1	<1	<1	<1	<1		N-Cen Prop. Line	4	5	2	20	80	1
	24-Hour	14	3	<1	<1	<1	2	<1		N-Cen Prop. Line	16	30	5	91	365	5
	3-Hour	17	8	3	1	3	6	4		EN-Cen Prop. Line	69	77	25	512	1,300	25
TSP	Annual	15	<1	<1	<1	<1	<1	<1	<1	NW Prop. Line	5	20	5	19	60	1
	24-Hour	34	<1	<1	0	<1	<1	<1	0	W-Cen Prop. Line[d]	87[d]	120	10	37	150	5
NO_2[e]	Annual	4								N-Cen Prop. Line	25	29			100	1
CO	8-Hour	2,500								W-Cen Prop. Line	39	2,539			10,000	500
	1-Hour	3,000								W-Cen Prop. Line	294	3,294			40,000	2,000

[a] Background concentrations are representative of facility area. The actual background concentration in other impact areas may be lower.
[b] FLAT = Flat Tops Wilderness west boundary; ARCH = Arches National Monument east boundary; BACA = Black Canyon of the Gunnison National Monument west boundary; WELK = West Elk Wilderness west boundary; COLO = Colorado National Monument north boundary; DINO = Dinosaur National Monument east boundary; MESA = Mesa County TSP Nonattainment Area; SIL = Significant Impact Level ($\mu g/m^3$).
[c] Colorado Category I increments are the same as PSD Class I increments for SO_2 only.
[d] Equal to or exceeds PSD increments.
[e] Modeled as total NO_x

analysis input requirements are the minimum distance of the emission source from the nearest Class I area boundary; total TSP, SO_2, and NO_x emission rates; and typical, worst case meteorology. The meteorology used for this analysis is that suggested by Latimer and Ireson (1980) which is moderate atmospheric stability conditions and light winds. These stable conditions create conservative straight line undisturbed plume movement. This analysis indicates that significant impacts cannot be ruled out with 55 miles where a NO_x-caused dark plume against a light sky could be noticeable.

Two sensitive areas, Flat Tops Wilderness and Colorado National Monument, fall within this radius (41 and 39 miles respectively) and thus fail the Level-1 analyses. The analysis indicates a potentially significant visibility impact due to a dark plume against the sky and a light plume against dark terrain resulting in these two sensitive areas. The pollutants responsible for this Level-1 test failure are SO_2, NO_x, and TSP. Additional detailed and inherently more realistic visibility analyses will be needed to further define this impact.

Atmospheric Deposition

Acid deposition is considered as an Air Quality Related Value (AQRV) for federally designated Class I areas which are within close proximity of a facility. Acid deposition is a regional phenomenon generally associated with emissions generated by large cities and major industrial sources. Even so, it has been documented in a high-altitude Rocky Mountain setting where no direct connection has been made to major emissions sources (Lewis and Grant 1980). Additional studies and analyses have been done by Lewis and Grant of CSU, Turk (1982) of U.S. Geological Survey, and Fox (1981) of the U.S. Forest Service. Most of these studies of western acid deposition indicate it is unlikely, but still unknown whether significant contributions are possible from an individual source alone.

Potential deposition of sulfur and nitrogen from the Cities Service proposed action in the Class I and Category I areas was modeled using the deposition results from the ISC long term model and the annual meteorological data set collected at Chevrons Clear Creek mesa station. The analysis assumes the following:

- The estimated worst-case single concentration is representative of deposition to the entire wilderness area.
- All sulfur compounds were assumed to be SO_2 and nitrogen compounds were assumed to be NO_x.
- Dry deposition velocity of NO_x and SO_2 was assumed to be 1 centimeter per second (cm/sec).
- Complete mixing in lakes occurred due to snowmelt or runoff.

Wet deposition rates were estimated from precipitation statistics for the Class I and Category I areas. Assuming annual average mixing depth of 8,300 feet to 8,500 feet (Holzworth 1972) and the complete removal during the 1-hour precipitation event on each of the event days (Department of Commerce 1968), the effective annual-average wet deposition velocity of 0.8 cm/sec was calculated for Flat Tops, Black Canyon, and West Elk Wilderness and 1.0 cm/sec for Arches, Colorado, and Dinosaur National Monuments. Applying these NO_x and SO_2 concentrations to these areas resulted in conservative wet deposition rates of 80 and 100 percent of the dry deposition rates. Table 4.3-8 presents the annual dry and wet deposition rates resulting from the proposed action.

The total nitrogen and sulfur deposition is conservatively expected to range from 7 to 294 mg/m^2 over an annual period. The estimated deposition rates are not expected to alter the pH of lakes with good buffering capabilities but may slightly lower the level of poorly buffered lakes below current pH values of about 7. It is not currently known what effect, if any, these shifts would have on sensitive biota of the Class I and Category I areas. In general, as aquatic systems acidify, the physiological stress is likely to progressively alter biological population structures. At the acidification levels reported, elimination of certain phyto- and zooplankton species is possible (reducing diversity), but a significant change in total biomass is unlikely.

Table 4.3-8 MAXIMUM ANNUAL ELEMENTAL DEPOSITION RATES IN SENSITIVE AREAS[a] - CITIES SERVICE PROPOSED ACTION (100,000 bpd)

Constituent	Flat Tops Dry	Flat Tops Wet	Arches Dry	Arches Wet	Black Canyon Dry	Black Canyon Wet	West Elk Dry	West Elk Wet	Colorado Dry	Colorado Wet	Dinosaur Dry	Dinosaur Wet
Nitrogen	162	130	6	6	22	18	17	14	90	90	41	41
Sulfur	32	26	1	1	4	3	3	2	17	17	8	8

[a] All values are mg/m^2.

4.3.8.2 Alternatives

This section considers the air quality impact of the proposed alternatives to the Cities Service project. These alternatives and subalternatives include the following:

- Reduced production rate at 50,000 bpd using VMIS and Union B retorts
- Full production rate at 100,000 bpd using VMIS and Lurgi retorts
- Reduced production rate at 50,000 bpd using VMIS and Lurgi retorts
- Full production rate at 100,000 bpd using all Union B retorts
- Reduced production rate at 50,000 bpd using all Union B retorts
- Full production rate at 100,000 bpd using all Lurgi retorts
- Reduced production rate at 50,000 bpd using all Lurgi retorts
- Full production rate at 100,000 bpd with an additional retort
- Reduced production rate at 50,000 bpd with an additional retort
- Spent shale disposal alternative.
- Cogeneration

The emission rates in grams per second (g/s) were provided by Cities Service (1983c). The emissions inventory for each alternative is presented in Table 4.3-9. The emissions included all emissions from the alternative oil shale facilities.

As for the proposed action, these emission rates were modeled using the ISC air quality model to analyze the short-term and annual concentrations of TSP, SO_2, and NO_x. Maximum impacts are reported. Carbon monoxide impacts were not modeled because of similarity to proposed action and full production emissions. All Lurgi retort alternatives showed CO emissions to be well below EPA's levels of significant impacts. Ozone impacts would be small for all alternatives due to the ratio of HC to NO_x emissions being well below optimum ozone production ratios (see Section 4.3.8.1). Table 4.3-10 summarizes the results of this analysis. Table 4.3-11 presents the acid deposition analysis in the sensitive receptor areas from the alternative configurations. The acid deposition analyses were performed using the methodology discussed in Section 4.3.8.1. Table 4.3-12 presents the spent shale disposal and cogeneration subalternatives. Level-1 visibility screening analyses were conducted and are discussed for each alternative below.

Table 4.3-9 SUMMARY OF EMISSION RATES - CITIES SERVICE PROJECT ALTERNATIVES[a,b]

	50,000 bpd 10,000 VMIS 40,000 UNION B			100,000 bpd 10,000 VMIS 90,000 LURGI			50,000 bpd 10,000 VMIS 40,000 LURGI			100,000 bpd All Union B Retorts			50,000 bpd All Union B Retorts		
Facility	TSP	SO_2	NO_x	TSP	SO_2	NO_x	TSP	SO_2	NO_x	TSP	SO_2	NO_x	TSP	SO_2	NO_x
Retorting and Upgrading															
Recycle Gas Heater	<1	13	70	--	--	--	--	--	--	<1	26	139	<1	13	70
Reboiler	<1	1	1	--	--	--	--	--	--	<1	2	3	<1	1	2
FGD	<1	35	143	<1	35	143	<1	35	143	0	0	0	0	0	0
Auxiliary Boiler	0	0	0	<1	<1	6	0	0	0	<1	1	57	<1	<1	29
Reformer Heater	<1	<1	63	<1	<1	126	<1	<1	63	<1	21	126	<1	<1	63
Whole Oil Heater	<1	11	5	<1	21	9	<1	11	5	<1	1	9	<1	<1	5
Naphtha Heater	<1	1	<1	<1	2	4	<1	1	<1	<1	2	1	<1	1	<1
Tail Gas Incinerator	0	1	<1	0	2	<1	0	1	<1	0	2	<1	0	1	<1
Lurgi Retorts	--	--	--	156	63	456	78	32	228	--	--	--	--	--	--
Mining and Material Handling															
Mining	2	<1	13	4	2	25	2	<1	13	4	2	25	2	<1	13
Surface Storage	3	0	0	27	0	0	13	0	0	6	0	0	0	3	0
Disposal	16	1	11	25	2	20	13	1	10	32	2	22	76	1	11
Miscellaneous	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TOTAL EMISSIONS	22	64	306	213	127	788	107	81	463	42	59	384	21	30	192

	100,000 bpd All LURGI Retorts			50,000 bpd All Lurgi Retorts			100,000 bpd Additional Retorts			50,000 bpd Additional Retorts		
Facility	TSP	SO_2	NO_x	TSP	SO_2	NO_x	TSP	SO_2	NO_x	TSP	SO_2	NO_x
Retorting and Upgrading												
Recycle Gas Heater	--	--	--	--	--	--	<1	26	139	<1	13	70
Reboiler	--	--	--	--	--	--	<1	2	3	<1	1	1
FGD	--	--	--	--	--	--	<1	35	143	<1	35	143
Auxiliary Boiler	<1	1	57	<1	<1	29	<1	1	126	<1	0	0
Reformer Heater	<1	1	126	<1	<1	63	<1	<1	6	0	0	0
Whole Oil Heater	<1	21	9	<1	11	5	<1	21	9	<1	<1	63
Naphtha Heater	<1	2	<1	<1	1	<1	<1	2	1	<1	11	5
Tail Gas Incinerator	0	2	<1	0	1	<1	0	2	<1	0	1	<1
Lurgi Retorts	156	63	456	78	32	228	16	6	46	8	6	23
Mining and Material Handling												
Mining	4	2	25	2	1	13	4	2	25	2	1	13
Surface Storage	27	0	0	13	0	0	6	0	0	3	0	0
Disposal	24	2	20	12	1	10	26	2	20	13	1	10
Miscellaneous	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TOTAL EMISSIONS	212	93	696	106	47	348	52	99	520	26	167	332

Source: Cities Service (1983c).

[a] All values at g/sec.
[b] Spent shale subalternative emissions are the same as the above respective alternatives.

Table 4.3-10 SUMMARY OF MAXIMUM AIR QUALITY IMPACTS[a] - CITIES SERVICE PROJECT ALTERNATIVES

Sensitive Areas	50,000 bpd (40,000 Union B/10,000 VMIS)						100,000 bpd (90,000 Lurgi/10,000 VMIS)						50,000 bpd[b] (40,000 Lurgi/10,000 VMIS)					
	TSP Annual	TSP 24Hr	SO_2 Annual	SO_2 24Hr	SO_2 3Hr	NO_x Annual	TSP Annual	TSP 24Hr	SO_2 Annual	SO_2 24Hr	SO_2 3Hr	NO_x Annual	TSP Annual	TSP 24Hr	SO_2 Annual	SO_2 24Hr	SO_2 3Hr	NO_x Annual
Class I Areas																		
Flat Tops	0	0	<1	<1	4	--	<1	4	<1	3	9	--	<1	2	<1	2	6	--
Arches	0	0	0	<1	1	--	<1	1	<1	<1	4	--	<1	<1	<1	<1	2	--
Black Canyon	0	0	0	<1	1	--	<1	1	<1	<1	2	--	<1	<1	<1	<1	1	--
West Elks	0	0	0	<1	2	--	<1	1	<1	<1	4	--	<1	<1	<1	<1	3	--
Category I Areas																		
Dinosaur	0	0	0	<1	3	--	<1	2	1	1	5	--	<1	1	<1	<1	3	--
Colorado	0	0	0	<1	4	--	<1	3	1	1	7	--	<1	1	<1	<1	4	--
Mesa County Attainment Area	<1	<1	--	<1	--	--	<1	2	--	--	--	--	<1	1	--	--	--	--
Class II Areas																		
Background	15	34	1	14	17	4	15	34	1	14	17	4	15	34	1	14	17	4
Maximum Conc.	4	54[c]	2	11	35	14	6	64[c]	4	18	69	28	4	32	2	9	34	15
Total Conc.	17	88	3	25	42	18	21	98	5	32	86	32	19	66	3	23	51	19
PSD Increments																		
Class I	5	10	2	5	25	--	5	10	2	5	25	--	5	10	2	5	25	--
Class II	19	37	20	91	512	--	19	37	20	91	512	--	19	37	20	91	512	--
Limiting NAAQS	60	150	80	365	1,300	100	60	150	80	365	1,300	100	60	150	80	365	1,300	100
Significant Impact Levels	1	5	1	5	25	1	1	5	1	5	25	1	1	5	1	5	25	1

Table 4.3-10 SUMMARY OF MAXIMUM AIR QUALITY IMPACTS[a] - CITIES SERVICE PROJECT ALTERNATIVES (continued)

	10,000 bpd (All Union B/10,000 VMIS)						50,000 bpd (All Union B)						100,000 bpd[b] (All Lurgi)					
Sensitive Areas	TSP Annual	TSP 24Hr	SO_2 Annual	SO_2 24Hr	SO_2 3Hr	NO_x Annual	TSP Annual	TSP 24Hr	SO_2 Annual	SO_2 24Hr	SO_2 3Hr	NO_x Annual	TSP Annual	TSP 24Hr	SO_2 Annual	SO_2 24Hr	SO_2 3Hr	NO_x Annual
Class 1 Areas																		
Flat Tops	<1	<1	<1	2	6	--	<1	<1	<1	1	3	--	<1	4	<1	<1	8	--
Arches	<1	<1	<1	<1	3	--	<1	<1	<1	<1	2	--	<1	1	<1	<1	3	--
Black Canyon	<1	<1	<1	<1	1	--	<1	<1	<1	<1	<1	--	<1	1	<1	<1	1	--
West Elks	<1	<1	<1	<1	5	--	<1	<1	<1	<1	3	--	<1	1	<1	<1	3	--
Category 1 Areas																		
Dinosaur	<1	<1	<1	<1	3	--	<1	<1	<1	<1	1	--	<1	2	<1	<1	4	--
Colorado	<1	<1	<1	2	4	--	<1	<1	<1	1	2	--	<1	3	<1	<1	6	--
Mesa County Attainment Area	<1	<1	--	--	--	--	<1	<1	--	--	--	--	<1	2	--	--	--	--
Class 11 Areas																		
Background	15	34	1	14	17	4	15	34	1	14	17	4	15	34	1	14	17	4
Maximum Conc.	5	86[c]	4	15	69	24	2	43[c]	2	8	34	12	8	64[c]	4	18	69	27
Total Conc.	20	120	5	29	86	28	17	76	3	22	51	16	23	98	5	32	86	31
PSD Increments																		
Class 1	5	10	2	5	25	--	5	10	2	5	25	--	5	10	2	5	25	--
Class 11	19	37	20	91	512	--	19	37	20	91	512	--	19	37	20	91	512	--
Limiting NAAQS	60	150	80	365	1,300	100	60	50	80	365	1,300	100	60	150	80	365	1,300	100
Significant Impact Levels	1	5	1	5	21	1	1	5	1	5	25	1	1	5	1	5	25	1

Table 4.3-10 SUMMARY OF MAXIMUM AIR QUALITY IMPACTS[a] - CITIES SERVICE PROJECT ALTERNATIVES (concluded)

	50,000 bpd (All Lurgi)						100,000 bpd (Additional Retort)						50,000 bpd[b] (Additional Retort)					
Sensitive Areas	TSP Annual	TSP 24Hr	SO_2 Annual	SO_2 24Hr	SO_2 3Hr	NO_x Annual	TSP Annual	TSP 24Hr	SO_2 Annual	SO_2 24Hr	SO_2 3Hr	NO_x Annual	TSP Annual	TSP 24Hr	SO_2 Annual	SO_2 24Hr	SO_2 3Hr	NO_x Annual
Class 1 Areas																		
Flat Tops	<1	2	<1	<1	4	--	<1	<1	<1	3	8	--	<1	<1	<1	<1	6	--
Arches	<1	<1	<1	<1	2	--	<1	<1	<1	<1	3	--	<1	<1	<1	<1	2	--
Black Canyon	<1	<1	<1	<1	<1	--	<1	<1	<1	<1	1	--	<1	<1	<1	<1	1	--
West Elks	<1	<1	<1	<1	2	--	<1	<1	<1	<1	3	--	<1	<1	<1	<1	3	--
Category 1 Areas																		
Dinosaur	<1	1	<1	<1	2	--	<1	<1	<1	<1	4	--	<1	<1	<1	<1	2	--
Colorado	<1	1	<1	<1	3	--	<1	<1	<1	2	6	--	<1	<1	<1	<1	4	--
Mesa County Attainment Area	<1	1	--	--	--	--	<1	<1	--	--	--	--	<1	<1	--	--	--	--
Class II Areas																		
Background	15	34	1	14	17	4	15	34	1	14	17	4	15	34	1	14	17	34
Maximum Conc.	5	32	2	9	34	13	5	45[c]	4	16	69	36	4	23	2	11	35	20
Total Conc.	20	66	3	23	51	17	20	79	5	30	86	40	19	57	3	25	52	24
PSD Increments																		
Class 1	5	10	2	5	25	--	5	10	2	5	25	--	5	10	2	5	25	--
Class II	19	37	20	91	512	--	19	37	20	91	512	--	19	37	20	91	512	--
Limiting NAAQS	60	150	80	365	1,300	100	60	150	80	365	1,300	100	60	150	80	365	1,300	100
Significant Impact Levels	1	5	1	5	25	1	1	5	1	5	25	1	1	5		5	25	1

[a] All values $\mu g/m^3$.
[b] Results were derived proportionally instead of modeled.
[c] May consume or exceed PSD increment.

Table 4.3-11 MAXIMUM ANNUAL ELEMENTAL DEPOSITION IN SENSITIVE AREAS[a] - CITIES SERVICE PROJECT ALTERNATIVES

		Flat Tops		Arches		Black Canyon		West Elk		Colorado		Dinosaur	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Proposed Action	50,000 bpd												
	Nitrogen	114	91	5	5	16	13	12	10	62	62	30	30
	Sulfur	24	19	1	1	3	2	2	2	13	13	6	11
Lurgi/VMIS	100,000 bpd												
	Nitrogen	273	218	10	10	37	29	27	22	153	153	67	67
	Sulfur	45	36	2	2	6	5	5	4	25	25	11	11
Lurgi/VMIS	50,000 bpd												
	Nitrogen	168	134	7	7	23	18	17	14	94	94	43	43
	Sulfur	31	24	1	1	4	3	3	2	17	17	8	8
All Union B	100,000 bpd												
	Nitrogen	28	22	<1	<1	2	2	2	2	10	10	4	4
	Sulfur	16	13	<1	<1	2	2	2	1	9	9	4	4
All Union B	50,000 bpd												
	Nitrogen	59	47	2	2	8	6	6	5	34	34	4	4
	Sulfur	8	6	<1	<1	1	1	<1	<1	5	5	2	2
All Lurgi	100,000 bpd												
	Nitrogen	228	182	8	8	30	24	23	18	130	130	52	52
	Sulfur	29	23	1	1	4	3	3	2	16	16	6	6
All Lurgi	50,000 bpd												
	Nitrogen	114	91	4	4	15	12	11	9	65	65	26	26
	Sulfur	14	11	<1	<1	2	2	1	1	8	8	3	3
Additional Retort (no fines stock)	100,000 bpd												
	Nitrogen	177	142	7	5	24	19	18	14	99	99	45	45
	Sulfur	34	27	1	1	5	4	3	3	19	19	9	9
Additional Retort (no fines stock)	50,000 bpd												
	Nitrogen	124	99	6	6	17	14	13	10	68	68	33	33
	Sulfur	26	20	1	1	4	3	2	2	15	15	7	7
Cogeneration with Proposed Action	100,000 bpd												
	Nitrogen	210	168	8	8	28	22	21	17	117	117	52	52
	Sulfur	32	26	1	1	4	3	3	2	18	18	8	8

[a] All values mg/m^2.

50,000 bpd - 40,000 Union B/10,000 VMIS Retorts

For the Union B/VMIS reduced-production rate alternative, the PSD Class II 24-hour TSP increment would be exceeded by 45 percent. This impact is located along the west central property boundary where the maximum TSP concentration of the proposed action occurred. This value, when added to the background concentration, represents 59 percent of the limiting federal standard. This alternative rates a low to medium adverse impact.

A Level-1 visibility screening analysis indicates that a NO_x-caused dark plume against a bright sky would be visible within a distance of 42 miles from the facility, while a TSP-caused light plume against dark terrain would be visible within a distance of 29 miles. This analysis indicates a potential for visibility degradation in Flat Tops Wilderness, and Colorado National Monument due to a Union B-VMIS/reduced-production alternative.

Table 4.3-12 SUMMARY OF MAXIMUM AIR QUALITY IMPACTS ON OFF-PROPERTY CLASS II AREAS - CITIES SERVICE PROJECT SPENT SHALE DISPOSAL AND COGENERATION[a]

	Alternate Disposal						Cogeneration					
	TSP Annual	TSP 24-Hr	SO_2 Annual	SO_2 24-Hr	SO_2 3-Hr	NO_2 Annual	TSP Annual	TSP 24-Hr	SO_2 Annual	SO_2 24-Hr	SO_2 3-Hr	NO_2 Annual
Background Core	15	34	1	14	17	4	15	34	1	14	17	4
Proposed Action 100,000 bpd												
Maximum	5	100[b]	4	16	61	31	5	87[b]	4	16	69	27
Total	20	134	5	30	78	35	20	120	5	30	77	29
Proposed Action 50,000 bpd												
Maximum	4	50[b]	2	11	31	17	2	54[b]	2	11	35	16
Total	19	84	3	25	48	21	17	88	3	25	42	20
Lurgi Retorts 90,000/100,000												
Maximum	10	98[b]	5	18	60	35	6	64[b]	4	18	69	30
Total	25	132	6	32	77	39	21	98	5	32	6	34
Lurgi Retorts 40,000/100,000												
Maximum	5	49[b]	2	9	30	14	4	32	2	9	34	17
Total	20	83	3	23	47	18	19	66	3	23	51	21
All Union B 100,000 bpd												
Maximum	5	100[b]	4	16	61	30	5	86[b]	4	15	69	26
Total	20	134	5	30	78	34	20	120	5	29	86	30
All Union B 50,000 bpd												
Maximum	4	50[b]	2	11	31	15	2	43[b]	2	8	34	14
Total	19	84	3	25	48	19	17	76	3	22	51	18
All Lurgi 100,000 bpd												
Maximum	10	98[b]	18	60	34	8	64[a]	4	18	69	29	
Total	25	132[b]	5	32	77	38	23	98	5	32	86	33

Table 4.3-12 SUMMARY OF MAXIMUM AIR QUALITY IMPACTS ON OFF-PROPERTY CLASS II AREAS - CITIES SERVICE PROJECT SPENT SHALE DISPOSAL AND COGENERATION[a] (concluded)

	Alternate Disposal						Cogeneration					
	TSP Annual	TSP 24-Hr	SO_2 Annual	SO_2 24-Hr	SO_2 3-Hr	NO_2 Annual	TSP Annual	TSP 24-Hr	SO_2 Annual	SO_2 24-Hr	SO_2 3-Hr	NO_2 Annual
All Lurgi 50,000 bpd												
Maximum	5	49[b]	2	9	30	17	5	32	2	9	34	15
Total	20	83[b]	3	23	47	21	20	66	3	23	51	19
Additional Retort 100,000 bpd												
Maximum	5	72[b]	4	16	61	27	5	45[b]	4	16	69	38
Total	20	106	5	30	78	31	20	79	5	30	86	42
Additional Retort 50,000 bpd												
Maximum	4	36	2	11	31	15	4	23	2	11	35	22
Total	19	70	3	25	48	19	19	57	3	25	52	26
Limiting NAAQS	60	150	80	365	1,300	100	60	150	80	365	1,300	100
PSD Class II Increment	19	37	20	91	512	--	19	37	20	91	512	--

[a] All values $\mu g/m^3$.
[b] Consumes or exceeds PSD Class II increments.

100,000 bpd - 90,000 Lurgi/10,000 VMIS Retorts

For the Lurgi full-production/VMIS alternative, the 24-hour TSP concentration is predicted to exceed the PSD Class II increment by 73 percent. When added to the background concentration, this impact represents 65 percent of the limiting federal standard. The 24-hour TSP concentration in the Flat Tops Wilderness is predicted to consume 40 percent of the Class I PSD increment. This alternative rates a moderate adverse impact. No other increments or federal standards are consumed or exceeded.

A Level-1 visibility screening analysis indicated that a NO_x-caused dark plume against a bright sky would be visible within a distance of 67 miles from the facility, while a TSP-caused light plume against dark terrain would be visible within a distance of 79 miles. This analysis indicates a potential for visibility degradation in Flat Tops Wilderness, Black Canyon of the Gunnison Wilderness, West Elk Wilderness, Colorado National Monument and Dinosaur National Monument due to the Lurgi full-production/VMIS alternative.

The maximum total acid deposition presented in Table 4.3-11 is less than 10 percent of threshold values presented earlier. Therefore, impacts to biota are unlikely.

50,000 bpd - 40,000 Lurgi/10,000 VMIS Retorts

For the reduced-production Lurgi/VMIS retorting alternative, the PSD Class II 24-hour TSP increment would be consumed by 66 percent. When added to the background concentration, the total concentration would represent 44 percent of the NAAQS. This alternative rates a low adverse impact.

A Level-1 visibility screening analysis indicated that a NO_x-caused dark plume against a bright sky would be visible to a distance of 52 miles from the facility, while a TSP-caused light plume against dark terrain would be visible within a distance of 59 miles. This analysis indicates a potential for visibility degradation in Flat Tops Wilderness, West Elk Wilderness, and Colorado National Monument due to a reduced Lurgi production alternative.

The maximum total acid deposition presented in Table 4.2-11 is less than 10 percent of threshold values presented earlier. Therefore, impacts to biota are unlikely.

100,000 bpd - All Union B Retorts

For the all Union B full-production alternative, the 24-hour TSP off-property concentration would one of the highest of all proposed alternatives, consuming the Class II increment by 2.3 times. When added to the background concentration, the total impact represents 80 percent of the NAAQS. Forty percent of the SO_2 24-hr Class I increment would be consumed in the Flat Tops Wilderness. When added to background concentrations, the total annual TSP and NO_x concentrations would represent about 30 percent of the applicable limiting NAAQS. This impact rates a moderate adverse impact.

A Level-1 visibility screening analysis indicated that a NO_x-caused dark plume against a bright sky would be visible to a distance of 40 miles from the facility, while a TSP-caused light plume against dark terrain would be visible to a distance of 48 miles. This analysis indicates a potential for visibility degradation in Flat Tops Wilderness and Colorado National Monument due to a Union B full-production alternative.

The maximum total acid deposition presented in Table 4.3-11 would be less than 10 percent of threshold values presented earlier. Therefore, impacts to biota are unlikely.

50,000 bpd - All Union B retorts

For the Union B reduced-production alternative, the PSD Class II 24-hour TSP increment would be exceeded by 16 percent. The total off-property TSP 24-hour concentration would be 50 percent of the NAAQS. No other increments would be exceeded. This alternative rates a low to medium adverse impact.

A Level-1 visibility screening analysis indicated a NO_x-caused dark plume against a bright sky would be visible to a distance of 27 miles from the facility while a TSP-caused light plume against dark terrain would be visible to a distance of 30 miles. This analysis indicates no potential for visibility degradation in the sensitive Class I and Category I areas due to a reduced Union B alternative.

The maximum total acid deposition presented in Table 4.3-11 is less than 10 percent of threshold values presented earlier. Therefore, impacts to biota are unlikely.

100,000 bpd - All Lurgi Retorts

For the all-Lurgi full-production alternative, the off-property PSD Class II 24-hour TSP concentration would be exceeded by 72 percent. The total 24-hour TSP increment would represent 65 percent of the limiting NAAQS. For the Flat Tops wilderness, 40 percent of the 24-hour TSP Class I increment and 32 percent of the 3-hour SO2 Class I increment would be consumed. This alternative rates a moderate adverse impact.

A Level-1 visibility screening analysis indicated that a NOx-caused dark plume against a bright sky would be visible to a distance of 63 miles from the facility, while a TSP-caused light plume against dark terrain would be visible to a distance of 78 miles. This analysis indicates a potential for visibility degradation in Flat Tops Wilderness, Black Canyon of the Gunnison Wilderness, West Elk Wilderness, Colorado National Monument, and Dinosaur National Monument due to a full-production/all-Lurgi alternative.

The maximum total acid deposition presented in Table 4.3-11 is less than 10 percent of threshold values presented earlier. Therefore, impacts to biota are unlikely.

50,000 bpd - All Lurgi Retorts

For a reduced-production all Lurgi alternative, no PSD Class I or Class II increments would be consumed. When added to the background concentrations, the background concentrations would represent 44 percent of the 24-hour TSP NAAQS and 30 percent of the annual TSP NAAQS. This alternative rates a low adverse impact.

A Level-1 visibility screening analysis indicated that a NO_x-caused dark plume against a bright sky would be visible to a distance of 42 miles from the facility, while a TSP-caused light plume against dark terrain would be visible to a distance of 57 miles. This analysis indicates a potential for visibility degradation in Flat Tops Wilderness and Colorado National Monument due to a reduced-production all Lurgi alternative.

The maximum total acid deposition presented in Table 4.3-11 is less than 10 percent of threshold values presented earlier. Therefore, impacts to biota are unlikely.

100,000 bpd - Additional Retort

The full production Union B/additional retort alternative would replace the fines stock pile with a single Lurgi retort. The 24-hour TSP Class II concentration would exceed the PSD increment by 22 percent. When added to the background levels, this would result in a total concentration which would be 52 percent of the federal standard. The 3-hour SO_2 concentration in Flat Tops would be 32 percent of the PSD Class I increment. This alternative rates a low to medium adverse impact.

A Level-1 visibility screening analysis indicated that a NO_x-caused dark plume against a bright sky would be visible to a distance of 52 miles from the facility, while a TSP-caused light plume against dark terrain would be visible to a distance of 70 miles. This analysis indicates a potential for visibility degradation in Flat Tops Wilderness, Black Canyon of the Gunnison Wilderness, West Elk Wilderness, Colorado National Monument, and Dinosaur National Monument due to the additional retort alternative.

The maximum total acid deposition presented in Table 4.3-11 is less than 10 percent of threshold values presented earlier. Therefore, impacts to biota are unlikely.

50,000 bpd - Additional Retort

The reduced production/additional retort alternative would replace the fines stockpile with an additional Lurgi retort. No TSP or SO_2 Class I, Class II, or Category I increments would be fully consumed or exceeded. When added to the background concentrations, the 24-hour off property TSP total concentration represents 38 percent of the NAAQS. This alternative rates a low adverse impact.

A Level-1 visibility screening analysis indicated that a NO_x-caused dark plume against a bright sky would be visible to a distance of 42 miles from the facility, while a TSP-caused light plume against dark terrain would be visible to a distance of 55 miles. This analysis indicates a potential for visibility degradation in the Flat Tops Wilderness and the Colorado National Monument. The maximum total acid deposition presented in Table 4.3-11 is less than 10 percent of threshold values presented earlier. Therefore, impacts to biota are unlikely.

Spent Shale Disposal

Table 4.3-12 presents the modeling results of the spent shale subalternatives involving two separate disposal areas. The 24-hour TSP Class II off property increment is predicted to be exceeded by all alternatives except for the reduced-production/additional retort alternative. The total concentration added to the background 24-hour TSP concentrations is compared to the NAAQS and is rated in Table 4.3-13.

Table 4.3-13 TSP Impact Rating for Spent Shale Disposal Alternatives

Alternative		Percent NAAQS	Impact Rating
Proposed Action	100,000 bpd	89	Moderate to high adverse
Proposed Action	50,000 bpd	56	Low to moderate adverse
Split Lurgi	100,000 bpd	88	Moderate to high adverse
Split Lurgi	50,000 bpd	55	Low to moderate adverse
All Union B	100,000 bpd	89	Moderate to high adverse
All Union B	50,000 bpd	56	Low to moderate adverse
All Lurgi	100,000 bpd	88	Moderate to high adverse
All Lurgi	50,000 bpd	55	Low to moderate adverse
Additional Retort	100,000 bpd	70	Moderate adverse
Additional Retort	50,000 bpd	46	Low to moderate adverse

Except for the full production/split-Lurgi and full production/additional retort alternatives, these impacts all occur along the west central property line. The maximum concentration for full production/split Lurgi and full production/additional retort occur on the east central property line due to the placement of the spent shale disposal area on the east side of the property. All other total concentrations for pollutants considered are below 30 percent of the respective NAAQS.

Cogeneration

Table 4.3-12 presents the modeling results of the cogeneration alternative. The 24-hour TSP concentrations are predicted to consume or exceed the PSD Class II increment for all full production alternatives and for the reduced production/split and all Union B retorts. These impacts would all occur in the same location as the original alternatives without cogeneration. When added to the background concentrations, the percent contribution to the 24-hour TSP NAAQS and the impact ratings are identical to those listed for the alternatives without cogeneration. All other total concentrations would be well below 30 percent of the NAAQS.

A Level-1 visibility screening analysis using the proposed action at full production indicated that a NO_x-caused dark plume against a bright sky would be visible to a distance of 46 miles from the facility, while a TSP-caused light plume against dark terrain would be visible to a distance of 63 miles. This analysis indicates a potential for visibility degradation in Flat Tops Wilderness, Colorado National Monument, and Dinosaur National Monument for the cogeneration alternative.

The maximum total acid deposition presented in Table 4.3-11 is less than 10 percent of threshold values presented earlier. Therefore, impacts to biota are unlikely.

4.3.8.3 Solid/Hazardous Wastes and Toxic Pollutants

None of the non-criteria pollutants typically found in combustor off-gas are expected to be emitted above de minimis values by the Union B and VMIS retort processes. This conclusion is based upon a review of the Union Oil Company's PSD permit application (Union Oil Company 1982a), a review of EPA's manual entitled Pollution Control of Modified In Situ Process for Cathedral Bluffs (EPA 1983), and a review of EPA's document entitled Trace Elements Associated with Oil Shale Processing (EPA 1977). Additional trace elements analysis for Union B retort combustor off-gas and noncriteria pollutant emissions for the VMIS process has been supplied by Cities Service (1983c) and are presented in Table 4.3-14 and Table 4.3-15. Based on the analysis of potentially toxic pollutants that might be emitted from the proposed project, all ranges of emissions for the identified toxics are minor and are below EPA de minimis levels.

Only limited data are available concerning the emissions of potentially toxic substances. However as noted in the Uinta Basin Synfuels Development Final EIS, the risk is very small (BLM 1983c), even for a 1,000,000-bpd oil shale industry. The BLM (1983c) risk calculation covered project workers, the existing population and people moving into the area.

4.3.8.4 Secondary Impacts

This section presents the estimated air quality impacts from secondary growth emission sources associated with the construction and operation of Cities Services upgrading, mining, and retorting facilities. The secondary growth sources included in the analysis are increased space heating requirements and increased motor vehicle traffic in the De Beque area.

The emission estimates from increased space heating and transportation requirements are presented in Table 4.3-16. Space heating emissions were calculated by assuming each new household was a consumer of natural gas and used 115,000 standard cubic feet of gas per customer year (BLM 1983a). Emission factors for natural gas combustion were derived from EPA's Compilation of Emission Factors (EPA 1977). Vehicle exhaust emissions were calculated from national average emission factors. It was assumed that each household operated an average of two vehicles and each vehicle averaged 12,000 miles traveled per year. The highest emissions are expected in the year 2007. The projected emissions impacts of the year 2007 were estimated with the highly conservative screening technique outlined in Appendix A.

To estimate the highest short-term concentrations possible in De Beque, a worst-case episode was considered from the projected year 2007 secondary emissions. The scenario assumes all motor vehicle emissions from 3 pm one day until 9 am the next morning are trapped over the De Beque area. In addition, continuous space heating emissions were added to the vehicle emissions. The meteorological conditions assumed were a regional high pressure stagnation condition, with zero ventilation. Thus, pollutants emitted during the 18-hour period were assumed to accumulate over the town, and then fumigated down to the ground and fill a well-mixed box surrounding De Beque. A 32-square-mile area surrounding De Beque was assumed for the well-mixed region. To add to the conservatism, the vertical extent of the mixed region was taken as only 650 feet. The worst-case short-term concentrations were then calculated as the total amount of pollutant mass released during the period divided by the volume of the well mixed box.

Table 4.3-14 TRACE ELEMENTS IN UNION B RETORT OFF-GAS[a] - CITIES SERVICE PROJECT

Element	Form	Concentration in Off-Gas (μg/SCM)	Toxicity Range[b] (TLV) (μg/m³)	Annual Emmision[c] Rate (Ton/Year)	De Minimis Value (Ton/Year)
Arsenic	Gas	15	500 to 2,000	0.25	--
	Particulate[d]	0.4			
		15.4			
Mercury	Gas	2.2	100 to 500	0.01	0.1
	Particulate	0.15			
		2.35			
Iron	Gas	120.0	--	0.44	--
	Particulate	6.0			
		126.0			
Chromium	Gas	90.0	500 to 2,000	0.32	--
	Particulate	2.0			
		92.0			
Zinc	Gas	40.0	500 to 150,000	0.14	--
	Particulate	0.5			
		40.5			

Source: Getty (1983c).

[a] Assumes net gas production of 500 SCM/ton shale (Harak et al. 1974).
[b] Source: Cowherd et al. (1977).
[b] Gaseous forms are defined as those not collected by a 0.5μ neopore filter.
[d] Assumes volume flow rate of 100 m³/sec.

The uniform hourly concentration estimates calculated using the above worst-case dispersion episode are 3, 8, 113, 415 and 66 μg/m³ for SO_2, TSP, NO_x, CO and HC respectively. Except for NO_x, these concentrations are at the level of background concentrations, and are insignificant.

Extrapolating the NO_x concentration to an annual average using a factor of 0.2 as recommended (EPA 1970) results in a concentration of 23 μg/m³, or 23 percent of the annual NO_2 NAAQS.

4.3.9 Noise

4.3.9.1 Proposed Action

The Cities Service project has been designed using engineering noise controls where required and whenever practical. Only nominal noise controls were assumed in estimating facility sound pressure levels (SPL). Some equipment may require additional noise controls such as lagging, acoustical enclosures, mufflers, or special designs to reduce noise to acceptable working conditions. Cities Service (1983c) has stated these items will be addressed as required.

The facility equipment noise inventory for the Cities Service project proposed action is presented in Table 4.3-17. The projected noise level on the access road segments on and off property was assumed to be 86 dBA at 10 feet. This assumes one medium to heavy utility truck (service or supply) on the access road segments at all times. Two spent shale trucks were assumed in the spent shale area, resulting in a sound pressure level (SPL) of 108 dBA, while one spent shale truck was placed in all of the haul road segments with a resulting SPL of 105 dBA.

Table 4.3-15 ESTIMATED VMIS EMISSIONS OF OTHER CRITERIA POLLUTANTS - CITIES SERVICE PROJECT

	Emissions (tpy)	
Pollutant	De Minimis	Cathedral Bluffs
Volatile Organic Compounds	40	40
Lead	0.6	0.15
Asbestos	0.007	0
Beryllium	0.004	0.003
Mercury	0.1	0
Fluorides	3	7.8
Sulfuric Acid Mist	7	0
Hydrogen Sulfide	10	0
Total Reduced Sulfur	10	0
Reduced Sulfur Compounds	10	0

Source: EPA (1983).

Table 4.3-16 MAXIMUM ANNUAL SECONDARY EMISSION RATES IN DE BEQUE - CITIES SERVICE PROJECT

Source Type	SO_2 (ton/yr)	TSP (ton/yr)	NO_x (ton/yr)	CO (ton/yr)	HC (ton/yr)
Space Heating (9,447 Units)	0.3	2	24	9	3
Transportation (14,894 Vehicles)	45	118	1,576	5,871	929
Total Emissions	45.3	120	1,610	5,880	929

Based on these untreated noise levels, calculation of the facilities noise sources spreading indicate operational noise would not have a significant impact away from the project. The radius of this additional noise from the center of the Cities Service property to the day/night noise level (Ldn) 55 dBA contour is about 7 miles. This results in a total affected area of about 94,000 acres. No known sensitive receptors residential or public land uses, were identified from recent 1:50,000 scale USGS topographical maps.

The proposed action does not utilize rail beyond De Beque for the Cities Service project. Thus, no noise impacts due to trains for this facility are expected.

Traffic along the Conn Creek road is expected to peak during the year 2004. Traffic would include 122 buses per day and 10.3 trucks per day. The BLM traffic noise impact technique (BLM 1982b) results in an equivalent noise level (Leq) of 60 dBA at 50 feet. Analyses in the CCSOP EIS (BLM 1983a) resulted in the traffic noise level along the Roan Creek road segment predicted to be 47 dBA at 50 feet without any oil shale projects. For perspective, typical houshold noise levels are in the range of 45 to 65 dBA (EPA 1978b). The average individual would probably not be able to detect the increase in traffic noise indoors, based on the equivalent sound level. Nevertheless, noise variation due to traffic from the Cities Service project would be perceptible, but should not be obtrusive.

The noise levels associated with the proposed action are rated as a low adverse impact. It must be noted, however, that the noise impact is highly specific to individuals. Many people living in the remote areas of western Colorado are there primarily because it is remote, and may very likely view any increase in noise as a medium-adverse impact. Additional adverse effects would be observed by persons seeking recreational activities (e.g., hunting or hiking) near the Cities Service facilities. Potential impacts associated with noise include possible minor physiological reactions; behavioral interferences with work, sleep, or hearing; as well as subjective effects including irritation and annoyance. Increased noise levels could also affect animals living on or near proposed facilties and transportation corridors. Effects on animals could be short-term duration due to the potential for adaptation.

Table 4.3-17 EQUIPMENT NOISE LEVELS - CITIES SERVICE PROPOSED ACTION

Description	Sound Pressure Level (dBA)	Distance From Source (m)
VMIS Surface - Process Facility		
Offgas Processing & Compressing	93	58
Steam Generation	81	58
Flue Gas Desulfurization	80	37
Ammonia Stripping	75	34
FGD Filters	76	22
Above Ground Retorting		
Union B Retorts	85	119
Retort Gas Plant	89	54
Sulfur Recovery	80	54
Upgrading		
Naphtha Hydrotreator	82	55
Hydrogen Plant	90	69
Whole Oil Hydrotreater	81	92
Gas Plant	82	27
Sulfur Recovery	79	45
Material Handling		
Spent Shale Disposal Truck	105	3

Source: Cities Service (1983c).

4.3.9.2 Alternatives

This section considers the noise impacts of the proposed alternatives to the Cities Service project.

All process technology alternatives for full production (100,000 bpd) including facilities and transportation corridors should not vary significantly from the proposed action. Specific relocation of the process equipment is not critical from a noise standpoint. Based on the large areas required for the plant and the remote site locations, process equipment noise impact would be approximately equivalent for all Cities Service full-production alternatives.

The facility equipment noise inventory for the Cities Service project 50,000-bpd alternatives are presented in Table 4.3-18. The noise levels of mobile equipment were assumed to be the same as for the proposed action.

Based on these untreated noise levels calculations of the facility, noise source spreading indicates operational noise would not have a significant impact. The radius of this additional noise from the center of the facility to the 55-dBA contour is about 6 miles, which results in a total of 70,000 acres affected. Again, no known sensitive receptors were identified on 1:50,000 scale USGS topographic maps.

Employees would be mass transported from De Beque to the plant site via buses. These sources coupled with other transportation/traffic noise impacts would be less than the proposed action traffic noise levels. Cities Service is considering the alternative of utilizing a railroad to transport workers up to near their property in Conn Creek valley. Three trains per day will transfer about 5,300 people during 2004, when peak transportation requirements occur due to construction and operation. Three trains per day to the Roan Creek Community Center were analyzed in the CCSOP EIS (BLM 1983a). The results of this analysis were factored to consider the smaller train segment and are presented in Table 4.3-19. Due to the low frequency, penetrating rumble of the trains (i.e., the higher noise levels shown in Table 4.3-19) may be objectionable to some individuals.

The noise levels associated with the reduced-production rate alternatives would rate as a low adverse impact. It must be noted, however, that noise impact is highly specific to individuals.

The use of cogeneration as an additional power supply is also an alternative to Cities Service proposed action. This addition would add another source of noise. Typical power plant noise generation has been supplied by Getty (1983c) and are presented in Table 4.3-20. The addition of this source should not greatly expand the radius of acreage affected presented for all alternatives.

4.3.9.3 Solid/Hazardous Wastes and Toxic Pollutants

On-site disposal of hazardous wastes would not create additional noise impacts. The noise impacts of transportation of any wastes off-site have been considered in the calculation for the proposed action and alternatives.

4.3.9.4 Secondary Impacts

Secondary noise impacts related to increased population in the region is not quantifiable, but some general statements taken from the CCSOP EIS (BLM 1983a) can be made. Noise impacts related to traffic increases (the major secondary noise source) should be diffuse and of low adverse impact. Additional railroad and construction noises would occur in the region to accompany the increased populations. Most of these impacts should be of short duration and temporary, although major project construction (e.g., a shopping center) or frequent train traffic could cause local temporary adverse impacts of some importance.

Table 4.3-18 EQUIPMENT NOISE LEVELS - CITIES SERVICE 50,000 BPD ALTERNATIVE

Description	Sound Pressure Level (dBA)	Distance From Source (m)
VMIS Surface - Process Facility		
Offgas Processing & Compressing	85	58
Steam Generation	81	58
Flue Gas Desulfurization	80	37
Ammonia Stripping	75	34
FGD Filters	76	22
Above Ground Retorting		
Union B Retorts	82	119
Retort Gas Plant	86	54
Sulfur Recovery	77	54
Upgrading		
Naphtha Hydrotreator	79	55
Hydrogen Plant	87	69
Whole Oil Hydrotreater	78	92
Gas Plant	79	27
Sulfur Recovery	76	45

Source: Cities Service (1983c).

Table 4.3-19 RAILROAD NOISE IMPACT - CITIES SERVICE PROPOSED ACTION

Railroad Segment	Trains Per Day	Distance to 50 dBA Contour (feet)	Area of Impact (acres)	Sensitive Receptors	Noise Level at Receptor (dBA)	
					Outdoor	Indoor
De Beque to Roan Creek Community Center	3	3,700	13,360	None	70-75	55-60
				4 Houses	65-70	50-55
				3 Houses	60-65	45-50
				5 Houses	55-60	40-45
				2 Houses	50-55	35-40

Source: BLM (1983a).

Table 4.3-20 TYPICAL POWER PLANT NOISE GENERATORS AND THE RANGE OF LEVELS PRODUCED - CITIES SERVICE PROJECT

Equipment	Noise Levels (dBA)
Boiler Feed Pumps	85 - 100
Forced Draft Fans	85 - 110
Induced Draft Fans	77 - 97
Condenser Rooms Below Turbine Generators	83 - 100
Pressure-Reducing Stations	82 - 109
Turbine-Generators	83 - 100
Auxiliary Exciters	88 - 93
D-C Generators	93 - 103
Demineralizers	85 - 101
Flue Dust Exhausters	85 - 103
Noise in Control Rooms	56 - 74

Source: Getty (1983c).

4.3.10 Cultural Resources

4.3.10.1 Proposed Action

Construction of the Cities Service underground room and pillar mine (100,000 bpd) would not impact any cultural resources due to the nature of the construction. Construction of the mine bench and associated surface facilities, primary crusher, portal, and vents has the potential to impact cultural resources where topographic conditions favorable to human habitation or use exist. Such conditions include gentle slopes, prominences, proximity to permanent or seasonal water, access corridors to major drainages, and proximity to available food resources, among others.

Although no sites were located on or adjacent to the waste rock disposal area during the Class II survey, the location near the head of an intermittent drainage indicates a potential for site location.

A multicomponent site (historic structures and prehistoric lithic scatter) was recorded by Nickens (1983) near the northern edge of the raw shale fines storage area. Further work is needed at the site in order to complete an evaluation for the NRHP. Only a small portion of the raw shale fines storage area has been surveyed.

Areas immediately adjacent to the process facilities site have been sample-surveyed by Nickens (1983). No cultural resource sites were identified during the survey. Although historic and prehistoric site densities are considered low for the area, construction of the process facilities has the potential to impact cultural resources given the proximity to Conn Creek and Cascade Canyon.

Construction of the spent shale disposal area has the potential to impact cultural resources, particularly along the wider portions of the Conn Creek and Cascade Canyon drainage areas. The steep-walled canyon areas inhibit past and present use, and sites are not anticipated in these areas.

Construction of proposed corridors (La Sal connection, Cities to Getty power and syncrude, Conn Creek multi-use) have the potential to impact resources since they pass through areas favorable for site location. A potential for locating cultural resources in unstudied areas exists, although estimated site density is considered low. Based upon the location of sites during pre-construction surveys, actual determination of impacts and appropriate mitigation measures for the remaining corridor routes will be developed according to agency regulations.

4.3.10.2 Alternatives

Reduction in size of the underground room and pillar mine for the lower production rate (50,000 bpd) would not affect cultural resources. Reduction of process facilities for 50,000 bpd would lessen surface disturbance, and therefore possibly lessen inadvertant impacts to cultural resources.

Construction of the spent shale alternative sites is considered to have the potential to impact cultural resources similar to the proposed action. The Rangely corridor is addressed in CCSOP EIS (BLM 1983a). Use of the North corridor alternative has the potential to impact cultural resources due to promimity to areas considered favorable to site location.

The Larkin Ditch water supply alternative would have minimal potential to impact cultural resources since the ditch and headgate are already in place. New construction of a pump station and sedimentation basin could cause little impact to cultural resources, since the area in question is substantially disturbed and now contains a cattle feed lot and a gravel pit. The remaining area is floodplain.

A potential exists for cultural resources in all unstudied areas, although it is assumed that site densities would be low. Based upon the results of preconstruction surveys, the actual determination of impacts and appropriate mitigation measures would be developed according to agency standards.

4.3.11 Land Use, Recreation, and Wilderness

4.3.11.1 Proposed Action

Land Use

The Cities Service property consists of 6,850 acres of predominately rangeland (Cities Service 1983a). The primary land use impacted by the Cities Service proposed action would be the loss of approximately 3,100 acres of rangeland from construction of mine facilities, process facilities, spent shale, and waste rock disposal in Conn Creek and Cascade canyons and raw shale fines storage at the head of Conn Creek. In addition to those activities evaluated in the CCSOP EIS (BLM 1983a), approximately 1,500 acres of rangeland and 10 acres of agricultural land would be disturbed by the construction of the various project corridors (product transport, utility, access, railroad, and water). These lands would essentially be lost as a resource for up to 25 years. Eventually the majority of this affected average would be returned to their original uses. No prime farmland would be affected. Another land use impact resulting from placement of corridors could be the alteration of livestock movement patterns. Corridors could present physical barriers to livestock and thus certain rangeland parcels may be used more or less intensely.

Recreation

The primary impact of the Cities Service proposed action on recreation would be increased numbers of people requiring recreational opportunities in the region. A detailed discussion of these regional impacts is presented in Section 4.1.11.

Project-specific recreational impacts would be the removal of up to 2,020 acres of big game wildlife habitat. However, hunting in this area is limited by access. Thus, this adverse impact could be ameliorated by the fact that other areas, which may be relatively inaccessible at present, would be made more accessible by the construction of new corridors and access roads. Although such access could open up additional areas to hunting, it could also lead to an unpredictable increase in the incidence of poaching, trespassing, and off-road vehicle use. Access through corridors would be strictly controlled, thus the impacts would be minimized.

Table 2.3-9 lists the BLM-administered public land to be considered for land exchange, purchase, lease, or rights-of-way approval for the Cities Service project. These public lands could be subject to impacts due to corridor routing or construction of reservoirs in the parcels. None of the public lands cited are located in Recreation Management Areas or Wilderness Study Areas.

Recreation and Wilderness

Recreational impacts and impacts to wilderness areas would be nearly identical to those described for the proposed action (Section 4.3.11.1).

4.3.11.3 Solid/Hazardous Wastes and Toxic Pollutants

Land use, recreation, and wilderness impacts resulting from the disposal of solid and hazardous wastes and toxic pollutants would be insignificant. Solid wastes would be disposed with spent shale on site. Therefore, land impacts of solid waste disposal would be the same as those associated with spent shale, waste rock, and spent shale fines disposal. Hazardous wastes and toxic pollutants would be sent to an unspecified off-site licensed disposal facility, thus minimizing impacts to the site-specific area, but contributing to additional land use impacts at the disposal site (see Section 4.4).

4.3.11.4 Secondary Impacts

Land Use

Indirect impacts to agricultural lands resulting from increased population growth could be more significant than direct impacts. A population increase of up to 17,000 individuals is predicted (Sections 4.1.13 and 4.3.13). Using the BLM (1982a) figure of 0.22 acres affected per individual, approximately 3,740 acres of land could be affected by project-induced growth. The percentage of this total acreage that is cropland is unknown. However, population-induced land use changes would be likely to impact flat valley areas where most agricultural land occurs. This is mitigated somewhat by the fact that the CITF model predicted more than 25 percent of the population increase is projected to occur in Battlement Mesa, where little or no agricultural land would be affected.

Project development could also reduce the amount of water available for irrigation. Essentially, Colorado River water potentially available for agricultural uses could be committed to industrial purposes.

Recreation and Wilderness

Secondary impacts to recreation and wilderness would be the same as those described in Sections 4.1.11 and 4.3.11.1.

Potential impacts to public lands would generally be the same as those described for private lands throughout Section 4.3. In general, project activities within public land parcels would result in the loss of rangeland and vegetation resources. Wildlife habitat and wildlife use patterns in the immediate vicinity of the corridors and reservoirs could be expected to change. Sensitive wildlife habitat such as aspen stands, Douglas-fir stands, riparian areas, and cliffs, as well as big game winter range, could potentiall be affected. Minimal effects to threatened or endangered wildlife and plants on public lands is expected.

Impacts to public lands would be detailed in a use application by Cities Service for BLM analysis of land-action alternatives (land exchange, land purchase, or Right-of-Way approval).

Wilderness

As a result of the proposed action, wilderness areas and wilderness study areas in the region could experience increased use. These effects are discussed in Section 4.1.11.

4.3.11.2 Alternatives

Land Use

With the exception of the 50,000-bpd alternative, the alternatives to the Cities Service proposed action would result in fewer adverse impacts to land use than the proposed action. The 50,000-bpd alternative would affect substantially the same area of rangeland as the 100,000-bpd proposed action, because ultimate volumes of spent shale, waste rock, and shale fines disposal would be unchanged.

The alternative spent shale disposal sites in Cascade Canyon and on the plateau would have greater land use impacts than the proposed action (disposal in Conn Creek and Cascade canyons) because greater total acres of rangeland would be disturbed on the plateau. Much of the land in Conn Creek and Cascade canyons is very steep and relatively unproductive. It thus has limited value as rangeland.

Although the alternative North power and syncrude corridor would be shorter than other proposed corridors, it would cross several drainages which contain productive vegetation which may serve as a water source for livestock. Therefore this alternative corridor could present more significant land use impacts than other proposed corridors. Additionally, the North power and syncrude corridor would cross public lands administered by the BLM. General impacts to the public lands are addressed in Section 4.3.11.1. Specific impacts will be detailed in a Use Application to BLM for land-action analysis.

Facilities construction for the Larkin Ditch water supply alternative would disturb an area presently containing a cattle feed lot and a gravel pit. The option of a water pipeline crossing the river by attaching the pipeline to the De Beque bridge is assumed for impact analysis purposes. The impact of the Upper Dry Fork reservoir is addressed in the CCSOP EIS (BLM 1983a).

4.3.12 Visual Resources

4.3.12.1 Proposed Action

The underground mine and VMIS retorts have been designed to minimize the potential of subsidence and associated impacts to surface features. The visual resource impacts of the mines would therefor relate to the mine portals, support surface facilities, waste rock disposal, shale fines disposal, and VMIS shale oil recovery units. The mine bench at the Mahogany Zone would introduce a form and color impact. Due to limited size of area, this impact is not expected to be significant. Surface facilities for the VMIS process, including piping, oil recovery units, and drill rigs, would contribute to the overall form, line, and color impact of the project on the plateau area.

Clearing of the site area for construction of process facilities (crusher, retort, and upgrade) would create a color (exposure of subsurface materials), line, and form (planar) impact. Process and support buildings would introduce box-like forms. Tanks, pipelines, and retort/upgrade structures would introduce linear and cylindrical forms. Conveyors, access roads, surface piping and transmission lines would introduce linear forms. Exposed raw shale stock piles would introduce color and form impacts. The colors of surface facilities would contrast with the surrounding landscape. The impact of all facilities is expected to be significant for the life of the project. Following completion of reclamation activities at project closure, the long-term impact is expected to be insignificant to nondiscernable. All activities would not be observed from an existing public roadway, community, or recreational center. No important vista or visual feature would be affected by the site.

Disposal of spent shale within the Conn Creek and Cascade Creek canyons would introduce a significant form and color impact on the canyon bottom. Although portions of the disposal area would be reclaimed as disposal activities advance within the canyon, the overall visual impact is expected to remain significant for the life of the project. Following completion of reclamation activities, the color impact would be eliminated. The form of the canyon bottom would be permanently altered, but the form change is not visible from an existing public roadway, community, or recreation center. Although the site would affect an area of high scenic quality, no important vista or visual feature would be affected.

The product transport corridor would traverse gently rolling terrain on the plateau. Assuming proper mitigation, the linear impact of constructing this corridor is expected to be insignificant.

Those portions of the utility, road, and water pipeline corridors that would traverse the bottom of Conn Creek canyon are not expected to have an insignificant linear impact. This assumes proper siting of facilities and reclamation of disturbances. Those portions of the utility, road, and water pipeline corridor that would cross the canyon walls within Conn Creek are expected to have a significant impact. These corridors would create line, form, and color impacts in an area of high scenic quality. Due to the need for cut and fill activities and the difficulty of reclaiming the canyon walls, the impact is expected to remain following project closure.

4.3.12.2 Alternatives

Visual impacts of a 50,000 bpd alternative would be reduced because fewer retort and upgrade units would be required. However, total disturbed area for the waste rock and shale fines disposal would be unchanged. Impacts of the mine surface facilities and VMIS facilities are expected to remain the same as for the 100,000 bpd alternative. The overall impact is expected to remain significant.

Processing of shale fines on site would eliminate the form and color impact of the shale fines disposal area.

Disposal of spent shale on the plateau and in upper Cascade Canyon would introduce less of a visual impact than disposal within Conn/Cascade canyons due to the scenic nature of the canyons. The plateau area has less scenic quality and disposed materials could be more easily contoured to reflect the rolling terrain of the plateau. Disposal within upper Cascade Canyon would contrast sharply with the steep side walls of the canyon.

The corridor alternatives on the plateau are not expected to differentially affect visual resources.

The existing Larkin Ditch withdrawal and pumping structure does not significantly affect visual resources in its present setting. The additional facilities required to pump and transport the water to the GCC reservoir are not expected to significantly affect visual resources. The use of an existing structure (De Beque bridge) to cross the river would have a nonsignificant to nondiscernable impact. However, a water pipeline crossing the Colorado River on a new structure would introduce a significant impact.

4.3.12.3 Solid/Hazardous Waste and Toxic Pollutants

Solid non-hazardous materials would be disposed of in the spent shale area. Disposal of such would not appreciably affect visual resources beyond that of the spent shale disposal area previously discussed. Disposal of hazardous materials would be done at an off-site licensed facility and thus would not affect visual resources of the project area.

4.3.12.4 Secondary Impacts

Secondary impacts due to employee housing, community and commercial facilities, powerlines, and roads would have a significant impact on the Roan Creek and Colorado River valleys (De Beque, Parachute, and Battlement Mesa areas). The rural and agrarian setting of the valleys would be altered to that of a more urban environment. Degree of impact would depend on the architecture, layout, and landscaping of the new communities.

4.3.13 Socioeconomics

The study area analyzed for Cities Service socioeconomic impacts includes Garfield and Mesa counties; the time-period covered is from the present through construction to full operation at 100,000 bpd. Allocations of probable effects are made to the study area as a whole and to the significant jurisdictions and communities. Projections are made for the "no action" and for the "with the Cities Service project" alternatives. Impacts are defined as the difference betweeen these two scenarios. The quantified projections are based upon output from the Planning and Assessment System (PAS) and FisPlan (MWR 1982; CITF 1982). The major subject areas covered are: economic, demographic, housing, public facilities and services, fiscal, and social impacts. The following impact discussions are summarized from a detailed technical report prepared by Mountain West Research — South West, Inc. (MWSW 1983), which is incorporated herein by reference.

4.3.13.1 Direct Project Employment, Wages, and Purchases

The Cities Service project would be developed in stages with initial construction beginning in 1986. Full-scale operation is anticipated by 2010. Information on project employment, wages, and local purchases was supplied by Cities Service. The schedule provided by Cities Service was modified by Mountain West Research to better represent the project impacts within the parameters allowed by the PAS model. PAS covers a 30-year period, 1980 to 2009. The Cities Service schedule runs to 2011. In order to show impacts for at least 1 year of full-scale operation, 2 years were deleted from the original schedule. This had the effect of moving the 100,000-bpd operation description from 2011 to 2009, the last year that could be included in the PAS projections. The two years deleted were 1998 and 2005. These years were selected because no construction was scheduled and in each case the operation employment, wages, and purchases were the same as those estimated for the immediately following year. To adjust the schedule shown in Table 4.3-21 to coincide with the original Cities Service version, 1 year should be added for the period 1998 through 2003, and 2 years for the period 2004 through 2009. The discussion in the remainder of this section is based upon the modified schedule as shown in Table 4.3-21.

Construction is expected to take place in stages with four corresponding peaks in construction work force occurring in 1991, 1997, 2003, and 2007. The peak construction work force of 3,100 is expected in 2003. Operation employment begins in 1988 with 100 workers and steadily increases to 3,700 at full operation in 2009. Total employment (construction plus operation) follows the construction employment pattern of four peaks. However, the peak project employment of 6,100 workers is reached in 2007.

If Cities Service were to pursue a nominal 50,000-bpd (approximately 40,000-50,000 bpd) alternative, the third and fourth construction cycles shown in Table 4.3-21 would be eliminated. Thus, the employment requirements for a 50,000-bpd alternative would be the same as for a 100,000-bpd alternative through 1998. After that time, construction employment would remain at 0 and operations employment at 1,800, roughly half of the operations employment in the 100,000-bpd scenario. In general, therefore, the 50,000-bpd alternative presented in Section 4.3.13.9 can be analyzed by reviewing the 1987-1998 impacts. The 1998 impacts would be representative of the effects that would continue through the operations period.

Wages are calculated (using CITF standard rates stated in 1982 dollars) at $34,400 annually for construction workers and $32,600 annually for operation workers. The pattern of wages paid follows the pattern of employment; the highest peak year for construction is 2003 when the annual wages reach $106 million. Annual wages paid during full operation are estimated to be $120.6 million.

Local purchase estimates are benchmarked to employment. Construction purchases are estimated at $49,000 per man year of employment; for operations the figure is $20,000. Like employment and wages, construction purchases peak in 1991, 1997, 2003, and 2007, with the highest estimate of $181 million reached in 2004. Annual local purchases during full-scale operation are estimated at $74 million.

4.3.13.2 Residential Allocation of Work Force

The residential allocation of the direct basic employment is shown in Table 4.3-22. This includes construction and operation work forces. The construction work force is divided into local and non-local components; 35 percent of the construction employment is estimated to come from the local study area and 65 percent is estimated to come from outside the study area. About 62 percent of the local construction workers are expected to come from Garfield County with the remaining portion residing in Mesa County. For the non-local workers, over 80 percent are expected to reside in Garfield County during the work week and just under 20 percent are assigned to Mesa County. Forty-nine percent of the non-local workers are expected to be housed in the Cities

Service single-status camp. Battlement Mesa would accommodate the next largest proportion, about 23 percent. The Grand Junction area would account for the greatest proportion of the Mesa County total, 28 percent of the local and 14 percent of the non-local construction workers.

During operations, 62 percent of the work force is estimated to reside in Garfield County with the largest proportion, 45 percent, assigned to Battlement Mesa. Mesa County is projected to be the residential location of 38 percent, with 28 percent of the workers being located in the Grand Junction area.

The allocation of workers was made by Mountain West Research — Southwest based upon information contained in descriptions made by other oil shale proposals and the location of the Cities Service resource site.

4.3.13.3 Study Area Employment and Income

In order to account for all the employment and income effects in the study area, two categories of economic activity are defined—basic and non-basic. Basic employment and income are created by demand from outside the study area, such as that resulting from the Cities Service project. As the basic income is spent and respent in the study area, additional jobs and income are created which are called non-basic. The ratio of basic to non-basic employment and income depends upon the ability of the local areas to provide the required goods and services.

Table 4.3-21 CITIES SERVICE PROJECT EMPLOYMENT, WAGES AND LOCAL PURCHASES 1986-2009[a]

	Employment			Total Wages[b]			Local Purchases[b]		
Year	Construction	Operation	Total	Construction	Operation	Total	Construction	Operation	Total
1986	400	-	400	13,760	-	13,760	19,600	-	19,600
1987	400	-	400	13,760	-	13,760	19,600	-	19,600
1988	600	100	700	20,640	3,260	23,900	29,400	2,000	31,400
1989	600	100	700	20,640	3,260	23,900	29,400	2,000	31,400
1990	1,700	100	1,800	58,480	3,260	61,740	83,300	2,000	85,300
1991	1,700	400	2,100	58,480	13,040	71,520	83,300	8,000	91,300
1992	-	500	500	-	16,300	16,300	-	10,000	10,000
1993	100	700	800	3,440	22,820	26,260	4,900	14,000	18,900
1994	400	700	1,100	13,760	22,820	36,580	19,600	14,000	33,600
1995	800	700	1,500	27,520	22,820	50,340	39,200	14,000	53,200
1996	2,100	1,000	3,100	72,240	32,600	104,840	102,900	20,000	122,900
1997	2,800	1,500	4,300	96,320	48,900	145,220	137,200	30,000	167,200
1998	-	1,800	1,800	-	58,680	58,680	-	36,000	36,000
1999	100	1,800	1,900	3,440	58,680	62,120	4,900	36,000	40,900
2000	700	1,800	2,500	24,080	58,680	82,760	34,300	36,000	70,300
2001	900	1,800	2,700	30,960	58,680	89,640	44,100	36,000	80,100
2002	2,200	2,100	4,300	75,680	68,460	144,140	107,800	42,000	149,800
2003	3,100	2,600	5,700	106,640	84,760	191,400	181,300	52,000	233,300
2004	100	2,800	2,900	3,440	91,280	94,720	4,900	56,000	60,900
2005	400	2,800	3,200	13,760	91,280	105,040	19,600	56,000	75,600
2006	1,800	2,900	4,700	61,920	94,540	156,460	88,200	58,000	146,200
2007	3,000	3,100	6,100	103,200	101,060	204,260	147,000	62,000	209,000
2008	600	3,500	4,100	20,640	114,100	134,740	29,400	70,000	99,400
2009	-	3,700	3,700	-	120,620	120,620	-	74,000	74,000

Source: Cities Service (1983b).

[a] This schedule has been adjusted from the original prepared by Cities Service to accommodate the PAS projection period. (See Section 4.3.13.1). To adjust the schedule to Cities Service's original form, add one year to the period 1998 to 2003, add two years to the period 2004 to 2009.

[b] Thousands of 1982 dollars.

The Planning and Assessment System (PAS) has determined the basic and non-basic ratios for each economic sector by county. The model allows the analyst to estimate the size, duration, and location of the non-basic response to significant changes in basic income.

Analysis of the "no action" alternative (without the Cities Service project) incorporated a number of assumptions about future growth in the study area. The Basic Activity System (BAS) file used for Cities Service projections is the CITF version as of May 1983, with an updating of the labor force participation rates to conform to data from the 4th count tapes, 1980 U.S. Census. Except for the modification to the labor force participation rates, this baseline description is the same as the one used for the Mobil and Pacific projects (Higgins 1983; Taylor 1983). Assumptions were made for basic employment in Garfield and Mesa counties for each of the economic sectors, agriculture, services, etc. In addition, information for specific types of activity was included. These included activities for conventional oil and gas, coal, uranium, water projects, utilities such as electric power generation, and their associated facilities. The only oil shale project in the "no action" baseline projections was Union I (10,000 bpd). Conservative guidelines were used for including projects; that is, only projects in progress or projects for which firm commitments have been made were included.

Local purchases, which affect basic and non-basic employment and income, were provided by Cities Service. The economic sector distribution was estimated by Mountain West Research based upon information contained in documents on other oil shale projects in the same area. The spatial distribution used assumptions formulated by the CITF. These assumptions were incorporated in the PAS model programming.

Employment

The employment impacts are defined as the difference between the projections for the "no action" and the "with the Cities Service Project" alternatives. This includes basic and non-basic jobs. Table 4.3-23 shows total employment for Garfield County, Mesa County, and the two-county study area.

Study area employment impacts follow the pattern of the project work force with four progressively rising peaks projected in 1991, 1997, 2003, and 2007. In 2003, the employment for the "no action" alternative is projected to be 58,428; for the "with project" alternative it would be 69,107. The impacts would be 10,678 or 18 percent

Table 4.3-22 RESIDENTIAL ALLOCATION OF CITIES SERVICE PROJECT WORK FORCE

Place	Construction[a] Local	Construction[a] Non Local	Operation Local
Garfield County	.620	.806	.620
Battlement Mesa	.450	.230	.450
Parachute Area	.050	.025	.050
Rifle Area	.120	.061	.120
Cities Service Single Status Camp	-	.490	-
Mesa County	.380	.194	.380
De Beque	.050	.025	.050
Grand Junction Area	.280	.143	.280
Palisade	.030	.016	.030
Fruita	.020	.010	.020

Source: CITF (1983); Cities Service (1983b); and Mountain West Research - Southwest, Inc. (1983).

[a] The local work force comprises 35 percent and the non local work force 65 percent of the total construction employment.

Table 4.3-23 SUMMARY OF EMPLOYMENT IMPACTS BY COUNTY FOR THE CITIES SERVICE PROJECT

	Garfield County				Total Garfield & Mesa Counties				Mesa County			
			Impact				Impact				Impact	
Year	With Project	No Action	Difference	%[a]	With Project	No Action	Difference	%[a]	With Project	No Action	Difference	%[a]
1980	11,306	11,306	0	0	47,908	47,908	0	0	36,602	36,602	0	0
1981	13,401	13,401	0	0	52,277	52,277	0	0	38,876	38,876	0	0
1982	14,890	14,890	0	0	54,683	54,683	0	0	39,793	39,793	0	0
1983	14,016	14,016	0	0	53,227	53,227	0	0	39,211	39,211	0	0
1984	12,663	12,663	0	0	51,053	51,053	0	0	38,390	38,390	0	0
1985	12,630	12,630	0	0	51,296	51,296	0	0	38,666	38,666	0	0
1986	12,751	12,470	280	2	52,349	51,727	622	1	39,598	39,257	341	0
1987	12,840	12,519	321	2	53,271	52,569	702	1	40,431	40,050	381	1
1988	13,160	12,602	557	4	54,571	53,374	1,196	2	41,411	40,772	639	1
1989	13,280	12,691	589	4	55,296	54,035	1,261	2	42,015	41,344	671	1
1990	14,149	12,783	1,366	10	57,176	54,030	3,145	5	43,027	41,247	1,779	4
1991	14,609	12,856	1,752	13	57,866	53,895	3,970	7	43,257	41,039	2,217	5
1992	13,621	12,929	692	5	55,829	54,450	1,379	2	42,208	41,521	687	1
1993	13,794	13,005	788	6	56,493	54,936	1,556	2	42,699	41,931	768	1
1994	14,104	13,082	1,022	7	57,301	55,239	2,061	3	43,197	42,157	1,039	2
1995	14,497	13,161	1,336	10	58,371	55,622	2,748	4	43,874	42,461	1,412	3
1996	15,813	13,244	2,569	19	61,421	56,033	5,387	9	45,608	42,789	2,818	6
1997	17,019	13,329	3,690	27	64,154	56,453	7,701	13	47,135	43,125	4,010	9
1998	15,560	13,419	2,140	15	61,057	56,879	4,177	7	45,498	43,460	2,037	4
1999	15,483	13,507	1,975	14	61,188	57,322	3,866	6	45,705	43,815	1,890	4
2000	15,992	13,600	2,392	17	62,518	57,738	4,779	8	46,526	44,139	2,386	5
2001	16,286	13,691	2,595	19	63,188	57,975	5,213	9	46,902	44,284	2,617	5
2002	17,596	13,783	3,812	27	66,017	58,199	7,818	13	48,421	44,415	4,005	9
2003	18,977	13,879	5,097	36	69,107	58,428	10,678	18	50,130	44,549	5,580	12
2004	17,294	13,979	3,315	23	65,161	58,668	6,493	11	47,867	44,689	3,177	7
2005	17,344	14,083	3,261	23	65,342	58,919	6,423	10	47,998	44,836	3,161	7
2006	18,544	14,191	4,352	30	67,978	59,182	8,795	14	49,434	44,991	4,443	9
2007	19,843	14,304	5,538	38	70,785	59,457	11,327	19	50,942	45,153	5,789	12
2008	18,800	14,423	4,377	30	68,380	59,746	8,634	14	49,580	45,324	4,256	9
2009	18,504	14,546	3,957	27	67,753	60,048	7,704	12	49,249	45,502	3,746	8

Source: Mountain West Research - Southwest, Inc. (1983).

[a] Percentages less than 1.0 are reported as 0.

higher than the "no action" scenario. For 2007, the impacts are slightly higher at 11,327, a 19 percent increase with the project. After construction of the project is completed, the employment impact during operation is expected to be 7,704, a 12 percent increase over the "no action" alternative.

The impacts for Garfield County would be more significant than for Mesa County. This would occur because Garfield County would receive about half the employment, due to a smaller employment base, the percentage of increase with the project would be substantially greater.

Mesa County accounts for slightly more employment impacts than Garfield County: its proportion declines to 49 percent only after construction is complete. In 1991 and 1997 the employment impact for Mesa County is estimated to be 2,217 and 4,010. The higher peaks in 2003 and 2007 project employment impacts of 5,580 and 5,789, 12 percent increases over the "no action" case. In 1991 and 1997, the increases are about 5 percent and 9 percent, respectively. After construction is completed, the impact figure is 3,746, an 8 percent increase over the "no action" alternative. These are important increases although they are a smaller proportion of the "no action" alternative baseline figures than those estimated for Garfield County. Most of the employment impacts would occur in the Grand Junction area, the service and trade center for the study area.

Income

The labor income impacts are displayed in Table 4.3-24. As in the case of employment, the impacts are calculated as the difference between the "no action" and the "with Cities Service project" alternatives. The overall pattern of the income impacts is quite similar to that shown for the employment impacts. The variations that appear are due to differential pay rates between economic sectors. In particular, the pay rates for the construction and mining sectors are significantly higher than those paid in the trade and service sectors, and higher than the averages paid for the "no action" alternative. As a result, the proportional impacts for income are somewhat higher than those recorded for the employment impacts. This holds true for the study area as a whole because the wage rates for the project workers are substantially higher than the average for the two counties. A similar result also applies to certain communities where the lower paying non-basic jobs are concentrated.

4.3.13.4 Population

Changes in population are brought about by births, deaths and migration. Projections of births and deaths are made using age-sex specific rates of change, which in this case were developed in cooperation with the CITF and reviewed by local officials. A natural increase or decrease results from the application of these rates to the population base of the study area. Migration, which includes consideration of employment and nonemployment components, accounts for population change due to people moving into or out of the area. Project-related in-migration is directly tied to the employment effects and conditions in the local labor force. Diminished out-migration due to the ability of local residents to obtain jobs in the study area instead of moving also contributes to a positive population impact. In addition to accounting for the workers, members of their households who move with them must also be included in population figures.

The distribution of population impacts to communities takes into account the location of the jobs, the commuting patterns of workers, and the available housing for households. Direct basic workers are allocated as shown in Table 4.3-22. Indirect basic employment is created by the local purchases made on behalf of the project, and these jobs are located at various work sites depending upon the goods or services that are purchased. Non-basic work is located in the market and trade centers. A commuter matrix is used to identify the locations of the indirect basic and the non-basic population.

The population projections for the "no action" and the "with Cities Service" alternatives are shown in Table 4.3-25. The data show the figures for the study area, for the two counties, and for the significant jurisdictions. Also shown are the impacts, defined as the difference between the "no action" and the "with Cities Service" alternatives.

The 1982 to 2009 population increase for the study area with the "no action" alternative would be 7,651, a 0.2 percent average annual rate of increase. Garfield County shows rapid increases for 1981 and 1982 during the recent oil shale development period, and a pattern of decline until 1986 and slow annual increases after that year. The population projection for 2009 is 29,420 with the "no action" alternative, slightly lower than the figure of 29,478 which was recorded for 1982. This is, for all practical purposes, a no-growth scenario.

The "no action" projections for Mesa County estimate only small annual rates of increase, about 0.3 percent for the period 1982 to 2009. The population in 2009 would be 95,186, a numerical increase of about 7,700 for the 28-year period.

The population impacts for the entire study area with the Cities Service project follow the four-phase pattern as those of employment with each peak progressively higher. The greatest population impact would occur in 2007 with a population growth of 17,711 with the Cities Service project, a 14 percent increase over the "no action" alternative. After construction is completed, an annual impact of 12 percent is forecasted. This is a significant increase with the project; the average annual rate of change between 1982 and 2009 is about triple that of the "no action" alternative.

Of the two counties in the study area, Garfield County would be most impacted. Nearly 60 percent of the additional population is expected to reside in Garfield County during the peak years of 2003 and 2007. Because of its smaller base, this proportion of the increase would mean impacts of 30 to 36 percent over the "no action" alternative.

Although the numerical population impacts are almost as high for Mesa County, the increase in percentage terms is much smaller due to the larger population base and, therefore, the impacts are less significant. While Garfield County and most of the communities would be expected to experience impacts over 10 percent during the projection period, the rates for Mesa County are typically under 10 percent with only Palisade and De Beque being the exceptions. Grand Junction is expected to have impacts of about 4 to 7 percent from 1997 to 2009.

Table 4.3-24 SUMMARY OF LABOR INCOME IMPACTS BY COUNTY FOR THE CITIES SERVICE PROJECT (in thousands of 1982 dollars)

	Garfield County				Total Garfield & Mesa				Mesa County			
			Difference				Diference				Difference	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	167,126	167,126	0	0	746,134	746,134	0	0	579,008	579,008	0	0
1981	230,084	230,084	0	0	864,981	864,981	0	0	634,898	634,898	0	0
1982	256,627	256,627	0	0	902,228	902,228	0	0	645,601	645,601	0	0
1983	238,076	238,076	0	0	871,400	871,400	0	0	633,325	633,325	0	0
1984	210,779	210,779	0	0	829,511	829,511	0	0	618,731	618,731	0	0
1985	210,587	210,587	0	0	835,045	835,045	0	0	624,458	624,458	0	0
1986	212,828	206,232	6,596	3	854,746	841,615	13,131	1	641,918	634,383	6,535	1
1987	214,112	206,873	7,238	3	871,650	857,369	14,280	1	657,538	650,496	7,042	1
1988	221,270	208,153	13,116	6	897,657	872,324	25,333	2	676,387	664,170	12,217	1
1989	223,117	209,519	13,597	6	909,854	883,548	26,305	3	686,738	674,029	12,708	1
1990	242,842	210,933	31,909	15	948,520	883,674	64,846	7	705,678	672,741	32,937	4
1991	253,027	211,968	41,059	19	963,851	881,367	82,483	9	710,824	669,399	41,424	6
1992	228,997	212,985	16,012	7	919,916	890,020	29,896	3	690,920	677,035	13,884	2
1993	234,251	214,049	20,201	9	934,358	897,633	36,725	4	700,108	683,584	16,523	2
1994	240,619	215,124	25,495	11	949,520	902,532	46,987	5	708,901	687,409	21,491	3
1995	248,865	216,228	32,637	15	969,667	908,644	61,022	6	720,802	692,416	28,385	4
1996	279,679	217,384	62,294	28	1,033,304	915,165	118,138	12	753,625	697,781	55,843	8
1997	307,485	218,559	88,926	40	1,090,129	921,835	168,293	18	782,644	703,276	79,367	11
1998	271,972	219,822	52,150	23	1,023,648	928,598	95,050	10	751,676	708,775	42,900	6
1999	271,196	221,040	50,156	22	1,026,471	935,608	90,863	9	755,276	714,569	40,706	5
2000	282,351	222,329	60,021	27	1,052,222	942,261	109,961	11	769,871	719,932	49,939	6
2001	287,830	223,574	64,255	28	1,064,104	943,528	120,576	12	776,274	719,954	56,320	7
2002	318,557	224,844	93,712	41	1,123,967	944,804	179,162	19	805,410	719,960	85,450	11
2003	350,156	226,153	124,002	54	1,187,254	946,108	241,146	25	837,098	719,955	117,143	16
2004	308,972	227,513	81,458	35	1,104,090	947,462	156,628	16	795,119	719,949	75,170	10
2005	311,310	228,935	82,375	36	1,109,845	948,878	160,966	17	798,535	719,943	78,591	10
2006	338,651	230,423	108,227	47	1,163,849	950,362	213,487	22	825,198	719,938	105,260	14
2007	367,507	231,977	135,530	58	1,220,663	951,911	268,751	28	853,156	719,934	133,221	18
2008	341,726	233,606	108,120	46	1,169,512	953,535	215,977	22	827,786	719,929	107,857	15
2009	335,619	235,300	100,318	42	1,157,898	955,226	202,671	21	822,279	719,926	102,353	14

Source: Mountain West Research - Southwest, Inc. (1983).

[a] Percentages less than 1.0 are reported as 0.

Table 4.3-25 SUMMARY OF POPULATION IMPACTS BY JURISDICTION FOR THE CITIES SERVICE PROJECT

	Garfield County				Carbondale				Glenwood Springs				New Castle			
			Impact				Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	22,514	22,514	0	0	1,997	1,997	0	0	4,637	4,637	0	0	563	563	0	0
1981	27,054	27,054	0	0	2,317	2,317	0	0	5,082	5,082	0	0	623	623	0	0
1982	29,478	29,478	0	0	2,381	2,381	0	0	5,165	5,165	0	0	677	677	0	0
1983	28,081	28,081	0	0	2,431	2,431	0	0	5,214	5,214	0	0	656	656	0	0
1984	27,132	27,132	0	0	2,468	2,468	0	0	5,237	5,237	0	0	647	647	0	0
1985	27,380	27,380	0	0	2,502	2,502	0	0	5,276	5,276	0	0	653	653	0	0
1986	27,518	27,176	342	1	2,534	2,516	18	0	5,310	5,288	22	0	656	652	3	0
1987	27,721	27,294	427	1	2,564	2,540	23	0	5,342	5,310	32	0	661	619	41	6
1988	28,009	27,456	552	2	2,590	2,565	25	1	5,370	5,335	34	0	665	622	42	6
1989	28,169	27,610	559	2	2,615	2,589	25	1	5,393	5,359	34	0	669	625	43	6
1990	28,892	27,755	1,137	4	2,636	2,611	25	1	5,413	5,380	33	0	672	628	43	7
1991	29,640	27,883	1,757	6	2,702	2,632	70	2	5,498	5,398	100	1	686	630	55	8
1992	28,919	27,998	921	3	2,726	2,651	75	2	5,524	5,413	110	2	690	632	57	9
1993	29,089	28,101	987	3	2,744	2,668	76	2	5,539	5,426	112	2	692	634	58	9
1994	29,348	28,191	1,157	4	2,761	2,683	77	2	5,551	5,437	114	2	694	635	58	9
1995	29,643	28,268	1,375	4	2,775	2,697	78	2	5,559	5,444	115	2	696	636	59	9
1996	31,512	28,290	3,222	11	2,858	2,705	153	5	5,664	5,445	219	4	713	636	77	12
1997	33,724	28,326	5,397	19	2,983	2,714	268	9	5,826	5,447	378	7	741	636	104	16
1998	32,393	28,374	4,019	14	3,001	2,725	276	10	5,841	5,449	391	7	743	637	106	16
1999	32,435	28,415	4,019	14	3,001	2,734	266	9	5,832	5,450	381	7	742	637	105	16
2000	32,841	28,454	4,386	15	3,013	2,743	270	9	5,839	5,451	387	7	744	637	106	16
2001	33,024	28,493	4,530	15	3,024	2,751	273	9	5,843	5,452	391	7	745	638	107	16
2002	34,321	28,532	5,788	20	3,067	2,759	307	11	5,893	5,453	439	8	754	638	115	18
2003	37,141	28,572	8,569	30	3,212	2,767	444	16	6,085	5,454	630	11	787	638	148	23
2004	35,640	28,611	7,029	24	3,221	2,775	446	16	6,086	5,456	630	11	788	639	149	23
2005	35,916	28,650	7,266	25	3,234	2,782	451	16	6,094	5,456	638	11	790	639	150	23
2006	36,764	28,687	8,076	28	3,246	2,790	455	16	6,102	5,458	644	11	791	639	151	23
2007	39,049	28,722	10,326	36	3,357	2,797	560	20	6,251	5,458	792	14	817	640	177	27
2008	37,865	28,962	8,902	30	3,365	2,829	536	19	6,251	5,512	738	13	818	650	168	26
2009	37,809	29,420	8,389	28	3,390	2,887	502	17	6,282	5,623	658	11	823	669	154	23

Table 4.3-25 SUMMARY OF POPULATION IMPACTS BY JURISDICTION FOR THE CITIES SERVICE PROJECT (continued)

Year	Garfield County				Carbondale				Silt				Battlement Mesa AA			
			Impact				Impact				Impact				Impact	
	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	331	331	0	0	3,215	3,215	0	0	923	923	0	0	416	416	0	0
1981	779	779	0	0	4,618	4,618	0	0	1,115	1,115	0	0	853	853	0	0
1982	1,071	1,071	0	0	5,112	5,112	0	0	1,185	1,185	0	0	1,733	1,733	0	0
1983	837	837	0	0	4,850	4,850	0	0	1,149	1,149	0	0	831	831	0	0
1984	586	586	0	0	4,444	4,444	0	0	1,123	1,123	0	0	820	820	0	0
1985	588	588	0	0	4,483	4,483	0	0	1,131	1,131	0	0	830	830	0	0
1986	589	575	13	2	4,530	4,460	69	1	1,133	1,127	5	0	760	601	159	26
1987	592	578	13	2	4,563	4,486	77	1	1,139	1,133	6	0	761	599	162	27
1988	602	581	20	3	4,613	4,512	101	2	1,146	1,139	7	0	839	598	241	40
1989	605	585	20	3	4,639	4,537	102	2	1,151	1,144	7	0	841	597	243	40
1990	640	587	53	9	4,775	4,561	214	4	1,157	1,150	7	0	1,265	597	688	111
1991	665	590	74	12	4,928	4,582	345	7	1,177	1,155	22	2	1,482	597	885	148
1992	618	593	25	4	4,785	4,602	182	4	1,184	1,159	24	2	835	596	238	40
1993	624	595	28	4	4,815	4,620	195	4	1,188	1,163	25	2	874	596	278	46
1994	635	597	37	6	4,864	4,635	228	4	1,192	1,167	25	2	991	596	394	66
1995	650	600	49	8	4,920	4,649	270	5	1,196	1,170	25	2	1,147	596	550	92
1996	739	601	137	22	5,318	4,655	663	14	1,222	1,172	50	4	2,065	595	1,470	247
1997	833	603	229	38	5,801	4,662	1,138	24	1,262	1,174	87	7	3,023	594	2,429	408
1998	755	605	149	24	5,544	4,672	872	18	1,267	1,176	90	7	1,969	594	1,375	231
1999	760	607	152	25	5,549	4,680	868	18	1,266	1,178	88	7	2,007	594	1,413	237
2000	781	609	172	28	5,629	4,689	939	20	1,270	1,180	89	7	2,251	594	1,657	278
2001	791	612	179	29	5,666	4,698	968	20	1,273	1,182	90	7	2,343	595	1,747	293
2002	857	614	243	39	5,940	4,706	1,233	26	1,286	1,184	101	8	3,069	596	2,473	414
2003	988	616	372	60	6,586	4,716	1,869	39	1,333	1,186	147	12	4,330	597	3,732	625
2004	904	619	285	46	6,301	4,725	1,575	33	1,336	1,188	147	12	3,209	598	2,611	436
2005	919	621	297	47	6,359	4,734	1,624	34	1,340	1,190	149	12	3,352	599	2,752	458
2006	966	624	342	54	6,527	4,744	1,783	37	1,343	1,192	151	12	3,918	601	3,316	551
2007	1,072	626	445	71	7,045	4,753	2,292	48	1,380	1,194	186	15	4,989	602	4,386	727
2008	1,006	634	371	58	6,823	4,802	2,021	42	1,382	1,208	174	14	4,103	607	3,496	575
2009	997	647	349	54	6,817	4,894	1,922	39	1,391	1,236	155	12	3,920	615	3,304	536

Table 4.3-25 SUMMARY OF POPULATION IMPACTS BY JURISDICTION FOR THE CITIES SERVICE PROJECT (continued)

	Mesa County				Grand Junction				Palisade				Fruita			
			Impact				Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	81,530	81,530	0	0	28,143	28,143	0	0	1,551	1,551	0	0	2,810	2,810	0	0
1981	86,100	86,100	0	0	29,915	29,915	0	0	1,751	1,751	0	0	2,990	2,990	0	0
1982	87,479	87,479	0	0	30,349	30,349	0	0	1,825	1,825	0	0	3,059	3,059	0	0
1983	87,936	87,936	0	0	30,554	30,554	0	0	1,776	1,776	0	0	3,077	3,077	0	0
1984	88,494	88,494	0	0	30,778	30,778	0	0	1,734	1,734	0	0	3,072	3,072	0	0
1985	88,631	88,631	0	0	30,995	30,995	0	0	1,746	1,746	0	0	3,060	3,060	0	0
1986	89,835	89,621	213	0	31,512	31,441	71	0	1,775	1,764	11	0	3,084	3,074	10	0
1987	90,868	90,652	215	0	31,928	31,856	71	0	1,793	1,781	11	0	3,121	3,111	10	0
1988	91,790	91,507	282	0	32,288	32,187	101	0	1,812	1,795	17	1	3,155	3,141	14	0
1989	92,586	92,302	284	0	32,597	32,496	101	0	1,826	1,808	17	1	3,184	3,170	14	0
1990	93,219	92,131	1,087	1	32,816	32,331	484	1	1,853	1,800	52	2	3,207	3,168	39	1
1991	93,323	91,355	1,967	2	32,793	31,884	909	2	1,847	1,782	64	3	3,205	3,153	51	1
1992	93,290	91,850	1,439	1	32,731	32,059	672	2	1,808	1,787	20	1	3,195	3,171	23	0
1993	93,763	92,303	1,459	1	32,903	32,215	688	2	1,815	1,793	22	1	3,214	3,189	24	0
1994	94,179	92,232	1,947	2	33,069	32,116	953	3	1,824	1,792	31	1	3,233	3,201	31	1
1995	94,697	92,234	2,463	2	33,262	32,147	1,114	3	1,839	1,785	54	3	3,256	3,206	50	1
1996	95,468	92,550	2,917	3	33,570	32,252	1,318	4	1,877	1,788	89	5	3,293	3,221	72	2
1997	96,004	92,829	3,175	3	33,779	32,344	1,434	4	1,899	1,790	109	6	3,319	3,234	84	2
1998	95,372	93,077	2,295	2	33,464	32,425	1,039	3	1,827	1,792	35	2	3,286	3,247	38	1
1999	95,650	93,296	2,353	2	33,560	32,495	1,064	3	1,832	1,793	38	2	3,300	3,259	40	1
2000	96,065	93,492	2,572	2	33,721	32,558	1,162	3	1,850	1,795	55	3	3,322	3,271	51	1
2001	96,339	93,679	2,660	2	33,818	32,616	1,202	3	1,856	1,796	60	3	3,337	3,282	55	1
2002	96,965	93,862	3,102	3	34,076	32,674	1,401	4	1,893	1,796	96	5	3,371	3,293	77	2
2003	10,020	94,045	5,974	6	35,326	32,732	2,594	7	2,022	1,798	224	12	3,489	3,305	184	5
2004	99,302	94,233	5,069	5	34,977	32,791	2,185	6	1,946	1,799	147	8	3,453	3,316	137	4
2005	99,657	94,424	5,233	5	35,109	32,852	2,257	6	1,957	1,800	157	8	2,472	3,328	144	4
2006	100,370	94,618	5,751	6	35,402	32,914	2,488	7	1,999	1,802	197	10	3,510	3,340	169	5
2007	102,198	94,813	7,385	7	36,145	32,977	3,167	9	2,083	1,803	279	15	3,587	3,352	235	7
2008	101,692	95,004	6,688	7	35,891	33,038	2,852	8	2,024	1,805	219	12	3,562	3,364	198	5
2009	101,758	95,186	6,571	6	35,895	33,096	2,798	8	2,012	1,806	206	11	3,566	3,376	190	5

Table 4.3-25 SUMMARY OF POPULATION IMPACTS BY JURISDICTION FOR THE CITIES SERVICE PROJECT (concluded)

Year	De Beque				Collbran				Total Garfield & Mesa			
			Impact				Impact				Impact	
	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	279	279	0	0	342	342	0	0	104,044	104,044	0	0
1981	313	313	0	0	352	352	0	0	113,154	113,154	0	0
1982	349	349	0	0	352	352	0	0	116,956	116,956	0	0
1983	318	318	0	0	352	352	0	0	116,017	116,017	0	0
1984	321	321	0	0	352	352	0	0	115,626	115,626	0	0
1985	323	323	0	0	352	352	0	0	116,011	116,011	0	0
1986	341	325	16	5	352	352	0	0	117,354	116,797	556	0
1987	343	327	16	5	352	352	0	0	118,589	117,946	642	0
1988	354	328	25	7	352	352	0	0	119,799	118,964	835	0
1989	356	330	25	7	352	352	0	0	120,755	119,912	843	0
1990	404	331	72	21	352	352	0	0	122,111	119,885	2,225	1
1991	406	332	73	22	352	351	0	0	122,963	119,238	3,725	3
1992	337	333	3	1	351	351	0	0	122,209	119,848	2,360	2
1993	342	335	7	2	351	351	0	0	122,851	120,404	2,446	2
1994	354	336	18	5	350	350	0	0	123,527	120,423	3,104	2
1995	372	335	37	11	350	349	1	0	124,340	120,502	3,838	3
1996	428	336	91	27	349	348	1	0	126,980	120,840	6,139	5
1997	458	336	122	36	348	347	1	0	129,728	121,115	8,572	7
1998	343	337	6	1	348	347	1	0	127,765	121,451	6,314	5
1999	348	337	10	3	347	346	1	0	128,085	121,711	6,373	5
2000	373	338	35	10	346	345	1	0	128,906	121,947	6,959	5
2001	382	338	44	13	345	344	1	0	129,363	122,172	7,190	5
2002	437	338	99	29	345	343	1	0	131,285	122,394	8,891	7
2003	567	338	228	67	348	343	5	1	137,160	122,617	14,543	11
2004	445	339	106	31	348	342	5	1	134,942	122,843	12,098	9
2005	459	339	120	35	347	341	5	1	135,573	123,074	12,499	10
2006	520	339	180	53	346	340	6	1	137,133	123,306	13,827	11
2007	614	339	274	80	348	340	8	2	141,247	123,536	17,711	14
2008	518	340	178	52	348	339	8	2	139,557	123,967	15,590	12
2009	496	340	155	45	347	338	8	2	139,567	124,607	14,960	12

Source: Mountain West Research - Southwest, Inc. (1983).

[a] Percentages less than 1.0 are reported as 0.

4.3.13.5 Housing

The housing demand (the total number of housing units required at any point in time) is tied to the population increases that have been forecasted with the Cities Service project. Housing supply is provided by utilization of the existing capacity and by the construction of new units. The infrastructure of services to the housing sector is important in determining the location of new housing; the availability of water, wastewater treatment, utilities, streets, roads and highways, schools and other public services, all play important roles. The current housing conditions are described in Section 3.1.13.4. The private sector response to housing demand resulting from the oil shale projects begun during the late 1970's and then terminated in mid-1982 produced an excess capacity in the study area (DRI 1983). In particular, there was the development of Battlement Mesa as a major population center designed for housing people associated with oil shale projects in the area. Given the current surplus of housing accommodations and readily developable property (i.e., Battlement Mesa), the demand created by any major new project would make a positive contribution to the housing sector of the local economy.

The housing demand forecast for study area communities does not include the Single Status Camp which is expected to house about 49 percent of the non-local workers during the construction period. This means the camp would accommodate almost 1,000 workers at peak construction, and these people are not distributed to the local communities as population who would create housing demand.

The future housing demand is derived from the population impacts. The total number of people, the age structure, and the household size determine the housing demand impacts. The mix of units (single family, multifamily, and mobile homes) is estimated from past experience, distribution of the demand both geographically and over time, and descriptions of the development potential. Table 4.3-26 displays a summary of housing demand for the "no action" and the "with Cities Service" alternatives. The first two columns show demand for the two alternatives. The impact columns show the difference between the housing demand for the two alternatives and the percent of increased demand with the Cities Service project as compared to the "no action" case.

The housing demand impacts for the study area follow the fluctuation of employment and are expected to be as high as 7,447 units in 2007, an increase of 12 percent over the "no action" alternative. The housing mix is expected to gradually shift for the "no action" and the "with Cities Service" alternatives, with the single family proportion declining from about 65.4 percent in 1983 to 60.9 percent by the year 2009. Mobile homes would remain constant at about 14.4 percent, while multi-family units would increase from about 20.2 percent in 1983 to 24.8 percent in 2009. The average rate of change for the projection period would be about a third higher for the "with Cities Service" alternative (1.4 percent) as compared to the "no action" case (1.0 percent).

Garfield County is forecasted to increase its housing stock at an average annual rate of 1.1 percent for the "no action" alternative and 1.9 percent "with the Cities Service" project. The estimates made with the PAS model outputs indicate that the Mesa County demand was for about 35,754 housing units in 1983, and this would increase to 45,414 units for the "no action" alternative by 2009, and 48,425 units for the "with Cities Service" case.

In the study area as a whole, housing demand would increase by 12 percent, over 7,000 units during the projection period. The housing sector in the study area recently demonstrated that it is capable of meeting this level of demand. An important factor in projecting future housing demand is that Battlement Mesa has developed the infrastructure to accommodate significant new housing. Other communities have also taken steps to upgrade their ability to provide support for housing development.

4.3.13.6 Education

Education impacts are reported for five school districts in the study area: Garfield County District No. RE-2 which serves Rifle, New Castle, Silt, and the surrounding area; Garfield County District No. RE-16 which serves the Parachute and Battlement Mesa area; Mesa County Joint District #49 which serves De Beque and the surrounding rural portions of Mesa and Garfield counties including the Roan Creek valley; Plateau Valley School District #50 which serves Collbran, Mesa, Plateau City, and Molina; and Mesa County Valley School District #51 which serves Grand Junction, Fruita, Palisade, and the surrounding unincorporated areas.

Table 4.3-26 SUMMARY OF CHANGES IN HOUSING DEMAND FOR THE CITIES SERVICE PROJECT

	Garfield County				Carbondale				Glenwood Springs				New Castle			
			Impact				Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	9,360	9,360	0	0	787	787	0	0	2,046	2,046	0	0	249	294	0	0
1981	11,578	11,578	0	0	932	932	0	0	2,237	2,237	0	0	276	276	0	0
1982	12,809	12,809	0	0	976	976	0	0	2,288	2,288	0	0	298	298	0	0
1983	12,423	12,423	0	0	1,015	1,015	0	0	2,332	2,332	0	0	295	295	0	0
1984	11,723	11,723	0	0	1,048	1,048	0	0	2,363	2,363	0	0	295	295	0	0
1985	11,951	11,951	0	0	1,078	1,078	0	0	2,396	2,396	0	0	300	300	0	0
1986	12,145	12,031	113	0	1,106	1,098	7	0	2,427	2,418	9	0	304	302	1	0
1987	12,346	12,200	145	1	1,132	1,123	9	0	2,455	2,442	13	0	309	291	18	6
1988	12,563	12,382	180	1	1,157	1,146	10	0	2,481	2,467	14	0	313	295	18	6
1989	12,745	12,567	178	1	1,180	1,170	10	0	2,506	2,492	13	0	318	299	19	6
1990	13,077	12,746	331	2	1,203	1,192	10	0	2,530	2,517	13	0	322	303	19	6
1991	13,494	12,923	571	4	1,244	1,215	29	2	2,582	2,541	40	1	332	307	25	8
1992	13,486	13,088	397	3	1,273	1,235	37	3	2,619	2,563	55	2	339	311	27	9
1993	13,665	13,243	422	3	1,293	1,255	38	3	2,641	2,584	56	2	343	314	28	9
1994	13,863	13,388	474	3	1,313	1,273	39	3	2,660	2,602	58	2	347	318	29	9
1995	14,061	13,524	536	4	1,330	1,290	40	3	2,678	2,620	58	2	351	321	29	9
1996	14,844	13,654	1,190	8	1,378	1,307	71	5	2,739	2,637	101	3	363	325	38	11
1997	15,809	13,775	2,033	14	1,444	1,322	121	9	2,822	2,652	169	6	379	328	51	15
1998	15,622	13,891	1,731	12	1,469	1,337	132	9	2,853	2,666	186	7	385	331	54	16
1999	15,747	14,004	1,742	12	1,480	1,351	129	9	2,863	2,679	184	6	388	334	54	16
2000	15,976	14,105	1,871	13	1,496	1,364	132	9	2,879	2,690	188	7	392	337	55	16
2001	16,132	14,199	1,933	13	1,511	1,376	134	9	2,893	2,701	191	7	395	339	56	16
2002	16,659	14,289	2,370	16	1,538	1,387	150	10	2,924	2,710	213	7	402	342	60	17
2003	17,817	14,363	3,453	24	1,607	1,397	210	15	3,012	2,717	295	10	420	344	76	22
2004	17,481	14,433	3,048	21	1,619	1,405	213	15	3,021	2,723	297	10	423	346	77	22
2005	17,666	14,508	3,158	21	1,632	1,415	217	15	3,033	2,730	303	11	426	348	78	22
2006	17,997	14,573	3,424	23	1,644	1,423	221	15	3,045	2,736	308	11	430	350	80	22
2007	18,911	14,623	4,287	29	1,698	1,430	268	18	3,112	2,739	373	13	444	351	92	26
2008	18,648	14,744	3,904	26	1,707	1,445	262	18	3,118	2,761	356	12	446	356	89	25
2009	18,851	14,939	3,912	26	1,733	1,470	263	17	3,153	2,803	350	12	453	366	87	23

Table 4.3-26 SUMMARY OF CHANGES IN HOUSING DEMAND FOR THE CITIES SERVICE PROJECT (continued)

	Parachute				Rifle				Silt				Battlement Mesa AA			
			Impact				Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	142	142	0	0	1,290	1,290	0	0	355	355	0	0	154	154	0	0
1981	333	333	0	0	1,857	1,857	0	0	434	434	0	0	289	289	0	0
1982	458	458	0	0	2,065	2,065	0	0	467	467	0	0	570	570	0	0
1983	354	354	0	0	1,990	1,990	0	0	460	460	0	0	274	274	0	0
1984	243	243	0	0	1,855	1,855	0	0	456	456	0	0	269	269	0	0
1985	247	247	0	0	1,893	1,893	0	0	464	464	0	0	271	271	0	0
1986	249	245	4	1	1,934	1,909	24	1	470	468	2	0	248	205	42	20
1987	253	248	4	1	1,968	1,941	26	1	477	474	2	0	248	207	41	19
1988	258	252	6	2	2,006	1,972	33	1	484	481	2	0	269	209	60	28
1989	262	256	6	2	2,037	2,005	32	1	491	488	3	0	269	211	57	27
1990	276	259	16	6	2,101	2,036	64	3	497	494	2	0	380	214	165	77
1991	288	263	25	9	2,186	2,068	117	5	510	500	9	1	455	216	238	110
1992	276	266	10	3	2,177	2,098	78	3	518	506	12	2	281	218	62	28
1993	281	269	11	4	2,211	2,127	83	3	524	512	12	2	295	221	74	33
1994	287	273	14	5	2,249	2,155	94	4	530	517	12	2	330	224	106	47
1995	294	276	18	6	2,288	2,181	107	4	535	522	12	2	373	226	146	64
1996	332	279	52	18	2,461	2,207	253	11	549	526	22	4	660	228	431	188
1997	375	282	92	32	2,678	2,231	446	20	569	531	38	7	989	231	758	328
1998	353	285	67	23	2,637	2,255	382	17	577	535	42	7	712	233	479	205
1999	358	289	69	24	2,662	2,278	384	16	580	539	41	7	734	236	497	210
2000	369	292	77	26	2,711	2,300	411	17	585	543	42	7	809	239	570	238
2001	375	295	80	27	2,745	2,320	424	18	589	546	43	7	841	241	599	248
2002	403	298	105	35	2,862	2,340	522	22	598	550	48	8	1,062	244	818	335
2003	462	300	161	53	3,139	2,357	782	33	620	552	67	12	1,499	246	1,252	507
2004	437	303	133	44	3,075	2,373	701	29	623	555	68	12	1,207	249	958	384
2005	446	306	139	45	3,117	2,391	726	30	627	558	69	12	1,265	252	1,012	401
2006	465	309	156	50	3,190	2,406	783	32	631	561	70	12	1,431	254	1,176	461
2007	511	311	200	64	3,408	2,419	989	40	649	563	85	15	1,789	257	1,532	596
2008	493	316	177	55	3,361	2,446	914	37	652	569	82	14	1,563	260	1,303	500
2009	497	323	174	54	3,405	2,488	916	36	661	581	80	13	1,546	264	1,281	484

Table 4.3-26 SUMMARY OF CHANGES IN HOUSING DEMAND FOR THE CITIES SERVICE PROJECT (continued)

	Mesa County				Grand Junction				Palisade				Fruita			
			Impact				Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	32,273	32,273	0	0	11,720	11,720	0	0	658	658	0	0	1,026	1,026	0	0
1981	34,376	34,376	0	0	12,549	12,549	0	0	740	740	0	0	1,104	1,104	0	0
1982	35,242	35,242	0	0	12,838	12,838	0	0	773	773	0	0	1,142	1,142	0	0
1983	35,754	35,754	0	0	13,042	13,042	0	0	760	760	0	0	1,159	1,159	0	0
1984	36,300	36,300	0	0	13,244	13,244	0	0	750	750	0	0	1,170	1,170	0	0
1985	36,702	36,702	0	0	13,441	13,441	0	0	760	760	0	0	1,177	1,177	0	0
1986	37,441	37,373	68	0	13,734	13,712	21	0	775	772	3	0	1,196	1,193	3	0
1987	38,144	38,074	70	0	14,000	13,978	21	0	787	784	3	0	1,222	1,218	3	0
1988	38,794	38,704	90	0	14,242	14,212	30	0	800	795	5	0	1,245	1,241	4	0
1989	39,401	39,309	91	0	14,467	14,436	30	0	810	805	4	0	1,267	1,263	4	0
1990	39,952	39,565	387	1	14,659	14,486	172	1	824	809	15	1	1,287	1,274	12	1
1991	40,309	39,544	765	1	14,767	14,408	359	2	828	807	21	2	1,298	1,280	17	1
1992	40,667	40,046	621	1	14,885	14,587	297	2	824	816	8	1	1,310	1,300	10	0
1993	41,160	40,526	633	1	15,064	14,758	305	2	833	824	8	1	1,328	1,318	10	0
1994	41,603	40,773	830	2	15,230	14,816	413	2	841	830	11	1	1,346	1,333	12	0
1995	42,117	41,086	1,030	2	15,418	14,940	478	3	853	833	19	2	1,366	1,347	19	1
1996	42,709	41,526	1,182	2	15,641	15,096	545	3	871	841	30	3	1,391	1,365	25	1
1997	43,207	41,932	1,274	3	15,826	15,241	585	3	884	848	35	4	1,411	1,382	29	2
1998	43,337	42,310	1,026	2	15,854	15,375	478	3	870	855	14	1	1,414	1,397	16	1
1999	43,720	42,663	1,057	2	15,993	15,500	492	3	877	861	15	1	1,430	1,413	17	1
2000	44,149	43,011	1,137	2	16,152	15,624	527	3	888	868	20	2	1,448	1,428	20	1
2001	44,505	43,328	1,176	2	16,281	15,736	545	3	896	873	22	2	1,464	1,442	22	1
2002	44,973	43,652	1,320	3	16,458	15,851	607	3	912	879	32	3	1,485	1,456	28	2
2003	46,414	43,947	2,467	5	17,048	15,955	1,093	6	969	885	83	9	1,539	1,469	69	4
2004	46,462	44,220	2,242	5	17,046	16,050	995	6	953	890	63	7	1,540	1,482	57	3
2005	46,828	44,503	2,324	5	17,181	16,150	1,031	6	962	895	67	7	1,556	1,495	60	4
2006	42,796	44,784	2,512	5	17,361	16,248	1,112	6	980	900	79	8	1,577	1,508	68	4
2007	48,191	45,031	3,160	7	17,719	16,334	1,384	8	1,016	905	111	12	1,614	1,520	93	6
2008	48,243	45,243	3,001	6	17,723	16,407	1,315	8	1,004	909	95	10	1,616	1,531	84	5
2009	48,425	45,414	3,010	6	17,784	16,465	1,319	8	1,005	912	93	10	1,624	1,540	83	5

Table 4.3-26 SUMMARY OF CHANGES IN HOUSING DEMAND FOR THE CITIES SERVICE PROJECT (concluded)

	De Beque				Collbran				Glenwood Springs			
			Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	134	134	0	0	159	159	0	0	41,633	41,633	0	0
1981	150	150	0	0	164	164	0	0	45,954	45,954	0	0
1982	169	169	0	0	165	165	0	0	48,051	48,051	0	0
1983	154	154	0	0	166	166	0	0	48,177	48,177	0	0
1984	156	156	0	0	168	168	0	0	48,023	48,023	0	0
1985	158	158	0	0	169	169	0	0	48,654	48,654	0	0
1986	166	160	6	3	170	170	0	0	49,587	49,404	182	0
1987	168	162	6	3	172	172	0	0	50,490	50,274	215	0
1988	173	163	9	5	173	173	0	0	51,356	51,086	270	0
1989	174	165	9	5	175	175	0	0	52,145	51,876	269	0
1990	193	167	26	15	176	176	0	0	53,029	52,311	718	1
1991	194	168	26	15	177	177	0	0	53,803	52,467	1,336	2
1992	169	169	0	0	178	178	0	0	54,153	53,134	1,019	1
1993	172	171	1	0	179	179	0	0	54,825	53,769	1,056	2
1994	177	172	5	3	180	180	0	0	55,466	54,161	1,305	2
1995	185	173	12	7	181	180	0	0	56,177	54,610	1,566	2
1996	207	174	32	18	182	181	0	0	57,553	55,180	2,373	4
1997	219	175	43	24	183	182	0	0	59,016	55,708	3,307	5
1998	176	176	0	0	184	183	0	0	58,959	56,201	2,758	4
1999	178	177	1	0	184	184	0	0	59,467	56,667	2,800	4
2000	189	178	10	5	185	184	0	0	60,124	57,116	3,008	5
2001	193	179	13	7	185	185	0	0	60,637	57,527	3,109	5
2002	214	180	34	18	186	185	0	0	61,631	57,941	3,690	6
2003	271	181	89	49	189	186	2	1	64,230	58,310	5,920	10
2004	226	182	44	24	189	186	2	1	63,943	58,652	5,290	9
2005	233	182	50	27	190	187	3	1	64,494	59,011	5,483	9
2006	257	183	73	40	190	187	3	1	65,293	59,356	5,936	10
2007	297	184	113	61	192	187	4	2	67,102	59,655	7,447	12
2008	262	185	77	41	192	188	4	2	66,893	59,987	6,906	11
2009	255	185	70	37	192	188	4	2	67,276	60,353	6,923	11

Source: Mountain West Research - Southwest, Inc. (1983).

[a] Percentages less than 1.0 are reported as 0.

Table 4.3-27 presents the projections of school age population for each district for the "no action" and the with Cities Service alternatives. The "no action" alternative projections for these five districts show a slight increase from 1983 until the mid-1990's, when a gradual decline in school age population would occur over the remainder of the projection period.

The additional school age children that would result from the Cities Service project would mean significant impacts for Garfield County District No. RE-16. This district would exceed its enrollment capacity and would require major investments in new facilities. The other four districts would be expected to experience only minor impacts that could be handled within their current capacities. Joint District #49 would have the value of the project added to its property tax base and this could provide a major source of funds for schools. During recent oil shale development, the Oil Shale Trust Fund and the developers made major contributions to the construction of new facilities for RE-16, most noticeably at Battlement Mesa.

4.3.13.7 Public Facilities, Services, and Fiscal

This section presents discriptions of the magnitude, direction (positive or negative), duration, and overall pattern of the impacts on public facilities, services, and fiscal conditions. As is the case for other areas, the most important data are those that can show a difference between the "no action" and the "with Cities Service"

Table 4.3-27 SUMMARY OF SCHOOL-AGE POPULATION WITH THE CITIES SERVICE PROJECT

	Mesa County Joint District #49 (De Beque)				Garfield County School District RE-2				Garfield County School District RE-16			
			Impact				Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	124	124	0	0	2,117	2,117	0	0	321	321	0	0
1981	133	133	0	0	2,461	2,461	0	0	555	555	0	0
1982	136	136	0	0	2,624	2,624	0	0	859	859	0	0
1983	120	120	0	0	2,538	2,538	0	0	534	534	0	0
1984	113	118	0	0	2,450	2,450	0	0	456	456	0	0
1985	101	101	0	0	2,512	2,512	0	0	475	475	0	0
1986	104	99	4	4	2,547	2,526	20	0	465	419	46	11
1987	103	99	4	4	2,581	2,547	33	1	474	429	45	10
1988	105	98	7	7	2,616	2,575	41	1	502	434	68	15
1989	104	97	7	7	2,641	2,598	43	1	506	438	68	15
1990	115	96	19	20	2,681	2,611	69	2	629	437	191	43
1991	114	95	19	20	2,727	2,615	112	4	679	433	245	56
1992	95	93	1	1	2,685	2,611	74	2	488	427	61	14
1993	95	93	2	2	2,688	2,612	75	2	507	420	86	20
1994	97	92	5	5	2,693	2,611	82	3	545	414	131	31
1995	100	87	13	15	2,678	2,586	92	3	586	404	182	45
1996	114	86	28	32	2,742	2,547	194	7	830	391	439	112
1997	121	84	36	43	2,836	2,507	328	13	1,075	378	697	184
1998	88	82	5	7	2,729	2,457	271	11	758	365	393	107
1999	88	80	7	9	2,650	2,378	271	11	769	347	421	121
2000	93	78	14	19	2,598	2,307	290	12	835	331	504	152
2001	93	75	17	23	2,537	2,235	301	13	851	316	534	168
2002	105	73	32	44	2,537	2,166	371	17	1,038	302	735	243
2003	132	70	61	87	2,641	2,101	540	25	1,349	289	1,059	366
2004	98	68	29	43	2,522	2,043	479	23	1,012	278	734	264
2005	100	66	34	51	2,483	1,991	492	24	1,056	268	788	293
2006	115	64	50	77	2,479	1,948	531	27	1,217	260	956	366
2007	136	63	73	116	2,577	1,915	662	34	1,493	253	1,239	488
2008	110	62	48	77	2,502	1,904	597	31	1,230	251	978	389
2009	104	61	42	69	2,472	1,917	555	29	1,179	252	926	366

Table 4.3-27 SUMMARY OF SCHOOL-AGE POPULATION WITH THE CITIES SERVICE PROJECT (continued)

	Plateau Valley School District #50				Mesa County Valley School District #51			
			Impact				Impact	
Year	With Project	No Action	Number	%[a]	With Project	No Action	Number	%[a]
1980	500	500	0	0	17,659	17,659	0	0
1981	453	453	0	0	18,164	18,164	0	0
1982	436	436	0	0	18,072	18,072	0	0
1983	408	408	0	0	17,834	17,834	0	0
1984	391	391	0	0	17,789	17,789	0	0
1985	381	381	0	0	17,896	17,896	0	0
1986	373	373	0	0	18,262	18,215	46	0
1987	368	367	0	0	18,655	18,607	47	0
1988	363	363	0	0	19,032	18,969	62	0
1989	358	358	0	0	19,356	19,293	63	0
1990	354	353	0	0	19,579	19,336	243	1
1991	349	347	2	0	19,623	19,185	437	2
1992	345	342	2	0	19,600	19,277	322	1
1993	342	340	1	0	19,773	19,438	334	1
1994	336	336	0	0	19,860	19,414	446	2
1995	334	323	10	3	19,922	19,376	546	2
1996	331	320	11	3	20,009	19,353	656	3
1997	328	316	11	3	19,962	19,240	721	3
1998	324	312	12	3	19,574	19,046	527	2
1999	319	306	12	4	19,313	18,768	544	2
2000	312	299	12	4	18,956	18,359	596	3
2001	304	292	12	4	18,531	17,914	617	3
2002	297	284	12	4	18,173	17,456	716	4
2003	296	277	19	6	18,277	17,005	1,272	7
2004	290	270	19	7	17,641	16,575	1,066	6
2005	284	264	19	7	17,283	16,178	1,104	6
2006	279	259	19	7	17,052	15,830	1,222	7
2007	278	255	23	9	17,088	15,538	1,550	10
2008	275	252	23	9	16,697	15,304	1,393	9
2009	273	249	23	9	16,501	15,127	1,373	9

Source: Mountain West Research - Southwest, Inc. (1983).

[a] Percentages less than 1.0 are reported as 0.

alternatives. These differences, or impacts, are based upon projections that use the same assumptions about the tax base, tax rates, levels of service, and demand for facilities.

Table 4.3-28 presents the fiscal impacts as the difference in the cumulative balance between the two alternatives for all the jurisdictions. The "no action" and "with project" columns present the net difference between the revenues and expenditures for each governmental unit or fund. If the net balance is positive, revenues were forecasted to exceed expenditures and if the net balance is negative, expenditures were forecasted to exceed revenues. These net balances are accumulated annually to show a running total for the projection period. Impacts are the difference between the two columns for each alternative. It is possible for the "no action" and the "with Cities Service" balances to be negative and the impact be positive. This can happen if the negative balance of the with Cities Service alternative is smaller than that projected for the "no action" case. The display of fiscal balances in this format makes it possible to show the total fiscal balance for the projection period and the general pattern of annual fiscal impacts.

Study Area

The sum of the Cities Service project fiscal impacts for all the jurisdictions over the entire projection period is shown as a positive fiscal balance of $278.8 million by the year 2009 (Table 4.3-28). This balance is produced by dramatic increases in the property taxes for Garfield County, by increased sales tax revenues which benefit Mesa County, and by severance taxes which are distributed to the local jurisdictions. The total fiscal gain is not equally distributed, however, and an analysis of more detailed data for various county and sub-county levels shows some negative impacts for certain years and/or for the entire period evaluated. Because of the extended construction schedule, the revenues from the property and the severance tax do not reach their maximum until the plant reaches full production. Therefore, they have a much smaller initial impact than would be the case with a quicker build-up of the project. These county and sub-county trends are discussed in more detail below.

Garfield County

The Cities Service Project would increase the assessed valuation of Garfield County $1.1 billion and at present property tax rates this would produce over $20 million per year in revenues. When this amount is added to the increased severance and sales taxes which the county would receive, the net fiscal impact for Garfield County by 2009 would be over $242 million, or over 86 percent of the total fiscal impacts for the entire study area. This net impact makes it clear that Garfield County would greatly benefit in terms of revenues from the project, much more so than any other public jurisdiction.

Rifle

The net fiscal deficit for the city of Rifle is projected to reach −$535,000 by the year 2009. Most of this comes from increasing annual losses in the Rifle Water Fund where the total deficit is estimated to be −$628,000 by 2009. The opposite is true of the sanitation fund which shows increasing surpluses. The fiscal impact for the Rifle General Fund shows a negative net cumulative impact of −$105,000 by the year 2009. The timing of the severance tax is such that it does not cover the expenditures required by the increased demand due to population growth, in fact it does not reach its maximum, of course, until the plant is at full capacity, which is the last year of the projection period.

Parachute

The net fiscal impacts on Parachute are negative until 2003, and then become positive, increasing to $304,000 by 2009. The water fund shows deficits until 2007, whereas the sanitation fund shows increasing surpluses throughout the projection period. The general fund shows negative impacts until 2009, when the severance tax payment would begin.

New Castle

New Castle would be expected to show a net fiscal deficit of −$161,000 by 2009. Both the general fund and the sanitation fund show annual losses throughout the projection period. The water fund shows a positive cumulative impact of $31,000 in 2009.

Silt

The net cumulative fiscal impacts projected for Silt are negative until 1997. Annual surpluses from that point to the end of the projection period result in a positive gain of $67,000 by 2009.

Mesa County

As the regional market center, Mesa County would realize significant revenues from the sales tax which has been recently restructured so the county collects 2 percent on most sales. The net fiscal gains for the entire projection period is $25.1 million, about 9 percent of the total fiscal gain for the study area. Each of the Mesa County communities shown in Table 4.3-28 are projected to show a net fiscal gain by the year 2009, although individual funds may show deficits.

Table 4.3-28 CUMULATIVE NET FISCAL IMPACT WITH THE CITIES SERVICE PROJECT (in thousands of 1982 dollars)

Year	With Project	No Action	Impact: Number	Impact: Percent[a]
1982	-1,757	-1,745	-11	0
1983	-14,121	-13,636	-485	-3
1984	-50,576	-50,038	-537	-1
1985	-75,242	-74,652	-590	0
1986	-88,332	-88,604	271	0
1987	-95,379	-96,533	1,153	1
1988	-105,539	-107,408	1,869	1
1989	-105,019	-108,439	3,420	3
1990	-102,268	-110,165	7,897	7
1991	-93,738	-107,017	13,278	12
1992	-83,152	-100,234	17,082	17
1993	-68,045	-90,482	22,437	24
1994	-50,191	-79,477	29,286	36
1995	-30,535	-66,972	36,436	54
1996	-5,984	-51,915	45,931	88
1997	21,817	-36,301	58,119	160
1998	48,173	-20,755	68,929	332
1999	75,638	-5,249	80,888	1,540
2000	103,906	10,263	93,642	912
2001	132,465	25,669	106,796	416
2002	164,117	42,756	121,361	283
2003	208,279	60,648	147,631	243
2004	244,451	78,789	165,662	210
2005	282,042	97,082	184,960	190
2006	321,167	115,515	205,652	178
2007	365,335	133,966	231,369	172
2008	406,867	152,584	254,283	166
2009	450,182	171,331	278,851	162

Source: Mountain West Research - Southwest, Inc. (1983).

[a] Percentages less than 1.0 are reported as 0.

Grand Junction

The net fiscal gain in Grand Junction would be $8.3 million with a $10.6 million positive balance in the general fund, somewhat offset by a $2.3 million loss for the water fund and a $13,000 deficit for the sanitation fund. The effect of the severance tax as well as the municipal sales taxes are shown in the general fund pattern. Deficits in the early years are offset by increased revenues after 1991.

Palisade

In 2009, Palisade would be expected to experience a net cumulative fiscal gain of $488,000 for the general fund and $748,000 for the utility fund. The net benefit would reach $1.2 million by the end of the projection period.

Fruita

Fruita shows a surplus for each of its three funds: sanitation, water, and the general fund. The gains for the water and sanitation funds are quite small indicating that the costs of operating these enterprises are balanced by user fees. The general fund shows positive balances starting with the income from the severance taxes and gradually accumulating to $1 million for the projection period.

De Beque

The De Beque Utility Fund shows a growing deficit with the added population resulting from the Cities Service project. This means that the present costs to utility users are insufficient and that the addition of more people will create larger deficits. The De Beque General Fund shows deficits in the early years, but annual fiscal gains once the severance tax payments begin. The net positive balance for the town by the end of the projection period would be slightly over $730,000.

Battlement Mesa

Battlement Mesa is not an incorporated municipality but rather a Planned Unit Development (PUD) operated by Battlement Mesa Inc. Therefore, it is not shown as a public entity that would experience fiscal impacts during the projection period. Significant growth could produce pressure for the incorporation of the PUD in order to provide services or to become a standard municipal government. On the other hand, the community could obtain adequate services from the county, where the tax base would be greatly expanded by the increased assessed valuation of the Cities Service project. At this point, however, no fiscal impact projections have been made for Battlement Mesa, although as a community it is expected to receive significant employment, population, housing, and other impacts.

Capital Expenditure

The FisPlan model was used to make projections of capital needs based on increases in population and housing. In many cases, capital spending would begin before the actual need is in place. This anticipation function is recognized in using FisPlan and it results in fiscal impacts prior to actual demand. As a result, some jurisdictions show fiscal impacts for as early as 1983. The capital facilities needs for the entire projection period are shown in Table 4.3-29. The expansion of capacities are made within the decision parameters reviewed and approved by the CITF.

The additional capital expenditures are shown as impacts for each jurisdiction. The largest capital needs are identified for Grand Junction where over $1.7 million for general governmental facilities and $1.2 million for the water system were estimated. The largest proportional increases are for utilities in De Beque, and the water funds in Rifle and Parachute. These are areas that would be expected to experience gains in population and housing and where the in-place facilities do not now have the capacity to meet the impact demand.

Summary

The estimated revenues produced by the Cities Service project would be expected to exceed required expenditures by a considerable amount, over $278 million for the study area over the entire projection period, 1982-2009. However, these fiscal benefits are not distributed equally among local jurisdictions. Garfield County would realize about 87 percent of the total fiscal increase while Mesa County would receive only about 9 percent, although it would serve as the location for up to half the population and housing effects. Many jurisdictions would experience deficits as expenditures would exceed revenues in the early years before taxes, especially the severance tax, come into effect (see mitigation comments in Section 4.8.3.13). In some cases, long-term deficits would occur with funds where user fees do not cover the operating costs. New capital expenditures are expected to be required for almost all the jurisdictions, but in most cases they seem modest given the amounts and the time period covered by the projections. The largest proportional increases would be for water and/or utility services in Parachute, Rifle, and De Beque.

4.3.13.8 Social Structure

A profile of the current social structures in the study area is presented in Section 3.1.13.8, along with a rationale for the approach taken. The purpose of this section is to discuss the development of the significant functional groups and the social structure for the "no action" and the "with Cities Service" alternatives. There is no quantified data on the groups as such, so a qualitative distribution of project-related effects was made. This distribution is shown in Tables 4.3-30 and 4.3-31.

Table 4.3-29 CITIES SERVICE PROJECT CUMULATIVE TOTAL CAPITAL EXPENDITURES: 1983-2009

Jurisdiction	Expenditures ($000)		Impact	
	No Action	With Cities	$000	%
Mesa County All Funds	$27,628.85	$28,330.52	$ 701.67	2.54
Grand Junction				
General Fund	63,004.68	64,745.02	1,740.34	2.76
Water Fund	23,550.36	24,781.05	1,230.69	5.23
Grand Junction City/County				
Sanitation	9,206.10	9,221.33	15.23	0.17
Fruita				
General Fund	7,904.02	7,919.20	15.18	0.19
Water Fund	1,050.21	1,055.76	5.55	0.53
Sewer Fund	1,017.47	1,017.47	0	--
Palisade				
General Fund	0	79.82	79.82	--
Utility Fund	3,266.55	3,266.55	0	--
De Beque				
General Fund	428.24	500.12	71.88	16.78
Utility Fund	107.06	219.66	112.60	105.17
Garfield County				
All Funds	934.63	1,414.55	479.92	51.35
Rifle				
General Fund	684.11	933.11	249.00	36.40
Water Fund	64.24	345.43	281.19	437.72
Sewer Fund	0	46.89	46.89	--
Parachute				
General Fund	803.76	1,020.25	216.49	26.93
Water Fund	131.46	256.72	125.26	95.28
Sewer Fund	0	0	--	--

Source: Mountain West Research - Southwest, Inc. (1983).

The changes forecasted for the social structure are only those that are the result of effects specific to the study area itself. It is understood that in the past, many changes to local social groups and their social structure have resulted from forces from outside the area, sometimes from national or even international causes. Abrupt changes in technology, travel, or communications have transformed social life in the last decades and analogous changes may have similar effects on local social conditions in the future. These exogenous factors are beyond the scope of the analysis intended in this section since the focus is on the study area itself and how it might be expected to respond to specific types of socioeconomic effects which have been considered important in social impact assessment literature.

Garfield County

The social structure of south-central Garfield County was divided into five significant functional groups: Agriculturalists, Business and Professional, Elderly, Other Long-Time Residents, and Newcomers. The

Table 4.3-30 CITIES SERVICE PROJECT EFFECTS ON GARFIELD COUNTY SOCIAL STRUCTURE

Group	Employment, Income, Purchases	Demographic	Housing, Land Use	Public Services Fiscal	Social (Intergroup)
Agriculturalists	Little or no effects.	Little or no effects, although will become a smaller proportion of the total population.	Significant effects: rising property values due to increased demand for land.	Possible impacts from lower tax rates with addition of major project to county's assessed valuation. higher level of service.	Political and social position expected to diminish as they become a smaller segment of the social structure.
Business and Professional	Significant impacts due to project purchases and resulting nonbasic employment and income activity.	Moderate increase in size to to in-migration is expected, as a result of nonbasic growth. Geographical distribution of impacts to Rifle, Battlement Mesa, and Parachute.	Housing effects would come primarily from the business response to increasing demand.	Will benefit from higher level of public facilities and services.	Social, political, and economic position should be strengthened due to significant economic benefits group would realize. Also tend to be well organized in political, business, and community affairs.
Elderly	Little or no effects.	Proportion of total population will decline, although actual numbers will not.	Some effects through increased housing costs for renters and rising housing values for owners.	Will benefit from access to higher level of public facilities and services.	Political and social power will decline as they become a smaller proportion of the population. May be anti-growth attitudes due to erosion of their lifestyle and value system.
Other Long-Time Residents	Significant effects from on-site employment and wages as well as non-basic employment and income.	Little effect for first decade; then group size would increase as newcomers become long-time residents.	Some effects through increased housing costs for renters and rising housing values for owners.	Increased service levels.	Moderate effects - position would be strengthened through increased employment, income, and diminished out-migration.
Newcomers	Significant impacts from on-site employment and wages as well as increased employment in nonbasic sectors.	Significant increase due to in-migration for both on-site and nonbasic employment. Size could fluctuate due to construction schedule.	Substantial increase in demand for housing especially rental units.	Will generate increased demand for public services.	Significant effects on social structure due to size and importance of group. Their integration could result in major readjustments in social structure due to their size, income, and lifestyles; the working class people could become politically more important.

Source: Mountain West Research - Southwest, Inc. (1983).

Table 4.3-31 CITIES SERVICE PROJECT EFFECTS ON MESA COUNTY SOCIAL STRUCTURE

Group	Employment, Income, Purchases	Demographic	Housing, Land Use	Public Services Fiscal	Social (Intergroup)
Agriculturalists	Little or no effects.	Little or no effects. Would become slightly smaller proportion of the growing population.	Will be affected by the additional demand for land (residential, commercial, and industrial), especially the orchardists east of Grand Junction.	Little or no effects.	Little or no effects.
Business and Professional	Low to moderate impact on employment caused by nonbasic employment. Moderate benefits will occur from increased spending due to higher overall income and project purchases.	Low to moderate increase.	Housing effects would come primarily from the business response to increasing demand.	Low to moderate effects.	Little or no effect - they would remain the dominant group in social structure.
Elderly	Little or no effects.	Little or no effects, although would become a slightly smaller proportion of population due to overall growth.	Some effects through increased housing costs for renters and rising housing values for owners.	Little or no fiscal impacts.	Little or no effects.
Hispanics	Some effects through nonbasic employment and income created by project purchases.	Little or no effects, although would become a slightly smaller proportion of population due to overall growth.	Some effects through increased housing costs for renters.	Little or no effects.	Little or no effects.
Other Long-Time Residents	Some effects through nonbasic employment and income created by project purchases.	Little or no effects in the short term; eventually, the group's size will increase as members of the newcomers group become long-time residents.	Some effects through increased housing costs for renters and rising housing values for owners.	Little or no effects.	Group would stabilize due to increased employment and declining out-migration.
Newcomers	Moderate impacts on employment and income.	Low to moderate increase in numbers due to in-migration for jobs. Size could fluctuate due to construction schedule.	Increase in population would create greater demand for housing.	Population and housing increases would generate greater demand on facilities and services.	Eventually, size would diminish as operation work force stabilizes and newcomers become integrated into Long-Time Residents.

Source: Mountain West Research - Southwest, Inc. (1983).

Newcomers were primarily oil shale people who recently came to the area. The other four groups were largely made up of natives and people who had been in the area for a long time. There is a small proportion of new business and professional people who arrived when the oil shale development effects were taking place and some have stayed on.

"No Action" Alternative. The projected growth rates for the "no action" alternative are quite small. In fact, the population projections estimate an annual average growth rate of only 0.2 percent for the period 1983 to 2009. This rate is less than natural increase (births minus deaths) and implies annual out-migration. A certain replacement function would occur (e.g., in jobs, housing, public facilities). In the social structure, there would be little change resulting from significant growth or decline in the economy or in the population. Over time, the Newcomers would either leave the area to obtain employment elsewhere or they would integrate into the social structure and become Long-Time Residents. The social structure would contract to four significant functional groups.

"With Cities" Alternative. The discussion of social structure impacts is based upon a distribution of effects to groups and their likely response to the significance of these occurrences. These qualitative assessments are shown in Table 4.3-30.

The significant economic effects include employment, income, and purchases made on behalf of the Cities Service project. There would be few effects for the Agriculturalists and the Elderly. Significant effects would accrue to the other three groups. The Business and Professional group would benefit from the additional spending in the county, and they would provide some goods and services obtained by Cities Service's local purchases. The Other Long-Time Residents would be in a good position to be employed directly for project work or through the purchases and non-basic effects. The Newcomers would be most affected since they would be in the area as a direct result of the increased employment. The size of the Newcomers group would tend to rise and fall with the peaks of the construction schedule which covers the entire projection period. This would imply a fairly rapid turnover in group members. This group would be especially important in filling the skilled jobs that are required for construction and operation.

Intergroup relations would be expected to change as a result of the project-related effects. The Agriculturalists could lose some of their political and social influence, as might the Elderly. Both groups would become a smaller proportion of the population, and both would become less important economically. The Business and Professional group would be expected to increase its political, economic, and social role. This group tends to be well organized, compared to the other groups, and would enjoy the advantages of a substantial new base for economic growth. The effects for the Other Long-Time Residents would be moderate, although they would be expected to play a major part in the interaction with the Newcomers. The role of the Newcomers would be a significant one as they would form a major new force in the social structure, one that would have to be integrated. Group integration into the social structure could be a continuing problem due to the rise and fall of the group size because of the extended construction schedule. The political role of the working class, mostly pertaining to the Newcomers and the Other Long-Term Residents could become important.

Mesa County

Grand Junction is the market and service center for Mesa County and the study area as a whole. In this role, the city dominates the social structure of the Grand Valley. Because of its central position, the city has many ties with the surrounding rural communities and areas, a fact that has been important in shaping its functional social groups and its social structure. The current social structure incorporates a relatively large population and it has a history of assimilating rapid growth. The following six groups were identified as significant functional units in the social structure: Agriculturalists, Business and Professional, Elderly, Hispanics, Other Long-Time Residents, and Newcomers.

"No Action" Alternative. Although the Mesa County projected growth rate is twice as great as that expected for Garfield County for the "no action" alternative, it is still less than half of 1 percent, a very small rate of increase. As was the case with Garfield, this rate is actually less than natural increase and implies the out-migration of natives who would not be able to get jobs in the study area. Under these conditions, the social structure would be expected to be quite stable. The Newcomers would become a smaller group and they might cease to exist at all. For the most part, the relationships between the groups would be expected to continue along current lines with only minor adjustments for the no-growth conditions. The population projections suggest a very stable population, economic, and income picture, one which also implies little change in the social structure.

"With Cities" Alternative. The overall impacts on the Mesa County social structure are expected to be smaller than was the case for Garfield County. This is because the size and strength of the functional groups is much greater and the level of change due to the socioeconomic effects is a smaller proportion of the total. For example, at peak employment in 2007, the population impacts on Garfield County would be about 36 percent, but in Mesa County they would be only 7 percent. The employment impacts would reach 12 percent for Mesa County compared to 38 percent for Garfield County. These are important levels of impact, but the changes implied for Mesa County are much smaller than those distributed to Garfield County. The qualitative distribution of these impacts by group is shown in Table 4.3-31.

Little change would be expected in the intergroup patterns due to the Cities Service project. The Other Long-Time residents would stabilize and increase somewhat due to the employment. They would also develop ties with the Newcomers who would be expected to be from about the same class. The Newcomers would have to become integrated into the community, but these could very well be fairly formal ties such as their day-to-day market interactions. As voters, the combined numbers of the Other Long-Time Residents and the Newcomers might make them politically more important. However, this would depend upon how active the two groups would become in local public issues. The Business and Professional group which is already well organized and dominates the political process in the Grand Junction area could be expected to continue their pivotal role. Family ties between groups such as the Elderly, Agriculturalists, Other Long-Time Residents, and the Business and Professional group could be better maintained with the increased employment and the diminished outmigration.

4.3.13.9 50,000-bpd Production Rate Alternative

The Cities Service project would involve initial production of 10,000 bpd, followed by three increments of 30,000 bpd each for an ultimate production of 100,00 bpd. As a result, their construction work force scenario in Table 4.3-21 shows four distinct cycles, each of approximately 6 years duration. After the first two cycles are completed in 1998, construction employment of zero and operations employment of 1,800 would occur. If this were to be continued throughout the remainder of the study period, the employment data through 1998 in Table 4.3-21 could be taken as indicative of the requirements of approximately 40,000 to 50,000 bpd, or a nominal 50,000-bpd alternative.

Thus, the socioeconomic impact analyses of the previous sections are appropriate to the 50,000-bpd and 100,000-bpd scenarios through 1998. Subsequent to 1998, under the 50,000 bpd alternative, impacts would stabilize at levels similar to those of 1998 (0 construction workers, 1,800 operations workers). Under the 100,000-bpd scenario, impacts continue to increase in each subsequent construction cycle because similar construction forces are added to progressively larger numbers of operations workers.

4.3.13.10 Summary - Socioeconomic Impact Conclusions

Employment

Employment impacts of a 100,000-bpd alternative would be significant, amounting to increases up to 19 percent for the study area as a whole at peak construction. Operating period impacts would stabilize at about 12 percent. For local jurisidiction, increases would often be much higher. Unemployment rates would be expected to drop during times of peak demand for workers. The employment effects would require significant in-migration in order to meet the needs of a larger work force. Under a 50,000-bpd alternative, employment effects would peak in 1997 at 13 percent and then stabilize at 7 percent during operations.

Income

The labor income impacts at 100,000-bpd production would exceed $268 million at the peak year, a 28 percent increase over the "no action" alternative. During operation, labor income would be 21 percent higher with the Cities Service project. For the 50,000-bpd alternative, peak impacts would be $168 million, an 18 percent increase. During operations, labor income would be about 10 percent higher than the "no action" alternative.

Purchases

Local purchases to support the project are projected to reach $233 million at peak construction and amount to $58 million annually during operation at 100,000 bpd. This would produce significant indirect basic and non-basic employment and income impacts. At 50,000 bpd, purchases would peak at $167 million, and during operations, expenditures would average about $36 million per year.

Demographic

Study area population impacts under a 100,000-bpd scenario would be over 17,000 at peak employment, a 14 percent increase over the "no action" alternative. By 2009, these impacts would be about 12 percent. These significant population impacts would be made up of in-migrants and diminished out-migration of local residents. At 50,000 bpd, peak impacts would occur in 1997 at 8572, a 7 percent increase over the "no action" alternative. Long-term impacts during operation would only average 5 percent of the "no action" population level.

Housing

Housing demand impacts would reach 7,447 units in 2007, and would decline to about 6,900 units in 2009 under a 100,000-bpd alternative. Battlement Mesa would be the location of the greatest proportional increases. At 50,000 bpd, peak impact would be in 1997 at 3307 units. During operation, the impact would be a little over 2,700 units.

Education

The school age population would increase by 3,547 at peak employment, 20 percent over the "no action" alternative. During operations at 100,000-bpd, the figure would be about 2,900, or about 17 percent higher. Additional school facilities would be required for RE-16. The assessed valuation of Joint District #49 would be increased by $1.1 billion since the Cities Service project would be located within its boundaries. Under a 50,000-bpd alternative, peak impacts would be lower and long-term effects about one-half those of the 100,000-bpd alternative.

Public Facilities, Services, and Fiscal

The study area fiscal impacts are projected to be over $278 million. Garfield County would receive most of this increase, about 87 percent, through the addition of the project improvements to the county's assessed valuation base. Other jurisdictions would obtain much smaller fiscal impacts, with the sales tax providing most of the positive results in Mesa County. With the extended construction schedule for the Cities Service project, the full effects of the severance tax and the property tax would not take place until the project reaches full production. Many local jurisdictions would make up their deficits with the increased revenues from the severance taxes and would experience deficits until after 2009. Some funds would accumulate net deficits with rising demand; this is most noticeable in water and other utility funds which are supported mainly by user fees. New facilities would be required for most jurisdictions with the greatest dollar costs occurring in Grand Junction. Under the 50,000-bpd alternative, revenue flows would be reduced, but would still be well over $100 million for the study period.

Social

Changes to the social groups and the social structure would be expected to take place in both counties with the Cities Service project. These impacts would be most significant in Garfield County due to the samller size of the social units. The Newcomers would be important groups in both counties and they would have to be integrated into the social structures. The fluctuations in the construction schedule could make the turnover high for the Newcomers group and prove to be a barrier to integrating them into the overall social structure. The groups with mainly natives or long-time residents would be strengthened due to the economic (jobs and income) and the demographic (diminished out-migration) impacts. Housing and public service impacts would be mixed for these groups. Relative to each other, the Business and Professional groups would be expected to gain the most while the Other Long-Time Residents and the Hispanics would be somewhat strengthened. The Agriculturalists and the Elderly would realize some positive benefits and, at the same time, their political and social positions would tend to diminish.

4.3.14 Transportation

4.3.14.1 Proposed Action

Road Systems

The development and operation of the proposed Cities Service project would not significantly impact the segments of Interstate Highway 70 (road segments A to E) analyzed for this EIS. Segments F and G would experience occasional traffic slowdowns and a potential reduction in the level of service in 2003. There should be no speed reductions for I-70 during normal operations (year 2010), but there would be traffic speed reductions along road segments F and G. Table 4.3-32 presents the anticipated level of traffic and associated impacts for each road segment.

The Roan Creek road would be significantly impacted by construction and operation of the proposed action. The existing road is inadequate for the anticipated traffic demand and would have to be upgraded to accomodate the increase in traffic.

Accidents along the road segments could also increase (Table 4.3-33). The impact of the proposed action would not, however, result in a significant increase of accidents over what is predicted to occur if the project is not developed (Table 4.3-33).

Accurate predictions of accident rates on the Roan Creek road are not possible due to lack of recent data on accidents. It is expected that accidents would increase in proportion to the increase in traffic.

Airports

Increases to air traffic at Walker Field could likely be proportional to the populations increases. A similar level of increase is expected at the Garfield County airport, but would likely be limited largely to private aircraft. Considering that both of these airports are designed to handle air traffic beyond current levels (in anticipation of oil shale and the development in the region), the proposed action should have no significant impact on air service for the area.

Railroads

The only increase in rail traffic along main rail lines would be due to material and product transport. Material transport would be most significant during construction while by-product transport would occur during operation. Considering that the present rail system is below capacity (Section 2.3.2.14), and that the daily train traffic attributable to material or product transport is expected to be low, impacts to the existing rail system would be minor.

Pipelines

Additional pipelines would be built to transport shale oil and water (Section 2.3.2.14). Placement of these pipelines would result in a net beneficial impact in that a new pipeline system would be in place for future transport of various commodities upon proper purging and refitting of the pipelines. Such commodities would potentially include all materials (e.g., oil, water) that are reasonably transported by pipelines.

Table 4.3-32 TRAFFIC PROJECTIONS FOR ROAD SEGMENTS A-H - CITIES SERVICE

Year	Road Segment	Segment Length	ADT[a]	PHT[b]	CAP[c]	PHT/CAP[d] Ratio
1980	A	29.6	3,600	400	3,400	.12
	B	19.4	5,200	650	3,500	.19
	C	17.0	5,450	750	3,450	.22
	D	8.9	5,400	750	3,450	.22
	E	42.4	6,100	850	3,500	.24
	F	15.1	3,750	500	950	.53
	G	4.3	21,150	2,350	2,000	1.18
	H	8.4	4,800	600	1,400	.13
2003[e]	A	29.6	7,100	900	3,400	.26
	B	19.4	11,850	1,950	3,500	.56
	C	17.0	13,350	3,050	3,450	.88
	D	8.9	17,550	3,050	3,450	.88
	E	42.4	14,450	2,350	3,500	.67
	F	15.1	7,000	900	950	.95
	G	4.3	33,450	4,000	2,000	2.00
	H	8.4	8,200	1,000	1,400	.71
2010	A	29.6	8,100	1,050	3,400	.31
	B	19.4	12,850	1,950	3,500	.56
	C	17.0	13,350	2,600	3,450	.75
	D	8.9	18,000	2,900	3,450	.84
	E	42.4	15,600	2,400	3,500	.66
	F	15.1	7,900	1,050	950	1.24
	G	4.3	36,200	4,200	2,000	2.10
	H	8.4	9,200	1,150	1,400	.82

[a] ADT = Average Daily Traffic
[b] PHT = Peak Hourly Traffic
[c] CAP = Capacity at Level of Service "C"
[d] PHT/CAP Ratio = see text (Section 3.1.14) for explanation
[e] Peak year of employment (construction and operation)

4.3.14.2 Alternatives

The 50,000-bpd alternative would be the only alternative that has a significant impact on any of the transportation systems. Impacts to the transportation network, particularly the road system, would be proportionately less than at 100,000-bpd during operation. However, the duration of the impacts would be approximately twice as long. Consistent with the socioeconomics analysis (Section 4.3.13), impacts to the road system are best represented by the population estimates shown for the year 2003.

Other alternatives, such as pipeline routes, would not have significantly different impacts than the proposed action.

4.3.14.3 Solid/Hazardous Wastes and Toxic Pollutants

Transport of wastes or toxic pollutants off-site could result in infrequent spills on roadways or along railroad lines. Considering the current industry standards for transport of such materials, such spills should be infrequent and would have, over the long-term, insignificant impacts. It is assumed that appropriate spill containment and control plans would be in place at the time of operations.

Table 4.3-33 PREDICTED NUMBER OF ACCIDENTS ON AFFECTED HIGHWAY SEGMENTS FOR THE CITIES SERVICE SHALE OIL PROJECT

			Predicted No. of Accidents (annual)[b]			
Year	Road[a] Segment	Segment Length	PDO[c]	INJ[d]	FAT[e]	TOTAL
1980	A	29.6	32	25	3	60
	B	19.4	44	15	3	62
	C	17.0	56	11	1	68
	D	8.9	40	22	0	62
	E	42.4	130	64	4	198
	F	15.1	39	22	1	62
	G	4.3	375	88	1	464
	H	8.4	37	16	0	53
2003[f]	A	29.6	63	49	6	118
	B	19.4	100	34	7	141
	C	17.0	137	27	3	167
	D	8.9	130	72	3	205
	E	42.4	308	152	10	470
	F	15.1	73	41	2	116
	G	4.3	593	139	2	734
	H	8.4	63	27	2	92
2010	A	29.6	72	56	7	135
	B	19.4	109	37	7	153
	C	17.0	137	27	3	167
	D	8.9	133	73	3	209
	E	42.4	332	164	10	509
	F	15.1	82	46	2	130
	G	4.3	642	151	2	795
	H	8.4	71	31	2	104

[a] See Figure 3.1-6 for location of road segments
[b] Numbers for 2003 and 2010 are total accidents. The incremental amount due to the proposed action can be derived by comparison to Table 3.1.14-2.
[c] PDO = Property damage accidents only
[d] INJ = Injury-producing accidents
[e] FAT = Fatality-producing accidents
[f] Peak year of employment (construction and operation)

4.3.14.4 Secondary Impacts

The potential secondary impacts to transportation due to the proposed action would be as a result of induced population growth. These secondary transportation effects were considered in the transportation impact analysis. As discussed above, most of the road segments would be able to handle the increased traffic without further improvements. Due to more road use, deterioration of road surface would likely occur more rapidly with project development. Road maintenance would need to be increased to alleviate these problems. A similar situation would occur for increased railroad traffic.

4.3.15 Energy

4.3.15.1 Proposed Action

Table 4.3-34 indicates the net energy analysis for production rates of 100,000-bpd and 50,000-bpd of shale oil. These calculations include all energy requirements and consider mine facilities, process facilities, spent shale disposal, and the various support facilities (e.g., product transport, roads, water transport). Infrastructure energy due to increased population is also included. As currently designed, the proposed project would have a net energy gain of 161.6 $\times$ 10^{12} Btu and the energy output to input ratio would be 3.7:1.

Electrical generation requirements to produce 100,000 bpd of oil would be supplied from outside sources. Projections indicate that Colorado will be a net importer of electricity by 1991, but that currently existing or projected power supply in the project region would be sufficient for the project's electric power requirements.

Table 4.3-34 SUMMARY OF ENERGY BALANCE FOR THE CITIES SERVICE SHALE OIL PROJECT (1×10^{12} Btu/yr)

Energy Type	Proposed Action (100,000 bpd)	Alternative Production Rate (50,000 bpd)
Materials Energy[a]	3.2	1.7
Direct Electrical[a]	14.8	7.5
Fuels[b]	35.6	18.7
Infrastructure[a,c]	6.7	3.6
Total Energy Consumed	60.3	31.5
Total Energy Produced	221.9	111.0
Ratio of Energy Produced-Energy Consumed	3.7:1	3.5:1

[a] Based on data in the Energy Analysis Handbook for oil shale development (BLM 1982).
[b] Fuel consumption includes liquid and gaseous fuels.
[c] Based on average population numbers (see Section 3.3.13).

4.3.15.2 Alternatives

The only alternative that would have substantial impact on the energy balance of the proposed action would be the 50,000-bpd production rate alternative. The energy requirements needed to produce 50,000 bpd of shale oil are also presented in Table 4.3-34. These figures, as with the 100,000-bpd figures, include mining and processing facilities, spent shale disposal, ancillary support facilities, and infrastructure energy.

The 50,000 bpd-alternative shows a net energy gain of 79.5 $\times$ 10^{12} Btu and an energy output to input ration of 3.5:1. This ratio is somewhat less favorable than the 100,000-bpd rate because the 100,000-bpd rate would extract a higher grade oil shale. Consequently, energy expenditures per unit of shale oil would be more.

If the processing of shale fines is implemented, the net energy balance would likely be somewhat more favorable for the 100,000-bpd and 50,000-bpd production rates. However, considering the large amount of energy produced over the life of the project, the incremental addition of energy produced by processing the shale fines would not represent a significant amount of additional energy.

Current information on the 100 percent Lurgi retort alternative shows it to be the most thermally efficient alternative due to its ability to process fines and recover maximum energy from the spent shale. If this alternative is implemented, and these benefits prove to be commercially practical, the net energy balance would be somewhat more favorable for the 100,000-bpd and 50,000-bpd production rates. Overall energy recovery from the property would increase by approximately the quantity of shale oil recovered from the extra fines processed, together with the additional energy that would be recovered by the combustion of residual carbon on the spent shale. The overall increase in energy recovered would be in the order of 10 percent. The energy output to input ratio, however, would be increased by a lesser amount (Cities Service 1983d).

Other alternatives (e.g., spent shale disposal sites, corridor alternatives, water supply alternatives) would not significantly alter the overall energy balance of the proposed action.

4.3.15.3 Solid/Hazardous Waste and Toxic Pollutants

Handling and disposal of solid wastes, hazardous wastes, and toxic pollutants would not have any significant impact on the net energy balance of the proposed action.

4.3.15.4 Secondary Impacts

The secondary impacts of the proposed action would be the additional energy required for the increased population due to implementation of the project. This additional energy was calculated in the net energy analysis and is shown in Table 4.3-34.

4.4 Cumulative Impacts

Cumulative environmental impacts are those which result from the incremental impacts of an action added to other past, present, and reasonably foreseeable future actions, regardless of whom is responsible for such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (CEQ 1978: 1508.7).

A number of proposed oil shale and other planned projects are in various stages of development in the region of the Getty and Cities Service shale oil projects. These projects, if completed, would add to the social, economic, and environmental effects of the Getty and Cities Service projects. The projects considered in the cumulative impact assessment are presented in Table 4.4-1 and do not imply any prioritization. The locations of these projects are shown on Figure 4.4-1.

Cumulative impact analysis requires the identification of reasonably foreseeable future actions which when combined result in a cumulative impact scenario. In this EIS, the cumulative impact scenario assumes operational projects with a total volume of production of 638,000 barrels per day (bpd). Total production at 683,000 bpd would be a high-level impact scenario for cumulative analysis. Time may show that the high-level impact scenario herein is premature, overstated, or simply speculative. Proposals and plans change, despite best intentions otherwise, and it must be understood that a certain degree of speculation and conjecture are built into any analysis which assumes that all plans will be carried out as originally conceived or currently designed. For the moment, however, this EIS employs the best information available.

The cumulative impacts for a high-level scenario including the Getty and Cities Service projects are addressed below, by discipline, in the same order as in Chapters 3.0 and 4.0.

4.4.1 Topography, Paleontology, Geology

Regionally, the cumulative impacts on topography as a result of the specified level of oil shale and related development would be moderately adverse. Areas of significant impact include the waste rock, shale fines, and spent shale disposal piles located on the plateau and in the drainages of Parachute Creek (Thorne 1973; Union 1982) and Roan Creek (BLM 1983a). Although reclamation programs would stabilize these disturbed areas for the foreseeable future, the extent and magnitude of the areas disturbed is significant, and their long-term stability is unknown. Topographic changes on these reclaimed areas could occur over the long-term, due to erosional and depositional processes.

Cumulative impacts to the paleontological resources of the area would be moderately adverse when considering all projects and the relative magnitude of disturbance. As previously discussed, the Late Cretaceous and Early Tertiary age rocks of the Piceance Basin are a potentially valuable paleontological resource (Lucas and Kihm 1982). Development of these areas without proper mitigation measures could significantly impact existing paleontological resources.

Cumulative impacts to the geological resources would be rated as no impact to low adverse. Regionally the potential impacts of increasing geological hazards are significant over the long-term, considering the number of impoundment structures and spent shale disposal sites that are to be constructed and maintained on the plateau and in the drainages of Parachute Creek (Thorne 1973; Union 1982) and Roan Creek (BLM 1983a). Offsetting the adverse impact of oil shale development to existing geology is the beneficial use of oil shale as an energy resource for local and national consumption.

4.4.2 Surface Water

The oil shale projects evaluated for the cumulative impact assessment are presented in Table 4.4-1. These data are further expanded in Table 4.4-2 to include the potentially disturbed areas and average annual water consumptions for each project.

Major facilities for the Colony, Union, and Mobil projects are located within the Parachute Creek drainage; the remainder of the projects are within the Roan Creek drainage. Roan Creek drains into the Colorado River in the vicinity of the town of De Beque. Parachute Creek flows into the Colorado River near Parachute, approximately 8 miles northeast of De Beque.

Table 4.4-1 PROJECTS CONSIDERED IN THE CUMULATIVE IMPACT ASSESSMENT

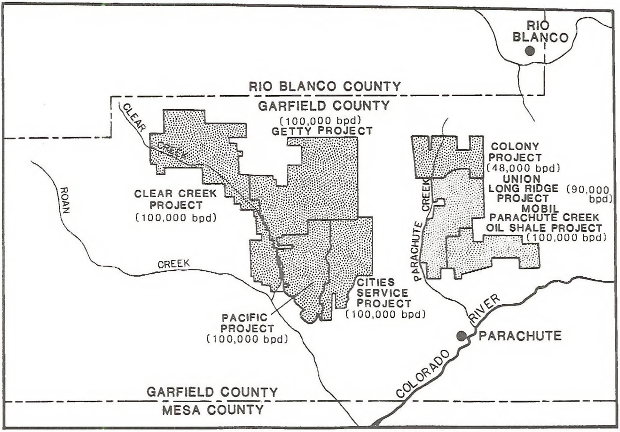
Project	Ultimate Shale Oil Production Rate (bpd)	Location[a]	Project Description Reference
Getty	100,000	Roan Creek/Parachute Creek	(Included in this EIS)
Cities Service	100,000	Roan Creek	(Included in this EIS)
Colony	48,000	Parachute Creek	BLM (1975)
Union	90,000	Parachute Creek	MLRD (1982)
Mobil	100,000	Parachute Creek	Davis (1983)
Pacific	100,000	Roan Creek	Pacific (1983a, 1983b)
Chevron	100,000	Roan Creek	BLM (1983)

[a] See Figure 4.4-1.

The average annual water consumption for all these oil shale projects would amount to 195 cfs (or 141,087 acre-feet), which represents approximately 5.0 percent of mean annual flow for Colorado River near De Beque. The salinity level of the Colorado River at Imperial Dam, due to the total water consumption by these oil shale developments, would increase by approximately 8.6 mg/l by the year 2010 (USDI 1982). The relative impact of the water withdrawal and salinity increase will depend on the resource impacted (e.g., water use, fishery resources).

Direct impacts on the surface water quality of Roan, Clear, and Parachute creeks would not be significant assuming that there would be no direct discharge of wastewater into streams by the oil shale operations. Under normal conditions, surface runoff from disturbed lands and spent shale piles would be collected and either evaporated or put to beneficial use. It should be noted that this conclusion may not apply to the post-operation phase if the reclamation efforts do not afford permanent stabilization. It is assumed, however, that the detailed reclamation permit would outline best management practices that would reduce the impact to the surface water systems.

Oil shale development within the Parachute Creek basin would disturb approximately 10,300 acres (16.1 square miles), which is about 8.0 percent of the drainage area (198 square miles) for Parachute Creek. Within the Roan Creek drainage basin, potential affected drainage area for oil shale development is estimated to be 12,128 acres (36.1 square miles), about 7.0 percent of the drainage area for Roan Creek. Surface runoff from disturbed areas would be retained during mining operations; therefore, stream flow interruption for Roan and Parachute creeks would be expected. In addition, surface runoff from disturbed lands could contribute to the suspended solids in the stream flow during project construction, however these oil shale projects are designed as zero-discharge systems. Consumption of water from tributaries by oil shale development could also affect localized stream segments and result in stream flow depletion. Increased industrial activities within these two drainage basins could also increase the likelihood of oil and chemical spills, which could cause water quality impacts on surface flows.



NOTE: Air quality cumulative impacts were considered on a broader impact region.

Figure 4.4-1 Shale Oil Projects Considered for Cumulative Impacts Analysis, Getty/Cities Service EIS.

The major surface water impact associated with oil shale development would be spent shale disposal activities. It is projected that oil shale facilities would produce spent shale at an average rate of 1.2 tons per barrel of oil (Ferraro and Nazaryk 1983). Based on a 638,000-bpd shale oil production rate, approximately 612,000 tons per day of spent shale (assuming 80 percent operating capacity) would be generated and disposed. Based on current available disposal and reclamation methods, potential leachate from spent shale disposal piles would exist. The major constituents likely to appear in spent shale leachate would be salts (sodium, calcium, sulfate, and chloride), trace ions (boron, flouride, and molybdenum), sulfur, lithium, and organic carbon compounds (Ferraro and Nazaryk 1983). Most of these constituents have been detected at concentrations approximating drinking or irrigation standards in laboratory shale leachate studies. In the unlikely event of failure of the spent shale impermeable liner and downstream collection system, leachate and surface runoff during heavy rainfall events from the spent shale piles could enter into the surface water drainage and cause water quality degradation. Surface streams immediately downstream of spent shale disposal piles would receive leachate and runoff from upstream disposal areas and could be adversely impacted.

4.4.3 Ground Water

Cumulative impacts to the ground water resources due to development of the Getty and Cities Service projects in combination with the five other projects identified in Table 4.4-1 would affect ground water quality more than quantity. Furthermore, alluvial aquifers appear to merit more concern than do bedrock aquifers, given existing and potential ground water uses.

Table 4.4-2 OIL SHALE PROJECT CHARACTERISTICS ASSUMED FOR SURFACE WATER CUMULATIVE IMPACT ASSESSMENT

Project	Maximum Production Rate (bpd)	Location	Potential Affected[a] Surface Area (acres)	Average Annual Water Use[b] (cfs)	Average Annual Water Use[b] (ac-ft)
Getty	100,000	Roan Creek/Parachute Creek	4,175[c]	38	28,233
Cities	100,000	Roan Creek	2,575[d]	39	27,426
Colony	48,000	Parachute Creek	4,000	12	8,688
Union	90,000	Parachute Creek	2,800	19	13,755
Mobil	100,000	Parachute Creek	3,500	22	15,927
Pacific	100,000	Roan Creek	3,150[e]	32	23,167
Chevron	100,000	Roan Creek	13,228[f]	33	23,891
Total	638,000		33,428	195	141,087

Source: CDM (1983j); BLM (1983a); Getty (1983b); Cities Service (1983b).

[a] Excludes any corridors outside of resource property boundaries.
[b] Excludes indirect water consumption such as community and power generation.
[c] Assumes 20% of oil shale resource land (20,880 acres).
[d] Assumes 25% of property area (10,300 acres).
[e] Assumes 25% of property area (12,600 acres).
[f] Includes 8,400 acres open pit mine and 2,296 acres Roan Creek Reservoir.

Cumulative impacts to bedrock aquifers should be somewhat limited due to several factors. These are:

- The majority of development activity would utilize underground mining, which disturbs less of the Uinta/Upper Parachute Creek member aquifer than would surface mining.
- Bedrock aquifers are generally poorly developed in this portion of the Piceance Basin, with little or no evidence of a lower aquifer below the Mahogany mining zone.
- Due to incision by stream courses, namely Roan, Clear, Conn, and Parachute creeks, bedrock strata are typically well drained. Individual sites are generally hydrogeologically isolated from one another.
- Ground water use from bedrock aquifers is minimal in the area.

Conversely, the potential for cumulative impacts to the alluvial aquifers appears to be greater. Of primary concern would be the spent shale piles situated in the head of larger tributary drainages. Existing technologies for the disposal and reclamation of spent shale would provide some degree of safety, but do not preclude seepage losses. As a result, contaminants such as soluble salts, trace metals, and organic compounds could be introduced to the ground water environment. Additional contaminants could result from utilization of retort waters in the moisturization of spent shale. Saturation of spent shale and mobilization of contaminants could occur with natural precipitation and runoff. Addition of water to facilitate the leaching of soluble salts (potentially necessary to allow revegetation) could also provide opportunity for leachate generation.

The 7 oil shale projects and related development considered herein drain primarily to Roan (4 sites) and Parachute (3 sites) creeks. Eventual migration of spent shale leachate could deleteriously affect alluvial aquifers in these valleys. Although existing ground water use from alluvial wells is somewhat limited (yet markedly greater than from bedrock wells) when compared with existing storage, increasing agricultural, municipal, and industrial demands on surface water supplies could necessitate further exploitation of ground water resources.

Cumulative ground water impacts could also include the disposal of hazardous waste. Most of the oil shale developments intend to utilize off-site, licensed facilities for such disposal. Construction of new handling/storage/disposal facilities would probably be required. Prudent siting, operation, and maintenance of such facilities would be necessary to preclude ground water impacts.

4.4.4 Aquatic Ecology

Cumulative impacts to aquatic resources would occur as a result of the development of the Getty and Cities Service projects in combination with the five other shale oil projects and related development in the region. These projects would greatly alter the aquatic habitats of the Roan and Parachute creek drainages. The alteration would primarily result in the elimination of low-value stream habitat and addition of reservoir habitats. This would probably result in an overall increase in aquatic habitat and, therefore, be a slight beneficial impact. Loss of the cold water fisheries from the headwaters of these two drainages would be an adverse impact, since cold water habitats are becoming more scarce in the region. Depending on total loss of coldwater habitats in the region due to oil shale and other development, these cumulative impacts could be significant.

The increased withdrawal and consumption of Colorado River water could potentially have an adverse impact on the threatened and endangered species in the region. This issue is addressed in the aquatic Biological Assessments prepared recently under Section 7 of the Endangered Species Act, for the GCC/Clear Creek Shale Oil and Pacific projects (Holden 1983; CDM 1983c). (The terrestrial Biological Assessment for the Getty and Cities Service projects is summarized in Appendix B of this EIS, but does not address this aquatics issue since it was previously addressed in the Clear Creek Shale Oil Project assessment.)

Other adverse cumulative impacts would occur as a result of project-related population growth. Increased population would result in further consumptive water uses and additional point and non-point pollution sources. Fishing pressure and other recreational water uses would also occur throughout the region. The development of all seven projects could increase the regional population by as much as 97,000 people during peak years (Section 4.4.13). This would result in an increase in fishing pressure of approximately 850,000 trips annually. The aquatic resources of the area are already harvested at or above production capacity and therefore, cannot produce additional fish. Stocking would be necessary to achieve the current Colorado Division of Wildlife goal of 2.3 fish per fishing trip. Streams containing Colorado River cutthroat trout would probably need to be closed to fishing if the species is to be protected (Higgins 1983; Taylor 1983).

Acid deposition as a result of air emissions needs to exceed 18 pounds per acre to impact even the most sensitive aquatic ecosystems (Higgins 1983; Taylor 1983). Therefore, indications are that even when considering the seven projects together, acid precipitation should not measureably impact aquatic resources.

4.4.5 Soils

Cumulative soil impacts would occur over the short- and long-term and are anticipated to be relatively insignificant. These impacts include temporary increases in soil erosion as well as temporary or permanent loss of prime farmland.

Impacts due to accelerated erosion are generally temporary and minor over the life of the projects, especially when sound soil conservation practices are implemented. Accelerated erosion would occur as a result of construction associated with these projects. Soil erosion loss resulting from secondary impacts, such as construction or residential subdivisions, may exceed those soil losses associated with direct impacts.

Loss of prime farmlands would occur due to construction activities associated with all seven projects. This loss of prime farmland is not easily mitigated. Prime farmland is a finite resource and is irretrievably lost when developed to non-agricultural uses. None of the exploitable oil shale resources of the seven projects considered lie beneath prime farmland. However, many of the various pipeline, road, rail, and transmission line corridors could potentially cross prime farmland. Furthermore, prime farmland is also often best suited for urban development.

If urban development associated with the seven projects occurs on prime farmland, the subsequent loss could be significant. Assuming the combined prime farmland losses resulting from primary and secondary impacts of the Getty and Cities projects is 3,300 acres, losses for the seven projects could range up to 12,000 acres. This is approximately 20 percent of all prime farmland in the Colorado River valley and its tributaries (excluding the Gunnison River valley) from Glenwood Springs to Fruita.

4.4.6 Vegetation

Direct cumulative impacts to the vegetation resources of the Getty and Cities Service projects and the additional five projects would result from surface disturbance due to construction and operation of the mine and process facilities, spent shale disposal, and activities within numerous corridors. Based on an analysis by the USFWS of a 538-square mile area in the Roan and Parachute Creek vicinity, approximately 40,000 acres of native vegetation and 1,200 acres of agricultural lands could be affected by all of the projects considered. Long-term and residual impacts could be anticipa ted with respect to the roles that vegetation plays in ecosystem structure, carrying capacity for livestock and wildlife, soil development processes, and microclimatic conditions.

Direct impact on forage productivity useful for livestock could be 20 percent of the forage resource available in the area analyzed. Most (approximately 75 percent) of this impact on productivity would result from construction of permanent facilities (roads, railroads, reservoirs) on agricultural lands. Additional secondary impacts on agricultural lands are anticipated as a result of associated urban development.

In the 538-square-mile area analyzed by USFWS, an average of 12 percent of all vegetation types could potentially be affected by the seven project configurations. Two sensitive vegetation units (agricultural lands and riparian woodlands) could potentially be affected at a level higher than this 12 percent average. However, several other sensitive vegetation units (cliffs and talus slopes, conifer forests, and palustrine wetlands) would be affected at a level below the 12 percent average.

Cumulative impacts to populations of plant species of special interest are presented in Table 4.4-3. As evidenced in this table, the greatest cumulative impacts from oil shale development would occur to Sevier blazing star, De Beque phacelia, sunloving meadow-rue, Uinta Basin hookless cactus, and sullivantia.

Direct impacts to Uinta Basin hookless cactus and De Beque phacelia by oil shale development would result from construction of the GCC water supply and storage system and construction within the Roan Creek corridor. Impacts to Uinta Basin hookless cactus and De Beque phacelia are discussed in detail in BLM (1983a) and Woodward-Clyde (1983). Additional incremental impacts to these species could occur as a result of the Getty and Cities Service projects.

Barneby columbine and sullivantia occupy moist cliffs, usually near waterfalls, in the deep canyons of the region. Both species are threatened by disruption of surface water flow or by corridor construction through such habitats. Up to 21 percent of the known Colorado localities of Barneby columbine and 37 percent of the known localities of sullivantia could be affected.

Sedge fescue and dragon milkvetch would be least affected by oil shale development. Dragon milkvetch, in particular, is abundant and widespread in the region. Approximately 10 percent of known Colorado localities of these plants could be cumulatively affected.

Sevier blazing-star and sunloving meadow-rue have only recently been discovered in Colorado. The potential impact to these species is uncertain. Where the species have been found, they are abundant (CDM 1983c; Getty 1983a; Cities Service 1983a), and as more regional studies are conducted, new populations (localities) of both species will likely be found. Therefore, potential oil shale development impacts to these species would likely be less significant than suggested by the evidence presented in Table 4.4-3.

Table 4.4-3 APPROXIMATE NUMBERS OF CUMULATIVELY AFFECTED RARE PLANT POPULATIONS (LOCALITIES)[a]

Plant Species	Common Name	Status	Getty[c]	Cities Service[c]	Chevron	GCC[d]	Union	Colony[e]	Mobil[f]	Pacific	Total	Total Known in Colorado[a]	Percent[g]
Aquilegia barnebyi	Barneby Columbine	Category 2	5	6	3	0	2	1		2	19	90	21
Astragalus lutosus	Dragon Milkvetch	Category 2	5	3	1	0	5	1		11	26	211	12
Festuca dasyclada	Sedge Fescue	Category 2	0	1	1	0	5	0		0	7	67	10
Mentzelia argillosa[b]	Sevier Blazing Star	Category 1	3	2	0	0	1	0		2	8	8	100
Phacelia submutica	De Beque Phacelia	Category 1	0	0	0	7	0	0		0	7	11	64
Sclerocactus glaucus	Uinta Basin Hookless Cactus	Threatened	0	0	3	4	0	0		0	7	21	33
Sullivantia hapemanii v. *purpusii*	Sullivantia	Colorado Natural Heritage Inventory (CNHI) Species of Concern	3	3	3	0	0	1		3	13	35	37
Thalictrum heliophilum[b]	Sunloving Meadow-Rue	CNHI Species of Concern	5	2	0	0	0	0	1	0	8	18	44
Total			21	17	11	11	13	3	1	18	95	461	

[a] Based on information in available project documents, CNHI data, and published literature.

[b] Species recently discovered in Colorado, most projects not adequately searched. Available information suggests species are abundant in suitable habitat (barren talus slopes).

[c] Locality information for *Astragalus lutosus, Mentzelia argillosa,* and *Thalictrum heliophilum* incomplete. Numbers presented are based on personal observations by CDM personnel and from assumption that one canyon (such as Cascade Canyon, Buck Gulch) constitutes only one locality. This assumption is inconsistent with data provided for other projects.

[d] Common water supply system to be used by Getty, Chevron, and Cities Service (impacts analyzed in BLM 1983a and Woodward-Clyde 1983).

[e] Data from Colony (1975). Many of the plant species were unknown or did not have special status in 1974, and thus were not included in searches.

[f] Data unavailable. Record for *Thalictrum heliophilum* from Wilken & DeMott (1983).

[g] Percent of total known occurrences in Colorado.

4.4.7 Wildlife

A cumulative wildlife impact analysis of the Getty, Cities Service, and five other oil shale projects was performed by the USFWS and CDOW using a modified Geographic Information System (GIS; Porter et al. 1979; USFWS 1981). Total disturbance areas associated with the seven oil shale projects were compared with computerized wildlife values (i.e., big game ranges, sensitive wildlife habitats) for a defined geographic unit which encompassed all seven oil shale projects. The purpose of the analysis was to determine the total extent of surface disturbance expected for each wildlife feature with all projects in full operation. The geographic unit for evaluation of sensitive wildlife habitats (e.g., aspen, cliffs, wetlands) was 538 square miles (344,580 acres) in size (see Section 4.4.6). Big game ranges (i.e., winter range, winter concentration area, and critical habitat) were defined by CDOW Data Analysis Units (DAU): DAU's 11 and 41 for mule deer and DAU 10 for elk. Determination of the cumulative effect of the oil shale projects on sensitive wildlife habitats and big game ranges was based on the total availability of these resources and total amount of anticipated disturbance in each of the geographic units described above. The geographic units used for the wildlife and vegetation cumulative impact analysis are generally smaller than those addressed by other disciplines in this EIS.

In general, the cumulative wildlife impacts of developing the Getty and Cities Service projects in conjunction with the other five projects would include direct habitat loss, disturbance of habitats in the vicinity of the proposed developments, and a decrease in the carrying capacity for most wildlife species in the region. Individuals would be likely to disperse from the affected areas into adjacent habitats and animals could modify their habitat use and migration patterns in response to disturbance. The abundance of big game and raptors could also be reduced as a result of roadkills, illegal hunting, and human harassment. Increased demands for recreational opportunities could cause increased hunting pressure and harvest.

Sensitive wildlife habitats which would be directly affected by the seven oil shale projects include aspen, cliff, Douglas-fir, and wetlands (palustrine, riverine, riparian woodland) types. Of the total available resources within the 538 square mile geographic unit, the following sensitive habitats would be disturbed: 12 percent of the aspen woodlands, 6 percent of the cliff habitat, 5 percent of the Douglas-fir woodlands, 9 percent of the palustrine, 21 percent of the riverine, and 16 percent of the upland riparian woodlands. (See Section 4.4.6 for a discussion of the significance of these results.) Disturbance of these types could result in the incremental loss of known or potential raptor nest sites, blue grouse brood and breeding areas, and important resources and concentration areas for various other species of wildlife. These impacts would range from low to medium adverse and be short to long-term in duration.

The total amount of potential disturbance to the deer and elk DAU's as a result of the seven proposed projects is 3.1 and 2.2 percent, respectively. The potential cumulative losses of big game winter ranges, winter concentration areas, critical habitat in relation to the total availability of these resources in Data Analysis Units 10, 11, and 41 are summarized below.

Mule Deer

- Winter Range — 9,276 acres affected or 2.0 percent of the total winter range available in DAU 11 and 41
- Winter Concentration Areas — 5,744 acres affected or 4.7 percent of the total winter concentration area available in DAU 11 and 41
- Critical habitat — 12,023 acres affected or 3.7 percent of the total critical habitat available in DAU 11 and 41

Elk

- Winter Range — 9,032 acres affected or 3.4 percent of the total winter range available in DAU 10
- Winter Concentration Area — 2,261 acres affected or 4.3 percent of the total winter concentration area in DAU 10
- Critical Habitat — 2,276 acres affected or 2.4 percent of the total critical habitat available in DAU 10

These figures suggest that, in comparison with the total amount of potential disturbance expected in the DAU's, all of the big game ranges (with the exception of deer winter range) would be disproportionately impacted compared to all habitats in the area by the oil shale projects. This is understandable in light of the fact that much of the development (e.g., corridors, reservoirs) associated with the proposed oil shale projects would be concentrated in the lowland areas where most of the big game winter ranges and critical habitat are also centered. Disturbance of these areas would contribute to the overall reduction in the regional big game carrying capacity. This potential reduction is unquantifiable at this time, but is likely to parallel the decrease which is expected to occur in the region's ability to support domestic animals (see vegetation, Section 4.4.6). Other impacts to big game include dispersal into adjacent habitats, modification in habitat use, alteration of migration patterns, potential exposure to toxic and hazardous materials, and increased incidence of roadkills. Indirect effects include increased hunting pressure, poaching, and harassment.

The cumulative effects of these projects on endangered species is not expected to be significant on a regional basis. However, these projects could contribute to the incremental loss of potential cliff nesting sites and hunting areas for peregrine falcon. As concentrated oil shale development occurs in the vicinity, increased levels of human disturbance, habitat loss, and operational noise could exclude the peregrine falcon from this area. In addition, increased levels of human activity and vehicle traffic along the Colorado River could cause a significant reduction in the number of wintering bald eagles which frequent the river between Fruita and Parachute. The projected depletion of the Colorado River could have a significant adverse effect on riparian habitats along the river.

4.4.8 Air Quality/Meteorology

Cumulative air quality impacts would occur from the proposed Getty and Cities Service projects and other existing and proposed sources in the region. Existing background concentrations of CO, NO_2, SO_2, O_3, TSP, and lead are presently at or below the measurable limits (BLM 1983c). Exceptions occur in short-term concentrations of TSP (potentially related to wind-blown fugitive dust) and ozone (potentially correlated to stratospheric intrusions and/or long range transport).

Cumulative impacts on the region were assessed by utilizing the Topographic Air Pollution Analysis System (TAPAS) from other cumulative studies (Taylor 1983; Higgins 1983) and the ISC analyses presented in Sections 4.1.8, 4.2.8, and 4.3.8. Many of the sources included in this analysis are in preliminary design phase and specific development details are lacking. Therefore, a worst-case analysis using conservative techniques was employed. Sources that were included are listed in Table 4.4-4; these are more numerous and extend to a wider area than the cumulative impact study area assumed for other disciplines in this section. Impacts predicted by the TAPAS analyses were factored in with the impacts predicted by site specific modeling for Getty and Cities Service projects for the same sensitive receptors.

The sensitive receptors analyzed are the PSD Class I areas: Flat Tops Wilderness and Mount Zirkel Wilderness; the Colorado Category I areas: Colorado National Monument and Dinosaur National Monument; and the sensitive regional Class II receptors: De Beque, Parachute, Rifle, Grand Junction, the Grand Mesa, and the Grand Hogback.

Table 4.4-4 SOURCES INCLUDED IN THE AIR QUALITY CUMUALTIVE ANALYSIS

Colorado Synfuel	Colorado Power Plants	Utah Synfuel	Utah Power Plant
Cathedral Bluffs	Craig	Enercor-Rainbow	Moon Lake
Chevron	Hayden	Paraho-Ute	
Colony	Southwest	Syntana	
Mobil		Western	
Rio Blanco		White River	
Pacific			
Union			
Getty			
Cities Service			

The TAPAS modeling method used by the BLM (Taylor 1983; Higgins 1983) is state-of-the-art in regional scale, complex terrain modeling. Because of the uncertainty associated with any modeling analysis in complex topography (especially one which carries the analysis out to 125 miles from 18 sources whose detailed emissions characteristics can only be speculated) the results should be viewed with uncertainty. Nevertheless, an effort was made to evaluate the worst possible situation in a conservative analysis. TAPAS was selected because it is applicable in complex terrain, it can model multiple emissions sources, it utilizes terrain influenced pollutant trajectories, it is suitable for the regional scale (30 to 125 miles transport distances), it is applicable for worst-case analysis, and similar versions of the model have been applied by regulatory agencies in specific situations.

TAPAS was used to model cumulative impacts in the Flat Tops Wilderness and Mt. Zirkel Wilderness areas. Complex I was used to model air quality impacts in the rest of the sensitive receptors mentioned above. Complex I is a steady state Gaussian plume model which estimates long- and short-term concentrations using hourly observed meteorological conditions. Complex I uses the VALLEY basic algorithm but incorporates bouyancy-induced dispersion. Results from this model are considered highly conservative because, in the actual worst-case scenario, identified transport would be influenced by complex topography and diverse wind variations along the trajections and would be unlikely to arrive at the sensitive receptors as predicted. However, because validated, widely approved modeling techniques are not available, this conservative approach was employed to identify potential problems and areas of concern.

Air Quality

Table 4.4-5 summarizes the cumulative impacts of TSP and SO_2 in the PSD Class I and Colorado Category I areas. The 24-hour SO_2 concentration is conservatively predicted to consume the Class I PSD increment in the Mount Zirkel Wilderness. Nevertheless, about half of this impact is due to a pre-PSD program, non-increment consuming source (Hayden Power Plant). Plumes modeled for many of the regional power plant and oil shale sources would not influence the Flat Tops Wilderness. No other Class I PSD increments are expected to be consumed or exceeded. The 24-hour SO_2 increment is conservatively estimated to be consumed in the Colorado National Monument. No other Colorado Category I increment is estimated to be exceeded.

High-development scenario cumulative impacts were also modeled using Complex I and ISC for Colorado River Valley towns and other sensitive regional receptors. Results are shown in Table 4.4-6. Maximum concentrations at the receptors were well below allowable PSD Class II increments.

Visibility

To assess potential cumulative visibility impacts from several sources, a Level-1 visibility screening analysis for each potential source in the region was performed.

Table 4.4-5 MAXIMUM CUMULATIVE AIR QUALITY IMPACTS IN PSD CLASS I AND COLORADO CATEGORY I AREAS

Pollutant	Averaging Time	Predicted PSD Class I Concentration ($\mu g/m^3$)		Predicted Colorado Category I Concentrations ($\mu g/m^3$)		PSD Class I[a] Increments ($\mu g/m^3$)
		Flat Tops	Mt. Zirkel	Colorado	Dinosaur	
SO_2	Annual	<1	<1	1	<1	2
	24-Hour	4	5[b]	5[c]	3	5
	3-Hour	10	NM[d]	20	17	25
TSP	Annual	<1	<1	<1	<1	5
	24-Hour	1	<1	2	2	10

[a] Colorado Category I increments are the same as PSD Class I increments for SO_2 only.
[b] Equal to or exceeds PSD Class I increment.
[c] Equal to or exceeds Colorado Category I increment.
[d] Not modeled.

Table 4.4-6 MAXIMUM PREDICTED CONCENTRATIONS ($\mu g/m^3$) FOR CUMULATIVE HIGH-DEVELOPMENT SCENARIO IMPACTS AT SENSITIVE CLASS II REGIONAL RECEPTORS

PSD Class II Increment	TSP		SO_2			NO_x	CO	
	Annual	24-Hour[a]	Annual	24-Hour[a]	3-Hour[a]	Annual	8-Hour[a]	1-Hour[a]
De Beque	<1	1	1	6	31	3	11	50
Parachute	<1	2	1	10	49	2	13	72
Rifle	<1	1	<1	3	22	1	8	47
Grand Junction	<1	1	<1	4	15	1	7	39
Grand Mesa	<1	1	<1	6	31	2	13	52
Grand Hogback	2	6	3	11	49	11	34	216
PSD Class II Increment	19	37	5	91	512	--	--	--

Source: BLM (1983d).

[a] Highest second-highest.

Rather than evaluate potential impact to a specific receptor, the model may be applied to determine the minimum distance beyond which "it would not be likely to cause adverse visibility impairment, and further analysis of potential visibility impacts would be unnecessary" (Latimer and Ireson 1980). Because the Level-1 screen applies worst-case assumptions, it should not be inferred that the emission source will necessarly impact visibility within the distance modeled; further detailed analysis is required to refine the potentiality and degree of impact.

Table 4.4-7 indicates the minimum distance beyond which visibility impairment from each individual source "would not be likely." Assumed production levels and the pollutant primarily responsible for the modeled impact are also presented. NO_x impacts would generally result in dark-colored NO_2 plumes against the sky, whereas TSP impacts would result in light-colored plumes against terrain. No regional haze problems were predicted by this screening.

Table 4.4-7 CUMULATIVE VISIBILITY ANALYSIS BASED UPON MINIMUM DISTANCE LEVEL 1 SCREEN PASSES

Source	Production Level[a]	Responsible Pollutant	Distance (km)
Cathedral Bluffs	76	NO_x	101
Chevron-retort	100	NO_x	134
-upgrade	(100)	NO_x	49
-combined	100	NO_x	147
Chevron-retort	50	NO_x	92
-upgrade	(50)	NO_x	33
-combined	50	NO_x	101
Cities Service	100,000	NO_x	89
Colony	48	NO_x	55
Getty	100,000	TSP	59
Mobil	100	NO_x	93
Rio Blanco	100	TSP	79
Pacific	100	NO_x	60
Union	90	TSP	87
Craig Power	1,340	NO_x	112
Hayden Power	465	NO_x	60
Southwest Power	500	NO_x	68
Enercor-Rainbow	5	TSP	13
Paraho-Ute	42	TSP	46
Syntana	57	TSP	55
Western	5	TSP	17
White River	100	TSP	68
Moon Lake Power	800	NO_x	99

[a] Synfuel production in 1,000 bpd; power production in megawatts.

Acid Deposition

Total wet and dry deposition from cumulative SO2 and NOx emissions at the PSD Class I and Colorado Category I areas were estimated by adding the Getty/Cities Service deposition to those used in other studies (Taylor 1983; Higgins 1983). The results are presented in Table 4.4-8.

Table 4.4-8 POTENTIAL ACID DEPOSITION CUMULATIVE IMPACTS

Sensitive Area	Annual Deposition Total Sulfur	(mg/m²-yr) Total Nitrogen
Flat Tops	70	270
Colorado National Monument	99	336
Dinosaur National Monument	30	110
Mount Zirkel	9	32

These rates are well below the threshold values 2.0 and 1.3 g/m^2-yr (2,000 mg and 1,300 mg, respectively) for wet and dry sulfate deposition discussed by Roberts (1983). Although no current threshold value has been proposed for judging nitrate deposition, the threshold impact value would be expected to be similar to the sulfate thresholds.

Secondary Impacts

Secondary Impacts Cumulative secondary impacts due to population growth would affect air quality. Corresponding emission rates could be estimated using the percent contribution of direct and indirect emission rates related to oil shale development (PEDCo 1982). Applying the percent contributions of the production years 1990 and 2000 to the individual source, emission rates that are presented can then be used to interpret potential air quality impact due to secondary sources.

The resulting emission values indicate a relative, potentially adverse impact to air quality, especially total suspended particulates. As shown in Table 4.4-9, particulates directly attributable to oil shale development make a small contribution (less than 20 percent of the total) to the total air quality emissions. The increased secondary emissions of TSP from additional vehicles on unpaved roads and wood fires would contribute over 80 percent to the overall emissions. Gaseous emissions of SO_2 and NO_x from residential heating and combustion engines, however, would have only a slight adverse effect when compared to the various oil shale point sources.

Table 4.4-9 PERCENT CONTRIBUTION OF DIRECT AND INDIRECT EMISSIONS RELATED TO CUMULATIVE OIL SHALE DEVELOPMENT

	Percent Contribution	
	Direct	Indirect
Total Suspended Particulates		
1990	15.1	84.9
2000	19.4	80.6
Sulfur Dioxide		
1990	96.3	3.7
2000	96.7	3.3
Oxides of Nitrogen		
1990	92.4	7.6
2000	94.4	5.6

Source: PEDCo (1982).

It would be inappropriate to model emission data which is proportioned in this manner, due to the other inadequate input. Nevertheless, because of the potential for growth-related significant TSP concentrations, local planning organizations will need to carefully manage growth, especially in the event that several oil shale projects should start concurrently.

4.4.9 Noise

No significant cumulative noise impacts are expected in the region other than some increase in the areal extent of moderated noise associated with the expected increased growth. These increases would be experienced in the communities of Rifle, Parachute, and De Beque. However, this increase should be generally low and good planning practices would prevent localized problems from becoming significant.

4.4.10 Cultural Resources

Cumulative impacts to regional cultural resources could be significant based on the extent of natural resource development. Specific impacts on public lands resulting from project construction can be mitigated according to the provisions of 36 CFR 800. Additional potential for impact to cultural resources exists based upon increased number of people in the area having access to previously undisturbed areas. The resulting impact could be inadvertent destruction of unknown sites (previously unrecorded), as well as purposeful vandalism of known cultural resource sites (e.g., unauthorized arrowhead collecting or pothunting).

4.4.11 Land Use, Recreation, and Wilderness

Cumulative impacts to land use, recreation, and wilderness resulting from development and operation of the Getty and Cities Service projects and the remaining five identified projects would, in general, be those identified in Section 4.1.11. Direct effects from oil shale development on land use would include decreased rangeland and agricultural productivity resulting from mining facilities, support facilities, and corridors. A major portion of affected lands could eventually be reclaimed to range or agricultural use; however, much of this land will be unavailable for the life of the various projects; generally in excess of 25 years. Approximately 21,000 acres would be lost as a result of the population increase induced by the projects. In addition, land utilization patterns would change due to physical barriers created by mining; competition for available water between agriculture, industry, and municipalities; and competition for labor. Competition for agricultural water alone could reduce irrigated agricultural lands by as much as 23 percent (Ferraro and Nazaryk 1983).

With an increasing population comes the need for more recreational opportunities in a limited recreational setting. Intense pressure for urban recreational facilities would have to be met by municipalities. Deer and elk hunting, which occurs throughout the areas to be mined to the extent that access can be obtained, would be affected. Controlled access into developed oil shale lands would probably further restrict use of such lands for hunting, thus placing more hunting pressure on adjacent lands. With the development of new corridors arises the problem of a greater incidence of poaching, trespassing, and off-road vehicle use.

Air quality impacts from oil shale production could affect visibility in recreation and wilderness areas (see Air Quality cumulative impacts discussion). This impact, combined with a greater number of visitor use days in these areas, could lower the aesthetic appeal and sense of solitude, so important to the recreational experience in these areas.

4.4.12 Visual Resources

Cumulative visual impacts from development of the Getty and Cities Service shale oil projects in combination with other developments in the region would result from alterations of landform, vegetation patterns, land uses, and the introduction of structures (e.g., buildings, powerlines, roadways) that would contrast with the existing landscape. With the exception of the existing Union Oil and proposed Chevron upgrade facilities, the majority of the oil shale developments would occur in remote areas currently not accessible by the general public. Surface mining and spent shale disposal activities would permanently alter the landform of the plateau and canyon areas.

The most evident visual impacts of development would occur as secondary impacts. The I-70 corridor from Rifle to approximately the Utah border would continue the current pattern of change: from rural and agricultural to urban and, in some locations, industrial. These land use pattern alterations would also be evident in the Roan Creek and Parachute Creek valleys. The overall nature of the I-70 corridor would be subject to change and, as a result, the aesthetic experience of visitors and residents in this corridor would be permanently altered.

4.4.13 Socioeconomics

The "no action" alternative (which was used as the baseline for estimating the socioeconomic impacts for the Getty and Cities Service projects) included only one oil shale project, the Union Phase I, designed to produce 10,000 bpd. Baseline data for considering impacts for a high-development scenario are not available. Hence, the description provided herein is qualitative and speculative. At the same time, some of the scope of a high-development scenario can be outlined based upon the socioeconomic work done on several projects, and descriptive data have been analyzed for the following proposed projects: Union II, Chevron, Colony, Mobil, Pacific, and the Southwest power generating facility (which would be required in a high-development scenario). The total estimated shale oil production capability of these projects, including Getty, Cities Service and Union I, is approximately 638,000 bpd.

Dramatic social and economic effects would occur in the study area if the changes required for oil shale construction and operation at the 638,000-bpd production rate were achieved. The socioeconomic categories discussed below are the same as those discussed in Section 4.0: employment, income, purchases, population, housing, public facilities and services, fiscal and social structure. A detailed technical report (MWSW 1983) supports the summary which follows.

Employment and Income

Direct basic employment for construction and operation, as well as local purchases are shown in Table 4.4-10. These data have been estimated in EISs and technical reports available at this time. The peak construction work force employment for the 638,000-bpd high-development scenario, based upon planning estimates of worker demand and schedules, could exceed 20,000 in 1991 and 1992. At full operation of all these projects, the on-site work force is estimated at 22,000 to 23,000. The years of peak employment, including construction and operation, would be 1995 to 1997 when about 30,000 on-site jobs would be filled.

The wage income from this employment, using CITF rates of $34,400 for construction and $32,612 for operation, would be expected to peak at over $1 billion in 1995, and exceed $750 million annually during operation. Local purchases made on behalf of these projects would also peak in 1995 at more than $750 million and would approach $500 million during the operation of all sites.

In addition to on-site employment, more jobs would be created through the local purchases by the operators (indirect basic) and through the spending of basic income. This indirect basic and non-basic employment and income should be added to the direct basic in order to estimate the total employment and income effects of the high-development scenario. Adding together all the employment effects suggests that the total number of new jobs created in the study area could reach 59,000 by 1995. This would more than double employment in the study area which was estimated at less than 56,000 for the "no action" alternative. Total labor income for the high-development scenario using this additive approach would be $1.3 billion in 1995, 144 percent higher than the "no action" alternative. During operations for the 638,000-bpd scenario, employment would be between 48,000 and 50,000 persons, while the labor income figure would be over $1.1 billion annually.

The reader should note that simply adding together the project effects which make up the high-development scenario probably understates the likely impacts. The detailed technical report (MWSW 1983) provides further discussion.

Table 4.4-10 CUMULATIVE PROJECTS CONSTRUCTION AND OPERATIONS EMPLOYMENT AND INCOME FOR THE GETTY AND CITIES SERVICE PROJECTS

Year	Construction	Operation	Total	Income ($000)	Purchases ($000)
1980	42	8	50	10,652	2,019
1981	786	35	821	28,180	37,781
1982	900	90	990	33,895	16,208
1983	225	25	250	8,555	4,458
1984	225	25	250	8,555	5,403
1985	1,745	25	1,770	60,843	25,735
1986	4,315	25	4,340	145,811	65,104
1987	6,582	668	7,250	248,206	94,502
1988	11,906	1,590	13,496	461,418	324,179
1989	15,030	3,298	18,328	624,582	467,349
1990	17,540	4,823	22,363	760,650	596,763
1991	21,290	6,838	28,128	955,353	730,624
1992	20,270	8,512	28,782	974,856	576,520
1993	17,305	11,040	28,345	955,301	569,020
1994	15,860	13,004	28,864	969,639	664,860
1995	16,580	14,425	31,005	1,040,745	758,485
1996	13,462	15,875	29,337	980,765	633,937
1997	11,800	17,973	29,773	992,003	543,634
1998	7,717	19,201	26,918	891,591	427,399
1999	6,640	19,590	26,230	867,229	549,114
2000	5,570	20,317	25,887	854,130	572,330
2001	4,215	21,195	25,410	836,151	527,575
2002	2,250	21,735	23,975	785,818	575,205
2003	3,155	22,235	25,390	833,594	650,725
2004	110	22,435	22,545	735,366	478,325
2005	400	22,435	22,835	745,342	493,025
2006	1,800	22,535	24,335	796,762	563,625
2007	3,000	22,735	25,735	844,562	626,425
2008	600	23,135	23,735	775,042	516,825
2009	---	23,335	23,335	760,922	491,425
	211,310[a] (37%)	359,162[b] (63%)	570,472	18,986,518	12,588,579

Source: Mountain West Research - Southwest, Inc. (1983). Projections for Chevron, Union Phase II, Mobil, and Pacific are based on EIS documents. Colony and Southwest descriptions are those in the CITF data base prior to the shut-down of these two projects. A start date of 1987 was assigned for the Colony and the Southwest projects.

[a] Total construction wages would be $7.2 billion figured at $34,400 per year in 1982 dollars. This would account for 38.1 percent of the total labor income.

[b] Total operations wages for the period would be $11.7 billion figured $32,600 per year in 1982 dollars. This is 61.9 percent of the total labor income.

Local Purchases

Local purchases for the high-development scenario have been estimated by adding the figures provided in the project descriptions. The peak year is 1995 when all the developments together estimate local purchases of over $750 million. During the first decade of the 21st century, when most of these projects would be in full operation, the annual purchases would range from $475 million to $650 million.

Population

Population impacts based upon adding together the estimates of all projects would be dramatic. The peak year for the high-impact scenario would be 1997, when more than 97,000 people would be added to the "no action" alternative estimates, an 80 percent increase that would result in a study area population of over 218,000. The distribution of this population, using these same reports and their allocation methods, would mean that Garfield County would exceed 80,000 in 1997, 185 percent higher than the "no action" case. For some of the local communities, the impacts would be even greater. Battlement Mesa would approach 25,000, 40 times the "no action" estimates. Rifle would be a city of more than 16,000, two and a half times the "no action" projection of 4,662. Parachute's population would be 3,418 instead of 603, an increase of four and a half times. Mesa County would have almost 50 percent more people. In other communities the impacts would range from increases of 50 percent in Grand Junction to almost 500 percent in De Beque.

Housing

Housing impact projections are derived from the population estimates and assumptions about the trends for the future housing mix (single family, multi-family, and mobile homes). The estimates for the 638,000-bpd scenario, based upon the population impacts, imply the demand for an additional 44,000 housing units in the study area. This is about a 79 percent increase over the "no action" alternative.

Limitations to the data exist for estimating the population and housing impacts. The reader is referred to the detailed technical report (MWSW 1983) for additional information.

Public Services and Facilities/Fiscal Impacts

The increases outlined for population and housing indicate that the impacts of the high-development scenario on public services and facilities would range from a demand of 25 percent to from 400 to 500 percent over the "no action" alternative. The distribution of the impacts for the high-development case is not possible given the uncertainty of the actual size, duration, and location of such vital conditions as employment, population, and housing. The prior studies of oil shale project impacts allocated much of their demand for public facilities and services to the current excess capacity in the study area. The potential surplus capacity was estimated to be just about enough to cover the increased use for one project.

The reports on public facilities and services impacts cannot be used to estimate the conditions for the 638,000-bpd scenario because they all use a surplus capacity that is only going to be available once. Therefore, to add up the impacts reported for these individual assessments would understate the public sector impacts for the high-development scenario. Once the current surplus capacity is exhausted, all additional demand would require new capital expenditures as well as program expansions for services in order to meet the new levels of demand. For the high-development case, significant public sector expansion would be required for most of the projection period.

There is no doubt that the 638,000-bpd scenario would theoretically produce potentially large fiscal surpluses. The major sources for the additional revenues are the property tax, sales and use taxes, and severance taxes. The great bulk of the fiscal surpluses are estimated to result from increased property taxes since a 100,000-bpd facility has a potential assessed valuation of more than $1 billion, or about $20 million a year in taxes at the current tax rate in Garfield County. This revenue source accounts for 85 to 95 percent of the surplus revenues projected by the various studies. As a practical matter, however, the concentration of so much of the tax base increase in one jurisdiction probably means that the potential revenues would never be realized. County tax rates would be likely to drop, perhaps to only a fraction of their current levels. Because of the tremendous additional assessed valuation that would be added with the 638,000-bpd scenario, this would be true even if the county were to devise various ways of increasing services or otherwise assisting the cities, towns, and local jurisdictions. While the overall fiscal effects are positive, it is not clear what they might be in dollar amounts nor how they might be used to meet increased demands for public facilities and services.

The additional revenues from the severance, sales, and use taxes contribute to modest surpluses for some jurisdictions, most notably Mesa County which has a 2 percent tax on most sales. Many jurisdictions would be expected to experience short-term deficits as demands for services exceed revenues in the period before severance taxes begin to come in and cover the shortfall. Whether any of these jurisdictions would cover their costs of providing entirely unprecedented increases in facilities and services cannot be assessed at this time. The amount of the new tax revenues available to jurisdictions other than Garfield County is modest to begin with, and its distribution to cover the potential new demand is uncertain.

Social Structure Impacts

The current social structure description is contained in Section 3.1.13.8. Estimates of probable social structure impacts with the high-development scenario cannot be made at this time. This is due in part to the uncertainty about the distribution of the other impacts (i.e., employment, income, population, housing, etc.) and to the probable size of the effects which would result from a 638,000-bpd scenario. Another consideration is the limited theoretical understanding of what would result from changes of this magnitude, and what these would mean in the study area context.

The population estimates for the high-development scenario project increases of up to 80 percent over the "no action" alternative for the study area, and up to 185 percent for Garfield County. Even these dramatic impacts are probably understated for the reasons outlined in the sections above. Socioeconomic changes of this size, duration, and intensity are probably without precedence anywhere in the United States. These levels of impact would be liable to overwhelm the existing social structure so that it would no longer be a question of how people would be integrated into what was already there but of what the new groups and social structure would be like. The implications for the existing social order are not clear.

4.4.14 Transportation

The cumulative impacts of the assumed projects would add additional pressures to existing transportation systems, particularly the road network. Current projections indicate that the major road network in the region (i.e., I-70) will be able to handle future traffic loads. This prediction is, however, extremely dependent on the time of development of each of the seven projects considered. If each of these projects experienced major development within a 5-year period (e.g., 1990-1995), the impacts to existing road systems would be significant. As such, the level of service of most roads in the region would drop to lower levels of service (D,E, or F) and would result in unstable traffic flow, fluctuations in volume, and some stoppages. This problem would be alleviated to a great extent by the phasing of projects and mass transportation systems.

Cumulative impacts to the other roads in the region (e.g., the Roan Creek road) would also be significant. These roads would have to be upgraded to accommodate the increased traffic flow.

Depending on the selected mode of transportation for by-products and upgraded oil, the effect to the railroad systems could be significant. Air transportation facilities would experience increased pressure. However, the recent improvements made at Walker Field in Grand Junction would serve to meet these additional pressures. The impact to the pipeline system of the area would be moderately beneficial due to increased pipeline capacity.

4.4.15 Energy

The cumulative power needs of all seven projects are estimated to be 1,550 MW. This amount of power represents a significant increase over existing capacity; however, many of the projects propose co-generation of electricity, hence reducing the need for imported power by as much as 15 percent. Additional energy for the region would be required in the form of natural gas, solid fossil fuels (e.g., coal), and liquid fuels.

The consumption of energy by the seven projects would be offset by the production of energy due to development of the oil shale resources. While energy ratios vary between projects, it is expected that the overall output/input energy ratio would be approximately 3.5 to 1.

4.5 Unavoidable Adverse Impacts

A number of unavoidable adverse impacts would result from development of either the Getty or Cities Service shale oil projects. As one might expect, impacts from each project are nearly identical due to the contiguous locations and the similar types of development activities. The unavoidable adverse impacts for each project are identified on the following pages.

4.5.1 Getty

The following unavoidable adverse impacts would be expected from development of the Getty shale oil project.

Topography: Leveling; cut-and-fill for roads, facility sites

Geology: Removal of the oil shale resource, possibly some subsidence; changes to aquifers and other strata

Paleontology: Inadvertent disturbance of fossilized rock layers due to construction, covering of potential fossil sites with earth and rock

Surface Water: Flow interruption, water quality degradation, alterations to existing stream channels

Ground Water: Quality and quantity effects, aquifer disruption

Soils: Temporary increases in soil erosion, permanent soil loss, probable permanent loss of prime farmland, and changes in soil productivity

Aquatic Ecology: Some impacts to the limited fisheries and aquatic resources on-site; sedimentation of existing, mostly intermittent streams

Vegetation: Losses of established plant cover, productivity, and habitat; potential impacts to threatened and endangered plant species

Wildlife: Loss of wildlife and wildlife habitat; reduction in regional carrying capacity for deer and elk

Air Quality: Emissions of various criteria and hazardous pollutants, fugitive dust and visibility impacts, degradation of air quality

Noise: Changes to acoustic environment of plant sites and corridors from rural or rangeland to industrial

Cultural Resources: Inadvertent destruction of previously undiscovered archaeological and historic sites, unauthorized collecting of known resources

Land Use: Changes from rural or rangeland to industrial, commercial, and residential uses

Recreation and Wilderness: Increased use and possible degradation of area recreation and wilderness resources

Socioeconomics: Changes to the rural lifestyle of the area; increased social problems, traffic accidents, and similar socioeconomic effects

Visual Resources: Modification of characteristic landscape from rural or rangeland to an industrial, commercial, and residential environment; general alteration of scenic (visual) conditions in the area through reduced visibility or construction of project facilities

Transportation: Over use of the existing road, railroad, and pipeline networks, especially during construction and early operations

Energy: Over taxing of existing energy resources and networks to construct and operate the project

4.5.2 Cities Service

The following unavoidable adverse impacts would be expected from development of the Cities Service shale oil project.

Topography: Leveling; cut-and-fill for roads and facility sites

Geology: Removal of the oil shale resource, possibly some subsidence; changes to aquifers and other strata

Paleontology: Inadvertent disturbance of fossilized rock layers due to construction; covering of potential fossil sites with earth and rock

Surface Water: Flow interruption, water quality degradation, alterations to existing stream channels

Ground Water: Quality and quantity effects, aquifer disruption

Soils: Temporary increases in soil erosion, permanent soil loss, probable permanent loss of prime farmland, and changes in soil productivity

Aquatic Ecology: Some impacts to the limited fisheries and aquatic resources on-site; sedimentation of existing, mostly intermittent streams

Vegetation: Losses of established plant cover, productivity, and habitat; potential impacts to threatened and endangered plant species

Wildlife: Loss of wildlife and wildlife habitat, reduction in regional carrying capacity for deer and elk

Air Quality: Emissions of various criteria and hazardous pollutants, fugitive dust and visibility impacts, degradation of air quality

Noise: Changes to acoustic environment of plant sites and corridors from rural or rangeland to industrial

Cultural Resources: Inadvertent destruction of previously undiscovered archaeological and historic sites, unauthorized collecting of known resources

Land Use: Changes from rural or rangeland to industrial, commercial, and residential uses

Recreation and Wilderness: Increased use and possible degradation of area recreation and wilderness resources

Socioeconomics: Changes to the rural lifestyle of the area; increased social problems, traffic accidents, and similar socioeconomic effects

Visual Resources: Modification of characteristic landscape from rural or rangeland to an industrial, commercial, and residential environment; general alteration of scenic (visual) conditions in the area through reduced visibility of project facilities

Transportation: Over use of the existing road, railroad, and pipeline networks, especially during construction and early operations

Energy: Over taxing of existing energy resources and networks to construct and operate the project

4.6 Irreversible and Irretrievable Commitments of Resources

Several types of resources would be consumed, irretrievably committed, or lost as a result of project construction for either the Getty or Cities Service shale oil projects. Use of many resources is required in the extraction of raw materials in order to meet each proponent's financial and consumptive needs. Again, as one might expect, these commitments from each project are nearly identical due to the locations and the similar types of development activities.

A number of the irreversible and irretrievable commitments identified on the following pages could be minimized or mitigated by the agency regulatory actions identified in Chapter 1.0. Likewise, Getty and Cities Service may make further commitments to minimize losses which are not governed by specific agency authority. Section 4.8 presents recommended mitigation measures.

4.6.1 Getty

The irreversible and irretrievable commitments of resources from the Getty shale oil project and related development are expected to be as follows:

- Degradation of the ambient air quality, which may never be restored to its present state due to increased population
- Ground and surface water impacts which may never be reversed or corrected
- Mining of 150,000 tpd of oil shale over the 30-year project life
- Permanent subsoil and possible topsoil losses due to erosion
- Permanent loss of prime farmland
- Loss of established plant cover for corridors, plant sites, and related facilities
- Wildlife losses in terms of habitat and individuals
- Degradation of scenic (visual) quality of the area
- Loss of archaeological, historical, and paleontological resources due to accidental disturbance or mitigation activities such that the resources can never be recovered or restored to their present state
- Addition of an area (approximately 1,600 acres) of retorted shale material which would be an inferior soil parent material, and which would potentially not support plant life without amendments

4.6.2 Cities Service

The irreversible and irretrievable commitments of resources from the Cities Service shale oil project and related development are expected to be as follows:

- Degradation of ambient air quality, which may never be restored to its present state due to increased population
- Ground and surface water impacts which may never be reversed or corrected
- Mining of 135,000 tpd of oil shale at the ultimate production rate of 100,000 bpd
- Permanent subsoil losses and possible topsoil losses due to erosion
- Permanent loss of prime farmland
- Loss of established plant cover for corridors, plant sites, and related facilities
- Wildlife losses, in terms of habitat and individuals
- Degradation of scenic (visual) quality of the area
- Loss of archaeological, historical, and paleontological resources due to accidental disturbance or mitigation activities such that the resources can never be recovered or restored to their present state
- Addition of an area (approximately 1,250 acres) of retorted shale material which would be an inferior soil parent material, and which would potentially not support plant life without amendments

4.7 Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

For purposes of this section, local short-term uses of man's environment are defined as those which occur during the 12-year period 1984-1995, while long-term productivity is considered for the 40-year period 1992-2031, which includes the project life, plus 10 years, for each project. Once again, the short-term and long-term considerations are nearly identical for either the Getty or Cities Service shale oil projects.

The short-term and long-term considerations identified on the following pages and the reactions and value judgements they elicit from various individuals, groups, organizations, and agencies will be compared and weighed by the Corps in selecting the agency-preferred alternative.

4.7.1 Getty

The major short-term and long-term considerations for the Getty shale oil project are expected to be as follows.

Short-term

- Effects on local air quality and climate
- Alteration of existing surface and ground water conditions
- Effects on wildlife, vegetation, soils, and aquatic resources in the project vicinity
- Visual and noise impacts
- Cultural resources and paleontological impacts due to construction, operation, and secondary growth
- Prime farmland losses
- Land use changes
- Increased uses of area recreation and wilderness resources
- Socioeconomic impacts, local and regional
- Project uses of energy and transportation facilities

Long-term

- Productive use of oil shale deposits
- Revegetation of disturbed acreage
- Re-establishment of some wildlife habitat and populations
- Long-term effects (mostly adverse) on area air quality (due to population growth), ground and surface water resources, and terrestrial and aquatic ecology
- Increased population, with the accompanying urban amenities and disadvantages
- Loss of prime farmland
- Primary and secondary economic growth locally, regionally, and nationally
- Production of 100,000 bpd of shale oil for the 30-year project life
- Associated national security/energy independence

4.7.2 Cities Service

The major short-term and long-term considerations for the Cities Service shale oil project are expected to be as follows.

Short-term

- Effects on local air quality and climate
- Alteration of existing surface and ground water conditions
- Effects on wildlife, vegetation, soils, and aquatic resources in the project vicinity
- Visual and noise impacts
- Cultural resources and paleontological impacts due to construction, operation, and secondary growth
- Prime farmland losses
- Land use changes
- Increased uses of area recreation and wilderness resources
- Socioeconomic impacts, local and regional
- Project uses of energy and transportation facilities

Long-term

- Productive use of oil shale deposits
- Revegetation of disturbed acreage
- Re-establishment of some wildlife habitat and populations
- Long-term effects (mostly adverse) on area air quality (due to population growth), ground and surface water resources, and terrestrial and aquatic ecology
- Increased population, with the accompanying urban amenities and disadvantages
- Loss of prime farmland
- Primary and Secondary economic growth locally, regionally, and nationally
- Production of 100,000 bpd of shale oil for the 25-year project life
- Associated national security/energy independence

4.8 Mitigation

4.8.1 Introduction

Mitigation involves avoiding, minimizing, compensating, rectifying, reducing, or eliminating an adverse environmental impact (CEQ 1978). For purposes of this EIS, recommended mitigation measures are those considered by the applicant or by other agencies relative to the 404 Permit application. These measures are proposed in consideration of their economic, technical, and political feasibility. The Corps expects to receive and evaluate additional mitigation measures during the Draft EIS review and evaluation period.

Mitigation measures presented below assume, where applicable, that reclamation would occur according to current state and federal requirements. Correspondingly, all other environmental performance standards currently in place are assumed to remain.

Recommended mitigation measures are presented below for each shale oil project, by discipline.

4.8.2 Getty Project

4.8.2.1 Topography, Geology

Topographic impacts would result from the development of the mine facility, corridors, and spent shale disposal sites. Surficial disturbance in these areas can be reduced by the implementation of an applicable reclamation program. In general, this program would include re-contouring of disturbed areas to be compatible with the surrounding landscape and post-mining land use. By successfully implementing such procedures, the areas would not differ substantially from their pre-mining appearance. The exception would be the spent shale disposal sites, where steep-walled canyons would be transformed into flatter topography, similar to existing plateau areas.

Impacts to the existing geology, as a result of the Getty project, include extraction of the oil shale resource and generation of potential geologic hazards by construction of reservoir impoundments, transportation corridors, and the spent shale disposal pile. There is no proposed mitigation for oil shale extraction. Mitigation procedures for geologic hazards include proper engineering design and site maintenance.

Paleontological impacts within the project area could be significant. The geological formations outcropping in the project area have been classified as having high potential for producing scientifically significant paleontological resources. Further information is required to determine if site development would detrimentally impact any significant paleontological resources. Mitigation measures to reduce impacts to paleontological resources would include avoidance of known resource sites and, if necessary, extraction and preservation of scientifically important fossils.

4.8.2.2 Surface Water

The primary impacts to surface water system would be water quality degradation resulting from the increased total dissolved and suspended solids due to surface runoff from disturbed areas, or from leachate and accidental spillage entering stream courses. General mitigation measures for such impacts include: (1) proper routing of all surface flows around disturbed areas, (2) sedimentation ponds at points downstream of all disturbance areas to reduce dissolved and suspended solids, (3) contingency plans for handling all accidental spills, (4) use of sediment control measures where appropriate, and (5) prevention of spent shale leachate from entering surface and ground water systems.

4.8.2.3 Ground Water

The principal impact to ground water resources would be potential contamination by dissolved solids resulting from infiltration of surface runoff from disturbed areas, and generation of leachate from spent shale disposal, waste rock, and shale fines piles. To a lesser degree, uncontrolled spills associated with surface processing and transport facilities could create localized ground water impacts.

Prevention or mitigation of such impacts could be accomplished by several methods, namely:

- Design, construction, and maintenance of drainage control systems.
- Design and installation of leachate collection systems for use during and subsequent to operations, including underdrains beneath the spent shale disposal areas.
- Installation of effective liners and/or barriers for all ponds and disposal areas.
- Engineering of low angle stable slopes for spent shale disposal.
- Optimal siting of potential impact-causing facilities.
- Development of contingency plans for any accidental spills.
- Rapid, effective sequential revegetation of exposed disposal areas.

4.8.2.4 Aquatic Ecology

Impacts due to increased runoff and sedimentation, which would occur in creeks within the project area as a result of construction, would be reduced if major surface disturbances were to occur during periods of low flow and low precipitation.

Proper construction and containment techniques for the spent shale disposal areas should provide protection to surface waters from toxic leachate contaminations. The aquatic life existing in these surface waters would likewise be protected.

Specific spill cleanup plans; storage of cleanup equipment and supplies; a personnel training program; and proper pipeline design (e.g., check valves), construction, and maintenance should reduce any damage to the aquatic resources due to accidental spills.

4.8.2.5 Soils

Impacts to soils would occur as erosion losses, losses of prime farmland, changes in soil profile characteristics, and losses of soil cover and productivity. Mitigation of incremental soil loss would largely be accomplished through the reclamation plan described in Section 2.3.2. Erosional impacts not specifically addressed in this plan would include: (1) erosion of the reclaimed areas other than the spent shale disposal area (particularly steeper slopes), and (2) streambank or hillside erosion by pipelines, roads, or other types of disturbance. Other selected mitigation applicable to these soil loss impacts would include measures such as (1) reducing slope of reclaimed sideslopes, (2) revegetation, and (3) application of wind and water erosion control measures (asphalt emulsifiers, mulches netting, contour furrows, and pitting).

Compensation, such as irrigation of appropriate soils, would probably be the least costly method of mitigating prime farmland loss. Otherwise, stripping and stockpiling of soil horizons and systematic replacement may be the only method to replace prime farmland soils.

Stockpiling and replacement of available topsoil would reduce changes to soil profile characteristics; however, duration of burial should be minimized during operational phases.

4.8.2.6 Vegetation

Impacts to vegetation from construction and operation activities would include permanent loss of listed and candidate threatened or endangered plant species populations and habitat, loss of riparian habitats and wetland, and loss of rangeland and cropland productivity. Impacts to all candidate or listed threatened or endangered plant populations and their habitats should be avoided to the extent practicable. Transplanting, artificial propagation, and re-establishment of habitat for threatened or candidate plants would be relatively costly mitigation measures which are uncertain of success. However, the feasibility of such measures should be evaluated if avoidance cannot be achieved. Designation of endangered plant species habitat areas for protection is an alternative mitigation approach. Direct impacts to riparian areas could be effectively mitigated by avoidance. Since irrigated croplands are greater forage contributors than surrounding areas, avoidance of these areas would significantly reduce residual impacts on productivity. Revegetation, employing native plant materials and topsoil, would mitigate the loss of stable and productive plant communities in some areas. Permanent revegetation of processed shale areas should be attempted.

4.8.2.7 Wildlife

This section presents the mitigation strategies recommended by the USFWS to reduce, avoid, or compensate for wildlife impacts as a result of the Getty project. To date, Getty has not committed to mitigation of the wildlife impacts discussed in Section 4.2.7.

Siting options for major facilities and within corridors should be exercised to the fullest extent feasible to maintain sensitive wildlife habitats and other important areas of wildlife use, including movement corridors. The following mitigation strategies should be adopted to avoid or compensate for habitat destruction as a result of the Getty project.

- Avoid all Category 1 habitats through construction siting.
- Mitigate for loss of approximately 982 acres of Category 2 habitats/ranges. The USFWS mitigation policy directs that mitigation of such impacts be accomplished such that no net loss of in-kind wildlife/habitat value is realized. Although no recommended commitment to required mitigation acreages is presented here, it should be recognized that, based on available information, 3-5 times the number of impacted acres may need to be acquired and/or enhanced to offset project impacts. New enhancement technologies in effect at the time of project develpoment may change the amount of required mitigation acres.
- Mitigate for loss of 860 acres of Category 3 habitats/ranges. The USFWS mitigation policy directs that mitigation of such impacts be accomplished such that no loss of relative habitat value occurs. In-kind loss of habitats are to be minimized. No required mitigation acreages are presented; however, it should be recognized that acquired and/or enhanced lands needed to offset project impacts may be from 2 to 3 times the amount of actual impacted acreage.

Riparian, wetland, and aquatic habitats could be maintained or enhanced through use of siting options. Wildlife use of the reservoir areas could be enhanced through construction of islands and nest structures for waterfowl and revegetation of adjacent reservoir lands and shallows. In conjunction with this, a reservoir management plan could also be implemented which would assure water levels conducive to nesting.

Activity buffer zones of at least 0.5 miles should be established for sage grouse leks and raptor nest sites to minimize disturbance during critical periods. Initial construction could also be timed to avoid critical nesting (raptors and sage grouse) and concentration (big game) periods. No "take" of raptors or raptor nests should occur except as specifically permitted by USFWS and CDOW. Construction on big game winter range should be avoided during December - April, and during May - July on spring ranges. A wildlife monitoring program should be developed in consultation with USFWS and CDOW to include such studies as habitat condition and trend, big game population distribution and movements, nesting raptor distribution and status, small game populations, or other wildlife monitoring work as appropriate.

Effective wildlife mitigation features could be incorporated into the project design: install electrocution-proof transmission lines, minimize fencing to hazardous areas only, use of underpasses and one-way deer gates where existing deer movement corridors transect proposed roads, and reseed roadway shoulders and borrow ditches with unpalatable vegetation. Water retention reservoirs downstream from the shale disposal area should be fenced to keep out wildlife and safeguards should be taken to prevent accidental discharge from the reservoirs.

Roadkill losses could be minimized through use of mass transportation (e.g., railroad) of workers and strict control of vehicle speeds to 30 mph, particularly at big game crossing areas. The best technology available should be employed to minimize big game roadkills or rail casualties if kill frequency exceeds 10 big game per mile per year.

A company firearm policy should be implemented to curb employee possession of weapons while at work and while commuting to and from the project site. A wildlife protection-education program should be promoted as a part of employee orientation. In addition, public access to portions of the project area should be controlled.

Reclamation for wildlife should be a principal priority in the final decommissioning of the project. Hence, all disturbed lands, except along roadways, should be revegetated with mixtures favorable to wildlife.

During the construction and operational phases of the project, off-site habitat enhancement measures including chaining, brush beating, clear cutting and selective thinning of forest stands, nitrogen fertilization, and adjustment of grazing pressures could be undertaken to mitigate lost big game carrying capacity. The value of affected areas following project closure and subsequent reclamation would depend on restoration of existing patterns of topographic and vegetational diversity, habitat interspersion, and sources of free water.

Getty should contribute to development of a regional wildlife management plan as mitigation for required and cumulative impacts.

4.8.2.8 Air Quality

Mitigation measures for air quality impacts include various types of process design, attention to operation schedules (including equipment use, road paving, and watering), and fixed controls equipment (e.g., desulfurization and baghouses). A certain level of control is included in the emission calculations used for the impact analyses. The fixed control design will be specified in required air quality state and federal permits.

4.8.2.9 Noise

Mitigation measures for noise impacts include attention to equipment selection, design, and operation schedules, and increased adsorbers or deflectors such as noise fences or increased vegetation. Some level of noise control is assumed in the sound pressure levels used in the impact analyses. Due to the lack of significant receptors near the project site, these controls should be adequate for the project area. For transporation corridors, some sensitive receptors will experience moderately adverse impacts attributed to increased traffic/railroad sources. Should this issue be judged significant, increased shielding between existing receptors coupled with limiting activities to daylight hours could reduce predicted impacts further.

4.8.2.10 Cultural Resources

Cultural resource mitigation would involve implementation of cultural resources surveys, as necessary, in advance of construction activities. Getty would be required to consult with the Colorado State Historic Preservation Officer and the Advisory Council on Historic Preservation concerning possible mitigation measures for sites on public lands eligible for the National Register of Historic Places. Types of mitigation would include excavation and analysis, avoidance of disturbance, and recording through photographs, drawings, or collection prior to disturbance.

4.8.2.11 Land Use, Recreation, and Wilderness

Because the primary and secondary land use impacts resulting from development of the Getty project would be to rangeland, and, to a lesser degree, agricultural productivity (Section 4.1.11), efforts should be made to accommodate the needs of local ranchers and farmers to the extent possible. Alternate rangeland areas and livestock drive trails could be needed. The project proponent should assist in the development of strict land use planning and control at the local level. As noted in Ferraro and Nazaryk (1983), economic incentives to farmers to maintain existing land use should be encouraged. With increased recreational pressure resulting from population growth, municipalities should be assisted in the development of recreational facilities. Restriction of access to recreation and wilderness areas may be required to minimize degradation from overuse.

4.8.2.12 Visual Resources

Facilities and corridors would alter the character of the local landscape by introducing changes in the natural form, line, color, and texture. Form impacts can be reduced in some areas through design and siting, but for the most part cannot be mitigated. Reclamation of disturbed areas would reduce and, in some cases, eliminate color impacts. Line impacts within corridors could be reduced by constructing corridors to complement existing landscape line; if reclamation is successful, little or no line impact would remain. Mitigation of texture impacts would depend on the success of reclamation efforts.

4.8.2.13 Socioeconomics

Socioeconomic mitigation for the Getty project includes two major strategies: the single-status camp for nonlocal workers, and the allocation of workers to residential locations that could best accommodate them. The general approach to socioeconomic mitigation is outlined below. Getty intends to base its implementation of specific mitigation measures on the results of a monitoring program and negotiations with local government officials at the time of project development. However, the following statements have been made by Getty at this time:

> "Getty believes that growth resulting from its shale oil project would generate adequate revenues to pay its own way and proposes to work with local governments to identify policies which would enable this to happen."
>
> "Getty believes that government has the responsibility to provide public services and facilities to both new and existing residents but also recognizes that its project-related growth could aggravate the problems of providing these services and facilities in a timely fashion. Getty proposes to work cooperatively with government officials to help ensure that financing would be available to meet these needs."
>
> "Getty proposes to continue its historic cooperation with the Cumulative Impact Task Force (CITF) and local government agencies."
>
> "Getty proposes to emphasize quality in all aspects of its mitigation efforts. In particular, through incentives offered to private developers, quality in design of housing and residential development would be stressed, so that desirable and enjoyable living environments are created for new and established residents alike."
>
> "Getty believes that emphasis should be placed on balancing population growth with the tax base. Those areas with a substantial sales or property tax base would be best equipped to respond to growth. As appropriate, Getty proposes to work cooperatively with government officials to ensure that adequate financing would be available at the front end to provide necessary services and facilities."
>
> "Getty realizes that the analysis of the socioeconomic assessment will result in estimates of potential impacts. However, in order to ensure that the impacts reflect actual conditions, Getty proposes to develop a monitoring program in conjunction with local governments and agencies."
>
> "Getty's mitigation efforts would place emphasis on providing technical assistance to local governments to increase their capability to manage growth. Getty proposes to work with local government and entities to identify impacts attributable to its shale oil project and possible solutions."
>
> "Getty proposes to provide regular employment estimates and updated scheduling information and would also provide information to new employees concerning the availability of housing and public services."
>
> "Getty proposes to encourage employees to locate in communities with current or planned infrastructure capacity to absorb new growth. This could require various types of incentive programs to ensure the timely availability of housing in certain communities. This would allow growth without exceeding the capacity threshold of their public facilities."
>
> "A key factor considered in determining the spatial allocation has been the desire by Getty to minimize the number of affected communities. Getty can thereby target its mitigation efforts and develop more comprehensive effective strategies rather than diluting its efforts over numerous communities. De Beque has been identified as the area where Getty's growth and mitigation efforts would be concentrated."

"Getty is aware that some infusion of capital into local financial institutions could be needed so that private capital construction such as housing and commercial development could occur. Similarly, in order to achieve its spatial allocation goals, Getty would use incentives both for the housing industry and for employees."

"Getty recognizes that the delays and uncertainties associated with the shale industry could make it more difficult to use traditional financing mechanisms, such as bonding, for public facilities. These could also inhibit the private sector from building housing on a speculative basis. Getty recognizes this problem and would make the necessary commitments or guarantees to ensure that adequate facilities and services would be in place in time to serve the new population."

4.8.2.14 Transportation

Mitigation measures to reduce impacts to the transportation network would include road construction and improvements, land use planning, implementation of a mass transit system, and shift scheduling. Road improvements would include work on the Roan Creek road and other roads as necessary. Road improvement plans could be developed in cooperation with government entities. Planning efforts could be implemented (with local government) to accommodate necessary railroad facilities and transhipment activities. Additionally, if a bypass around De Beque to connect to I-70 becomes necessary, planning efforts could be undertaken in conjunction with De Beque authorities. A bus system or alternative mass transportation system could reduce the effects of the workforce on roadways. The system could have pickup points in both counties. Varying shift schedules could also minimize conflicts with other traffic using the regional transportation system.

4.8.2.15 Energy

Mitigation for energy impacts include energy conservation, co-generation, and construction of other energy sources within and outside of the region. Energy conservation measures have been, to a great extent, included within the project description. Cogeneration is an alternative considered by Getty, which would reduce the need for importing power from existing sources. Retorting of the shale fines and burning of the carbon off the Union B spent shale would improve the overall energy balance of the project.

4.8.3 Cities Service Project

4.8.3.1 Topography, Geology

Topographic impacts would result from the development of the mine facility, corridors, shale fines stockpile, waste rock pile and spent shale disposal sites. Surficial disturbance in these areas could be reduced by the implementation of an applicable reclamation program. In general, this program would include re-contouring of disturbed areas to a shape compatible with the surrounding topography and proposed post-mining land use. Implementation of these procedures would return the disturbed areas to their general pre-development appearance and limit erosion. The exception would be the spent shale disposal sites, where steep-walled canyons would be transformed into flatter topography, similar to existing plateau areas.

Impacts to the existing geology, as a result of the Cities Service project, would include the extraction of the oil shale resource and the generation of potential geologic hazards related to site construction, reservoir impoundments, transportation corridors, shale fines stockpile, waste rock stockpile, and the spent shale disposal pile. There is no mitigation for oil shale extraction. Mitigation procedures for geologic hazards include proper engineering design and site maintenance.

Paleontological impacts within the project area could be significant. The geological formations outcropping in the project area have been classified as having high potential for producing scientifically significant paleontological resources. Further information is required to determine if site development would detrimentally impact any significant paleontological resources. Mitigation measures to reduce impacts to paleontological resources would include avoidance of known resource sites and, if necessary, extraction and preservation of scientifically important fossils.

4.8.3.2 Surface Water

The primary impacts to surface water would be water quality degradation resulting from increased total dissolved and suspended solids (due to surface runoff from disturbed areas) or from leachate and accidental spillage entering stream courses. General mitigation measures for such impacts include: (1) proper routing of all surface flows around disturbed areas, (2) sedimentation ponds at points downstream of all disturbance areas to reduce total dissolved and suspended solids, (3) contingency plans for handling all accidental spills, (4) use of sediment control measures where appropriate, and (5) prevention of spent shale leachate from entering surface and ground water systems.

4.8.3.3 Ground Water

The principal impact to ground water resources would be potential contamination by dissolved solids resulting from infiltration of surface runoff from disturbed areas, and generation of leachate from spent shale disposal, waste rock, and shale fines piles should it bypass the control system. To a lesser degree, uncontrolled spills associated with surface processing and transport facilities could create localized ground water impacts.

Prevention or mitigation of such impacts may be accomplished by several methods, namely:

- Design, construction, and maintenance of drainage control systems.
- Design and installation of leachate collection systems for use during and subsequent to operations, including underdrains beneath the spent shale disposal areas.
- Installation of effective liners/barriers for all ponds and disposal areas.
- Engineering of low angle stable slopes for spent shale disposal.
- Optimal siting of potential impact-causing facilities.
- Development of contingency plans for any accidental spills.
- Rapid, effective sequential revegetation of exposed disposal areas.

4.8.3.4 Aquatic Ecology

Impacts due to increased runoff and sedimentation, which would occur in creeks within the project area as a result of construction, would be reduced if major surface disturbances were to occur during periods of low flow and low precipitation.

Proper construction and containment techniques for the spent shale disposal areas should provide protection to surface waters from toxic leachate contaminations. The aquatic life existing in these surface waters would likewise be protected.

Specific spill cleanup plans; storage of cleanup equipment and supplies; a personnel training program; and proper pipeline design (e.g. check valves), construction, and maintenance should reduce any damage to the aquatic resources due to accidental spills.

4.8.3.5 Soils

Impacts to soils would occur as erosion losses, losses of prime farmland, changes in soil profile characteristics, and losses of soil cover and productivity. Mitigation of incremental soil loss would largely be accomplished through the reclamation plan described in Section 2.3.2. Erosional impacts not specifically covered in this plan would include: (1) erosion of the reclaimed areas other than the spent shale disposal area (particularly steeper slopes), and (2) streambank or hillside erosion by pipelines, roads, or other types of disturbance.

Other selected mitigation applicable to these soil loss impacts would include monitoring of development activities and implementation of mitigation measures such as (1) reducing slope of reclaimed sideslopes, (2) revegetation, and (3) application of wind and water erosion control measures (asphalt emulsifiers, mulches, netting, contour furrows, and pitting). Compensation, such as bringing irrigation water to the appropriate soils, would probably be the least costly method of mitigating prime farmland losses. Otherwise, stripping and stockpiling of soil horizons and subsequent systematic replacement may be the only method to replace prime farmland soils.

Stockpiling and replacement of available cover soil would reduce changes to soil profile characteristics; however, duration of burial should be minimized during operational phases.

4.8.3.6 Vegetation

Impacts to vegetation from construction and operation activities would include permanent loss of listed and candidate threatened or endangered plant species populations and habitat, loss of riparian habitats and wetland, and loss of rangeland and cropland productivity. Impacts to all candidate and listed threatened or endangered plant populations and their habitats should be avoided to the extent practicable. Transplanting, artificial propagation, and re-establishment of habitat for threatened or endangered plants would be relatively costly mitigation measures which are uncertain of success. However, the feasibility of such measures should be evaluated if avoidance cannot be achieved. Designation of habitat areas for endangered plant protection is an alternative mitigation approach. Direct impacts to riparian areas could be effectively mitigated by avoidance. Since irrigated croplands are much more productive of forage than surrounding areas, avoidance of these areas would reduce impacts on productivity. Revegetation employing native plant materials and topsoil would mitigate the loss of stable and productive plant communities. Permanent processed shale revegetation should be attempted.

4.8.3.7 Wildlife

This section presents the mitigation strategies recommended by the USFWS to reduce, avoid, or compensate for wildlife impacts as a result of the Cities Service project. To date, Cities Service has not committed to mitigation of the wildlife impacts discussed in Section 4.3.7.

Siting options for major facilties and within corridors should be exercised to the fullest extent feasible to maintain sensitive wildlife habitats and other important areas of wildlife use, including movement corridors. The following mitigation strategies should be adopted to avoid or compensate for habitat destruction as a result of the Cities Service project:

- Avoid all Category 1 habitats through construction siting.
- Mitigate for loss of approxmiately 680 acres of Category 2 habitats/ranges. The USFWS mitigation policy directs that mitigation of such impacts be accomplished such that no net loss of in-kind wildlife/habitat value is realized. Although no recommended commitment to required mitigation acreages is presented here, it should be recognized that, based on available information, 3-5 times the number of impacted acres may need to be acquired and/or enhanced to offset project impacts. New enhancement technologies in effect at the time of project development may change the amount of required mitigation acres.
- Mitigate for loss of 1,736 acres of Category 3 habitats/ranges. The USFWS mitigation policy directs that mitigation of such impacts be accomplished such that no loss of relative habitat value occurs. In-kind loss of habitats are to be minimized. No required mitigation acreages are presented; however, it should be recognized that acquired and enhanced, or enhanced lands needed to offset project impacts may be from 2 to 3 times the amount of actual impacted acreage.

Riparian, wetland, and aquatic habitats could be maintained or enhanced through use of siting options. Activity buffer zones of at least 0.5 miles should be established for sage grouse leks and raptor nest sites to minimize disturbance during critical periods. Initial construction could also be timed to avoid critical nesting (raptors and sage grouse) and concentration (big game) periods. Not "take" of raptors or raptor nests should occur except as specifically permitted by USFWS and CDOW. Construction on big game winter range should be avoided during the periods December to April, and during May to July on spring ranges. A wildlife monitoring program should be developed in consultation with USFWS and CDOW to include such studies as habitat condition and trend, big game population distribution and movements, nesting raptor distribution and status, small game populations, or other wildlife monitoring work as appropriate.

Effective wildlife mitigation features could be incorporated into the project design: install electrocution-proof transmission lines; minimize fencing to hazardous areas only; use underpasses and one-way deer gates where existing deer movement corridors transect proposed roads; and reseed roadway shoulders and borrow ditches with unpalatable vegetation. Water retention reservoirs downstream from the shale disposal area should be fenced to keep out wildlife, and safeguards should be taken to prevent accidental discharge from the reservoirs. Road kill losses could be minimized through use of mass transportation (i.e., railroad) of workers and strict control of vehicle speeds to 30 mph, particularly at big game crossing areas. The best technology available should be employed to minimize big game roadkills or rail casualties if kill frequency exceeds 10 big game per mile per year.

A company firearm policy should be implemented to curb employee possession of weapons while at work and while commuting to and from the project site. A wildlife protection-education program should be promoted as a part of employee orientation. In addition, public access to portions of the project area should be controlled.

Reclamation for wildlife should be a principal priority in the final decommissioning of the project. Hence, all disturbed lands, except along roadways, should be revegetated with mixtures favorable to wildlife.

During the construction and operational phases of the project, off-site habitat enhancement measures including chaining, brush beating, clear cutting and selective thinning of forest stands, nitrogen fertilization, and adjustment of grazing pressures could be undertaken to mitigate lost big game carrying capacity. The value of affected areas following project closure and subsequent reclamation would depend on restoration of existing patterns of topographic and vegetational diversity, habitat interspersion, and sources of free water.

Cities Service should contribute to development of a regional wildlife management plan as mitigation for regional and cumulative impacts.

4.8.3.8 Air Quality

Mitigation measures for air quality impacts include various types of process design, attention to operations schedules (including equipment use, road paving, and watering), and fixed control equipment (desulfurization and baghouses). A certain level of control is included in the emission calculations used for the impact analyses. The fixed control design will be specified in required air quality state and federal permits.

4.8.3.9 Noise

For noise impacts, mitigation measures include equipment selection and design, operation schedules, and increased adsorbers or deflectors such as noise fences or increased vegetation. Some level of noise control is assumed in the sound pressure levels used in the impact analyses. Due to the lack of significant receptors near the project site, these controls should be adequate for the project area. For transporation corridors, some sensitive receptors would experience moderately adverse impacts attributed to increased traffic sources. Should this issue be judged significant, increased shielding between existing receptors coupled with limiting activities to daylight hours could reduce predicted impacts further.

4.8.3.10 Cultural Resources

Cultural resource mitigation would involve implementation of cultural resources surveys, as necessary, in advance of construction activities. Cities Service would be required to consult with the Colorado State Historic Preservation Officer and the Advisory Council on Historic Preservation concerning possible mitigation measures for sites on public lands eligible for the National Register of Historic Places. Types of mitigation would include excavation and analysis, avoidance of disturbance, and recording through photographs, drawings, or collection prior to disturbance.

4.8.3.11 Land Use, Recreation, and Wilderness

Because the primary and secondary land use impacts resulting from development of the Cities Service project would be to rangeland, and, to a lesser degree, agricultural productivity (Section 4.1.11), efforts should be made to accommodate the needs of local ranchers and farmers to the extent possible. Alternate rangeland areas and livestock drive trails may be needed. The project proponent should assist in the development of strict land use planning and control at the local level. As noted in Ferraro and Nazaryk (1983), economic incentives to farmers to maintain existing land use should be encouraged. With increased recreational pressure resulting from population growth, municipalities should be assisted in the development of recreational facilities. Restriction of access to recreation and wilderness areas may be required to minimize degradation from overuse.

4.8.3.12 Visual Resources

Facilities and corridors would alter the character of the local landscape by introducing changes in the natural form, line, color, and texture. Form impacts could be reduced in some areas through design and siting, but for the most part the impacts cannot be mitigated. Reclamation of disturbed areas would reduce and, in some cases, eliminate color impacts. Line impacts within corridors could be reduced by constructing corridors to complement existing landscape line; if reclamation is successful, little or no line impact would remain. Mitigation of texture impacts would depend on the success of reclamation efforts.

4.8.3.13 Socioeconomics

The socioeconomic mitigation for the Cities Service project assumes two major strategies: provision of single-status camp for nonlocal workers and the encouragement of workers to reside in locations that could best accommodate them. The general approach to socioeconomic mitigation is outlined below. Cities Service intends to base its implementation of specific mitigation measures on the results of a monitoring program and negotiations with local government officials at the time of project development.

Cities Service's current socioeconomic planning philosophy favors controlled growth of existing communities, while supporting government in its role of providing existing and new residents with public services. When development of Cities Service's venture adversely affects government's ability to provide these services in a timely manner, Cities Service will work cooperatively with government to identify and help implement workable solutions.

Cities Service's approach to mitigating social and economic impacts of its venture is outlined below. Actual mitigation measures will be based on discussions with local officials at the time of seeking permits, prior to project development.

"Cities Service believes, that over the long term, revenues accruing to impacted communities directly and indirectly from Cities Service's shale venture will be more than adequate to meet growth needs resulting from development of that venture. Cities Service recognizes, however, that demands for increased human and social services will precede the onset of project related revenues. At the time of project-development, Cities Service proposes to work cooperatively with government officials to seek means of providing front-end funds to meet these needs."

"Cities Service proposes to provide local governments with technical assistance, as required, to identify impacts resulting from its shale venture and develop possible approaches to mitigate these impacts."

"Prior to the onset of construction, Cities Service envisions construction of a camp and it proposes to work with local officials to secure offsite housing to meet the temporary needs of the construction workforce. Cities Service's experience at Syncrude Canada Ltd. has shown the merits of a camp during initial construction. The camp has now been modified to better handle temporary employee needs during shutdowns for maintenance. However, construction labor housing strategies will be firmed up in cooperation with local officials at the appropriate time."

"Cities Service proposes to encourage employees to locate in areas having the best capacity to absorb growth without overwhelming their infrastructure and public service facilities."

"Cities Service recognizes that in order for housing and commercial development to precede new Cities Service's shale venture employees, local financial institutions may need some capital inflows. Cities Service proposes to work cooperatively with local government and financial sectors to assist in seeking means to provide such needed capital."

"Socioeconomic impacts of the proposed Cities Service shale oil venture are being estimated, and mitigation measures will be formulated to reduce adverse growth effects. In order to ensure that impacts and mitigation measures reflect actual conditions, Cities Service will cooperate with local governments and agencies in monitoring socioeconomic factors."

"Cities Service will maintain contact with appropriate local officials to provide them with updated employment estimates and scheduling information as necessary to meet mitigation objectives."

4.8.3.14 Transportation

Mitigation measures to reduce impacts to the transportation network would include road construction and improvements, land use planning, implementation of a mass transit system, and shift scheduling. Road improvements would include work on the Roan Creek road and other roads as necessary. Road improvement plans would be developed in cooperation with government entities. Planning efforts could be implemented (with local government) to accommodate necessary railroad facilities and transhipment activities. Additionally, if a bypass around De Beque to connect to I-70 becomes necessary, planning efforts could be undertaken in conjunction with De Beque authorities. A bus system or alternative mass transportation system could reduce the effects of the workforce on roadways. The system could have pickup points in both counties. Varying shift schedules could also minimize conflicts with other traffic using the regional transportation system.

4.8.3.15 Energy

Mitigation for energy impacts include energy conservation, cogeneration, and construction of other energy sources within and outside of the project region. Energy conservation measures have been, to a great extent, included within the project description. Cogeneration is an alternative considered by Cities Service which would reduce the need for importing power from existing sources. Retorting of the shale fines and burning of the carbon off the Union B spent shale would improve the overall energy balance.

5.0

Consultation and Coordination

5.0 CONSULTATION AND COORDINATION

The U.S. Army Corps of Engineers, Sacramento District, is the designated lead federal agency for this EIS. The U.S. Bureau of Land Management, U.S. Environmental Protection Agency, and U.S. Fish and Wildlife Service are cooperating federal agencies. Other agencies, as noted below, are responsible for reviewing the DEIS, and providing the Corps with their evaluations and comments.

Federal Agencies

U.S. Army Corps of Engineers—Sacramento (California) Office
U.S. Bureau of Land Management—Colorado State Office
U.S. Environmental Protection Agency–Region VIII, Denver
U.S. Fish and Wildlife Service—Salt Lake City
U.S. Forest Service—Denver
U.S. National Park Service—Denver
U.S. Bureau of Mines—Denver

State Agencies

Department of Natural Resources
Mined Land Reclamation Board
Geological Survey
Division of Water Resources
Water Conservation Board
Department of Health
Department of Highways
Division of Wildlife
State Historic Preservation Office
Department of Agriculture
Department of Local Affairs
Public Utilities Commission

County Agencies

Garfield County—Garfield County Planning Department
Mesa County—Mesa County Planning Department

Other Agencies

Northwest Council of Governments
Town of De Beque

6.0

List of Preparers

6.0 LIST OF PREPARERS

This EIS for the Getty and Cities Service shale oil projects was written and produced by Camp Dresser & McKee Inc. under the technical direction of the U.S. Army Corps of Engineers, Sacramento District Office (California). Corps, CDM, and CDM subcontractor (Mountain West Research-Southwest and Western Cultural Resource Management) personnel involved in the production of the EIS, their qualifications, and responsibilities are presented below.

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Qualifications - B.A. Biology
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Responsibilities - Coordination of total EIS effort

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4 years with Colorado Land Use Commission and Department of Natural Resources
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7.0

Glossary

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7.0 GLOSSARY OF TERMS

Aboriginal - Relating to the first human group present in a region, and one which is often primitive in comparison with more advanced types.

Air Quality Related Values - Values which must be considered by the federal land manager in reviewing new pollution sources in Class I areas. Adverse impacts to visibility and those caused by acid deposition are among those addressed.

Alluvial Aquifer - An aquifer that is contained in alluvial materials (alluvium) and is recharged by surface water flows.

Alluvium - A general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during comparatively recent geological time by a stream or other body of running water as a sorted or semi-sorted sediment in the bed of a stream.

Animal Unit Month - The amount of forage that a cow and a calf (6 months of age and under) would consume in 1 month. This unit is used to calculate carrying capacity and serves as a basis for grazing fees.

Aquifer - A water-bearing statum of permeable rock, sand, or gravel.

Artifact - Any man-made object of common use that reflects the skills of man in past cultures.

Bedrock Aquifer - Ground water that is contained in porous or fractured bedrock.

Benthic Invertebrate - An invertebrate (primarily insects and worm-like organisms) that dwells on the bottom of aquatic environments for a portion of or its entire life cycle.

Breccia - A coarse-grained rock held together by a mineral cement in a fine-gravel matrix.

Category 1 Species - Include over 1,800 plants for which the U.S. Fish and Wildlife Service presently has sufficient information on hand to biologically support their listing as Endangered or Threatened species.

Category 2 Species - Include nearly 1,200 plants for which information now in the possession of the U.S. Fish and Wildlife Service indicates the probable appropriateness of listing as Endangered or Threatened species, but for which sufficient information is not presently available to biologically support a proposed rule. Further field study and biological research (in some cases including taxonomic research) will usually be necessary to determine the status of the taxa included in this category.

Category 3 Species - Include nearly 800 plants no longer being considered for listing as Endangered or Threatened species.

Class 1 Cold Water Aquatic Life - Waters which provide, or could provide, a habitat consisting of water quality levels and other considerations such as flow and streambed characteristics which do or could protect and maintain a wide variety of cold water biota, including sensitive species. Cold water biota are considered to be life forms, including trout, in water where temperatures do not normally exceed 20°C. If there are limitations to the potential variety of life forms, they are due primarily to uncorrectable water quality conditions.

Class 1 Warm Water Aquatic Life - Waters which provide, or could provide, a habitat consisting of water quality levels and other considerations such as flow and streambed characteristics which do or could protect and maintain a wide variety of warm water biota, including sensitive species. Warm water biota are considered to be the life forms in waters with temperatures frequently exceeding 20°C. If there are limitations to the potential variety of life forms, they are due primarily to uncorrectable water quality conditions.

Class 1b Paleontological Resource - Areas of high potential for producing scientifically significant fossils.

Class 2 Cold and Warm Water Aquatic Life - Waters where the potential variety of life forms is presently limited primarily by flow and streambed characteristics.

Colorado Category I (Air Quality) - A State of Colorado designated air quality area that is equivalent to a PSD Class I area for SO_2 only.

Conductivity - The quality or power of conducting or transmitting electricity. As a measure of water quality, conductivity is a measurement of ionic concentrations (and therefore salt concentrations) occurring in a water sample.

Criteria Pollutants - The criteria pollutants are sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), lead (Pb), carbon monoxide (CO), total suspended particulates (TSP), and hydrocarbons. The EPA has promulgated standards for these pollutants for the purpose of protecting health.

Critical Habitat - A designation which may be applied to any biological feature mapped for a species, thus indicating that within a given DAU, loss of that biological feature would adversely affect that species. Mapping any geological feature does not arbitrarily classify that feature as "critical".

Cultural Modification - Any man-caused change in landform, water, vegetation pattern, or landscape color, either through land management practice or addition of a structure, which creates a visual contrast in the basic elements (form, line, color, texture) of the naturalistic character of a landscape.

Cumulative Impact Task Force (CITF) - A cooperative venture of state and local governments and industry to develop tools to assess potential social and economic impacts from major developments in northwestern Colorado.

DAU (Data Analysis Unit) - Unit used for data analysis and mapping purposes by the federal and state wildlife agencies.

Dendritic Pattern - A drainage pattern in which the streams branch randomly in all directions at almost any angle, resembling in habit the branching patterns of certain trees.

Endangered Species - Any species which is in danger of extinction throughout all or a significant portion of its range.

Eolian - Pertaining to the wind; especially said of deposits such as loam and dune sand, of sedimentary structures such as wind-formed ripple marks, or of erosion and deposition accomplished by the wind.

Eyrie - The nest of a bird of prey (raptor).

Facies - The aspect, appearance, and characteristics of a rock unit, usually reflecting conditions of its origin.

Fluvial - Of or pertaining to a river or stream; a sedimentary deposit consisting of materials transported by, suspended in, or laid down by a stream.

Hydrostratigraphic Unit - A body of rock having considerable lateral extent and composition forming a geologic framework for a reasonably distinct hydrologic system.

Lacustrine - Pertaining to, produced by, formed in, or deposited in a lake.

Latilong - An areal unit or block in a plotting system based on latitude and longitude which is used to describe the distribution of wildlife species in a large geographic area, e.g., a state. The State of Colorado is divided into 28 latilong blocks. The Getty and Cities Service project areas fall within block number 8, "Grand Junction".

Leachate - A solution containing soluble substances obtained by percolation of a liquid through a medium containing amounts of the soluble substance.

Lek - An area where grouse carry on display and courtship behavior during the breeding season.

Lineament - A topographic feature (e.g., fault) of regional extent that is believed to reflect a crustal structure.

Lithic Scatter - Pertaining to materials resulting from the manufacturing of stone tools and weapons by early mankind.

Lithology - The description of rocks, especially in hand specimen and in outcrop, on the basis of such characteristics as color, mineralogic composition, and grain size.

Non-Attainment Area - An area in which air quality standards for any of the criteria pollutants are violated due to emissions from industrial, domestic, or mobile sources.

Prime Farmland - Land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is available for these uses. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air, are not excessively erodible or saturated with water for a long period of time, and either do not flood frequently or are protected from flooding. Prime farmlands are determined by criteria established by the U.S. Soil Conservation Service.

PSD Class I - An area designated by the Clean Air Act as part of the new source review process for the purpose of limiting emission sources to protect air quality. PSD Class I primarily pertains to Wilderness Areas.

PSD Class II - An area designated by the Clean Air Act as part of the new source review process for the purpose of limiting emission sources to protect air quality. PSD Class II primarily pertains to nonurban areas exclusive of wilderness.

Riparian - Pertaining to or situated on the bank of a body of water, especially of a watercourse such as a river.

Scenic Quality - The degree of harmony, contrast, and variety within a landscape that makes the landscape either pleasing or unattractive to the viewer.

Sensitive Habitat - A habitat which provides nesting, foraging, and other seasonal requirements for important wildlife species and therefore represents an area of high sensitivity to disturbance.

Sour Water - Water containing significant fractions of sulfur compounds.

Stratigraphy - The science of rock strata (layers), primarily dealing with the origin, composition, distribution, and succession of strata.

Synoptic - Relating to atmospheric or weather conditions that exist over a broad area.

Transmissivity - The rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

Threatened Species - Any species which is likely to become an endangered species within the forseeable future due to declining populations or degrading habitat.

Unconsolidated Deposit - A sediment that is loosely arranged or unstratified, or whose particles are not cemented together, occuring either at surface or at depth.

Universal Soil Loss Equation - A quantitative means of predicting soil loss from sheet and rill erosion as a result of rainfall.

Visual Sensitivity - The sensitivity of a landscape to visual change based on the numbers of viewers or the type of observation by the general public on a landscape.

Winter Concentration Area - That part of the winter range of a species where densities are X% higher (defined for each DAU) than the surrounding winter range density during the same period used to define winter range, in the average five winters of ten.

Winter Range - That part of the home range of a species where 90 percent of the individuals are located during a site-specific period of winter during the average five winters of ten (this period is to be defined by the fieldmen for each DAU).

Worst-Case Meteorology - Meteorological conditions not conducive to good atmospheric dispersion, resulting in the predicted highest concentrations of pollutants.

8.0

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Appendix

APPENDIX A

AIR QUALITY TECHNICAL APPENDIX

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AIR QUALITY TECHNICAL APPENDIX

A.1.0 INTRODUCTION

This appendix documents the analyses of air quality impact studies of the Getty and Cities Service proposed shale oil developments in northwestern Colorado. These studies were performed by Camp Dresser & McKee Inc. (CDM) for the U.S. Army Corps of Engineers. The primary objective of the studies were to evaluate the air quality impacts and associated related values at or near the projects' boundaries, and in the nearby sensitive PSD Class I Areas (Flat Tops Wilderness, Black Canyon of Gunnison Wilderness, West Elks Wilderness, and Arches National Monument), the Colorado Category I areas (Colorado National Monument and Dinosaur National Monument), and the Mesa County TSP nonattainment area.

The analyses included the predicted air quality impacts for the proposed actions and viable alternatives. For the Getty oil shale project, these alternatives include:

- o 100,000-bpd production Union B retort technology
- o 50,000-bpd production Union B retort technology
- o 100,000-bpd production Lurgi retort technology
- o 50,000-bpd production Lurgi retort technology

In addition to the above four primary alternatives, two sub-alternatives were evaluated. These sub-alternatives can be added to any of the four primary alternatives.

- o Cogeneration
- o Spent shale disposal in Tom, Buck, and/or Doe gulches

Air quality impacts for the project configuration considered for the Cities Service shale oil project include the following:

- 100,000-bpd production - 90,000-bpd Union B and 10,000-bpd VMIS retort technology
- 50,000-bpd production - 40,000-bpd Union B and 10,000-bpd VMIS retort technology
- 100,000-bpd production - 90,000-bpd Lurgi and 10,000-bpd VMIS retort technology
- 50,000-bpd production - 40,000-bpd Lurgi and 10,000-bpd VMIS retort technology
- 100,000-bpd production Union B retort technology
- 50,000-bpd production Union B retort technology
- 100,000-bpd production Lurgi retort technology
- 50,000-bpd production Lurgi retort technology
- 100,000-bpd production additional retort, no fines stockpile
- 50,000-bpd production additional retort, no fines stockpile

In addition to the ten primary alternatives, two sub-alternatives were evaluated. Either of these sub-alternatives could represent added facilities to any of the ten primary alternatives.

- Alternate spent shale disposal sites
- Cogeneration

The following sections discuss the methodology used to predict the air quality impacts of the above project configurations.

A.2.0 INPUT DATA BASE

A.2.1 METEOROLOGICAL DATA BASE

The modeling studies performed to evaluate potential air quality effects of emission sources from the Getty and Cities Service shale oil projects required the preparation of data sets consisting of specific meteorological information for use as input to the dispersion models. Two meteorological monitoring sites were considered representative of the Getty and Cities

Service shale oil project areas. A 9-month data set collected from 1 November 1982 through 31 July 1983 from the Pacific project 60-m tower mesa site (CDM 1983f,g,h), located on the mesa above Deer Park Gulch. The data set was considered more representative of the worst-case meteorology for short-term air quality impacts due to its close proximity to the project areas. Because this data set does not comprise a full year of meteorological data, the Chevron Clear Creek mesa 60-m tower data was utilized to predict the annual air quality impacts.

Due to the multi-level meteorological data set made available as a result of the Pacific and Chevron projects, it was possible to develop separate data sets for the elevated and ground release sources. Tall stack sources such as at the retorting and upgrading facilities were thus modeled using data recorded at the 60-m level, while low-level fugitive emissions such as shale screening, handling, crushing, and spent shale compaction were modeled using data from the 10-m level.

Hourly wind speed and wind direction data were vector-averaged from the raw data records from the Pacific Project mesa meteorological monitoring site. The EPA-recommended (1981) Mitchell-Timbre (1979) sigma theta stability classification techniques were used to derive the Pasquill-Gifford stability categories. These same methods were also employed to derive the annual joint frequency of wind direction and wind speed by stability classification of the Chevron Clear Creek mesa 60-m tower data.

The sequential air quality models require hourly values of ambient temperature for computing the initial buoyancy of stack gas released to the atmosphere. The buoyancy flux is, in turn, used to calculate plume rise above stack level according to Briggs' (1969, 1975) formulations. To meet this requirement, hourly arithmetic averages were derived from the Pacific mesa tower temperature values. For the annual averaging time modeling runs, the average maximum, mean, and minimum temperatures were derived from the Chevron Clear Creek mesa tower as a full year of data was unavailable from the Pacific site.

The sequential diffusion models used to estimate hourly ambient pollutant concentrations require specification of hourly mixing depth estimates for the area under consideration. This mixing height information was obtained from Holzworth's (1972) contiguous United States mixing height document.

A.2.2 EMISSION INVENTORIES

The emission rates and stack height information for the proposed actions and alternatives were provided by Getty (1983b,c) and Cities Service (1983b,c). This information has been presented in the DEIS in Tables 4.2-6 and 4.2-9 for the Getty project, and Tables 4.3-7 and 4.3-9 for the Cities Service project. These emissions data were reviewed, developed, checked to convention, and converted to input files for the air quality modeling. Complete references for the development of these emission rates are provided in Getty (1983b) and Cities Service (1983b) project descriptions and alternatives reports.

A.3.0 METHODOLOGY

Because both of the projects considered are configured on the Roan Plateau (where significant demarcation of terrain is minimal) and because of the wide variety of area and point sources, the Industrial Source Complex (ISC) Dispersion Model (EPA 1979) was determined to be the most applicable air quality model for the purposes of this environmental impact statement. The ISC dispersion model combines various steady-state Gaussian dispersion algorithms into a set of two computer programs that can be used to assess the air quality impact of emissions associated with an industrial source. The ISC short-term model is designed to calculate concentration values for any pollutant for all of the regulated averaging times using sequential, hourly meteorology. The ISC long-term model is a sector-averaged model that uses statistical wind summaries (STAR files) to calculate annual ground level concentrations, or for the acid deposition analyses and dry deposition values. Both models accommodate a user-defined discrete receptor guide. The ISC model computer programs are written in FORTRAN IV programming language, and were executed on CDM's in-house DEC-20 computer.

For each of the projects' alternatives the major emissions source locations for each pollutant were used in executing the ISC short-term model. The analyses included all hours of the 258 days comprising the Pacific mesa meteorological data set. First, a screening run was performed for a 10-km squared area with receptor spacing of 1.5 to 2.0 km within this grid. Additional receptors were placed at Federal Class I areas, Colorado Category I areas, and other potentially sensitive areas including the Mesa County nonattainment area. The full data set was run to determine the worst-case meteorological conditions and the locations of the highest and second-highest concentrations. The model was then re-executed with the worst-case meteorological data set with a refined receptor grid with tighter spacing (100-500 m) and the sensitive receptor areas.

The particle deposition algorithm in the ISC model requires specification of deposition velocities and reflection coefficients for each particle size class. Five particle size classes were used in modeling the Getty and Cities Service fugitive dust area sources for alternative. Table A-1 presents the mass fraction, gravitational settling velocity, deposition velocity, and reflection coefficient for each particle size class. The mass distribution for the five specified size categories is based on an average of particle size measurements made by PEDCo/MRI (1981) at surface coal mining operations in the western United States. The gravitational settling velocities were calculated from the Stokes equation using an assumed particle density of 2 g/cm^3.

The annual average concentrations were calculated using the ISC long-term model, the same discrete receptors, and the Chevron annual wind and stability summary. These concentrations were then reported in the EIS in Tables 4.2-7 and 4.2-10 for the getty project, and Tables 4.3-7 and 4.3-10 for the Cities Service project.

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Table A-1 PARTICLE SIZE DISTRIBUTION AND DEPOSITION PARAMETERS

Particle Size Class	Range of Particle Size (um)	Mass Distribution %[a]	Characteristic Particle Diameter (um)	Gravitational Settling Velocity[b] (m/sec)	Deposition Velocity (m/sec)[c]	Reflection Coefficient
1	0-2.5	3	1.6	0.0001	0.002	0.82
2	2.5-5	4	3.9	0.0009	0.006	0.71
3	5-10	9	7.8	0.0036	0.01	0.50
4	10-15	5	12.7	0.0095	0.019	0.26
5	>15	79	22.2	0.0294	0.029	0.03

[a] Source: PEDCo/MRI (1981). Mass distribution shown for fugitive sources. The mass distribution for sources controlled by a baghouse were linearly adjusted assuming no particles >15 microns.

[b] Based on Stokes law for particles of spherical shape with diameter equal to the characteristic particle diameter for each size class. The density of the particles was assumed to be 2 g/cm^3.

[c] Source: Sehmel and Hodgson (1980).

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APPENDIX B
BIOLOGICAL ASSESSMENT

BIOLOGICAL ASSESSMENT
FOR THE GETTY OIL COMPANY AND
CITIES SERVICE OIL AND GAS CORPORATION
RESOURCE PROPERTIES AND ACCESS CORRIDORS

R. W. BECK AND ASSOCIATES

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FILE NO. CC-2294-JZ5-AO
CC-2299-JZ4-AO

September 22, 1983

Mr. Michael C. Richards
Associate
Operations Manager
Camp, Dresser and McKee, Inc.
11455 West 48th Avenue
Wheat Ridge, Colorado 80033

Dear Mr. Richards:

Pursuant to the terms of our employment as authorized in your correspondence No. LSN-8425-026, September 15, 1983, we submit herewith our report entitled: Biological Assessment for the Getty Oil Company and Cities Service Oil and Gas Corporation Resource Properties and Access Corridors. This report is supplemental to the terrestrial biological assessment (Woodward-Clyde 1983) and the aquatic biological assessment (Bio-West 1983) prepared for CCSOP/GCC and, therefore, describes only a portion of the proposed action.

This report sets forth a biological assessment containing analyses of the effects of construction, operation, and reclamation activities with respect to the resource properties and various access corridors to those properties of the Getty Oil Company and Cities Service Gas and Oil Corporation oil shale projects in Garfield County. The assessment has been prepared to satisfy the U.S. Army Corps of Engineers (COE) requirements under Section 7(c) of the Endangered Species Act of 1973 (as amended) which requires the COE to submit to the U.S. Fish and Wildlife Service (FWS) a biological assessment to determine the effects of issuing a 404 permit for the GCC Joint Venture water system. Also, the assessment has been prepared to conform to guidance presented by FWS in a letter to COE dated August 26, 1983 (included as Appendix A in the report). It is our understanding that Camp, Dresser and McKee, Inc. intends to append this biological assessment to the third-party EIS now being prepared by them for the COE, and to incorporate it as an integral part of the document for purposes of satisfying NEPA and agency requirements regarding threatened and endangered species.

Should subsequent developments indicate the need to modify or supplement this report, we are prepared to provide the necessary services.

Sincerely,

R. W. BECK AND ASSOCIATES

R W Beck and Associates

BIOLOGICAL ASSESSMENT FOR THE GETTY OIL COMPANY AND CITIES SERVICE OIL AND GAS CORPORATION RESOURCE PROPERTIES AND ACCESS CORRIDORS

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BIOLOGICAL ASSESSMENT
FOR THE GETTY OIL COMPANY AND
CITIES SERVICE OIL AND GAS CORPORATION
RESOURCE PROPERTIES AND ACCESS CORRIDORS

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APPENDIX C
WILDLIFE IMPACT RATINGS

United States Department of the Interior
FISH AND WILDLIFE SERVICE
COLORADO FIELD OFFICE
730 SIMMS STREET
ROOM 292
GOLDEN, COLORADO 80401

IN REPLY REFER TO:

November 15, 1983

Ms. Linda Brown
Camp, Dresser and McKee, Inc.
11455 West 48th Avenue
Wheatridge, CO 80033

Dear Ms. Brown:

With this letter, we are transmitting results of wildlife impact analyses for the Getty and Cities oil shale projects.

Impact assessments were performed using a modified Geographic Information System approach similar to the technique described in the Chevron, Fish and Wildlife Coordination Act technical assistance report. Please refer to the Chevron report for specific analysis methodology.

As previously discussed, we believe the attached results should be incorporated in the Getty/Cities DEIS and should be used to develop mitigation recommendations. The Chevron technical assistance report can provide further guidance in devising mitigation measures. We are also prepared to provide you with any additional assistance you may need in developing mitigation strategies for the DEIS.

If you have any questions regarding mitigation or the attached analyses, please feel free to call either myself or Mike Lockhart.

Sincerely,

L. Rl Fin

Energy Project Leader

cc: COE, Sacramento, CA

Attachment

MATRIX AND TABLE KEY

*( ) = acres
bz = .5 mile buffer zone

Getty

Mine Bench and Plant Site (318)*	= GEPRT & MNPT
Mine Bench and Plant Site-bz (1357.5)	= GPRT & MNB2
Additional Retort Site (234)	= GEPRTADD
Additional Retort Site-bz (1227)	= GPRTADDB2
Tom Creek Reservoir (174)	= GEPRESTCRK
DeBeque Silt Pond (55.5)	= GEPSILTPD
Roan Creek Re-reg Reservoir (44.28)	= GERESNEW
Proposed Shale Disposal Site (2220)	= GEPSDSITE
Proposed Shale Disposal Site-bz (2869.5)	= GPSDSITEB2
Buck Gulch Corridor (124.58)	= GPCOR1
Buck Gulch Corridor-bz (1468.5)	= GCOR1B2
Road Corridor A (292.5)	= GEPCORR2
Road Corridor A-bz (2731.5)	= GPCOR2B2
Road Corridor B (64.90)	= GPCOR8
Road Corridor B-bz (1159.5)	= GPCOR8B2
Road Corridor C (328.22)	= GPCOR4
Road Corridor C-bz (2670.0)	= GCOR4B2
Product Corridor A (66.09)	= GPCOR3
Product Corridor A-bz (1029.0)	= GCOR3B2
Product Corridor B (159.81)	= GPCOR5
Product Corridor B-bz (1968.0)	= GPCOR5B2
Alt. Shale Disposal Site (1579.5)	= GEASDSITE5
Alt. Shale Disposal Site-bz (4126.5)	= GASDSITEB2
W. Fk. Parachute Reservoir (283.5)	= GEARESWFPC
Pipeline Corridor W. Fk. Parachute (174.62)	= GPCOR9
Pipeline Corridor W. Fk. Parachute-bz (1978.5)	= GPCOR9B2
Upper Roan Creek Corridor (1076.29)	= GPCOR7
Upper Roan Creek Corridor-bz (8316.0)	= GPCOR7B2
Lower Roan Creek Corridor (2105.04)	= GPCOR6
Lower Roan Creek Corridor-bz (6633.0)	= GPCOR6B2
Dry Fork Reservoir (1758)	= DRYCRKRES

MATRIX AND TABLE KEY (continued)

Cities

Cities Mine Bench (3.0)	= CTPMNBENCH
Cities Mine Bench-bz (540.0)	= CPMNBENB2
Retort & Plant Site (195.0)	= CTPRT & MNPL
Retort & Plant Site-bz (1135.5)	= CPT & MNB2
Shale Fines Site (418.5)	= CTPSHALEFN
Shale Fines Site-bz (1572.0)	= CPSHALEFB2
Proposed Shale Disposal Site (777.0)	= CTPSDSITE
Proposed Shale Disposal Site-bz (2530.5)	= CPSDSITEB2
Waste Rock Pile (84.0)	= CTPWSROCKP
Waste Rock Pile-bz (961.5)	= CPWSROCKB2
Road Corridor A (475.17)	= CPCOR2
Road Corridor A-bz (5118.0)	= CPCOR2B2
Road Corridor B (255.0)	= CTPCORR3
Road Corridor B-bz (2404.5)	= CPCOR3B
Road Corridor C (130.61)	= CPCOR5
Road Corridor C-bz (1509.0)	= CPCOR5B2
Product Corridor A (414.35)	= CPCOR4
Product Corridor A-bz (3513.0)	= CCOR4B2
Product Corridor B (159.81)	= GPCOR5
Product Corridor B-bz (1968)	= GPCOR5B2
Alt. Shale Disposal Site (1506.0)	= CTASDSITE1 & CTASDSITE2
Alt. Shale Disposal Site-bz (3982.5)	= CASDSIT1B2 & CASDSIT2B2
Pipeline Corridor A (67.33)	= CPCOR1
Pipeline Corridor A-bz (1096.5)	= CCOR1B2
Pipeline Corridor B (90.73)	= CPCORGNG
Pipeline Corridor B-bz (1198.5)	= CPCORGNGB2
Alternate Product Pipeline (840.06)	= CTACORR2
Alternate Product Pipeline-bz (4485.0)	= CACOR2B2
Larkin Ditch Pond (8.33)	= LDSEDPD
Dry Fork Reservoir (1758)	= DRYCRKRES

Wildlife/Habitat Types

MDWR = Mule Deer Winter Range = MDD41.WR82

MDWCA = Mule Deer Winter Range Concentration Area = MDD41WCA82

Wildlife/Habitat Types (cont.)

MDCH	=	Mule Deer Critical Habitat = MDD41CH83
EKWR	=	Elk Winter Range = EKE10WR83
EKWCA	=	Elk Winter Concentration Area = EKE10WCA82
EKCH	=	Elk Critical Habitat = EKE10CH83
RAREPL	=	Rare Plant Populations = GCEP
RAREP-1	=	Rare Plant .5 mi. Buffer Zone = GEEPB1
SAGR	=	Sage Grouse Leks = SG58.S.83
SAGR-1	=	Lek Buffer Zone .5 mile = SAGELEKB2
SAGR-2	=	Lek Buffer Zone 2 mile = SAGELEKB4
ACCI	=	Inactive Accipiter Nest and .25 mile buffer zone = SAGELEKB4
COHA-1	=	Active Cooper's Hawk Nest and .25 mile buffer zone = CHOAB1A
COHA-2	=	Active Cooper's Hawk Nest and .5 mile buffer zone = CHOAB2A
RTHI	=	Inactive Red-tailed Hawk Nest and .25 mile buffer zone = RTHIB1A
RTHA-1	=	Active Red-tailed Hawk Nest and .25 mile buffer zone = RTHAB1A
RTHA-2	=	Active Red-tailed Hawk Nest and .5 mile buffer zone = RTHAB2A
GOEI-1	=	Inactive Golden Eagle Nest and .25 mile buffer zone = GOEIB1
GOEI-2	=	Inactive Golden Eagle Nest and .5 mile buffer zone = GOEIB2
GOEA-1	=	Active Golden Eagle Nest and .25 mile buffer zone = GOEAB1
GOEA-2	=	Active Golden Eagle Nest and .5 mile buffer zone = GOEAB2
GOEA-3	=	Active Golden Eagle Nest and 1 mile buffer zone = GOEAB3
KEST	=	Active kestrel and .25 mile buffer zone = CTRPAAMK
ASPEN	=	Aspen Cover Type = HBASPEN
ASPEN-1	=	Aspen Cover Type, .25 buffer zone = HBASPENB2
DFIR	=	Doug Fir Cover Type = HBDOUGFIR
DFIR-1	=	Doug Fir Cover Type, .25 buffer zone = HBDOUGFB2
RIP	=	Riparian Cover Type = HBRIPARIAN
RIP-1	=	Riparian Cover Type, .25 buffer zone = HBRIPB2
CLIFF	=	Cliff = HBCLIFF

Table C-1 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE GETTY SHALE OIL PROJECT

Project Feature	Wildlife/Habitat Values							
	MDWR	MDWCA	MDCH	EKWR	EKWCA	EKCH	RAREPL	RAREP-1
Mine Bench & Plant Site	0	0	0	94.5	0	0	46.5	235.5
Mine Bench & Plant Site-bz	0	0	0	562.5	61.5	61.5	378.0	780.0
Additional Retort Site	0	0	0	0	0	0	0	0
Additional Retort Site-bz	0	0	0	0	0	0	0	0
Tom Creek Reservoir	0	0	0	174.0	174.0	174.0	22.5	124.5
DeBeque Silt Pond	55.5	55.5	55.5	0	0	0	0	0
Roan Creek Re-reg Reservoir	45.0	45.0	45.0	0	0	0	0	0
Proposed Shale Disposal Site	0	0	0	0	0	0	0	0
Proposed Shale Disposal Site-bz	0	0	0	0	0	30.0	0	55.5
Buck Gulch Corridor	0	0	0	124.5	84.0	84.0	34.5	120.0
Buck Gulch Corridor-bz	127.5	0	0	1359.0	868.5	868.5	505.5	999.0
Road Corridor A	0	0	0	270.0	61.5	61.5	160.5	187.5

Table C-1 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE GETTY SHALE OIL PROJECT (Continued) Page 1b

Project Feature	Wildlife/Habitat Values							
	SAGR	SAGR-1	SAGR-2	ACCI	COHA-1	COHA-2	RTHI	RTHA-1
Mine Bench & Plant Site	0	0	0	0	0	13.5	0	0
Mine Bench & Plant Site-bz	0	0	43.5	0	13.5	298.5	51.0	30.0
Additional Retort Site	0	0	0	0	0	0	0	0
Additional Retort Site-bz	0	0	0	0	0	64.5	0	0
Tom Creek Reservoir	0	0	0	0	0	0	0	0
DeBeque Silt Pond	0	0	0	0	0	0	0	0
Roan Creek Re-reg Reservoir	0	0	45.0	0	0	0	0	0
Proposed Shale Disposal Site	0	0	0	249.0	124.5	751.5	150.0	111.0
Proposed Shale Disposal Site-bz	0	0	0	124.5	0	396.0	174.0	135.0
Buck Gulch Corridor	0	0	24.0	0	37.5	82.5	0	0
Buck Gulch Corridor-bz	0	0	616.5	0	84.0	738.0	0	0
Road Corridor A	0	0	85.5	0	0	0	0	33.0

Table C-1 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE GETTY SHALE OIL PROJECT (Continued)

Project Feature	Wildlife/Habitat Values							
	RTHA-2	GOEI-1	GOEI-2	GOEA-1	GOEA-2	GOEA-3	KEST	ASPEN
Mine Bench & Plant Site	48.0	0	15.0	0	0	0	0	0
Mine Bench & Plant Site-bz	346.5	16.5	292.5	0	0	0	0	0
Additional Retort Site	0	0	0	0	0	0	0	0
Additional Retort Site-bz	10.5	0	0	0	0	0	0	19.5
Tom Creek Reservoir	0	0	61.5	0	0	0	0	0
DeBeque Silt Pond	0	0	0	0	0	0	0	0
Roan Creek Re-reg Reservoir	0	0	0	0	0	0	0	0
Proposed Shale Disposal Site	817.5	0	0	0	0	0	0	0
Proposed Shale Disposal Site-bz	997.5	0	174.0	0	0	0	0	18.0
Buck Gulch Corridor	0	0	16.5	0	0	0	0	0
Buck Gulch Corridor-bz	0	13.5	322.5	0	0	0	0	0
Road Corridor A	76.5	82.5	144.0	0	0	0	0	0

Project Feature	Wildlife/Habitat Values					
	ASPEN-1	DFIR	DFIR-1	RIP	RIP-1	CLIFF
Mine Bench & Plant Site	0	0	0	0	0	0
Mine Bench & Plant Site-bz	0	0	0	0	0	0
Additional Retort Site	0	0	0	0	0	0
Additional Retort Site-bz	159.0	0	0	4.5	91.5	0
Tom Creek Reservoir	0	0	0	0	0	0
DeBeque Silt Pond	0	0	0	1.5	54.0	0
Roan Creek Re-reg Reservoir	0	0	0	0	0	0
Proposed Shale Disposal Site	0	0	0	0	0	0
Proposed Shale Disposal Site-bz	144.0	0	0	0	3.0	0
Buck Gulch Corridor	0	0	0	0	0	0
Buck Gulch Corridor-bz	0	0	0	0	0	0
Road Corridor A	0	0	0	0	0	0

Table C-1 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE GETTY SHALE OIL PROJECT (Continued)

Project Feature	Wildlife/Habitat Values							
	MDWR	MDWCA	MDCH	EKWR	EKWCA	EKCH	RAREPL	RAREP-1
Road Corridor A-bz	0	0	0	1822.5	504.0	504.0	694.5	1732.5
Road Corridor B	0	0	0	67.5	57.0	57.0	43.5	24.0
Road Corridor B-bz	0	0	0	1123.5	766.5	766.5	261.0	529.5
Road Corridor C	0	0	0	0	0	0	0	0
Road Corridor C-bz	0	0	0	9.0	0	0	15.0	171.0
Product Pipeline A	0	0	0	0	0	0	0	0
Product Pipeline A-bz	0	0	0	0	0	0	0	0
Product Pipeline B	0	0	0	0	0	18.0	0	0
Product Pipeline B-bz	0	0	0	0	0	646.5	0	0
Alt. Shale Disposal Site	1.5	0	0	1563.0	582.0	582.0	916.5	1176.0
Alt. Shale Disposal Site-bz	178.5	0	0	2241.0	1020.0	1020.0	450.0	2253.0
W. Fk. Parachute Reservoir	0	0	0	0	0	0	0	0

Table C-1 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE GETTY SHALE OIL PROJECT (Continued)

Project Feature	Wildlife/Habitat Values							
	SAGR	SAGR-1	SAGR-2	ACCI	COHA-1	COHA-2	RTHI	RTHA-1
Road Corridor A-bz	0	0	829.5	0	0	192.0	120.0	91.5
Road Corridor B	0	0	0	0	0	0	0	0
Road Corridor B-bz	0	0	216.0	0	0	0	0	0
Road Corridor C	0	0	0	0	0	0	55.5	42.0
Road Corridor C-bz	0	0	0	0	0	240.0	117.0	79.5
Product Corridor A	0	0	0	0	0	57.0	0	0
Product Corridor A-bz	0	0	0	0	102.0	397.5	0	45.0
Product Corridor B	0	0	0	0	0	58.5	0	0
Product Corridor B-bz	0	0	0	0	112.5	472.5	115.5	51.0
Alt. Shale Disposal Site	0	0	501.0	0	111.0	412.5	69.0	106.5
Alt. Shale Disposal Site-bz	0	0	1663.5	0	10.5	531.0	51.0	18.0
W. Fk. Parachute Reservoir	0	0	0	0	0	0	0	0

Project Feature	Wildlife/Habitat Values							
	RTHA-2	GOEI-1	GOEI-2	GOEA-1	GOEA-2	GOEA-3	KEST	ASPEN
Road Corridor A-bz	712.5	367.5	1230.0	0	0	0	0	0
Road Corridor B	0	0	28.5	0	0	0	0	0
Road Corridor B-bz	75.0	109.5	448.5	0	0	0	0	0
Road Corridor C	88.5	0	0	0	0	0	0	0
Road Corridor C-bz	853.5	0	0	0	0	0	0	0
Product Pipeline A	42.0	0	0	0	0	0	0	0
Product Pipeline A-bz	333.0	0	0	0	0	0	0	13.5
Product Pipeline B	49.5	0	0	0	0	0	0	24.0
Product Pipeline B-bz	375.0	0	0	0	0	0	0	417.0
Alt. Shale Disposal Site	291.0	271.5	949.5	0	0	0	0	0
Alt. Shale Disposal Site-bz	747.0	301.5	1497.0	0	0	7.5	0	0
W. Fk. Parachute Reservoir	0	0	0	0	0	0	0	6.0

Table C-1 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE GETTY SHALE OIL PROJECT (Continued) Page 2d

Project Feature	Wildlife/Habitat Value					
	ASPEN-1	DFIR	DFIR-1	RIP	RIP-1	CLIFF
Road Corridor A-bz	0	0	0	0	0	0
Road Corridor B	0	0	0	0	0	0
Road Corridor B-bz	0	0	0	0	0	0
Road Corridor C	0	0	0	0	0	0
Road Corridor C-bz	0	0	0	0	0	0
Product Pipeline A	0	0	0	0	0	0
Product Pipeline A-bz	165.0	0	0	6.0	88.5	0
Product Pipeline B	106.5	0	0	0	63.0	0
Product Pipeline B-bz	1167.0	0	0	21.0	402.0	0
Alt. Shale Disposal Site	0	0	0	0	0	0
Alt. Shale Disposal Site-bz	0	0	0	0	0	0
W. Fk. Parachute Reservoir	202.5	0	0	55.5	222.0	0

Table C-1 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE GETTY SHALE OIL PROJECT (Continued) Page 3a

Project Feature	Wildlife/Habitat Values							
	MDWR	MDWCA	MDCH	EKWR	EKWCA	EKCH	RAREPL	RAREP-1
Pipeline Corridor W. Fk. Parachute	0	0	0	0	0	0	0	0
Pipeline Corridor W. Fk. Parachute	0	0	0	0	0	0	0	0
Upper Roan Creek Corridor	918.0	754.5	745.5	249.0	147.0	147.0	0	24.0
Upper Roan Creek Corridor-bz	6340.5	5100.0	4939.0	2598.0	1710.0	1710.0	99.0	462.0
Lower Roan Creek Corridor	2097.0	1674.0	1581.0	0	0	0	0	0
Lower Roan Creek Corridor-bz	6316.5	5841.0	5784.0	0	0	0	0	0
Dry Fork Reservoir (GCC)	1758.0	1758.0	1758.0	0	0	0	0	0

Table C-1 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE GETTY SHALE OIL PROJECT (Continued)

Project Feature	Wildlife/Habitat Values							
	SAGR	SAGR-1	SAGR-2	ACCI	COHA-1	COHA-2	RTHI	RTHA-1
Pipeline Corridor W. Fk. Parachute	0	0	0	0	0	27.0	0	0
Pipeline Corridor W. Fk. Parachute-bz	0	0	0	0	66.0	336.0	0	12.0
Upper Roan Creek Corridor	0	0	555.0	0	0	6.0	0	0
Upper Roan Creek Corridor-bz	0	0	4687.5	0	4.5	322.5	0	0
Lower Roan Creek Corridor	0	0	0	0	0	0	0	0
Lower Roan Creek Corridor	0	0	18.0	0	0	0	0	0
Dry Fork Reservoir (GCC)	0	0	0	0	0	0	0	0

Table C-1 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE GETTY SHALE OIL PROJECT (Continued)

Project Feature	Wildlife/Habitat Values							
	RTHA-2	GOEI-1	GOEI-2	GOEA-1	GOEA-2	GOEA-3	KEST	ASPEN
Pipeline Corridor W. Fk. Parachute	6.0	0	0	0	0	0	0	54.0
Pipeline Corridor W. FK. Parachute-bz	267.0	0	0	0	0	0	0	277.5
Upper Roan Creek Corridor	0	0	0	0	0	108.0	0	0
Upper Roan Creek Corridor-bz	0	0	6.0	0	172.5	733.5	0	0
Lower Roan Creek Corridor	0	0	0	0	0	0	0	0
Lower Roan Creek Corridor-bz	0	0	0	0	0	0	0	0
Dry Fork Reservoir (GCC)	0	0	0	0	0	0	0	0

Table C-1 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE GETTY SHALE OIL PROJECT (Concluded)

Project Feature	Wildlife/Habitat Values					
	ASPEN-1	DFIR	DFIR-1	RIP	RIP-1	CLIFF
Pipeline Corridor W. Fk Parachute	124.5	0	0	45.0	133.5	0
Pipeline Corridor W. Fk. Parachute-bz	1248.0	0	0	66.0	924.0	0
Upper Roan Creek Corridor	0	0	0	0	49.5	0
Upper Roan Creek Corridor-bz	0	0	0	153.0	879.0	10.5
Lower Roan Creek Corridor	0	0	0	169.5	891.0	0
Lower Roan Creek Corridor-bz	0	0	0	246.0	1806.0	64.5
Dry Fork Reservoir (GCC)	0	0	0	138.0	981.0	0

Table C-2 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE CITIES SERVICE SHALE OIL PROJECT

Project Feature	Wildlife/Habitat Values							
	MDWR	MDWCA	MDCH	EKWR	EKWCA	EKCH	RAREPL	RAREP-1
Cities Mine Bench	0	0	0	0	0	0	3.0	3.0
Cities Mine Bench-bz	0	0	0	27.0	0	0	301.5	505.5
Retort & Plant Site	0	0	0	0	0	0	0	0
Retort & Plant Site-bz	0	0	0	0	0	0	4.5	187.5
Shale Fines Site	0	0	0	0	0	0	0	27.0
Shale Fines Site-bz	0	0	0	19.5	0	0	102.0	264.0
Proposed Shale Disposal Site	6.0	0	0	762.0	0	0	124.5	307.5
Proposed Shale Disposal Site-bz	210.0	0	0	1612.5	0	0	649.5	1192.5
Waste Rock Pile	0	0	0	0	0	0	0	0
Waste Rock Pile-bz	0	0	0	0	0	0	0	0
Road Corridor A	342.0	246.0	225.0	279.0	0	0	31.5	46.5
Road Corridor A-bz	3024.0	2314.5	2067.0	2545.5	0	0	370.5	772.5

Project Feature	Wildlife/Habitat Values							
	SAGR	SAGR-1	SAGR-2	ACCI	COHA-1	COHA-2	RTHI	RTHA-1
Cities Mine Bench	0	0	0	0	0	3.0	0	0
Cities Mine Bench-bz	0	0	0	0	64.5	327.0	3.0	0
Retort & Plant Site	0	0	0	52.5	0	169.5	133.5	0
Retort & Plant Site-bz	0	0	0	70.5	123.0	397.5	249.0	0
Shale Fines Site	0	0	0	4.5	0	0	144.0	22.5
Shale Fines Site-bz	0	0	166.5	118.5	0	201.0	147.0	102.0
Proposed Shale Disposal Site	0	0	0	0	0	21.0	28.5	0
Proposed Shale Disposal Site-bz	0	0	108.0	0	28.5	315.0	93.0	0
Waste Rock Pile	0	0	0	0	0	0	0	10.5
Waste Rock Pile-bz	0	0	0	0	0	43.5	0	238.5
Road Corridor A	0	0	325.5	0	0	0	0	0
Road Corridor A-bz	0	0	2847.0	0	0	0	154.5	0

Table C-2 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE CITIES SERVICE SHALE OIL PROJECT (Continued)

Project Feature	Wildlife/Habitat Values							
	RTHA-2	GOEI-1	GOEI-2	GOEA-1	GOEA-2	GOEA-3	KEST	ASPEN
Cities Mine Bench	0	3.0	0	0	0	0	0	0
Cities Mine Bench-bz	0	120.0	420.0	0	0	0	0	61.5
Retort & Plant Site	0	0	0	0	0	0	0	10.5
Retort & Plant Site-bz	282.0	0	174.0	0	0	0	0	271.5
Shale Fines Site	208.5	0	0	0	0	0	0	76.5
Shale Fines Site-bz	547.5	0	112.5	0	0	219.0	0	235.5
Proposed Shale Disposal Site	0	127.5	598.5	0	217.5	355.5	40.5	0
Proposed Shale Disposal Site-bz	0	393.0	1363.5	112.5	367.5	615.0	82.5	19.5
Waste Rock Pile	73.5	0	0	0	0	0	0	4.5
Waste Rock Pile-bz	708.0	0	0	0	0	96.0	0	238.5
Road Corridor A	0	31.5	63.0	1.5	93.0	75.0	0	0
Road Corridor A-bz	0	247.5	1029.0	123.0	646.5	900.0	108.0	0

Table C-2 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE CITIES SERVICE SHALE OIL PROJECT (Continued) Page 1d

Project Feature	Wildlife/Habitat Values					
	ASPEN-1	DFIR	DFIR-1	RIP	RIP-1	CLIFF
Cities Mine Bench	3.0	0	0	0	3.0	0
Cities Mine Bench-bz	283.5	12.0	126.0	57.0	339.0	46.5
Retort & Plant Site	147.0	0	0	0	18.0	0
Retort & Plant Site-bz	595.5	0	24.0	58.5	523.5	0
Shale Fines Site	292.5	0	0	72.0	336.0	0
Shale Fines Site-bz	553.5	0	0	36.0	570.0	7.5
Proposed Shale Disposal Site	0	12.0	376.5	93.0	552.0	6.0
Proposed Shale Disposal Site-bz	180.0	214.5	1192.5	51.0	649.5	250.5
Waste Rock Pile	79.5	0	0	0	7.5	0
Waste Rock Pile-bz	672.0	0	0	39.0	450.0	0
Road Corridor A	0	7.5	117.0	9.0	225.0	3.0
Road Corridor A-bz	13.0	145.5	1042.5	159.0	1489.5	238.5

Table C-2 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE CITIES SERVICE SHALE OIL PROJECT (Continued)

Project Feature	Wildlife/Habitat Values							
	MDWR	MDWCA	MDCH	EKWR	EKWCA	EKCH	RAREPL	RAREP-1
Road Corridor B	0	0	0	141.0	0	0	153.0	169.5
Road Corridor B-bz	0	0	0	870.0	0	0	627.0	1437.0
Road Corridor C	0	0	0	0	0	0	0	0
Road Corridor C-bz	0	0	0	0	0	0	0	0
Product Pipeline A	0	0	0	0	0	0	0	0
Product Pipeline A-bz	0	0	0	0	0	0	0	0
Product Pipeline B	0	0	0	0	0	18.0	0	0
Product Pipeline B-bz	0	0	0	0	0	646.5	0	0
Alt. Shale Disposal Site	0	0	0	498.0	0	0	171.0	321.0
Alt. Shale Disposal Site-bz	60.0	0	0	1069.5	0	0	468.0	1131.0
Pipeline Corridor A	0	0	0	0	0	0	27.0	48.0
Pipeline Corridor A-bz	0	0	0	144.0	0	0	195.0	471.0

Table C-2 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE CITIES SERVICE SHALE OIL PROJECT (Continued) Page 2b

Project Feature	Wildlife/Habitat Values							
	SAGR	SAGR-1	SAGR-2	ACCI	COHA-1	COHA-2	RTHI	RTHA-1
Road Corridor B	0	0	0	0	4.5	117.0	39.0	0
Road Corridor B-bz	0	0	90.0	57.0	121.5	751.5	307.5	0
Road Corridor C	0	0	0	21.0	0	1.5	0	0
Road Corridor C-bz	0	0	0	102.0	1.5	217.5	213.0	162.0
Product Corridor A	0	0	0	0	0	25.5	0	0
Product Corridor A-bz	0	0	0	0	90.0	336.0	0	124.5
Product Corridor B	0	0	0	0	0	58.5	0	0
Product Corridor B-bz	0	0	0	0	112.5	472.5	115.5	51.0
Alt. Shale Disposal Site	0	0	0	6.0	0	169.5	126.0	208.5
Alt. Shale Disposal Site-bz	0	0	0	117.0	129.0	760.5	202.5	66.0
Pipeline Corridor A	0	0	0	0	0	10.5	0	0
Pipeline Corridor A-bz	0	0	160.5	39.0	22.5	267.0	343.5	0

Table C-2 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE CITIES SERVICE SHALE OIL PROJECT (Continued) Page 2c

Project Feature	Wildlife/Habitat Values							
	RTHA-2	GOEI-1	GOEI-2	GOEA-1	GOEA-2	GOEA-3	KEST	ASPEN
Road Corridor B	0	60.0	204.0	0	0	64.5	42.0	12.0
Road Corridor B-bz	136.5	418.5	1483.5	0	115.5	402.0	81.0	186.0
Road Corridor C	90.0	0	0	0	0	0	0	51.0
Road Corridor C-bz	958.5	0	0	0	0	0	0	511.5
Product Pipeline A	67.5	0	0	0	0	0	0	27.0
Product Pipeline A-bz	798.0	0	0	0	0	0	0	544.5
Product Pipeline B	49.5	0	0	0	0	0	0	24.0
Product Pipeline B-bz	375.0	0	0	0	0	0	0	417.0
Alt. Shale Disposal Site	501.0	133.5	499.5	0	0	220.5	0	399.0
Alt. Shale Disposal Site-bz	969.0	241.5	1435.5	0	229.5	405.0	115.5	844.5
Pipeline Corridor A	0	0	15.0	0	0	0	0	0
Pipeline Corridor A-bz	4.5	45.0	313.5	0	0	27.0	0	54.0

Table C-2 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE CITIES SERVICE SHALE OIL PROJECT (Continued) Page 2d

Project Feature	Wildlife/Habitat Values					
	ASPEN-1	DFIR	DFIR-1	RIP	RIP-1	CLIFF
Road Corridor B	57.0	0	103.5	9.0	144.0	42.0
Road Corridor B-bz	625.5	90.0	594.0	165.0	1102.5	94.5
Road Corridor C	78.0	0	0	0	54.0	0
Road Corridor C-bz	985.5	0	0	85.5	696.0	0
Product Pipeline A	238.5	0	0	0	57.0	0
Product Pipeline A-bz	1651.5	0	0	37.5	744.0	0
Product Pipeline B	0	0	0	0	0	0
Product Pipeline B-bz	106.5	0	0	0	63.0	0
Alt. Shale Disposal Site	540.0	61.5	334.5	136.5	963.0	63.0
Alt. Shale Disposal Site-bz	1644.0	136.5	876.0	177.0	1600.5	159.0
Pipeline Corridor A	13.5	0	0	6.0	40.5	0
Pipeline Corridor A-bz	322.5	1.5	76.5	57.0	429.0	16.5

Table C-2 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE CITIES SERVICE SHALE OIL PROJECT (Continued)

Project Feature	Wildlife/Habitat Values							
	MDWR	MDWCA	MDCH	EKWR	EKWCA	EKCH	RAREPL	RAREP-1
Pipeline Corridor B	0	0	0	0	0	0	9.0	36.0
Pipeline Corridor B-bz	0	0	0	84.0	0	0	153.0	396.0
Alternate Product Pipeline	0	0	0	0	0	0	0	0
Alternate Product Pipeline-bz	0	0	0	0	0	201.0	0	0
Larkin Ditch Pond	0	0	0	0	0	0	0	0
Dry Fork Reservoir	1758.0	1758.0	1758.0	0	0	0	0	0

Table C-2 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE CITIES SERVICE SHALE OIL PROJECT (Continued) Page 3b

Project Feature	Wildlife/Habitat Values							
	SAGR	SAGR-1	SAGR-2	ACCI	COHA-1	COHA-2	RTHI	RTHA-1
Pipeline Corridor B	0	0	70.5	0	0	0	0	0
Pipeline Corridor B-bz	0	0	714.0	0	0	16.5	70.5	0
Alternate Product Pipeline	0	0	0	0	0	0	0	0
Alternate Product Pipeline-bz	0	0	0	0	0	0	0	30.0
Larkin Ditch Pond	0	0	0	0	0	0	0	0
Dry Fork Reservoir (GCC)	0	0	0	0	0	0	0	0

Table C-2 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE CITIES SERVICE SHALE OIL PROJECT (Continued) Page 3c

Project Feature	Wildlife/Habitat Values							
	RTHA-2	GOEI-1	GOEI-2	GOEA-1	GOEA-2	GOEA-3	KEST	ASPEN
Pipeline Corridor B	0	0	10.5	0	0	0	0	0
Pipeline Corridor B-bz	0	9.0	385.5	0	0	112.5	0	10.5
Alternate Product Pipeline	21.0	0	0	0	0	0	0	147.0
Alternate Product Pipeline-bz	277.5	0	0	0	0	0	0	790.5
Larkin Ditch Pond	0	0	0	0	0	0	0	0
Dry Fork Reservoir (GCC)	0	0	0	0	0	0	0	0

Table C-2 PROJECT COMPONENT/WILDLIFE VALUE ACREAGE OF THE CITIES SERVICE SHALE OIL PROJECT (Concluded)

Project Feature	Wildlife/Habitat Values					
	ASPEN-1	DFIR	DFIR-1	RIP	RIP-1	CLIFF
Pipeline Corridor B	0	0	0	1.5	18.0	0
Pipeline Corridor B-bz	115.5	0	24.0	40.5	304.5	13.5
Alternate Product Pipeline	517.5	0	0	52.5	459.0	0
Alternate Product Pipeline-bz	2580.0	0	0	343.5	2542.5	0
Larkin Ditch Pond	0	0	0	0	9.0	0
Dry Fork Reservoir (GCC)	0	0	0	138.0	981.0	0

Table C-3 ACRES OF DISTURBED AND POTENTIALLY DISTURBED WILDLIFE HABITATS ASSOCIATED WITH THE PROPOSED GETTY SHALE OIL PROJECT AND ALTERNATIVES

Wildlife/Habitat Feature	Proposed Action		/Alternative Shale Disposal Site		/West Fork Parachute Creek Reservoir	
	Disturbed	Potentially Disturbed	Disturbed	Potentially Disturbed	Disturbed	Potentially Disturbed
MDWR	105.0	127.5	106.5	306.0	105.0	127.5
MDWCA	105.0	0	105.0	0	105.0	0
MDCH	105.0	0	105.0	0	105.0	0
EKWR	730.5	4876.5	2293.5	7117.5	730.5	4876.5
EKWCA	376.5	2200.5	958.5	3220.5	376.5	2200.5
EKCH	394.5	2877.0	976.5	1384.5	394.5	2877.0
RAREPL	307.5	1854.0	1224.0	2304.0	307.5	1854.0
RAREP-1	691.5	4267.5	1867.5	6465.0	691.5	4267.5
SAGR	0	0	0	0	0	0
SAGR-1	0	0	0	0	0	0
SAGR-2	154.5	1705.5	655.5	3369.0	0	1705.5
ACCI	249.0	124.5	0	0	0	124.5
COHA-1	162.0	312.0	148.5	322.5	162.0	378.0
COHA-2	963.0	2799.0	624.0	2934.0	990.0	3135.0
RTHI	205.5	577.5	124.5	454.5	205.5	577.5
RTHA-1	186.0	432.0	181.5	315.0	186.0	444.0
RTHA-2	1122.0	3703.5	595.5	3453.0	1128.0	3970.5
GOEI-1	82.5	507.0	354.0	808.5	82.5	507.0
GOEI-2	265.5	2467.5	1215.0	3790.5	265.5	2467.5
GOEA-1	0	0	0	0	0	0
GOEA-2	0	0	0	0	0	0
GOEA-3	0	0	0	7.5	0	0
KEST	0	0	0	0	0	0
ASPEN	24.0	448.5	24.0	430.5	84.0	726.0
ASPEN-1	106.5	1635.0	106.5	1491.0	433.5	2883.0
DFIR	0	0	0	0	0	0
DFIR-1	0	0	0	0	0	0
RIP	1.5	31.5	1.5	31.5	102.0	97.5
RIP-1	117.0	585.0	117.0	582.0	472.5	1509.0
CLIFF	0	0	0	0	0	0
Project Area	4081.88	16,480.5	3441.38	17,737.5	4540.0	18,459.0

Table C-4 ACRES OF DISTURBED AND POTENTIALLY DISTURBED WILDLIFE HABITATS ASSOCIATED WITH THE PROPOSED CITIES SERVICE SHALE OIL PROJECT AND ALTERNATIVES

Wildlife/Habitat Feature	Proposed Action		/Alternative Shale Disposal Site		/Alternative Product Pipeline	
	Disturbed	Potentially Disturbed	Disturbed	Potentially Disturbed	Disturbed	Potentially Disturbed
MDWR	348.0	3225.0	342.0	3084.0	348.0	3225.0
MDWCA	246.0	2314.5	246.0	2314.5	246.0	2314.5
MDCH	225.0	2067.0	225.0	2067.0	225.0	2067.0
EKWR	1182.0	5302.5	918.0	4759.5	1182.0	5302.5
EKWCA	0	0	0	0	0	0
EKCH	18.0	646.5	18.0	646.5	0	445.5
RARE PL	348.0	2403.0	394.5	2221.5	348.0	2403.0
RAREP-1	637.5	5226.0	651.0	5164.5	637.5	5226.0
SAGR	0	0	0	0	0	0
SAGR-1	0	0	0	0	0	0
SAGR-2	396.0	4086.0	396.0	3978.0	396.0	4086.0
ACCI	78.0	387.0	84.0	504.0	78.0	387.0
COHA-1	4.5	564.0	4.5	664.5	4.5	301.5
COHA-2	406.5	3345.0	555.0	3790.5	322.5	2536.5
RTHI	345.0	1696.5	442.5	1806.0	345.0	1581.0
RTHA-1	33.0	678.0	241.5	744.0	33.0	532.5
RTHA-2	489.0	3810.0	990.0	4779.0	393.0	2914.5
GOEI-1	222.0	1233.0	228.0	1081.5	222.0	1233.0
GOEI-2	891.0	5281.5	792.0	5353.5	891.0	5281.5
GOEA-1	1.5	235.5	1.5	123.0	1.5	235.5
GOEA-2	310.5	1129.5	93.0	991.5	310.5	1129.5
GOEA-3	495.0	2371.5	360.0	2161.5	495.0	2371.5
KEST	82.5	271.5	42.0	304.5	82.5	271.5
ASPEN	205.5	2550.0	604.5	3375.0	301.5	2379.0
ASPEN-1	1015.5	7170.0	1555.5	8634.0	1188.0	6931.5
DFIR	19.5	463.5	69.0	385.5	19.5	463.5
DFIR-1	597.0	3079.5	555.0	2763.0	597.0	3079.5
RIP	190.5	807.0	234.0	933.0	243.0	1092.0
RIP-1	1518.0	7699.5	1929.0	8650.5	1857.0	9096.0
CLIFF	51.0	667.5	108.0	576.0	57.0	667.5
Project Area	3070.5	23,547.0	3799.5	24,999.0	3336.4	22,551.0

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ERRATA

On Page vi, under 4.4.8, Meterology should be Meteorology.

On Page 2-26, Table 2.3-7, footnote "a" should read "Train round trip..."; footnote "b" should read "...requirements occur...".

On Page 2-40, fourth complete paragraph, sixth line, the superscript 4 preceeding 1/8 inch should be a less than (<) symbol.

On Page 2-87, ninth paragraph, the heading "2.3.4.2.9 Power Generation" should be "2.4.3.2.9 Power Generation".

On Page 3-42, the heading 3.1.14.3 Railroads should be 3.1.14.4 Railroads; the heading 3.1.14.4 Pipelines should be 3.1.14.5 Pipelines.

On Page 3-45, Table 3.1-20, "Colbran" is misspelled twice; it should be "Collbran".

On Page 3-54 (initially), and throughout Sections 3.2.7 and 3.3.7, the reference "ERT 1981" should be "ERT 1981a". The "CDOW 1983" reference throughout these sections should also read either "CDOW 1983a" or "CDOW 1983b".

On Page 3-54, the fifth full paragraph, the reference "Gumbar 1982" should read "Gumber 1982".

On Page 4-1, last paragraph, third line, "tha" should be "that".

On Page 4-15, last paragraph, the reference "EPA 1977" should read "EPA 1977a".

On Page 4-34, the citations in paragraph two, should read "Turk and Adams (1982) ..... and Fox et al. (1981) .....".

On Page 4-43, the reference "EPA 1977" should read "EPA 1977c". This is also applicable on Page 4-115, sixth paragraph.

On Page 4-44, last paragraph, the reference "EPA 1978b" should read "EPA 1978".

On Pages 4-53 and 4-128, the reference "CITF 1983" should read "CITF 1982".

On Page 4-88, paragraph starting with "Nonhazardous wastes" should be preceeded with the heading "4.3.3.3 Solid/Hazardous Wastes and Toxic Pollutants".

On Page 4-91, the citation in footnote "b" of the table should read "BLM 1983a".

ERRATA (concluded)

On Page 4-94, first full paragraph, fifth line, "abe" should read "be".

On Page 4-115, third paragaph, the reference "EPA 1977" should read "EPA 1977a".

On Page 4-118, second paragraph, the reference "EPA 1978b" should read "EPA 1978".

On Page 4-122, second paragraph, third line, "prominity" should be "proximity".

On Page 4-124, Section "4.3.11.2 Alternatives" is incorrectly placed in the document. The correct location for the section, including its Land Use discussion, is on the top of Page 4-123, above the heading "Recreation and Wilderness".

On Page 4-155, third full paragraph, first line, "ration" should be "ratio".

On Page 4-157, paragraphs five and seven, the reference "Union 1982" should read "Union 1982b".

On Page 158, Table 4.4-1, the reference "MLRD 1982" should read "Union 1982b", and the reference "BLM 1983" should read "BLM 1983a".

On Page 4-172, Table 4.4-10, the titles should be changed to "Cumulative Project Impacts, Construction and Operations, Employment, Income, and Purchases".

ADDITIONAL REFERENCES

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