800493

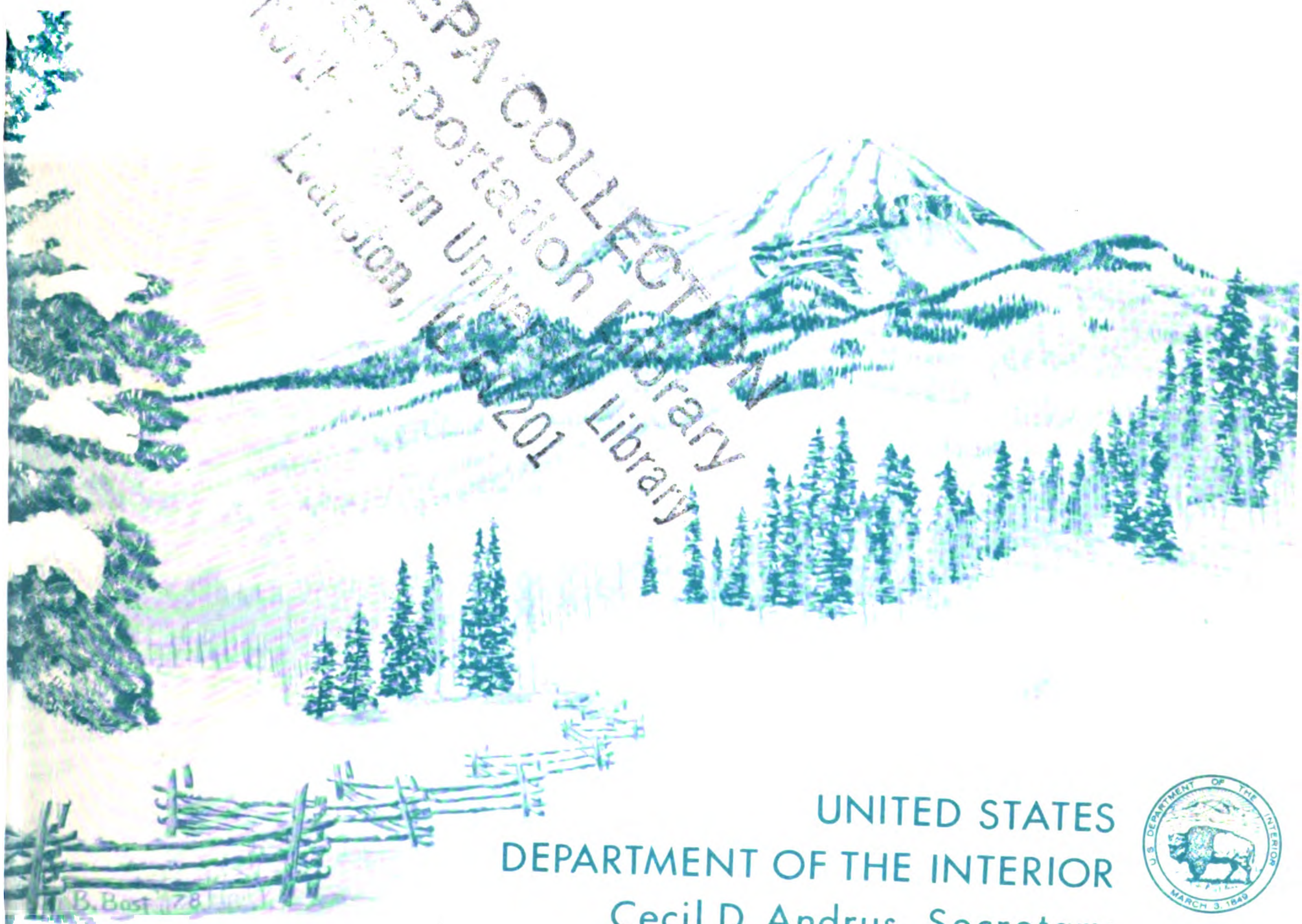
# Animas-LaPlata Project



## colorado-new mexico

# DRAFT ENVIRONMENTAL STATEMENT






UNITED STATES
DEPARTMENT OF THE INTERIOR
Cecil D. Andrus, Secretary

BUREAU OF RECLAMATION
R. Keith Higginson, Commissioner

DEPARTMENT OF THE INTERIOR
(INT DES 79-45)

# DRAFT
# ENVIRONMENTAL STATEMENT

Authorized

ANIMAS-LA PLATA PROJECT
COLORADO-NEW MEXICO

Prepared by

Upper Colorado Regional Office, Salt Lake City, Utah
Bureau of Reclamation
Department of the Interior

N. W. Plummer, Regional Director
JUL 25 1979

SUMMARY

(X) Draft ( ) Final Environmental Statement

Department of the Interior, Bureau of Reclamation, Upper Colorado Region

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

2. Description of the proposal: The Animas-La Plata Project would be located in La Plata and Montezuma Counties in southwestern Colorado and in San Juan County in northwestern New Mexico. It would involve the diversion of water from the Animas River to the La Plata and Mancos River drainages. The project would include two off-stream reservoirs, Ridges Basin and Southern Ute Reservoirs; two major pumping plants; three major conveyance systems; a major power transmission line; and two diversion dams on the La Plata River. The project water supply would average 198,200 acre-feet for irrigation and municipal and industrial use. About 118,100 acre-feet of the water supply would be used for irrigating 21,480 acres of Indian and non-Indian land presently being irrigated and 48,620 acres of Indian and non-Indian land now dry farmed or not under production. An average annual municipal and industrial water supply of 47,600 acre-feet would be made available for communities in Colorado and New Mexico. Also, an average annual supply of industrial water totaling 32,500 acre-feet would be provided to the Southern Ute and Ute Mountain Ute Indian Tribes to develop resources on their reservations; prior to delivery of project water, the Tribes would have to comply with the National Environmental Policy Act (NEPA) and write specific environmental statements for the developments. The project would enhance recreational activities and provide fishing opportunities at both project reservoirs. A program for the development of land for wildlife would compensate for wildlife losses at both reservoirs. A 10-year construction period is anticipated.

3. Summary of environmental impacts and unavoidable adverse effects: Agricultural production would be increased in the project area, as would farm and farm-related incomes. During construction, the project work force would place strains on local housing, education, and law enforcement and fire protection agencies. Two people who are now renting a house in Ridges Basin would have to find new housing.

The average annual flow of the Animas River would be depleted by an amount varying from 131,200 to 161,400 acre-feet. The average annual flow of the La Plata River would be depleted by 12,400 acre-feet and the average annual flow of the Mancos River would be increased by 5,500 acre-feet. The San Juan and Colorado Rivers would have an annual depletion of 154,800 acre-feet. Salinity in the Colorado River at Imperial Dam would be increased by an annual average of 17.9 mg/l, about 1.7 percent above present levels. Depletions would account for an increase of 18.6 mg/L, and salt loading would actually decrease salinity by 0.70 mg/l because of the high percentage of industrial water that would be nonreturning.

The nongame population of fish in the Animas River may be reduced somewhat downstream of the Durango Pumping Plant, primarily because of lower winter flows resulting from the project. Fish species common to the San Juan River would be reduced to a slight degree because of decreased aquatic habitat. Wildlife habitat would be lost with the inundation of 3,630 acres of land and the removal of 770 acres of similar habitat because of project features. Approximately 880 acres of wetlands habitat would be lost along about 140 miles of existing canals and laterals on supplemental service land with the conversion to project canals and a buried lateral system. However, project reservoirs, Southern Ute Diversion Dam, open project drains and an increased water supply for that portion of the supplemental service land retaining existing canals and laterals would result in a net increase in wetlands. The densities of some of the nongame mammals and birds, varmints, raptors,reptiles, and amphibians would be reduced as a result of net reduction in habitat.

The project would have unavoidable adverse effects on some prehistoric sites. Some of these sites would be damaged by testing or excavation before construction; construction work would damage others. In each case, the sites would not be available for future studies or preservation.

Over the long term, an anticipated increase in population in the project area would mean an increase in problems similar to those Farmington has experienced in recent years such as more traffic, poorer air quality, and more demands for housing and services.

Project structures could be visually unattractive to some people, as would the exposure of foreshore at Ridges Basin and Southern Ute Reservoirs during periods of drawdown. Approximately 165 million kilowatt-hours of electricity would be required annually for operating project pumping plants.

4. Alternatives considered:
   1. Development without the project.
   2. Plan at authorization.
   3. Teft Diversion Plan.
   4. Bondad Diversion Plan.
5. Statements are being distributed to the following:
   See list on next page.
6. Date draft statement made available to EPA and the public: JUL 2 5 1979

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Honorable Reginald A. Begage, New Mexico State Representative, Tohatchi, N. Mex.
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    Division of Parks and Outdoor Recreation

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Colorado White Water Association, Boulder, Colo.
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Colorado Wildlife Federation, Denver, Colo.
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Sierra Club, Rocky Mountain Chapter, Denver, Colo.
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Four Corners Environmental Research Institute, Durango, Colo.
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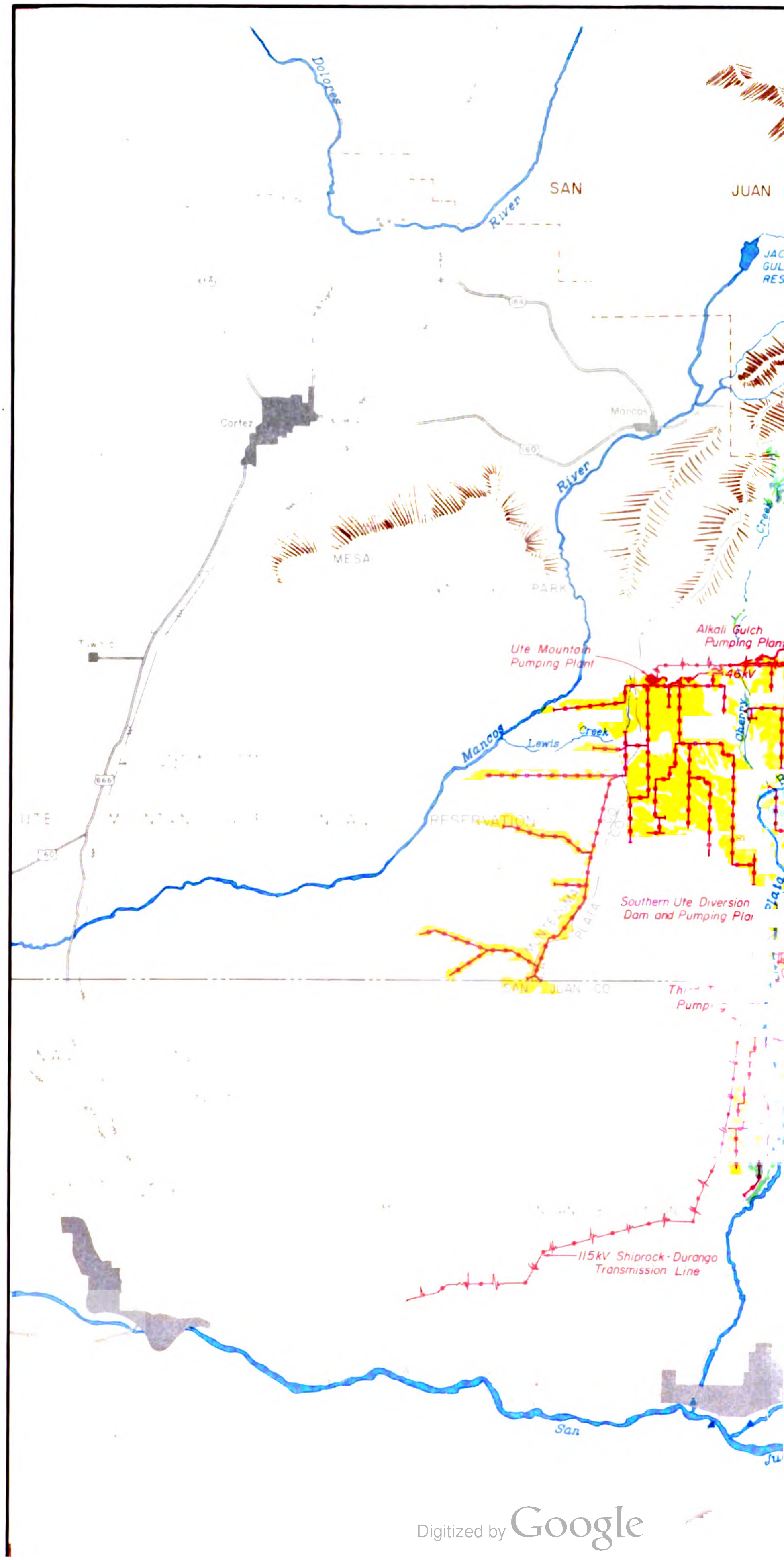
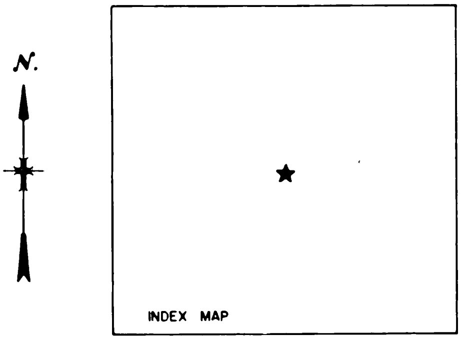


Dolores
River
SAN
JUAN
Cortez
Mancos
River
MESA
PARK
Towaoc
Ute Mountain
Pumping Plant
Alkali Gulch
46kV
Lewis
Creek
Mancos
UTE
RESERVATION
Southern Ute Diversion
Dam and Pumping Pla
115kV Shiprock-Durango
Transmission Line
San




*EXPLANATION*

Supplemental Irrigation Service Lands

Full Irrigation Service Lands

Proposed Dam and Reservoir

Proposed Canal

Proposed Pumping Plant

Proposed Pipeline Lateral

Transmission Lines

USGS Gaging Station

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

UPPER COLORADO REGION

# ANIMAS LA PLATA PROJECT

COLORADO-NEW MEXICO

## GENERAL MAP

MAP NO. 69-406-1551

MARCH, 1978

1 0 1 2 3 4 5 6 7 8 9 10
SCALE OF MILES

1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
SCALE OF KILOMETERS

# CHAPTER A

# DESCRIPTION OF THE PROPOSAL

## A. DESCRIPTION OF THE PROPOSAL

### 1. Introduction

This statement has been prepared on the environmental aspects of the Animas-La Plata Project, which would be located in southwest Colorado and northwest New Mexico in the Upper Colorado River Basin. The project was authorized for construction by the Colorado River Basin Act of September 30, 1968 (Public Law 90-537) as a participating project of the Colorado River Storage Project. The project would commit to beneficial uses part of the streamflows allocated to Colorado and New Mexico by the Colorado River Compact of 1922 and the Upper Colorado River Basin Compact of 1948.

The project would develop water for irrigated agriculture and municipal and industrial (M&I) use in both States. Programs and features also are included for recreation, flatwater fishing opportunities, wildlife, and cultural resources.

The beneficiaries of the agricultural water would be tribal members residing on the Ute Mountain Ute and Southern Ute Indian Reservations in Colorado and non-Indian farmers in both States, many of whom have residences and private holdings within the general boundaries of the Southern Ute Indian Reservation. Municipal and industrial water would be supplied to the two Ute Indian Reservations to the Navajo Nation in New Mexico, and to non-Indian water users throughout the project area.

The La Plata Water Conservancy District in Colorado, the La Plata Conservancy District in New Mexico, the Southern Ute and Ute Mountain Ute Indian Tribes, and the Navajo Nation sponsor and actively support the Animas-La Plata Project. The proposed plan has been formulated as a result of cooperative endeavors by many Federal, State, and local agencies and private organizations and individuals.

The Bureau of Reclamation intends to pursue the course of action provided for under Section 67(r) of the Clean Water Act of 1977 (Public Law 95-217). The Bureau will be exempt from applying for dredge and fill permits (404) from the Army Corps of Engineers. The environmental statement discusses the impacts of discharging dredge and fill material into navigable waters at the project construction sites and the measures that would be employed to control or limit water pollution from these discharges. This information, which is indexed in Attachment 5, is on the technical analysis contained in the environmental statement. This analysis is in accordance with Section 404(b)(1) of the Environmental Protection Agency's interim regulations published in the Federal Register on September 5, 1975. The Bureau of Reclamation will submit the final environmental statement of the Animas-La Plata Project to Congress prior to construction funding. In addition, consideration has been given to Executive Order 11990 on the protection of wet lands throughout the document.

## 2. Location

As shown on the general map, the project area lies within La Plata and Montezuma Counties of southwestern Colorado and San Juan County of northwestern New Mexico in what, because of the unique juncture of the States of Arizona, Utah, Colorado, and New Mexico, is referred to as the Four Corners Area. The project would involve four river systems within the Upper Colorado River Basin. They are, from east to west, the Animas, La Plata, and Mancos Rivers, which are tributary to the fourth river in the south, the San Juan. The San Juan River in turn is a major tributary of the Colorado River, which it joins at Lake Powell in southeastern Utah. The principal cities in the project area--Durango, Colo., and Aztec and Farmington, N. Mex.--are situated along the Animas River. All of the project agricultural land is within the La Plata and Mancos River drainages and is predominantly within the general boundaries of the Southern Ute and Ute Mountain Ute Indian Reservations.

## 3. Water Uses

The project would provide average annual water supplies of about 198,200 acre-feet, consisting of 118,100 acre-feet for irrigation and 80,100 acre-feet for municipal and industrial use. Approximately 169,400 acre-feet of water would come from the Animas River, 17,000 acre-feet from the La Plata River, and 11,800 acre-feet from reusable return flows. The irrigation water would provide full service for land that is presently not irrigated, but which studies (Bureau of Reclamation, 1979) have shown is suitable for sustained irrigated crop production. Supplemental service would be provided for land that is presently irrigated, but for which the present water supply is inadequate in most years to allow for maximum crop production. With the exception of land in the La Plata drainage that is north of the general boundaries of the Southern Ute Reservation, all project land would be sprinkler irrigated.

Of the water that would go to various municipal and industrial users, almost one-half would be provided to the two Ute Indian Tribes to accommodate industrial development of resources, principally coal, on the reservations. The remaining municipal and industrial water supply would be made available to meet existing or projected demands in Durango, Aztec, and Farmington and their immediate surrounding areas; the smaller communities of Bloomfield and Blanco, N. Mex. rural users in Colorado in the La Plata drainage; and the Navajo Tribal Utility Authority for distribution to the towns of Ojo Amarillo, Upper Fruitland, Nenanezad, and Shiprock, N. Mex., all on the Navajo Indian Reservation west and south of Farmington. The municipal and industrial water supplies are planned to meet projected needs of the project area until approximately

2010 in New Mexico and 2020 in Colorado. Some of the supply would be used when available; the remainder would be used as the needs developed. A more detailed breakdown of water allocation by State and Indian and non-Indian users is shown on Table A-1.

4. Construction Features and Project Operation

a. General

The primary construction features of the project would be the Ridges Basin Reservoir system and the Southern Ute Reservoir system. The major feature of each system would be an offstream reservoir. Ridges Basin Reservoir, the larger of the two, would be located west of the Animas River and about 3 miles southwest of the town of Durango. Southern Ute Reservoir would be located east of the La Plata River by the Colorado-New Mexico State line.

The Ridges Basin Reservoir system, in addition to the reservoir, would consist of the Durango Pumping Plant, Ridges Basin Inlet Conduit, Durango Municipal and Industrial Pipeline, Ridges Basin Pumping Plant, the Dry Side Canal, Long Hollow Tunnel, and the La Plata Diversion Dam. The Durango Pumping Plant would pump water from the Animas River through the Ridges Basin Inlet Conduit into Ridges Basin Reservoir. The stored water would be available for project use from three points within the reservoir--the inlet conduit, the outlet works of Ridges Basin Dam, and the west end of the reservoir through the Ridges Basin Pumping Plant. Releases would be made for the Durango area from the inlet conduit to a treatment plant to be constructed by the water users near the reservoir and then would be piped to the city's distribution system through the project's Durango Municipal and Industrial Pipeline. For municipal and industrial users in New Mexico, releases would be made back to the Animas River through the outlet works in the dam. Some New Mexico users would divert water directly from the San Juan River upstream of that river's confluence with the Animas; project water would then replace the diverted water for present users downstream on the San Juan. Existing nonproject facilities would be used to divert and treat project water for New Mexico users.

Water for irrigation in Colorado and New Mexico and for municipal and industrial use in the western part of the project area in Colorado would be pumped from the west end of the reservoir by the Ridges Basin Pumping Plant into the Dry Side Canal, which would head in a southwest to west direction and carry water to the La Plata and Mancos River drainages. Integral to the canal would be the Long Hollow Tunnel, which would be constructed through the divide that separates the Animas and La Plata River drainages. The canal would extend westward and provide water for irrigation on the Indian and non-Indian land in Colorado and for industrial use by the Ute Mountain Ute Indian Tribe for development of coal resources on the reservation. Water would be turned out from the canal for municipal and industrial use by rural Colorado

Table A-1
Water allocation

| | Colorado | | New Mexico | |
|---|---|---|---|---|
| | Average annual water supply (acre-feet) | Land area (acres) | Average annual water supply (acre-feet) | Land area (acres) |
| Irrigation | | | | |
| Full service | | | | |
| Indian | | | | |
| Southern Ute | 3,300 | 1,800 | | |
| Ute Mountain Ute | 25,600 | 11,600 | 800 | 380 |
| Subtotal Indian | 28,900 | 13,400 | 800 | 380 |
| Non-Indian | 54,600 | 30,310 | 11,900 | 4,530 |
| Total | 83,500 | 43,710 | 12,700 | 4,910 |
| Supplemental service | 17,800 | 17,760 | 4,100 | 3,720 |
| Total irrigation | 101,300 | 61,470 | 16,800 | 8,630 |
| Municipal and industrial | | | | |
| Durango area | 8,200 | | | |
| Rural users | | | | |
| La Plata, Colo. | 1,000 | | | |
| Southern Ute | 26,500 | | | |
| Ute Mountain Ute | 6,000 | | | |
| Aztec area | | | 5,800 | |
| Farmington area | | | 19,700 | |
| Bloomfield area | | | 5,300 | |
| Navajo Tribal Utility Authority | | | 7,600 | |
| Total M&I water | 41,700 | | 38,400 | |
| Project total | 143,000 | 61,470 | 55,200 | 8,630 |

residents. When flows in the La Plata River were high, diversions would be made from the river through the La Plata Diversion Dam to the Dry Side Canal to augment the supply west of the river. Project supplemental service land north of the canal would receive an additional supply of water from the La Plata River; in exchange, project water would be delivered from the canal to replace La Plata River water now diverted for use downstream of the canal. Existing laterals and canals would be used to serve this land. Water could also be delivered from the Dry Side Canal to the La Plata River, when needed, for diversion into Southern Ute Reservoir downstream.

Project features in the Southern Ute Reservoir system, in addition to the reservoir, would be the Southern Ute Diversion Dam and Inlet Canal and the New Mexico Irrigation Canal. The dam would divert natural flows of the La Plata River, water from Ridges Basin Reservoir turned out from the Dry Side Canal, and irrigation return flows from land in Colorado. The water would be conveyed to Southern Ute Reservoir by the Southern Ute Inlet Canal, with a small amount of water being pumped from the canal for irrigation of land immediately north of the Colorado-New Mexico State line. Water in the reservoir would be used to develop the Southern Ute Tribe's coal resources on the reservation and to irrigate non-Indian project land in New Mexico. Irrigation water would be conveyed from the outlet works of Southern Ute Dam to this land by the New Mexico Irrigation Canal.

Power to operate project facilities would be transmitted to the area from the Shiprock Substation of the Colorado River Storage Project (CRSP) by a 115-kilovolt (kV) project transmission line, the Shiprock-Durango Transmission Line or would be purchased. Project transformers would convert power for the operation of the project sprinkler pumping plants and the Ridges Basin and Durango Pumping Plants.

A cultural resources program would be undertaken for data recovery, analysis, and publication of information on significant historical and prehistorical resources that would be unavoidably affected. Recreation facilities would be provided at Ridges Basin and Southern Ute Reservoirs. The specific program planned for fish and wildlife includes a fish stocking program at project reservoirs, minimum pools to protect the fishery at the reservoirs, and the acquisition and improvement of land for big game to compensate for the loss of wildlife habitat at Ridges Basin and Southern Ute Reservoirs.

### b. Ridges Basin Reservoir System

#### (1) Design

##### (a) Durango Pumping Plant and Ridges Basin Inlet Conduit

The Durango Pumping Plant, as explained earlier, would lift water from the Animas River through the Ridges Basin Inlet Conduit to Ridges Basin Reservoir (see Figure A-1). The plant would be located on the west bank of the river approximately 1/4 mile downstream from the town of Durango and would consist of an intake structure, a settling basin to remove sediment, and a pumping plant. The intake structure would be a 300-foot-long, concrete-lined structure leading from the river to the settling basin. Approximately 150 cubic yards of concrete would be placed in the river. It would have a side slope ratio of 2:1 and a maximum water depth of about 11.6 feet. A gate structure would regulate diversions from the river to the canal, and a trashrack would guard against debris clogging the gates or entering the settling basin. A screen would be placed over the inlet to keep fish from entering; fish would be rechanneled back to the river through a 300-foot-long pipe. The settling basin, which would not be concrete lined, would have about 2 surface acres and a maximum water depth of 11.6 feet. The settling basin is designed to remove particles of sediment 0.10 millimeter and larger. An estimated 6,300 cubic yards of sediment would settle out annually, and removal of the deposited material would be required about once a year. The material would consist primarily of fine and medium sand, and could be used locally within a 5-mile radius for building fill material, road construction, sanitary land fill cover, or improving the Ridges Basin Reservoir shoreline. Design drawings for the pumping plant are shown in Attachment 5.

The pumping plant itself would house 13 dual electrical pump units and operation and maintenance offices and shops in a building with about 18,000 square feet of floor space. A parking area and substation would be located adjacent to the building. The pumping plant would have the capacity to deliver water at a rate of 430 cubic feet per second (cfs) through a maximum static lift of 525 feet to the reservoir and would have a peak electric capacity of 25,500 kilowatts and an annual energy requirement of 105,508,000 kilowatt-hours.

The Ridges Basin Inlet Conduit would begin at the pumping plant and extend up the ridge that separates the reservoir basin from the Animas River. It would parallel an existing county road and have an overall length of about 2.1 miles. About 1.6 miles of the conduit would be formed of concrete and steel pipe with an inside diameter of 8.5 feet and buried at about 5 to 10 feet below the ground surface, and the remaining 0.5 mile would consist of concrete-lined tunnel. A valve station would allow water to be delivered to an adjacent treatment plant to be constructed by the La Plata Water Conservancy District for use in the Durango area. The inlet conduit would begin at an elevation of 6,453 feet and would end at an elevation equal to the top of the reservoir's inactive pool (elevation 6,897.5 feet). The final 0.5 mile would consist of a tunnel bored through the separating ridge so that the pumping head required to deliver water to the reservoir could be held to a minimum. The tunnel would allow gravity releases back through the conduit to the turnout for the treatment plant when water was not being pumped to the reservoir. Gravity releases would be controlled by a gate chamber in the tunnel. The gates themselves would be operated from a control house located about midway along the tunnel portion of the conduit.

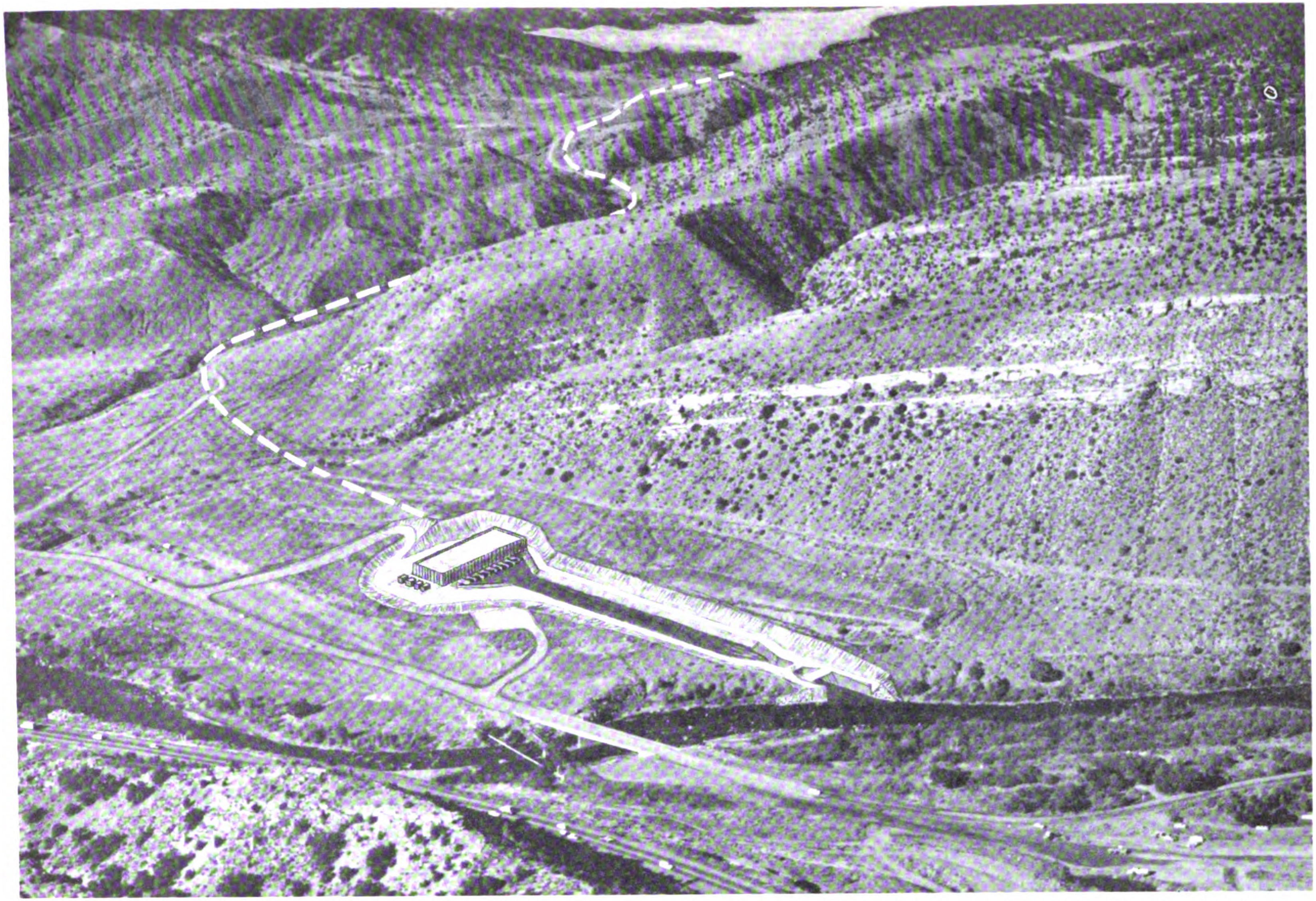


Figure A-1--Artist's concept of the Durango Pumping Plant and Ridges Basin Inlet Conduit leading to the Reservoir

Approximately 1,000 feet of gravel-surfaced road would be built from an existing gravel surfaced county road for construction and operation access to the plant. The road to the inlet conduit would allow construction and operation access. The road would be upgraded in sections to facilitate access. Waste from the tunnel could either be used for landfill at the water users treatment plant site or placed in the reservoir basin.

(b) Ridges Basin Reservoir

The project's primary storage feature, Ridges Basin Reservoir, would be formed by the construction of Ridges Basin Dam on Basin Creek approximately 2 miles upstream from its confluence with the Animas River. Figures A-2 and A-3 show the basin and an artist's concept of the reservoir. The dam would be a rolled, earth-fill structure with a height of 313 feet, a crest length of 1,600 feet, and a material volume of 7,620,000 cubic yards. An outlet works with a 2,160 cfs discharge capacity would be constructed in the right abutment.

Releases of municipal and industrial water for users in New Mexico would be made through the outlet works, which would have an intake near the base of the dam and could consequently evacuate almost the entire contents of the reservoir. The dam would not have a spillway, since the reservoir's short-term flood storage capacity (surcharge) in combination with the outlet works discharge capacity would protect the dam against the maximum probable flood. An emergency spillway, however, would be constructed about 1.5 miles north of the dam in the ridge that separates the reservoir from the Animas River. The spillway, 100 feet wide, would be excavated to an elevation 7 feet below the crest of the dam so that if the outlet works ever malfunctioned during a flood the inflow could still escape from the reservoir without cresting the dam. Concrete sill blocks would be constructed to control erosion. The spillway would empty into an unnamed intermittent tributary of the Animas River.

The reservoir formed behind the dam would extend about 3.8 miles up Basin Creek and have a storage capacity of 280,040 acre-feet, as shown on Table A-2. At the top of active capacity the reservoir would have a surface area of approximately 2,270 acres. The reservoir's active capacity of 130,000 acre-feet would be used to help satisfy project water needs. The dead and inactive capacity of about 150,040 acre-feet would form the reservoir's minimum pool and would not be drawn upon under normal circumstances. The large minimum pool would be necessary so that the power required to pump water out of the reservoir at the Ridges Basin Pumping Plant could be held to a minimum and so that gravity releases could be made through the Ridges Basin Inlet Conduit to the treatment plant for use in the Durango area. The large minimum pool would also benefit recreation and fishing use. The northern, western, and southwestern reservoir boundaries would have about 15 miles of fence to keep livestock from entering the reservoir area and to restrict uncontrolled access to the reservoir.

Table A-2
Ridges Basin Reservoir

| | |
|---|---|
| Capacities (acre-feet) | |
| Active capacity | 130,000 |
| Inactive capacity | 150,000 |
| Dead storage | 40 |
| Total | 280,040 |
| Surcharge capacity | 9,200 |
| Deposited sediments after 100 years (acre-feet) | 1,400 |
| Surface areas (acres) | |
| Top of active capacity | 2,270 |
| Top of inactive capacity | 1,657 |
| Top of dead storage | 1 |
| Top of surcharge capacity | 2,302 |

An existing 4-wheel-drive trail would be upgraded to allow construction access to the dam from County Road 213, 3.5 miles southeast of the damsite. After construction the dam would be accessible from an existing improved road along with 1.3 miles of the construction access road which would then be improved. A road about 3 miles long would be built along a part of the north side of the reservoir to provide access to the proposed recreation area and to the Ridges Basin Pumping Plant. The filling of the reservoir would result in the inundation of 3.6 miles of unpaved County Road 211 and 1.5 miles of an unpaved service road.

(c) Durango M&I Pipeline

The Durango M&I Pipeline would deliver treated water at a rate of 29 cfs from a new treatment plant to be constructed by the water users to the town of Durango. Locations for the plant and pipeline are now being studied, and one possible alternative is shown on the General Map. Made of 27-inch-diameter pressure pipe, the line would be buried with a minimum ground cover of 3 feet, and would be about 2.3 miles long, crossing under the Animas River and State Highway 160 and beneath about 6 blocks of city streets before connecting with the city's distribution system. Construction access would be from existing roads. The water pressure in the pipeline would be about equal to that in the pipeline from the city's existing treatment plant so that the introduction of water from either source into the existing distribution system would not be inhibited.

(d) Ridges Basin Pumping Plant

Constructed at the west end of the reservoir to deliver a maximum of 700 cfs of water to the Dry Side Canal, Ridges Basin Pumping Plant would house eight electrical pumps, a transformer, and operation and maintenance shops in a building with approximately 15,000 square feet of floor space. The pump lift would vary from 264 to 330 feet depending upon the water level in the reservoir. The plant would

Figure A-2--Aerial view of Ridges Basin Dam and Reservoir Site

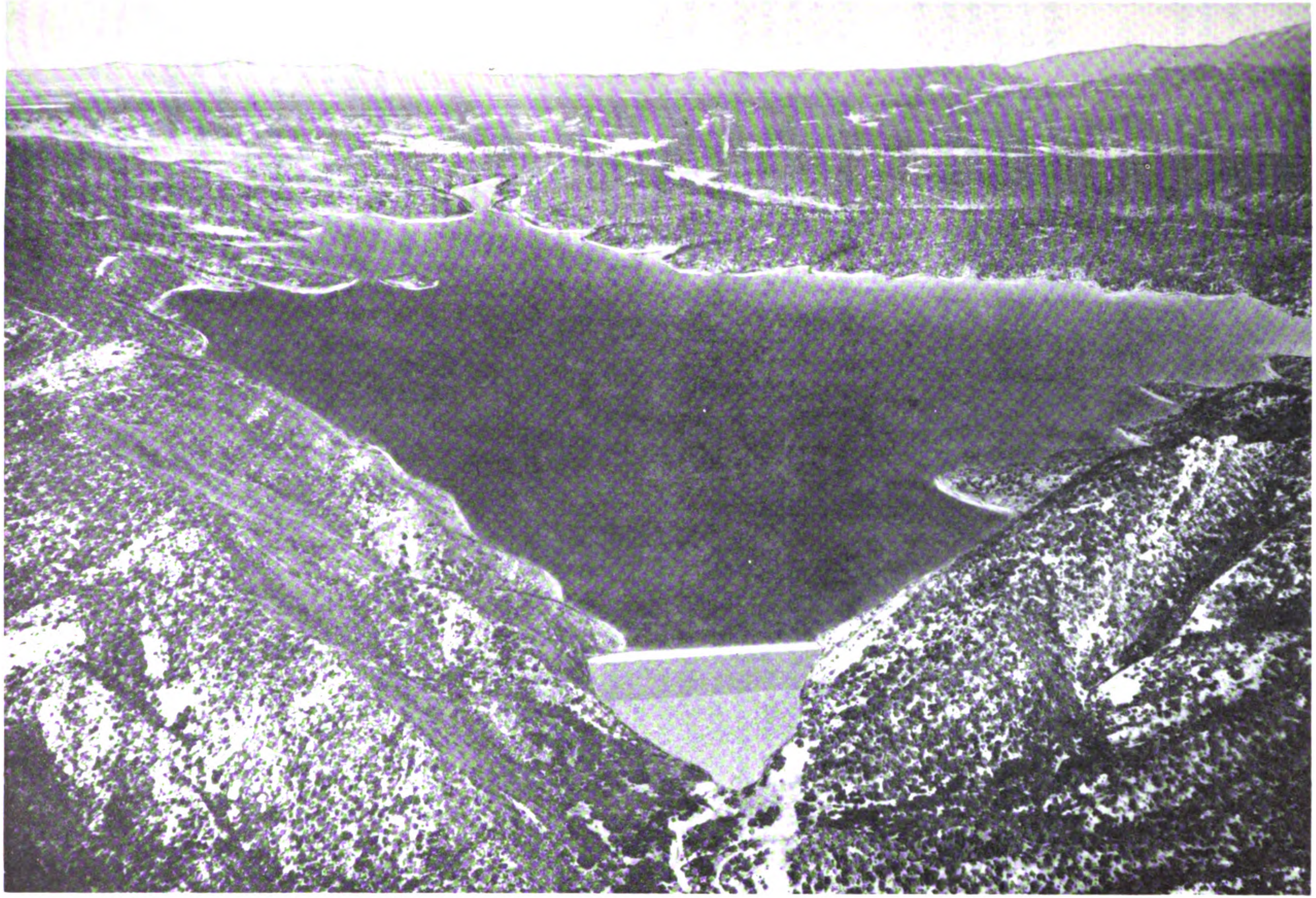


Figure A-3--Artist's concept of Ridges Basin Dam and Reservoir

have a peak electrical capacity of 23,600 kilowatts and an annual energy requirement of 50,531,000 kilowatt-hours. A 2,760-foot buried discharge line would extend from the plant to the canal. Each pumping unit would be equipped with a fish screen so that fish larger than 2-inches long would not be drawn into the plant. A switchyard and parking lot would be constructed adjacent to the plant.

(e) Dry Side Canal and Long Hollow Tunnel

The Dry Side Canal, which would extend over 27.4 miles from Ridges Basin Pumping Plant to the western project lands, would be earth lined except for about 0.9 mile that would be concrete, lined, a 3.2-mile section that would be formed by the Long Hollow Tunnel, and 3.2 miles of other inline structures. Some of the canal's associated structures would be bridges, a pipe road crossing, game crossings, and siphons.

Consistent with the capacity of Ridges Basin Pumping Plant, the Dry Side Canal would have an initial capacity of 700 cfs and a water depth of 7.6 feet at capacity, gradually diminishing to 230 cfs with a water depth of 4.8 feet. The Long Hollow Tunnel, which would be bored through the divide that separates the Animas and La Plata River drainages, would be concrete-lined and would have a finished diameter of 10.5 feet. The tunnel's spoil material would be used to construct a portion of the canal west of the tunnel. Construction access to the canal and tunnel would be from existing roads. An operation and maintenance road would be constructed along the crest of the left canal bank and would be permanently maintained after construction. Livestock fencing about 4 feet high would be installed on both sides of the estimated 20 miles of earth-lined canal to keep out livestock. The estimated 0.9 mile of concrete-lined canal would also be fenced on both sides with 8-foot-high fencing to prevent the entry of wildlife, particularly deer.

A total of 56,262 acres of project land would be served from the canal by means of turnouts and seven lateral systems consisting of about 162.1 miles of buried pressurized pipe. Four of the lateral systems serving about 75 percent of the land would be gravity fed, since the gradient between the canal turnouts and the land to be served is sufficient to develop pressure in the pipe lateral for sprinkler irrigation. To develop sufficient water pressure in each of the three remaining lateral systems, however, three pumping plants (shown on the general map) would be constructed to lift water from the canal to elevated steel tanks that would stand from about 145 to 220 feet above the ground surface. Each plant would be fully automatic and occupy a fenced area of about 5/8 acre. Additional information for each pumping plant is provided in Table A-3, and a typical pumping plant is shown in Figure A-4.

Table A-3
Dry Side Canal sprinkler irrigation
pumping plants

| Pumping plant | Maximum pumping rate (cfs) | Acres served | Peak electrical capacity (kW) | Average annual energy requirements (kWh) |
|---|---|---|---|---|
| Red Mesa | 77 | 6,865 | 1,900 | 3,586,000 |
| Alkali Gulch | 45 | 3,499 | 740 | 1,157,000 |
| Ute Mountain | 56 | 4,337 | 1,100 | 1,966,000 |

Construction and operation access would be provided by existing roads or the canal's operation and maintenance road. For construction purposes, access to the right-of-way of the buried lateral systems would be generally adequate from existing roads. For operation and maintenance purposes, about 63 miles of gravel-surfaced road would be constructed for access to turnouts and valves.

In addition to the four gravity turnouts and three pumping plants for irrigation, a wasteway turnout with a capacity of 700 cfs would be constructed from the canal to the La Plata River so that water could be released when needed to satisfy project purposes downstream, and another with a capacity of 30 cfs would be constructed near the canal terminus to deliver municipal and industrial water to the Ute Mountain Ute Indian Tribe. Water for rural municipal and industrial users would be turned out near Breen, Colo., treated at a proposed water treatment plant to be constructed by the water users and delivered by pipeline to users.

(f) La Plata Diversion Dam

The La Plata Diversion Dam would be located on the La Plata River about 1.5 miles from Breen, Colo., and would divert riverflows by gravity to the Dry Side Canal. The diversion dam would span the river and consist of a concrete overflow spillway 50 feet long flanked by two compacted earth dikes that would form a pond immediately upstream of about 7.5 surface acre with a maximum depth of 8.5 feet. Approximately 1,300 cubic of concrete and 11,300 cubic yards of riprap and compacted embankment material would be placed in the river. Approximately 1,300 cubic of concrete and 11,300 cubic yards of riprap and compacted embankment material would be placed in the river. Diverted flows would be conveyed to the canal through a settling basin and buried pipe inlet. Construction and operation access would be from the canal O&M road. A design drawing of the dam is shown in Attachment 5.

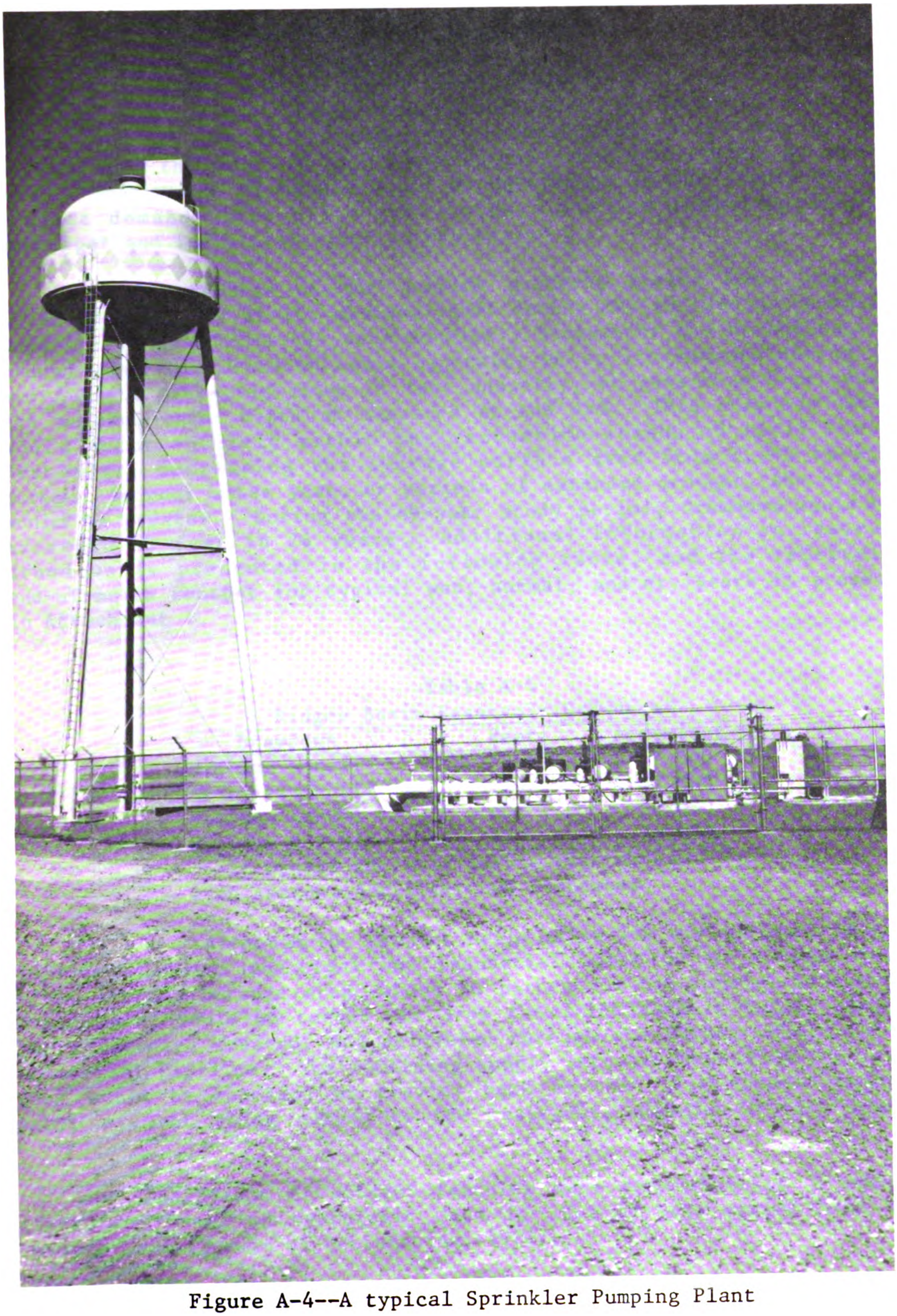


Figure A-4--A typical Sprinkler Pumping Plant

(2) Operations[1]

Pumping from the Durango Pumping Plant to Ridges Basin Reservoir could occur throughout the year, but would be done primarily during the annual spring runoff when flows in the Animas River were highest. Pumping would be restricted so that a minimum of 125 cfs in the winter and 225 cfs in the summer or natural flow, whichever was less, would bypass the plant to help preserve the river's ecosystem and appearance. The amount of bypass would be determined by the downstream non-project demands with prior water rights and the demand for project municipal and industrial water in New Mexico.

Because of the pumping pattern, Ridges Basin Reservoir would generally be at its maximum level during May and reach the maximum capacity in 20 of the 49 years studies. Because of the demand pattern, annual reservoir drawdown would generally be at its maximum during July and August, averaging about 22 feet annually, or less than 8 percent of the maximum water depth as measured at the dam. This drawdown usually would occur entirely within the recreation season of April through September, decreasing the average surface area from 2,160 to 1,950 acres. In poor water years or periods of extended drought, the drawdown would be greater. During the 49-year study period, drawdown would have exceeded 22 feet in 26 years. Additional information on reservoir drawdown is presented in the following table, and the reservoir's end-of-month content for typical wet, normal, and dry years is presented in Attachment 1.

Table A-4
Ridges Basin Reservoir Drawdown

| Drawdown | Feet | Acre-feet |
|---|---|---|
| Minimum annual | 3.4 | 7,000 |
| Average annual1/ | 22 | 47,000 |
| Maximum annual | 40 | 84,000 |
| Maximum monthly | 17 | 35,000 |

1/ Occurs entirely during the recreation season, April through September.

Although the project would allow for the delivery of 8,200 acre-feet of the municipal and industrial water on an average annual basis for the Durango area, about 90 percent of the supply, as shown in Figure A-5, would be turned out from the inlet conduit before reaching the reservoir, treated, and delivered through the Durango Municipal and Industrial Pipeline. The remaining supply actually stored in the reservoir would be released by gravity back to the inlet conduit whenever water was not being pumped to the reservoir, usually in late summer.

1/ Operations of project features were studied using a computer simulation based on hydrologic data for the 49-year period from 1929 through 1977 (Bureau of Reclamation, 1979).

Releases from the outlet works at Ridges Basin Dam to satisfy municipal and industrial demand in New Mexico would be infrequent, since most of the average annual supply would simply be bypassed at the Durango Pumping Plant, as shown in Figure A-5. When there was insufficient flow in the Animas River to supply nonproject and project demands, downstream releases would be made from the outlet works to Basin Creek. During the 49-year study period, releases would have been made for short periods of 1 to 3 months in 21 years and would have averaged between 20 and 25 cfs with a maximum of 70 cfs.

As shown in Figure A-5, the largest demand on the storage provided in Ridges Basin Reservoir would come from project users served through the Dry Side Canal. Because the canal could have freezing and maintenance problems during the winter months, all pumping to the canal would occur from April through October. In addition, all canal flows would be needed to satisfy peak irrigation demands in June and July. Therefore, it would be necessary for the Ute Mountain Ute Indian Tribe and the rural water users to provide secondary storage for the municipal and industrial water delivered to them through the canal.

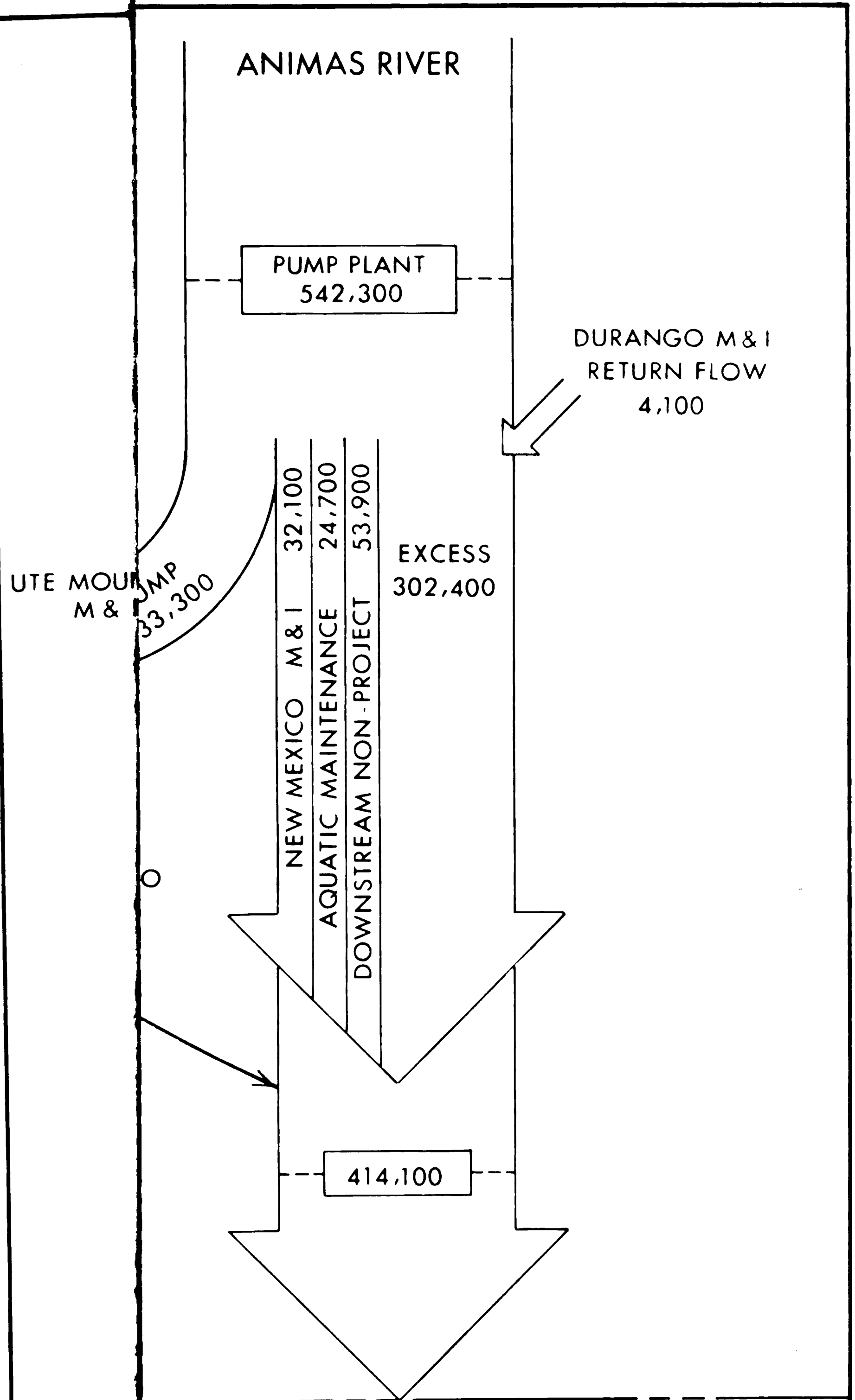
Releases to the La Plata River from the Dry Side Canal would be needed to supplement the supply available for Southern Ute Reservoir downstream and to replace water that would be diverted upstream from the canal for supplemental irrigation under project operation. Releases for one or both of these purposes would generally occur throughout the summer except during peak irrigation demand periods when the entire capacity of the canal would be required to serve the seven project lateral systems. Diversions to the Dry Side Canal from the La Plata Diversion Dam would be intermittent and would occur only when the natural flow of the river exceeded existing downstream water rights in addition to the diversion capability to Southern Ute Reservoir downstream, or when the reservoir was full. The diversion dam would have been operated during 17 years of the 49-year study period.

c. <u>Southern Ute Reservoir System</u>

(1) <u>Design</u>

(a) <u>Southern Ute Diversion Dam and Inlet Canal</u>

The Southern Ute Diversion Dam, which would span the La Plata River, would be located 2.8 miles north of the State line and would consist of a concrete overflow spillway 100 feet long flanked by two compacted earth dikes that would form a pond of about 17 surface acres with a maximum depth of 9.5 feet at the dam. About 2,400 cubic yards of concrete and 16,250 cubic yards of riprap and compacted embankment material would be placed in the river. A design drawing of the dam is shown in Attachment 5. Water would be diverted from the pond to the Southern Ute Inlet Canal, which would have a capacity of 375 cfs, a water depth of 4.5 feet at capacity, and a concrete lining for almost its entire length of 3.3 miles. Fencing would be installed to exclude




## ANIMAS - LA PLATA PROJECT
### WATER DISTRIBUTION DIAGRAM
### (AVERAGE ANNUAL 1929-1977)

DIVERSIONS ARE PROJECT WATER ONLY
RETURN FLOWS ARE FROM PROJECT
AND NONPROJECT USERS

FIGURE A-5

livestock along the entire canal. Construction and operation and maintenance access to the diversion dam would be over an existing road that would be upgraded. Construction access to the canal would be from existing roads. An operation and maintenance access road would be constructed along the canal bank.

Some project land would be served directly from the canal by means of the Southern Ute Pumping Plant, which would pump water from the canal into an elevated tank that would pressurize an irrigation lateral system serving project land immediately north of the State line. The pumping plant would be similar to those to be constructed along the Dry Side Canal. About 4.6 miles of buried laterals would convey water for the irrigation of 988 acres. Table A-5 provides additional information for the pumping plant.

Table A-5
Southern Ute Pumping Plant

| | |
|---|---|
| Maximum pumping rate (cfs) | 17 |
| Acres served | 988 |
| Peak electrical capacity (kilowatts) | 600 |
| Average annual energy requirement (kilowatt-hours) | 1,080,000 |

(b) Southern Ute Dam and Reservoir

Southern Ute Dam and Reservoir would store water for the irrigation of project land in New Mexico and for industrial use on the Southern Ute Indian Reservation. The dam would be located in New Mexico on Cinder Gulch, an intermittent tributary 2 miles east of the La Plata River. Figures A-6 and A-7 show the site and an artist's concept of the reservoir. It would be a rolled, earthfill structure with a height of 170 feet, a crest length of 2,900 feet, and a material volume of 2,640,000 cubic yards. An outlet works with a 730-cfs discharge capacity would be constructed near the left abutment. The dam would not have a spillway because the reservoir's surcharge capacity of 3,300 acre-feet, in conjunction with the outlet works, would protect the dam against the inflow design flood.

The reservoir with a capacity of 70,000 acre-feet, would extend about 2.6 miles up Cinder Gulch and would receive water from the Southern Ute Inlet Canal. The reservoir's active capacity of 40,000 acre-feet would be released through the outlet works. The dead and inactive capacity of about 30,000 acre-feet, which would form the reservoir's minimum pool and would not be drawn upon under normal circumstances, would benefit recreation and fishing use at the reservoir. Table A-6 provides additional data on the reservoir.

Table A-6
Southern Ute Reservoir

| | |
|---|---|
| Capacities (acre-feet) | |
| Active | 40,000 |
| Inactive | 29,500 |
| Dead storage | 500 |
| Total | 70,000 |
| Surcharge | 3,300 |
| Deposited sediments after 100 years (acre-feet) | 3,900 |
| Surface areas (acres) | |
| Top of active capacity | 1,386 |
| Top of inactive capacity | 821 |
| Top of dead storage | 37 |
| Top of surcharge capacity | 1,421 |

A fence would be constructed around the reservoir right-of-way to keep livestock from entering. The fence would be 9 3/4 miles long. Construction access would be over an existing road that would be upgraded. For operation and maintenance access to the dam and outlet works, a road about 2 miles long would be constructed from Colorado State Highway 140, generally following the course of the Southern Ute Inlet Canal.

(c) New Mexico Irrigation Canal

The New Mexico Irrigation Canal would extend for 3.1 miles in a westerly direction from the outlet works of Southern Ute Dam and would be earth lined for its entire length. The canal, with a capacity of 140 cfs and a water depth of about 4 feet, would also include various inline structures. A livestock fence 6.2 miles long would be constructed along the entire length of the canal, and a permanent operation and maintenance road would be located next to the canal.

Three irrigation turnouts would be located along the canal. Two would serve 6,370 acres through 21.6 miles of buried laterals and would develop sufficient pressure for sprinkler irrigation from the gradient between the canal turnouts and the project land. The third turnout, serving 1,874 acres, would require a pumping plant to develop the necessary water pressure for sprinkler irrigation. This plant, the Third Terrace Pumping Plant, would be similar to those along the Dry Side Canal and would connect to 9.5 miles of buried lateral. Access to the pumping plant during construction and for operation and maintenance would be over the canal operation and maintenance road; construction access to laterals would be from existing roads, and approximately 7.3 miles of gravel-surfaced road would be constructed to provide access to laterals for operation and maintenance. Table A-7 provides additional data on the pumping plant.

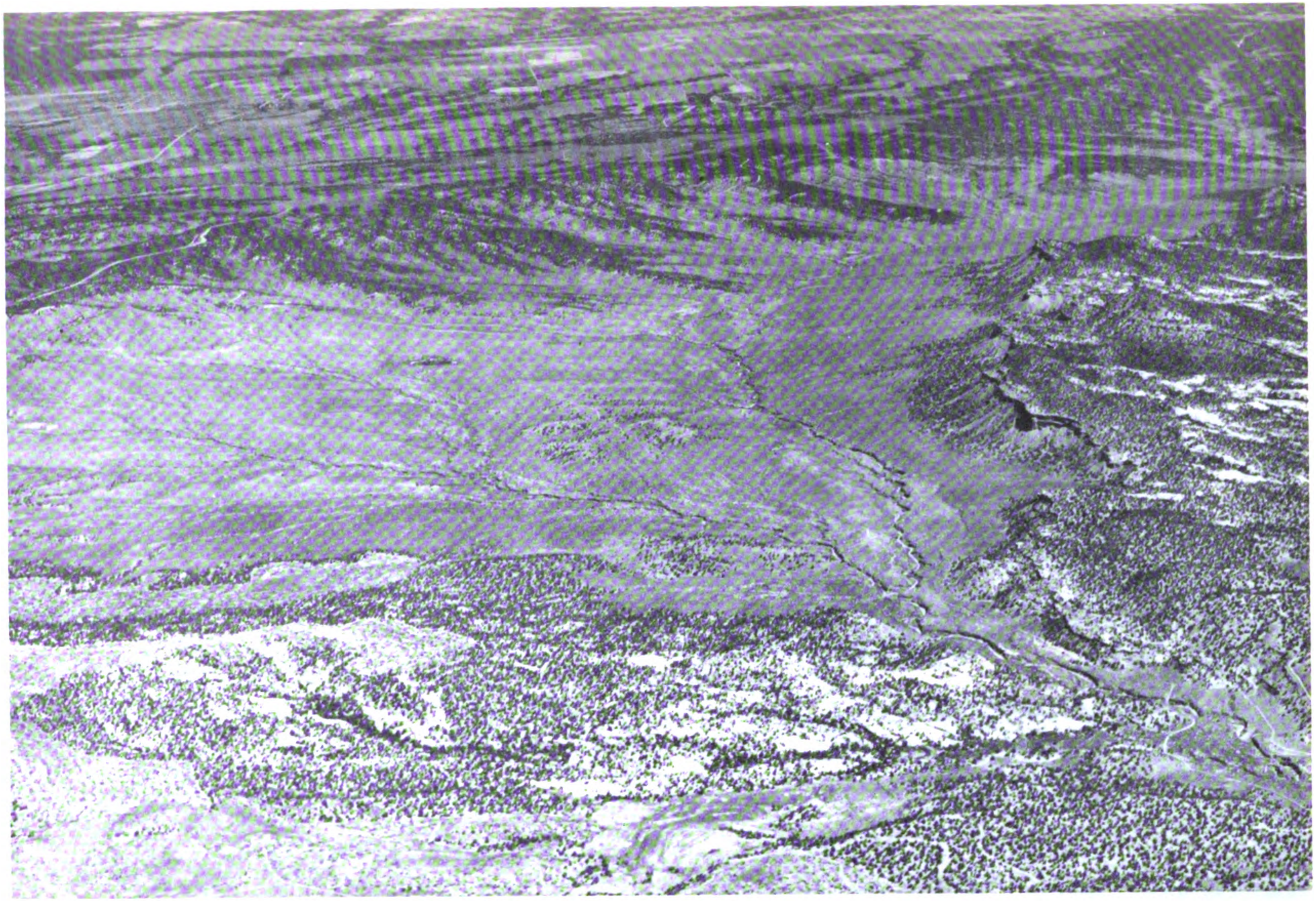


Figure A-6--Aerial view of Southern Ute Dam and Reservoir site

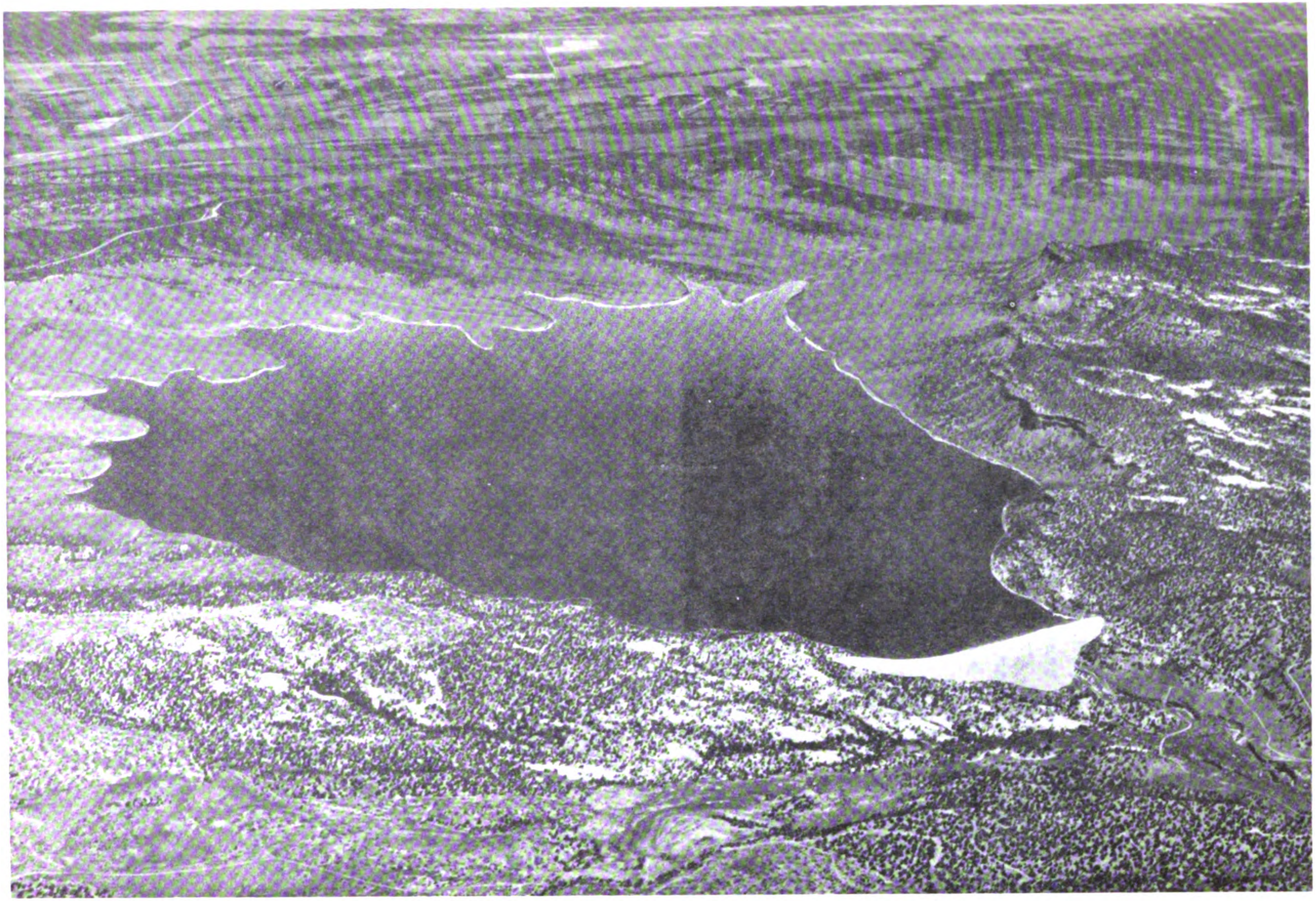


Figure A-7--Artist's concept of Southern Ute Dam and Reservoir

Table A-7
Third Terrace Pumping Plant

| | |
|---|---|
| Maximum flow (cfs) | 30 |
| Acres served | 1,874 |
| Peak electrical capacity (kilowatt) | 500 |
| Average annual energy requirement (kilowatt-hour) | 973,000 |

(2) Operations[1/]

Essentially all flow in the La Plata River would be diverted to Southern Ute Reservoir, although bypass would occur under certain circumstances. Flows would be bypassed to fulfill prior non-project rights in New Mexico, usually occurring in May and averaging 200 acre-feet annually. In addition, flows would be bypassed whenever necessary to ensure a streamflow of 1 cfs at the Colorado-New Mexico State line. In addition to natural La Plata River runoff, most of the return flow from project land would be diverted to Southern Ute Reservoir for reuse, as would water turned out from the Dry Side Canal to the La Plata River specifically for storage in Southern Ute Reservoir.

Southern Ute Reservoir would be maintained at approximately one-half capacity during average runoff years with the total capacity used for storage only during years of high runoff (in 6 years during the 49-year study period). This practice would keep pumping from Ridges Basin Reservoir, and consequently project operating costs, to a minimum while maximizing project efficiency. The annual maximum level would generally occur in May, and the annual minimum level would usually occur in March. During the 49-year study period, the reservoir was drawn down to the top of the inactive pool only in 1 year. Releases of municipal and industrial water from Southern Ute Reservoir would be made year round at a constant rate of 36.6 cfs. Releases for irrigation for New Mexico project land would be made to meet demands during the irrigation season.

Because of the large constant municipal and industrial demand and the low inflow during the winter, the reservoir water level would usually be at its lowest during March and would result in an average drawdown of 9 feet, decreasing the surface area from 1,265 to 1,150 acres. During the 49-year study period, the average annual drawdown of 9 feet was exceeded in 28 years. The following table is a summary of information on drawdown that was developed using the computer simulation of operations. The reservoir's end-of-month content for typical wet, normal, and dry years is presented in Attachment 1.

---

1/ Operations of project features in the Southern Ute Reservoir system were studied using computer simulation of operations, as for Ridges Basin Reservoir system, based upon hydrologic data for the 49-year period from 1929 through 1977 (Bureau of Reclamation, 1978).

Table A-8
Southern Ute Reservoir Drawdown

| Drawdown | Feet | Acre-feet |
|---|---|---|
| Minimum annual | 3 | 3,900 |
| Average annual | 9 | 11,000 |
| Average during recreation season1/ | 7 | 8,500 |
| Maximum annual | 19 | 21,700 |
| Maximum monthly | 6 | 7,300 |

1/ April through September.

d. Drainage Facilities

Project drainage facilities would be provided on full and supplemental service land in the project area, except for the supplemental service land receiving water by exchange, in locations that demonstrate drainage needs during the early years of project operation. Preliminary estimates based on an examination of soil and topographic characteristics indicate that about 45 miles of drains would be needed in Colorado and 21 miles of drains in New Mexico (Bureau of Reclamation, 1979). The drains would consist of pipes buried at depths ranging from 7 to 10 feet, manholes, and surface outlet channels. After the completion of construction and the restoration of vegetative cover, those portions of the drains above ground which would be serviced by the district or tribes would consist of manholes made of steel or concrete pipe and the 55 miles of outlet channels to existing drainageways in the La Plata, Mancos, and San Juan River drainages.

e. Recreation Facilities

Recreation facilities would be constructed at both project reservoirs to help meet existing and projected needs in camping, fishing, boating, picnicking, and sightseeing. The facilities would accommodate 2,720 people at one time and an estimated annual use of 307,500 recreation days. The locations of the facilities are shown in Figure A-8

The development at Ridges Basin Reservoir, accommodating 1,800 people at one time and 210,000 recreation days annually, would include 10 miles of hiking trails, 54 camping units, 48 picnic units, a seven-lane boat ramp, a boat dock, 3 miles of paved access roads, 574 parking stalls and an entrance station, and administrative building. Drinking water, electricity (not at individual camp units), and minimal sanitary facilities would also be provided.

To preserve the natural setting within the Ridges Basin Reservoir boundary as much as possible, recreation facilities would be concentrated at the northwest end, and the point of access to the recreation area would be controlled by a single entrance station. In addition, 15 miles of fencing to be provided along the northern, western, and

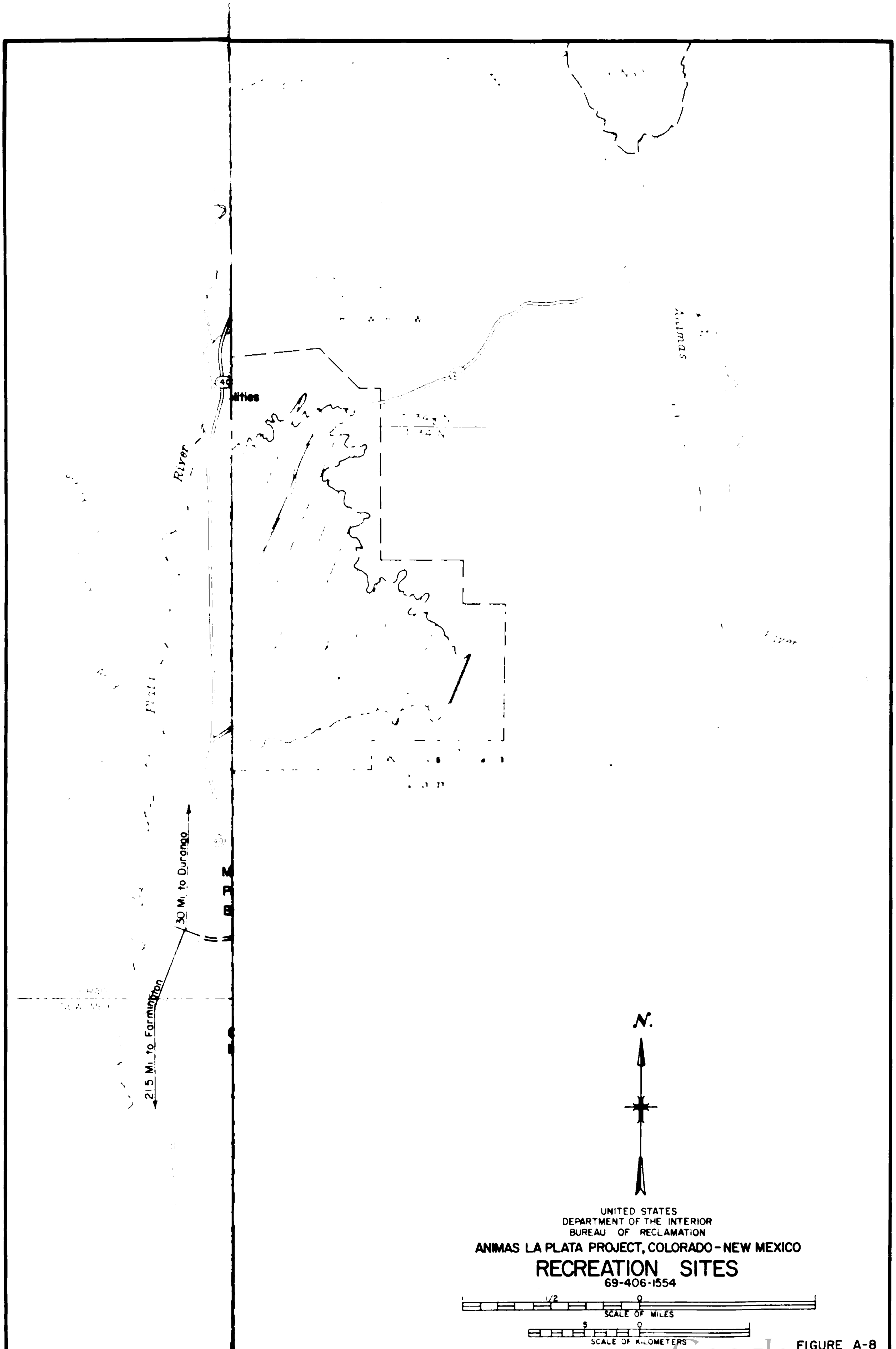

River
30 Mi. to Durango
21.5 Mi. to Farmington
N.
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ANIMAS LA PLATA PROJECT, COLORADO-NEW MEXICO
RECREATION SITES
69-406-1554
1/2
0
SCALE OF MILES
5
0
SCALE OF KILOMETERS

FIGURE A-8

southwestern boundaries would facilitate recreation management at the reservoir by limiting uncontrolled access. To enhance the natural lake setting, the western part of the reservoir would be restricted to non-motorized boats.

Recreation development at Southern Ute Reservoir, accommodating 920 people at one time, and 97,500 recreation days annually would include 76 camping units, 16 picnic units, a four-lane boat ramp, a boat dock, 2 miles of paved access and 5 miles of graveled access roads, 276 parking stalls, and an entrance station and administrative building. Drinking water, electricity (not at individual camp units), and minimal sanitary facilities would be provided. The development here would also be centralized on the southwestern shore to preserve as much as possible the natural setting. The fenced rights-of-way and entrance station would facilitate management.

f. Transmission Facilities

Hydroelectric power for the project would be obtained from the Colorado River Storage Project Shiprock Substation 12 miles west of Farmington and conveyed by the proposed 115-kV Shiprock-Durango Transmission Line, which would extend for 52 miles from the substation to the Durango Pumping Plant, or power would be purchased. The location of the corridor is shown on the general map. Both the Ridges Basin and Durango Pumping Plants would be adjacent to the Shiprock-Durango transmission line and would be served directly from it, while the irrigation pumping plants would be served by tap lines totaling 23 miles in length. The line would not be constructed if additional power is developed in the area, and purchasing of power or an existing line would be more economical. The distances involved would be essentially the same from the other sources. These facilities would require an average of 165 million kilowatt-hours annually, with a peak load of 54,000 kilowatts. The outlet works at the two dams and the recreation facilities would require only an incidental amount of power, which would be supplied by existing lines in the area. Table A-9 provides information on the project transmission line.

Table A-9
Transmission lines

| Line | Length (miles) | Capacity (kV) |
|---|---|---|
| Shiprock-Durango Transmission line | 52.0 | 115 |
| Tap lines | | |
| Ridges Basin Reservoir System | | |
| Red Mesa Pumping Plant | 3.0 | 46 |
| Alkali Gulch Pumping Plant | 7.9 | 46 |
| Ute Mountain Pumping Plant | 7.6 | 46 |
| Southern Ute Reservoir System | | |
| Southern Ute Pumping Plant | 0.5 | 12.5 |
| Third Terrace Pumping Plant | 4.0 | 12.5 |

The transmission poles of the main line if constructed would consist of a double-pole H frame made of wood and would be 40 to 75 feet high and 25 feet wide between the outer wires. For the tap lines, the transmission poles would be 30 to 60 feet high with a single or double crossarm about 8 feet wide. All of the transmission lines and poles would conform to acceptable standards to protect raptors. Construction and operation and maintenance access would be over existing roads and along the rights-of-way for the transmission and tap lines.

g. Sources of Construction Materials

The required construction materials for building the dams, pumping plants, and canals would include impervious and pervious earth fill, riprap, concrete aggregate, and ready-mix concrete. Table A-10 lists the quantities of materials required for the storage dams, and Figures A-9 and A-10 show the location of the earthfill and riprap materials to be used.

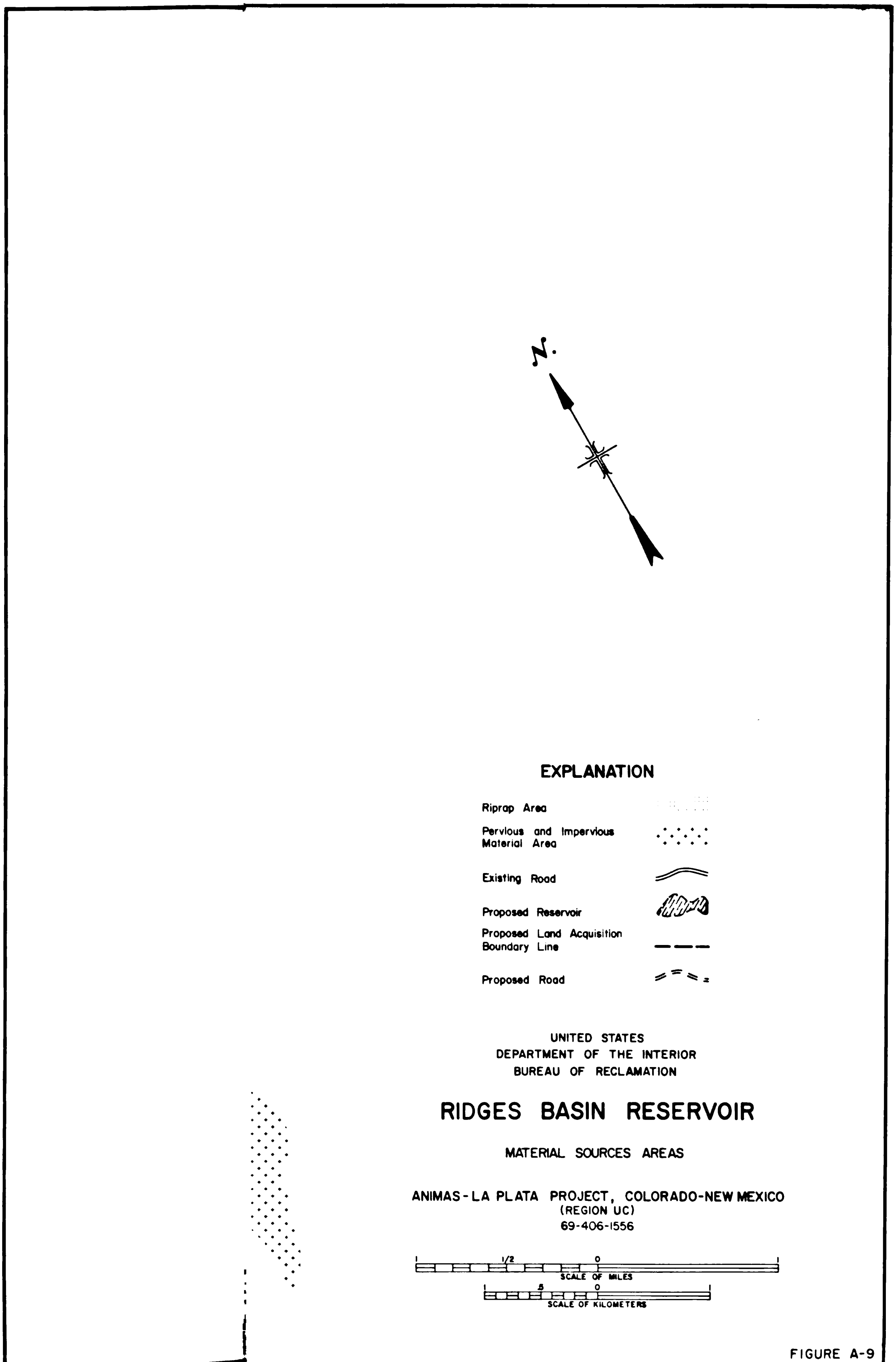
Table A-10
Materials required for project dams

| | Quantity (cubic yards) | | |
|---|---|---|---|
| | Impervious | Pervious | Riprap |
| Ridges Basin Dam | 2,600,000 | 4,970,000 | 29,000 |
| Southern Ute Dam | 1,900,000 | 680,000 | 43,000 |
| Total | 4,500,000 | 5,650,000 | 72,000 |

The impervious materials for both dams would be available below the maximum water level of the respective reservoirs. The impervious materials for lining the Dry Side Canal would be obtained along the canal alignment. The materials for lining the New Mexico Irrigation Canal would be obtained from along the canal alignment and from below the maximum water level of Southern Ute Reservoir and hauled over existing adequate roads for a maximum of 3 miles. Impervious fill material for the La Plata and Southern Ute Diversion Dams would be obtained from lean clay deposits adjacent to the La Plata River. On completion of removal activities, all of the areas would be shaped to conform with the surrounding terrain, and those outside the reservoir basins would, in addition, be covered with topsoil and then seeded.

Pervious material for construction of Ridges Basin Dam would come from terrace deposits along the Animas River and would be hauled 3.5 miles along upgraded roads. The pervious materials for Southern Ute Dam would come from deposits along the La Plata River and would be hauled from 2 to 6 miles along existing adequate roads. Pervious fill material would be aggregate, sand, and gravel from La Plata River deposits or nearby river terrace deposits. The coarse gravel borrow material for the Dry Side Canal, New Mexico Irrigation Canal, and the features along these canals would come from along the canal alignments.

Riprap for construction of Ridges Basin and Southern Ute Dams and the fill material for La Plata and Southern Ute diversion dams would be obtained from an existing granite and quartzite quarry located about


N.
EXPLANATION
Riprap Area
Pervious and Impervious Material Area
Existing Road
Proposed Reservoir
Proposed Land Acquisition Boundary Line
Proposed Road
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIDGES BASIN RESERVOIR
MATERIAL SOURCES AREAS
ANIMAS-LA PLATA PROJECT, COLORADO-NEW MEXICO
(REGION UC)
69-406-1556
1/2
0
1
SCALE OF MILES
.5
0
1
SCALE OF KILOMETERS
FIGURE A-9

5 miles north of Lemon Dam (see General Map). The materials would be hauled over existing, adequate roads about 25 miles to Ridges Basin Damsite and 45 miles to Southern Ute Damsite.

Manufactured materials such as cement, pipe, steel gates and structures, pumps, electric motors, and operating and control equipment would probably be obtained from outside the project area. The materials would be hauled to the construction sites by truck.

h. Cultural Resources Program

The project would include a program to compensate for losses of archaeological sites that would occur as a result of construction and operation. This program would be undertaken in coordination with the Colorado State Historic Preservation Officer and the Advisory Council on Historic Preservation. Based upon site densities indicated in previous studies, it is estimated that as many as 3,500 sites may be identified before project investigations are completed. Most of these sites are from the Anasazi or "ancient ones," one of the more advanced prehistoric cultures of North America.

The proposed program would consist of data recovery, analysis, technical publication, and construction of storage and curation facilities for permanent maintenance of the artifact collection and other related information. In addition to the scientific value, this would produce information of considerable public interest. An enhancement program is also proposed which would include a visitor center, stabilization and interpretation of significant ruins, displays of active excavations, and similar public-oriented facilities and activities.

Many sites could be preserved in their present condition by adjusting the alignments of project facilities to avoid them whenever possible (such as road rights-of-way, recreation areas, and laterals). Extensive data recovery would be necessary on a sample of sites adequate to answer basic questions on the development of Anasazi society, which would be about 175 sites or about 5 percent of those believed to be in the project area. The program would proceed at a rate of approximately 25 sites per year for 7 years. To complete the regional picture and provide information on settlement patterns, population densities, and similar problems, minimal data recovery would be obtained through site visits at 1,000 sites and through the use of various remote sensing techniques.

The Antiquities Act of 1906 requires storage and curation at a public facility for artifacts and information recovered from public land to ensure future scientific and public use of the material. The availability of carefully curated collections significantly decreases the need to excavate additional sites and thus plays an important role in continued preservation. The Bureau proposes to construct such a facility and to seek cooperative agreements with other agencies for its operation.

In addition, the Bureau is evaluating the possibility of constructing a visitor center near Ridges Basin Reservoir to display and interpret the Anasazi Tradition. The center would be designed to complement facilities currently available in Mesa Verde National Park to the west of the project area. The location proposed would result in year-round accessibility, whereas Mesa Verde is virtually closed by weather during the winter.

The Bureau is authorized to expend nonreimbursable project funds of up to 1 percent of the authorized project cost to mitigate impacts on cultural resources, under the Archaeological and Historic Preservation Act of 1974 (Public Law 93-291). Because of the large number of sites in the area, however, it is estimated that an adequate program would exceed this authorization, and the Bureau would consequently seek Congressional approval for the additional expenditures required (about 4 percent of the project cost). The proposed measures discussed in this section are based upon such additional funding.

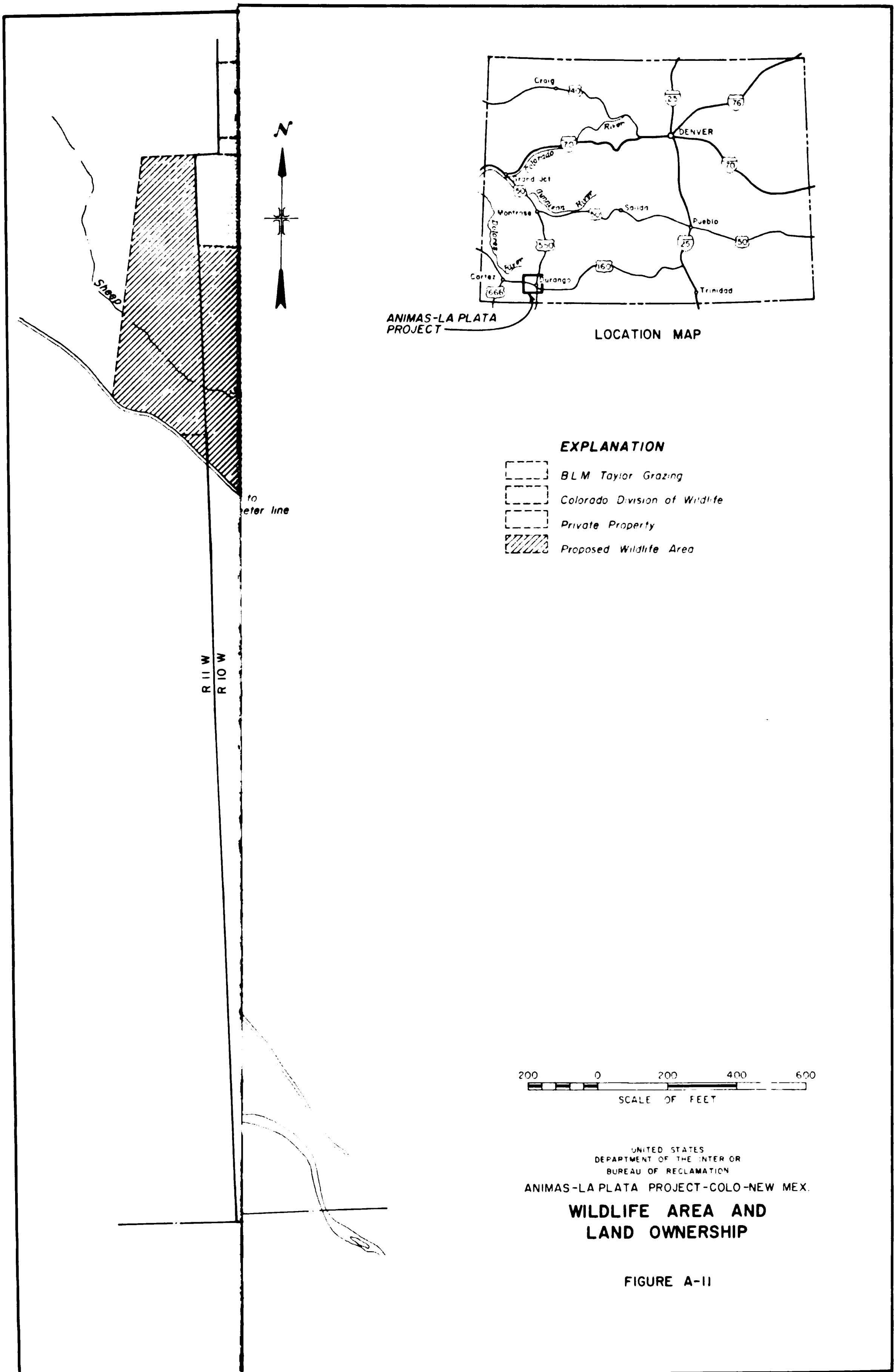
i. Fisheries Program

The fisheries program would consist of a stocking plan both to establish and to maintain fisheries at Ridges Basin and Southern Ute Reservoirs. Initially, both reservoirs would be stocked with fry-fingerling size trout. If the plants prove successful, this program would be perpetuated, along with the possible introduction of kokanee salmon in Ridges Basin Reservoir. Eventually, public fishing demand might increase to the point that catchable-size rainbow trout might be stocked in both reservoirs to supplement the game fish populations. Fish screens would be provided at the Durango and Ridges Basin Pumping Plants to prevent fish larger than two inches from entering the pumps. Also, a fish screen installed at the Southern Ute Diversion Dam would prevent the migration of larger-sized rough-fish species into Southern Ute Reservoir.

j. Wildlife Program

The wildlife program would include several measures to compensate for habitat losses. To compensate for about 2,500 acres of wildlife habitat that would be lost because of Ridges Basin Reservoir and other project features (excluding Southern Ute Reservoir), two tracts of land would be acquired and developed for big game (See Figure A-11). These areas consist of 1,600 acres of primarily oakbrush vegetation located north of U.S. Highway 160 and west of Durango and 900 acres of predominantly pinyon-juniper located west of the proposed reservoir site. Development, which would benefit both big game and other wildlife, would consist of chaining, seeding, and instituting management practices specifically for wildlife.

To compensate for inundation of 1,400 acres of habitat at Southern Ute Reservoir, about 1,000 acres of land acquired for the reservoir would be developed and managed for wildlife. Development would include establishing food plots, reseeding, clearing selected areas, and fencing.




UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ANIMAS-LA PLATA PROJECT-COLO-NEW MEX.

**WILDLIFE AREA AND LAND OWNERSHIP**

FIGURE A-11

To help prevent wildlife, primarily deer, from accidentally entering the 0.9 mile of concrete-lined section of Dry Side Canal, protective fencing about 8 feet high would be installed along this section, and a bridge would be constructed to allow deer to cross the canal. In addition to protective fencing, wildlife escape devices would be installed on concrete-lined sections of the Southern Ute Inlet Canal as well. These devices would consist of flotation logs that would span the canal and be anchored by cable to the banks. The side slopes in these sections of canal would be at a ratio of 4:1 to permit escape. Game crossings to provde access for wildlife over project canals would be installed to coincide with game trails in the area. The exact number has not been identified but from 3 to 11 crossings would be necessary. The Bureau, in conjunction with the Colorado Division of Wildlife, would select the sites for the crossings prior to completion of the canals.

k. Relocations

At Ridges Basin Reservoir one occupied farm dwelling and several older farm structures would be relocated, probably by purchasing them and selling them back to the present owners for dismantling. The dwelling, which is owned by the Colorado Division of Wildlife and rented, is now occupied by two tenants on a temporary basis. The people who would be affected would be informed of their rights under the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646). Construction and operation of the reservoir would also entail the relocation of about 4.4 miles of natural gas pipeline around the south side of the reservoir and about 3.8 miles of natural gas pipeline, 3.5 miles of 115-kV powerline, and 1.5 miles of telephone cable around the north side of the reservoir.

The construction of Ridges Basin Reservoir would also require the relocation of a big game management area administered by the Colorado Division of Wildlife. The division purchased the land in 1974 with funds from the U.S. Heritage Conservation and Recreation Service and through a cooperative agreement with the Nature Conservancy, the original purchaser of the land. To satisfy certain encumbrances put on the land by the Service and the Nature Conservancy, the Bureau of Reclamation must replace a portion of the Division of Wildlife's 7,000 acres, totaling about 4,000 acres, with land of equal value in terms of wildlife, acreage, and monetary amounts. The land, obtained from a willing seller and preferably in single ownership, would be acquired at an as yet undetermined location near the project area and turned over to the Division concurrently with the acquisition of land at Ridges Basin.

At Southern Ute Reservoir about 2.5 miles of natural gas pipeline would be relocated. The wellheads of two gas wells that area near the edge of the reservoir would be raised to prevent inundation.

## 5. Construction Program

The construction of the project would be under the supervision of a construction office located at Durango. Field offices of a temporary nature would be set up at the Ridges Basin and Southern Ute Damsites and next to the Red Mesa and Ute Mountain Pumping Plants. It is anticipated that construction personnel would live in the communities in the project area.

Construction of the project would take approximately 10 years. During the eighth year of construction, which is estimated to be the peak year, the project would furnish direct employment for about 800 private and Governmental employees. Total local employment over the 10 years of construction would amount to about 6,760 man-years. The proposed construction schedule is shown in Figure A-12.

## 6. Lands for Project Features

Approximately 15,139 acres of land would be needed for project features, as shown in Table A-11. This total includes 7,559 acres of private land, 2,485 acres of land belonging to the Southern Ute and Ute Mountain Ute Indian Tribes, 4,296 acres of land administered by the States of Colorado and New Mexico, and 799 acres of Federal land.

Public land withdrawn for project features would remain under the administration of the Bureau of Reclamation for the life of the project. Private land acquired would become public land and would, except for the proposed wildlife area, remain under the administration of the Bureau of Reclamation for the life of the project. Land for the wildlife area would fall under the administration of the Colorado Division of Wildlife. Indian tribal land obtained for project purposes by permanent easement would stay under Reclamation administration, although the Tribes would keep full use and access consistent with project purposes. Land obtained for construction access easements would revert to the original owner or administrator after the completion of construction.

## 7. Municipal and Industrial Water Development

The project would provide a sufficient supply of municipal and industrial water to serve water users until about the year 2010 in New Mexico and until about 2020 in Colorado. The water users would construct a treatment plant near Ridges Basin Reservoir for the city of Durango and a treatment plant near Breen, Colo., for the rural users in the La Plata River drainage of Colorado. All of the municipalities in New Mexico would continue to divert water to their existing treatment and distribution systems. The Navajo Tribal Utility Authority would probably purchase project water treated by the city of Farmington and distribute it to the towns within its jurisdiction. All of the municipalities receiving project water would be responsible for undertaking any planned

Figure A-12
Proposed construction schedule

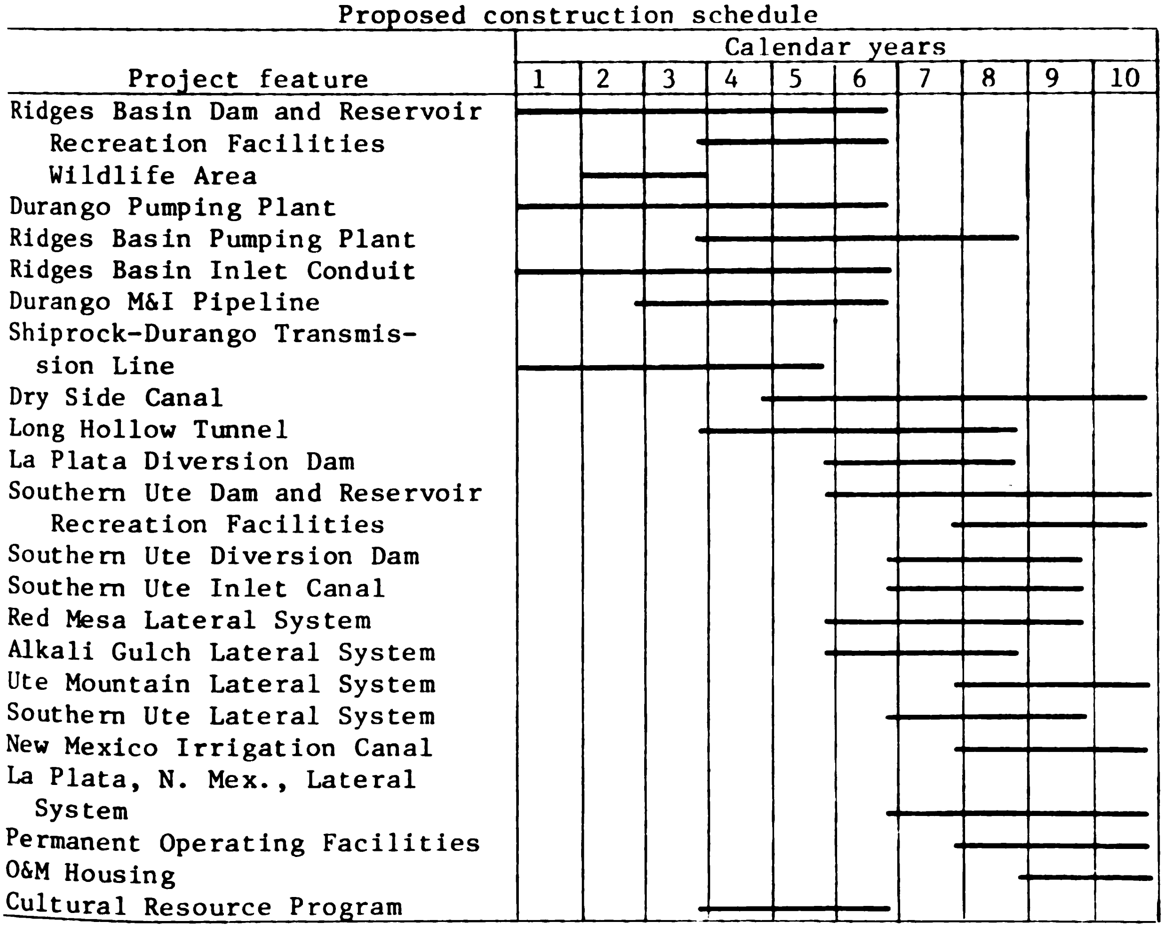


Table A-11
Lands required for project features
(acres)

| Project feature | Private | Southern Ute Tribe | Ute Mountain Ute Tribe | State of Colorado | State of New Mexico | Bureau of Land Management | Total |
|---|---|---|---|---|---|---|---|
| Ridges Basin Reservoir | | | | | | | |
| Permanent acquisition | 1,020 | | | 4,230 | | | 5,250 |
| Southern Ute Reservoir | | | | | | | |
| Permanent acquisition | 365 | 1,832 | | | | | 2,197 |
| Withdrawn | | | | | | 625 | 625 |
| La Plata Diversion Dam | | | | | | | |
| Permanent acquisition | 24 | | | | | | 24 |
| Southern Ute Diversion Dam | | | | | | | |
| Permanent acquisition | 30 | | | | | | 30 |
| Durango Pumping Plant | | | | | | | |
| Permanent acquisition | 26 | | | | | | 26 |
| Ridges Basin Inlet Conduit | | | | | | | |
| Permanent acquisition | 4 | | | 18 | | | 22 |
| Dry Side Canal | | | | | | | |
| Permanent acquisition | 596 | 28 | | | | | 624 |
| Long Hollow Tunnel | | | | | | | |
| Permanent easement | 8 | | | | | | 8 |
| Southern Ute Inlet Canal | | | | | | | |
| Permanent acquisition | 28 | 49 | | | | | 77 |
| New Mexico Irrigation Canal | | | | | | | |
| Permanent acquisition | 11 | | | | | | 11 |
| Withdrawn | | | | | | 79 | 79 |
| Durango Municipal and Industrial Pipeline | | | | | | | |
| Permanent easement | 2 | | | | | | 2 |
| Construction access easement | 4 | | | | | | 4 |
| Laterals | | | | | | | |
| Permanent easement | 585 | | 142 | | | | 727 |
| Construction access easement | 776 | | 188 | | | | 964 |
| Drains | | | | | | | |
| Permanent easement | 912 | 23 | 86 | | | | 1,021 |
| Construction access easement | 355 | 10 | 35 | | | | 400 |
| Transmission lines | | | | | | | |
| Permanent easement | 275 | 92 | | 15 | 26 | 95 | 503 |
| Operating facilities | | | | | | | |
| Permanent acquisition | 3 | | | | | | 3 |
| Wildlife area | | | | | | | |
| Permanent acquisition | 2,500 | | | | | | 2,500 |
| Ridges Basin Access Road | | | | | | | |
| Construction access easement | 35 | | | 7 | | | 42 |
| Total | 7,559 | 2,034 | 451 | 4,270 | 26 | 799 | 15,139 |

expansion of their present water storage, treatment, and distribution facilities.

In consideration of the President's July 12, 1978, directive on water policy, the water user entities would be required, in consultation with state and local interests, to prepare a water management plan for Bureau approval. Emphasis would be placed on municipal and industrial water conservation measures which could include metering requirements or management techniques.

Industrial water would be stored in Ridges Basin Reservoir for the Ute Mountain Ute Indian Tribe and in Southern Ute Reservoir for the Southern Ute Indian Tribe. The Ute Mountain Ute Indian Tribe would be responsible for conveying water from the end of the Dry Side Canal to develop coal resources on its reservation and for providing any storage facilities required, and the Southern Ute Indian Tribe would be responsible for conveying water from Southern Ute Reservoir to develop its coal resources. At this time, the Tribes do not have specific plans for developing these coal resources. Upon completion of their planning and prior to the delivery of project water, each tribe would have to comply with the National Environmental Policy Act of 1969 by assessing in an environmental statement the impact of its proposed actions. In order to convey as complete a picture as possible of fuiture conditions in the area, however, the Bureau has added to Section C-13 of this statement a brief presentation of hypothetical coal development scenarios and the major impacts that might result.

## 8. Agricultural Development

### a. General

Project irrigation water would be provided to 420 existing farms in private ownership and to the two Ute Indian Tribes. Under the provisions of the project authorization, water could be delivered to privately owned farms of 175 to 198 acres in single ownership and 350 to 396 acres in joint ownership. At the present time, between 82 and 92 owners have land in excess of the limits for single ownership, and 51 of the owners also have land in excess of the limits for joint ownership. A total of about 10,350 acres, or 15 percent of the privately owned project land, is in excess ownership. The owners would have to dispose of the excess acreage before receiving project water or sign contracts with the United States agreeing to the disposition of the land within 10 years after receiving project water. They could, however, decide not to receive project water at all, or they could retain their excess land and not receive project water for the excess land.

All Indian land is exempt from the excess acreage limitations. The Tribes would operate their land in any size farm units they might choose, ranging from large single Tribal farms to small family farms. Acreage limitations would only be imposed on this land if it should pass into non-Indian ownership.

Project irrigation supplies would be used primarily for the production of feed crops, such as alfalfa, small grains, and pasture to support beef, sheep, and dairy enterprises. Pinto beans and grain corn would be grown as cash crops.

Although the Bureau of Reclamation would construct the major pressurized lateral systems and turnouts to private farms and Tribal land, all on-farm improvements would be the responsibility of the individual landowners--whether Indian or non-Indian. On-farm improvement on the supplemental service land would consist primarily of the installation of pressurized lateral and sprinkler systems. The exception would be the land above the Dry Side Canal which would continue to be served by the present system of gravity ditches, which is adequate for the proposed development.

On full service land, on-farm improvements would include, in addition to sprinkler distribution systems, land leveling and clearing. Indian full service land would require extensive clearing since, unlike the non-Indian full service land which is already cleared for dryland farming, it is now used primarily for livestock grazing. Indian land would also require field layouts, selective fencing, and the construction of some access roads. Of particular interest in this regard is the Ute Mountain Ute Indian land which is approximately 30 road miles from Towaoc, the Tribal headquarters and population center. Because of the distance involved and the present condition of the connecting road, it is anticipated the Tribe would undertake a considerable road improvement program and the construction of a farming headquarters nearer the land to accommodate Tribal members who would work the land.

The U.S. Department of Agriculture and the States of Colorado and New Mexico are expected to provide technical assistance to individual farmers in their on-farm programs, as are the Department of Agriculture and Bureau of Indian Affairs to the two Tribes. In addition, the Bureau of Reclamation would encourage all farmers in the area to avail themselves of the programs available, including those of the Extension Service and the Soil Conservation Service, to ensure the most successful and efficient operation and management of their farms. These programs vary from year to year but generally include such items as surveys for land leveling and the furnishing of information with respect to the planning and layout of farm fields, crop and livestock programs, and weed and erosion control.

b. <u>Water Conservation</u>

As a requirement of the repayment contract, the districts, under the initial guidance of the Bureau, would institute a program of irrigation scheduling on all project land, except that receiving supplemental water by exchange (that is the land above the Dry Side Canal).

The goals of the program would be water conservation and increased agricultural production. Irrigation scheduling would involve the farm operators and district personnel, and their goal would be to test soil samples periodically to determine when crops would need water.

## 9. Water Quality Protection Program

Water quality programs would be established for both the construction and operation of the project. The construction program would consist of point-source and nonpoint-source pollution control plans.1/ The point-source plan would be developed in accordance with 40CFR125, National Pollution Discharge Elemination System (NPDES). Water quality monitoring stations would be established in accordance with NPDES requirements. Central to the nonpoint-source plan would be the establishing erosion control measures at all construction sites on or near waterways to limit water pollution from erosion. Sampling stations would be established and maintained on the Animas and La Plata Rivers during construction upstream and downstream of each construction site. Samples would be taken on a daily and seasonal basis to help monitor nonpoint-source pollution.

The Bureau would establish and maintain monitoring programs in both Ridges Basin and Southern Ute Reservoirs so limnological studies stressing water quality and aquatic biota could be carried out. Although no problems are anticipated (see Section C-5a), if problems were to occur with water quality in the reservoirs, the Bureau would determine corrective operational procedures and provide corrective measures.

The Water Quality monitoring stations which would be established during construction on the Animas and La Plata Rivers upstream of the Durango Pumping Plant and Southern Ute Diversion Dam, would be maintained by the Bureau during project operation. Analysis of samples from these stations would include nutrients, salts, suspended solids, trace elements, and bacteria. The frequency of these analyses would be at least quarterly or, if necessary, more frequently depending on the concentrations found. Data analysis would be handled by the Bureau and results made available to appropriate local, State, and Federal agencies. The Bureau would coordinate with mining companies upstream of Durango so that ample notification could be received if any water pollution were to occur. The Durango Pumping Plant would then be shut down during possible water pollution periods to prevent contaminants from being pumped into the reservoir.

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1/ Point-source pollution is that which occurs from a clearly definable source such as a discharge pipe or ditch; nonpoint-source pollution is that which occurs from a more diffuse source such as a cleared reservoir basin.

## 10. Public Safety

The Bureau would incorporate safety measures into the design of project features. In accordance with Bureau policy, the final design of Ridges Basin and Southern Ute Reservoirs would be made based on extensive geologic investigations, including complete investigation of such matters as seismic history, geology, and the material composition of the dam. Additionally, independent engineering firms with the appropriate expertise would review the design data to ensure that nothing was overlooked or incorrectly analyzed. The Bureau would develop and strictly follow criteria for filling the reservoir and monitoring the safety of the dam.

A number of safety measures would be undertaken with respect to the project's canals, including safety nets used at the inlets to all siphons and safety ladders spaced at intervals along the concrete-lined sections. Fences would be constructed around the electrical switchyards, and, where appropriate, warning signs would be installed for both construction and operation. The public would not have access to dams or pumping plants. Releases through the outlet works at Ridges Basin Dam to Basin Creek should present no hazard to the public, since these releases would begin slowly and would be relatively small in capacity. If any threats to public safety were to present themselves, measures would be taken to eliminate them or to warn people of the danger.

## 11. Project Administration

Because the project area would be located in two States and on two Indian reservations, a joint administrative board would be established under terms specified in the project repayment contract. The board would consist of representatives from the board of directors of both conservancy districts and the two Indian tribes. The board would ensure that the respective water users coordinated closely in the operation and maintenance of project facilities and in the most efficient and equitable use of project water.

The La Plata Water Conservancy District in Colorado would operate and maintain the Durango and Ridges Basin Pumping Plants, Ridges Basin Inlet Conduit, Ridges Basin Dam and Reservoir, the Dry Side Canal, and the La Plata Diversion Dam. Within its jurisdiction, the district would also operate and maintain the sprinkler irrigation pumping plants, laterals, and gravity turnouts in Colorado. The Ute Mountain Ute Indian Tribe would operate the laterals and drains within the reservation boundaries. Because the project land belonging to the Southern Ute Indian Tribe would be scattered among the non-Indian land, the tribe would contract with the district for operation and maintenance. The city of Durango would operate and maintain the Durango Municipal and Industrial Pipeline. Municipal and industrial users in the San Juan area would contract with the district for their share of the operation and maintenance of Ridges Basin Dam and Reservoir. The La Plata Conservancy

District in New Mexico would be responsible for the operation and maintenance of Southern Ute Diversion Dam and Inlet Canal, Southern Ute Dam and Reservoir, the New Mexico Irrigation Canal, the Third Terrace Pumping Plant, and gravity turnouts, laterals, and drains for the project land in New Mexico.

The operation and maintenance headquarters for the La Plata Water Conservancy District would be located near Breen, Colo. Because adequate housing is available in the area, none would be provided for district personnel. A small maintenance headquarters and one house would be located near Southern Ute Dam for the La Plata Conservancy District.

The Bureau of Reclamation would administer the recreational facilities Ridges Basin Reservoir, and the Southern Ute Tribe has expressed an interest in administering the facilities at Southern Ute Reservoir. The U.S. Fish and Wildlife Service would be responsible for the stocking of fish in the project reservoirs. Fish would be available from the Fish and Wildlife Service hatcheries constructed solely for stocking the facilities of the Colorado River projects. The Colorado division of wildlife would administer the wildlife areas near Ridges Basin Reservoir, but no administering agency has yet been determined for the wildlife area at Southern Ute Reservoir.

## 12. Interrelationships

### a. Federal Developments

The project is related both directly and indirectly to other Federal projects in the area in providing water for the multiple purposes. The project is related to 19 units and participating projects of the Colorado River Storage Project which were constructed or were under construction before 1976, and to 7 developments that have been scheduled for construction starts after 1976 and are in various stages of construction or pre-construction planning. CRSP now develops 595,500 acre-feet for the irrigation of about 349,000 acres of full and supplemental service land, generates over 5.8 million megawatt-hours of power for marketing in seven western states and for CRSP project operations, and develops about 442,500 acre-feet of water for municipal and industrial use. These projects are covered in some detail in Section C-14, "Cumulative Impacts."

Relationships exist with the Pine River, Florida, and Dolores Projects. The Pine River Project, located in Colorado to the east of the Animas-La Plata Project area, was completed in 1941 and provides supplemental irrigation water for about 13,000 acres of Southern Ute Indian land. The project water supply is developed from storage on the Pine River, a tributary of the San Juan River. The Florida Project, completed in 1964, provides irrigation and municipal and industrial water to rural areas to the east of Durango and to residents of Durango. Water is developed by storage on the Florida River, a tributary of the Animas

River. The Dolores Project, now under construction to the west of the Animas-La Plata Project area, would develop a water supply of about 126,600 acre-feet for various uses, including 8,700 acre-feet for the Ute Mountain Ute Indian Tribe for irrigation on 7,500 acres of Tribal land and for domestic use in the Tribal headquarters of Towaoc.

The project is directly related to the Navajo Indian Irrigation Project, which is under construction along the San Juan River west of Farmington to irrigate about 110,000 acres on the Navajo Reservation. Storage for the project is provided in Navajo Reservoir located on the river to the east of Farmington. The various communities housing long-term workers on this farming enterprise would receive municipal and industrial water from the Animas-La Plata Project.

b. Private Developments

As a result of the project, the water users would probably construct two water treatment plants to serve municipal and industrial users in Colorado, as stated earlier in this chapter. Although various locations for the plants are still being considered, it is likely that one would be located near the eastern edge of Ridges Basin Reservoir to serve users in the Durango area, and the other would be located near Breen, Colo., to serve rural La Plata County residents in the La Plata River drainage. Both plants would be constructed and operated in accordance with applicable Federal and State standards for water quality.

# CHAPTER B

# DESCRIPTION OF THE ENVIRONMENT

## B. DESCRIPTION OF THE ENVIRONMENT

### 1. Social and Economic Conditions

#### a. Introduction

Bordered by mountains and National Forest, and rich in archaeological resources and Indian traditions, the project area is popular recreation country for skiers, hikers, campers, and sightseers. The area is generally sparsely populated. Population concentrations are Durango, Colorado, a tourist center; Farmington, New Mexico, an expanding center for manufacturing and trade; and a number of smaller, isolated farming and ranching communities, many of them within the Ute Mountain Ute and Southern Ute Indian Reservations, where most of the project lands are located.

Various Indian groups inhabited the project area leaving evidence of their habitation in the Mesa Verde cliff dwellings. Large-scale non-Indian settlement occurred with the growth of the railway, trade, and mining in the project area in the mid-1800's. Homesteading was widespread near the turn of the century, when some unappropriated parcels of land on the Southern Ute Indian Reservation were made available to the public and which have resulted in a present-day checkerboard pattern of settlement of non-Indian and Ute Indians on that reservation.

During the first half of the 20th century, the project area was predominantly agricultural, providing a stable, if at times marginal, living. After about 1950, however, discoveries of oil and gas and other minerals expanded the population, although agriculture. to some degree, remains an underlying and stabilizing force. In the Farmington area, the growth of basic industries has provided increasing employment. During the same period, the community of Durango prospered from sharp increases in tourism, recreation-related service industries, overall retail sales, and real estate expansion. In the mid-1950's, the two Ute Indian tribes began receiving revenues from mineral leases, but royalties have been declining since the mid-1970's. Population increases in the area have continued into the late 1970's because of a basic westward movement of the Nation's population and the increasing popularity of the southwestern Sun Belt.

For the purposes of this study, information for the project area is derived from material on La Plata County, Colorado; San Juan County, New Mexico; the Southern Ute Indian Reservation in Colorado; and the Ute Mountain Ute Indian Reservation, which spans a part of both States. Statistics used are the most recent available, and the analysis is a summary of a detailed technical study (Bureau of Reclamation, 1979). Though a small portion of the Navajo Nation is found in the southwest corner of the project area, it is not emphasized since the much larger part of the reservation lies outside the project area. Since, however, the Navajos would receive 7,600 acre-feet of project municipal and industrial water from Farmington through an existing distribution system, they are discussed where appropriate.

b. Population

The 1976 project area population of about 86,000 is the product of erratic growth over the past half century, as shown in Table B-1. Before the 1950's, the growth rate remained at about 1 percent reflecting a stable agrarian society. Only Farmington grew rapidly because of its location in the fertile river valley at the junction of the San Juan, Animas, and La Plata Rivers. The mineral discoveries of the 1950's caused an increase in growth in the overall area of about 9 percent. During the 1950's, the most rapid growth occurred in San Juan County, with an unprecedented growth rate of 21 percent in Farmington. The 1960's saw a decrease in growth throughout the area following a decline in exploration activities. However, growth has since picked up and the population is currently increasing due both to renewed interest in mineral development, particularly in San Juan County, and an expanding recreation and tourism industry, particularly in Durango in La Plata County.

More than 75 percent of the population of the project area resides in Durango (12,600) and Bayfield (1,100) in Colorado; and Farmington (37,000), Aztec (6,900), Bloomfield (4,300) and Shiprock (5,200) in New Mexico. High growth rates for Bayfield and Bloomfield since 1970 have resulted from the spillover in populations from rapidly growing Durango and Farmington, which are near the two smaller communities. The remaining population resides in rural areas which include the unincorporated towns of Breen, Kline, Marvel, and Redmesa in Colorado, and La Plata, Blanco, and Fruitland in New Mexico.

In 1970, the last official census year, approximately 25 percent of the population of La Plata County and 59 percent of the population of San Juan County were members of racial and ethnic minorities. Members of the three Indian tribes made up about two-thirds of the minority population. The Southern Ute Indians live primarily in Ignacio, their tribal headquarters and a town of about 1,000 persons in La Plata County. The major portion of the Ute Mountain Ute Tribe resides in Towaoc (1,070) in Montezuma County, which serves as their tribal headquarters. The Navajos in the project area reside primarily in Shiprock and Farmington and account for most of the large minority population in San Juan County. Hispanic Americans make up approximately one-third of the minority population (10,600 people). About 6,900 live in San Juan County and 3,700 in La Plata County. Other minority groups comprise only about 1 percent of the area's population.

| | wth te :0-90 | 2000 | Growth rate 1990-2000 | 2010 | Growth rate 2000-10 | 2020 | Growth rate 2010-20 |
|---|---|---|---|---|---|---|---|
| Project area | .1 | 212,744 | 3.2 | 269,709 | 2.4 | 346,492 | 2.5 |
| La Plata County | ..7 | 46,744 | 2.1 | 59,409 | 2.4 | 79,792 | 3.0 |
| Durango | ..4 | 21,054 | 1.9 | 26,361 | 2.3 | 35,035 | 2.9 |
| Remainder Durango servi | .0 | 11,148 | 5.0 | 12,314 | 1.0 | 13,302 | .8 |
| Rural La Plata service | .4 | 2,700 | 1.9 | 3,260 | 1.9 | 3,930 | 1.9 |
| Bayfield | .1 | 6,226 | 4.6 | 9,495 | 4.3 | 14,742 | 4.5 |
| Southern Ute Indian Tribe | .2 | 1,082 | 1.0 | 1,151 | .6 | 1,190 | .3 |
| Ute Mountain Ute Indian Tr | .2 | 2,150 | 1.9 | NA | | NA | |
| San Juan County | .6 | 204,920 | 3.6 | 259,760 | 2.4 | 329,290 | 2.4 |
| Farmington | .7 | 105,600 | 3.6 | 133,800 | 2.4 | 169,600 | 2.4 |
| Aztec | .6 | 19,200 | 3.6 | 24,300 | 2.4 | 30,900 | 2.4 |
| Bloomfield | .7 | 18,200 | 3.6 | 23,000 | 2.4 | 29,200 | 2.4 |
| Navajo Tribal Utility A | .6 | 23,200 | 3.8 | 29,200 | 2.3 | 37,000 | 2.4 |

1/ U.S. Bureau of the C
2/ U.S. Bureau of Recla
3/ Estimates based on p
NA Not available.

c. Jobs and Income

In the Durango area of La Plata County about one-third of all jobs are in tourism/recreation services and sales, while in the Farmington area of San Juan County about one-third of jobs are in mineral production--gas, coal, and petroleum--and in related services and sales. Employment in both counties is affected by the composition of the overall industrial sector and by their location in areas with large numbers of tourist attractions. Both obtain substantial revenues from motels, restaurants and cafes, and other travel-related enterprises. However, the effect of the seasonal nature of the tourism industry in the Durango area can be observed in other industries, with jobs and sales receipts declining substantially in winter and to a greater degree than is the case in Farmington. These basic differences produce other dissimilarities in the job market in the two areas. As the mineral industry continues to grow in Farmington, the entire area expands because of increased job opportunities and economic needs. However, in the Durango area, a growth in tourism does not prompt rapid job or services expansion because of the industry's seasonal nature. Moreover, although retail trade occupies a major place in industrial sales in both counties, wholesale trade and manufacturing is slightly stronger in the Farmington area.

The major employers on the two Ute Indian reservations are the Bureau of Indian Affairs and tribal governments. Most of these jobs are clerical, though there are a few administrative positions. More limited sources of employment are the Horse Training and Conditioning Center and Pino Nuche Tourist Center on the Southern Ute Indian Reservation, and a cattle operation, wood- and water-hauling, and Sleeping Ute Mountain Homelands Arts and Crafts Center on the Ute Mountain Ute Indian Reservation.

Farming in the overall project area provides jobs for about 9 percent of the population in La Plata County and 3 percent in San Juan County, and has declined in recent years because of farm consolidation and increasing mechanization. A small number of Indian families both on and off reservation make their living in marginal agricultural activity supplemented by seasonal and odd jobs.

Unemployment in the Durango area and La Plata County was about 6 percent[1/] in 1976, and, in the Farmington area and San Juan County, about 11 percent, compared to averages of 5.8 percent for Colorado as a whole and 9.2 percent for New Mexico. The relatively high unemployment rate, coupled with income factors, has resulted in the area's designation as the Four Corners Economic Development Region, which is eligible for assistance under public law. Unemployment rates among the area's ethnic minorities are higher than those of the white society. Among Hispanic people in the overall project area the unemployment rate was about 25 percent in 1976; in 1978, the unemployment

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1/ Unemployment figures include ethnic minorities, whose unemployment rates are higher than those of the majority.

rate among Southern Utes was 73 percent and among Ute Mountain Utes, 62 percent.[1/] The reasons for the high unemployment rate among the Hispanics and in the two Ute Indian tribes are complex and difficult to assess. However, among them are discrimination in hiring and in the types of jobs offered, and, among the Indians, a desire to work on, rather than off, the reservation, where the economic base has not been sufficiently strong to consistently provide a substantial number of jobs for tribal members.

In the overall project area, average family income in 1970 was about $9,900, near the two-State average of about $10,000. However, median family income--or the middle point in the income scale--was only about $7,900, indicating a disproportionately large number of wage-earners in lower income brackets. Among Hispanic residents, average family income in 1970 was about $6,800, or two-thirds of the area's average. The 1970 census showed nearly 20 percent of all project area residents living below the poverty level, including one-fourth of Hispanic families and nearly half of Indian families.

Average family income for both the Southern Ute and Ute Mountain Ute Indian tribes was only about $4,000 in 1977. This included direct wages, tribal payments, or dividends and some nonjob, noncash benefits such as scholarships, free or rent-subsidy housing, and tribally- or Federally-funded assistance programs. Per capita dividend payments to Ute Mountain Tribal members which began in 1952 with $1,500 decreased to $1,000 in 1977 and only $50 in 1978. No payment is expected to be made in 1979. This decline is due to the derivation of these payments from oil and gas royalties which have been on the decrease because of declining production from many of the older wells. For the Southern Utes, tribal income is also derived from oil and gas royalties and is used to fund employment enterprises and for dividend payments to Tribal members. These dividends are paid quarterly and were increased from $100 to $200 in the last quarter of fiscal year 1978. The Southern Ute Tribe and its members also derive some income from land leased to both Indians and non-Indians for farming and grazing.

The future employment picture in the project area depends in part on the Nation's energy supply. Short fuel supplies could affect tourism and tourism-related jobs in the Durango area, but the same energy needs could significantly enhance the value of coal resources which, in turn, would create jobs for tribal members and others. The development of coal would be expected to provide jobs in connection with the minerals industry throughout La Plata County. Similarly, the Farmington area could experience even greater industrial expansion than the present level with stepped-up exploration and exploitation of coal, gas, and petroleum reserves. Any rapid expansion in energy resources

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1/ The unemployment rate for the two Ute Indian tribes tends to fluctuate with the introduction and completion of State, Federal, and local projects, such as those sponsored by the Federal Government under Title X of the Public Works and Development Act.

development in the project area would, however, require an additional water supply. If the present trend continues on the Ute Mountain Ute Reservation of diminishing revenues from gas and oil royalties without the development of other resources, it is likely that the number of jobs available to tribal members will continue to decline because of depletions in the collective tribal funds that have been used to fund job-creating enterprises. A less-pronounced trend would be expected on the Southern Ute Reservation, where per capita dividend payments have consistently been lower and where some new gas wells currently are being drilled.

d. Trade and Manufacturing

Retail sales have been increasing steadily in the two-county area, accounting for over two-thirds ($96,400,000) of all industry sales in La Plata County and over one-third ($204,300,000) in San Juan County in 1976. The largest sales in the overall area were in retail food, automobiles and supplies, building materials, general merchandise, and hotel and motel businesses. Wholesale trade amounted to about $7,900,000 in La Plata County and $37,100,000 in San Juan County in the same year. Although both Durango and Farmington are major trade centers, the latter has a larger selection of goods, and consumers from the entire area--including La Plata County--often shop there.

Major manufacturing encompasses food, construction equipment, and lumber enterprises in La Plata County and petroleum refining in San Juan County. Manufacturing sales in 1976 were $10,000,000 in La Plata County and $32,800,000 in San Juan County. Manufacturing enterprises on the two Ute reservations are few, as outlined in Section B-1(c), Jobs and Income. Some manufacturers have shown an interest in establishing on the Southern Ute Reservation, but the Tribe has not found outside investors whose proposals have proved equitable in the eyes of the Tribe (Southern Ute Economic Development Department, 1975). Currently there is no manufacturing in the towns that would be served by the Navajo Tribal Utility Authority.

e. Agriculture

Agriculture provides income to approximately 9 percent of the labor force in La Plata County and to about 3 percent in San Juan County and, while not the area's major employer, remains a stabilizing base industry. In the project area, about 1 out of 16 families receives direct income from farming, compared to 1 out of 26 nationally. The main source of farm income is livestock, with crop production of lesser importance, as shown in Table B-2. The total value of crop and livestock production on land to receive project water was nearly $3,200,000 in 1978, as projected from Bureau of Reclamation farm budget studies. The budget studies and other detailed economic and farm management assessments are the base for agriculture analysis presented in this section (Bureau of Reclamation, 1979).

Table B-2
Agricultural statistics for La Plata County, Colorado and San Juan County, New Mexico (1974)1/

| | La Plata County | San Juan County |
|---|---|---|
| Farms and farmland | | |
| Farms (number) | 527 | 407 |
| Average farm size (acres) | 1,122 | 4,698 |
| Irrigated acres per farm | 176 | 86 |
| Value of agriculture products sold | | |
| Livestock and products | $6,134,000 | $2,888,000 |
| All crops | 1,751,000 | 2,697,000 |
| Total | 7,885,000 | 5,585,000 |
| Livestock (number) | | |
| Cattle and calves | 39,740 | 23,301 |
| Sheep and lambs | 13,624 | 42,183 |
| Acreage and production | | |
| Small grains (wheat, oats, barley) (acres) | 13,293 | 845 |
| Corn (for all purposes) (acres) | 2,034 | 3,773 |
| Hay (acres) | 32,968 | 15,904 |

1/ 1974 U.S. Census of Agriculture.

(1) Farming Enterprises

The principal crops grown in the presently irrigated portions of the project area in Colorado, and their share of the total irrigated crop distribution, are: wheat, 24 percent; alfalfa, 19 percent; and barley, 7 percent. About 52 percent of the irrigated acreage is used for crops, 30 percent is used for pasture, and 16 percent is idle or fallow. The main dryland crop in the Colorado portion of the project area is pinto beans, which make up 60 percent of total dryland crop distribution; wheat accounts for 25 percent and 15 percent of the land is idle or fallow.

In the presently irrigated sections of the project area in New Mexico, alfalfa is the main cash crop, accounting for 58 percent of total irrigated crops. Other primary crops, and their share of the total irrigated crop distribution, are: barley, 12 percent; corn silage, 7 percent; oats, 3 percent; and wheat, 3 percent. About 83 percent of irrigated land is used for crops and 17 percent for pasture or farmstead. Grazing accounts for essentially all dryland use of the project area in New Mexico.

Among the Ute Indian population, livestock grazing and low-intensity farming are the main agricultural activities, but rarely do these provide full support for the Indian families. There were 17 full-time farms and ranches and 24 part-time farm operations on the Southern Ute Reservation in 1975, and, on the Ute Mountain Ute Reservation, a tribally-subsidized and operated cattle enterprise and 51 individual cattle operations whose owners also received full subsidies from the tribe for their operation costs (Southern Ute Economic Development Department, 1975; Ute Mountain Ute Tribe Planning Committee, 1976). A lack of sufficient irrigation water, especially on the Ute Mountain Ute Reservation, has hindered potential agricultural development.

In the project area as a whole, inadequate water supplies severely limit agricultural development. Limited precipitation, averaging from about 7 inches in the north to 4 inches in the south from May through September, permits some dry farming but makes irrigation essential for successful production. The demands for irrigation water, however, cannot be met by the fluctuating flows in local streams and by the limited storage facilities now available. Because of the lack of sufficient water, crops on irrigated land often cannot attain maturity, and it is estimated that this land produces less than half of its potential. The lack of water limits the use of much potentially productive land to native range and low-yielding pasture.

The U.S. Soil Conservation Service has conducted a preliminary investigation for prime and unique farmlands in Colorado and New Mexico (U.S. Soil Conservation Service, personal communication, 1979a, 1979b). No unique farmlands were found within the project area. Approximately 10,000 acres of prime farmland were tentatively identified in the Colorado portion of the project area from just north of Breen to just south of Redmesa along State Highway 140, and 400 to 800 acres in the New Mexico portion between the State line and Farmington along the La Plata River. A final classification will be made by the Soil Conservation Service following a field review and a determination of the water supply associated with the proposed prime farmland. Land not meeting the water supply criteria, which is an adequate water supply 8 out of 10 years, will be removed from the prime farmland classification. Much of the land in the project area will not meet the water supply criteria.

(2) Project Land

(a) Soils

The soils of the full and supplemental service land in the project area are suitable for irrigated agriculture because they are relatively free of soluble salts and drainage problems and have good texture (Bureau of Reclamation, 1979). Technical analyses of the soils are available for examination at Bureau offices in Durango and Salt Lake City.

Project land may be broadly grouped as either mesa or valley land. The mesa land comprises about 93 percent of the project arable land and would comprise both full service and supplemental service land. The mesa soils are reddish-brown, wind-borne in origin, and notable for their uniformity. Ranging in depth from 3 to more than 25 feet, the soils have medium to moderately fine textures, and good water intake rates (1.0 to 2.0 inches per hour). The soils are mostly free of salt problems. On the full service land, the total dissolved solids would range from about 1,000 to 3,000 milligrams per liter (mg/l) in the first 10 years of project operation and decrease to about 800 to 1,000 mg/l as irrigation water flushes out salts. On the supplemental service land, the levels of total dissolved soils would remain relatively stable during project operation, ranging from about 500 to 1,000 mg/l.

In the estern part of Colorado's project land and in project land in New Mexico, the material underlying the mesa soils is highly permeable gravel, ranging in thickness from 2 to more than 125 feet, which was derived from outwash from glacial activity in the mountains to the north. This material, in turn, rests on permeable and impermeable shale. In the western part of the project land in Colorado, the soil rests directly on sandstone, except for project land straddling the Ute Mountain Ute Indian Reservation boundary, where 1,500 acres of full service land have soil that rests on permeable shale.

The valley land, which primarily comprises the supplemental service land in Colorado and New Mexico, is located along the La Plata River and its tributaries. The valley soils, predominantly brown in color, have medium to fine textures, and their depth ranges from about 3 to 50 feet. Most of the land has smooth to gentle slopes with good rate of water intake (0.9 to 2.0 inches per hour). The levels of total dissolved solids would range from about 2,000 to 4,000 mg/l in the first 20 years of project operation and, as water flushes the silts, decrease to an average of about 2,000 mg/l thereafter. These levels would not cause detrimental effects to crops grown on project land.

The material underlying the valley soils is cobbles, sand, shale, and sandstone. Some of the supplemental service land in New Mexico has drainage problems because it has a high water table and receives excessive applications of irrigation water, when excess water is available. Only that land that could be drained adequately and economically, however, was included in the project.

(b) Agricultural Chemicals

Insecticides, herbicides, and commercial fertilizers do not receive the same degee of use in the project area as they do in more intensively farmed areas in other parts of the county, but the use that does occur is consistent with a growing trend nationally to use pesticides that are more toxic but less persistent. Because alfalfa is the area's primary crop, parathion--used to control the alfalfa weevil--is the primary insecticide and is sprayed at the rate of about 1 pint per acre on 2,000 to 2,500 acres (less than 40 percent of the alfalfa acreage). The primary herbicide used in the area is 2,4-D, which is applied at a rate of 1/2 to 1 pint per acre on about 3,000 acres to control broad-leafed weeds in small grains (less than 20 percent of the small grains acreage). Herbicides are also used to control isolated infestations of noxious weeds along irrigation ditches, drains, and canals. Fertilizers are used on about 25 percent of the irrigated land in the project area, or about 220 tons of fertilizer (68 percent nitrogen and 40 percent phosphate) on slightly more than 21,500 acres. Of fertilizer used, about 33 percent is derived from organic humus and manure with the balance commercial fertilizers. The lack of dependable supply of late-season irrigation water limits the effective use of fertilizers.

f. Mineral Resources

The project area is in the heart of a rich mineral- and coal-producing region that is of Nationwide significance in its endowment of fossil fuels. The area is dotted with oil and gas fields and is underlain by coal reserves, the most potentially economical of which lie in northwestern San Juan County and parts of the two Ute reservations as shown in Figure B-1. At present and in the recent past, petroleum and natural gas production have been dominant industries, while coal extraction has become increasingly important since 1976, all as shown in Table B-3.

Within the project area, crude petroleum is the largest single source of mineral value in San Juan County and natural gas in La Plata County. In San Juan County, three refineries in Bloomfield and one in Kirtland account for about 20 percent of New Mexico's total refining capacity; in La Plata County, crude oil is shipped elsewhere for refining.

The economic importance of the mineral industry in the project area is demonstrated in San Juan County's contribution of 11 percent, or $283,764,000 of New Mexico's total mineral production value in 1976, while La Plata County contributed slightly less than 2 percent, or $16,282,964 of Colorado's total mineral production value in that year.

An estimated 6 billion tons of coal are available for strip mining in the northwestern part of the San Juan Basin, with more extensive reserves that could be recovered by more costly underground mining methods. The coal is of a good grade for steam production, with low sulfur and high heat content. Currently, coal is extracted at two strip mines in San Juan County and is used at the Four Corners Powerplant, which has a 2,175-MWH capacity and which serves customers in Utah, Arizona, Texas, and New Mexico, and the San Juan Powerplant, which has a 1,588-MWH capacity and which serves customers in New Mexico. A lack of transportation facilities to carry coal to major markets has been a limiting factor in coal production in the past; two railway spurs have been proposed for access to mining operations, but construction of the spurs is dependent upon approval from the Department of Interior for the mining activity.

The two Ute reservations have the potential for vastly increased coal development. Approximately 39 million tons of coal lie within 250 feet of the surface on the Ute Moutain Ute Reservation, and would be recoverable by surface mining methods (Shoemaker and Holt, 1973). Estimates of strip mineable reserves ranging from 116 million tons (Speltz, 1977) to 400 million tons (Shoemaker and Holt, 1973) have been made for the Southern Ute Reservation. Reserves as much as two to three times these amounts lie deeper and could be recovered with underground mining methods in the future.

While oil and gas have shown stable production rates over the last few years, exploration in the area has not kept pace with the rate at which existing wells are being pumped out. Based on a well life of 20 to 25 years, it is projected that, without substantial new drilling, production may decline somewhat within the next decade. This may be offset by increased development from producing well fields and stepped-up exploration activity, and by an increased emphasis on coal production.

g. Recreation and Tourism

Recreation and tourism make a substantial contribution to the project area's economy because of the scenic quality of the region and its prehistoric and historic resources. Durango's economy, as discussed earlier in this chapter, is dependent on tourism, and, because of the city's location, it serves as a hub and short-term destination point for many visitors, as shown in Figure B-2. Farmington, the other population center, while less dependent on recreation and tourism to support its economy, also derives substantial economic benefit from the area's attractions largely because of tourists passing through the area or because of visitors whose final point of destination is within driving distance of Farmington.

In the Durango area, the primary appeal is the San Juan National Forest, which is located north of the project area and which provided more than 1.8 million visitor days of use in 1977. During the summer and fall, visitors to the forest engage in fishing, hiking, horseback riding, boating, and camping, the last despite a limited number of camping facilities. The average length of summer visitors' stopovers in Durango is 1-1/2 days. Many of the tourists ride the Durango-Silverton narrow-gauge train, which parallels the Animas River and which can accommodate 120,000 passengers in one season; others spend vacations at cabins and trailers around Vallecito Reservoir northeast of Durango; many visit Mesa Verde National Park west of Durango, which had 677,000 visitors in 1976, and tour the restored historic buildings of Durango. Other attractions include big game hunting, which, during fall, draws a number of out-of-state visitors to the Federal and State land in the area; and skiing and other winter sports at Purgatory ski area, a privately-run area in the San Juan National Forest north of Durango, attracted nearly 195,000 skiers in the 1976-77 season; cross-country skiing and snowmobiling also are popular in the National Forest.

Both the Ute Mountain Ute and Southern Ute Indian Tribes recognize the need to provide recreation facilities for organized visitation to the reservations as a source of revenue. In a planning report,

# MINERAL RESOURCES

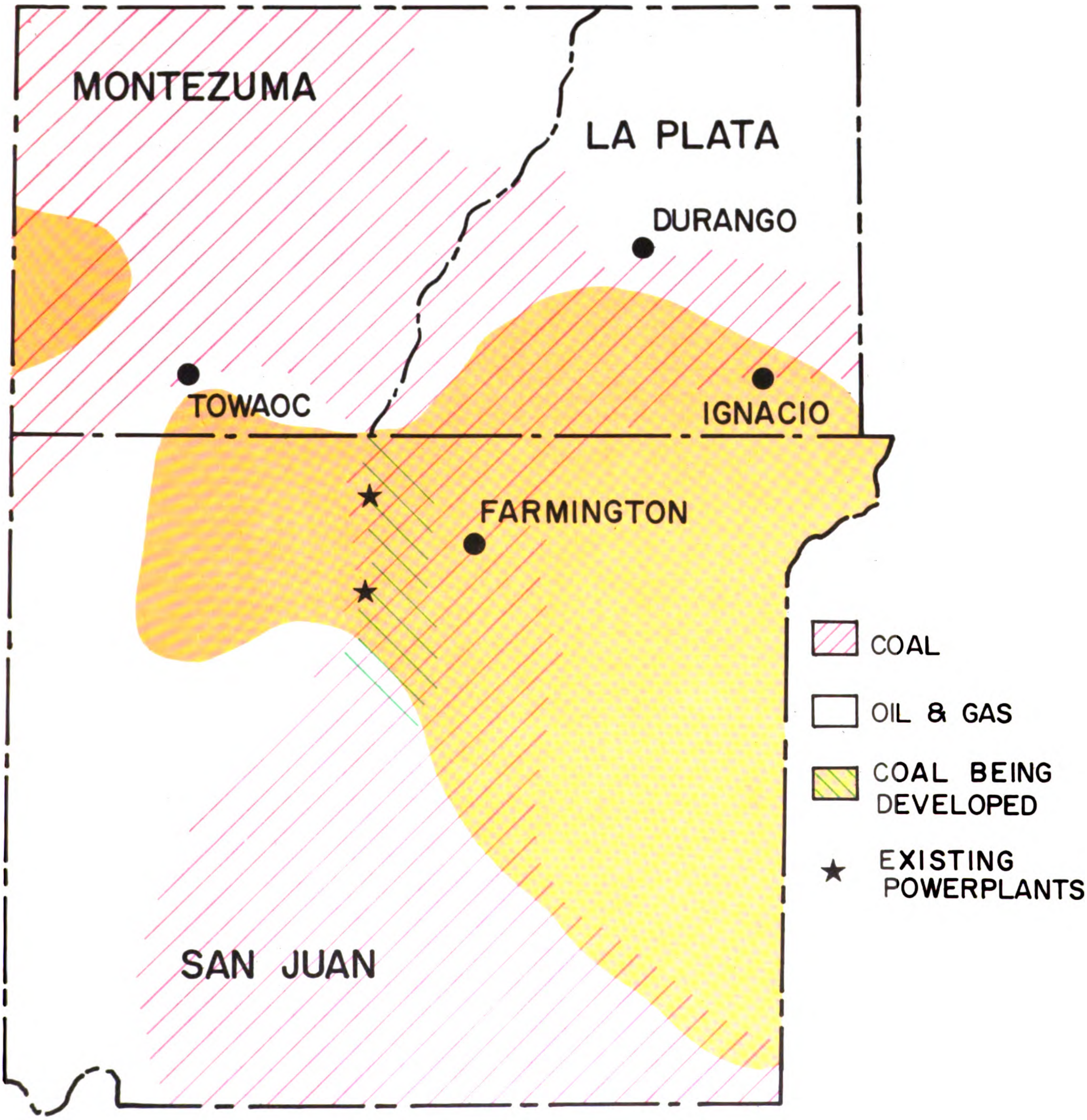

Table B-3
Mineral industry production[1]

| Year | Petroleum (estimated barrels)[2] San Juan County New Mexico | Petroleum (estimated barrels)[2] La Plata County Colorado | Natural gas (estimated million cubic feet) San Juan County New Mexico | Natural gas (estimated million cubic feet) La Plata County Colorado | Coal (estimated tons) San Juan County New Mexico | Coal (estimated tons) La Plata County Colorado |
|---|---|---|---|---|---|---|
| 1972 | 4,619,104 | 25,783 | 398,420,125 | 27,257,947 | 6,636,000 | 11,370 |
| 1973 | 4,079,956 | 20,346 | 368,077,284 | 31,241,598 | 7,515,724 | 9,488 |
| 1974 | 4,998,550 | 21,065 | 368,565,817 | 25,399,910 | 8,085,688 | 9,913 |
| 1975 | 3,934,275 | 25,825 | 345,031,131 | 25,263,592 | 7,443,449 | 15,790 |
| 1976 | 3,936,844 | 35,848 | 361,656,335 | 25,750,073 | 7,688,670 | 16,870 |
| 1977 | 3,107,352 | 46,617 | 363,605,342 | 27,336,993 | 8,593,076 | 25,648 |

1/ Summary of Mineral Industry Activities in Colorado, Colorado Division of Mines, Department of Natural Resources, State of Colorado, and Annual Reports, New Mexico, Oil Conservation Division.

2/ All estimates are based on dollar value divided by average price.

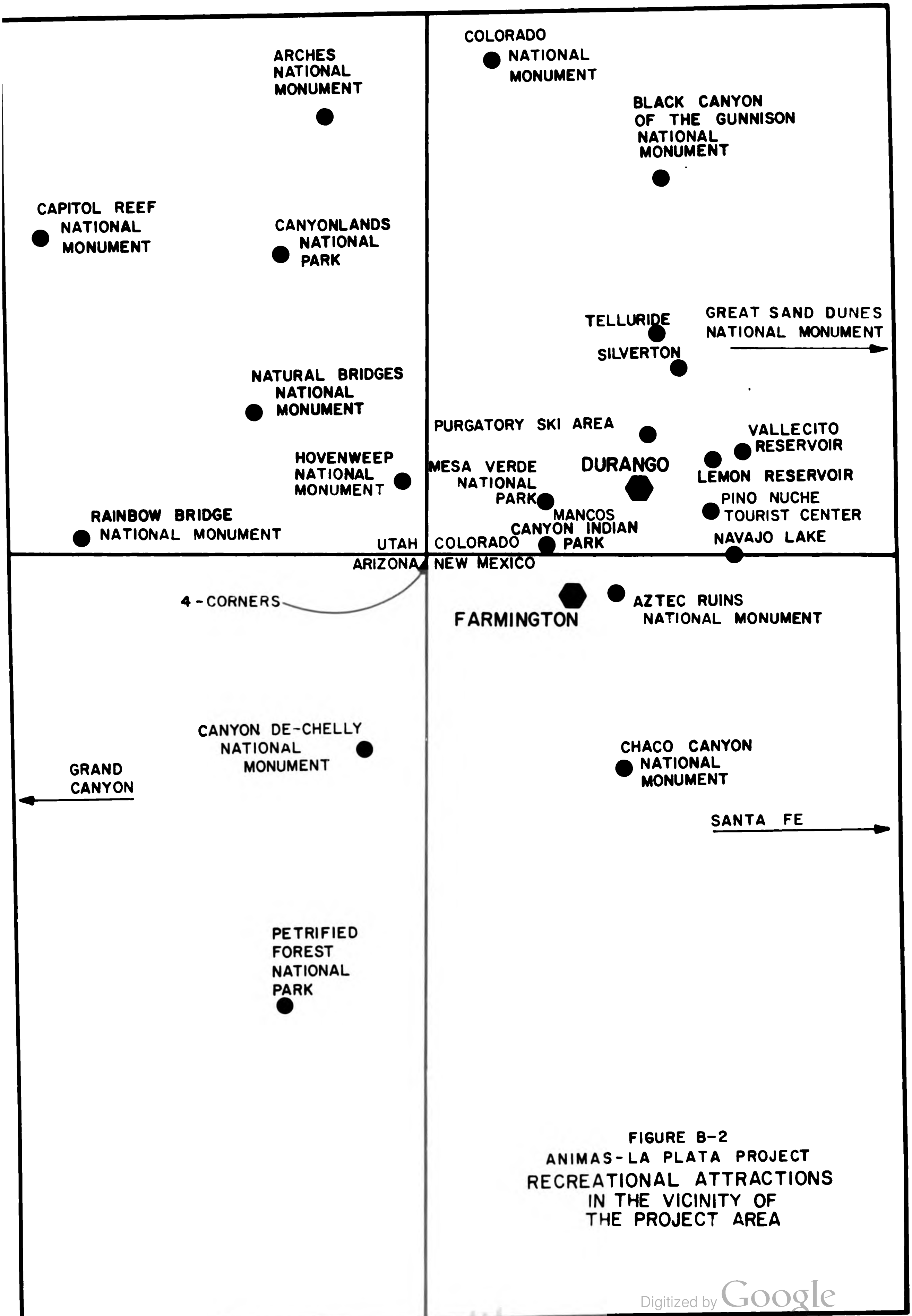


FIGURE B-2
ANIMAS-LA PLATA PROJECT
RECREATIONAL ATTRACTIONS IN THE VICINITY OF THE PROJECT AREA



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the Ute Mountain Ute Indian Tribe expressed a major goal of recreation development on their reservation as an attempt to preserve the scenic and historic resources of the reservation for general public use and enjoyment and for the economic betterment of the Tribe (Ute Mountain Ute Tribe, 1976). The Ute Mountain Ute Indian Tribe is completing construction of Mancos Canyon Indian Park, which has ruins similar to Mesa Verde, on the reservation south of Cortez. The Southern Ute Indian Tribe operates a tourist complex in Ignacio and plans to develop camping and recreation facilities near Chimney Rock, which is located east of Bayfield on the reservation.

Visitors to the Farmington area generally come from other areas to camp and fish and to view prehistoric ruins. Navajo Reservoir, located east of Farmington and less than a three-hour drive from Albuquerque, provides opportunities for camping, boating, fishing, picnicking, and hunting. Downstream of Navajo Dam, the San Juan River is described by the State of New Mexico as having the finest cold-water fishery in the State. Visitors interested in archaeology may visit Aztec Ruins National Monument, which had 68,170 visitors in 1976; Chaco Canyon National Monument, which is located south of Farmington and had 30,550 visitors in 1976; and Canyon de Chelly National Monument, which is located southwest of Farmington and had 308,440 visitors in 1976. To the west and southwest of Farmington are other scenic recreation areas, such as Glen Canyon National Recreation Area and Grand Canyon National Park; and to the east, Sante Fe and Taos, N. Mex.

According to the Colorado Comprehensive Outdoor Recreation Plan (Colorado Division of Parks and Outdoor Recreation, 1976) and Outdoor Recreation 1976 - a Comprehensive Plan for New Mexico (New Mexico State Planning Office, 1976), a need for additional activity areas exists in the following categories: sightseeing, picnicking, and camping; biking, walking, and horseback riding trails; and lake areas for fishing, boating, and waterskiing. The State of New Mexico believes that additional camping facilties are needed in a one- to three-hour drive of urbanized areas for weekend camping and for vacation camping (New Mexico State Planning Office, 1976).

#### h. Land Use and Housing

A large proportion of project area land is Federally-administered--much of it for Indian reservations. In the larger surrounding area, 57 percent (604,300 acres) of the land in La Plata County and 86 percent (3,040,000 acres) of the land in San Juan County is Federally owned. About 7.5 percent of the land in San Juan County is privately owned, limiting the area available for expansion because the private land is in use for existing residential and business areas, roads, parks, and agricultural purposes. Because of the scarcity of available open land for future development, the agricultural sector in San Juan County stands to receive the greatest impact from any future growth. On the other hand, in La Plata County approximately 440,000 acres of the total 1,066,000 acres (or 41.6 percent) are privately owned and there are abundant opportunities for development and expansion. Land immediately to the east of Durango that now is used in part for agriculture is considered a probable and suitable area for urban expansion, and currently that area is undergoing some subdivision. Also under development are two areas near the Ridges Basin Reservoir site. One, immediately northwest of the site, is a 490-unit tract of 3-acre lots, about 300 of which are in stages of development that range from application for building permits to 60 completed homes. The other, west of the reservoir site, is a 13-unit tract of 40-acre parcels where six homes are presently being completed (Phillips, Brandt, Reddick, 1978). These and other housing proposals outside the limits of incorporated communities must meet provisions of state and county land use legislation. Colorado Senate Bill 35 (1972) extended the definition of "subdivision" to include practically any new land development. The bill requires counties to draw up regulations which require the subdivider to provide information on geological and soil conditions, the adequacy and quality of the water supply, and the adequacy of sewage disposal and storm drainage facilities for his subdivision. The bill also makes provisions for the developer to provide land, or a payment in lieu of the land, for schools and parks, as well as performance bonds for public improvements, such as roads.

Corresponding to the growth in population and the upswing in economic activity in the project areas over the last decade, there has been marked growth in housing construction and an even greater increase in the number of mobile homes. In La Plata County, total year-round units increased 35 percent to nearly 8,600 units between 1970 and 1976, and in San Juan County, total year-round units increased 25 percent to over 18,500 units. Over the same period, mobile homes increased 300 percent in La Plata County and 760 percent in San Juan County to 1,570 and 4,420 mobile homes, respectively. The large increase in mobile homes stems from a general shortage of middle-income housing in La Plata County and from the inability of housing construction to keep up with the influx of people in San Juan County, particularly in smaller communities. In San Juan County in 1970, the majority of the 14,960 housing units were in Farmington (46 percent), Aztec (7 percent), and Bloomfield (3 percent). In La Plata County, approximately 46 percent of the total 7,000 housing units were in Durango and 2 percent were in nearby Bayfield. Of housing vacancies in 1970, Durango had one-third of the vacant units in La Plata County, and Farmington had one-half of the vacant units in San Juan County.

In 1975, about a third of houses on the Ute Reservation were classified as substandard, but many were planned for rehabilitation under Federal programs. The improvements of old structures and the construction of new housing through the Department of Housing and Urban Development is an ongoing endeavor of each tribe. One hundred new units have been added on the Ute Mountain Ute Reservation since 1975, and 75 new units and 3 apartment complexes on the Southern Ute Reservation. Current housing shortages in the overall project area and the growing reliance on mobile homes are trends that probably will continue in the immediate future because of the spiraling cost of building materials accompanied by growing demand from the continuing population growth that is expected.

i. Domestic Water and Utilities

There are five principal suppliers of treated municipal water in the project area. In La Plata County, they are the cities of Durango and Bayfield and in San Juan County, Farmington, Aztec, and Bloomfield. As shown in Table B-4, the capacity of Durango's water treatment plant is 12 million gallons per day; however, the maximum production since 1974 has been 9 million gallons per day (MGD). The plant is estimated to be adequate until about 1987, with the present rate of consumption and population growth in the area, and with such conservation measures as the installation of water meters and restrictions on lawn watering. Durango plans initially to derive additional water for domestic consumption in the future from rights it holds in the Florida River, as discussed in Section B-4, Water Resources. When it becomes necessary in 15 to 20 years to derive the additional water required from the Animas River, a new treatment plant would be needed that would provide the aeration treatment necessary to eliminate the manganese in that river's water (see Section B-5, Water Quality). Bayfield's present water treatment facility will not reach full capacity until about 1990 with present consumptive use and growth rates.

Table B-4
Per capita use and the capacity of present water treatment facilities

| | Per capita use (gallons per day) | Capacity of present system (million gallons per day) | Maximum population that could be served |
|---|---|---|---|
| Colorado | | | |
| Durango | 280 | 12 | 23,900 |
| Bayfield | 180 | .6 | 3,300 |
| New Mexico | | | |
| Farmington | 265 | 23 | 48,200 |
| Aztec | 160 | 3 | 10,400 |
| Bloomfield | 125 | 1 | 8,000 |

Farmington's existing treatment facilities have a capacity of 23 MGD. They are planning to construct an additional treatment plant in 1979 which will have a capacity of 10 MGD and will serve the city through 1995, based on existing use rates and the projected level of growth. In Aztec, the water treatment facilities were expanded in 1976 to 3 MGD and are expected to be adequate until 1984. Bloomfield's water treatment plant is unable to meet demand, and temporary additional facilities are being installed to increase the capacity. Conservation measures have been instituted, and a 5-year master water plan is being prepared. The city has applied for a Federal loan for a 1 MGD storage tank for treatment water, and for a State grant for treatment plant to serve the needs identified in the master plan.

Although some water treatment facilities are presently adequate, water storage facilities are barely adequate; as population continues to increase and during dry years problems with inadequate storage can become severe. Among communities with limited water storage are Durango, which has only 6 days of storage available, Bloomfield with 18, and Aztec with 4. Bayfield, with 80 days' storage at present use rates, appears to have adequate storage, as does Farmington, with a present capability of 70 days and planned expansion to 150 days in 1980.

Municipalities in the project area operate their own sewage disposal plants, some of which are adequate only for present populations. Durango, with a present plant capacity of 2 MGD, has a new facility in the design stage which is to be constructed in about 3 years to accommodate future growth that would exceed the present facility's capacity. The Environmental Protection Agency, which will prepare an environmental statement on construction of the new facility, will hold public meetings to determine the areas to be served and the size of the plant. An estimated 5.4 MGD capacity would be needed if both the city and outlying areas were served, and 4 MGD if use were restricted to the city. Also at full capacity is Aztec's system--0.44 MGD--which is scheduled for expansion. They are seeking a Federal grant to expand, but plant size has not been selected. Bayfield recently expanded their system to 1 MGD which will be adequate to about 1985. Farmington, with a plant capacity of 5.5 MGD, is enlarging the plant to 11.5 MGD to be adequate through 1995. Bloomfield began operating a new plant with a capacity of 1 MGD in 1978, with the plant adequate to 1985.

The Southern Ute Water Treatment Plant was recently completed in Ignacio to provide treatment, storage, and delivery within a 20-mile radius of the town in anticipation of future needs, and sewer lagoons in the community recently were enlarged. The Ute Mountain Ute Indian Tribe operates a water treatment plant and sewage disposal facilities in Towaoc. Other residents of the reservation are served by water delivery tank and by septic tank systems for sewage disposal.

The project area, including the Indian reservations, is served by People's Natural Gas and La Plata Electric Association in Colorado, and the Gas Company of New Mexico and Farmington Electric Company in New Mexico. Places not located on gas distribution lines, such as small settlements and mobile home parks, are served by tank truck, and some individuals use bottled natural gas. These utilities and telephone service are adequate to meet existing and estimated future needs.

j. Education

The project area has an adequate educational system, with 40 public and 19 private schools including elementary, junior, and senior high schools. In 1976 La Plata County had 5,638 students for a pupil-teacher ratio of 19 to 1 which is well below the State recommended ratio of 25 to 1. The school district that serves Durango reports slightly declining enrollment since 1970, with the expectation that it will begin increasing by 1980; in 1976 the student-teacher ratio was 20:1. In Bayfield, the number of students has steadily increased, reaching a 20:1 student-teacher ratio in 1976. In San Juan County there was a total of 10,827 students for a pupil-teacher ratio of 21.7 to 1 compared to the New Mexico recommended ratio of 25 to 1. School age children of the Southern Ute Tribe attend public schools in Ignacio; the Ute Mountain Ute children attend Cortez public schools; and Navajo children attend both public and BIA schools in Shiprock and Farmington.

About 56 percent of project area residents are high school graduates compared to 32 percent for the total two-State area. Institutions of high education in the project area include Fort Lewis College, a four-year liberal arts college in Durango, and the San Juan Campus of New Mexico State University, a two-year college in Farmington, and Navajo Community College in Shiprock, N. Mex. The San Juan Basin Area Vocational School east of Cortez in Montezuma County also provides a source of technical and vocational training for the area.

k. <u>Health and Social Services</u>

Health care in the project area appears adequate, though some facilities are below the two-State average numerically. Of three hospitals within the project area, the two Durango facilities contain 156 beds (approximately 5.8 beds per 1,000 persons), while San Juan Hospital in Farmington has 118 beds (about 1.6 beds per 1,000 persons) and serves the entire county. The physician-patient ratio in La Plata County was 1 to 748 in 1976, compared to 1 to 693 in Colorado, while that of San Juan County was a high 1 to 1,282 compared to 1 to 690 in the State of New Mexico. Both the Southern Ute and Ute Mountain Ute Indian Tribes have Public Health Service clinics served by physicians who are available about 10 hours a week.

Public assistance recipients, including those who receive food stamps, remained at a fairly constant level of about 6 percent of project area residents between 1971 and 1975. Both Ute Indian Tribes have well-developed tribal assistance measures available to their members, including child development, supplemental food, and aid to the elderly programs, all supported by Bureau of Indian Affairs funds.

l. <u>Police and Fire Protection</u>

The project area's law enforcement needs are served by both State and local agencies. The Colorado State Patrol has a regional office in Durango, and the New Mexico State Patrol has an office in Farmington. In addition, there are sheriff's departments in both counties and city police departments in Durango, Ignacio, Aztec, Bloomfield, and Farmington. With increasing population in these cities, crime has also increased, placing a greater demand on law enforcement. Although this has not yet produced the need for an increase in personnel, it is forseeable that more law enforcement officers may be needed if this trend continues in the future. The Southern Ute Indian Tribe has law enforcement personnel in Ignacio who serve the reservation, and the Ute Mountain Ute Indian Tribe has law enforcement personnel in Towaoc. State Patrol and county law enforcement officers also serve both reservations.

Both counties in the project area have volunteer fire departments, and Durango and Farmington communities have, in addition, full-time fire protection forces. At present the La Plata County volunteer firefighting force is scarcely able to cover the large area it is charged with protecting, although efforts have been made to place firefighting equipment near present rural population concentrations. San Juan County's volunteer fire protection force, on the other hand, is adequate and could meet the additional services required with population growth. Both city forces are adequate and are able to call upon county volunteers should a serious fire occur.

m. Transportation

The major highways in the project area are U.S. Highways 160 and 550, where use is below carrying capacity. The heaviest traffic occurs near Durango. Along Highways 550 and 160, traffic is about 84 percent of carrying capacity at the south limits of the city, decreasing to 72 percent on Highway 550 southward toward Farmington and to 20 percent at the State line; on Highway 160 westward, the present use is 68 percent of capacity, progressively decreasing to 36 percent at Bayfield. A new four-lane city bypass on Highways 550 and 160 south of Durango will be completed in 1979 and will provide additional carrying capacity in the more heavily used area. State Highways 140 and 172 in Colorado and 17, 44, and 173 in New Mexico also provide access to most of the project area, and county roads, most of which are graveled, provide a network of interconnecting access routes. La Plata County has an airport located 15 miles southeast of Durango capable of handling commercial jet aircraft, and an airport in Farmington serves that area with multi-engine aircraft In addition, in the project area are two smaller airports in Aztec and Durango that provide facilities for light planes. The project area has no public transportation, but an interstate bus line serves the population. Commodities transportation is accomplished by 30 truck lines because there are no railways to provide transport. The nearest railhead is at Gallup, N. Mex. There are presently two separate plans that would bring rail spurs to within 20 miles of potential coal development; the lines would not alter commodity transportation (Bureau of Reclamation, 1977).

2. Cultural Resources

The project area has unusual significance with respect to cultural resources because of the presence of large numbers of archaeological sites dating from the Anasazi who lived on and farmed the same mesa tops and valleys that are needed for cultivation today. The Anasazi are best known for their spectacular cliff dwellings, such as those in Mesa Verde National Park; less spectacular, but more important to the understanding of the events and processes of Anasazi cultural history, are the earlier surface pueblos and smaller pithouse structures scattered across the mesa tops.

Although the majority of sites in the project area are Anasazi (from Basketmaker II to Pueblo III cultural periods), earlier and later traditions are also represented. The time span and basic characteristics of these cultures are given in Table B-5. The developmental changes outlined show the gradual progression from a basic nomadic hunting and gathering society to a complex sedentary society based on horticulture, with progressively more sophisticated habitation, tools, and household equipment. The excellent preservation of materials in southwestern Colorado, the large number of ruins, and the diversity in size and in use over time combine to provide a unique opportunity to investigate this development of a single society from a simple hunting and gathering band to a considerably more complex society.

A compilation of information available on the project area was prepared by Centuries Research, Inc. (1978) under contract with the Bureau of Reclamation Records from 8 studies dating from 1876 through 1968 show that at least 1,500 prehistoric sites were identified in the project area. Only 484 of these have reliable information on site location. In addition to these studies, the University of Colorado under contract with the Bureau completed an intensive (Class III) survey in 1975 of the areas that would be affected by the reservoirs and other major physical features of the project. Identified in that study were 10 historic and 46 prehistoric sites. None of the historic sites appears eligible for the National Register of Historic Places (Centuries Research, Inc., 1978 and Bureau of Reclamation, 1979). Attachment 2 is a complete listing of all known sites from the general project vicinity for which accurate information exists. The listing consists of the site number, the culture period the site is believed to represent, and the type of site.

Approximately 17,000 acres remain to be surveyed in areas such as full service land, recreation areas, and along rights-of-way. Intensive (Class III) surveys will begin in these areas during the 1979 field season. Based upon site density in the areas that were intensively surveyed for the Bureau, as many as 3,500 prehistoric sites may eventually be identified, once intensive surveys on all project land have been completed.

Because of the density and value of the prehistoric sites, the project area is believed to be eligible for the National Register of Historic Places as the La Plata Archaeological District (Bureau of Reclamation, 1979). Both the Colorado and New Mexico State Historic Preservation Officers have expressed their concurrence with the concept of establishing a district. The concentration and value of these

Table B-5
Archaeological and historic periods and characteristics

| Cultural period | Characteristics |
|---|---|
| Pre-Ceramic (2,500 B.C. - A.D. 1) | People were hunting and perhaps living year round in the area by at least 2,500 B.C. Tools and other artifacts predominantly of stone. None of these have been identified as yet in the project area. |
| Basketmaker II (1 - A.D. 500) | Tools and other artifacts of stone, baskets, seminomadic hunters. Agriculture begins late in the period. |
| Basketmaker III (500 - A.D. 750) | Baskets, fired pottery, horticulture, small villages of pithouses with nearby storage facilities. |
| Pueblo I (750 - A.D. 950) | Continuation of large pithouses, beginning of surface habitations, red ware pottery, textural manipulation in cooking pots. |
| Pueblo II (900 or 950 - A.D. 1150 or 1200) | Masonry surface villages, new styles of pottery, supplementary features such as sewers and irrigation check dams. |
| Pueblo III (1150 or 1200 - A.D. 1300 or 1350) | New styles of pottery, larger pueblos, climax of the Anasazi culture. |
| Historic Sites | Evidence of occupation by Ute and Navajo Indians and early Euroamericans. The sites are primarily sweat lodges and lithic scatters and from industrial activities such as ranches and a coal mine. |

resources have previously been recognized by the Ute Mountain Indian Tribe, and part of their reservation has been listed on the National Register of Historic Places as the Ute Mountain Ute Mancos Canyon Historic District. Part of the project land which lies within the Reservation is in this district.

3. Geology

The project is located in the eastern portion of the Colorado Plateau Province on the northwest edge of the San Juan Basin. The San Juan Basin overlaps the Colorado-New Mexico border, but the major portion is in New Mexico. It is generally circular shaped and approximately 100 miles across.

The general geology map, figure B-3, shows the types of rocks in and adjacent to the project area and the prominent structural features. The exposed rocks are mainly of sedimentary origin and range in age from Quaternary[1/] to Permian[2/].

A large ridge trends northeast through the project area and extends from northeast of Durango, Colo., to south of Shiprock, N. Mex. This ridge is composed mainly of upwarped Tertiary[3/] and Cretaceous[4/] rocks which gradually flatten to the southeast in the central part of the San Juan Basin.

a. Ridges Basin Reservoir System Area

Ridges Basin was formed by the erosion of uplifted sedimentary beds on the southeast flanks of the Durango Anticline. The dip of the beds is downstream to the southeast and ranges from 25 to 30 degrees at the dam site. Outcrops at the dam site consist of the Pictured Cliffs Sandstone and the Fruitland Formation of Cretaceous age. All of the foundation and most of the abutment area is underlain by the Pictured Cliffs Sandstone which consists mainly of hard, marine sandstone composed mostly of quartz sand particles. A few weak coal beds are exposed high on the right abutment. Unconsolidated alluvial deposits consisting of sands and silts overlie the bedrock in the valley bottom. These deposits have a maximum depth of approximately 70 feet and a cutoff trench would be required through these deposits to prevent seepage and possible subsurface erosion. Bedrock at the dam site appears to be structurally sound for supporting the weight of a dam providing a suitable founation, with the added safety of a cutoff trench and grouting.

---

1/ A period of geologic time extending from the present to approximately 3 million years ago.

2/ A period of geologic time extending from approximately 225 to 280 million years ago.

3/ A period of geologic time extending from approxiomately 3 to 65 million years ago.

4/ A period of geologic time extending from approximately 65 to 136 million years ago.

The Lewis Shale and the Cliff House Sandstone underlie the reservoir site. The Lewis Shale extends north from the dam location across the proposed reservoir area until it grades into the Cliff House Sandstone about 1.5 miles north of the dam site. The Lewis Shale is a dark gray to greenish gray marine shale with some sandy shale layers and occasional thin layers of impure limestone. The underlying Cliff House Sandstone is a buff to tan, massive, marine sandstone which is usually a hard, cliff-forming rock. The reservoir basin is covered by clayey deposits which should form a relatively impermeable bottom for the reservoir.

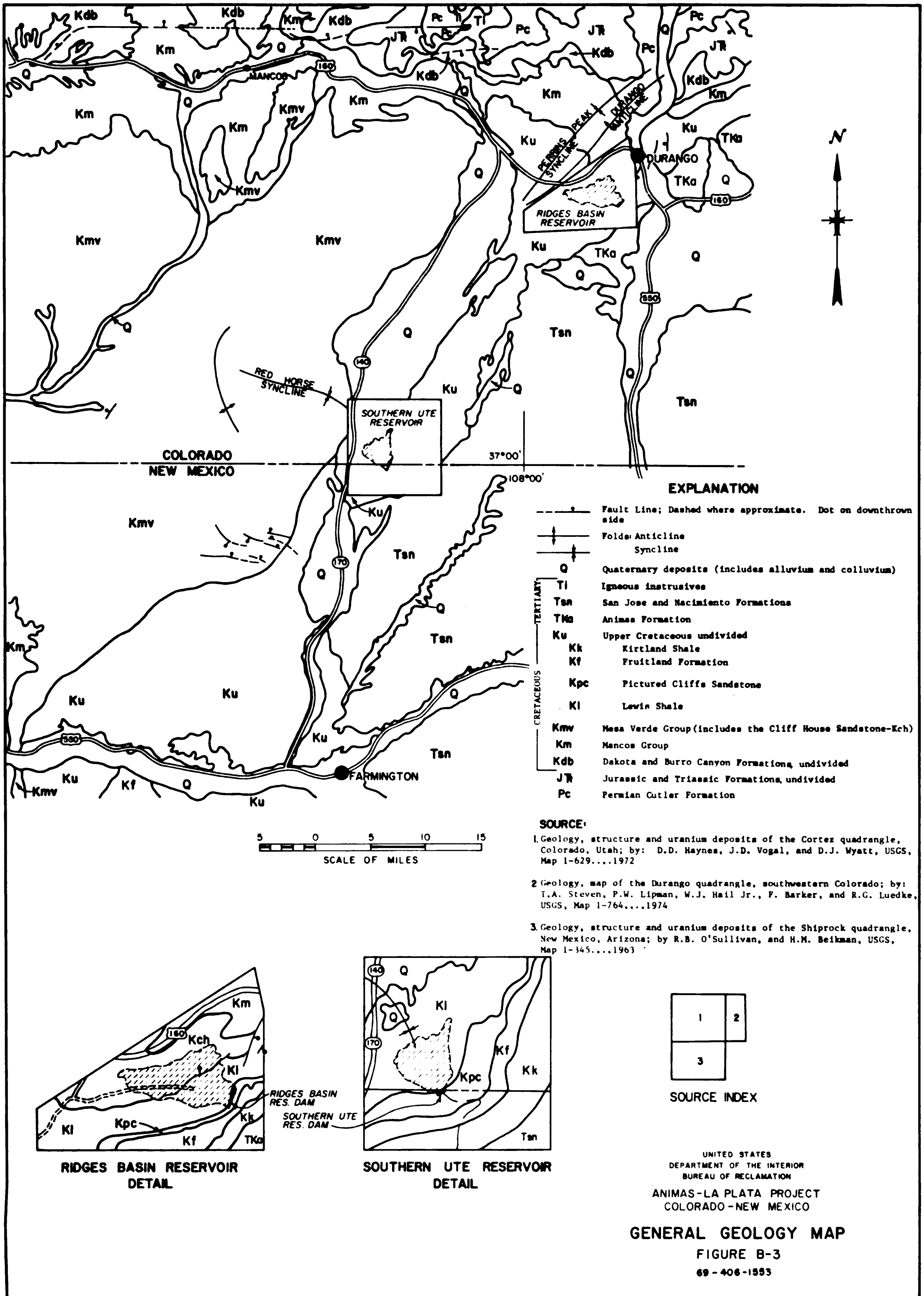
A fault extends along the contact between the Lewis Shale and the Cliff House Sandstone in the northern part of the reservoir. This fault is part of a fault zone that extends across the south edge of Durango. The fault zone is related to regional faulting of late Cretaceous and Tertiary age and probably has not been active since middle Tertiary about 25 million years ago; no construction problems are anticipated.

The Durango pumping plant site is underlain by approximately 23 feet of alluvial deposits; 15 feet of clayey sand containing some boulders which overlies 8 feet of gravels, cobbles, and boulders. These unconsolidated deposits are underlain by the Mancos Shale which is a gray to black, soft marine shale containing interbeds of clayey limestone and calcareous claystone, siltstone, and sandstone. The location is along the southeast flank of the Durango anticline and the beds dip approximately 10 degrees to the southeast. There are no faults in the immediate vicinity and no serious construction problems are anticipated.

The proposed Ridges Basin inlet canal and conduit alignments are underlain by formations of the Mesa Verde group; the Lewis Shale; and unconsolidated deposits consisting of residual soil, slopewash, and fluvial deposits. A large part of the conduit alignment is in the Lewis Shale which is susceptible to erosion and contains some weathered zones. Some faults trend NE-SW across the inlet alignments, but probably have not been active in recent times.

The Long Hollow Tunnel which would extend through the divide between the La Plata River and the Animas River drainage, would be excavated through the Cliff House Sandstone and the Lewis Shale. All but the last 100 feet of the 17,400-foot tunnel would be excavated in the Lewis Shale which is rather soft and weak and weathers rapidly when exposed. The Cliff House Sandstone is generally a competent rock, but it contains some interbedded shale layers in the upper part which have characteristics similar to the Lewis Shale.

Nearly horizontal beds of the Cliff House Sandstone underlie the La Plata Diversion damsite. Unconsolidated deposits consist of loose stream deposits approximately 10 feet thick. The Cliff House Sandstone is generally hard and resistant to erosion and would provide a stable foundation for the structure. No faults have been mapped along the Long Hollow Tunnel or La Plata Diversion Dam site.



Kdb
Km
Kmv
Q
Pc
Ti
JTR
MANCOS
DURANGO
PERRINS PEAK SYNCLINE
DURANGO ANTICLINE
Ku
TKa
RIDGES BASIN RESERVOIR
Tsn
RED HORSE SYNCLINE
SOUTHERN UTE RESERVOIR
COLORADO
NEW MEXICO
37°00'
108°00'
FARMINGTON
Kf
N
5 0 5 10 15
SCALE OF MILES
EXPLANATION
Fault Line; Dashed where approximate. Dot on downthrown side
Folds: Anticline
Syncline
Q Quaternary deposits (includes alluvium and colluvium)
TERTIARY
Ti Igneous instrusives
Tsn San Jose and Nacimiento Formations
TKa Animas Formation
CRETACEOUS
Ku Upper Cretaceous undivided
Kk Kirtland Shale
Kf Fruitland Formation
Kpc Pictured Cliffs Sandstone
Kl Lewis Shale
Kmv Mesa Verde Group (includes the Cliff House Sandstone-Kch)
Km Mancos Group
Kdb Dakota and Burro Canyon Formations, undivided
JTR Jurassic and Triassic Formations, undivided
Pc Permian Cutler Formation
SOURCE:
1. Geology, structure and uranium deposits of the Cortez quadrangle, Colorado, Utah; by: D.D. Haynes, J.D. Vogal, and D.J. Wyatt, USGS, Map 1-629....1972
2. Geology, map of the Durango quadrangle, southwestern Colorado; by: T.A. Steven, P.W. Lipman, W.J. Hail Jr., F. Barker, and R.G. Luedke, USGS, Map 1-764....1974
3. Geology, structure and uranium deposits of the Shiprock quadrangle, New Mexico, Arizona; by R.B. O'Sullivan, and H.M. Beikman, USGS, Map 1-345....1963
Kch
RIDGES BASIN RES. DAM
SOUTHERN UTE RES. DAM
RIDGES BASIN RESERVOIR DETAIL
SOUTHERN UTE RESERVOIR DETAIL
1
2
3
SOURCE INDEX
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ANIMAS-LA PLATA PROJECT
COLORADO-NEW MEXICO
GENERAL GEOLOGY MAP
FIGURE B-3
69-406-1553

b. Southern Ute Reservoir System Area

The Pictured Cliffs Sandstone and the Fruitland Formation which consists of sandstone, shale, and coal are exposed in the dam abutments. Lewis Shale was found in the foundation and is covered with approximately 53 feet of alluvial fill. The alluvium consists mainly of clayey sand and sandy clay. Rocks at the site are weathered and fractured and would require treatment to reduce seepage. A cutoff would likely be needed through the alluvium to prevent seepage. As at Ridges Basin dam site, the bedrock appears to be a suitable foundation with the added safety of a cutoff trench and grouting.

The Lewis Shale and Pictured Cliffs Sandstone underlie the reservoir basin. These formations are overlain by unconsolidated deposits consisting of sand, silt, and clay containing some gravels, cobbles, and boulders. The rock beds dip away from the reservoir to the southeast along the southern perimeter. Formation bedding is covered by slopewash.

No landsliding was found at the site. A pattern of fault plains lies subparallel to Cinder Bluffs Ridge through the reservoir and dam site.

Hard, resistant Cliff House Sandstone would be the foundation for the Southern Ute Diversion Dam and should present no construction difficulties. The inlet canal will be in Lewis Shale and Cliff House Sandstone. Some of the sandstone is moderately permeable and, in places, the shale is soft and weathered.

The Pictured Cliffs Sandstone and the Fruitland formation underlie the New Mexico Irrigation Canal alignment. These formations are overlain by rather shallow slopewash and alluvial deposits. No evidence of folding or faulting was noted along the alignment except for a general upwarping of the beds in the vicinity of the San Juan Basin rim.

c. Seismicity

The project is located in an area considered to be subject to only minor seismicity (Algermissen and Perkins, 1976). All recorded earthquake activity from 1901 to 1976 within a 200-mile radius of the reservoir sites is shown in Figure B-4. Magnitudes range from 3.1 to 5.4 on the Richter Scale and from III to VIII on the Modified Mercali Scale; these magnitudes indicate minimal risk, with only minor damage to poorly constructed structures to be expected in the event of an earthquake. No recorded epicenters are located within the project area. The most recent nearby earthquake occurred in January 1976, with an epicenter located about 70 miles south of Farmington. This earth movement, and the earlier 1966-67 activity shown east of Aztec and Farmington on Figure B-4, occurred because of subsidence caused by removal of oil and gas.

## 4 Water Resources and Use

### a. Stream Systems

The major streams in the project area are the San Juan River and three of its tributaries--the Animas, La Plata, and Mancos Rivers. The San Juan and Animas Rivers originate in the San Juan Mountains of Colorado to the east and north of Durango, respectively. The La Plata and Mancos Rivers originate in the La Plata Mountains to the northwest of Durango. The San Juan River flows generally in a westerly direction through Colorado and New Mexico to its confluence with the Colorado River in southeastern Utah. The three tributaries flow generally southward to join the San Juan in New Mexico.

All of the streams have extreme seasonal fluctuations in flow under natural conditions, reaching their highest levels in the spring snowmelt period and dropping sharply in late summer (see Figure B-5). The natural flows have been modified, however, by the construction of three Bureau of Reclamation reservoirs--Navajo Reservoir on the San Juan River about 35 miles east of Farmington, Lemon Reservoir on a tributary of the Animas River about 14 miles northeast of Durango, and Jackson Gulch Reservoir on the Mancos River about 28 miles west of Durango.1/ The average annual runoff of the Animas, La Plata, Mancos, and San Juan Rivers is shown in Table B-6.

Table B-6
Summary of annual runoff

| Location | Period of record | Average annual runoff (acre-feet) |
|---|---|---|
| Animas River at Durango | 1929-77 | 546,500 |
| La Plata River at Southern Ute Diversion Dam | 1929-77 | 22,800 |
| Mancos River near Towaoc | 1951-77 | 25,900 |
| San Juan River near Bluff, Utah | 1939-77 | 1,580,000 |

Within the project area, water is presently diverted from the Animas River for municipal and industrial use and irrigation in Colorado and New Mexico, from the La Plata River for irrigation in both States, and from the San Juan River for municipal and industrial use in New Mexico. No water is diverted from the Mancos River within the project area.

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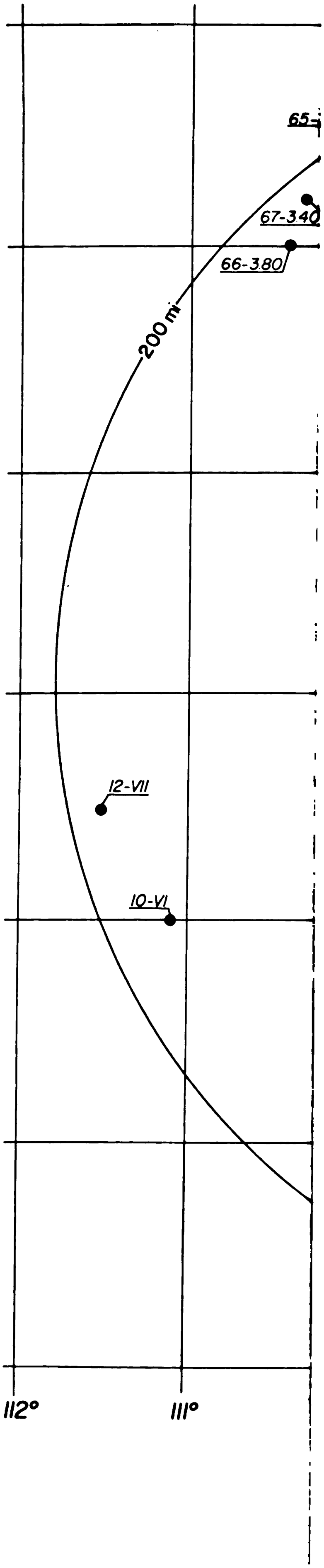
1/ Lemon Reservoir is a feature of the Florida Project which, together with Navajo Reservoir, was discussed in Section A12. Jackson Gulch Reservoir is a feature of the Mancos Project, which was constructed by the Bureau of Reclamation on the Mancos River west of Durango in the vicinity of the town of Mancos. The project supplies supplemental irrigation water to land near the town of Mancos and domestic water to the town and to Mesa Verde National Park.




## EXPLANATION

67-4.1 or IV — *Earthquake Epicenter with Year and Magnitude (Richter Scale) or (Modified Mercali)*

**SOURCE:** *National Geophysical and Solar-Terrestial Data Center, Boulder, Colorado*

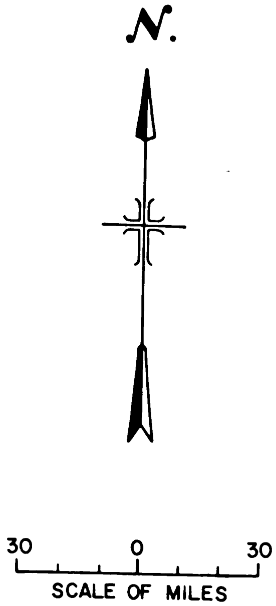



FIGURE B-4

Figure B-5--The dry LaPlata River channel south of Hesperus. Although runoff is high during the spring, the river is often low or dry during the late summer and fall.

The amount of water available for future use is 463,700 acre-feet from the Animas River and 19,200 acre-feet from the La Plata River. These amounts are the difference between the streamflows in Table B-6 and the amount required for downstream uses, which is estimated at 78,600 acre-feet from the Animas River and 7,200 acre-feet from the La Plata River. The amount required for downstream uses includes water for existing diversions on both rivers which cannot be met by downstream tributaries or return flows, water to maintain a minimum flow in the Animas River, and water to satisfy operational requirements of Navajo Reservoir.

No additional water is considered to be available for project use from the Mancos or San Juan Rivers. The Mancos Project has developed most of the flows of the Mancos River, and the use of the small amount of water remaining would require considerable pumping and lengthy conveyance facilities to areas of use in the project area. Flows of the San Juan River are essentially totally committed for downstream use.

b. Ground Water

Ground water is limited in the project area and is used primarily for domestic water. Supplies are not sufficient for development as irrigation water or for other large-scale uses.

In Colorado, depths to ground water range from less than 50 feet along stream bottoms and on presently irrigated land to more than 500 feet on plateaus and stream divides. Yields of from 5 to 50 gallons per minute occur in the eastern part of the area and from 1 to 10 gallons per minute west of Hesperus. Some wells east of Breen have a very low yield and may sometimes become dry. In the western part depths greater than 500 feet are common. In the southeastern part of the Ute Mountain Ute Indian Reservation, depths range from 200 to 500 feet, and yields are from 1 to 10 gallons per minute. Approximately 500 wells produce about 200 acre-feet of water per year in the Colorado area.

In New Mexico, depths to water range from less than 50 feet along stream bottoms to more than 500 feet on plateaus and near stream divides. Yields are from 5 to 50 gallons per minute. An estimated 200 wells produce about 600 acre-feet of water annually.

c. Municipal and Industrial Use

Cities in the project area divert and treat water for use inside and outside their city limits. Most rural users either rely on private wells, or, because of problems such as undependable supplies or poor quality, haul their water for domestic consumption.

In Colorado, the city of Durango diverts water for municipal and industrial use from the Florida River immediately downstream of Lemon Dam and pipes it to a reservoir immediately east of the city. For high demand periods during the summer, additional water is pumped from the Animas River to the reservoir. Untreated municipal water is used to irrigate a public golf course and lawns at Fort Lewis College, a high school, and a cemetery. The city also sells water to three water companies which serve adjacent suburban areas, rural users, and a local resort.

In 1976, water use in Durango and adjacent areas, including people on wells, amounted to about 5,200 acre-feet, or about 280 gallons per capita per day, exclusive of the untreated water. The per capita use rate is high because an estimated daily average of 2,500 tourists and 2,200 students at Fort Lewis College reside in the city but are not included in the population figures. Municipal water is also used for lawns and gardens. The city's water system will be placed on meters in 1979. Inclusion of the nonpermanent population in the computation of per capita use would result in an overall rate of 220 gallons per day which is within the 225 gallons per capita per day rate used by the Bureau of Reclamation for planning purposes.

As a condition of project participation, the Durango area would retain its right to 5,600 acre-feet of Florida River water, which is considered to be the dependable supply available for future use. The area would also retain a portion of its right to Animas River water for irrigation and emergency use during the irrigation season. The 5,600-acre-foot base supply would be sufficient for needs prior to 1980, but a lack of adequate storage precludes the use of additional water beyond that used in 1987. Requirements for additional water are estimated at 500 acre-feet in 1980, 3,900 acre-feet in 2000, and 8,200 acre-feet in 2020.

Bayfield diverts water from the Pine River, a tributary of the San Juan River which it joins at Navajo Reservoir, and also uses water from wells in the area. Water use is about 180 gallons per capita per day. The city has water rights for 2.55 cubic feet per second on the Pine River and also has a firm supply of 80 acre-feet of water from Vallecito Reservoir, which is located upstream of the town on the Pine River.

About 1,500 people in the rural areas of the Durango service area are served by wells, springs, or small community systems, and are not served by the Durango system. Because of undependable wells or no water at all, rural users east of Breen must haul their water by truck from a spring near Marvel, which is a dependable supply. West of the La Plata River, rural users haul their drinking water from the same spring because of the limited quantity and poor quality of local water supplies that come from wells 300 to 400 feet deep. In the remainder of the Colorado portion of the project area, rural users rely on private wells. During dry years, however, some wells dry up, and water for domestic use must be hauled.

Water use in the rural areas in the project area in Colorado was estimated at about 100 acre-feet in 1976, or 65 gallons per capita per day. This use rate is extremely low because water supplies are severely limited and frequently must be hauled. Also, domestic water is not used for lawns and gardens. Future requirements are estimated at 300 acre-feet in 1980, 600 acre-feet in 2000, and 800 acre-feet in 2020.

The city of Farmington obtains water from both the Animas and San Juan Rivers. Water is diverted from the Animas River north of Aztec and conveyed in a ditch for storage in Farmington Lake, which is located northeast of the city. Additional water is pumped from the Animas River south of the city and from the San Juan River southeast of the city. The city sells water to the communities of Kirtland, Fruitland, and Waterflow, and to the Navajo Tribal Utility Authority (NTUA), which distributes water to the Indian communities of Shiprock, Upper Fruitland, and Nenanezad.

Water use in Farmington and nearby non-Indian communities was about 10,700 acre-feet or 255 gallons per capita per day in 1976. The city has rights to about 18,100 acre-feet of water from the Animas and San Juan Rivers, which would meet anticipated needs to the late 1980's. Requirements for additional water are estimated at 10,300 acre-feet in 2000 and 27,500 acre-feet in 2020.

The NTUA used about 1,590 acre-feet of water, or 220 gallons per capita per day, in 1976. Since the NTUA has no decreed water rights, it purchases all of its water from Farmington and, therefore, has no dependable future supply. Future requirements are estimated at 2,500 acre-feet in 1980, 5,500 acre-feet in 2000, and 8,900 acre-feet in 2020.

The City of Aztec diverts water from the Animas River north of the city for distribution to city residents and to two water users organizations. In 1976 the city used approximately 990 acre-feet of water, which is about 130 gallons per capita per day. The use rate is low because of inadequate storage, inadequate pipe sizes in some areas, limited water rights, and a lack of supply during cold months because of freezing problems. Although Aztec has rights to about 850 acre-feet of water, only 175 acre-feet are senior to the project water rights and, therefore, are considered as a firm supply available for future use. Additional water requirements are estimated at 1,900 acre-feet in 1980, 4,400 acre-feet in 2000, and 7,200 acre-feet in 2020.

Bloomfield obtains its water from the San Juan River through an irrigation ditch. The city sells some water to nearby areas outside of its limits. Water use in 1976 was about 900 acre-feet or 0.14 acre-foot per capita. The use rate is low because of limited water rights, distribution system problems, and a lack of a continuous flow in the ditch which conveys the water from the river to the city. The city's right to 400 acre-feet of water is considered as the firm supply available for future use. Requirements for additional water are estimated at 1,500 acre-feet in 1980, 4,000 acre-feet in 2000, and 6,600 acre-feet in 2020.

The community of Blanco obtains its water from an infiltration gallery on the San Juan River. Water use has not been measured but is estimated at about 0.11 acre-foot per capita per year, exclusive of use by lawns and gardens. Blanco has no decreed water rights, and therefore, has no dependable supply available for future use. Future requirements are included in those shown above for Bloomfield.

The community of La Plata obtains its water from wells or by hauling. Per capita use is estimated at 0.07 acre-feet per year, which does not include water used on lawns or gardens. The town has no water rights, and therefore, no dependable supply. Future requirements are included in the requirements for Farmington.

## 5. Water Quality

The following discussion is a summary of a detailed technical report prepared by the Bureau of Reclamation (Bureau of Reclamation, 1979), on the water quality of the four project area rivers. That study is based on information gathered at 11 sampling stations within the area. The information collected has been tabulated, along with water quality standards and criteria, and is shown in Attachment 3 and summarized in Table B-7. Figure B-6 shows the location of the 11 stations.

### a. Animas River

Although all four rivers in the project area have their headwaters in or near a heavily mineralized region of the Colorado Rockies north of the project area, heavy metal pollution is a water quality problem only in the Animas River. At the Animas River headwaters, leached minerals and acid water from natural sources and abandoned and existing mining operations enter the river. High concentrations of iron, manganese, copper, lead, zinc, silver, cadmium, mercury, and arsenic, along with the acid water, cause the river to be nearly devoid of fish and aquiatic insects and unusable for domestic and agricultural purposes. By the time the river reaches Durango, the first major municipal and industrial water aeration caused by the stream's continual turbulent action and the high-quality inflow from tributaries have acted to improve the river's overall quality.

The city of Durango withdraws raw water from the river during the high demand period of late summer to supplement its main supply from the Florida River. While the total concentration of several heavy metals in the Animas may periodically exceed drinking water standards, most of the metals are in suspension, a form that allows them to be removed by standard settling and filtration treatment. Water from the two sources is mixed in a holding reservoir before treatment and distribution to the city, allowing the metals in suspension to precipitate out and the remaining metal concentrations to be diluted to be well within drinking water standards.

Table B-7
Water quality summary

| Sampling site | Annual mean temperature (°C) | Annual maximum temperature (°C) | Average total dissolved solids[1] (mg/l) | Minimum dissolved oxygen[2] (mg/l) | Average dissolved oxygen (mg/l) | Hardness[3] | Average pH[4] | Sodium adsorption ratio |
|---|---|---|---|---|---|---|---|---|
| Animas River | | | | | | | | |
| At Durango | 9 | 22 | 320 | 7.8 | 8.0 | 260 | 7.8 | 0.4 |
| At State line | 10 | 24 | 280 | 4.3 | 9.1 | 210 | 8.1 | .5 |
| At Farmington | 12 | 28 | 380 | 6.0 | 6.6 | 240 | 7.8 | .9 |
| La Plata River | | | | | | | | |
| At Hesperus | 8 | 22 | 100 | 7.5 | 9.3 | 100 | 8.1 | .1 |
| At State line | 10 | 32 | 870 | 7.0 | 9.5 | 790 | 8.0 | 1.1 |
| At Farmington | 15 | 34 | 2,030 | 7.0 | 7.8 | 580 | 7.9 | 4.1 |
| Mancos River | | | | | | | | |
| Near Towaoc | 12 | 29 | 1,760 | 5.8 | 9.6 | 910 | 8.2 | 1.5 |
| San Juan River | | | | | | | | |
| Near Archuleta | 10 | 26 | 180 | 8.6 | 11.3 | 110 | 7.8 | .8 |
| Near Farmington | 12 | 28 | 310 | 5.5 | 9.8 | 160 | 7.9 | 1.4 |
| Near Bluff | 15 | 29 | 650 | 1.3 | 9.3 | 340 | 7.7 | 1.9 |

1/ Recommended limit for drinking water is 500 mg/l. National Interim Drinking Water Standards, Environmental Protection Agency, 1975.

2/ Recommended level for aquatic species is 5.0 to 6.0 mg/l. Quality Criteria for Water, Environmental Protection Agency, 1976.

3/ Hardness as calcium carbonate (mg/l). Ranges: 0–75 (soft), 75–150 (moderately hard), 150–300 (hard), 300 and up (very hard).

4/ Primary and secondary national interim levels are 6.5 and 8.5. The level for aquatic species is 6.5 to 9.0.

Over the long term, as Durango grows and requires more Animas River water to meet its domestic needs, manganese concentrations in the water could become of concern to users, since conventional sedimentation-filtration water treatment facilities, such as in Durango, do not adequately remove dissolved concentrations of manganese.[1/] In such an event, a method such as third-phase-aeration treatment would have to be added to existing facilities to remove the manganese.

In the Animas River downstream of Durango, high levels of radioactivity were noted in the early 1960's and were traced to tailings piles at a working uranium mill located just south of Durango (Tsivoglov, 1960). While the mill remained open, radioactive readings were continually recorded in water samples taken downstream; however, when the mill closed in 1963, levels of radioactivity in downstream samples declined almost immediately. Recent water quality samples show that alpha and beta levels (indicators of radioactivity) are within the safe limits for humans, agricultural use, and aquatic life. The uranium tailings piles still remain and are just north of the proposed Durango Pumping Plant. Recent flood studies by the Corps of Engineers indicate that neither an intermediate regional flood (100-year flood) nor a more severe local flood would inundate the tailings, nor would such floods erode the underlying bank material (Corps of Engineers, 1974).

The runoff from precipitation at the piles does not enter the river (Energy Research and Development Administration, 1977). The concentrations of nitrogen and phosphorus (nutrients) and the number of coliform organisms found in samples taken from the Animas River at and just upstream of Durango indicate upstream domestic and agricultural influence on the water. The nutrients have not caused obvious instream or use problems, but domestic water supplies using this water must be disinfected to eliminate the coliform organisms. Proceeding downstream to Aztec and Farmington, Further increases in nutrients are noticeable.

Because of domestic and agricultural return flows, total dissolved solids increase from Durango to Farmington. Sulfate, which makes up a large portion of the total dissolved solids, occasionally exceeds drinking water standards. Instream water temperatures as noted in Table B-6, also increase downstream because of irrigation return flows, slower moving water, and an increasing sediment load. This limits the aquatic population to warm water species.

As the Animas River proceeds toward Farmington, the River's increasing sediment load and decreasing velocity allow many of the heavy metals to settle out and become deposited in the river bottom. Lead

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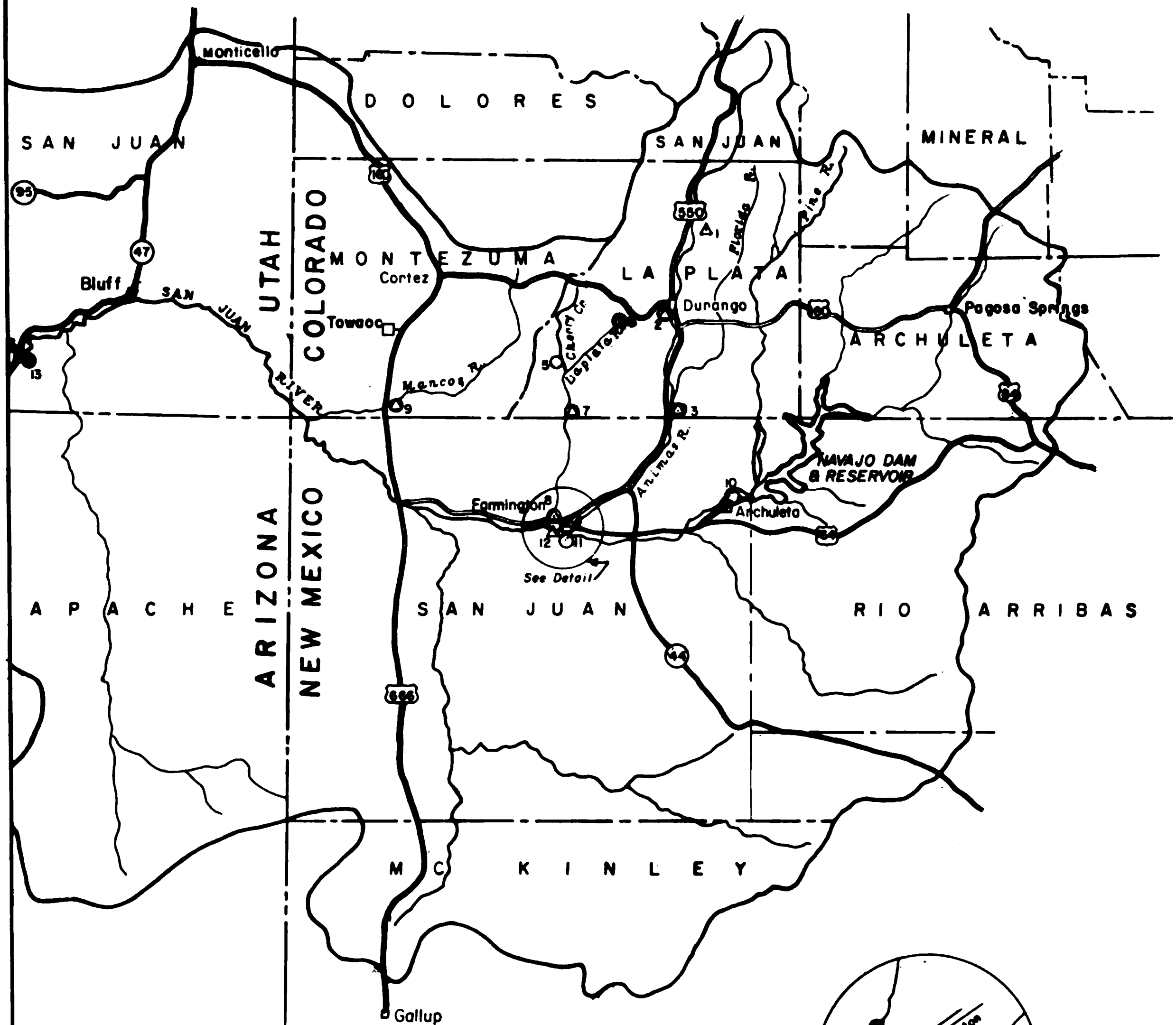
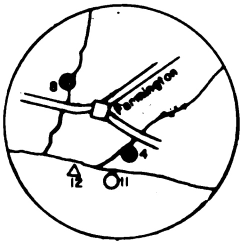
1/ Manganese is not considered a health hazard, but it is undesirable in domestic water supplies because it causes unpleasant tastes, leaves deposits on food during cooking, stains and discolors laundry and plumbing fixtures, and fosters the growth of some micro-organisms in reservoirs, filters, and distribution systems (California State Water Resources Control Board, 1974).




## LOCATION OF STREAM GAGING AND WATER QUALITY SAMPLING STATIONS

○ GAGING STATION △ QUALITY SAMPLING STATION

1. Animas River above Durango, Colo.
2. Animas River at Durango, Colo.
3. Animas River near Cedar Hill N.M.
4. Animas River at Farmington, N.M.
5. Cherry Creek near Red Mesa, Colo.
6. LaPlata River at Hesperus, Colo.
7. LaPlata River at Colo.-N.M.-state line
8. LaPlata River at Farmington, N.M.
9. Mancos River near Towaoc, Colo.
10. San Juan River near Archuleta, Colo.
11. San Juan River above Animas at Farmington, N.M.
12. San Juan River at Farmington, N.M.
13. San Juan River near Bluff, Utah




DETAIL

20 0 20 40

SCALE OF MILES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
UPPER COLORADO REGION

**ANIMAS-LA PLATA PROJECT**

COLORADO-NEW MEXICO

**STREAM GAGING AND WATER QUALITY SAMPLING STATIONS**

FIGURE B-6

concentrations at Farmington, however, have exceeded drinking water standards and the recommended criteria for aquatic life, but since the lead is in a suspended form, it can be removed by standard water treatment methods for drinking water and it is biologically unavailable for aquatic life as a general rule.

The primary water users downstream of Durango are agricultural interests and the cities of Farmington and Aztec. The river's quality is suitable for both purposes except during periods when accidental pollution from mining areas near the headwaters occurs. The most recent spills have occurred twice in the last five years. As a result, municipal raw water intakes along the river had to be shut down for several days because of the accompanying sharp increase in metal concentrations, agricultural use was also restricted.

Increased future mining in the Animas River headwaters area would be possible with the discovery of new deposits and the rising economic value of metals (Wentz, 1972). With increased mining activity, close regulation will be necessary to prevent further degradation of downstream water quality.

Area-wide water quality management plans are being developed at the State and Federal levels. The Bureau has coordinated with the State of Colorado's Region 9 Areawide Water Treatment Management Plan (Section 208 of Public Law 92-500), which covers the Colorado portion of the project area. A draft report of the plan is expected to be completed during the fall of 1979 (Hess, personal communication, 1979). The city of Durango is currently planning an expansion of its wastewater treatment plant which would be downstream of the proposed Durango Pumping Plant, and has completed the first phases of a Title II Grant for Construction of Treatment Works (Section 201 of the Amendment to the Clean Water Act, 1977). Part of this plan includes the preparation of an environmental statement by the Environmental Protection Agency.

b. <u>La Plata - Mancos Rivers</u>

The La Plata and Mancos Rivers also pick up some heavy metals in their headwaters, such as zinc, silver, cadmium, cyanide, and mercury; however, they do not limit existing agricultural or domestic uses. Since there is a trout fishery in the upper reaches of each river, the aquatic community does not appear to be adversely affected.

Both rivers are extensively dewatered for agricultural uses and by some domestic water taken from the Mancos River. Agricultural return flows and natural spring flows supply most of the water in the rivers downstream of the major diversions. An increase in total dissolved solids is indicative of the return flow supply (see Table B-6). Along with the salinity increase, some additional trace elements (iron, manganese, and aluminum), nutrients, suspended solids, and coliform organisms are present. Water temperatures also increase downstream because of irrigation return flow and natural thermal warming in the rivers.

The total dissolved solids concentration of the lower reaches of the rivers limit agricultural use to irrigation of salt-tolerant crops, which are presently grown, and require careful management to prevent salt build-up in the soil. Livestock watering is not a problem. The warmer water temperature and seasonal river dewatering limit the species of aquatic life inhabiting the lower reaches of the rivers. No domestic water is supplied from the lower portions of either river, but if domestic water were required, would be needed.

c. San Juan River

The San Juan River has good quality water suitable for most purposes since it is released from Navajo Reservoir. The cold temperatures, high oxygen content, low suspended solids content, and the lack of toxic elements begin to change several miles downtream, however. The river picks up high suspended-sediment loads, which have wide seasonal fluctuations. Along with the sediment, the temperature also increases significantly with a corresponding decrease in dissolved oxygen. Beginning at Archuleta, about 10 miles downstream of the Navajo Reservoir, irrigation and returns of municipal waste water degrade water quality by increasing salinity, nutrients, coliform organisms, and water temperatures. Notable concentrations of heavy metals are present in the San Juan River (copper, iron, lead, manganese, silver, zinc, and mercury), and at Archuleta lead concentrations have exceeded drinking water standards at times. These metals were probably deposited in the river sediments before the construction of Navajo Reservoir. The tributaries, primarily the Animas, La Plata, and Mancos Rivers, also add suspended heavy metals. Since most of the heavy metals are in suspension, by using standard water treatment domestic use would not be adversely affected by their presence.

Nutrient levels from Farmington to Bluff, Utah, are high enough to cause excessive aquatic plant growth, although the occasionally high turbidity from suspended sediment probably makes reduced light a limiting factor for such growth. Coliform organisms steadily increase in numbers from Archuleta to Bluff. Domestic water supplies must be disinfected to eliminate the coliform bacteria. Standard water treatment would allow domestic use of water in the San Juan River. Agricultural use also would not be limited. Aquatic life inhabiting the river is limited by temperature and suspended solids.

d. Ground Water

The chemical characteristics of ground water vary considerably depending on local geology. The ground water aquifers from the Lewis Shale and the Mesaverde Group, found on the irrigated land area in Colorado and New Mexico, generally have high concentrations of total dissolved solids. The dissolved solids range from 220 to 7,130 mg/l in springs and wells tested by the Geological Survey. In contrast, total dissolved solids in alluvial ground water ranged from 150 to 1,000 mg/l.

Alluvial ground water is directly connected to the surface waters, and thus is usually less mineralized than the deeper confined aquifers.

Constituents found in the ground water of the irrigated portion of the project area include iron, manganese, sulfate, magnesium, chloride, selenium, and fluoride. Of 34 springs and wells tested, 10 exceeded the drinking water standards for iron, 5 for manganese, 21 for sulfate, 6 for magnesium, 2 for chloride, 1 for selenium, and 10 for fluoride.

## 6. Stream Fisheries

### a. Introduction

The aquatic resources in the project area vary on each of the four rivers because of such limiting factors as water quality and man's use of the rivers. Table B-8 shows the estimated relative distribution and abundance of fish species in the Animas, La Plata, Mancos, and San Juan Rivers. Surveys of these rivers were conducted by the Colorado Division of Wildlife (1976), the New Mexico Department of Game and Fish (1976), and Eastern New Mexico State University (1976); and the following is a summary of the technical report proposed by the Bureau of Reclamation from these studies (1979).

### b. Animas River

In most of the Animas River, game fish populations are severely limited because of a combination of poor water quality and excessive seasonal flow fluctuations. The upper reaches will not support fish populations because of mining pollution. Because it receives excellent water from numerous tributaries between the headwaters and Durango, the river improves sufficiently to support limited aquatic life. From Durango downstream to Farmington, chronic mining pollution is no longer a major limiting factor.

The only significant trout fishery in the Animas River, consisting of rainbow and brown trout, occurs within the city limits of Durango and extends approximately 5 miles downstream. This fishery results exclusively from the intensive stocking operation undertaken by the Colorado Division of Wildlife. Understandably, most of the total fisherman use of the entire river occurs in this stretch, or 85 to 90 percent of the total 4,520 man-days of use estimated for 1976 (Smith, 1976).

South of Durango, trout habitat becomes scarce because of high summer water temperatures, excessive silt deposits, and diminishing water velocities. Sucker populations begin to dominate since the physical characteristics of the river become more favorable to their needs; bluehead and flannelmouth suckers constitute an estimated 61 percent of the total fish population from Durango to the State line. In this reach, suckers and other nongame fish species outnumber the trout population 30 to 1 (Smith, 1976).

In New Mexico, most of the factors limiting the presence of trout in the river increase, and aquatic studies reveal that very few trout occur (Sublette, 1976). The most abundant fish species are bluehead and flannelmouth suckers and speckled dace. Although the State of New Mexico in 1975 stocked about 200,000 fry rainbow trout in an attempt to establish a trout fishery in this reach of the river, the venture appears to have been essentially unsuccessful. Fishing pressure is extremely light throughout this section with only one group of fishermen noted during the course of the aquatic study (Sublette, 1976).

Other species of fish captured or otherwise identified from the Animas River during the course of aquatic surveys were cutthroat trout, speckled dace, and mottled sculpin in Colorado; and, in New Mexico, carp, fathead minnows, black bullheads, and Rio Grande killfish.

c. La Plata River

The Upper La Plata River north of Hesperus supports a substantial game fish population. Cutthroat, brook, brown, and stocked catchable-size rainbow trout can all be found throughout this section. Supporting virtually all of the known fisherman use on the La Plata River, this upper section had an estimated 15,329 fisherman days in 1975.

The La Plata River fishery downstream of Hesperus has been drastically altered by numerous water diversions that dry up large sections of river during the irrigation season. Low seasonal flows, increased water temperatures, and deteriorating water quality cause trout populations to essentially disappear between Hesperus and the State line. The predominant fish species in this section are flannelmouth and bluehead suckers, fathead minnow, and speckled dace. The New Mexico portion of the La Plata River does not support a resident fish population because of annual flow depletions as a result of numerous water diversions.

d. Mancos River

Upstream of the town of Mancos, a limited trout population is perpetuated in the Mancos River as a result of stocking by the State of Colorado. Downstream of Mancos, warmer water temperatures, lower water velocities, and poorer overall water quality all combine to limit the composition of fish species. This lower section contains but one species of game fish, channel catfish, which is believed to be only a summer migrant from the San Juan River. The more common species of nongame fish found in this section are flannelmouth suckers, speckled dace, and red shiners.

| | | San Juan River | |
|---|---|---|---|
| | os r | Farmington to State line | State line to Lake Powell |
| Game species | | | |
| Rainbow trout | | | |
| Brown trout | | | |
| Cutthroat tro | | | |
| Brook trout | | | |
| Channel catfi | mon | | Trace |
| Largemouth ba | | | Trace |
| Black bullhea | | Trace | Uncommon |
| Green sunfish | | Trace | Trace |
| Nongame species | | | |
| Carp | | Uncommon | Trace |
| Fathead minno | | Uncommon | Common |
| Rio Grande ki | | Trace | Uncommon |
| Flannelmouth | mon | Common | Uncommon |
| Bluehead suck | | Common | Trace |
| Speckled dace | n | Common | Trace |
| Red shiners | n | | Common |
| Mottled sculp | | Trace | |
| Mosquitofish | | | Trace |

1/ The ord

e. San Juan River

The San Juan River downstream of Farmington is a large, broad river limited primarily to such nongame fish species as bluehead suckers and speckled dace, which are abundant, and flannelmouth suckers and fathead minnows, which also are common in the project area. Species occurring in smaller numbers are mottled sculpin, red shiner, Rio Grande killfish, largemouth bass, carp mosquitofish, and green sunfish. Black bullheads and channel catfish are also known to occur in the area.

## 7. Vegetation

### a. Introduction

The dominant vegetative communities in the project area are grasslands, sagebrush, pinyon-juniper woodlands, which in this area have often been cleared in an attempt to create grassland for livestock grazing, mountain shrubs, riparian (streamside), and irrigated and dry cropland. A general vegetative inventory was made by Owen (Fort Lewis College, 1975). Figure B-7 depicts the distribution of the communities in the project area.

### b. Grasslands

The vegetation in this community consists of mixed grasses with various saltbrushes. When found at higher elevations in the area, such as Ridges Basin, the grasses consist of species including wheatgrass, mountain brome, mountain muhly, and oatgrass. In lower areas such as Cinder Gulch, the community is represented by species such as Indian ricegrass, alkali sacaton, and cheatgrass in association with various low-growing shrubs such as shadscale, four-winged saltbrush, greasewood, and rabbit brush.

### c. Sagebrush

The vegetation in this community, which is scattered throughout the project area and may be found particularly on the full service lands in New Mexico, consists of strands of big sagebrush of varying density with an understory of different perennial grasses and annual forbs. Generally, sparse stands of sagebrush are found in association with scattered stands of pinyon-juniper and various shrubs.

### d. Pinyon-Juniper

This community, which consists of the equally dominant pinyon-pine and juniper and often an understory of mountain shrubs, is found at the higher elevations of the project area in Colorado, ranging in elevation from 6,000 to 7,500 feet. The woodland is often broken, forming parks in valley bottoms and some upland areas. Galleta and big sagebrush are also present, most commonly in overgrazed areas. Where the range has deteriorated substantially, big sagebrush has become the dominant community. On the full service land in Colorado, the pinyon-juniper community is found on the fringe of dry cropland or in areas unsuitable for farming because of terrain.

e. Chained areas

In this community, which reflects efforts to promote grasslands for grazing, the pinyon-juniper woodland or dense mountain shrubs have been uprooted and burned to increase potential forage production on the cleared land. After reseeding, primarily with western wheatgrass, the process is completed; however, because seeding attempts fail in certain areas or because of overgrazing, cheatgrass often becomes the dominant vegetation. All of the chained areas are on the Ute Mountain Ute Indian Reservation (See Figure B-8).

f. Coniferous Forest

Although this vegetative type is rarely found on land to be affected by the project, some coniferous forest is found at the Ridges Basin Reservoir site. In this area, ponderosa pine dominates with some pinyon-juniper and sagebrush. A large diversity of other shrubs, grasses, and forbs are also present.

g. Mountain Shrubs

This community, which is found above 5,500 feet in Colorado, is composed of mountain browse shrubs, including Gambel's oak, service berry, mountain mahogany, and fendlerbush, with an understory of grasses in association with annual forbs. It exists as a stable community primarily on southern exposures and is interspersed with pinyon and juniper on northern exposures. Disturbed areas often support dense stands of Gambel's oak with little or no understory.

h. Irrigated and Dry Cropland

Approximately 50 percent of the Colorado project area irrigated cropland is pasture or alfalfa, and 31 percent is in small grains. Most of the remaining is idle because of the lack of irrigation water. In New Mexico, 72 percent of the presently irrigated project land is pasture or alfalfa, 18 percent is in small grains, and 7 percent in corn silage. The balance is idle. Pinto beans are produced on 60 percent of the dry cropland, small grains on 25 percent, and the balance is fallow or idle. A typical area of dry cropland is shown in Figure B-9. Approximately 1,430 acres of marginal riverine (flowing water) wetland habitat,[1/] the result of existing canals and laterals in the area, are in the project area. The plant community along this waterway consists of cottonwood, willows, grasses and several brush species.

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1/ Habitat criteria adapted from U.S. Fish and Wildlife Service (1977).

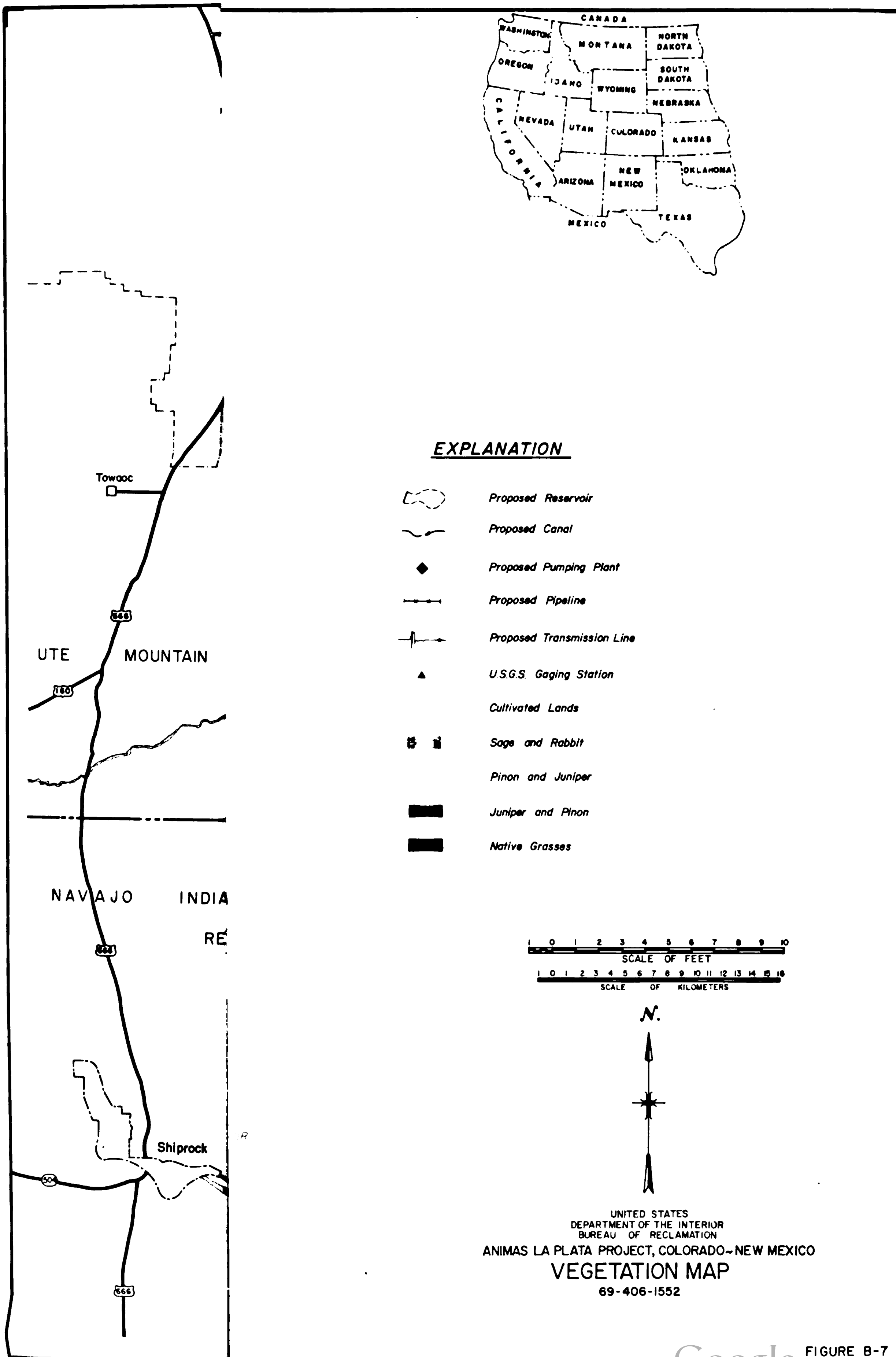

CANADA
WASHINGTON
MONTANA
NORTH DAKOTA
OREGON
SOUTH DAKOTA
IDAHO
WYOMING
NEBRASKA
CALIFORNIA
NEVADA
UTAH
COLORADO
KANSAS
ARIZONA
NEW MEXICO
OKLAHOMA
MEXICO
TEXAS
Towaoc
666
UTE
MOUNTAIN
160
NAVAJO
INDIA
RE
Shiprock
504
666
EXPLANATION
Proposed Reservoir
Proposed Canal
Proposed Pumping Plant
Proposed Pipeline
Proposed Transmission Line
U.S.G.S. Gaging Station
Cultivated Lands
Sage and Rabbit
Pinon and Juniper
Juniper and Pinon
Native Grasses
1 0 1 2 3 4 5 6 7 8 9 10
SCALE OF FEET
1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
SCALE OF KILOMETERS
N.
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ANIMAS LA PLATA PROJECT, COLORADO-NEW MEXICO
VEGETATION MAP
69-406-1552
FIGURE B-7

Figure B-8--A chained area on the Ute Mountain Ute Indian Reservation. Pinyon juniper woodland or mountain shrubs have been removed to promote the growth of forage.

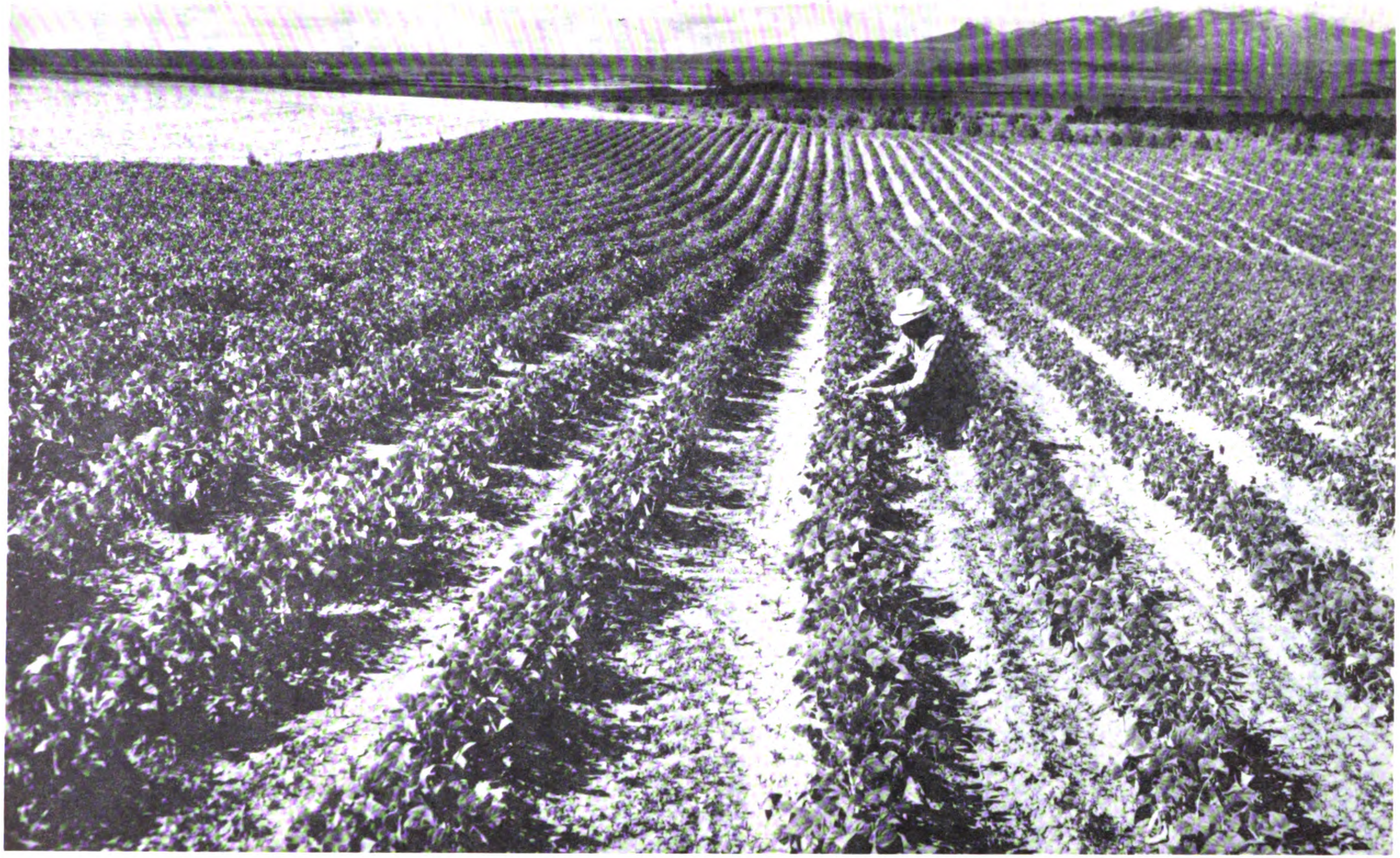


Figure B-9--Dry cropland south of Hesperus. With unreliable water from precipitation in the summer, crop yields are often below potential and for pinto beans were as low as 100 pounds per acre during a recent drought. Dependable irrigation supplies could increase the yields to as much as 2,000 to 3,000 pounds per acre.

i. Riparian

All of the streams in the project area have narrow bands of riparian vegetation. At the higher elevations, some of the dominant species are narrowleaf cottonwood and box elder trees interspersed with dense growths of willows, alder, and hawthorne. At the lower elevations tamarisk replaces the willows, and Fremont cottonwood replaces the narrowleaf cottonwood.

8. Wildlife

a. Introduction

The information on terrestrial wildlife in the project area comes from reports prepared by the Colorado Division of Wildlife (1976), Fort Lewis College (1976), the New Mexico Department of Game and Fish (1977 and 1978), and the Bureau of Reclamation (1979). These reports are available for inspection at Bureau of Reclamation offices in Durango, Grand Junction, and Salt Lake City.

b. Big Game

(1) Mule Deer

The project area in Colorado supports two distinct herds of mule deer. A resident herd of about 1,000 animals is distributed evenly year round in an area extending west of Durango to about 20 miles south of U.S. Highway 160. A migratory herd of about 4,000 mule deer generally winters in the same area but summers at elevations above 6,000 acre-feet in the San Juan Mountains to the north of Durango. The project area in New Mexico supports a migratory herd of about 380 deer that winter in an area extending southward about 20 miles along the La Plata River toward Farmington. Deer population areas and migration routes are shown in Figure B-10.

Ridges Basin Reservoir site lies within the boundaries of a Colorado Division of Wildlife management area. During the winter, the reservoir site is inhabited by approximately 200 deer, both migrant and resident animals.

(2) Elk

The project area in Colorado supports two herds of elk, while few if any elk are found in the project area in New Mexico. The two herds in Colorado are a migratory herd of 1,700 to 2,000 elk and a resident herd of about 200 animals. The migratory herd summers in the San Juan Mountains north of Durango and moves southward across U.S. Highway 160 in winter, while the resident herd remains evenly distributed south of the highway on the Southern Ute Indian Reservation throughout the year. Elk concentration and migration routes in Colorado are shown in Figure B-11.

Ridges Basin reservoir site is also a winter concentration area for about 200 elk. These animals are both resident and migrant also.

(3) Antelope

A small amount of project land in new Mexico west of the La Plata River and north of Farmington lies within a large New Mexico State wildlife management area, that is estimated to contain about 50 antelope. There are no antelope within the project area in Colorado.

(4) Black Bear and Mountain Lion

No bears or mountain lions were found during surveys conducted in the project area in Colorado and New Mexico (Bureau of Reclamation, 1979), but the Colorado Division of Wildlife estimates that six lions may occasionally use the project area and adjacent lands in Colorado.

c. Small Game Mammals

Two species of small game mammals are commonly found in the project area--the mountain and desert cottontails. The mountain (or Nuttall's) cottontail, an important food for predators, is found in brushy forest areas above 6,000 feet, such as Ridges Basin. The desert cottontail is common at lower elevations of the project area in sage-brush and greasewood shrublands. Although no harvest figures are available, the desert cottontail receives moderate hunting pressure. The Abert's squirrel, an uncommon small mammal in the project area, is found primarily in the ponderosa pine forests.

d. Furbearers

Furbearers in the project area include the beaver, musk-rat, long-tailed weasel, badger, striped skunk, and gray and red foxes. No beaver colonies are found on project land in Colorado, but colonies are found in New Mexico along the La Plata River. The muskrat uses streams and small ponds in the project area. The badger, which prefers an open habitat with loose soil, is found throughout the project area, as is the long-tailed weasel, which exists in almost every habitat. The striped skunk is common in agricultural and residential areas throughout the project area. Both the gray fox and the red fox are found in the rougher terrain adjacent to the stream systems.

e. Varmints

Varmints are defined as mammals capable of causing significant damage to public property or of being a nuisance to human interests, but

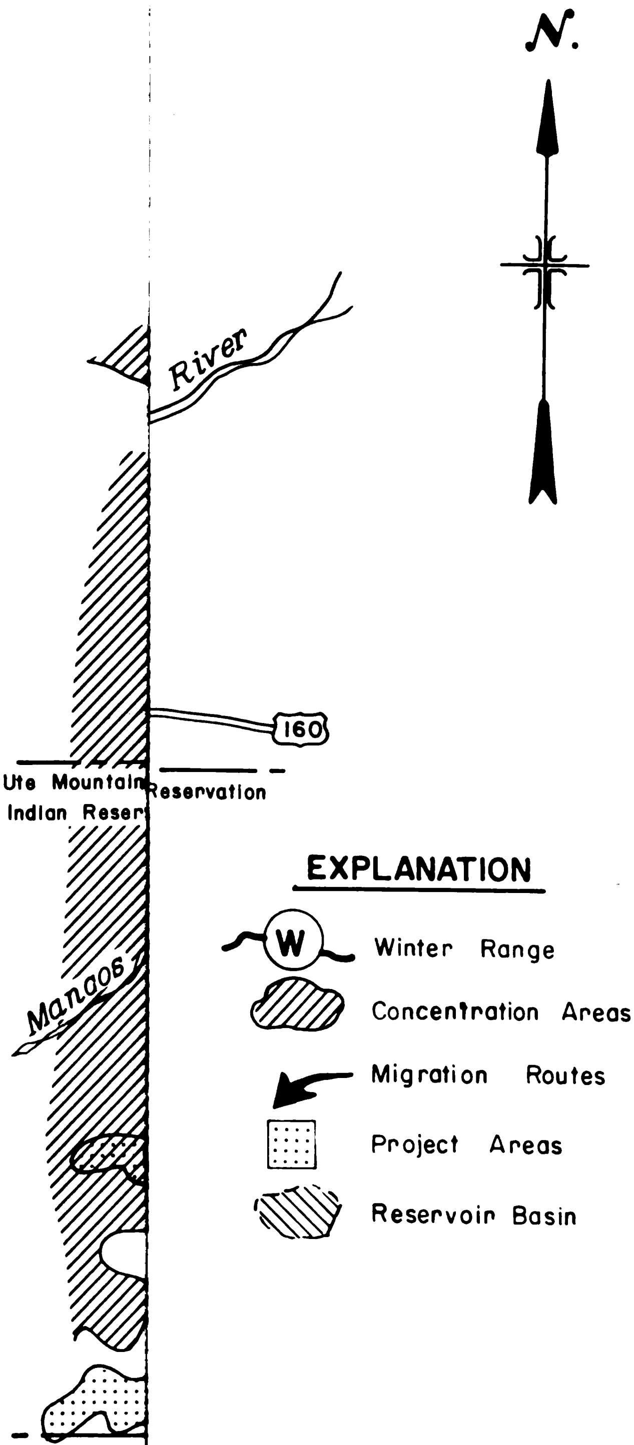



FIGURE B-10

A PLATA PROJECT AREA

CONCENTRATION AND

IGRATION AREAS

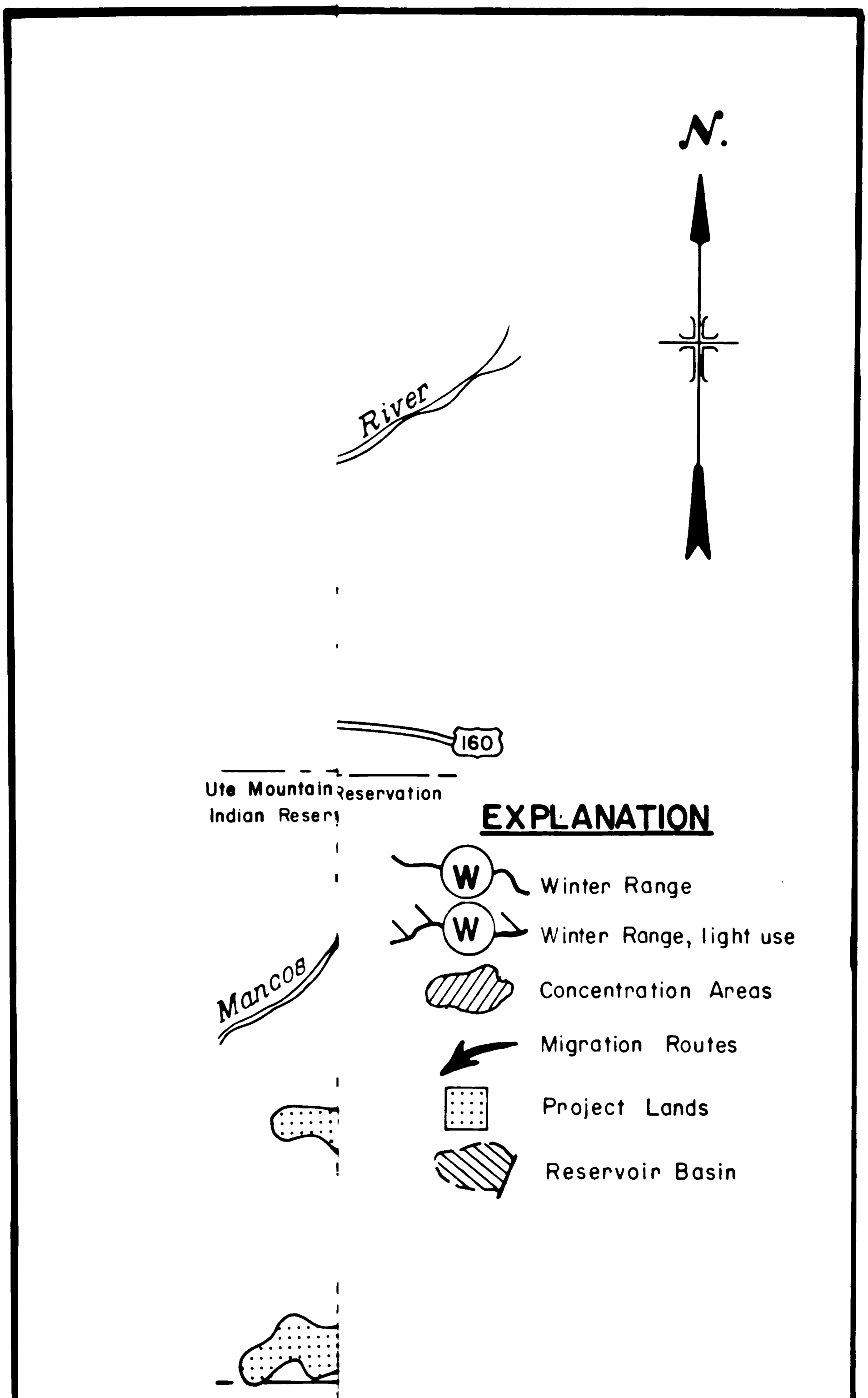



FIGURE B-11

CENTRATION AREAS AND
IGRATION ROUTES

PLATA PROJECT AREAS

which also offer opportunities for hunting as defined by the Colorado Division of Wildlife. Varmints in the project area include the coyote, bobcat, black-tailed jackrabbit, yellow-bellied marmot, Gunnison's prairie dogs, porcupine, and racoon.

The coyote is common at all elevations throughout the project area (estimated at 2 per square mile) and is considered to be increasing. Although no bobcats were seen during the wildlife inventories, local people have observed them throughout the project area, particularly in rough, brushy canyons and areas of broken terrain.

The black-tailed jackrabbit is found in dry, open habitat such as the shrub and grassland of the project area. The yellow-bellied marmot is found occasionally at the higher elevations in the vicinity of Ridges Basin.

Gunnison's prairie dog is found in open, dry habitat throughout the project area on land that, although once irrigated, is now fallow. The porcupine, on the other hand, is found in wooded areas. Raccoons are most commonly found along streams, ponds, and irrigated portions of the project area.

f. Small Nongame Mammals

The small nongame mammals of the project area, some of which are an important food source for predators, include shrews, bats, chipmunks, squirrels, pocket gophers, mice, rats, and voles. The most common, widely distributed small mammal in the inventory was the deer mouse.

g. Birds

(1) Raptors

Fourteen species of raptors were recorded in the project area during wildlife inventories. Year-round residents include the redtailed hawk, goshawk, sharp-shinned hawk, golden eagle, prairie falcon, marsh hawk, Cooper's hawk, American kestrel, great-horned owl, and burrowing owl. The seasonal residents recorded were the Swainson's hawk, rough-legged hawk, and osprey.

The golden eagle is also found in the area, with nest sites recorded on bluffs on the east end of Ridges Basin and next to Cinder Gulch. The bald eagle is a common winter resident of the area.

(2) Gamebirds

Gamebirds of the area include turkey, Gambel's quail, ring-necked pheasant, chukar, band-tailed pigeon, and mourning dove. The Colorado Division of Wildlife, which planted 11 turkeys to establish a population in the Ridges Basin area in 1975, believes its effort to be successful and that the population has increased to approximately 20. Gambel's quail and ring-necked pheasant are uncommon year-round residents in the northern part of the project area, but are more common on project land in New Mexico. Gambel's quail is usually found in desert thickets near water, and pheasants primarily use areas with cultivated land. The chukar was found on the Ute Mountain Ute Indian Reservation and on the full service land in New Mexico. As many as 200 birds were observed on one occasion; these birds are believed to be a result of Colorado Division of Wildlife plants west of Cortez. This year-round resident seems to prefer arid lands.

The band-tailed pigeon and mourning dove migrate through the project area, arriving in the spring and departing in the fall. Although the pigeon is uncommon, large migration flocks that prefer areas of Gambel's oak, where they feed on acorns, occasionally may be seen. The mourning dove is common throughout the area.

(3) Waterfowl and Shorebirds

The Animas and La Plata Rivers are important nesting and feeding areas for many species of waterfowl and shorebirds, which vary in number with the season since most are migrants. The mallard duck is the most numerous of the waterfowl species. Some other waterfowl found along the rivers include the snow goose, gadwall, pintail, green-winged teal, blue-winged teal, cinnamon teal, American wigeon, common goldeneye, and common merganser.

Shorebirds, including the killdeer, common snipe, greater yellowlegs, and Wilson's phalarope, were recorded along the Animas and La Plata Rivers. Many other species of shorebirds use the stream systems in the project area during their migration.

(4) Nongame Birds

Nongame birds in the project area include passerines, woodpeckers, nighthawks, swifts, and hummingbirds. Many of these species migrate to the area in the spring and summer. The Animas and La Plata Rivers and their associated riparian habitats support the largest number of nongame species in the project area.

h. Reptiles and Amphibians

The reptiles and amphibians in the project area are those characteristic of the Southwestern United States. Some of the common species include the eastern fence lizard, sagebrush lizard, western terrestrial garter snake, gopher snake, chorus frog, and woodhouse's toad. Some less common species are the lesser earless lizard, many-lined skink, milk snake, and western rattlesnake.

## 9. Endangered Species

### a. General

In accordance with the provisions of the 1978 amendments to the Endangered Species Act, the Fish and Wildlife Service was contacted in regard to any endangered species that may occur in the project area. The Fish and Wildlife Service responded with a memorandum dated March 9, 1979, in which it listed the bald eagle, peregrine falcon, and the Colorado River squawfish as possibly occurring in the project area. These species are also listed by Colorado and New Mexico as endangered species. At this time the Bureau of Reclamation has completed a biological assessment of the effects of the project on the listed species and has forwarded the assessment to the Fish and Wildlife Service. As required by the Endangered Species Act, the Service is now required to prepare a biological opinion which is the determination of the degree of impact the project may have on the listed specie under the act.

### b. Fish

During recent surveys, no Colorado River squawfish were collected in any of the rivers directly affected by the project (Sublette, 1978; Smith, 1976; Robertson, 1977; U.S. Fish and Wildlife Service, 1976 and 1978; Colorado Division of Wildlife, 1978). In 1959 and 1961, prior to the completion of Navajo Dam, six specimens were collected in the San Juan River above Blanco, New. Mexico. One specimen was found in 1965 near Bloomfield, New Mexico (Conway, 1975).

In the San Juan River downstream of the project area, fishermen reportedly caught squawfish in the San Juan arm of Lake Powell, 200 miles downstream of Farmington, New Mexico, in October 1977 (Fish and Wildlife Service, 1978). Also, in April 1978, one juvenile squawfish was taken from the San Juan River about 100 miles downstream of Farmington near Aneth, Utah (Bureau of Reclamation, 1978).

The roundtail chub is listed by New Mexico as a species that may be in jeopardy in the foreseeable future. In Colorado, this species is found commonly in most of the streams and rivers at lower elevations. Unlike the Colorado River squawfish, this species can tolerate cooler water temperatures and small streams, although it is not the preferred habitat (Colorado Division of Wildlife, 1979). In the Animas and La Plata Rivers it is found only in the extreme southern portions and is probably much more common in the San Juan River, where aquatic conditions are more favorable.

### c. Wildlife

The bald eagle is a common winter resident and also has been seen at other times of the year. According to the U.S. Fish and Wildlife Service (1979), a nest site for this species is located on land adjacent to the project area. However, no nest sites were identified in the project area during studies by Fort College (1976).

Although no peregrine falcons were sighted during the study by Fort Lewis College (1976), a pair of falcons used a nest in the project area as recently as 1975 (Colorado Division of Wildlife (1976). No young were reproduced from this site, and the Division of Wildlife has requested that the precise location of aerie not be revealed.

## 10. Vector and Related Problems

The U.S. Public Health Service (1960, 1976), San Juan Basin Health Unit (1976 and oral communication, May 1978) and the Animas Mosquito Control District (oral communication, May 1978), have provided information on vectors and related problems.

While vector-carried diseases are not a major problem in the project area, they are known to occur in the general region. Larvae of the mosquito species Culex tarsalis, the primary vector for western and St. Louis encephalitis is present in most of the areas with standing water. The serious equine encephalitis, which can be transmitted by several species of mosquitoes, occurred recently in eastern Colorado, although no cases were reported in western Colorado. The mosquito species that is the western vector for malaria is also found in the area; however, the parasite for the disease cannot survive the local winters. Three other species of mosquitoes found along the La Plata River are vicious in their biting of humans and may create public health problems not related to the transmitting of specific diseases. These mosquitoes often interfere with outdoor activities of people. Some persons may even require medicaal attention for the secondary infection and allergic reactions resulting from these bites. Other mosquitoes, although not causing health problems, are a nusiance in places such as recreation areas.

Also common in the area are wood ticks, which can transmit Rocky Mountain spotted fever and Colorado tick fever to people. Rocky Mountain spotted fever has not occurred for many years in the project area, but last year from 5 to 10 cases a week of Colorado tick fever were treated locally during the tick season. Bubonic plague a disease which can be transmitted to humans by fleas from wild animals, is a problem in other areas of Colorado and New Mexico, but no cases have been reported in the project area.

## 11. Air Quality

Air quality in the project area esentially meets all primary National air quality standards, although some violations (less than 1 percent of recorded samples) of the primary and secondary standards for carbon monoxide emissions have occurred in downtown Farmington in recent years.[1] Table B-9 shows the carbon monoxide readings for two monitoring sites in Farmington located in the downtown area. Data collected in the Durango area by the State of Colorado from January 1970 to June 1977 reveal no violations of Federal primary or secondary standards. Although coal fired power generating plants are located in the Four Corners area, the rapid dispersion of gases results in no recordable violations of Federal standards for sulfur dioxide or nitrogen oxides in the project area.[2]

Table B-9
Carbon monoxide levels in
Farmington, New Mexico
(parts per million)

| | Main Street and Vine (1975) | County Law Building (1976) |
|---|---|---|
| Number of samples | 845 | 1,606 |
| 8-hour readings | | |
| First high | 13.5 | 10.4 |
| Second high | 12.8 | 10.2 |
| 8-hour standard | | |
| Federal | 9 | 9 |
| State | 8.7 | 8.7 |
| 1-hour readings | | |
| First high | 20.0 | 17.0 |
| Second high | 19.0 | 16.0 |
| 1-hour standard | | |
| Federal | 35 | 35 |
| State | 13.1 | 13.1 |

Some of the monitoring stations in the project area have recorded violations of Federal particulate standards. Generally resulting from windblown dust, suspended particulates pose a health hazard by interfering with lung capacity and by causing headaches and eye problems. Suspended particulate levels vary in the project area for a variety of reasons. The project area in New Mexico has less vegetative cover than in Colorado. It also apparently has no wide seasonal variations in suspended particulate levels, compared to Durango, where the first and fourth quarters of each year are significantly worse than the rest of the year. This variation may be attributed to mud carried to paved roads from surrounding unpaved county roads and private driveways, resulting in

1/ Primary standards were established to protect human health and secondary standards to protect the quality of life.

2/ Federal primary standards for sulfur dioxide for a 24-hour period are 0.14 part per million and for 1 year, 0.03ppm. In 1976 Farmington had 24-hour average highs of 0.025 and 0.014 and an annual arithmetic mean of 0.0090. Federal primary standard for nitrogen dioxide is 100 $ug/m^3$ for 1 year; from January 1976 to June 1977 Farmington had arithmetic means ranging from 30 to 70 $ug/m^3$.

increased amounts of soil drying on city streets which eventually becomes wind-borne. From Farmington to Shiprock, the prevailing wind is more severe than in the Durango area, resulting in more sustained periods with suspended particulates in the air. Farmington recorded eight violations of the 24-hour primary standard in a 1.5-year period in 1976-77 (see Table B-10). In comparison, the city of Denver, with a much higher population, more vehicular traffic, and more air quality problems, recorded 120 violations of the same standard within a 1-year period (1976). Table B-10 shows data for 1976 and the first two quarters of 1977 from particulate monitoring stations in the project area.

Table B-10
Suspended particulates 1/
January 1, 1976, to June 30, 1977

| Monitor location | Number of observations | 24-hour readings (ug/m3) High | 24-hour readings (ug/m3) Second high | Violations Primary (260 ug/m$^3$) | Violations Secondary (260 ug/m$^3$) | Annual geometric mean (1976) |
|---|---|---|---|---|---|---|
| Durango, Colorado | 131 | 218 | 162 | 0 | 4 | 70 |
| Red Mesa, Colorado | 103 | 280 | 188 | 1 | 9 | 44 |
| Aztec, New Mexico | 65 | 253 | 138 | 0 | 3 | 54 |
| Farmington, New Mexico 2/ | 55 | 357 | 284 | 8 | 18 | 3/ 137 |
| Kirtland, New Mexico | 4/ 56 | 290 | 124 | 1 | 3 | 71 |
| Shiprock, New Mexico 5/ | 58 | 356 | 346 | 2 | 4 | 52 |

1/ Based on information from the Environmental Protection Agency (Region VIII), the Colorado Department of Health, and the New Mexico Environmental Improvement Agency.

2/ Monitor located at Health Department adjacent to Main Street and heavy traffic area.

3/ A violation of the Federal 1-year summary standard of 75 ug/m$^3$. Durango, Farmington, and Kirtland also recorded violations of the 1-year secondary standard of 60 ug/m$^3$.

4/ Data not available for first quarter of 1976.

5/ Monitor located at the Bureau of Reclamation's Shiprock Power Substation, Colorado River Storage Project (CRSP), due west of Four Corners Powerplant. The generally rural area has many unpaved roads and a prevailing west wind.

# CHAPTER C

# ENVIRONMENTAL IMPACTS OF PROPOSED ACTION

## C. ENVIRONMENTAL IMPACTS OF PROPOSED ACTION

### 1. Social and Economic Impacts

Short- and long-term direct, indirect, and induced impacts of the project, in addition to the impacts of the growth expected in the area without project development, were analyzed with the assistance of the Bureau of Reclamation Economic Assessment Model (BREAM) and the Construction Worker Profile, both of which were developed for the Bureau by Mountain West Research, Tempe, Arizona. Bureau of Reclamation analyses (1979) are available for public inspection at the Durango Projects Office, Durango, Colorado, and the Upper Colorado Regional Office, Salt Lake City, Utah. Using 1970-1976 statistical data as a baseline and past experience of the Bureau, the BREAM produced detailed estimates for 50 years into the future. These estimates, however, are subject to change due to future external events which may affect their accuracy over the long-term. The impacts of hypothetical Indian coal development scenarios are discussed separately in Section C-13.

Assuming a ten year construction period beginning in 1980, the direct socioeconomic effects of construction of the project would be concentrated in the decade between 1980 and 1990, and would include an influx of 3,730 persons by the peak year, 1988. About 90 percent (3,360 persons) are expected to reside in La Plata County, Colo., and particularly the Durango area due to its proximity to major project facilities; the remaining 10 percent (370 persons) would probably reside in Farmington in San Juan County, N. Mex. Consequently, the major direct socioeconomic impacts of the project would be concentrated in the Durango area.

Such direct impacts would include an accelerated demand on the labor pool during the construction period resulting in a small immediate, although temporary, decrease in unemployment. As a result of increased demand for construction materials, the construction industry would receive economic stimulus throughout the project area. The influx of persons in La Plata County during the construction period would increase demands on housing, education, health care, and public utilities. Housing would be severely strained, but other demands would be met with present facilities or expansions already undertaken.

Indirect impacts include both increased employment and purchases in industries other than construction. These would result from an increased demand for the goods and services of local industries, and from secondary purchases made from suppliers and wholesalers, particularly from Farmington and outside the area. The long-term effect of project water would be to fulfill a basic need in accomodating the future growth that is expected to occur in the area irrespective of development of the proposed project. This growth would result in a population of about 82,000 in La Plata County, Colo. and 270,000 in the project area in San Juan County by the year 2020.

These population estimates represent increases of 3 times the 1976 population of La Plata County, and 4.5 times the 1976 population of the project area in San Juan County.

Accompanying this population growth will be proportionate increases in air and water pollution, changes in land use, and demands for housing, schools, utilities, medical and social services. The social systems of the affected communities would be expected to change as the increasing population transformed the area into a more densily populated, more urbanized area. The diverse values and attitudes of substantial numbers of new residents in the area would undoubtedly alter the social interactions in the project area.

a. Population

The analysis of impacts of the influx of population attributable to project construction is based on two assumptions. First, it was assumed that 60 percent of construction workers would have to come from outside the area because of the relatively small size of La Plata County's labor force and the distance of the labor force of San Juan County from major project features. Second, based on past Bureau experience, it was assumed that 70 percent of incoming workers would bring their families with them. In this manner, then, it is estimated that the population influx would begin with about 190 persons in the first year of construction, peak at about 3,730 in the eighth year, and gradually decline in the final 2 years of construction (see Table C-1).

La Plata County, and especially the Durango area, are expected to receive the major impacts as far as population growth from project construction because of available community facilities and short commuting distances to major project facilities. Of the additional 3,360 persons in the county by the peak construction year, about 1,510 would reside in the Durango area, representing a 6.7 percent increase in the population. This would result in a population of 24,190 in the peak year compared to 22,680 which is expected to occur without project construction. An estimated 840 persons are expected to reside in the Bayfield area because of the growing preference of many residents to commute the 18-mile distance to Durango to work in order to take advantage of the less expensive housing offered in Bayfield. This would make the population 3,950 in the peak year compared to 3,110 without the project, for a relatively high increase of 27 percent. This increase implies that Bayfield will receive more significant impacts due to project construction, the ramifications of which are discussed in their appropriate sections later in this report. The remaining persons immigrating to La Plata County are expected to settle in rural areas outlying these communities.

Due to their relatively large distance from major project facilities, communities within the project area in San Juan County are

| | 8 | 9 | 10 |
|---|---|---|---|
| 89 | 3,728 | 2,848 | 2,532 |
| 77 | 1,744 | 965 | 867 |
| 12 | 1,984 | 1,883 | 1,675 |
| 30 | 3,355 | 2,563 | 2,279 |
| 89 | 1,569 | 868 | 781 |
| 41 | 1,786 | 1,695 | 1,508 |
| 59 | 373 | 285 | 253 |
| 88 | 175 | 97 | 86 |
| 71 | 198 | 188 | 167 |

expected to receive a much smaller influx of non-local construction workers during the construction period. Because of its location with respect to the construction area and direct commuting routes, and also the availability of services, these persons are expected to reside in Farmington. The estimated peak year influx is about 370 persons, which represents only 0.5 percent difference above the population that would occur in Farmington without the project, and would not have a significant impact on the population of this area.

In the long-term, construction of the project would be more of a growth-accommodating factor than a growth-inducing one, since the area's population would be almost identical with or without the project. The population of La Plata County in 2020 is estimated to be only 2.2 percent greater with the project than without it (See Table C-2). The Durango service area is estimated to have a 2020 population which is 1 percent larger with the project than without it. Bayfield would grow to an estimated 2.7 percent if the project is constructed. The estimated growth would be primarily indirect, related to jobs created in the service industries during the project construction period and the time of rapid agricultural expansion immediately following construction. The population of San Juan County and Farmington would be the same whether or not construction of the project is undertaken.

The general trends in migration do not affect membership of any of the three Indian Tribes within the project area and, consequently, construction of the project is not expected to accelerate their population growth above that due to natural increase.

b. Jobs and Income

The short term, direct effects of construction of the project on employment would be the creation of about 1,150 direct and 1,950 indirect jobs by the peak (eighth) year of construction, increasing from 70 direct and 50 indirect jobs in the first year. The employment opportunities would be somewhat fewer following the peak year, decreasing to about 1,650 direct and indirect jobs in the last year of construction. Most of the direct employment jobs would be in the areas of construction and Government, while indirect jobs would be in the provision of goods and services, including the supply of project materials. The creation of these job opportunities should result in a slight temporary decrease in the unemployment rate. Many of the jobs associated with construction would be seasonal in nature, causing unemployment to fluctuate, somewhat higher in the winter months and lower in the summer months. The results would be a yearly average unemployment rate that would be about 1 percent less during the construction period in La Plata County. San Juan County would receive approximately 147 workers which would cause only a minute, if any, decrease in the unemployment rate.

Under Public Law 93-638, preferential hiring of Indians would be undertaken during project construction. Most of these jobs would go to members of the Southern Ute Tribe because they are within reasonable commuting distance of major project features. Because their labor force is relatively small, about 40 jobs are expected to be taken by Indians in the peak year of construction. This would lower their unemployment rate an estimated 6 percent in that year.

Major industrial sectors would experience increases in employment opportunities due to the project, although some would be more temporary than others. For example, the construction industry would receive immediate impacts if the project were undertaken; however, these impacts are more temporary in nature than in other industries. Construction employment in La Plata County would rise to about 8 percent of the labor force in the peak year compared to 3 percent without the project. Similarly, in San Juan County, 12 percent of the labor force would be employed in the construction industry with the project compared to 9 percent without. This is one of the major impacts that would be experienced in San Juan County.

While 120 jobs on farms and in agriculture-related business would result, long-term employment opportunities would come almost entirely from growth of the area in general. Some stimulating effect would also come from project-increased farm production, and the operation of recreational facilities at the two reservoirs. San Juan County would receive limited indirect employment expansion in the areas such as retail and wholesale trade, but the increase in jobs would be on a short-term basis and virtually impossible to distinguish from the growth that is already occurring. No long-term impacts, whether direct or indirect, would result in the area of employment if the project is constructed.

Over the total construction period, about $336 million would be spent on the project. About 30 percent would be spent on on-site government and construction workers' salaries and another 11 percent on non-local Government salaries. On-site government and construction workers' paychecks would be spent in Durango, Bayfield, and Farmington, with an indeterminent amount leaving the area either in purchases made outside the area or taken out when workers leave the area. The increase in wages, profits, and rents from construction of the project is expected to almost double disposable personal income in La Plata County by the final year of construction, from about $108 million in 1976 to $200 million in 1990. By 2020, disposable personal income would equal an estimated 3.4 percent greater with the project than without it in La Plata County. No difference would appear in disposable personal income in San Juan County as a result of project construction in the long-term.

In addition to these benefits, $134.5 million would be spent for construction materials which would give impetus to the construction industries in both La Plata and San Juan Counties, and to wholesalers and suppliers outside of the area. These impacts would be short-term in nature and concentrated primarily in the decade of construction.

| | ) | 2020 | |
| --- | --- | --- | --- |
| | Without project | With project | Without project |
| La Plata County | 59,409 | 81,555 | 79,792 |
| Durango | 26,361 | 35,585 | 35,035 |
| Remainder of Durang service area | 12,314 | 13,315 | 13,302 |
| Bayfield | 9,495 | 15,134 | 14,742 |
| San Juan County | | | |
| Farmington area | )0 | 169,600 | |
| Aztec area | )0 | 30,900 | |
| Bloomfield area | )0 | 29,200 | |
| NTUA | )0 | 37,000 | |

c. Agriculture

(1) Employment

Most of the impact of the project in the agricultural section would occur after completion of the project. However, an estimated 57 new jobs, mostly in agriculture-related businesses as opposed to new operation, would exist by 1988. This increase would be evidence of some irrigation water already being delivered, and preparations for increased production in the future. By the time construction of the project features is completed there would be a total of 121 jobs in both agriculture and related businesses. This includes about 31 new on-farm jobs in La Plata County and in San Juan County with total wages estimated at $200,000 annually.

(2) Production and Farm Income

With completion of the project and delivery of water to the area, agricultural production would increase. Farm income would increase soon after project water delivery on supplemental service land, but 5 to 10 years would probably be required for full service land to reach full economic potential. Annual gross agricultural production would be increased by an estimated $13,732,000, and net farm income would ultimately be increased by about $5,599,000 annually. Increases in production resulting from irrigation of project land are shown in Tables C-3 and C-4. In Colorado, significant increases in crop production would be realized in alfalfa, pinto beans, and small grains--wheat, barley, and oats. In New Mexico, small grains, alfalfa, and corn production would be increased by the project.

The production of all livestock and livestock products--dairy, beef, and sheep--would be greatly increased as a result of project irrigation. Livestock production value, presently $684,300 annually, would increase more than tenfold, to $7,708,000 annually. An estimated 15,000 additional head of cattle could be supported with the increase in crop production and grazing capacity. This number could be supported on the farms throughout the year with no effect on public land, where grazing permits are at capacity.

The increased farm production and income, in addition to providing new on-farm and support-industry employment, would provide a long-term stimulus to the area's business community and in turn would enrich the area's tax base; 48,620 acres of full service land would be added to tax rolls as irrigated farmland. Tax revenues from project land would not change where supplemental water would be delivered to already irrigated land, and Indian trust land is tax exempt.

(3) Effects on Indian Operations

The primary benefit to the Ute Mountain Ute Indian Tribe would come from the irrigation of 11,980 acres of full service land and

Table C-3
Crop and grazing production with and without the project
Colorado

| | Unit of production | Without project: Acres | Without project: Total production | With project: Acres | With project: Total production | Annual production increase with project | Percent increase |
|---|---|---|---|---|---|---|---|
| Full service | | | | | | | |
| Total land | | 43,710 | | 43,710 | | | |
| Farmstead and waste | | 2,186 | | 2,186 | | | |
| Cropping | | | | | | | |
| Alfalfa hay | Ton | | | 24,477 | 117,489 | 117,489 | |
| Pinto beans | Cwt. | 25,352 | 76,056 | 6,994 | 118,898 | 42,842 | 56 |
| Small grains | Bu. | 10,928 | 196,695 | 6,994 | 489,580 | 292,885 | 148 |
| Grazing | | | | | | | |
| Rotation pasture | AUM | | | 3,497 | 29,724 | 29,724 | |
| Crop aftermath | AUM | | | 31,471 | 17,309 | 17,309 | |
| Supplemental service | | | | | | | |
| Total land | | 17,760 | | 17,760 | | | |
| Farmstead and waste | | 888 | | 888 | | | |
| Cropping | | | | | | | |
| Alfalfa hay | Ton | 3,552 | 8,170 | 9,946 | 47,740 | 39,570 | 484 |
| Pinto beans | Cwt. | | | 2,842 | 48,314 | 48,314 | |
| Small grains | Bu. | 3,374 | 88,267 | 2,842 | 198,940 | 110,673 | 125 |
| Grazing | | | | | | | |
| Rotation pasture | AUM | 5,328 | 9,058 | 1,421 | 12,078 | 3,020 | 33 |
| Crop aftermath | AUM | 9,235 | 4,618 | 12,787 | 6,394 | 1,776 | 38 |
| Total project | | | | | | | |
| Total land | | 61,470 | | 61,470 | | | |
| Farmstead and waste | | 3,074 | | 3,074 | | | |
| Cropping | | | | | | | |
| Alfalfa hay | Ton | 3,552 | 8,170 | 34,423 | 165,229 | 157,059 | 1,920 |
| Pinto beans | Cwt. | 25,352 | 76,056 | 9,836 | 167,212 | 91,156 | 120 |
| Small grains | Bu. | 14,302 | 284,962 | 9,836 | 688,520 | 403,558 | 141 |
| Grazing | | | | | | | |
| Rotation pasture | AUM | 5,328 | 9,058 | 4,918 | 41,802 | 32,744 | 361 |
| Crop aftermath | AUM | 9,235 | 4,618 | 44,258 | 23,703 | 19,085 | 413 |

Table C-4
Crop and grazing production with and without the project
New Mexico

| | Unit of produc-tion | Without project | | With project | | Annual production increase with project | Percent increase |
|---|---|---|---|---|---|---|---|
| | | Acres | Total production | Acres | Total production | | |
| Full service | | | | | | | |
| Total land | | 4,910 | | 4,910 | | | |
| Farmstead and waste | | | | 246 | | | |
| Cropping | | | | | | | |
| Alfalfa hay | Ton | | | 2,750 | 14,163 | 14,163 | |
| Small grains | Bu. | | | 786 | 58,950 | 58,950 | |
| Corn (grain) | Ton | | | 737 | 92,125 | 92,125 | |
| Grazing | | | | | | | |
| Rotation pasture | AUM | | | 442 | 3,978 | 3,978 | |
| Crop aftermath | AUM | | | 4,235 | 847 | 847 | |
| Supplemental service | | | | | | | |
| Total land | | 3,720 | | 3,720 | | | |
| Farmstead and waste | | | | 186 | | | |
| Cropping | | | | | | | |
| Alfalfa hay | Ton | 2,418 | 7,979 | 2,083 | 10,728 | 2,749 | 34 |
| Small grains | Bu. | 521 | 32,550 | 595 | 44,640 | 12,090 | 37 |
| Corn (grain) | Bu. | | | 558 | 69,750 | 69,750 | |
| Grazing | | | | | | | |
| Rotation pasture | AUM | 595 | 2,976 | 335 | 3,015 | 39 | 1 |
| Crop aftermath | AUM | 2,939 | 588 | 3,209 | 642 | 54 | 1 |
| Total project | | | | | | | |
| Total land | | 8,630 | | 8,630 | | | |
| Farmstead and waste | | | | 432 | | | |
| Cropping | | | | | | | |
| Alfalfa hay | Ton | 2,418 | 7,979 | 4,833 | 24,891 | 16,912 | 212 |
| Small grains | Bu. | 521 | 32,550 | 1,381 | 103,590 | 71,040 | 218 |
| Corn (grain) | Bu. | | | 1,295 | 161,875 | 161,875 | |
| Grazing | | | | | | | |
| Rotation pasture | AUM | 595 | 2,976 | 777 | 6,993 | 4,017 | 135 |
| Crop aftermath | AUM | 2,939 | 588 | 7,444 | 1,489 | 901 | 153 |

additional water to 460 acres of partially irrigated land. Because most of this land is concentrated in relatively large blocks, it would be attractive for farming as a Tribal enterprise and could augment existing Tribal livestock operations. Income from that enterprise could be an estimated $1,017,000 annually. For the Southern Ute Indian Tribe, water to 1,800 acres that would be essentially all full service land would enable the Tribe to realize $153,000 annually in net farm income. The increased income would benefit all Tribal members since it would be used to fund Tribal business expansion or would be allotted to individual members.

Up to 60 new on-farm jobs would become available as a result of new farm production and income, principally to the Ute Mountain Ute Tribe. About 40 of these would be available in association with Indian trust land with $160,000 in wages available to Tribal members annually, with the additional jobs available on non-Indian farming operations.

(4) Effects on Private Farm Operations

Provisions of project water to non-Indian land would benefit 419 families on existing farms, plus 30 new farm families who would purchase the land to be sold that is in excess of acreage limitation allowed under the authorizing legislation. The increased income to these families would be an estimated $1,130,000 annually.

(5) Agricultural Chemicals

Some increase in the use of agricultural chemicals would occur in the area as a result of project operation. It is anticipated, however, that any increase would be restricted to those chemicals now in use or the replacements that would result from advancing technology.

The greatest increases in insecticide use would be directly related to the increase of about 33,000 acres in alfalfa on which parathion would be used for the control of weevils and aphids. This chemical is extremely toxic to warm-blooded animals when inhaled or absorbed through the skin and it would be dangerous for any wildlife utilizing the field during the time of application. However, because application in the project area is generally made but once a year and the chemical has a short life (3 to 5 days), losses to wildlife would be minor.

Herbicide usage would increase, especially on small grains as a result of project operation because broadleaf weed control is a much greater problem under irrigation than under dry land conditions. It is estimated that most of the small grains (about 10,500 acres) would be sprayed annually with 2,4-D or a similar herbicide for the control of broadleaf weeds (Bureau of Reclamation, 1979).

The use of commercial fertilizers would increase under project operation since the availability of a full water supply would allow the farmers to achieve maximum utilization of the fertilizer they use. Reclamation studies (1979) indicate that an average of 60 to 70 pounds of available phosphate and 30 to 40 pounds of available nitrogen would be applied to all project land. This equals a total of 3,100 to 3,900 tons of available nutrients applied annually to project land. This represents 1400 to 1800 percent increase in the use of fertilizer on project land. However, it would take several years before this full usage would be attained. Some of this increase would be due to the projected increase in fertilized acreage from 21,500 acres to 70,100 acres. The rest of the increase would be a result of the farmers increasing their rate of application as they gain confidence in the increased water supply.

(6) Effects on Prime Farmland

Approximately 44 acres of the Colorado land now tentatively classified as prime farmland by the Soil Conservation Service would be taken for right-of-way for the Dryside Canal. Land to be removed from the prime farmland classification because of inadequate water supply would be classified as prime if a full water supply would be furnished by the project. Approximately 15,000 additional acres in the project area would meet all criteria for prime farmland if given a full water supply.

d. Recreation and Tourism

The project would help to meet anticipated general recreation needs in the area particularly by providing enhanced opportunities for reservoir boating and fishing, camping and picnicking. The largest general recreation increases would occur because of opportunities created by the construction of Ridges Basin Reservoir which would provide an additional 210,000 recreation days annually.

An increase of 97,500 recreation days would result from construction of Southern Ute Reservoir. Recreation losses on the Animas River would primarily affect rafting and kayaking. These losses would be in the form of reduced quality as opposed to total elimination. Recreation losses in the Ridges Basin Reservoir area would consist mainly of the loss of hunting and nature observation. Congestion could occur on County Road 141 from recreation traffic to the reservoir. An increase in vandalism could be a problem because of the increased number of people using the area, and the need for increased law enforcement could develop.

An estimated 8 seasonal or part-time employees would be needed to maintain the recreation facilities at Ridges Basin Reservoir. The expected increase in recreation could cause an increase in indirect employment; an estimated 225 additional jobs in service industries would exist in 1988, some of which would be in the area of recreation. Most of these service industry jobs are expected to be in La Plata County, although some may be in from San Juan County because of its close proximity to Southern Ute Reservoir.

The Southern Ute Indians should also receive economic benefits from construction of Southern Ute Reservoir. Approximately 10 seasonal employees would be needed. If the Tribe operates recreation facilities at Southern Ute Reservoir, those facilities constructed as part of the project could not be run for a profit. However, additional facilities within the reservoir boundary, subject to Bureau approval, could be established by the Tribe and operated for profit. The Tribe could provide facilities outside the boundary as well, creating additional employment opportunities and opportunity for profit. Recreation traffic to Southern Ute Reservoir could increase congestion on State Highway 17 immediately north of Farmington; however, traffic quickly thins northward and the congestion would be only near Farmington. Use of the reservoir area by recreationists should not increase additional trespassing problems on Indian land since the reservoir boundary would be entirely fenced.

e. Housing

Short-term, direct impacts on housing due to project construction would be pronounced in La Plata County. The demand for about 960 units in the peak construction year, or nearly one out of 10 of existing units in that year, could produce a shortage in an already inflated market. This, in turn, could increase the cost of housing, particularly in the city of Durango which stands to receive a demand for 570 more units in the peak year, or a 13 percent increase over the estimated 4,400 additional households in that year without the project. According to the Animas Regional Planning Commission (1972), housing development would occur as low density housing (0-4 dwelling units/acre) in the areas north and west of town, and medium (5-7 dwelling units/acre) and high density (8+ dwelling units/acre) housing adjacent to existing business areas. Student housing is also proposed near Fort Lewis College. However, it is unlikely that expansion would be able to keep up with the population influx expected during the decade of construction, and a shortage is likely. It is also expected a large number of construction workers families from outside the area would choose to live in mobile homes.

As a result of the short supply of housing anticipated in Durango, it is expected that about 200 new households would be added to Bayfield by the peak year of construction because of availability of less expensive housing. This represents an 8 percent increase over the estimated 1,580 households in that year, which, again would probably cause a short supply in Bayfield accompanied by an increase in housing costs. The remaining households would be established in rural areas of La Plata County, amounting to a 5 percent increase in the peak year, which should cause relatively minor problems compared to the impacts that could be realized in Durango and Bayfield. Although some new-comers would choose to live in mobile homes, and still others in multi-family apartments, a shortage of housing is likely to occur during the construction period and housing costs would rise. After the construction period, the temporary mobile home facilities may or may not be utilized further. Housing built to accommodate the construction period influx would probably be absorbed into the steadily expanding future market.

San Juan County is currently experiencing an upsurge in both housing construction and the number of mobile homes due to energy related exploration and development, and the estimated 150 project-related households in the peak year of construction represents only 0.5 percent of estimated housing in Farmington in that year. This demand should be well accomodated by the expansion that is expected to take place by that time.

In the long term, there would be an estimated 650 more household in La Plata County in 2020 with the project to accommodate a corresponding 2.2 percent increase in population (See Section C-1a). This should not cause any adverse effects on housing in La Plata County in that year. San Juan County would experience no long-term difference in the number of households due to the project. Since residential housing is already planned and being constructed in the available areas near Ridges Basin Reservoir (See Section B-1g), it is anticipated that the reservoir would not stimulate residential development above that which would have occurred without the project. Recreational housing would not develop around the reservoir because of the project recreation areas, wildlife mitigation area, and fencing of a large area of the reservoir boundary. The topography precludes building close to the reservoir also, and because of the topography there would be no good view of the reservoir from the existing roads to attract recreational housing. At Southern Ute Reservoir, access, topography, and natural setting are such that housing developments would not be expected.

f. Land Ownership and Use

Construction of the project would result in the removal of 7,559 acres of private land, 2,485 acres of Indian land, and 5,095 acres of State and Federal grazing lands from their present uses (See Table A-11). Of the private land, approximately 10 percent is classified as irrigated land, 24 percent as non-irrigated land, and 66 percent is classified as grazing land, waste, and other. In addition, easements would be obtained on 3,000 acres of private land leaving the ownership unchanged, but essentially restricting them to their present use as either grazing, residential, or undeveloped land. Approximately 14,000 acres of private and 12,170 acres of Indian land presently used principally for grazing would be changed to irrigated cropland.

Other than these changes which are directly related to the project, land use in the area is expected to follow much the same pattern with or without the project. La Plata County has no formal land use plan to date; however, Phillips-Brandt-Reddick Regional Planning Commission of Durango (personal communication, 1979) suggests that there are certain areas in the county that would be more likely to sustain this growth than others. They are of the opinion that major growth would continue along the outskirts of present communities and developments. Specifically, this includes Bayfield, Hermosa, Durango West, and the Florida Mesa area along U. S. Highway 160.

The city of Durango would experience growth in all directions; however, development north and west of current development is presently limited due to flood plains and lack of water, respectively. The Animas Regional Planning Commission (1972) suggested that a strong downtown area be maintained along Main Avenue and on Sixth Street, any necessary expansion should take place to the southeast, and the existing industrial area south of the city should be maintained as such with other industrial areas around the city being phased out. Expansion of facilities to accommodate population growth is also being considered: a new post office, two new fire stations, expansion of hospitals, park areas and recreation facilities, and educational facilities.

In San Juan County, development of coal in particular stands to make a significant impact on land use. New Mexico State University published a study entitled, Socio-Economic Impacts of Coal Mining on Communities in Northwestern New Mexico. This study estimates the impacts of coal development in San Juan County under two assumed conditions of growth; moderately paced development defined as the construction of two coal gasification plants, and rapid development defined as the construction of six or seven coal gasification plants. As a result of this study it was estimated that under the moderate rate of development, approximately 56,250 acres of land, or one-fifth of existing private land, would be affected either directly or indirectly by coal development in the next 25 years. Under the rapid rate, approximately 196,875 acres would be affected in the next 25 years, representing three-fourths of existing private land. Not all of the land, however, that may be involved in coal development would be private. The coal companies want long-term leases for their plants on private land as well as land on the Navajo Reservation. But this land, as well as the private land that is best suited for urban development, is presently being used for agricultural purposes. The agricultural sector, then, is where the major land use impacts will fall, as land is permanently removed from agricultural use for coal development and consequent urban growth. The county, however, realizing the stable nature of agriculture, is seeking alternatives to using this valuable agricultural land so as to maintain agriculture as a part of the base of its economy.

City and county planners have identified potential growth areas in San Juan County (San Juan County Land Use Planning Commission, 1978). This report cites the Lower Valley, which includes the communities of Kirtland, Fruitland, and Waterflow, as the fastest growing area in the county. This is due to proximity to major communities and proposed energy development sites, as commuting distance is a primary factor affecting where people choose to live. The availability of water will be a decisive factor in the growth of this area as well as the remainder of San Juan County.

g. Domestic Water and Utilities

Water treatment facilities in Durango and Bayfield would be adequate to provide treated water to the construction worker influx. The city of Farmington would also not experience any undue strain on the availability of treated water as a direct result of project construction (See Table B-4). Sewer lines, telephone service, electricity, and natural gas would all have to be provided to areas of growth; this should not pose any problems as all are currently able to handle growth and expansion. Sewage treatment plants are currently adequate or expansions are being made and will handle growth in all project area municipalities. Long-term expansion in all areas would have to take place with or without the project.

h. Education

The educational systems in La Plata County are expected to receive a greater impact from construction of the project than those of San Juan County. The increase in school age children in La Plata County is expected to start in the first year of construction with a total of about 50, peak with 1,020, and decline for the two years until the construction period ends. If no teachers were added to the 1978 total, the resulting student-teacher ratio in the peak year would be 28 to 1, which is slightly higher than the recommended Colorado ratio of 25 to 1. Without the project, the student-teacher ratio would equal the State recommended ratio. About 70 percent of the influx (690 students in the peak year) would attend school in the city of Durango, 25 percent (260 students in the peak year) would attend school in Bayfield, with the remaining students attending rural schools, some of which are included in Durango's school district.

When asked what impact they thought this influx might have on the areas' school systems, school officials in the county were of the opinion that this influx should not pose any undue stress on the system. This is partially because the proportion of incoming students from project-related growth in each grade level would be about the same proportions as expected in the existing systems. This increase corresponds to their present planned expansion, including the possible addition of another elementary school in the Durango area and the hiring of additional teachers. Payment of the costs associated with any increase in students due to project construction would be distributed among local taxes, State Funds, and Federal Impact Aid Funds available under Public Law 874 to alleviate the effects of Federal projects.

An estimated 200 students would be added to the school system of San Juan County as a result of construction of the project, all of whom would be expected to attend schools in the Farmington school district. These additional children should pose no problems since the pupil-teacher ratio would be raised only one half of one percent and the ratio would be below the recommended State rate of 25 to 1.

Long-term effects on education in the project area after project construction include about 200 more students in La Plata County, with no difference expected in the school systems of San Juan County.

i. Health Care and Community Services

Construction of the project should not put a strain on health care facilities throughout the project area, both in the short term and long term. La Plata County, which should receive most of the influx due to the project, has two hospitals both of which are expanding and should have no problems accommodating the additional people. San Juan County, which has one hospital, would receive only 370 additional people by the peak year of construction. This should not put a strain on that facility. To maintain the 1977 physician-patient ratio of 1 to 750, La Plata County would have to gain about 15 physicians by 1988. San Juan County would have to gain nearly 40 physicians to maintain the 1977 ratio of 1 to 1,300. Based on an average increase of two physicians a year since 1970 in the project area, the situation could improve by 1988 in both counties. Indian health care facilities are expected to expand proportionately with their population.

Public welfare payments could be reduced because of increased employment opportunities resulting from the project. During the peak year of construction the project should lower the unemployment rate and, consequently, lowering welfare payments in the form of unemployment benefits. This effect will continue through the year 2020. Indians in the area, particularly members of the Southern Ute and Ute Mountain Ute Tribes, would also benefit from about 40 jobs during the peak year of construction. Some jobs might be available in the areas of services and recreation at Southern Ute Reservoir after completion of the project.

j. Police and Fire Protection

Assuming the National planning rate of 1.9 police officers per thousand population, La Plata County would need about eight more officers by the peak year of construction of the Animas-La Plata Project, four of which would be needed in Durango, and one in Bayfield. This of course, is dependent upon many unforeseeable factors such as the type of calls. If the current trend of increasing crime calls continues, the number of officers required could be larger. San Juan County would need no additional police protection to cope with the influx from the project. Again referring to the National planning rate of one fireman per thousand population, La Plata County would need about four firemen by 1988, two of which would be needed in Durango. The influx of people into San Juan County would warrant no increase in fire protection personnel. In the long term, the additional residents in 2020 would cause the need for about three more policemen and one fireman in La Plata County San Juan County would experience no aqdditional need over the long term from construction-related effects.

k. Transportation

Construction of the project would result in increased use of road systems throughout the project area, particularly in the Durango area and near the two proposed reservoirs. All major roads are in good condition and below full carrying capacity. Traffic resulting from the influx of workers involved with construction of project features and subsequent recreation traffic would necessitate more frequent upkeep of existing roads in the area. A bypass on State Highway 160 south of Durango is already under construction and will be completed in 1979, which would alleviate any traffic problems to the south of the city. Although one county road would be inundated by Ridges Basin Reservoir, access to the area is not dependent on this road.

The existing material source area to be used for riprap is on Forest Road 2597, about 1.5 miles east of County Road 243 which extends along the east side of Lemon Reservoir. The Forest Service has been contacted concerning use of the roads. Both roads are all-weather roads and of suitable condition for truck traffic.

The specific route to be taken to the dam sites would be determined by the contractor at the time of construction, but the likely route would follow County Roads 240 and 501 to a junction with U. S. Highway 160 just north of Bayfield, and then Highway 160 westward to County Road 213 for access to Ridges Basin Dam site. To reach Southern Ute Dam site, Highway 160 would be used to State Highway 140, then State Highway 140 southward. All highways and county roads are adequate, paved roads. Approximately 20 trips per day, 6 days a week, for 6 months would be required to Ridges Basin during the last year of construction on the dam, and for about 9 months at Southern Ute Dam site. This increased use of the county roads would mean inconvenience to local residents because of increased noise, dust, and slower traffic during these months.

Should the contractor elect to use County Road 141 southward from Highway 160 for riprap hauling or hauling of equipment, the loads anticipated would be within legal limits for this road. It is likely that trucks used would be similar to those already using the road for construction in the area. For unusual loads, the La Plata County Engineer's Office and the State Patrol furnished information on load regulations. The heaviest load that would be carried over County Road 141 would be the motors for Ridges Basin Pumping Plant, each weighing 100,000 pounds, and these would be within the limits. The contractor would be responsible for any road damages. Other hauling would be done on access roads from the south, which would be upgraded or constructed for project purposes, as discussed in Section A-5b(1)(b) and A-5c(1)(b).

1. Public Finance

Land acquisitions and project-associated developments, particularly in La Plata County, would create both economic losses and gains. The removal of 7,559 acres of private land from the tax rolls would have a negative effect on the assessed valuation of land in the area. The counties would be eligible for compensatory payment for the loss of tax revenue under provisions of Public Law 94-565 (Local Government Units Public Lands Payment). Additionally, the increase in the values of land due to enhanced agricultural activity, and recreational activities would have a net positive effect on the total assessed valuation in La Plata County. The assessed valuation of La Plata County would reach over $153 million with the project by the final year of construction compared to over $148 million without the project, a difference of 3.4 percent. By 2020, the estimated assessed valuation would be 5 percent greater with the project than without. The assessed valuation in San Juan County would remain the same with or without the project and would reach an estimated $7 billion by 2020.

2. Cultural Resources

Project construction and operation would disturb a number of archaeological sites both directly and indirectly. This adverse affect would be compensated for by a data recovery program, publications, and on-going curation of the recovered materials and information. The data recovery program would be conducted on a representative sample of the affected sites. The State Historic Preservation Officers of Colorado and New Mexico and the Advisory Council on Historic Preservation have reviewed and commented on the proposed actions concerning cultural resources. As stated in Section A-4h, the program would exceed the project authorization and is thus contingent upon Congressional approval and funding for full effectiveness.

Out of a total of 484 archaeological sites for which specific locations are known from previous surveys, up to 279 would be affected by the project of these sites are located in the proposed location of the Ridges Basin Dam and Reservoir, and in the location of the Southern Ute Dam and Reservoir and would be lost as a result of construction or operation, although some significant would also be excavated as part of the cultural resource program prior to construction. The sites affected only by inundation would not necessarily be destroyed, but it is unlikely that information or artifacts would be obtained from them in the future because of the expense and difficulty of excavation and the large number of more readily accessible sites in the general area.

An additional 191 sites are located on the projects full service land. The majority of these sites are on the Ute Mountain Ute Indian Reservation, which is an area of intense prehistoric settlement. These sites would be adversely affected by agricultural practices, although some of the significant sites would also be excavated for the cultural resources program.

The remaining 39 known sites that may be affected by the project are located along canal, lateral, or road alignments or in project administrative areas such as recreation sites. Of the sites are located within the area of the Proposed Dry Side Canal, along the Southern Ute Inlet Canal and along the New Mexico Irrigation Canal. These sites would probably not undergo direct disturbance, since the proposed features would be adjusted wherever possible to avoid the sites. Because of improved access and increased human activity, however, the sites would be subject to a higher incidence of disturbance.

As discussed in Section A-4h, the Bureau estimates that as many as 3,500 archaeological sites may be identified before investigations of the area are completed, and in addition, sites could be located during construction of project features. Although some of these sites could be avoided by adjusting the locations of project features, any significant sites located in areas where adjustments could not be made would be excavated for the cultural resource program.

3. Geology, Mineralogy, and Seismicity

The Lewis Shale at Ridges Basin Reservoir site has weathered zones that may be susceptible to landslides when wet. Inundation of the formation could create minor sliding and slumping of the shale until a new landform equilibrium is established. Along the northeastern side of Ridges Basin Reservoir, the prevailing southwesterly winds would create eroding wave action on this formation, and some sliding and slumping would be anticipated as the shale slopes were undercut by wave action. Turbidity would be limited to the immediate localized area of slumping and would not be a threat to the reservoir's overall water quality. Along the Ridges Basin Conduit alignment some erosion and possibly some minor sliding could occur from wave action on the Lewis Shale where the proposed alignment enters the northeastern end of the reservoir. Weak areas requiring support and lining could be encountered in both Lewis Shale and Cliff House Sandstone in constructing the Long Hollow Tunnel.

At Ridges Basin Dam site, an abandoned coal mine and related minor exploratory openings would be back-filled and sealed off.

Neither proposed reservoir is of the large size associated with induced seismic activity, and no problems of this nature would be expected. Considerations for dam safety are detailed in Attachment 4.

The possibility of future development of natural gas at the Southern Ute Reservoir site has been studied by the Bureau of Reclamation, evaluating the current status and potential development with information from the U. S. Geological Survey and the Bureau of Indian Affairs' Southern Ute Agency. Interest in the area has waned. Leases not in production have expired and are not expected to be renewed. Two producing gas wells in the resersvoir basin were each initially brought in at 400,000 cubic feet of gas per day; however, production is steadily declining, and the wells now average about 20,000 to 40,000 cubic feet per day. The reservoir would not preclude future development of the gas resource, should economic conditions change significantly in the future and interest be renewed in gas production in the area, but an unorthodox spacing of wells would be necessary in the immediate vicinity of the reservoir boundary and there would be some increase in development costs.

The impacts from future coal development are discussed in detail in Section C-13.

## 4. Water Resources

### a. Stream Depletions

The average annual depletion of the Animas River would be 131,200 acre-feet at the State line and 161,400 acre-feet at the confluence with the San Juan River. The La Plata River would have a depletion of 18,000 acre-feet just north of the State line and 12,400 acre-feet at the confluence with the San Juan River. The Mancos River would have an average annual increase of 5,500 acre-feet at its confluence with the San Juan River, which is attributable to return flow from project irrigation. The total project depletion of the San Juan River downstream of the confluence with the Mancos River and the Colorado River downstream of the San Juan River would average 154,800 acre-feet annually. Of this average, 120,700 acre-feet would be attributed to water use in Colorado and 34,100 acre-feet in New Mexico. This depletion would consist of about 9 percent of the San Juan River flow at its confluence with the Colorado River and about 2 percent of the Colorado River flow at Lee's Ferry. Table C-5 shows the monthly pre-project and project streamflow. The effects of the decreased or increased flows are discussed in sections on water quality and fisheries.

### b. Streamflows Under Project Conditions

#### (1) Animas River

The flow of the Animas River downstream of the Durango Pumping Plant, would generally be decreased through most of the year, as shown in Table C-5. In the spring, the flow would decrease by an average of 315 cubic feet per second, or 17 percent; summer, fall, and winter flows would decrease by an average of 130 cubic feet per second, or 33 percent. About 11 percent of the time, most often in the late irrigation season during August and September, the pumping plant would not be operating because either the reservoir was full, the riverflow was below 225 cfs in the summer or 125 cfs in the winter, or maintenance was being performed in the plant. During these times, the flow in the river to Aztec would be increased because of municipal and industrial return flow from Durango and occasional municipal and industrial releases from Ridges Basin Reservoir.

#### (2) La Plata River

Between the existing diversion point about 4 miles north of Hesperus and the Dry Side Canal, a distance of about 12 miles, supplemental service water demand north of the canal would decrease the average flow from May through September by 6 cubic feet per second or 13 percent. From Hesperus to the canal, the river often has been dry in the past and should continue to be so under project conditions. The project would have no effect on late fall and winter and early spring flows.

Table C-5
Preproject and project streamflows
(unit--cubic feet per second)

| Month | Preproject monthly flows Average | Preproject monthly flows Maximum | Preproject monthly flows Minumum | Project monthly flows Average | Project monthly flows Maximum | Project monthly flows Minumum |
|---|---|---|---|---|---|---|
| | Animas River downstream of Durango Pumping Plant | | | | | |
| October | 375 | 1,868 | 163 | 210 | 1,550 | 127 |
| November | 270 | 815 | 158 | 155 | 729 | 126 |
| December | 211 | 413 | 146 | 140 | 411 | 126 |
| January | 194 | 327 | 103 | 139 | 290 | 109 |
| February | 196 | 308 | 110 | 141 | 271 | 113 |
| March | 260 | 493 | 137 | 166 | 376 | 127 |
| April | 793 | 1,437 | 247 | 576 | 1,309 | 209 |
| May | 2,107 | 4,353 | 462 | 1,783 | 3,936 | 392 |
| June | 2,562 | 5,127 | 380 | 2,158 | 4,712 | 277 |
| July | 1,062 | 2,990 | 195 | 763 | 2,574 | 258 |
| August | 522 | 1,487 | 192 | 329 | 1,072 | 203 |
| September | 416 | 1,698 | 148 | 291 | 1,332 | 197 |
| | Animas River at confluence with San Juan River | | | | | |
| October | 419 | 2,637 | 86 | 228 | 2,294 | 63 |
| November | 338 | 1,153 | 166 | 201 | 1,044 | 90 |
| December | 277 | 573 | 174 | 182 | 546 | 100 |
| January | 267 | 433 | 163 | 188 | 397 | 105 |
| February | 285 | 494 | 168 | 208 | 365 | 117 |
| March | 400 | 826 | 117 | 278 | 622 | 92 |
| April | 861 | 1,780 | 35 | 603 | 1,729 | 7 |
| May | 2,037 | 5,194 | 140 | 1,650 | 4,716 | 8 |
| June | 2,521 | 5,635 | 182 | 2,044 | 5,148 | 7 |
| July | 921 | 3,374 | 0 | 555 | 2,891 | 4 |
| August | 424 | 2,116 | 18 | 165 | 1,635 | 4 |
| September | 363 | 1,856 | 0 | 190 | 1,442 | 4 |
| | La Plata River immediately upstream of La Plata Diversion Dam | | | | | |
| October | 15 | 150 | 3 | 39 | 143 | 3 |
| November | 8 | 52 | 1 | 8 | 52 | 1 |
| December | 7 | 18 | 1 | 7 | 18 | 1 |
| January | 5 | 13 | 1 | 5 | 13 | 1 |
| February | 5 | 13 | 1 | 5 | 13 | 1 |
| March | 11 | 36 | 1 | 11 | 36 | 1 |
| April | 77 | 178 | 3 | 128 | 234 | 25 |
| May | 127 | 361 | 15 | 145 | 265 | 37 |
| June | 84 | 351 | 7 | 59 | 282 | 3 |
| July | 20 | 111 | 3 | 13 | 98 | 1 |
| August | 11 | 57 | 1 | 70 | 101 | 6 |
| September | 10 | 64 | 1 | 35 | 77 | 1 |

Table C-5 (continued)
Preproject and project streamflows
(unit--cubic feet per second)

| Month | Preproject monthly flows Average | Preproject monthly flows Maximum | Preproject monthly flows Minumum | Project monthly flows Average | Project monthly flows Maximum | Project monthly flows Minumum |
|---|---|---|---|---|---|---|
| La Plata River immediately upstream of Southern Ute Diversion Dam | | | | | | |
| October | 14 | 260 | 0 | 64 | 267 | 3 |
| November | 10 | 99 | 1 | 14 | 99 | 2 |
| December | 9 | 34 | 2 | 11 | 34 | 3 |
| January | 10 | 38 | 1 | 11 | 37 | 3 |
| February | 14 | 54 | 3 | 15 | 54 | 4 |
| March | 27 | 97 | 1 | 30 | 98 | 3 |
| April | 93 | 350 | 3 | 158 | 324 | 82 |
| May | 98 | 506 | 5 | 180 | 399 | 78 |
| June | 63 | 306 | 4 | 96 | 370 | 30 |
| July | 19 | 99 | 1 | 93 | 185 | 70 |
| August | 12 | 65 | 0 | 155 | 205 | 94 |
| September | 9 | 73 | 0 | 87 | 133 | 50 |
| La Plata River at State Line | | | | | | |
| October | 14 | 260 | 0 | 6 | 41 | 2 |
| November | 10 | 99 | 1 | 2 | 42 | 2 |
| December | 9 | 34 | 2 | 2 | 2 | 2 |
| January | 10 | 38 | 1 | 2 | 2 | 2 |
| February | 14 | 54 | 3 | 2 | 2 | 2 |
| March | 27 | 97 | 1 | 2 | 10 | 2 |
| April | 93 | 350 | 3 | 9 | 242 | 2 |
| May | 98 | 506 | 5 | 9 | 116 | 5 |
| June | 63 | 306 | 4 | 5 | 57 | 3 |
| July | 19 | 99 | 1 | 8 | 15 | 8 |
| August | 12 | 65 | 0 | 10 | 15 | 9 |
| September | 9 | 73 | 0 | 7 | 20 | 3 |
| La Plata River at Farmington | | | | | | |
| October | 24 | 537 | 0 | 17 | 59 | 11 |
| November | 9 | 116 | 0 | 14 | 65 | 8 |
| December | 10 | 49 | 0 | 12 | 12 | 7 |
| January | 13 | 44 | 0 | 11 | 12 | 7 |
| February | 20 | 73 | 1 | 10 | 10 | 3 |
| March | 23 | 111 | 0 | 11 | 21 | 10 |
| April | 67 | 358 | 0 | 18 | 296 | 8 |
| May | 58 | 783 | 0 | 15 | 135 | 8 |
| June | 32 | 252 | 0 | 3 | 29 | 2 |
| July | 8 | 47 | 0 | 0 | 0 | 0 |
| August | 12 | 64 | 0 | 14 | 14 | 6 |
| September | 12 | 170 | 0 | 7 | 21 | 3 |

With the project, the river would have considerably more flow than at present in the 14 miles between the La Plata Diversion Dam and Southern Ute Diversion Dam because of releases from the Dry Side Canal and increased return flow. The average increase immediately upstream of Southern Ute Diversion Dam would be 60 cubic feet per second or 71 percent from April through June, 86 cubic feet per second or 640 percent from July through October and 2 cubic feet per second or 13 percent from November through March. Because of existing and projected diversions upstream, the reach immediately downstream of the canal would continue to have occasional periods of zero flow, but approximately 2 or 3 miles farther downstream of the canal, return flow would create a constant stream south to Southern Ute Diversion Dam.

Almost all of the flow upstream of Southern Ute Diversion Dam would be diverted into Southern Ute Reservoir. As a result of this diversion, the average decrease in flow at the State line would be 77 cubic feet per second or 91 percent from April through June, 6 cubic feet per second or 42 percent from July through October, and 12 cubic feet per second or 87 percent from November through March. If insufficient return flow were entering the river about 0.5 mile upstream of the State line to maintain a minimum flow of 1 cfs at the line, then releases would be made during dry periods through Southern Ute Diversion Dam to maintain that 1 cfs flow. When Southern Ute Reservoir was full and during periods of high flow in the spring, water would naturally spill over the diversion dam and flow downstream.

At the river's confluence with the San Juan River, about 20 miles south of the State line, the average flow would be decreased by 40 cubic feet per second or 77 percent from April through June and 4 cubic feet per second or 27 percent during the remainder of the year. As shown in Table C-5, a continuous year-round flow would exist in the year, except for the month of July when no flow would exist under monthly average, maximum, or minimum conditions.

(3) Mancos River

Return flow from the full service land on the Ute Mountain Ute Indian Reservation would increase the flow of the Mancos River from a point 20 miles downstream of the town of Mancos by a year-round average of 8 cfs or 21 percent.

(4) San Juan River

The flow of the San Juan River at Farmington would be decreased during the spring runoff by an average of 370 cubic feet per second or 8 percent; for the remainder of the year, the flow would be decreased by an average of 160 cubic feet per second, or 13 percent. Near Bluff, the decrease in flow during spring runoff would be 390 cubic feet per second, or 9 percent, and during the rest of the year the average decrease would be 140 cubic feet per second, or 10 percent.

## 5. Water Quality

### a. Surface Water

#### (1) Animas River

Water quality of the Animas River would not significantly change under the proposed project. During construction of project features, some suspended solids would enter the river and increase turbidity temporarily. During project operation small increases in salinity, nutrients, trace elements, and water temperatures are predicted. The water quality changes should not alter downstream water uses. During construction of the Durango Pumping Plant, increases in turbidity and suspended solids and a slight decrease in light tramsmission in the Animas River are anticipated. Placing of the concrete pad and bottom vanes of the intake structure into the river would not cause any other changes in water quality. Because it is an off-stream site, major construction activity on Ridges Basin Dam would not have a significant impact on the Animas River. A point-source (402, NPDES Permit) and nonpoint-source water pollution control program, as discussed in Section A-9, would be used to minimize the water quality impacts during construction. The requirements set forth in the 402 permit (NPDES) and 404 (b) (1) analysis section of the 1977 Clean Water Act commit the Bureau of Reclamation to maintain State and Federal water quality standards during the construction period.

The effects of the projects operation on water quality in the Animas River consist of changes in water temperature, nutrients, coliform organisms, trace elements, and salinity. Unquantifiable increases in nutrients, coliform organisms, and trace elements are probable because of the increased domestic wastewater treatment plant effluent from Durango and Aztec which would be produced as the cities grow. The concentration of total dissolved solids would also increase because of the domestic wastewater and river depletions, as shown in Table C-6 (Bureau of Reclamation, 1979). These increases should not noticably affect downstream water uses.

Low flows in the Animas River, which are critical in waste loading levels, would not be affected (Bureau of Reclamation, 1979). In late summer, because of reduced flow from pumping, a slight increase in water temperature downstream of the Durango Pumping Plant is possible (Welch, 1952). This could possibly affect the downstream non-game species (see Section C-6).

Releases made from Ridges Basin Reservoir to Basin Creek after traveling 5 miles to the Animas would not adversely affect the river's water quality (Bureau of Reclamation, 1979).

The uranium waste piles, as discussed in Section B-5, would not adversly affect the quality of water entering Ridges Basin Reservoir. The proposed facility for Durango's wastewater treatment system includes a sewage outfall downstream of the Durango Pumping Plant, eliminating possible high nutrient loads being pumped to Ridges Basin Reservoir (Henningson, 1977). The existing wastewater outfall upstream of the pumping plant would be shut down before the operation of the reservoir.

Some heavy metals, as described in Section B-5, are present in the Animas River at Durango. Of these metals, manganese currently poses a potential water treatment problem for Durango's domestic water supply. New water treatment facilities for the Durango service area should be designed to reduce this metal concentration. Durango's raw water would be supplemented more in the future from the Animas River, and Durango's water treatment problems because of manganese would develop with or without the project.

(2) Ridges Basin Reservoir

The water in Ridges Basin Reservoir would be of adequate quality for the proposed irrigation, recreation and, once treated, municipal and industrial uses. The fate of the heavy metals pumped into Ridges Basin Reservoir is dependent on many factors, most of which indicate that the reservoir sediments would retain most of the metals, substantially reducing the potential for water quality problems. Bioassay and nutrient-loading studies on Animas River water lead to the prediction that the reservoir would approach a mesotrophic state (moderate biological production). Studies on oxygen concentrations in the lower levels of the reservoir predict no critical oxygen depletions (Utah State University, 1979).

The vegetation in the reservoir basin is sparse, limiting initial reduced oxygen conditions in the reservoir bottom. The basin bedrock is mainly a marine shale formation that produces alkaline ground water. All these findings, plus the fact that a large portion of the inflowing metals are in suspended form rather than in solution indicate the metals should accumulate and precipitate in the reservoir sediments. Also, with all water into the reservoir being pumped, the inflow of high concentrations of metals such as found during mining activity pollution can be easily controlled.

If the situation should occur during operation of the reservoir where unpredictable reducing conditions occurred in the reservoir bottom, some of the metals could come into solution. Iron and manganese would be the first, and probably only, metals to be noticed because of their reduction potentials. These reduced metals would remain in solution until coming into contact with oxygen-enriched water near or below the inlet level in the reservoir and then would be deposited in the bottom sediments (Hutchinson, 1957). As this oxidation and precipitation occurred, turbidity at this depth would increase and the coating of fish gills could possibly occur if they inhabited this area (California State Water Resources Control Board, 1963). If metal problems do occur sometime during the reservoirs life, destratification techniques for controlling their distribution are available for use, such as a water recirculation system.

Ridges Basin Reservoir would be classified as a temperate lake. A temperature simulation model on the reservoir has shown that bottom temperatures would remain near 4° C (39° F) (Bureau of Reclamation, 1979). With these conditions the reservoir should experience two turnovers, one in spring and one in autumn (Welsh, 1952). Increased turbidity and suspended solids levels would be noticed during these periods in the reservoir. Water use would not be appreciably limited because of this. Thermal stratification should occur in the summer, as predicted in the temperature model, and winter stratification with an ice cover is also predicted.

The total dissolved solids concentration in the reservoir would vary only slightly seasonally or yearly with a 230 mg/l level estimated (Bureau of Reclamation, 1979). The average annual sediment load pumped into the reservoir would be approximately 9,300 tons. Neither the total dissolved solids levels nor sediment would cause any quality problems or affect water use. Post-impoundment limnological studies in the reservoir would be established by the Bureau to monitor both water quality and aquatic biota to help with reservoir management and provide information for planning and operation of other water impoundments.

(3) La Plata River to Southern Ute Diversion Dam

Construction would take place during low or no-flow periods, resulting in only slight increases in turbidity and sediment concentrations. Fill material would be obtained from natural sources nearby (see Section A-4g) and would not contain toxic substances. Point and non-point source water pollution control programs would be initiated.

With the project, changes in water quality are probable, such as increased salinity, nutrients, coliform organisms, and trace elements. The total dissolved solids concentration just downstream of the La Plata Diversion Dam would increase from the present flow weighted average of 90 mg/l to approximately 230 mg/l because of water being introduced from the Animas River through Ridges Basin Reservoir. The level of total dissolved solids upstream of the proposed Southern Ute Diversion Dam would increase with the project from the current flow weighted average of 535 mg/l to approximately 610 mg/l. This change reflects irrigation return flow from project land, which was estimated to average 1,250 mg/l over the first 45 years of irrigation. Salt pick-up from newly irrigated land draining this area would vary from 0.28 ton per acre annually in the first year to less than 0.10 ton per acre annually in the 20th year (Bureau of Reclamation, 1979). No adverse effects on present or proposed project uses are expected with this change.

As agricultural activity increases in the project area there would be an additional use of fertilizers and pesticides along with increased cattle density. Along with these changes would be unquantifiable increases in nutrient, pesticide, and coliform organism levels in the river. Pesticides are not expected to be a problem since baseline levels are at a minimum and improved technology in application and new chemicals would probably enhance their safe use. The nutrient and coliform organisms should not cause serious instream problems, but the nutrient increase could promote sporatic excess aquatic plant growth.

As new project land was irrigated, temporary flushing of trace metals such as iron, manganese, and aluminum could occur; however, because of the other chemical characteristics of the water (alkaline pH and high hardness) these metals should settle out and become unavailable biologically.

(4) Southern Ute Reservoir

The quality of water in Southern Ute Reservoir should be adequate for proposed industrial, agricultural, and recreational uses. Periodic overgrowth of aquatic plants is possible in the reservoir because of nutrient concentrations introduced into the reservoir.

Assuming increased nutrients in the La Plata River from the project in addition to the current river concentrations, a worst case of eutrophic conditions was predicted (Bureau of Reclamation, 1979). Water from Ridges Basin Reservoir, which is low in nutrients, would be imported into the river, diluting the nutrient level. The unquantifiable nutrient loads from irrigated land and Ridges Basin Reservoir leave some doubt as to the trophic state of Southern Ute Reservoir due to nutrient loads. The average yearly sediment inflow would be approximately 39 acre feet and consist of 90 percent silt and clay (Bureau of Reclamation, 1979). This periodic sediment inflow would increase turbidity at the reservoir inlet due to the high percentage of small diameter particles. This seasonally high turbidity may make light a physically limiting factor to aquatic biota production (Welsh, 1952), thus decreasing the possibility of eutrophic conditions in the reservoir. Coliform organism levels in the reservoir should cause no problems for the proposed water uses since there would be no designated swimming area or domestic use.

Heavy metals and pesticides entering the reservoir would be in suspended form and settle out in the reservoir sediments. If problems were to occur with re-solution available destratification techniques for controling their distribution, such as a water recirculation system would be used. The average total dissolved solids concentration predicted in the reservoir would be 670 mg/l. This concentration would not vary significantly on a seasonal or annual basis (Bureau of Reclamation, 1979). This level would not adversely affect proposed agricultural and recreational uses.

Post-impoundment limnological studies in the reservoir would be established by the Bureau to monitor both water quality and aquatic biota to help with reservoir management and provide information for planning and operation of other water impoundments.

(5) La Plata River Downstream of Southern Ute Diversion Dam

Construction of Southern Ute Diversion Dam would take place during periods of low or no-flow and result in only slight increases in turbidity and sediment concentrations. Fill material would be obtained from natural sources nearby (see Section A-4g) and would not contain toxic substances. Point and non-point erosion control plans would be established to minimize these increases further.

The major impact of project operation would be salinity increase in the La Plata River; because of the large quantity of salt imported from the Animas River and re-use of project return flow, the level of total dissolved solids at Farmington over a 45-year period (see Table C-6) would increase from a flow-weighted average of 847 mg/l to 2,530 mg/l (Bureau of Reclamation, 1979). Because of this increase the water could be used only for salt tolerant crops on permeable soils with careful management practices. Existing agricultural practices would not be severely impacted because the crops presently grown and those proposed to be grown during project operation would have a high salt tolerance. Return flow from project land in New Mexico would carry approximately 19,630 tons of salt annually, of which 5,050 tons would be salt pickup from the application of irrigation water to full service land and additional irrigation water on supplemental service land. This salt pickup would vary from 1.1 tons per acre in the eleventh year to less than 0.57 ton per acre after 50 years.

The industrial water taken from Southern Ute Reservoir would contain an annual average of 24,150 tons of salt. An estimated 4,560 tons of salt would return to the river system (Bureau of Reclamation, 1979). The remaining salt would not re-enter the river system because it is assumed the water would be recycled until unusable and then evaporated at an industrial plant site. Unquantifiable increases in nutrients, pesticides, coliforms, organisms, and trace metals (iron, manganese, and aluminum) could occur as newly irrigated land would be put into production. No significant problems with these increases are expected with anticipated uses of the water.

(6) Mancos River

Irrigation return flow from land on the Ute Mountain Ute Indian Reservation and a part of the non-Indian land adjacent to the reservation would increase the total dissolved solids concentration and salt loading in the river (see Tables C-6 and C-7). Bureau of Reclamation studies (1979) indicate that the salt pickup from the irrigated project land would vary from 0.89 tons per acre in the first year to less than 0.10 ton per acre in the twenty-third year.

Unquantifiable increases in the amounts of nutrients, pesticides, coliform organisms, and trace metals (iron, manganese,

Table C-6
Total dissolved solids[1/]
(unit--mg/l)

| Month | Animas River at Farmington | | La Plata River at Farmington | | Mancos River north of State line | | San Juan River at Bluff, Utah | |
|---|---|---|---|---|---|---|---|---|
| | Preproject | Project | Preproject | Project | Preproject | Project | Preproject | Project |
| January | 430 | 445 | 1,810 | 2,990 | 1,690 | 1,635 | 665 | 725 |
| February | 425 | 445 | 1,570 | 3,005 | 1,510 | 1,520 | 615 | 655 |
| March | 375 | 390 | 1,165 | 2,760 | 1,320 | 1,350 | 565 | 605 |
| April | 290 | 325 | 410 | 2,055 | 1,045 | 1,075 | 430 | 475 |
| May | 215 | 235 | 420 | 1,695 | 960 | 990 | 350 | 380 |
| June | 200 | 220 | 505 | 2,330 | 975 | 1,020 | 340 | 375 |
| July | 275 | 330 | 1,740 | 3,460 | 1,355 | 1,400 | 485 | 555 |
| August | 355 | 455 | 1,605 | 2,305 | 1,350 | 1,400 | 515 | 575 |
| September | 375 | 435 | 1,080 | 3,165 | 1,450 | 1,480 | 610 | 685 |
| October | 365 | 420 | 720 | 2,365 | 1,410 | 1,450 | 550 | 620 |
| November | 400 | 435 | 1,390 | 2,855 | 1,580 | 1,565 | 635 | 720 |
| December | 425 | 420 | 1,800 | 3,075 | 1,635 | 1,595 | 665 | 730 |

1/ Figures are flow-weighted and averaged for 45 years of study.

and aluminum) are probable as the newly irrigated land is agriculturally developed. No problems are predicted with these increases with the anticipated uses of the water.

(7) San Juan River

While there could be a sharp increase in salinity upon initial irrigation of agricultural land, the project would have a small effect on the long-term water quality of the San Juan River. Increases, presently unquantifiable, in nutrients, trace elements, coliform organisms, and pesticides could be attributable to the project. No major problems are anticipated with these increases, because of the present uses of the water and the treatment of domestic water. The average annual salinity in the river at Bluff, Utah, would be increased after 45 years of project operation (see Table C-7) from a current flow-weighted average of 470 mg/l to 520 mg/l (Bureau of Reclamation, 1979). The following table shows the average annual salt tonnage and flow-weighted total dissolved solids concentration for the Animas, La Plata, Mancos, and San Juan Rivers with and without the project. The project averages represent an average over 45 years of simulated project operation (Bureau of Reclamation, 1979).

Table C-7
Average annual salt tonnage and flow-weighted average of total dissolved solids concentration

| | Without project | | With project | |
|---|---|---|---|---|
| | Salt (tons) | TDS (mg/l) | Salt (tons) | TDS (mg/l) |
| Animas River at Farmington | 215,000 | 275 | 167,000 | 295 |
| La Plata River at Farmington | 20,000 | 845 | 27,000 | 2,530 |
| Mancos River north of State line | 43,000 | 1,195 | 55,000 | 1,255 |
| San Juan River at Bluff, Utah | 1,006,000 | 470 | 1,005,000 | 520 |

(8) Colorado River

The salt concentration effect of project depletions and the salt contributions from project uses would increase the salinity of the Colorado River. The average annual increase, based on the 100-year average would total 17.9 mg/l as measured at Imperial Dam, about 1.7 percent above present levels. Depletions would account for an increase of 18.6 mg/l, and salt loading would actually decrease salinity by 0.70 mg/l because of the high percentage of project industrial water that would be nonreturning. If the industrial water for the Indian Tribes were not developed initially, the total project effect at Imperial Dam would be 16.4 mg/l, consisting of 1.5 mg/l from salt loading and 14.9 mg/l from depletions. The values showing this delay in use are based on the assumption that the water would be left in the Animas River. The following table reflects the impact of the project on water quality on the Colorado River at Imperial Dam.

Table C-8
Average annual project on salinity
(Unit--mg/1)1/

| | Present level | With project |
|---|---|---|
| Colorado River at Imperial Dam | 2/1,052.0 | 1,069.9 |

1/ Flow-weighted average.

2/ The modified salinity level in 1976, which is a hypothetical situation that takes into consideration all of the projects constucted or under construction in the Colorado River system as of 1976. For further explanation, see Cumulative Impacts Section C-14.

Studies by the Bureau of Reclamation (1974) conclude that increasing salinity causes both direct and indirect economic losses in the Colorado River Basin. The losses, estimated at $230,000 annually for each increase of lmg/l at Imperial Dam, have a number of causes. In agriculture, they come from decreased crop yields, increased leaching requirements, increased management costs, and application of various adaptive practices. In the municipal and industrial areas, the losses arise primarily from increased water treatment costs, accelerated pipe corrosion and appliance wear, increased use of soap and detergents, and decreased palatability of drinking water.

### b. Ground Water

The project would not have significant impacts on the quality of ground water. Soils in the project area do not contain large quantities of salts or concentrations of other materials that would have adverse effects on ground-water quality. The effects from irrigation return flow would be limited to a small increase in soluble salts and nutrients in subsurface drainage water, which should not affect the quality of the existing ground water. Other constituents, including heavy metals, would precipitate out or be filtered out as water passes through the soil structure. More ground water would be produced in the newly-irrigated areas, particularly in bottom land, and would have water quality similar to existing ground water.

## 6. Fisheries

### a. Introduction

The project would establish two reservoirs, Ridges Basin and Southern Ute, which would be managed as cold-water fisheries (Fish and Wildlife Service, 1979). In the Animas River, nongame fish populations, including mostly sucker species, may be reduced slightly downstream of the pumping plant, primarily because of lower winter flow resulting from the project, but the small trout populations presently existing are not expected to be significantly affected. Also, nongame fish populations in the La Plata and Mancos Rivers may be increased because of augmented flows, while fish species occurring in the San Juan River may be reduced to a slight degree as a result of decreased aquatic habitat. Detailed analysis of the aquatic fauna occurring in these affected river systems can be found in reports submitted by the Colorado Division of Wildlife, 1976; Eastern New Mexico State University, 1976; and the Bureau of Reclamation 1979. A discussion of the impact on water quality may be found in Section C-5. The increase future population in the project area could put an added demand on streams fisheries, which could be handled by additional stocking. The addition of the two project reservoirs would reduce the increasing use that is occurring at existing reservoirs.

b. Animas River Downstream of Durango Pumping Plant

Construction work on the Durango Pumping Plant inlet would cause periodic increases in turbidity. Since the Animas River is now frequently subject to sudden increases in turbidity, particularly from April through October, resulting from rain showers upstream, this turbidity should not have a significant effect on either the aquatic habitat or the species of fish downstream.

The most significant long-term effect on the Animas River would be the reduction in flow because of pumping, particularly in the fall and winter when water levels in the river are at their annual minimum. The Fish and Wildlife Service has informally recommended that a 250 cfs and 161 cfs flow be minimally maintained in the Animas River downstream of the pumping plant in the summer and winter, respectively. Bureau of Reclamation studies indicate that economically these recommended flows could not be provided. Environmental impacts of project flows on the downstream environment were assessed and determined to be minimal. Specifically, the U.S. Fish and Wildlife Service's recommendation was based upon the Colorado Division of Wildlife's minimum stream flow criteria. These criteria were developed as they apply to "trout streams." The Bureau's recommended minimum flow would satisfy all of these criteria except average minimum depth. In this instance, the minimum depth would be reduced 0.08 foot from the Division's recommended 0.8 foot to 0.72 foot. Since two out of the three flow parameters would be met and also because of the lack of both trout and trout habitat downstream, the minimum flow recommendation would not have an adverse impact on the limited trout population downstream. It is anticipated that the loss in wetted acreage will adversely affect rough fish populations, principally suckers, and eventually reduce their population by approximately 10 percent. A more detailed explanation of the biological analysis of all project affected rivers can be obtained in technical reports at the Bureau of Reclamation offices in Durango, Colorado and Salt Lake City, Utah.

As a result of pumping, the amount of habitat for non-game species, which are principally suckers, would be reduced somewhat. This reduction would correspondingly reduce the overall sucker population by approximately 10 percent. As described in the Water Quality Section in Chapter B, the Animas River fish populations are limited by a combination of harsh physical and chemical factors that are much more severe than the possible decrease in winter flow to 125 cfs. The reduced flow would decrease the total wetted acreage downstream. This reduction in wetted acreage would also reduce the amount of aquatic invertebrate production areas. This loss would be minimal, however, and would not adversely affect other aquatic life. During pumping, the game fish in the Animas River would be protected by fish screens.

Pumping from the Animas River would not only cause a reduction in flow but also would cause an increase in water temperature downstream, which would be most pronounced in the late summer. The effect of this increase would be the shifting of the summer. The effect of this increase would be the shifting of the southern range of cold-water fish species farther north during the this period, affecting mostly trout and bluehead suckers. Accordingly, warmer water fish species, such as the speckled dace, could extend their range farther north.

c. Ridges Basin Reservoir

Ridges Basin Reservoir would create potential for a new cold-water fishery supporting 62 pounds of sport fish per acre and an estimated 39,600 fisherman days per year (Fish and Wildlife Service, 1978). A detailed analysis of the anticipated productive potential of this reservoir may be found in Chapter C, Water Quality.

Fry-fingerling trout, one to four inches in length, would be most likely to be stocked in the reservoir. Initially, fry-fingerling trout species, 1 to 4 inches in length, would be introducted into the reservoir. If the growth and survival rate of these species were to prove inadequate, catchable-size fish would then be stocked. Kokanee salmon fry may also be introduced. Because of a lack of spawning habitat, an annual stocking program would be required to fill the void created by the lack of natural reproduction. The reservoir fishery would be protected by placement of fish screens. A comprehensive fish management plan, including the development and implementation of a stocking schedule to include a composition of species, would be coordinated by the Fish and Wildlife Service and the Colorado Division of Wildlife.

d. La Plata River Downstream of the La Plata Diversion Dam

The diversion dam would create an intermittent 7.5-acre impoundment by actively backing up natural flow from the La Plata River during periods of high flow, which would most often occur in the spring. No water would be impounded when La Plata River flow fell below 10 cfs. The impoundment would be dry much of the year and, therefore, would not create an additional fish habitat potential. The downstream aquatic environment would not be affected by this diversion dam.

Water supplied to project irrigation land from the Dry Side Canal would accumulate in the La Plata River from 2 to 3 miles downstream as return flow. From this point to the Southern Ute

Diversion Dam, a continual annual flow would be provided. The quality of water from this return flow would be relatively poor and is not expected to provide any game fish habitat; however, a significant nongame fish population composed primarily of sucker species would develop.

Southern Ute Diversion Dam would create a 17-acre pond that would support a limited nongame fish population composed primarily of sucker species. Downstream of the diversion dam, reductions in flow would have a negligible effect on the aquatic environment since no resident fish population is currently present.

e. Southern Ute Reservoir

The U.S. Fish and Wildlife Service has recommended that Southern Ute Reservoir be managed as a cold-water fishery with catchable-size and smaller than catchable-size trout being stocked on a continuing basis. It is anticipated that the U.S. Fish and Wildlife Service would develop the management plan. Because of warm temperatures in late summer, and possible eutrophic conditions, the fishery in the reservoir would only be suitable for stocked catchable trout. No suitable spawning areas would exist for trout. The Fish and Wildlife Service estimates that the reservoir would support 61 pounds of game fish (trout) per surface acre and 15,400 fisherman-days per year. The fishery in the reservoir would be protected from the intrusion of rough fish by fish screens.

f. Mancos River

The Mancos River, which would receive irrigation return flow from project land on the Ute Mountain Ute Indian Reservation, would have an increase in flow of about 30 percent. This increase should enhance the habitat available to aquatic life, with a correspondingly slight increase in nongame fish population. During the summer months, an increase in the number of migrant channel catfish from the San Juan River may occur in the Mancos River as more habitat becomes available.

g. San Juan River

On an annual basis, the flow in the San Juan River would be depleted a maximum of 9 to 12 percent. The affected portion of the river is a sluggish stream characterized by broad channels, heavily silted bottom, and turbid water; therefore, the expected flow depletions would only minimally affect aquatic habitat with slight reductions in wetted perimeter, stream velocities, and average depth. Correspondingly, aquatic life would not be greatly impacted. Reductions in pool and backwater habitat would reduce slightly the sucker populations and, to a lesser degree, large catfish; channel reductions would reduce habitat available to smaller channel catfish, as well as species such as speckled dace and fathead minnows. A reduction in riffle areas would decrease aquatic invertebrate production by reducing the amount of food available to these species and decreasing some spawning habitat for resident species.

## 7. Vegetation

During construction, temporary disturbances to vegetation would occur, but this disturbed land would be reseeded with native vegetation. The long-term changes in vegetation in the project area would be the greatest in the grassland community, chained area, and dry farmland, where conversion to irrigated cropland would occur.

Table C-9 shows the vegetative communities and the changes in acreage. Vegetative changes of a long-term nature would occur on approximately 62,421 acres. Of major significance would be the conversion of 48,470 acres to irrigated cropland, consisting of approximately 26,170 acres of native vegetative and chained areas and 22,300 acres of dry-farmed land. This conversion would constitute about 77 percent of the total acreage affected. About 34 percent of the acreage acquired for construction of project features (4,196 acres) would be either inundated, including 2,350 acres at Ridges Basin Reservoir and 1,522 acres at Southern Ute Reservoir, or used for other project features such as canals, roads, recreation sites, and project structures. The remaining 66 percent would be replanted with native vegetation or left unchanged.

This discussion is in consideration of the impact of the project on "wetlands". Because of the project, 14 miles of existing canal and lateral would be eliminated and replaced by underground pipe. This change in the method of irrigating would cause the loss of about 880 acres of marginal riverine wetland habitat. However, with the prospect of about 3,630 acres of lacustrine (lakes and reservoirs), wetland habitat would be created by Ridges Basin and Southern Ute Reservoirs. The project would also create approximately 124 acres of riverine habitat along the Dry Side Canal and has the potential for creating about 15 acres of palustrine (marsh) habitat as a result of Southern Ute Diversion Dam. There would also be a potential increase in the riverine habitat along some open canels and laterals north of the Dry Side Canal and the La Plata and Mancos River in certain sections because of the increase in flow. The only alternative within the proposed plan would be to retain irrigation with open canals and laterals, which would then create marginal wetland areas. This trade-off would require a reduction in land to be served and would mean loss of the conservation of water possible under sprinkler irrigation. Overall, the project would have a net increase in wetland habitat. Wetlands would also be created near the outlet channels of project drains, which would total about 66 miles and would be installed after project operation begins.

## 8. Wildlife

### a. Introduction

Construction and operation of the project would eliminate about 4,746 acres and change approximately 26,170 acres of existing wildlife habitat within project area boundaries. The 26,170 acres consists of grassland, sagebrush, pinyon-juniper, and chained areas, which would be converted to full service irrigation (see Table C-9). The 4,746 acres would be completely lost for terrestrial wildlife, including such species as deer, cottontail rabbits, rodents, and some bird species. The change that would occur on the 26,170 acres would result in an adverse impact to such species as the sagebrush lizard, sage sparrow, and prairie dog, while it would benefit such species as red-wing blackbird, Gamble's quail, mule deer, and the muskrat. A temporary disturbance to wildlife in the area would occur with the construction of the project transmission line, but would be minimal and of short duration. The following sections are a summary of the detailed technical analysis made by the Bureau of Reclamation (1979). The complete analysis is available for public inspection at the Durango Projects Office, Durango, Colorado, and the Upper Colorado Regional Office, Salt Lake City, Utah.

#### Future Conditions

As can be seen from Table B-1, the human population of the area is expected to continue to increase. Along with this population rise will be a continued increase in the development of housing. The present trend data show no appreciable decrease in this rate of development.

The overall condition for wildlife will be that of continuing reduction in habitat, caused by the continuing development of more of the area for housing and other needs of the increased human population. Since most housing areas inside the city of Durango are developed, the greater part of the housing construction is occurring outside of the city limits. This construction generally is in subdivisions, where owners of large parcels of land divide their property into small tracts and sell to individual home owners. As a result of this type of development, the wildlife habitat in the area is being greatly reduced. This reduction in habitat affects all species of wildlife in some way or another; it is eliminating food sources as well as cover for many species. As more and more development occurs, the animals now in the project area are being forced to occupy less desirable habitat and to over-populate certain areas.

### b. Big Game

#### (1) Mule Deer

The primary impact on mule deer would be the loss of about 4,700 acres of habitat presently being used by deer herds in the project

| m | Total | Acres of vegetation lost to project purposes | Acres revege- tated or unchanged | Acres changed to irri- gated crops |
|---|---|---|---|---|
| Ridges Basin Reserv | 4,830 | 2,350 | 2,480 | |
| Durango Pumping Pla | 26 | 26 | | |
| Ridges Basin Access | 42 | 12 | 30 | |
| Wildlife area | 2,500 | | 2,500 | |
| O&M Headquarters | 3 | 3 | | |
| Dry Side Canal | 648 | 238 | 410 | |
| Southern Ute Inlet | 107 | 24 | 83 | |
| Southern Ute Reserv | 2,822 | 1,522 | 1,300 | |
| New Mexico Irrigati | 107 | 21 | 86 | |
| Laterals | 1,791 | | 1,791 | |
| Powerline easement | 503 | | 503 | |
| Ridges Basin Inlet | 22 | | 22 | |
| Full service land ) | 48,470 | | | 48,470 |
| Supplemental servic | 550 | 550 | | |
| Total ) | 62,421 | 4,746 | 9,205 | 48,470 |

1/ Approximatemental service land to be served by the proposed Dry Side Canal.

area. This decrease would cause the displacement of about 150 out of the 200 deer now utilizing the Ridges Basin Reservoir site as winter range (Colorado Division of Wildlife, 1976b), and essentially no impact at the Southern Ute Reservoir site because of the low number of deer now inhabiting that site. The displacement would cause no direct mortality of deer; however, it would reduce the overall range of the deer herds, moving them onto land that is presently supporting deer at maximum capacity. This would have an indirect mortality effect probably occurring the first winter after displacement. Therefore, 2,500 acres of land in the project area would be purchased and developed concurrently with construction of the project to offset these losses.

The project canals should not have significant effects on deer. Because of its size, the Dry Side Canal would have the greatest potential for impact on deer. Except for fawns, the animals should have little trouble crossing the canal because it would be primarily earth-lined. As discussed in Chapter A, protective fencing, crossing structures, or escape devices on canals should eliminate potential adverse effects on deer.

The conversion of dryland farm and native range to irrigated land would have little effect upon deer in the area since most of the area has been chained or dryland farmed in the past year.

(2) <u>Elk</u>

During construction, human activity would cause some minor impacts on elL herds of the area by causing them to leave the area of construction.

Inundation of Ridges Basin Reservoir would cause the loss of 2,230 acres of primarily winter range, causing the displacement of about 150 head of elk to adjacent land (Colorado Division of Wildlife, 1976b). This adjacent land is in poor condition and not capable of supporting this increase in the number of animals; therefore, mortality would occur. However, with the acquisition of 2,500 acres of land and the development of this land by chaining and seeding, the carrying capacity would be raised enough to support the displaced elk. The Southern Ute Reservoir site would have no impact upon elk since few, if any, presently utilize this site.

(3) <u>Antelope</u>

The project would have no long-term effect on the antelope in the area. The herd utilizes the range areas west of any project service area. During construction of the Shiprock-Durango Transmission Line some temporary impact would occur due to human activity in the area. Once the powerline is in place, no impact would occur to the herd.

(4) The Mountain Lion and Black Bear

The project would have no effect upon either of these species. The project would cause the loss of an insignificant amount of feeding range of the lion but would reduce no denning areas. Since no bears have been sighted in the area for the past 10 years, no effect would occur to these animals.

c. Small Game Mammals

The reservoirs, project canals, pumping plants, and roads would remove habitat supporting the desert cottontail, the primary small game mammal of the area. However, with the development of the wildlife areas and the reseeding of land and road rights-of-way this loss should be more than offset. The conversion of land to irrigated farming would also be of benefit to desert cottontails by establishing permanent cover and increased forage areas along waterways.

d. Furbearers

The increase in water to the area as a result of the project would have an overall benefit to furbearers of the area, primarily beaver and muskrat. The inundation of the reservoirs and the project canals would cause a loss in habitat to skunks and weasels, but the conversion to irrigation would offset these losses, since these species are both quite adaptable and do very well associated with agricultural practices.

e. Varmints

The project would have beneficial impacts on jackrabbits, coyotes, raccoons, and bobcats; and adverse impact on prairie dogs. The increase in irrigated land would probably increase the jackrabbit and rodent populations, thereby providing additional prey for the coyote and bobcat, which would increase their numbers. Irrigated cropland would have a detrimental impact upon prairie dogs by eliminating their habitat, and a positive impact on the raccoon by providing more cover and food.

f. Nongame Mammals

Almost all project features, particularly the inundation of the reservoir basins, would remove habitat that supports nongame mammals, but this loss would be partly offset by the growth of vegetation around the reservoirs and adjacent to the irrigated land. This vegetation, the reseeding along canal rights-of-way, and the food plots at the wildlife management areas would cause a net increase in habitat and in the number of nongame mammals.

g. Gamebirds

The revegetation of canal rights-of-way and the resulting development of cover and food in connection with the laterals and irrigated land would have an overall beneficial effect on gamebird habitat and more than offset losses of habitat incurred during construction. Inundation by Ridges Basin and Southern Ute Reservoirs would remove habitat used by the turkey, mourning dove, and bandtailed pigeon and displace most of these species to suitable habitat on adjoining land. Newly irrigated land would create habitat for upland and migratory gamebirds, such as the mourning dove, pheasant, and Gambel's quail.

h. Waterfowl and Shorebirds

Ridges Basin and Southern Ute Reservoirs would increase the available habitat for waterfowl and shorebirds. Because of the fluctuating water levels, the reservoir probably would not become nesting areas. During the irrigation season, the canal system would provide resting and feeding areas for resident and migrant birds. The increased crop production of the area would create an increased food supply for these birds.

i. Raptors

Ridges Basin and Southern Ute Reservoirs would eliminate hunting and resting areas used by several species of raptors, including the red-tailed hawk, sharp-shinned hawk, and American kestrel. This habitat loss would be of benefit to other species such as eagles because the reservoirs would provide a food source, such as fish, shorebirds, and waterfowl. The reservoirs would provide valuable habitat for the bald eagle, and a significant wintering population would be attracted during late fall and early winter.

The other project features should, with some exceptions, have very little effect on raptors. The project transmission, if constructed, would be raptor safe (Miller, 1975), and would have no impact upon raptors. Project roads and canals would eliminate the pinyon-juniper nesting and resting habitat of the sharp-shinned hawk, Cooper's hawk, and great horned owl. Newly irrigated land would produce additional cover and increse the number of rodents which should offset the loss of prairie dogs as prey.

j. Nongame Birds

Because of the large number and diversity of nongame birds, the project's effects would vary from benefiting some to being detrimental to others. The reservoirs would inundate the dryland habitat that many species prefer, as well as create a new ecosystem that would cause an increase in the diversity of species using the reservoir areas. Although the construction of canals, roads, pumping plants, and other features would destroy habitat, revegetation would compensate for any loss. The increase in irrigated cropland would furnish additional food, water, and cover for some species; however, the new habitat would result in changes in the distribution and diversity of species, causing some to gain in number and others to lose.

k. Reptiles and Amphibians

Ridges Basin and Southern Ute Reservoirs would eliminate reptiles and amphibians using the existing habitat. Because of fluctuating water levels, the reservoirs' shores would not provide suitable habitat for most species accustomed to stable ponds.

Other project features are expected to have little effect on reptiles or amphibians because of low population densities and because disturbed areas would be revegetated. The change to irrigated farming would increase the population of many species of amphibians; however, reptiles, which generally favor arid areas, would decrease in numbers.

## 9. Endangered Species

### a. General

The endangered species that were reviewed for possible import in the projects area were the peregrine falcon, the bald eagle, and the Colorado River Squawfish. The Bureau has completed a biological assessment of the project's impact on these species, in compliance with the Endangered Species Act Amendments of 1978. This assessment has been forwarded to the Fish and Wildlife Service for a biological opinion.

### b. Fish

The Colorado River Squawfish is not presently known to occur in the Animas, La Plata, and Mancos Rivers. The small squawfish population occurring in the lower portions of the San Juan River will probably never be reestablished over its historical range. This can be attributed, in part, to the effects of cold water releases from Navajo Dam, competition from exotic species, and numerous water diversions and associated structures, all of which inhibit the upstream migration of squawfish. In light of these adverse factors, the relatively small flow depletions and slightly increased salinity levels in the San Juan River would not affect squawfish.

The roundtail chub, classified by the State of New Mexico as a potentially threatened species, would not be adversely impacted by project diversions. An uncommon resident of the San Juan River, the small flow depletions would not affect this species.

The Colorado River squawfish does not exist now, as it did not exist historically in the Animas or the La Plata Rivers, according to surveys conducted in 1975, 1976 and 1978. The depletion caused by the

Animas-La Plata project would not greatly affect the average relocation, depth, or wetted perimeter of the San Juan River; therefore, the project would have no adverse impact upon the Colorado River squawfish.

c. Wildlife

The bald eagle is a common winter resident of southwest Colorado. The eagle shows preference for fish as the mainstay of its diet and, therefore, is found along the shores of streams and reservoirs. There has only been one reported nesting site in the project area, and this would not be affected by the project.

The reduction in flow of the Animas River would have no impact upon the eagles that now use it for a feeding area. In addition, the two project reservoirs should have a positive effect upon the distribution and abundance of bald eagles.

Surveys of the project area did not record any sightings of the peregrine falcon. The only confirmed sighting in the project area was recorded in 1963 by the U.S. Fish and Wildlife Service. The sighting confirmed the presence of a nesting pair along the cliffs on the north side of the proposed Ridges Basin Reservoir. This site has not been used in recent years. In view of the fact that many other potential sites exist in southwest Colorado, the project would not affect any peregrine falcons.

10. Air Quality and Noise Levels

a. Construction Activities

The project would have short-term adverse effects on air quality and noise levels during the 10-year construction period as a result of exhaust emissions and dust from construction equipment blasting operations, and the movement of earth or aggregate materials, and smoke from the burning of cleared timber, brush, and rubbish. These construction activities would increase ambient particulate levels in the vicinity of the reservoir basins, canals, pumping plants, transmission line and roads, but the increase would be relatively minor and would disperse quickly. Another adverse effect would be noise from construction equipment, increased traffic, and blasting. Most of the construction activities, however, would take place removed from population centers. Construction would not have any long-term adverse impacts on ambient air quality or noise levels.

b. Long-term Effects

During project operation, the long-term adverse impacts on ambient air quality and noise levels would be minor. In the summer, the recreation areas would attract a number of people whose vehicles would create emission levels higher than present levels. Farming practices such as plowing and discing would increase particulate levels on full service land that previously had native vegetation. Land converted from dry to irrigated farming would contribute fewer air-borne particulates than before because sprinkler-irrigation would suppress wind-blown soil. Farm vehicles would also contribute emissions, but the levels would not be high and the gasses should disperse quickly.

As shown in Table C-2, population in the project area is expected to increase, with attendant increases in suspended particulates and carbon monoxide levels. Increased traffic on unpaved roads would increase particulate levels, and increased automobile traffic in downtown areas would increase levels of carbon monoxide particulates and hydrocarbons. The potential impacts from the development of Indian resources with project industrial water are discussed in Section C-13.

## 11. Scenery

During construction, heavy machinery, increased human activity, and clearing operations would detract temporarily from the area's scenic value. The relocation of power and natural gaslines also would cause a temporary detraction. The reservoir basins would be unattractive until they were filled. Excavation for canals, laterals, roads, buildings, and other features would create a more lasting scenic degradation. Although cleared areas around these structures and features would be revegetated, some would remain unsightly for 5 to 10 years until vegetation could become fully reestablished.

After construction, the existence and operation of project features would have a lasting effect on the scenery of the area. The major visual impacts would be at the project dams and reservoirs, pumping plants, water towers, and the Shiprock-Durango Transmission Line.

The scenic quality of the two reservoirs would vary somewhat. When full in early summer they would tend to enhance the landscape. In late summer and fall, when drawdown would be at its maximum, their scenic value would be diminished.

The Durango Pumping Plant would be situated in an area that is already being industrially developed; however, it would be close to the new Highway 160-550 interchange, which is under construction, and visible from an area proposed for a city park. The Ridges Basin Pumping Plant would detract from its surroundings, since it would be located in a relatively undeveloped area. Permanent project features such as these would be constructed of materials and be of a color to integrate with their surroundings as much as possible.

The five water towers to be erected would have a round shape and be of substantial size and height, so they would contrast sharply with the surrounding landscape and would have a negative visual effect. This effect would be reduced by painting them a color to blend with the background as much as possible.

The Shiprock-Durango Transmission Line, if constructed, would use existing corridors for about 7.8 miles and new alignment for 44.2 miles (see General Map). The line generally would run through sparsely inhabited rural areas. The most significant visual impact would occur where the line would cross State Highway 170 about 4 miles south of Redmesa, and along County Road 141 where the alignment follows the same route as the Durango Municipal and Industrial Pipeline and Ridges Basin Inlet Conduit. The 46-kilovolt line also would be located in a sparsely populated area, but would be visible for a short distance from the town of Breen. The relocation of the existing 115-kilovolt line at Ridges Basin Reservoir would follow an existing corridor to the north of the basin and then use the same corridor as the proposed Durango-Shiprock Transmission Line. The relocation would avoid potential recreation sites and would be out of view from the reservoir. The poles for all transmission lines would be made of wood, which would reduce visual impact.

The project full service land would change from natural vegatation to a crop species. There would be no change in landscape values of presently irrigated land.

## 12. Vectors and Related Problems

Potential increases in the production of mosquitoes could result because of the project reservoirs, conveyance systems, and increase in irrigated land. The Bureau of Reclamation would minimize this potential, however, following the procedures described in Section D-3e. Sprinkler irrigation and irrigation management scheduling would produce more efficient irrigation practices with less ponding of water than would gravity irrigation methods, and this would reduce potential mosquito increases that could occur from applying irrigation water to more land.

The project recreation facilities could expose people to mosquitoes and ticks, and some control measures conducted by the administering agencies would need to be instituted if vectors were to become a problem.

## 13. Coal Development

### a. Introduction

The proposed project would provide a total of 32,500 acre-feet of municipal and industrial water to the Southern Ute and Ute Mountain Ute Tribes. It is recognized that the impact of providing water for industrial purposes to the reservations would be to stimulate development of natural resources.

Several hypothetical scenarios which might occur, given the coal resource and water supply, were developed. The general types of impacts which could occur as a result of each development scenario were then assessed. While this approach gives the reader an overview of typical impacts, it is not the intent of this analysis to provide NEPA compliance for any natural resource development proposal. Any specific proposal requiring the use of project water will be the subject of a site-specific EIS when the plan is finalized. A thorough analysis of site specific impacts would have to be made for any proposal. Areas of particular concern include the air quality at Mesa Verde and social and economic impacts on the two tribes and the surrounding communities.

The following analysis of coal mining, electric generation, coal gasification, and coal slurry are not intended to be an exhaustive list of every development option open to either tribe. It is also not intended that the following analysis pre-select or recommend a specific plan of development of policy for either tribe. At this time, neither tribe has definite plans for developing their mineral and water resource packages. Both tribes are in the process of evaluating their coal resources and development options.

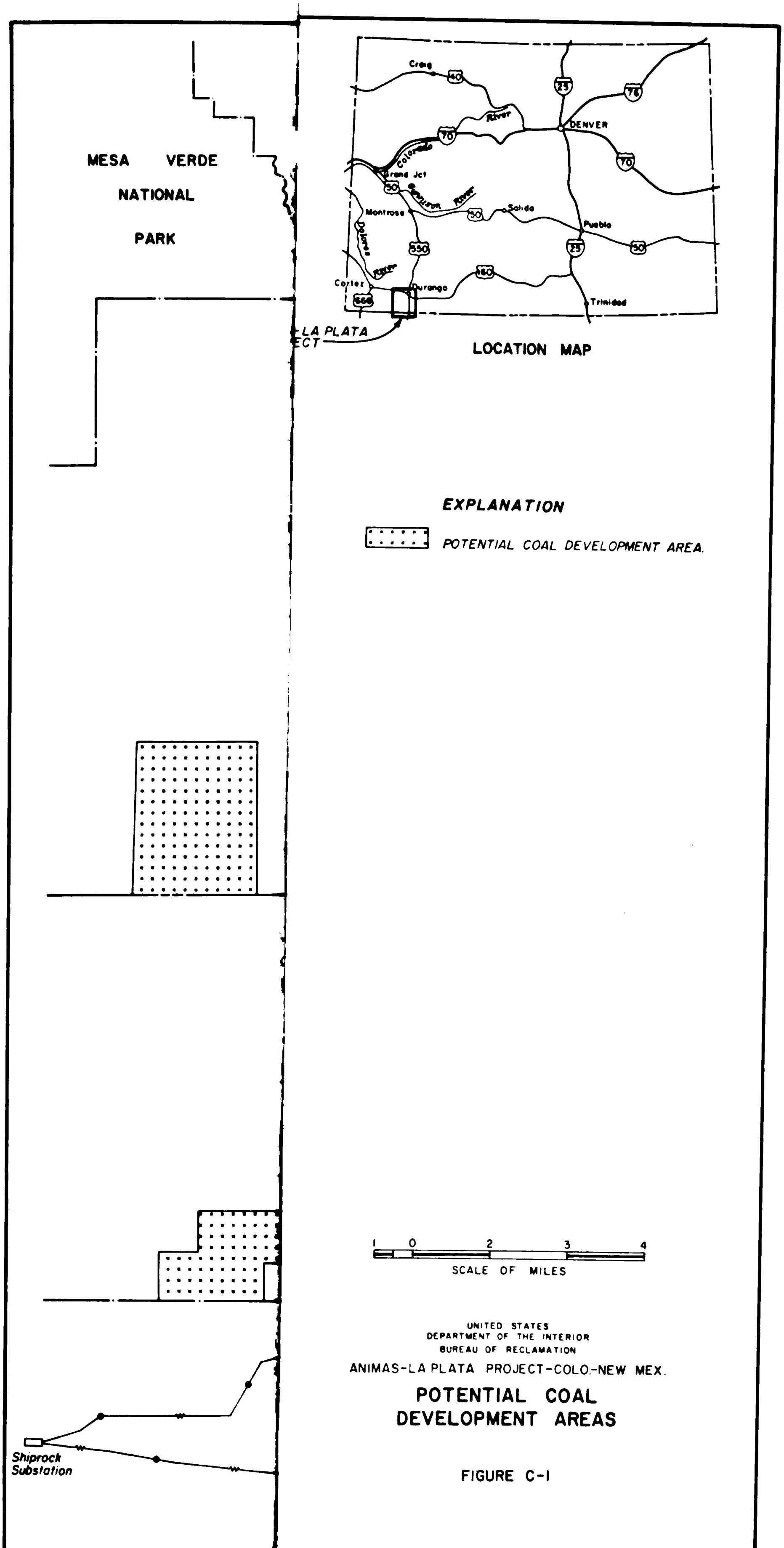
While only strippable coal reserves were used for this analysis, deep coal reserves are much larger. These could be mined which could use the entire amount of industrial water for any given situation.

b. Off-Site Sale of Coal Scenario

For the purposes of this analysis, two possible coal tracts were identified on each reservation. These are shown on Figure C-1. Other assumptions used to develop the hypothetical scenario were a recovery factor of 80 percent that coal would be strip mined; and that coal would be strippable to a depth of 250 feet.

(1) Southern Ute Reservation Scenario

No customers for coal or a mine operator have been identified at this time. A strip mining operation on the Southern Ute Reservation would be similar to the methods at the ColWyo Mine in southwestern Colorado. (Bureau of Land Management 1977). The mining company selected would be required to submit a detailed mining plan for approval by the Bureau of Indian Affairs and the Secretary of the Interior. At this time, the tribe does not have any regulations governing strip mining. It is likely that some type of tribal regulation would be promulgated prior to development. Any proposal would be in conformance with tribal and Federal regulations governing strip mining and would include extensive mine reclamation requirements. No schedule or plan has been proposed, but mining would be possible as soon as a mine operator was selected, a contract negotiated, site-specific NEPA requirements were fulfilled, and the mining plan was approved.




UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ANIMAS-LA PLATA PROJECT-COLO.-NEW MEX.

POTENTIAL COAL DEVELOPMENT AREAS

FIGURE C-I

Topsoil would be removed and stockpiled where it is suitable for reclamation purposes. Overburden overlying the uppermost seam would then be blasted. The shot material would be leveled and a dragline would remove the overburden and move it to an area not overlying the coal. After the coal was uncovered, it would be broken by blasting and loaded by power shovels. Mining would progress along the seam with the draglines moving back and forth along the seams. As the mining progressed, the next lower seam would be uncovered and mined in the same manner. Assuming a 35-year life for the mining operation, 9.1 million tons of run-of-mine coal could be produced each year. Water requirements at this level of development were estimated at about 625 acre-feet annually for all mine purposes.

Coal transportation methods are indeterminate at this time. It is likely that large off-road trucks would transport the coal from the pit to a loading area. If a proposed railroad between Gallup and the San Juan Powerplant is constructed, the Southern Ute area would be 20 air miles from the railroad. In this event, a rail spur would be attractive. Unit trains could be used to transport the coal to market areas to the southwest.

It is assumed that the mining support facilities such as an office, shop, crushing equipment, and storage piles, would be located at the mine. Haul and access roads, powerlines, and waterlines would also be required.

Reclamation of the strip-mined area would probably proceed concurrently with mining. All reclamation procedures would conform with Federal and tribal regulations. The end use of the reclaimed land will be determined by the tribe.

Standard environmental control measures at strip mines include collection and treatment of surface runoff, erosion control measures, road surfacing and chemical treatment, and dust suppression systems at transfer points.

(2) Ute Mountain Ute Reservation Scenario

Similarly, on the Ute Mountain Ute Reservation, neither a mine operator nor a customer for off-site coal sales have been identified. Any coal mining company would be subject to the same types of approval and permitting requirements as outlined earlier for the Southern Utes. Mining techniques in this scenario were assumed to be essentially the same as those for the Southern Ute scenario. Coal production from both coal areas could be sustained at 891,000 tons annually for 35 years. Water requirements are estimated to be 65 acre-feet each year. Transportation of the coal is undefined. The potential Ute Mountain Ute coal areas are 5 to 16 miles from the proposed railhead. The southern tract appears to be a logical extension of the existing Western Coal Company Mine.

c. Coal-fired Steam Electric Generation Scenario

The demand for additional sources of electricity in southwestern Colorado is increasing at a rate of 9 to 10 percent a year. At this rate of growth, one utility serving western Colorado has forecast a need for substantial amounts (about 1,000 MW) of new generating capacity by the year 1992.

The following discussion centers on hypothetical development of construction of the maximum size coal-fired steam electric generating stations given the available water and coal resources. Any proposals for generating stations would be the subjects of site-specific environmental statements and tribal approvals.

Since there is no specific proposal at this time, the scenario was sized using the following assumptions:

1. The coal, as received from the mine, would have an average heat value of 11,250 Btu/pound.

2. The average sulfur content was assumed to be .98 percent; the average ash content, 13.4 percent.

3. Coal cleaning and processing could upgrade the Btu content by 3 percent to 11,600 Btu/pound; ash and sulfur content were assumed to decrease by 20 percent. Ten percent of the run-of-mine coal could be lost during cleaning. In view of the numerous partings, it is likely that the coal would be cleaned.

(1) Southern Ute Tribe Scenario

Using the estimates of the available strippable coal a maximum plant size of four 435-megawatt units with a 35-year plant life was assumed. For the purposes of analysis, a general geographic area for the plant was identified at the southern mine tract area near Southern Ute Reservoir. A plant of this size would require about 1,000 acres of land for the plant, coal,and water storage, and appurtenant facilities.

Approximately 26,000 acre-feet of water would be required for a plant of this size. It is likely that water would be delivered to the plant from Southern Ute Reservoir. It was also assumed that the water and water recycling systems would be closed systems, with no outflow to streams. Ash from the plant would probably be disposed of in the mined-out areas.

New plants are required to meet several Federal air quality and emissions standards. At this time, the tribe has no regulations governing coal-fired generating stations. It is possible the tribe may also propose regulations governing this type of development.

Construction of each unit would take about 4 years. The total construction period is estimated at 11 years and would commence the first year of water delivery.

Permit requirements which are prerequisites to construction include an unspecified agreement with the tribe, an archaeological clearance, a certificate of public convenience and necessity,a mining permit, a determination on air quality by EPA, and approval of the Secretary of the Interior.

New transmission lines would be required if this plant was constructed. Either three 345-kV lines or two 500-kV lines would be needed to transport the power to the market area. Estimates indicate that rights-of-way would require from 50 to 65 acres for each mile of new transmission lines.

The mining operation to support a 1740-megawatt plant would follow the same procedures on a smaller scale as the off-site coal sale scenario. Approximately 5.1 million tons of coal would be required each year for the plant. Reserves present in the southern mine tract would probably be sufficient to provide coal over the life of the plant. Since reserves in the northern tract are largely in excess of those required for a powerplant, concurrent off-site coal sites could also be possible. However, for the purposes of analysis of this alternative, the powerplant and mine are considered exclusive of any such coal sale. A mining plan would have to be approved and applicable regulatory requirements met prior to the mine operation.

(2) Ute Mountain Ute Tribe Scenario

Using the same assumptions, the maximum plant size which the coal resource on the Ute Mountain Ute Reservation was estimated to be one 275-megawatt unit. The tribe has indicated that a broad area near Harrison Reservoir could be a likely area for development. This size plant and related facilities could occupy 250 to 500 acres of land. This size unit would require about 4,100 acre-feet of water. Permit requirements would be similar to those outlined for the Southern Ute scenario.

Like the Southern Ute scenario, any mining operation was assumed to use the same methods presented in the description of the off-site coal sales. An estimated 810,000 tons of coal would be required each year for this scenario. Reserves from both areas would have to be mined. A mining plan would have to be approved and applicable regulatory requirements met prior to the mine's being opened.

d. Coal Gasification Plant

A coal gasification complex was assumed to be another development option. Only the strippable coal reserves on the Southern Ute Reservation are sufficent to support a 250-million-cubic-foot-per-day

(MMCFD) Lurgi coal gasification plant, thus the development of a coal-gasification plant would only be a development option for the Southern Ute Tribe.

Plant site requirements and location for a coal gasification scenario were assumed to be similar to those for a power plant. The plant would take about 2-1/2 years to construct and mine construction would take about 2 years.

The mining operation to support a plant would be similar to the maximum mining scenario outlined above. Reserves from both mine tracts would be required to supply coal to the hypothetical plant. Total coal consumption for the gasifiers and the steam boilers is estimated at 8.8 million tons per year. Large quantities of by-products are produced by the process. These include elemental sulfur, phenols, naptha, tar oils, tar, and ammonia. The plant was assumed to be equipped with a sulfur removal facility to remove most of the sulfur. Water requirements for a plant of this size were estimated at about 7,800 to 10,000 acre-feet per year. The area which could be developed lies just south of a major gas pipeline. It is possible that product gas could be shipped via this system.

e. <u>Coal Slurry Pipeline Scenario</u>

The final hypothetical development option considered in this analysis is that of a coal slurry pipeline.

Since it is unlikely that two slurry lines would be built, a scenario that follows assumes that both Tribes' coal resources would be slurried through the same line and that a maximum sized mining operation would ensure for 35 years. It should be noted that the issue of exporting water from Colorado would have to be resolved prior to any transport by slurry to customers outside of Colorado. A maximum estimated straight line distance between the general coal area and points within Colorado of 360 miles was assumed for purposes of analysis.

A 24-inch slurry pipeline would be required to transport the coal present in both reservations. This size pipeline would require an estimated 7,400 acre-feet of water annually. Each mile of pipeline would require about 5 acres of land. After the 12 to 15 month construction period, the areas along the right-of-way would probably be rehabilitated to minimize erosion problems and visual scars.

A coal preparation plant would be constructed at each mine. This could consist of crushers and equipment to mix the coal and water. Dust suppression measures would be included in the design. At the service end of the line, large centrifuges could be used to separate the coal from the water. The water would have to be impounded and treated prior to re-use or release to the environment.

The mining operation to support the pipeline would be similar to that outlined above.

### f. Environmental Impacts of Development Scenarios

The following discussion of environmental impacts is based on hypothetical scenarios and an array of assumptions. While an attempt has been made to estimate the magnitude of potential impacts, any numerical predictions should be viewed with these assumptions in mind.

#### (1) Air Quality Impacts

There is no meteorological data available for either Tribes' potential development area. Since this data must be highly site-specific, it is not possible to estimate ambient levels of pollutants until a site is selected and data gathered for that location. Any facility would be required to meet, at the very least, applicable Federal emissions and ambient air quality standards. It is also possible that either Tribe could promulgate their own regulations for air quality.

It should also be noted that any industrial facility which might be constructed would be the subject of extensive monitoring and air quality modeling prior to approval of delivery of water by the Secretary of Interior. The possible interaction with other existing or proposed industrial facilities would also be modeled. Considerations would include predicted ambient air quality, particularly at Mesa Verde and in nearby communities.

Coal Mines

The primary sources of pollutants at the potential mines would be exhaust emissions from diesel mining equipment, fugitive dust, and emissions from a transportation system. Any equipment used would be subject to emission standards promulgated by EPA.

Process emissions of suspended particulates involve fugitive dust emitted from coal preparation plants. Suspended particulates from the coal processing plants at both mines could total about 750 tons annually and would increase the ambient particulate level. Meaningful estimates of emissions from equipment and handling of overburden are not possible to make without a definite mining plan; however, these emissions may reach 6,700 tons of particulate matter every year for the maximum sized mine.

As noted previously, ambient air quality cannot be estimated. Best available control technology would be required to control particulate emissions. It is expected that levels of pollutants would decrease rapidly with distance. The highest particulate concentrations expected would be downwind from the mines during stable atmospheric conditions.[1/] The addition of particulates into the atmosphere around the mine could reduce visibility an indeterminate amount.

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1/ Stable conditions are defined as those with wind speed of 1 m/sec for at least 8 hours.

## Steam Electric Generation Plants

Again, it is not possible to predict ambient air quality in the event a maximum sized coal-fired electric plant was developed on each reservation.

Emissions standards are in a state of flux. New proposed Federal standards were published on December 19, 1978. The current standards which were promulgated on December 23, 1971, and supplemented on December 5, 1977, are shown, along with the proposed standards in Table C-10. These standards were fixed at levels designed to protect human and animal health and to minimize damage to property. Even with this assumption, and since there is little research available, there is the possibility that there could be adverse effects to health and property from long-term low-level pollutant concentrations. This table also indicates the estimated daily emissions from the two generating complexes. A steam-fired plant would be expected to increase ambient levels of these pollutants.

Table C-10
Emissions Standards and Estimated Emissions
from Electric Generation Scenarios

| Standard | | Estimated Emissions (T/day) | |
|---|---|---|---|
| | | Southern Ute Powerplant | Ute Mountain Ute Powerplant |
| Sulfur Dioxide | | | |
| Old 1/ | 1.2#/MMBtu heat input | 260 | 40 |
| New 2/ | 1.2#MMBtu heat input | 260 | 40 |
| | or 85% removal | 30 | 5 |
| 3/ | .5#/MMBtu heat input | 110 | 20 |
| Nitrogen Oxides | | | |
| Old 1/ | .7#/MMBtu heat input | 150 | 25 |
| New 2/ | .5#/MMBtu heat input | 110 | 20 |
| Particulates | | | |
| Old 1/ | .1#/MMBtu heat input | 20 | 2 |
| New 2/ | .03#/MMBtu heat input | 10 | 1 |

1/ Emissions standards for new sources are under revision. The "old" standards are those promulgated December 23, 1971, and December 5, 1977.

2/ The "new" standards were those proposed on December 19, 1978. These are not finalized at this time.

3/ Since 85 percent removal will not be possible with low sulfur coal, this level of emissions is cited as being representative of future emissions levels.

The combustion of coal also releases those trace elements occurring in the coal. Most of the metals form stable oxides and are collected with the ash. Precipitators and scrubbers can effectively remove larger fly ash particles. The removal efficiency depends on the element as well as the control equipment design. The impact of long-term low-level exposure to these elements is unknown.

Emissions from the mining operations are estimated at about 500 T/yr of particulates from coal processing and 4,700 T/yr of fugitive dust from the actual mining of the coal.

The emissions from the plants and the mines have the potential to decrease visibility in the area.

Coal Gasification

There are presently no emissions standards for a Lurgi coal gasification plant. The following analysis is based on the Environmental Protection Agency March 1978 "Guidelines for control of Emissions from Lurgi Coal Gasification Plants." This document investigated two alternative emissions control systems. Depending on the system selected, estimated emissions of sulfur dioxide for a 250 MMCFD plant could range from 10 T/day to 25 T/day.

Emissions of hydrocarbon are estimated at 3T daily. Sulfur recovery would be well over 90 percent in both cases.

A coal gasification plant would increase ambient levels of these pollutants. It is assumed that any new facility would meet the ambient air quality standards and the criteria for prevention of significant degradation. Similar possibilities exist for adverse effects from long-term low-level pollutant concentrations. Emissions from mining operations would be like those outlined for the maximum size mine discussed above. The emission from the plants and the mines have the potential to decrease visibility in the area.

Coal Slurry Pipeline

The impacts on air quality froma coal slurry pipeline would result largely from the emissions of fugitive dust and particulate matter during construction of the pipeline and from mining and processing the coal. The predicted emissions level would be virtually identical to those outlined previously for the maximum size coal mine.

(3) Aesthetic

Any industrial development would have significant negative aesthetic impacts. Prior to reclamation, the coal stripping operation would change the existing topography into conical spoil piles. The regimented appearance would gradually be replaced with a level, rolling topography as reclamation progressed. If reclamation is not successful, the mined area would present a large barren vista to the viewer. Mining would also increase noise levels and fugitive dust levels at the site.

Visibility could be impacted from atmospheric emissions. Noise levels would increase markedly from present levels. Further negative impacts on aesthetics would result from associated population growth in the area. This could be particularly severe if unregulated development to accommodate the population influx were allowed.

g. Geographic and Land Use Impacts

(1) Coal Mine Scenario

The development of mining operations would gradually replace the natural topographic variations with a less varied, rolling, land form. Any natural drainages would be obliterated and replaced by man-made drainages where needed. Overall, the surface elevation could be 4 to 9 feet higher due to expansion during mining. Soil horizons on the mined areas would be disturbed. Most soil characteristics would be altered. Some of the lower strata could contain materials which may be toxic to plants and animals. Unprotected soils would be susceptible to erosion. Construction, mining equipment, and off-road-vehicle use would compact soils, decrease soil permeability and infiltration of water, and disturb vegetative cover.

A maximum of approximately 6,000 acres of land on the Southern Ute Reservation and 2,000 acres on the Ute Mountain Ute Reservation could be impacted if coal mines were developed on both reservations. Any transportation system such as roads or a railroad spur would disturb additional acreage.

Land use in the potential mining areas would change from dryland farming and rangeland to intensive industrial use. In the northern area on the Ute Mountain less than 1,000 acres of project irrigated land would be converted to industrial use. Reclamation practices would be designed to return the land to its original condition and use, but the Tribes would determine the final use of the reclaimed areas.

A concurrent trend in land use changes would occur as a result of anticipated population increases associated with construction and operation of two mines. Increasing amounts of land would be required for homes, municipal facilities, roads, utilities, etc.

(2) Steam Electric Generation Stations and Gasification Plant Scenarios

A plant site for a generating station or gasification plant must be relatively level. If generating stations were

were developed on both reservations, approximately 1,500 acres of land on both reservations would have their present topography, soil structure, and vegetations converted to a level, graded, and graveled surface. One thousand acres would be affected if a coal gasification plant was constructed.

Secondary land use changes induced by construction and operation employment would also occur.

Transmission lines rights-of-way would restrict the use of between 50 and 65 acres of land per mile of line constructed. Actual disturbed areas or areas occupied by structures would be a relatively small amount. Land use within the right-of-way would change since the building of structures and use in the right-of-way are restricted.

Impacts from the support mine would be like those in Section A, but would involve an estimated 4,600 acres roughly 60 percent of the potential mine areas on both reservations.

(3) Coal Slurry Pipeline Scenario

Impacts along a coal-slurry pipeline are somewhat different than those associated with a plant site. While perhaps 100 acres could be required for coal preparation and dewatering facilities at either end of the line, the majority of land impacted would lie along the length of the pipeline. An estimated maximum of 1,800 acres of right-of-way could be required. About one-third of this area would actually be excavated. Attendant impacts would include disturbed soil horizons and loss of vegetation during construction. The remaining two-thirds would be susceptible to compaction from heavy equipment. The impacts would include vegetation loss and decreased infiltration rates and soil permeability. It is expected that the right-of-way would be rehabilitated, hence the impacts would be relatively short term. Land use of the right-of-way would be restricted and thus would represent a change of use to industrial purposes.

If a spill of slurry occurred; soil porosity, water-holding capacity, and aeration would be impaired. These adverse effects should be localized.

h. Impacts on Vegetation and Wildlife

(1) Coal Mine Scenarios

Development of the coal resources of the Ute Mountain Ute and Southern Ute Tribes would cause the loss of approximately 8,000 acres of vegetation. This vegetation would be replaces after reclamation practices were implemented.

Mine reclamation practices would be in accordance with the March 13, 1979, "Surface Coal Mining and Reclamation Operations Permanent Regulatory Program," and any regulations which the Tribes may wish to promulgate. The potential for successful reclamation continues to be a controversial issue. At the best, it may take 5 to 10 years to restore vegetation on a mined area.

The increased population and levels of human activity would place additional stress on the wildlife due to increased recreation pressures.

The removal of vegetation would cause a reduction in the available wildlife habitat. This reduction would occur gradually as the mining operations proceed to extract the seams of coal. It is not possible to estimate the acreages to be disturbed on a yearly basis.

This disturbance, plus the increased human activity in the area, would cause more mobile wildlife to leave the area of the mining operation. More immobile species would probably be destroyed. As the mining operations proceed through the area and the reclamation of the land is completed, the wildlife would move back into the area and re-settle. The actual loss of wildlife as a result of the mining would probably be minor since the area is not presently heavily inhabited by wildlife.

(2) Steam-fired Plant and Coal Gasification Plant Scenarios

The primary impacts which may occur as a result of using the coal in a power or coal gasification facility would be the loss of an estimated 1,000 to 1,500 acres habitat due to the disturbance to the area as a result of increased human activity. There would be several secondary impacts such as increased human activity. There would be several secondary impacts such as increased noise levels and dust. These impacts would be of an isolated nature and would occur in the immediate plant site vicinity. It is not expected that there would be a major effect upon the overall wildlife population in the areas since the areas are not heavily utilized at the present time.

There could be some low-level impacts on vegetation and wildlife due to plant emissions. The greatest potential for adverse effects would occur during periods of plume fumigation in areas downwind from the facility. Studies of long-term intermittent effects are extremely limited. Plants are generally more sensitive to $SO_2$ than animals, and about equally susceptible to nitrogen dioxide. Native species of vegetation are usually less likely to be damaged than crops or introduced species. Exposure of animals and humans to these pollutants can cause respiratory irritation at relatively low levels. It should be noted that the Federal Air Quality Standards were designed to protect human health and prevent other deleterious effects. Since any facility would meet these standards, it is not anticipated that there would be a significant effect on human or animal health. Effects of exposure to trace element emissions are even less understood. Available literature suggests that changes in an ecosystem are not measurable. However, it is possible that long-term exposure could have adverse effects.

Impacts from mining would be similar to those outlined above.

(3) Coal Slurry Pipeline

Vegetation along the coal slurry pipeline right-of-way would be destroyed as construction progressed. Nearly 2,000 acres could be disturbed. The types of vegetation and habitat are unknown. These impacts should be temporary since the right-of-way would be rehabilitated after construction. Five to 10 years could be required to re-establish vegetation. Noise and increased human activity construction would temporarily disturb wildlife in the immediate vicinity of the right-of-way. If a spill occurred, adverse impacts could occur to vegetation and wildlife. Vegetation and small animals would be killed. If the spilled slurry entered surface water, adverse impacts to aquatic species could occur including destruction of habitat, clogging of gills, reduced growth rates and possible toxic effects. Impacts from mining would be similar to those outlined above.

i. Water Quality Impacts

(1) Coal Mining Scenario

Surface water drainage patterns would be affected by mine excavations. Even though natural drainage patterns would be preserved where possible, an increased sediment load from the mining area would be expected in any drainages near the mines, particularly during periods of heavy runoff. These increased sediment loads could amount to several hundred tons each year. If shallow aquifers are encountered and drainage occurs through mined-out areas, surface water quality would be impaired.

(2) Steam Electric Generation Stations and Coal Gasification Plant Scenarios

The impact on surface water quality if generating stations or a coal gasification plant are developed should be minimal. The impacts on the quality of the Colorado River due to depletion of 32,500 acre-feet of water annually are discussed in Section C-5.

It is probable that any facility developed would be a closed loop system; that is, there would be no return flow to streams. Cooling tower drift could cause a slight increase in salt levels in surface runoff from the site.

Emissions of sulfur dioxide and trace elements could have the potential to increase the levels of these constituents in local watersheds by 5 to 20 percent. The greatest potential for enrichment occurs for mercury and selenium. It is not possible to predict concentrations with any degree of accuracy. It should be noted that no measurable concentrating effects in soils on the watershed were found when this problem was studied at the nearby Four Corners Powerplant.

If ash or waste disposal occurred in the mined out areas, there is a potential for adverse effects on the ground water system. This problem is less important in areas of low rainfall. Although total dissolved levels may increase, it is unlikely that trace element levels in ground water would increase.

Construction of transmission lines or pipelines would also increase the potential for erosion and increased sedimentation in local streams.

The increase in population associated with construction and operation of the plant could result in increased discharges of sewage effluent into the Animas River. This would mean an increase in levels of fecal coliform and plant nutrients which could limit the suitability of the river for certain uses.

The impact on Southern Ute Reservoir of developing a large industrial facility near the reservoir is commensurate with the amount of water used. The reservoir would fluctuate in response to the plant needs. It is not anticipated that the reservoir would be used as a cooling pond. It if were, however, temperature and total dissolved levels would be expected to increase significantly. Emissions from a plant located nearby could increase the levels of salt and trace elements in the reservoir. Impacts on water quality from mining would be similar to those outlined above.

(3) Coal Slurry Pipeline

Soil disturbance during construction could increase erosion and the sediment loads in local drainages. Accidental release of the slurry could result in the addition of solid and liquid contaminants to surface waters. Such additions could cause pH changes, introduce toxic material, and cause increased turbidity. Water recovered from the slurry at the terminal end would probably be held in retention ponds and treated prior to reuse or discharge. Impacts on water quality from mining would be like those outlined above.

j. Social and Economic Impacts

(1) Introduction

Social and economic impacts from the hypothetical development of coal resources on the Ute Mountain Ute and Southern Ute Reservation could range from slight to major, depending on which scenario, or combination of scenarios is undertaken. Three of the possible combinations are summarized below. Each analysis was based on the assumption that construction of the Animas-La Plata Project was complete and project water delivered, which then translates the initial year of construction to be 1996. Therefore, the baseline includes the impacts from the Animas-La Plata Project. The second common assumption was that one-half of the jobs would be filled by workers from outside the two-county area.

Certain similar impacts would result from the undertaking of any development scenario. These might include the expansion of certain industries in the area, particularly those associated with coal. These and other impacts such as increased demands on health care, welfare services, transportation, and other community resources are difficult to assess, since these activities could occur 20 years in the future.

An analysis utilizing the Bureau of Reclamation Economics Assessment Model (BREAM) was completed. This analysis included a distribution of population, employment, and other impacts. Ten percent of the potential new jobs were assumed to be filled by Indians. Although training and preferential hiring programs may raise long-term Indian employment rates, experience has shown that short-term skilled employment is little affected. A more detailed discussion of the BREAM application is contained in the Social Assessment Appendix to the Animas-La Plata Definite Plan Report.

(2) General Cultural Impacts

Since no in-depth area-wide social studies have been completed, only generalizations can be made. The area has been experiencing relatively large in-migration, and this trend is expected to continue. By 1996 when the coal resource development related influx might occur, the area's social structure, relationships, and processes may have been heavily influenced by changes in the size and composition of the population. Beliefs and values would alter as new influences are felt. There would be attempts to preserve the area's unique lifestyle and world-view which could prove relatively successful due to the strong foundation of the current society. Community solidarity and a commitment to the preservation of basic values, while enhancing the community through selective adoption of new influences, would probably continue to be a part of the area's social orientation. Economic development would be welcomed on a selective basis.

Construction workers coming into the area for a short-time would have less of a commitment to the community; however, much of the construction work force would be locally available. Potential short-term social conflict would be minimized by previous exposure to population influx. The smaller the influx the less the influence that will be created.

On the Indian reservations the influence exerted by future coal development, while similar to the area as a whole, would be different due to the Ute's uniqueness. Policy decisions about site location, training programs, preferential hiring, construction camps, and development alternative selection, etc., could influence the nature and scope of potential impacts. Careful consideration and control has been the approach taken by both Tribes. Continuation of this trend is expected, although the revenues from coal development would be extremely useful to both Tribes in aiding their people. The faster and larger the development, the harsher the consequences for the Ute cultures. Tribal planners are already considering the long-term social consequences. The potentially urban/industrialized influence of the development would conflict with some aspects of the Ute cultures while it may provide a means of preserving and enhancing other aspects.

The major long-term impact would be that during the operational phase, workers would become a part of the community. A higher proportion of these workers would probably come from the local population (both Indian and non-Indian) than the construction workers. Even those in-migrating may be more accepted due to their non-transient status and commitment to the community.

(3) Coal Mining Scenarios

This alternative involving the operation of a maximum size coal mine on both Indian reservations, would result in an influx of about 1,100 persons the initial year of operation. Approximately 900 persons are expected to settle in La Plata County with about 1/3 living in Durango, and the remainder settling in other areas in the county. The majority of the influx of about 250 persons to San Juan County was assumed to settle in Farmington.

The influx of people is expected to peak at about 2,200 in the third year and remain at that level indefinitely as mine operations continue. In this manner, the population of La Plata County in 2020 was estimated to increase by about 2 percent. The estimated additional persons living in San Juan County represents a negligible increase of only .04 percent of their expected 2020 population. The resulting need for additional dwelling units in La Plata County could result in a small housing squeeze if existing general shortage conditions, which are now prevalent in Durango, continue. The additional dwelling units in San Juan County and Mancos should not pose any accommodation problems if the present availability of houses continues in the future.

Employment generated by the mining developments would be concentrated in the Government, trade, services, and mining industries with about one-third of the new jobs occurring in mining. Total direct employment during operation was estimated to be 445, with 400 at the potential Southern Ute Mine and 45 at the potential Ute Mountain Ute Mine. About half of these jobs would be filled by non-local workers. Approximately 20 percent of the jobs filled by local workers would be held by tribal members. A preferential hiring program may be initiated by each tribe which could alter the composition of the work force.

Total direct and indirect employment generated by the operation of the mines is estimated at about 1,300 with about half being filled by workers from San Juan County and Mancos, and half being filled not expected to be lower in the long-term as a result of operation of these mines; however, Indian unemployment could be lower.

While income estimates are made with uncertainty due to inflation, it appears that overall per capita income would increase about 2 percent. Disposable income could also increase by as much as 4 percent over levels predicted if coal mines were not developed. Although the increase is measurable, not all people would benefit from it, such as those whose occupational training could not be used. Also, the increase in local buying power would inflate the cost of living in the area. Those persons living on a fixed income would experience a relative decrease in their buying power. Furthermore, it is not possible to predict the effect of coal mining on the income of either tribe since coal agreements and payments to the Tribes have not been negotiated.

An estimated 4 percent increase in the number of students would be expected in the school system in La Plata County in 2020 due to mining operations. Although sketchy, present plans for expansion indicate this should pose no problem as several new elementary schools and a new junior high school would probably be added in the long run to the existing facilities in the county. Based on current plans for expansion, the addition of about 330 students to the San Juan County school system should not create a substantial impact on these areas.

(4) Coal-Fired Steam Electric Generation Scenario

The maximum impact long-term socio-economic conditions would occur upon construction of a coal-fired steam electric generation plant on the Southern Ute Reservation, with a similar coal and generation development on the Ute Mountain Ute Reservation as discussed previously. For example, the influx into the area was estimated to peak in the fourth year of construction of an 11-year construction period, at about 7,000. The population influx into La Plata County is again expected to reside primarily in Durango and the remainder in the rest of the county. Approximately 1,400 persons would live in Farmington. The long-term results of such an influx would be a 5.8 percent increase in the 2020 population. In the Farmington-La Plata area the population in 2020 would increase 1 percent. The difference in Mancos would make the 2020 population 23 percent above the estimated population without the influx.

This potential influx would have a significant effect upon housing in La Plata County and Mancos, with increases of 5.1 percent and 15 percent respectively in demand for housing. This could definitely cause a squeeze in the housing market resulting in an increase in housing costs. It is likely that, even though much of the people desiring living quarters would be in the area on a permanent basis, much of this demand would be met by mobile homes, apartments, and other multi-family units, due to a lack of other types of housing. Because of the large inventory of housing expected in San Juan County in 2020, there should be no shortage of housing caused by potential Indian coal developments.

Employment needs for projects of this size could be large. In the peak year of construction, direct employment would total 1,100 workers, and the total direct and indirect jobs generated by 2020 could reach 3,500. Operation of four plants on the Southern Ute Reservation would require an estimated 725 workers. Again, about 45 persons would be needed for operations on the Ute Mountain Ute Reservation. The unemployment rate would be slightly decreased if this scenario occurred.

Per capita income would increase an estimated 3.5 percent with these potential coal developments. Personal income would increase 9.5 percent. Most of this money would be spent in the immediate area.

La Plata County schools could expect an enrollment of almost 1,000 students more with coal development than without it. This could conceivably place a strain on these schools. it is likely, however, that with future expansion plans in mind, the major impact would be to increase the pupil-teacher ratio and prompt the hiring of new teachers rather than result in the addition of new classrooms or buildings.

(5) Southern Ute Coal Gasification and Ute Mountain Ute Coal Mine

The slightly more involved scenario of the operation of a coal gasification plant on the Southern Ute Reservation would result in a greater rate of increase in the population oi the area over the short-term from increased employment opportunities. In the first year of construction activity about 2,300 persons are expected to enter the area with an estimated 90 percent living in La Plata County. Most of the persons moving into La Plata County are expected to settle in Durango, with the remainder dispersed throughout the rest of the county. After the second year of construction there would be a marked decrease in employment as operation levels are achieved.

With the operation of the coal gasification plant beginning in 1999, the population increase in San Juan County communities and Mancos were estimated to level at about 1,000. La Plata County would stabilize at about 3,000 persons by that year. These levels would again remain indefinately due to the operation of the plant and mines. In this manner, the Farmington-La Plata area should reach a population 0.6 percent above the population predicted without these developments. The population in La Plata County would increase by 3 percent.

The resulting increased demand for 3 percent more dwelling units in La Plata County, could present a more serious problem than in the first alternative. The demand for this many more units, especially in the smaller towns, could result in a short housing supply and a resulting increase in housing costs. No pressing shortages of housing would be expected for San Juan County.

Major employment gains from this alternative would occur in the areas of mining, transportation, communications, and public utilities with an estimated 2,400 direct and indirect jobs being created by the year 2020. About 650 persons would be employed in operations of the facilities.

Per capita income would increase by 2.5 percent over the level predicted without these coal developments in 2020. Disposable income with these developments would be 6 percent greater than without them. These figures, are again subject to inflationary influence and a cost of living increase is almost inevitable in the long term.

The school system in La Plata County would have about 500 more students with these operations than without them and again, should undergo no undue stress, as the distribution between elementary, junior high school, and senior high school students closely approximated that of the expected distribution without these projects. The addition of about 500 students to the school system of other areas would have no adverse effects either.

## 14. Cumulative Impacts

### a. Introduction

The Bureau of Reclamation has proposed preparation of a comprehensive environmental statement covering Reclamation activities along the entire Colorado River. In order for this undertaking to proceed, Congressional funding will be required. If funded, the statement will assess the environmental impacts resulting from operation and maintenance activities on existing projects and propose further actions on existing projects. In addition, it will assess the significant cumulative impacts expected in about the next 25 years whether they come from operation of existing projects, projects under construction, projects proposed for construction, or projects under study in the Colorado River area. The comprehensive statement also will be responsible to issues raised by several environmental groups, including the Environmental Defense Fund, Colorado Open Space Council, Trout Unlimited, the Island Foundation, the Sierra Club, and the Wilderness Society.

The statement will require some time to prepare if it is indeed to be comprehensive in scope and depth. In order to give as much information as is now available, however, the following discussions are prepared as an appraisal of the cumulative effects in the Upper Colorado River Basin of 19 units and participating projects of the Colorado River Storage Projects (hereinafter designated CRSP) which are constructed or under construction and seven developments which are scheduled for construction starts after 1976 pending compliance with the National Environmental Policy Act. The latter seven include five of the CRSP and two of the Colorado River Basin Salinity Control Project. Except for salinity, the analysis does not extend beyond these seven developments since firm data for other future projects are not available.

The base for the discussions, termed the 1976 modified base, is a hypothetical condition which includes actual conditions in 1976 with modifications for effects of developments which are under construction. The base includes many Federal and private developments, but the effects of CRSP are analyzed separately. In turn, the cumulative effects of the seven developments scheduled for construction since 1976 are analyzed as an increment to the 1976 modified base condition. The comparisons of project conditions with the assumed base conditions are admittedly imprecise. They are based on the best data curently available, however, and give some perspective to impacts of Reclamation developments in the Upper Colorado River Basin.

The individual developments included in the appraisals are listed in Table C-11 and shown on the map in Figure C-2. The dates of authorization and actual or anticipated dates of completion are listed with the projects. Although some of the developments are not scheduled for completion for several years, they are considered as in place since their construction has been started and in some cases is well along.

Two of the developments listed, the Bonneville Unit of the Central Utah Project and the San Juan-Chama Project, would involve diversions of water out of the Colorado River Basin. Essentially all of the water of the San Juan-Chama Project would be delivered to the Rio Grande River Basin in New Mexico. Water of the Bonneville Unit would be used both in the Uinta Basin of Utah, which is part of the Colorado River Basin, and in the Bonneville Basin of Utah, which is a part of the Great Basin.

The Fruitland Mesa Project in Colorado and the Savery-Pot Hook Project in Colorado and Wyoming, both participating projects of the CRSP had been scheduled for early construction starts. They were not funded in the Public Works Appropriation Bill of August 7, 1977, however, and the President's Water Review of 1977 resulted in the administration's proposal they be deauthorized; therefore, they are not included in the appraisal of future developments.

The discussions of cumulative impacts are used on numerous reports of the Bureau of Reclamation and Federal, State, and local agencies. The references are so numerous that they could not all be identified in this section, but they are included in the Bibliography in Section I.

b. Socio-Economic Conditions

(1) Crop Production

(a) CRSP Developments Constructed or Under Construction

The contribution to crop production of CRSP developments constructed or under construction is large, amounting to a value

Table C-11
Developments included in cumulative impact analysis

| | Actual or estimated completion date |
|---|---|
| **CRSP developments constructed or under construction** | |
| Storages Units--Act of April 11, 1956 | |
| Curecanti, Colo. | |
| Blue Mesa Dam, Reservoir, and Powerplant | 1966 |
| Morrow Point Dam, Reservoir, and Powerplant | 1970 |
| Crystal Dam, Reservoir, and Powerplant | 1977 |
| Flaming Gorge, Wyo. | 1963 |
| Glen Canyon, Utah and Ariz. | 1965 |
| Navajo, N. Mex. | 1963 |
| Participating projects | |
| Act of April 11, 1956 | |
| Florida, Colo. | 1963 |
| Paonia, Colo. | 1962 |
| Silt, Colo. | 1966 |
| Smith Fork, Colo. | 1963 |
| Hammond, N. Mex. | 1975 |
| Central Utah, Utah | |
| Bonneville Unit, Collection System | 1988 |
| Jensen Unit | 1986 |
| Vernal Unit | 1961 |
| Emery County, Utah | 1965 |
| Lyman, Wyo. | 1980 |
| Seedskadee, Wyo. (Fontenelle Dam and Powerplant) | 1964 |
| Act of June 13, 1962 | |
| Navajo Indian, N. Mex. | 1987 |
| San Juan-Chama, Colo. and N. Mex. | 1983 |
| Act of September 2, 1964 | |
| Bostwick Park, Colo. | 1971 |
| Act of September 30, 1968 | |
| Dallas Creek, Colo. | 1981 |
| **Developments scheduled for construction since 1976** | |
| Act of April 11, 1956 | |
| Upalco Unit, Central Utah Project, Utah (CRSP) | 1985 |
| Bonneville Unit, Central Utah Project, Utah (CRSP) M&I System | 1991 |
| Act of September 30, 1968 | |
| Dolores, Colo. (CRSP) | 1988 |
| Uintah Unit, Central Utah Project, Utah (CRSP) | 1986 |
| Animas-La Plata Project, Colo. and N. Mex. (CRSP) | 1990 |
| Act of June 24, 1974 | |
| Grand Valley Unit, Colo. (Colorado River Basin Salinity Control Project) | 1987 |
| Paradox Valley Unit, Colo. (Colorado River Basin Salinity Control Project) | 1984 |

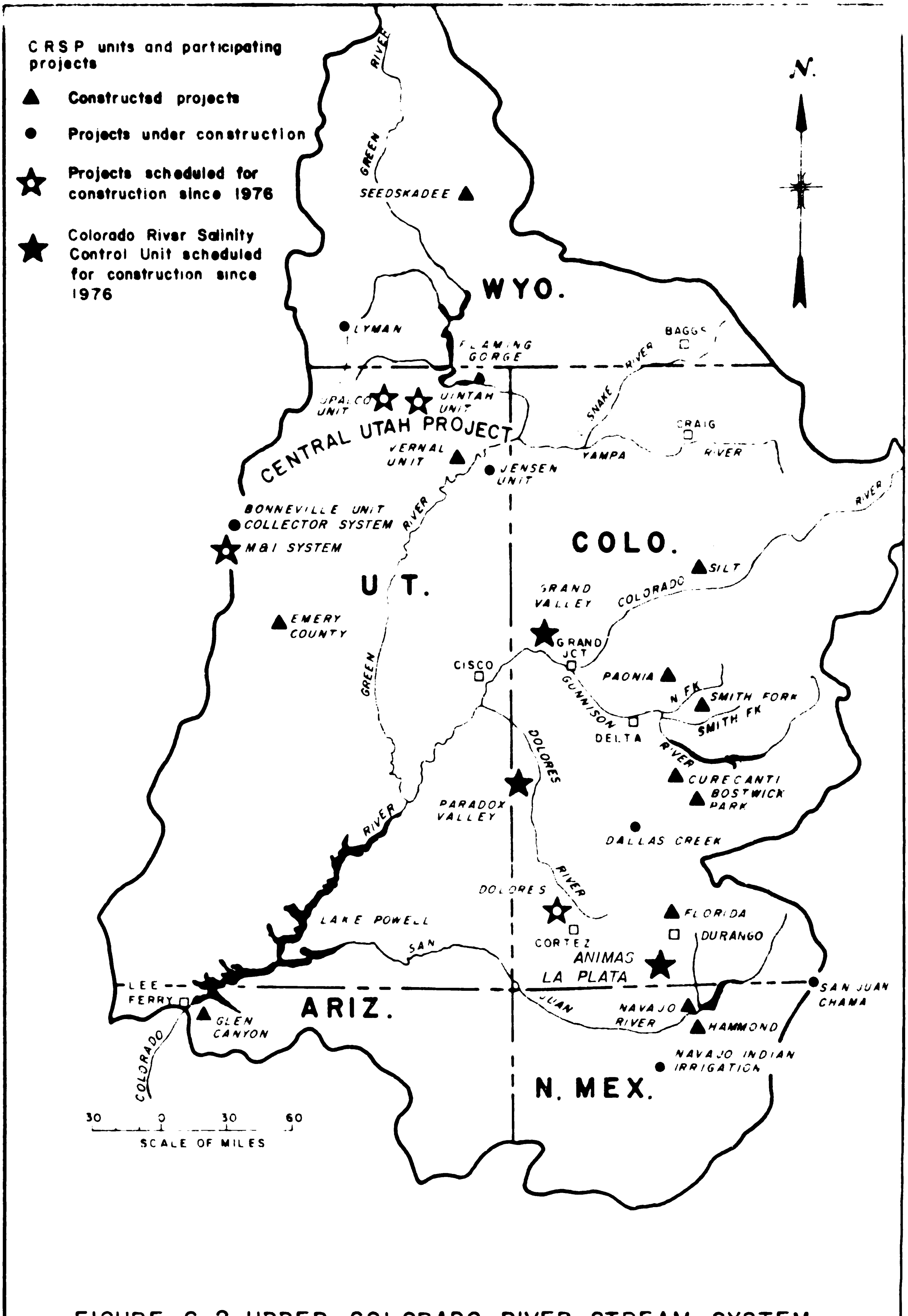


FIGURE C-2 UPPER COLORADO RIVER STREAM SYSTEM of about $26 million annually, or about 25 percent of the total crop production in the basin with assumed ultimate development of the CRSP projects considered (1976 modified base). Additional crop production from water exported from the Colorado River Basin under the San Juan-Chama Project would have a value of more than $3 million annually. A project-by-project comparison of crop production is shown in Table C-12 along with data used for comparisons. The value of water for irrigated pasture and the value of livestock and livestock products have not been included in either the base or the CRSP project evaluations because comparable data are not available. As a general rule in the upper basin, however, it can be stated that the value of crop production is only about a third of the gross agricultural production and the value of livestock and livestock products accounts for the remaining two-thirds. Thus the total value of agricultural production in the upper basin from CRSP developments constructed or under construction is roughly estimated at about $78 million annually, with an additional value of about $11 million outside of the basin.

(b) Developments Scheduled for Construction Since 1976

The seven developments scheduled for construction since 1976 would contribute almost $38 million in additional agricultural crop production of which all but about $3,100,000 associated with the M&I system of the Bonneville Unit would be in the basin. A comparison of crop production that would result from the seven projects is shown in Table C-13. With crop production representing only about a third of the total agricultural production, the value of gross agricultural production from the seven projects is estimated at more than $134 million.

(2) Power

(a) CRSP Developments Constructed or Under Construction

The capability for power production from CRSP projects constructed or under construction is estimated at almost 6 million megawatt-hours. This is equivalent to nearly 9 percent of the 1975 power consumption in the CRSP power marketing area which includes the entire States of Arizona, Colorado, New Mexico, Wyoming, and Utah, as well as three southwestern counties of Nevada and a small portion of California. The comparison of project capability and consumption in the market area is shown in Table C-14. On the basis of an average annual use of 2,600 kilowatt-hours per capita, the CRSP power generation from projects constructed or under construction would be sufficient to meet residential needs of more than 2.2 million people or, from another perspective, could supply the entire estimated residential needs in the State of Arizona.

(b) Developments Scheduled for Construction Since 1976

Of the seven developments scheduled for construction since 1976, only the Bonneville Unit M&I System would have the capability for power production. The capacity of the system would be 10.4 megawatts

## Table C-12

Summary of annual gross crop values from
CRSP projects constructed or under construction

| | Irrigable acreage (acres) | | | |
|---|---|---|---|---|
| | Full service land | Supplemental service land | Irrigation supply (acre-feet) | Gross value of crop production[1/] |
| Production in basin shown in 1969 Agricultural Census indexed to 1975 | | | | $84,957,000 |
| Crop production based on 1975 Bureau of Reclamation crop reports | | | | |
| Curecanti Unit | | | No irrigation | |
| Flaming Gorge Unit | | | No irrigation | |
| Glen Canyon Unit | | | No irrigation | |
| Navajo Unit | | | No irrigation | |
| Florida Project | 5,730 | 13,720 | 26,000 | 1,057,000 |
| Paonia Project | 2,230 | 13,070 | 20,000 | 1,352,000 |
| Silt Project | 2,120 | 4,480 | 13,000 | 548,000 |
| Smith Fork Project | 1,420 | 8,060 | 10,000 | 251,000 |
| Hammond Project | 3,900 | | 19,000 | 733,000 |
| Bonneville Unit Collection System | | | No irrigation | |
| Jensen Unit | 440 | 3,640 | 5,000 | 167,000 |
| Vernal Unit | | 14,781 | 18,000 | 602,000 |
| Emery County Project | 770 | 17,210 | 22,000 | 473,000 |
| Lyman Project | | 46,670 | 49,000 | 486,000 |
| Navajo Indian Irrigation Project[2/] | 100,000 | | 330,000 | 19,256,000 |
| Bostwick Park Project | 1,320 | 4,290 | 11,000 | 305,000 |
| Dallas Creek Project[2/] | | 20,850 | 11,200 | 622,000 |
| Seedskadee Project | | | No irrigation | |
| Subtotal | 117,930 | 146,771 | 534,200 | 25,852,000 |
| Crop production in both 1969 and 1975 reports | | | | -5,016,000 |
| Total crop production in basin (1976 modified base) | | | | 106,595,000 |
| Percent of crop production from CRSP developments | | | | 25 |
| Crop production out of basin | | | | |
| San Juan-Chama Project | | | | |
| Rio Grande Basin[2/] | | 84,380 | 61,300 | 3,577,000 |
| Subtotal outside of basin | | 84,380 | 61,300 | 3,577,000 |
| Total in and outside of basin | 117,930 | 231,151 | 595,500 | 30,231,000 |

1/ Exclusive of irrigated pasture and livestock projection.
2/ Based on 1975 per acre values for nearby existing projects.

Table C-13
Summary of annual gross crop values from developments scheduled for construction since 1976

| Time frame | Irrigable area (acres) Full Service land | Supple-mental service land | Irrigation supply (acre-feet) | Gross value of crop production 1/ |
|---|---|---|---|---|
| 1976 modified base | | | | $106,595,000 |
| Projects scheduled for construction since 1976 | | | | |
| Dolores Project | 35,360 | 26,300 | 90,900 | 13,200,000 |
| Grand Valley Unit | | | | Negligible |
| Paradox Valley Unit | | | | No irrigation |
| Uintah Unit | 7,818 | 59,312 | 46,800 | 10,547,000 |
| Upalco Unit | 0 | 42,610 | 17,900 | 7,056,000 |
| Animas-La Plata Project | 61,470 | 8,630 | 118,100 | 13,732,000 |
| Subtotal | | | | 44,533,000 |
| Total | | | | 151,130,000 |
| Percent of 1976 modified base | | | | 42 |
| Crop production out of basin | | | | 0 |
| Bonneville Unit M&I System | 0 | 22,740 | 14,100 | 3,128,000 |

1/ Exclusive of irrigated pastures and livestock production.

Table C-14

Power capability of CRSP projects constructed or under construction compared with 1975 consumption in market area

| | Capacity (MW) | Generation[1/] (MWh) |
|---|---|---|
| Project capability | | |
| Curecanti Unit | | |
| Blue Mesa | 60 | 268,984 |
| Morrow Point | 120 | 365,664 |
| Crystal | 28 | 173,000 |
| Flaming Gorge | 108 | 604,903 |
| Glen Canyon Unit | 950 | 4,233,668 |
| Seedskadee Project | 10 | 63,912 |
| Navajo Indian Irrigation project | 23 | 118,000 |
| Total | 1,299 | 5,828,131 |

| State | 1975 consumption[2/] (MWh) |
|---|---|
| Power market area | |
| Arizona | 20,468,000 |
| California | N/A |
| Colorado | 15,792,000 |
| Nevada | 7,672,000 |
| New Mexico | 6,748,000 |
| Utah | 7,644,000 |
| Wyoming | 4,452,000 |
| Total | 62,776,000 |

1/ Based on 19th Annual Report, Colorado River Storage Project and Participating Projects for Fiscal Year 1975 for projects completed.

2/ Based on the 1975 Energy Production System in the States of the Rocky Mountain Region by Charles D. Kolstad, Los Alamos Scientific Laboratory of the University of California.

with an average annual generation of about 40,000 megawatt-hours. However, as shown in Table C-15, the seven developments would result in a net cumulative average annual generation loss of about 230,000 megawatt-hours. This amount of power would meet the residential needs of a city of about 89,000 people.

Table C-15
Power capability (1,000 MWh) of CRSP projects scheduled for construction since 1976

| Project | Generation | Consumption | Retired | Net gain or loss |
|---|---|---|---|---|
| Dolores Project | | 16.8 | | - 16.8 |
| Grand Valley Unit | | | | |
| Paradox Valley Unit | | 15.3 | | - 15.3 |
| Uintah Unit | | | 7.5 | - 7.5 |
| Upalco Unit | | | 6.5 | - 6.5 |
| Bonneville Unit | | | | |
| M&I System | | | 59.0 | - 19.0 |
| Animas-La Plata Project | 40.0 | 164.8 | | -164.8 |
| Total | 40.0 | 196.9 | 73.0 | -229.9 |

(3) Municipal and Industrial Water

(a) CRSP Developments Constructed or Under Construction

The municipal and industrial water supply for CRSP developments constructed or under construction amounts to a total of 442,500 acre-feet annually, including about 117,500 acre-feet for municipal uses and 325,000 acre-feet for industrial use. Based on an estimated annual per capita use of 0.25 acre-foot, the water for municipal use could supply the domestic water for a population of about 470,000 or a city about the size of Salt Lake City, Utah. The largest single use of industrial water is for steam-electric power generation. The supply available from individual projects is shown in Table C-16.

(b) Developments Scheduled for Construction Since 1976

Of the seven developments scheduled for construction since 1976, the Upalco and Uintah Units of the Central Utah Project and the Bonneville Unit's M&I System, and the Dolores and Animas-La Plata Projects would provide water for municipal and industrial use. They would develop 181,800 acre-feet for residential use in local communities. The available supply from individual projects is shown in Table C-17.

(4) Recreation

(a) CRSP Developments Contructed or Under Construction

It is estimated CRSP developments constructed or under construction will provide more than 5 million man-days of

Table C-16
Municipal and industrial water supply--
CRSP developments constructed or under construction
(Unit--acre-feet)

| | |
|---|---|
| For use within Upper Colorado River Basin | |
| Glen Canyon Unit | 142,000 |
| Navajo Unit | 64,000 |
| Central Utah Project | |
| Jensen Unit | 18,000 |
| Vernal Unit | 2,000 |
| Emery County Project | 6,000 |
| Lyman Project | 1,500 |
| Seedskadee Project | 120,000 |
| Dallas Creek Project | 28,000 |
| Subtotal | 381,500 |
| For use outside Upper Colorado River Basin | |
| San Juan-Chama Project | 61,000 |
| Subtotal | 61,000 |
| Total | 442,500 |

Table C-17
Municipal and industrial water supply--
developments scheduled for construction since 1976
(Unit--acre-feet)

| | |
|---|---|
| For use within Upper Colorado River Basin | |
| Dolores Project | 8,700 |
| Central Utah Project | |
| Uintah Unit | 1,000 |
| Upalco Unit | 2,000 |
| Animas-La Plata Project | 80,100 |
| Subtotal | 91,800 |
| For use outside Upper Colorado River Basin | |
| Central Utah Project | |
| Bonneville Unit M&I System | 90,000 |
| Total | 181,000 |

recreation use annually within the Upper Colorado River Basin, as shown in Table C-18. This constitutes an estimated 12 percent of the overall recreation use within the basin, assuming all CRSP developments are in place (1976 modified base). The greatest contribution from CRSP comes in the area of water-related recreation which is limited in the largely semiarid to arid Upper Colorado River Basin. This is borne out in Table C-18 which shows 29 percent of the fishing, 25 percent of the boating, and 14 percent of the camping in the basin is at CRSP developments. From an economic standpoint, these contributions are significant since recreation and tourism are major industries in the basin. In addition to recreation development in the basin, CRSP developments provide another 45,600 man-days of recreation use outside the basin.

One of the tradeoffs for the new recreational opportunities has been the elimination of white-water boating opportunities in the canyon sections of Lake Powell (Glen Canyon) and Flaming Gorge Reservoir. Some reservoirs, particularly Lake Powell, have adversely altered the natural spendor of the landscape by inundation, but, on the other hand, these areas now receive increased recreation use because of the improved access and facilities. For instance, it has been estimated that Rainbow Bridge at Lake Powell had been seen by no more than 20,000 people prior to CRSP.1/ The National Park Service now estimates that, with Lake Powell, as many as 80,000 people visit the bridge each year.

(b) Developments Scheduled for Construction Since 1976

Of the seven projects scheduled for construction since 1976, five projects would increase the recreation use base. As shown in Table C-19, the Upalco and Uintah Units, Bonneville Unit's M&I System, the Dolores and Animas-La Plata Projects would result in an additional 1,755,420 days annually of which just over one-third would be associated with the M&I System and would, therefore, occur outside the basin. The greatest increases would come in camping, sightseeing, and boating. The elimination of 14.2 miles of trout fishery streams in Utah for the creation of 5,431 acres of reservoir fishery and associated recreational uses would be a significant recreational tradeoff associated with the Bonneville Unit M&I System, and Upalco and Uintah Units. The most significant recreational tradeoff associated with the Dolores Project would be the loss of some white-water boating opportunities for the establishment of a perennial stream for fishing, other recreational uses, and improvement of aesthetic values. The Animas-La Plata Project would cause the loss of some river rafting and kayaking while providing reservoir boating and fishing and related recreation.

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1/ Sypulski, John S., The Colorado River, Reprint from New York State Ranger School Alumni News.

(5) Employment Opportunities

(a) CRSP Development Constructed or Under Construction

CRSP developments constructed or under construction account for about 3,100 permanent jobs annually, including about 2,600 jobs in agriculture and 400 associated with operation and maintenance of CRSP developments, as shown in Table C-20. Of the 3,100 jobs, about 2,800 are associated with employment in the basin and 300 outside of the basin. Total employment in the basin in the 1976 modified base, including CRSP developments constructed or under construction, is about 168,800, with the CRSP developments accounting for about 2 percent of the total. The impact of CRSP on agricultural employment is more significant, however, amounting to about 14 percent of the total in the 1976 modified base. Additional employment opportunities are created outside of the basin by the San Juan-Chama Project.

(b) Developments Scheduled for Construction Since 1976

Developments scheduled for construction since 1976 would result in an increase of as many as 1,405 permanent jobs, including about 1,029 jobs in agriculture and about 108 jobs associated with project operation and maintenance. Temporary employment would amount to a total of more than 31,000 additional jobs over the various construction periods for the seven projects. Estimated employment opportunities from the seven projects are listed in Table C-21.

c. Aquatic Wildlife

(1) Habitat Changes

(a) CRSP Developments Constructed or Under Construction

As shown in Table C-21a, CRSP has resulted in a slight increase (an estimated 1 percent) in the miles of cold water fishery (primarily supporting trout) in the Upper Colorado River Basin and a significant decrease (an estimated 34 percent) in the miles of warm water fishery (primarily supporting catfish and nongame species). In total, these changes constitute an estimated 6 percent reduction in the miles of sport stream fishery in the Upper Colorado River Basin. Additional impacts not shown in Table C-21a include the degradation of 183 miles of existing cold water fishery, the improvement of 285 miles of existing cold water fishery, and the improvement of 190 miles of existing warm water fishery.

A project-by-project description of the streams impacted and the reservoirs created is presented in Table C-22. The table points to some of the more significant trade offs which have resulted. For instance, in place of the estimated 532 miles of stream fishery inundated, CRSP impoundments create approximately 257,480 surface areas of flat water fisheries. Moreover, some of the better trout stream fishing in the Upper Basin States has been created

| | png 2/ | Other 3/ | Total |
|---|---|---|---|
| Upper Color | | | |
| Recreati | | | |
| CRSP ( | ,640 | 9,311,940 | 38,905,370 |
| CRSP rec | | | |
| Curec | 110 | 5,070 | 739,610 |
| Flami | ,900 | 119,300 | 658,800 |
| Glen | 530 | 91,980 | 1,371,350 |
| Navaj | ,910 | 87,660 | 350,890 |
| Flori | | 3,000 | 77,600 |
| Paoni | 10 | 650 | 16,760 |
| Silt | 150 | 4,070 | 76,020 |
| Smitl | | 1,520 | 99,100 |
| Hammc | | | |
| Centı | | | |
| B( | | | |
| | ,150 | 24,400 | 856,800 |
| J( | ,200 | 3,200 | 49,500 |
| V( | 50 | 7,910 | 60,860 |
| Emer | ,900 | 16,400 | 175,400 |
| Lymaı | ,830 | 5,500 | 83,670 |
| Seed | 600 | 1,650 | 87,250 |
| Bost | 100 | 200 | 34,700 |
| Dall | imate | No estimate | 353,340 |
| | ,440 | 372,510 | 5,091,650 |
| Recreat with fied | ı,080 | 9,684,450 | 43,997,020 |
| Percent to CR | 2 | 4 | 12 |
| CRSP use o | | | |
| San Jua | imate | 4,050 | 45,630 |
| | imate | 4,050 | 45,630 |
| Total CRS outside | ,440 | 376,560 | 5,137,280 |

1/

2/

3/

4/ ve basin States involved,

updated t

| | Projing 2/ | Other | Total |
|---|---|---|---|
| Recreation use CRSP (1976 m | 33,080 | 9,684,450 | 43,997,020 |
| Recreation use projects sch constructino | | | |
| Dolores | stimate | 57,940 | 442,100 |
| Grand Valle | | | |
| Paradox Val | | | |
| Uintah Unit 4/ | | 18,290 | 210,300 |
| Upalco Unit 4/ | | 7,700 | 140,170 |
| Animas-La P | | 88,100 | 422,900 |
| Subtot | | 172,030 | 1,214,350 |
| Recreation use basin for pr uled for con since 1976 | | | |
| Bonneville | | 75,220 | 655,356 |
| Total recreati and outside | 33,080 | 9,931,700 | 45,866,726 |
| Percent Increa | 0 | 2.6 | 4.2 |

1/ Inclu

2/ Does

3/ Inclu

4/ Alth alco Units, respectively, they are not included i

Table C-20
Average annual employment opportunities
CRSP developments constructed or under construction

| | Agriculture | | | CRSP operation and main-tenance | Other | Total |
|---|---|---|---|---|---|---|
| | Direct | Indirect | Total | | | |
| Upper Colorado River Basin without CRSP1/ | 12,000 | 3,000 | 15,000 | | 151,000 | 166,000 |
| Upper Colorado River Basin | | | | | | |
| Storage units and Seedskadee Project1/ | | | | 230 | | 230 |
| Florida Project | 120 | 30 | 150 | 6 | | 156 |
| Paonia Project | 300 | 70 | 370 | 6 | | 376 |
| Silt Project | 70 | 20 | 90 | 6 | | 96 |
| Smith Fork Project | 70 | 20 | 90 | 2 | | 92 |
| Hammond Project | 50 | 10 | 60 | 5 | | 65 |
| Bonneville Unit Collection System | 80 | 20 | 100 | 10 | | 110 |
| Jensen Unit | 20 | 10 | 30 | 5 | | 35 |
| Vernal Unit | 140 | 30 | 170 | 7 | | 177 |
| Emery County Project | 150 | 40 | 190 | 3 | | 193 |
| Lyman Project | 140 | 30 | 170 | 3 | | 173 |
| Navajo Indian Irrigation Project | 750 | 180 | 930 | 102 | | 1,032 |
| Bostwick Park Project | 30 | 10 | 40 | 2 | | 42 |
| Dallas Creek Project | 30 | 10 | 40 | 2 | | 42 |
| Subtotal (rounded) | 1,900 | 500 | 2,400 | 400 | | 2,800 |
| Outside of Upper Colorado River Basin | | | | | | |
| San Juan-Chama Project | 170 | 40 | 210 | 37 | | 247 |
| Subtotal | 170 | 40 | 210 | 37 | | 247 |
| Total (rounded) | 2,100 | 500 | 2,600 | 400 | | 3,100 |
| Total basin employment including CRSP 1976 modified base | 13,900 | 3,500 | 17,400 | 400 | 151,000 | 168,800 |
| Percent of basin employment resulting from CRSP developments | 14 | 14 | 14 | 100 | 0 | 2 |

1/ For interrelated power operations.

Table C-21
Employment opportunities--
developments scheduled for construction since 1976

| | Average annual permanent employment opportunities (number of jobs)1/ | | | | | Total temporary employment opportunities over project construction periods (man-years) |
|---|---|---|---|---|---|---|
| | Agriculture1/ | | | Operation and maintenance | | |
| | Direct | Indirect | Total | | Total | |
| 1976 modified base2/ | 13,900 | 3,500 | 17,400 | 400 | 17,800 | |
| Employment increases | | | | | | |
| Dolores Project | 270 | 70 | 340 | 30 | 370 | 6,270 |
| Grand Valley Unit | | | | 10 | 10 | 4,840 |
| Paradox Valley Unit | | | | 4 | 4 | 700 |
| Uintah Unit | 106 | 64 | 170 | 17 | 187 | 2,920 |
| Upalco Unit | 50 | 35 | 85 | 10 | 95 | 1,240 |
| Bonneville Unit M&I System | 30 | 24 | 54 | 16 | 70 | 8,400 |
| Animas-La Plata Project | 300 | 80 | 380 | 21 | 401 | 6,640 |
| Total | 756 | 273 | 1,029 | 108 | 1,137 | 31,010 |
| Percent of 1976 modifed base | 5 | 9 | 6 | 28 | 4 | |

1/ Project figures represent equivalent man-years of labor resulting from expected production increase.

2/ Based on U.S. Water Resources Council, 1975 Water Assessment Specific Problem Analysis, Upper Colorado Region, Technical Memorandum No. 2, August 1976.

Table C-21a
Changes in stream fisheries
in Upper Colorado River Basin
from projects constructed or under construction

| | Stream miles | | | | |
|---|---|---|---|---|---|
| Type of fishery | Without CRSP1/ | Inundated | Changed from warm to cold water2/ | 1976 modified base | Changes (percent) |
| Cold water | 7,715 | 126 | +212 | 7,801 | +1 |
| Warm water | 1,811 | 405 | -212 | 1,194 | -34 |

1/ Based on Upper Colorado Region Comprehensive Framework Study, Apprendix XIII, Fish and Wildlife, June 1971.

2/ Changed as a result of storage regulation.

| Project (res | change [ery improved] | Use (fisher-man days) | Flat water fishery created: Acres and type of fishery2/ | Flat water fishery created: Estimated use in 19[illegible] (fisher-man days) |
|---|---|---|---|---|
| Upper Colorado River | | | | |
| Curecanti | | | | |
| (Blue Mesa) | uality, | No estimate | | |
| (Morrow Point) | ures, | available | 9,130 CW | 82,700 |
| (Crystal) | dity | | | |
| Flaming Gorge | | | | |
| (Flaming Gorge) | | 16,900 | 42,000 CW | 126,8[illegible] |
| Glen Canyon | | | | |
| (Glen Canyon) | | 3,800 | 163,000 CW and WW | 207,000 |
| | | Not available | | |
| | | Not available | | |
| Navajo | | | | |
| (Navajo) | as im- | 40,000 | 15,600 CW and WW | 48,500 |
| | | Not available | | |
| Florida (Lemon) | | 5,000 | 600 CW | 20,000 |
| Paonia (Paonia) | | None | 300 CW | 2,600 |
| Silt (Rifle Gap) | | None | 350 CW | 28,700 |
| Smith Fork (Crawfo | | None | 400 CW and WW | 36,700 |
| Hammond (no reserv | | | | |
| Central Utah | | | | |
| Bonneville Unit | | 2,[illegible] | 13,500 CW | 5/ 539,800 |
| Collection S | | | | |
| Jensen Unit (Re | | | | |
| Vernal Unit (St | | None | 900 CW | 7,400 |
| Emery County (Joes | | None | 1,200 CW | 40,000 |
| (Huntington) | | None | 200 CW | 8,200 |
| Lyman (Meeks Cabin | access, | 1,000 | 500 CW | 30,000 |
| (Stateline) | rove- | 1,000 | 300 CW | 17,000 |
| | s | | | |
| Seedskadee (Fonten | tempera- | 33,[illegible] | 8,750 CW and WW | 22,000 |
| | bidity | | | |
| Bostwick Park (Sil | flows | 4,300 | 300 CW | 3,600 |
| | ater | | | |
| Dallas Creek (Ridg | | 6,000 | No fishery planned6/ | |
| Total within bas | | | | |
| No fishery | | | | |
| Warm water f | | | | |
| Cold water f | | | | |
| Total | | 113,000 | 257,480 | 1,2[illegible],500 |
| Outside of basin | | | | |
| San Juan-Chama | flows | 1,000 | 5,[illegible] C[illegible] | 7,300 |
| Total outside | | 1,000 | 5,[illegible] | [illegible],300 |
| Total changes outside of | | 114,[illegible] | 263,280 | [illegible],[illegible] |

1/ Table shows t[…] Upper Colorado River Basin since the base data necessary to make an impact analys[…]

2/ Quality facto[…]

3/ Quality of th[…]

4/ Consists of t[…]water, and stabilization of Midview Reservoir.

5/ Combination o[…]

6/ A reservoir w[…]. If public pressure forced stocking, however, an estimated 24,400 man-days of fi[…]

downstream of a number of the CRSP reservoirs. Fifteen miles of the Colorado River below Glen Canyon, 73 miles of the Green River below Fontenelle, 26 miles of the Green River below Flaming Gorge, and 18 miles of the San Juan River below Navajo are rated as good to excellent trout stream fisheries whereas before CRSP they were rated primarily as poor to fair warm water fisheries. In contrast to the creation of the cold water stream fishery areas, important adverse impacts pertaining to the cold water stream fishery of the Upper Colorado River Basin are the inundation of 40 miles of Gunnison River by the Curecanti Unit, the inundation of 20 miles of several streams by the Bonneville Unit of the Central Utah Project, and the degradation of about 214 miles of stream by the Bonneville Unit. Some of these stream sections were rated good to excellent prior to inundation, with the Gunnison River section regarded as one of the better cold water stream fisheries in the entire basin.

Table C-23 shows that with the increase in the available fishing water created by the CRSP activities there has been an accompanying and significant annual increase of fishing use in the upper basin. From the standpoint of aesthetics or quality experience, it could be argued that the existing conditions after CRSP are artificial or man made and therefore no longer constitute a natural, quality fishery experience. However, it should also be recognized that although the fishing experience may be artificial, CRSP has generally improved fisherman access and provided fishing opportunites to a much greater segment of the Nation's fishing public.

Various specific fishery programs have been completed or are being planned under CRSP that are not reflected in the table. For example two National fish hatcheries have been developed with CRSP funds. Jones Hole Hatchery in Utah produced 2.6 million trout in 1975, and Hotchkiss Hatchery in Colorado produced 3.3 million. These hatcheries are used to help stock CRSP reservoirs and segments of improved streams. Specific fishery lakes hve been constructed or stabilized in association with the Curecanti, Bonneville, and Emery County Projects, and post-impoundment studies have been funded to provide management data for project streams and reservoirs.

(b) Developments Scheduled for Construction Since 1976

Of the seven projects scheduled for construction since 1976, the six that are in the Colorado River Basin would cause an estimated 2.3 percent decrease in the miles of warm water stream fishery (Table C-23). These changes would amount to a net decrease in the miles of stream fishery in the Upper Colorado River Basin of only about 27 miles (0.4 percent). In addition, the projects would improve about 67 miles of existing cold water fisheries and 52 miles of existing warm water fisheries.

Table 23
Changes in stream fisheries in
Upper Colorado River Basin from developments scheduled for construction since 1976

| Type of fishery | Stream miles: 1976 modified base | Inundated | Changed warm to cold water 1/ | Remaining conditions | Changes (percent) |
|---|---|---|---|---|---|
| Cold water | 7,801 | 11 | +11 | 7,801 | -0.06 |
| Warm water | 1,194 | 16 | -11 | 1,167 | -2.3 |

1/ Changed as a result of storage regulation.

Table C-24 gives a project-by-project description of the streams to be affected and shows that of 27 miles of stream to be inundated, 16 miles can be classified as poor warm water fisheries and 11 miles can be classified as poor to good cold water fisheries.

The trade-offs for the streams lost and degraded are the creation and improvement of reservoir fisheries with a total surface area of about 13,230 acres and the improvement of 17 miles of cold water stream fishery and 52 miles of warm water stream fishery. Although the Grand Valley and Paradox Valley Units would improve the downstream water quality, no significant change in the related water fisheries is expected. It is estimated the six projects would result in a net increase of approximatley 317,200 man-days of fishing annually for warm and cold water species of fish in the basin.

The M&I System, which would not affect the stream system in the Colorado River Basin, would, however, inundate 5 miles of fair- to good-quality trout stream in the Bonneville Basin and reduce the value on another 53 miles of cold- and warm-water stream fishery. The tradeoff would be constructed of a 320,000 acre-foot reservoir and improved streamflows on 53 miles of cold-water stream fishery. The total increased fishery use would be 153,356 annual fishing days.

(2) Endangered Fish Species

(a) CRSP Development Constructed or Under Construction

The endemic species of fish unique to the Colorado River and its larger tributaries (generally the downstream portions of the Green, Yampa, Gunnison, and San Juan Rivers) are of particular concern in evaluating impacts of the CRSP. These two species are the Colorado squawfish and the humpback chub. Because of a change in habitat and apparent decline in population the Fish and Wildlife Service has classified the Colorado squawfish and humpback chub as endangered species.

The four species are all large river fishes. They evolved in the natural river and its larger tributaries when the

| Pro | Increase in use (fisherman days) | Flatwater fishery created or improved: Acres and type of fishery[1/] | Flatwater fishery created or improved: Estimated use (fisherman days) |
|---|---|---|---|
| Dolores | | | |
| McPhee Re | 10,000<br>28,000 | 4,470 CW | 52,000 |
| Monument | | 84 WW | 1,500 |
| Dawson Dr | | 294 CW | 35,000 |
| Groundhog | 8,000 | 400 CW | 17,000 |
| Grand Valley | | None | None |
| Paradox[3/] | o estimate available | None | None |
| Uintah Unit | | | |
| Uinta Res | 750 | 740 CW | 44,000 |
| Whiterock | 500 | 400 CW | 29,000 |
| Paradise | | 117 CW | 8,000 |
| Twelve hi | | 675 CW | 28,000 |
| Upalco Unit | | | |
| Taskeech | 1,570 | 1,223 CW | 38,700 |
| Moon Lak | | 798 CW | 14,100 |
| Twin Pot | | 192 CW | 1,100 |
| Fourteen lakes[2] | | 610 CW | 3,200 |
| Big Sand | | | |
| Animas-La P | | | |
| Ridges B | | 2,270 CW | 39,600 |
| Southern | | 1,386 CW | 15,400 |
| Summary | | | |
| Warm wat | 28,000 | 84 | 1,500 |
| Cold wat | 20,820 | 6/ 13,575 | 6/ 315,700 |
| Tot | 48,820 | 6/ 13,659 | 6/ 317,200 |

1/ Qu denotes a warm water fishery.
2/ Ex
3/ In
4/ An
5/ An
6/ Op oir. An estimated 1,700 fisherman days would rman days and the net acreage improved for

environment of these streams was extremely harsh and characterized by warm water, radical flow fluctuations, heavy silt load, areas of extreme turbulence, and high dissolved solid concentrations. The populations have declined drastically, however, with the changes in aquatic habitat caused by man's activities. The decline is attributable to such activities as construction of large river impoundments, dumping of wastes and pollution in the river systems, introduction of exotic species of game and nongame fish, and other physical and chemical alterations in the system.

Fish and Wildlife Service under the Endangered Species Act of December 28, 1973 (P.L. 93-205) has proposed that approximately 620 miles of the Colorado River and tributaries be designated as critical habitat for the Colorado River squawfish. The stream sections to be affected by this proposal are the Colorado River from Lake Powell to Grand Junction, Colo., the Green River from the confluence to the junction with the Yampa, the Yampa River upstream for about 90 miles, and a short section of the Gunnison River upstream from the junction of the Colorado River.

However, the Endangered Species Act Amendment of 1978 modified the requirements for evaluating and justifying critical habitat for endangered species. Thus the Fish and Wildlife Service has until October 1979 to justify the original critical habitat proposed, in order to comply with the 1978 Amendments. It appears at this time because of the detailed requirements for that justification that the critical habitat proposal requirements will not be met by the October 1979 deadline and that there will be no critical habitat designation for the Colorado squawfish.

Within the lower Colorado River Basin, the area downstream of Glen Canyon Dam, the species are now either rare or nonexistent.[1/] The basic reason most often cited for their decline is the construction and operation of approximately 15 impoundments which control the lower river and have significantly altered the river habitat. In the Upper Basin it can be estimated that prior to the CRSP there were approximately 1,350 miles of habitat occupied by the Colorado River squawfish and the humpback chub. The CRSP has inundated 364 miles and changed the river conditions in another 170 miles of stream habitat below mainstream impoundments to eliminate a total of 534 miles of habitat, as shown in Table C-25.

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1/ Holden, Paul B. and Stalnaker, Clair B. Distribution and Abundance of Mainstream Fishes of the Middle and Upper Colorado River Basins, 1967-1973. Transactions of the American Fisheries Society, April 1975.

Table 25
Loss of river habitat for endangered fish species in Upper Colorado River system--CRSP developments constructed or under construction
(Unit--miles)

| | Eliminated by inundation | Loss due to water quality change | Total |
|---|---|---|---|
| Glen Canyon | | | |
| Colorado River | 186 | 1/ 15 | 201 |
| San Juan River | 71 | | 71 |
| Flaming Gorge (Green River) | 72 | 65 | 137 |
| Navajo (San Juan River) | 35 | 40 | 75 |
| Curecanti (Gunnison River) | | 50 | 50 |
| Total | 364 | 170 | 534 |

1/ Also altered habitat in Lower Basin.

Glen Canyon Dam, in addition to altering 15 miles of habitat downstream in the Upper Basin, also altered flow and water quality downstream in the Lower Basin for many more miles, including the Marble and Grand Canyon areas which were once considered significant habitat for the native fish species. Prior to closing Flaming Gorge Dam the Fish and Wildlife Service conducted a fish eradication program in the reservoir basin and in the tributary area downstream to Dinosaur National Monument, which eliminated many of the native fishes in this section of the Green River. However, this operation did not kill all of the fish or permanently alter the river habitat. The Curecanti Unit dams have not directly affected any of the original habitat of the four large river species. However, the associated changes in flow regime and temperature in the 50-mile stretch of the Gunnison River between Delta and Grand Junction, Colorado, have probably contributed to the decline of some species and the elimination of others.1/

Unlike the large storage units discussed above, the smaller participating projects constructed or under construction have not eliminated habitat of the Colorado River endangered fish species. The projects in total, however, reduce the flows in the mainstem, change water quality, and therefore may indirectly have an adverse effect on the endangered fish species. The degree to which the projects may adversely affect the endangered species is very difficult to estimate because of the lack of information concerning life history and aBiat requirements.

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1/ Kidd, George, An Investigation of Endangered and Threatened Fish Species in Upper Colorado River as Related to Bureau of Reclamation Projects, Unpublished Consultant's Report for Bureau of Reclamation, January 1977.

(b) <u>Projects Scheduled for Construction Since 1976</u>

Of the seven projects scheduled for construction since 1976, one, the M&I system of the Bonneville Unit, would be constructed in the self-contained Bonneville Basin and could not, therefore, have an impact on Colorado River Basin endangered fish species. The other six projects would not directly affect any known populations of the two endangered species by inundation of habitat or by discharge of tailwaters into inhabited areas. The fish stocked in project reservoirs and streams would not be expected to travel the substantial distances necessary for them to compete with the endangered fish populations. As Table C-26 shows, the Grand Valley Salinity Control Unit is the only development located near endangered fish habitat. That unit, however, does not entail storage or any major features which would alter fish habitat in the Colorado River, nor is a fish stocking program planned in association with this project.

Table C-26
Major project features in relation to endangered fish species habitat

| | | Known endangered fish population | |
|---|---|---|---|
| Project | Feature | Location | Distance from project (miles) |
| Dolores | McPhee Reservoir | Colorado River at mouth of Dolores | 180 |
| Grand Valley | Irrigation system improvements | | 0 |
| Paradox Valley | Brine well field | Colorado River at mouth of Dolores | 75 |
| Uintah | Uinta Reservoir | Green River at confluence of Duchesne | 49 |
| | Whiterocks Reservoir | Green River at confluence of Duchesne | 48 |
| Upalco | Taskeech Reservoir | Green River at confluence of Duchesne | 56 |
| Animas-La Plata | Ridges Basin and Southern Ute Reservoir | San Juan River near Aneth, Utah 1/ | 100 |

1/ One juvenile squawfish collected in 1978.

Although tolerances of the endangered fishes for temperature, turbidity, salinity, and flow changes have not been determined, the Bureau of Reclamation does not believe the species or habitat would be significantly affected by the small changes which have been predicted for these environmental factors for the following reasons.

The Upalco and Uintah Units and the Dolores Project, projects with on-stream storage reservoirs, would change temperatures in flows immediately below the reservoirs. By the time these flows reached the Green and Colorado Rivers, which are known to be inhabited by endangered fish species, however, they would have equilibrated with the average air and soil temperature. Thus, water temperatures of endangered fish habitat would not be influenced.

It is anticipated that turbidity levels in the Lake Fork, Uinta, Whiterocks, and Dolores Rivers immediately downstream of the Upalco and Uintah Units and Dolores Project would be slightly decreased during spring runoff as a result of sediment deposition in the reservoirs. The changes would be indiscernible by the time flows from the project areas reached known endangered fish habitat because of natural interchanges of sediment pickup and deposition in the Duchesne and Dolores Rivers. Project return flows from agricultural lands would enter the Duchesne and San Juan Rivers where they would slightly increase turbidity levels during the summer. The Paradox Valley and Grand Valley Units are not expected to affect stream turbidity.

The salinity changes in the Colorado River Basin that would result from the six projects in the Colorado River Basin are not expected to affect any of the endangered species for all have been recorded as living in areas with extensive variations in salinity levels. Salinity levels as far downstream as Lees Ferry are projected to average about 651 mg/l after construction of the six projects. At the Colorado-Utah border in 1974, salinity levels in the Colorado River ranged from 339 mg/l to 1,300 mg/l with no apparent adverse effects on the endangered species in that area. The Colorado squawfish has also been successfully reared from egg stage to lengths of 10 to 12 inches at Willow Beach National Fish Hatchery in water with salinity levels greater than 800 mg/l.1/

The Upalco and Uintah Units and Dolores and Animas-La Plata Projects would reduce historic peak flows and slightly increase historic low flows in known habitat areas of endangered fish species. During average years flows during the July-August-September spawning and rearing season would be increased while late fall, winter, and spring flows would be reduced. Because post-project flows would be within the range of historic flow fluctuations in these areas, however, it is not thought that the flow changes would have adverse effects. Change in stream flows resulting from the Paradox Valley and Grand Valley Units would not be significant. Exact numerical values for the flow changes caused by the six projects are not given because the probability of error in measurement is substantially greater than the changes themselves would be. An unknown amount of endangered species habitat may be restored in the Green River below Flaming Gorge Dam as a result of the penstock modifications which were completed in 1978. The modifications allow water to be released from the Dam that will reach optimum temperature ranges for endemic fish species downstream.

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1/ Willow Beach National Fish Hatchery, Quality of Supply Water for Raceway at Willow Beach Hatchery, 1976.

(c) Fish and Wildlife Coordination

The Bureau of Reclamation has initiated consultation under Section 7 of the 1973 Endangered Species Act and the Amendments of 1978 for Upalco, Uintah, Paradox Valley, and the Bonneville Unit Collection System for the Colorado squawfish and Humpback chub. The Fish and Wildlife Service (FWS) determined that Paradox Valley would not affect either endangered species. The consultation process has been initiated for the Amimas-La Plata Project and the Bureau is preparing a biological assessment. The Service has concluded that the other three projects may jeopardize the continued existence of the two species. This requires the Bureau to provide the Service with detailed biological data from which it can make a "biological opinion" regarding impacts on these fishes. The Bureau is presently working with the Service to initiate a study in the Colorado River Basin that will develop the necessary biological and physical data for the Service to make its final determination which would then complete the consultation compliance requirements of the Endangered Species Act.

d. Terrestrial Wildlife

(1) Developments Constructed or Under Construction

Because of the many variables involved and the limited data available on wildlife populations, no attempt has been made to estimate changes in terrestrial wildlife populations caused by CRSP developments constructed or under construction. Indications of the effects on the wildlife, however, can be gained from study of changes in habitat. In this analysis, five broad types of habitat--(1) riparian, (2) aspen-conifer, (3) shrub, brush, pinon-juniper, (4) grass land, and (5) crop land-pasture--have been considered as key habitat, or habitat essential to the preservation of a species, with the emphasized species being game species such as mule deer, elk, moose, bighorn sheep, antelope, sage grouse, turkey, and waterfowl. Of the area in the upper basin in these types, a total of about 442 million acres is considered key habitat.[1/] CRSP reservoir and irrigation developments constructed or under construction reduce this habitat by about 364,200 acres or about 1 percent. In addition to changes in the Upper Basin, changes occur on about 37,500 acres of land in the Bonneville Basin and Rio Grande Basin as a result of CRSP developments. All of the habitat changes are not a total loss to wildlife since most key habitat has been converted to reservoirs and irrigated crop land which have value to a variety of waterfowl, small game, and nongame species. Although the changes in the basin appear small in relation to the total habitat, they have significant impacts in local areas of individual projects and are one of the many man-caused factors placing pressure on wildlife in the basin. A summary of the habitat changes is given in Table C-27.

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1/ Key habitat description and estimated acreage have been developed from Upper Colorado River Basin Framework Study, Appendix XIII: Fish and Wildlife Resources, 1971.

In addition to the habitat changes tabulated, adverse impacts on wildlife result from construction of such facilities as canals, powerlines, recreation areas, and access roads. In addition, some reservoirs such as Flaming Gorge have indirectly affected key habitat by interfering with historic big game migration routes. Irrigation projects have also probably adversely affected wildlife by necessitating localized control measures because of crop depredation problems on newly irrigated cropland. On the other hand, livestock grazing has been controlled within rights-of-way for some reservoirs to the benefit of wildlife.

Losses of riparian shrub habitat, amounting to about 5,800 acres, are especially significant to local project areas because of the relative scarcity of such vegetation and its importance to a diversity of species. Mule deer, and to a lesser extent, elk use these areas for food and cover. Other wildlife groups which are more dependent on this vegetative type and which have been adversely affected by its loss are furbearers, nongame birds, small mammals, and birds of prey. At Glen Canyon, for example, the narrow band of riparian habitat inundated probably represented the most critical habitat in this desert environment and should be recognized as a locally significant loss.

The losses of approximately 2,400 acres of subalpine-montane forest habitat have probably not been significant because of the small acreages involved with individual projects. Such lands, however, are important to deer and elk for food, cover, and fawning and calving areas.

Some of the most significant impacts would be related to the loss of approximately 187,000 acres of brushlands and pinyon-juniper woodlands in the basin. In much of the basin these areas are winter range for deer and elk. Some of these areas also provide key habitat for antelope and sage grouse. Cottontail rabbits and numerous nongame species also utilize this habitat. In terms of key habitat available, this acreage loss does not appear significant basinwide, but this habitat type often includes crucial areas for individual herds or groups of animals.

Most of the grassland lost, approximately 153,000 acres, was in Glen Canyon. Much of this land would be considered desert and would not represent key wildlife habitat. It had a low density of vegetation including Indian rice grass and galleta and desert shrubs which provided little food and cover for wildlife.

CRSP has increased irrigated croplands and pasture by about 107,000 acres. These lands and small patches of weeds, fence rows, and "waste" areas associated with them provide important feeding area during certain times of the year for game species such as rabbits, pheasants, doves, quail, and waterfowl. Small mammals, nongame birds, and raptors also use such habitat extensively.

| | Flatwater | Specific wildlife developments |
|---|---|---|
| Key habitat in Upper Colorado River Basin without CRSP[1] | 80,700 | Not determined |
| | Gains | Gains |
| Changes in Upper Basin[4] | | |
| Curecanti Unit | 9,180 | |
| Flaming Gorge Unit | 42,000 | 5,520 |
| Glen Canyon Unit | 163,000 | |
| Navajo Unit | 15,600 | 3,060 |
| Florida Project | 600 | |
| Paonia Project | 300 | |
| Silt Project | 350 | |
| Smith Fork Project | 400 | |
| Hammond Project | | |
| Bonneville Unit Collection System | 12,700 | 17,000 |
| Jensen Unit | 500 | 500 |
| Vernal Unit | 800 | 600 |
| Emery County Project | 1,400 | 2,030 |
| Lyman Project | 800 | 1,270 |
| Seedskadee Project | 8,750 | 22,000 |
| Navajo Indian Irrigationa Project | | |
| San Juan-Chama Proje | | |
| Bostwick Park Projec | 300 | |
| Dallas Creek Project | 1,000 | 1,000 |
| Total | 257,680 | 52,980 |
| Total remaining habita in basin-1976 modifi base (rounded) | 338,380 | |
| Percent change | 319 | |
| Changes outside of bas | | |
| San Juan-Chama Proj Rio Grande Basin | 5,905 | 8,000 |
| Total | 5,905 | 8,000 |
| Total changes in and o side of basin | 263,585 | 60,980 |

1/ Derived from at changes due to CRSP units constructed prio

2/ Data on quantis of miles of stream inundated, with the ex-impoundment studies.

3/ Includes pinoes.

4/ Figures shown

5/ Generally not

CRSP developments constructed or under construction increase the surface areas of flatwater in the Upper Basin by more than 300 percent. This habitat is of value to wildlife, particularly waterfowl and shorebirds.

Some losses of habitat, for instance riparian habitat, are difficult, if not impossible, to mitigate. Wildlife mitigation and enhancement programs, however, are being undertaken to offset other wildlife habitat losses incurred by the projects. For example, one wildlife refuge and four waterfowl areas are being developed to replace losses or enhance waterfowl habitat. These include the Seedskadee National Wildlife Refuge in Wyoming and the Brown's Park Waterfowl Management Area in Utah, both along the Green River; Miller Mesa Waterfowl Area on the west shore of Navajo Reservoir in New Mexico; and the Desert Lake Waterfowl Management Area in eastern Utah. Stewart Lake Waterfowl Management Area in eastern Utah is being improved in connection with the Vernal and Jensen Units, and planning is underway to mitigate waterfowl losses on the Uintah-Ouray Indian Reservation by construction of waterfowl habitat areas along the Duchesne River in eastern Utah. The wildlife losses attributable to the Bonneville Unit Collector System are being compensated for through acquisition and management of private lands.

Big game range improvements designed to increase the carrying capacity of existing range to replace habitat losses incurred by CRSP developments are being made in association with the Flaming Gorge Unit, Emery County and San Juan-Chama Projects, and the Jensen and Bonneville Units of the Central Utah Project. Additional purchases are being planned in the Bonneville Unit and Lyman and Dallas Creek Projects to mitigate big game range losses. Adequate measures to mitigate habitat losses associated with the Curecanti Unit have not been accomplished to date. However, updated recommendations have recently been received from the Colorado Division of Wildlife, and the Bureau plans to actively respond to the recommendations.

(2) Developments Scheduled for Construction Since 1976

The six projects scheduled for construction within the basin since 1976 result in an estimated direct reduction of about 44,109 acres of wildlife habitat as shown in Table C-28. Most of this habitat would be considered key habitat. This loss represents a small portion of the total key habitat available in the basin but is significant to some local areas. Because of the importance of these lands to game species, approximately 15,330 acres of the same types of lands are planned for acquisition and initial development to mitigate potential wildlife losses. The acquired lands should substantially offset potential wildlife losses.

Although the M&I System of the Bonneville Unit would not affect wildlife habitat in the Colorado River Basin, it would eliminate about 3,500 acres of wildlife habitat in the Bonneville Basin, a loss that would be substantially offset by the acquisition of 1,910 acres of land specifically for wildlife.

e. Availability of Water

(1) CRSP Developments Constructed or Under Construction

The amount of water in the Colorado River available for consumptive use in the Upper Basin has been conservatively estimated by the Secretary of the Interior at an average of 5,800,000 acre-feet annually. This estimate is based on provisions of the Colorado River Compact of 1922 and the Upper Colorado Basin Compact of 1948 and is based on the Upper Basin's assumed obligation to meet one-half (750,000 acre-feet annually) of the commitment of the Mexican Water Treaty of 1944. The estimate also takes into consideration, among other factors, the capability of existing regulatory storage in the Upper Colorado River system to meet compact commitments to the Lower Basin.

Of the average of 5,800,000 acre-feet annually estimated to be available to the Upper Basin, approximately 4,591,000 acre-feet is committed to developments constructed or under construction. Of these commitments, 1,214,000 acre-feet, or 26 percent, is committed to units and participating projects of the CRSP. Depletions by States are shown in Table C-29. Depletions from individual projects are shown in Table C-30.

(2) Developments Scheduled for Construction Since 1976

Estimated depletions for the six projects scheduled for construction within the basin since 1976 amount to a total of 274,400 acre-feet annually. These depletions are shown in Table C-30 in comparison with the estimated entitlements and estimated 1976 depletions for Utah, Colorado, New Mexico and the Upper Basin as a whole. The M&I System of the Bonneville Unit would be constructed outside the basin and would not affect Colorado River flows.

f. Salinity

(1) CRSP Developments Constructed or Under Construction

The salinity level of the Colorado River at Imperial Dam under 1976 modified base conditions, including effects of CRSP developments constructed or under construction, is estimated at 1,100 mg/l. This reflects the effects of many variable factors. It includes the natural salt in the river before man's activities both in upper and lower Colorado Basin as well as salt resulting from man's activities, including storage regulation, diversions for use within and outside of the basin, evaporation, and return flows. Because of the many variable factors involved, it is extremely difficult to determine the effects on salinity from any particular development. Nevertheless it has been estimated that of the 1,100 mg/l salinity level in the modified base, approximately 147 mg/l or 13 percent could

| Time frame | | Flatwater | Specific wildlife developments |
|---|---|---|---|
| Total habitat in 1976 modi base conditions | | 338,380 | 45,980 |
| | Gains | Habitat gains | |
| Habitat changes in basin w jects scheduled for cons since 1976 | | | |
| Dolores Project | 7,500 | 5,200 | 4,200 |
| Grand Valley Unit | | | 1/ |
| Paradox Valley Unit | | | 3,700 |
| Uintah Unit | 7,800 | 1,100 | 2,850 |
| Upalco Unit | | 1,200 | 1,080 |
| Animas-La Plata Project | 18,310 | 3,656 | 3,500 |
| Subtotal | 33,610 | 11,153 | 15,330 |
| Remaining habitat in basin | | 349,536 | 61,310 |
| Percent change | | +3.3 | +33.9 |
| Habitat changes outside of Bonneville Unit M&I Sys | | 3,068 | 1,910 |
| Total habitat changes in c of basin | 33,610 | 14,224 | 17,240 |

1/ A fish and wildli

2/ Approximately 50

Table C-29
Stream depletions of CRSP

5.8 million acre-feet and 1976 modified conditions
(Unit--1,000 acre-feet)

| | Colorado | Wyoming | Utah | New Mexico | Arizona | Total |
|---|---|---|---|---|---|---|
| Estimated share | 2,976 | 805 | 1,322 | 647 | 50 | 5,800 |
| Actual depletions as of 1976 1/ | 2,097 | 409 | 835 | 332 | 25 | 3,698 |
| Additional depletions from projects under construction | 295 | 120 | 165 | 291 | 22 | 893 |
| Total depletions to 1976 modified base | 2,392 | 529 | 1,000 | 623 | 47 | 4,591 |
| CRSP depletions | 339 | 109 | 336 | 430 | | 1,214 |
| Percent of CRSP depletion to total depletion | 14 | 21 | 34 | 69 | | 26 |

1/ Includes evaporation from storage reservoirs.

Table C-30
Stream depletions of developments scheduled for construction since 1976 compared with States' share of 5.8 million acre-feet and 1976 modified conditions
(Unit--acre-feet)

| | Utah | Colorado | New Mexico | Total Upper Basin |
|---|---|---|---|---|
| Estimated share | 1,322,000 | 2,976,000 | 647,000 | 5,800,000 |
| Total depletions in 1976 modified base | 1,000,000 | 2,392,000 | 623,000 | 4,591,000 |
| Depletions from projects scheduled for construction since 1976 | | | | |
| Dolores Project | | 80,900 | | 80,900 |
| Grand Valley Unit | | -4,000 | | -4,000 |
| Paradox Valley Unit | | 4,000 | | 4,000 |
| Uintah Unit | 28,200 | | | 28,200 |
| Upalco Unit | 10,500 | | | 10,500 |
| Bonneville Unit, M&I System 1/ | 0 | | | 0 |
| Animas-La Plata Project | | 120,000 | 34,100 | 154,800 |
| Subtotal | 38,700 | 201,600 | 34,100 | 274,400 |
| Remainder of estimated share | 283,300 | 382,400 | -10,100 2/ | 934,600 |

1/ The M&I System would utilize Colorado River water that has been developed under the Bonneville Unit Collection System, the depletions for which have been calculated in Table C-29.

2/ New Mexico would exceed its share of the 5.8 million acre-feet level because of the temporary delivery of water from Navajo Reservoir for municipal and industrial use in New Mexico under a long term contract authorized by PL90-272. This contract will expire on Dec. 31, 2005 and contracts for future delivery of water after that date will be subject to renegotiation if such renegotiation is authorized by law.

be attributable to the units and participating projects of the CRSP included in the base. Of the total 147 mg/l contribution, 128 mg/l would be attributable to concentrating effects of stream depletion and 19 mg/l to the salt loads contributed. Except in cases where special studies have been made to determine specific loading from a project, it has been assumed that irrigation would increase the salt load from new lands by 2 tons an acre but would result in no additional salt load from supplemental service lands. The depletions and salt loads from each development are shown in Table C-31.

Table C-31
Estimated depletions and salt loads
CRSP developments constructed or under construction

| Projects | Depletions (1,000 acre-feet) | Salt loads (1,000 tons) | Total |
|---|---|---|---|
| Storage units | | | |
| Curecanti | 10 | | |
| Flaming Gorge | 50 | | |
| Glen Canyon | 460 | | |
| Navajo | 26 | | |
| Participating project | | | |
| Florida | 14 | 11 | |
| Paonia | 10 | | |
| Silt | 6 | 4 | |
| Smith Fork | 6 | 3 | |
| Hammond | 5 | 8 | |
| Central Utah | | | |
| Bonneville Collection System 1/ | 166 | 2/ -27 | |
| Jensen | 15 | 1 | |
| Vernal | 12 | | |
| Emery County | 17 | 2 | |
| Lyman | 10 | | |
| Seedskadee | 22 | | |
| Navajo Indian | 254 | 220 | |
| San Juan-Chama | 110 | 2/ -16 | |
| Bostwick Park | 4 | 3 | |
| Dallas Creek | 17 | 9 | |
| Total | 1,214 | 218 | |
| Increase in concentration at Imperial Dam (mg/l) | 128 | 19 | 147 |

1/ Constitutes the total stream depletion and salinity increase to the Colorado River associated with the Bonneville Unit. All other unit water would be developed from within the self-contained Bonneville Basin.

2/ Negative amount due to transbasin diversion of salts.

### (2) Developments Scheduled for Construction Since 1976

Estimates have been made of salinity impacts that could be expected with the six developments in the Upper Colorado River Basin's scheduled for construction since 1976. Table C-32 shows the developments' effects on the Colorado River System at points above Imperial Dam while Table C-33 shows the estimated salinity impacts of the developments at Imperial Dam. Table C-33 also shows estimates of economic externalities of the salinity effects. These externalities have been based on a rate of $230,000 for each mg/l of salinity increase at Imperial Dam. This rate has been estimated by the Bureau of Reclamation and takes into account reduced productivity and increased agricultural production costs that downstream water users might experience from the salinity impacts. It also takes into account increased costs that might be necessary for treatment of municipal and industrial water as a result of salinity increases and the reduced life of water pipes and other facilities that would result from the increases in concentration.

Table C-32
Salinity effects of projects scheduled for construction in Upper Colorado River Basin since 1976 as related to base conditions on Colorado River System
(Unit--mg/l)1/

| Stream and reference point | 1976 modified base | Effects of six projects | Base with six projects |
|---|---|---|---|
| Green River at Green River, Utah | 495 | 8 | 503 |
| Colorado River at Lees Ferry, Ariz. | 677 | -26 | 651 |
| Colorado River at Imperial Dam | 1,100 | -30 | 2/1,070 |

1/ Rounded to nearest unit.
2/ Includes effect of Las Vegas Wash (first stage).

### (3) Overview of Colorado River

Estimates of future salinity levels in the Colorado River are highly speculative. Various entities have made projections in the past and have arrived at differing estimates because of different base conditions assumed with respect to quantity of runoff, rate of development, and implementation of salinity control measures. In order to provide some early perspective of projected salinity levels in the river, however, this section includes a discussion of Bureau of Reclamation estimates and the results of one of several analyses made by the Colorado River Basin Salinity Control Forum.

or
'6

| ng Economic exter- nalities ($1,000) | Total effects on salinity (mg/l) | Total economic exter- nalities ($1,000) |
|---|---|---|
| -$230 | 11.1 | -$2,553 |
| -368 | 5.1 | -1,173 |
| 0 | 1.3 | 299 |
| 0 | .0 | 0 |
| 161 | 17.9 | -4,117 |
| 9,775 | -43.0 | 9,890 |
| 4,278 | -18.2 | 4,186 |

In its study the Bureau of Reclamation analyzed effects of 43 water resource developments and 17 salinity control measures. Except for the Fruitland Mesa and Savery-Pot Hook Projects which were excluded from the study since they were not funded in the 1977 Public Works Appropriation Bill, the developments are the same as those discussed in the Final Environmental Statement, Water Quality Improvement Program of May 1977 (FES 77-15) prepared by the Bureau of Reclamation and Soil Conservation Service. Also except for the exclusion of the Fruitland Mesa and Savery-Pot Hook Projects, the water resource developments are the same as those listed in the Department of the Interior's Progress Report No. 8, Quality of Water, Colorado River Basin. The water resource developments include authorized Federal developments as well as State, local, and private developments. Thirty-three of these are in the Upper Basin and 10 in the Lower Basin. The salinity control measures are planned to provide control of point, diffuse, and irrigation sources of salinity. Under the Colorado River Salinity Control Act of June 24, 1974, four salinity control projects were authorized for construction and 12 authorized for further study. The seventeenth unit, the Meeker Dome Unit in Colorado, is now also under investigation. Of the 17 salinity control measures, 12 would be in the Upper Basin and 5 in the Lower Basin.

The Bureau of Reclamation estimates were made to the year 2000. They were based on hydrologic records for the period 1941-74 since this is the only period having extensive concurrent runoff and quality data. During this period the mean annual virgin runoff at Lees Ferry was approximately 13.9 million acre-feet. The corresponding depletion levels at Imperial Dam for the years 1990 and 2000 were projected to be 3.5 million acre-feet and 13.9 million acre-feet, respectively, part of which is supplied by inflows below Lees Ferry.

Estimates of future salinity in the Colorado River were compared against a standard salinity level of 879 mg/l at Imperial Dam (average historical concentration of 1972). This standard was proposed by the Colorado River Basin Salinity Control Forum and approved by the Environmental Protection Agency. Establishment of this standard was part of the salinity program in the Colorado River Basin which is being undertaken with the general objective of keeping salinity in the Lower Basin at or below present levels while the Basin States continue to develop their compact apportioned water.

Salinity projections of the Bureau of Reclamation are shown in Table C-34 and Figure C-3. As shown in the table, salinity control measures authorized and under study would provide a reduction of about 1.9 million tons of salt annually. This level represents a concentration reduction of about 204 mg/l at Imperial Dam in the year 2000, which only partially offsets the expected maximum total concentration of 1,205 mg/l. In order to attain the adopted salinity standard, additional control, augmentation, or management steps will be necessary. Thus weather modification, vegetation management, watershed improvement, additional desalting, and various nonstructural measures remain to be considered and studied in detail.

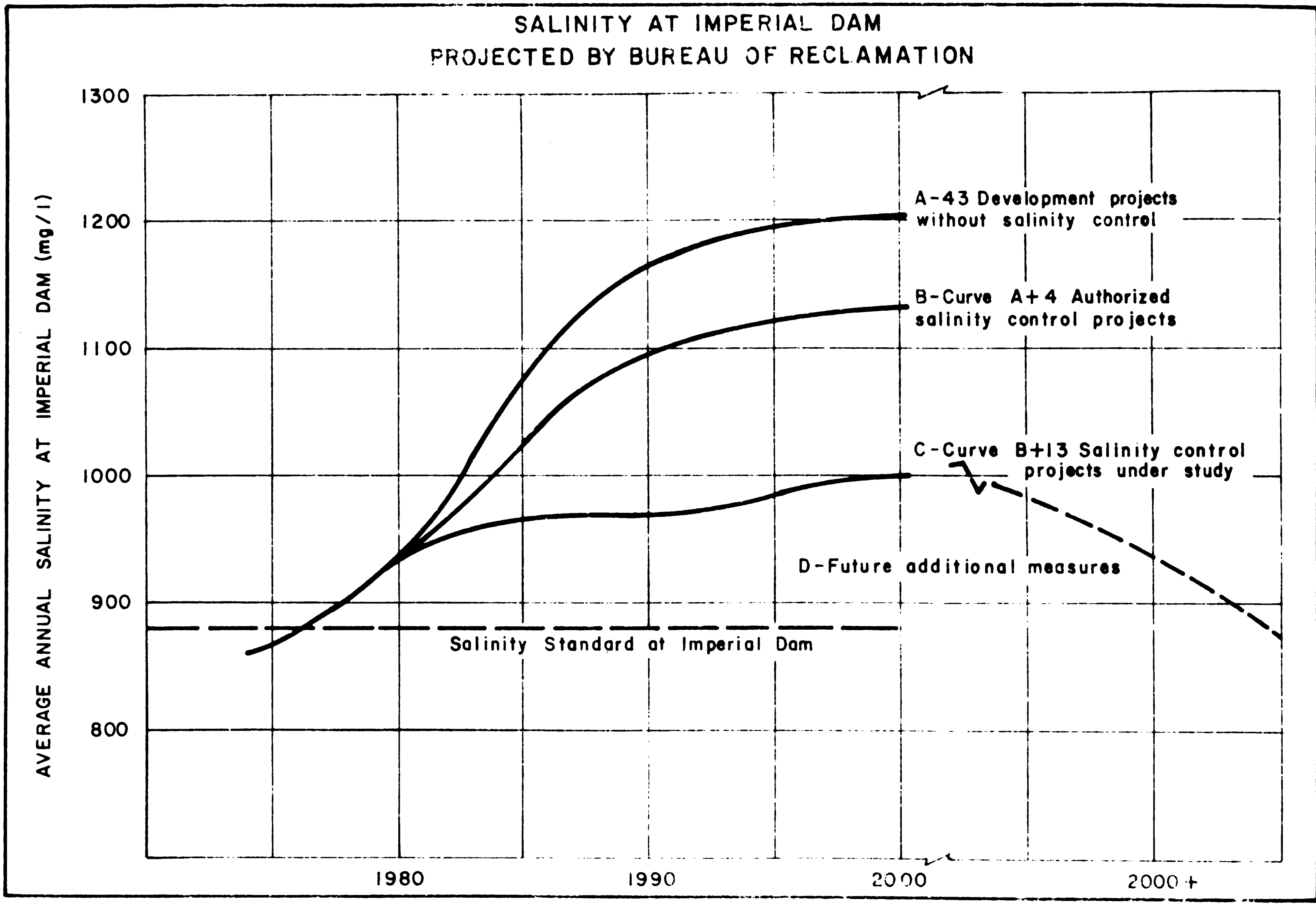
Table C-34
Summary of cumulative salinity impacts at year 2000
projected by Bureau of Reclamation
(average annual conditions)

| | Total depletions (1,000 acre-feet) | Salt added (1,000 tons) | Salinity at Imperial Dam (mg/l) | Salt Removal necessary to maintain 879 mg/l at Imperial Dam (1,000 tons) |
|---|---|---|---|---|
| | Development level | | | |
| Present modified (1974)1/ | 11,500 | | 861 | |
| Developed projects | 2,350 | 67 | 344 | 2,830 |
| Projected total year 2000 | 13,850 | 67 | 1,205 | 2,830 |

Salinity control measures

| | Salinity reduction at Imperial Dam (mg/l) | Salt to be removed (1,000 tons) |
|---|---|---|
| Authorized (4 units) | 73 | 634 |
| Under investigation (13 units) | 131 | 1,250 |
| Total | 204 | 1,884 |

1/ Present modified refers to historic conditions (1941-74) modified to reflect all upstream existing projects for the full period.


SALINITY AT IMPERIAL DAM
PROJECTED BY BUREAU OF RECLAMATION
A-43 Development projects without salinity control
B-Curve A+4 Authorized salinity control projects
C-Curve B+13 Salinity control projects under study
D-Future additional measures
Salinity Standard at Imperial Dam
AVERAGE ANNUAL SALINITY AT IMPERIAL DAM (mg/l)
1300
1200
1100
1000
900
800
1980
1990
2000
2000+

Curve A on Figure C-3 shows the shape and magnitude of salinity effects of anticipated Colorado River Basin Development from the 43 identified water resource development projects without any salinity control. Curve B shows salinity effects shown by Curve A accompanied by the timely construction of four authorized salinity control units. Curve C shows the cumulative effects of incorporating the 17 salinity control units authorized and under study. Curve D shows the additional measures needed to obtain the 1976 salinity standard.

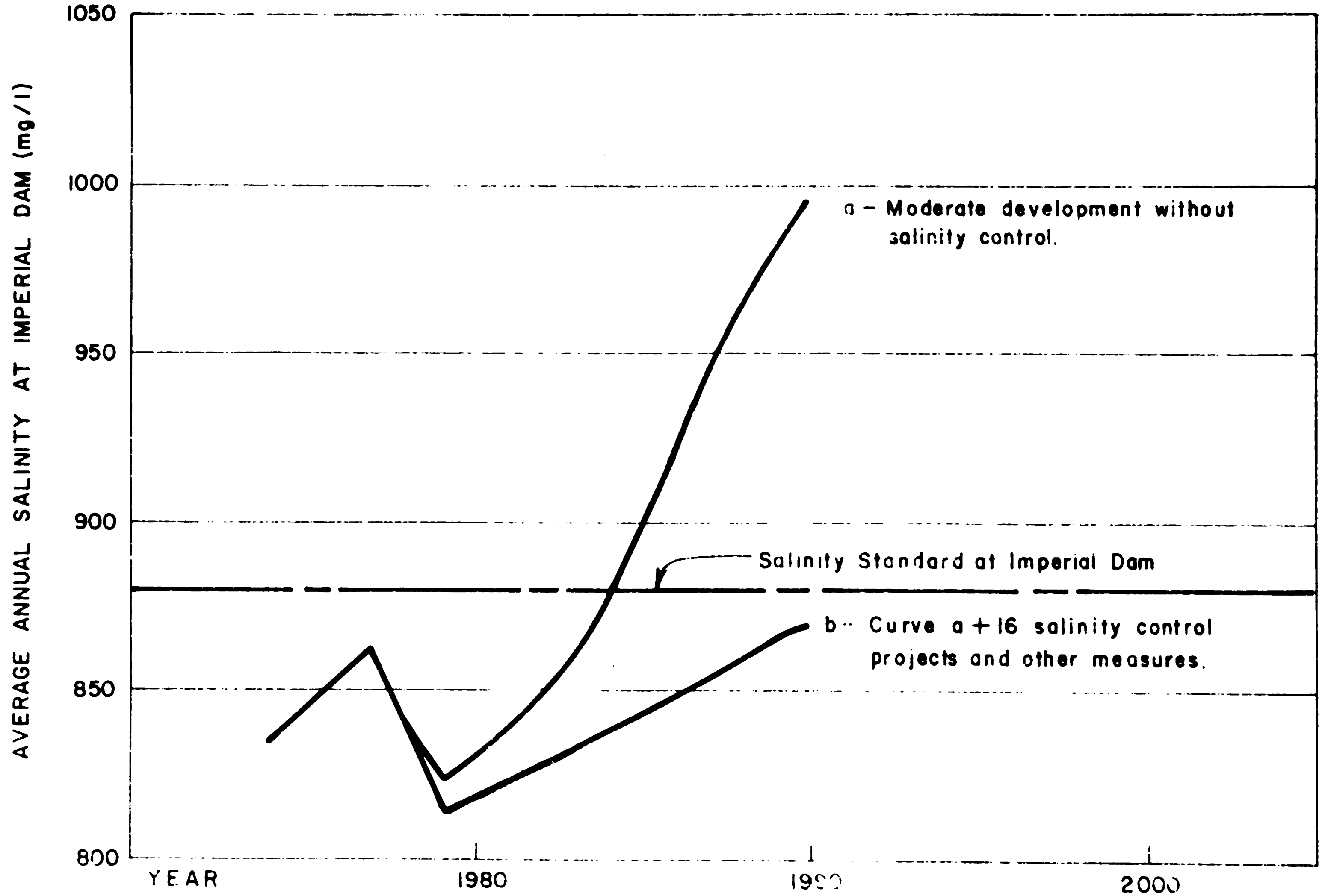
The Colorado River Basin Salinity Control Forum analyzed an array of runoff and depletion levels in developing the salinity standards. The result of one of its analyses are plotted in Figure C-4. Curve A represents the salinity effects of the anticipated basin development without salinity control measures. Curve B represents the effect of adding the 4 authorized salinity control projects, 12 of the salinity control projects under investigation (Meeker Dome not included) and the adoption of a "no salt return" policy to industrial development. The Forum has concluded that the salinity standard can be maintained through 1990 under certain sets of conditions. Recognizing the inherent difficulty in projecting cumulative future impacts in the basin, a key provision allows for reassessment and review of salinity criteria every 3 years.

The methods of analysis used by the Forum and the Bureau of Reclamation are similar. The input assumptions were different, however, and the resulting projected 1990 salinity levels are different. The following is a comparison of one set of assumptions used by the Forum with those used by the Bureau in its study.

| | Bureau of Reclamation | Forum |
|---|---|---|
| Virgin runoff (Lees Ferry) | 13,900,000 acre-feet | 15,000,000 acre-feet |
| Depletion level | 13,500,000 acre-feet | 12,600,000 acre-feet |
| Salinity control | Completion of 4 authorized and 13 investigated projects. Grand Valley 410,000 tons salt load depletion. Adoption of a "no salt return" policy to large industrial development. | Completion of 4 authorized and 12 investigated projects (Meeker Dome not included). Grand Valley 200,000 tons salt load depletion. Adoption of a "no salt return" policy to industrial development. |

As shown in Figure C-4, the Forum projected a decrease in salinity for the period 1977-79 because of projected releases of excess flows from storage passing Imperial Dam. These releases would be required because an average inflow of 15 million acre-feet would occupy all available storage in the basin before the projected depletions equalled the total inflow. The Forum depletion projections include most of the

# SALINITY AT IMPERIAL DAM PROJECTED BY THE COLORADO RIVER BASIN SALINITY CONTROL FORUM



same projects and developments as those of the Bureau of Reclamation. The anticipated date of completion for some of the projects is later in the Forum's projections and its projected total depletion by 1990 is less. The long-term runoff at Lees Ferry (1906-74) is 14.9 million acre-feet and the Forum adopted a future water yield closer to that number in its assessment.

CHAPTER D

# MITIGATING MEASURES AND AIR AND WATER QUALITY ASPECTS

## D. MITIGATING MEASURES AND AIR- AND WATER-QUALITY ASPECTS

### 1. General

This section presents the measures that would be carried out to protect the environment and to mitigate potentially adverse effects of the project. The term "mitigation" refers to the lessening of an adverse impact or the compensating for a loss. Portions of the plans for mitigation are also discussed in Chapters A and C.

### 2. Standard Measures to be Employed During Construction

#### a. Air Quality and Noise Control

Whenever and wherever necessary, the contractor must comply with all Federal regulations and take proper and efficient measures to reduce dust and exhaust pollution that might originate from construction and prevent it from becoming an annoyance to persons or causing damage to crops, cultivated fields, or dwellings. The Bureau of Reclamation would be particularly critical of dust pollution resulting from the manufacture of concrete aggregate or excessive exhaust pollution resulting from improperly tuned engines or improperly equipped vehicles and equipment. The contractor would be held liable for any damage caused by dust and air pollution from construction operations.

The contractor would comply with all applicable Federal, State, and local laws, orders, and regulations concerning the prevention, control, and abatement of excessive noise. No operation producing high-intensity impact noise would be performed at night unless approved by the Bureau, including such operations as using a jackhammer or pile driving.

#### b. Water Quality

The contractor would comply with the applicable Federal and State laws, orders, and regulations concerning the control and abatement of water pollution. The contractor's construction activities would be performed by methods that would prevent entrance, or accidental spillage, of solid matter, contaminants, debris, and other objectionable pollutants and wastes into streams, flowing or dry water courses, lakes, and underground water sources and would be monitored by Reclamation inspectors to insure compliance. Such pollutants and wastes might include, but are not restricted to, refuse, garbage, cement, concrete, oil, and other petroleum products, and aggregate processing tailings. Sanitary wastes would be disposed of on land by burial at approved sites or by other approved methods.

Construction wastewater would be treated and discharged in compliance with all Federal and State laws and regulations concerning the control and abatement of water pollution.

Water pollution control during construction would consist of a point-source and nonpoint-source program designed to eliminate or greatly reduce adverse water quality impacts. All point-source discharges would meet the appropriate State and Federal effluent standards, and the contractor would obtain an NPDES permit. Sewage, oil and grease, and any hazardous substances such as herbicides used during construction would be used according to best management practices as recommended by the Environmental Protection Agency. Point Sources would also be treated to meet State and Environmental Protection Agency effluent standards for suspended solids.

A nonpoint-source control program would be implemented by the contractor as specified in the contract to provide for an erosion control plan, since sediment generated on a construction site can have a significant impact on the downstream aquatic ecology by destroying the macroinvertebrate community essential to aquatic life. Although stream turbidity standards would be violated periodically during stream diversions and stream crossings construction, the erosion control plan would provide for maintenance of State turbidity standards most of the time.

The erosion control plan wold follow best management practices outlined for construction and strip-mining activities. Measures would include:

1. Using the fewest stream diversions possible, with early placement of the permanent diversions for the construction periods;

2. Leaving a specified buffer zone of the stream channel Intact;

3. Diverting runoff around and through disturbed areas to reduce the sediment load reaching the stream; and

4. Establishing a schedule for all clearing activities in relation to the overall construction program. Clearing, to the greatest extent possible, would not occur until dam construction neared completion unless the contractor could demonstrate that adequate erosion controls had been provided.

Water quality will be monitored on a daily and seasonal basis during construction. Daily samples analysis would include, as a minimum, turbidity and suspended solids. Seasonal sampling analysis would include nutrients, salts, suspended solids, turbidity, trace elements, and bacteria. All data would be made available to appropriate local, State, and Federal agencies.

c. Landscape Restoration and Revegetation

Temporary construction areas, including camps, shops, offices, and yard areas, would be located so as to minimize the removal of trees and vegetation. For Ridges Basin and Southern Ute Reservoirs, these temporary construction areas would be located within the reservoir basins where practical. On abandonment, all materials and debris would be removed from the temporary construction sites, and those sites outside of the basins would be reshaped and revegetated. The movements of crews and equipment would be limited to established routes whenever possible.

Construction material source areas would be excavated so that they would not create ponds. Before being abandoned, the slopes of the earth fill areas would be stabilized and shaped to present a natural appearance. Where practical, the slopes would be no greater than 2:1.

All areas temporarily disturbed by construction, such as temporary access roads and utility relocation corridors, would be rehabilitated and revegetated to restore them as closely as practical to natural conditions. Waste material would be disposed of commercially as landfill or would be bladed into contours resembling the local terrain and revegetated.

d. Preservation of Cultural Resources

The Bureau of Reclamation would comply with specific regulations designed to protect, preserve, restore, and maintain historic and prehistoric resources on public land in the project area, and would follow procedures as set forth in 36 CFR 800 (Procedures for the Protection of Historic and Cultural Properties) and 43 CFR 422 (Bureau of Reclamation Procedures for the Identification and Administration of Cultural Resources). The Bureau is proposing inclusion of the project area on the National Register of Historic Places as the La Plata Archaeological District. This would allow a comprehensive study of the area using a sampling of sites. Which of the sites would be included in the data-recovery program cannot be determined at this time, but would be a professional determination based on the potential of the site to produce information important to the entire district.

Extensive data recovery would be obtained from about 175 sites, which is about 5 percent of the 3,500 sites estimated to exist in the project area. Additional information would be obtained through site visits to about 1,000 sites and by using various remote sensing techniques. Storage and curation for artifacts and information recovered would be provided at a facility to be constructed by the Bureau so that access to the material could be maintained.

Because of the unusually rich prehistoric resource, the mitigation program would require an expenditure of funds above the 1 percent of project costs authorized for mitigation of impacts to cultural resources, and the Bureau would seek Congessional approval for additional funds (about 4 percent of the project costs). If this approval is not given, only about 1 percent of the sites could be investigated intensively; less material and information would be recovered and correspondingly less would need curation or be available for public use. The mitigation program to be followed is discussed in Section A-4.

e. Other Considerations

If the use of pesticides were necessary, only those registered with the Environmental Protection Agency in compliance with the Federal Environmental Pesticide Control Act of 1972 would be used. Drilling and blasting would be done in compliance with applicable Federal, State, and local safety regulations.

Because of increased truck traffic during construction, safety measures would be coordinated with the appropriate state and local agencies and instituted on specific highways and county roads in the project area. When the Durango Municipal and Industrial Pipeline would be laid under city streets, interruptions to traffic flow would be coordinated with city officials and, after construction, road surfaces would be restored.

## 3. Measures Incorporated into the Project Plan and Operation

### a. Safety of Dams

In accordance with Bureau of Reclamation policy, the final design of Ridges Basin and Southern Ute Dams would include full consideration of such factors as seismic history, geology, hydrology, and material composition. In addition, the design data of the dam would be reviewed by independent engineering firms with appropriate expertise to insure that no significant data were overlooked or incorrectly analyzed. Criteria for filling the reservoir and monitoring the safety of the dam would be developed by the Bureau of Reclamation and strictly followed. The two reservoirs would take about 2 years to fill under average runoff conditions.

The Bureau would conduct an extensive program to define the accurate geological characteristics of the proposed dams and reservoir basins, as well as alternative dam axes, and would also conduct seismic hazard programs. The basic objectives would be to provide sufficient data for evaluating the specific characteristics of the proposed structures. Particular attention would be given to determining the nature and extent of any geologic defects that may be identified. A detailed discussion of the dam safety considerations is included in Attachment 4.

### b. Protection from Hazards

Project features have been designed to minimize hazards. Safety devices along canals, at canal structures, and around the dams would include fences, signs, guardrails, and handrails. Concrete-lined canals would have escape ladders and escape mats for humans and wildlife. Dropline cables, floats, nets, and trashracks would be placed above the entrances to such canal structures as siphons, drops, tunnels, and road crossings. All buildings, access facilities, and mechanical and electrical facilities would have fences and warning signs.

c. Land Acquisition and Relocation of Families

The acquisition of private land for project ownership and the relocation of displaced individuals would be accomplished according to provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646) and other applicable Federal legislation and regulations. Individuals renting the home at Ridges Basin would be entitled to compensation for relocation expenses, as provided for in the Act. All landowners and tenants would be advised of acquisition procedures and assisted in the preparation of applications for reimbursement and provided with other services required by the Act.

d. Preservation of Scenery

Wherever practical, roads, material source areas, and other facilities would be located so as to minimize adverse visual effects. Design criteria, color, and textures would also be considered in blending features into the surrounding landscape. Trees and other vegetation would be left standing unless removal is required for construction purposes. Where appropriate, trees damaged by construction would be replaced.

e. Control of Vectors

The risk of potential mosquito increases would be minimized by following the applicable recommendations of the U.S. Public Health Service (1960). The reservoirs would be cleared and contoured to reduce the ponding of water during drawdown, and regular maintenance of the shorelines would be undertaken to eliminate mosquito habitat. The normal summer fluctuation zones of the reservoirs would be completely cleared, except for isolated vegetation along abrupt shorelines that would be exposed to wave action or other places where mosquito production is not likely to occur. Low areas which could form pools at minimum water levels would be connected with the reservoir by channels to ensure drainage during low water levels. Drainage would also be provided for seeped and ponded areas where significant mosquito production could occur. In order to ensure unrestricted drainage, vegetation, debris, and flotage would be periodically removed from the control drains.

Material source areas that would not be inundated would be made self-draining. Project conveyance systems would be lined to prevent seepage and ponding. The use of sprinklers would reduce most of the problems associated with applying water by gravity systems, and project drains would remove excess water. The Bureau would advise farmers on how to install their irrigation systems to avoid excess ponding of water, and irrigation scheduling would result in the most effective applications of water.

f. Water Quality

The Water Quality monitoring stations which would be established during construction on the Animas and La Plata Rivers upstream of the Durango Pumping Plant and Southern Ute Diversion Dam would be maintained by the Bureau during project operation. Analysis of samples from these stations would include nutrients, salts, suspended solids, trace elements, and bacteria. The frequency of these analyses would be at least quarterly or, if necessary, more frequently depending on the concentrations found. Data analysis would be handled by the Bureau and results made available to appropriate local, State, and Federal agencies. The Bureau also would establish and maintain monitoring programs in both Ridges Basin and Southern Ute Reservoirs so limnological studies stressing water quality and aquatic biota could be carried out.

The operation of Ridges Basin Reservoir would be managed so that excessive concentations of heavy metals would not be pumped into the reservoir from the Animas River. During critical periods, such as during possible mine tailings spills, the Bureau would specifically monitor water quality in the Animas River to recommend proper reservoir operation for decreasing the metal inflow. The Bureau would coordinate with mining companies upstream of Durango so that ample notification could be received if any spills were to occur. The Durango Pumping Plant would then be shut down during possible water pollution periods to prevent contaminants from being pumped into the reservoir. If water quality problems within the reservoirs do become a problem for water users, as evidenced from the monitoring programs, the Bureau would recommend operation changes and implement other corrective measures. For example, if metal reduction from the Ridges Basin Reservoir sediments be comes a problem, destratification techniques such as water recirculation systems for controlling the metal distribution within the reservoir could be implemented.

g. Fish and Wildlife Measures

To fully compensate for the loss of wildlife habitat and for wildlife losses caused by the project, about 1,600 acres of land north of U.S. Highway 160, 900 acres west of the Ridges Basin Reservoir site, and 1,000 acres within the boundary of Southern Ute Reservoir would be acquired, developed, and maintained for wildlife, as discussed in Chapter A. Development of the areas would consist of selective chaining or clearing, seeding, and planting of food plots so this land would support more animals. Canals rights-of-way would be vegetated, fertilized, and fenced to protect the habitat from damage by livestock. Certain concrete sections of canals could present a potential hazard to wildlife.

Several methods that would be used to eliminate the hazard include game fencing, crossing at known game-trail locations, and escape devices which consist of floating booms and 4 to 1 side slopes.

Fish screens would be installed at Durango Pumping Plant and Ridges Basin Pumping Plant to keep fish from entering the pumps. A fish screen would be installed at the entrance to Southern Ute inlet Canal to prevent rough fish greater than two inches in length from entering the reservoir.

# CHAPTER E

# UNAVOIDABLE ADVERSE EFFECTS

## E. UNAVOIDABLE ADVERSE EFFECTS

The projected beneficial and adverse environmental impacts associated with the Animas-La Plata Project have been discussed in Chapter C. Measures designed to mitigate adverse effects and protect the environment are discussed in Chapter D. This chapter lists the most significant adverse impacts that could not be avoided or fully compensated for.

### 1. Water Resources

The average annual depletion of the Animas River between Durango and the mouth would range from 131,200 to 164,300 acre-feet. The San Juan and Colorado Rivers would have an average annual depletion of 154,800 acre-feet. The salinity level in the Colorado River would be increased by an annual average of 17.9 milligrams per liter, as measured at Imperial Dam, thus decreasing the quality of water available for irrigation and municipal and industrial use in the Lower Colorado River Basin.

Turbidity would increase temporarily in the Animas River during construction of the Durango Pumping Plant. When fill material would be placed in the La Plata River for the La Plata and Southern Ute Diversion Dams the river would probably be dry.

### 2. Fish and Wildlife

All of the project facilities would remove wildlife habitat. The two proposed reservoirs would inundate a total of 3,630 acres of native vegetation and cropland that now supports wildlife to varying degrees. Associated features such as the Ridges Basin Pumping Plant, recreation sites, canals, pipelines, and access roads would remove 770 acres of similar habitat. These losses must be regarded as adverse effects even though the development of wildlife management areas and the seeding of rights-of-way would accommodate many of the displaced numbers of wildlife and compensate for the impacts on total populations of the various species. Initially, densities of some of the nongame mammals, varmints, nongame birds, raptors, reptiles, and amphibians now inhabiting the area would be unavoidably reduced because of net reductions in their habitat, although in some areas their numbers would be increased with the project. About 140 miles of existing canals and laterals totaling 880 acres on supplemental service land that support riverine vegetation considered to be wetlands, would be lost in the conversion with the project to sprinkler irrigation and buried laterals. This loss must be considered as an adverse effect even though open project drains, and increased water supply north of the Dry Side Canal, project reservoirs and Southern Ute Diversion Dam would create or increase wetlands.

3. Cultural Resources

The project will cause the loss of some information which might otherwise be preserved for study of the cultural resources by future generation. However, the mitigation program would result in the recovery and dissemination of current information. If Congress would authorize funds for the full program described in Section A-4.h., the Data Recovery Program would adequately offset the loss of information due to project construction and operation through the professional investigation of up to 175 significant sites. Although investigation of these sites at this time will remove the option of future investigation, one criteria would be to select only those sites to be impacted. If congressional authorization is not received, the net result would be loss of more significant data and the Data Recovery Program would be inadequate.

4. Scenery

The project structures could be visually unattractive to some people, as would the exposure of foreshore at Ridges Basin and Southern Ute Reservoirs during periods of drawdown.

5. Economic and Social Conditions

During the 10-year construction period, the project work force would place strains on local housing, education, and law enforcement and fire protection agencies. Adverse effects would also occur from the relocation of about two people in one family now renting in the project area who would have to find new housing. A loss in tax revenues would result from the acquisition of 7,559 acres of private land for project features. Land occupied by project features would be precluded from grazing or other uses. If interest should be renewed in the natural gas field at Southern Ute Reservoir site, development costs would be increased. Approximately 165 million kilowatt-hours of electricity would be required annually for operation of project pumping plants.

CHAPTER F

# SHORT- AND LONG-TERM ENVIRONMENTAL USES

## F. SHORT- AND LONG-TERM ENVIRONMENTAL USES

This chapter contains a brief discussion of the extent to which the proposed action involves short-term environmental gains in comparison to long-term losses and short-term environmental losses in comparison to long-term gains, and a discussion of the extent to which the proposed action forecloses future options. The anticipated life of the project features would be at least 100 years.

### 1. Short-term Gains Compared to Long-Term Losses

Over the short-term, Federal funds for construction would provide employment opportunities and stimulate the local economy during the 10-year period of construction. The investigation and study of the prehistoric sites would add to the knowledge of the prehistory of the area.

Over the long-term, a number of environmental losses would take place. The project would cause an average annual depletion of the San Juan River downstream of the Mancos River, and of the Colorado River downstream of the San Juan River, totaling 154,800 acre-feet. In addition, salinity in the Colorado River would increase by an estimated 17.9 milligrams per liter as measured at Imperial Dam.

About 4,400 acres of wildlife habitat would be permanently lost as a result of project construction, including habitat for prairie dogs, some nongame birds, and reptiles and amphibians and riparian habitat. About 140 miles of existing canals and laterals totaling 880 acres on supplemental service land that support riverine vegetation considered to be wetlands would be lost in the conversion with the project to sprinkler irrigation. The nongame fish population downstream of the Durango Pumping Plant would be reduced because of lower flow, and the southern range of the salmonid population would be restricted during late summer because of pumping. About 3,400 recreation days would be lost and 15,200 recreation days reduced in value because of the project. These losses and reductions would be associated with hiking and sightseeing and, on the Animas River, recreational floating and kyaking and a commerical river-floating enterprise. Over the life of the project, approximately 165 million kilowatt hours of electrical power per year would be used for project pumping. This energy could serve the annual electrical needs for residential use for a city of about 63,000 people. Project facilities would disrupt the aesthetics of the area for a long period of time. The excavation or inundation of prehistoric sites would be considered a long-term loss. The excavation or inundation of prehistoric sites, as well as cultivation of land and construction of features on prehistoric sites, would be considered long-term losses of cultural resources. The acquisition of 11,559 acres of private land would remove them from the tax rolls, which would create an impact on the assessed valuation of private property in the project area.

2. Short-Term Losses Compared to Long-Term Gains

Short-term losses would include the stress placed on area services, including housing, education, law enforcement and fire protection, and road maintenance. Construction and clearing within project rights-of-way would temporarily reduce the number of mule deer and elk, nongame mammals, and game birds and create turbidity and sedimentation in the Animas and La Plata Rivers. During construction, traffic on roads in the project area would increase.

Over the long-term, one of the most significant gains resulting from the project would be an increase in agricultural production of about $19,475,300 annually, as well as increases in related businesses providing goods and services. The domestic water provided by the project would represent a long-term benefit to area communities and rural areas. Recreational facilities at project reservoirs would provide a variety of long-term opportunities for the public.

As a result of project return flow, the flow of the Mancos River would increase over the long-term by about 30 percent annually. An increase in ground water would occur in the project area because of newly irrigated land. Nongame species of fish would increase upstream of Southern Ute Diversion Dam and in the Mancos River. The project would create a cold-water fishery in Southern Ute Reservoir, thereby increasing the opportunities for fishermen. Certain species of wildlife, such as the desert cottontail, raccoon, beaver, muskrat, nongame birds, amphibians, and waterfowl and shorebirds, would benefit from project conveyance systems and newly irrigated land. Project reservoirs would provide a source of food for raptors. Land developed for wildlife would create valuable habitat for a number of species. Open project drains, an increased water supply north of the Dry Side Canal, project reservoirs and diversion dams would result in quality wetlands. The project could have a long-term benefit to prehistoric resources through preservation of much of the resource by the nomination of the La Plata Archeological District to the National Register of Historic Places. The investigation of sites would be of long-term benefit in contributing to the knowledge of the area's prehistory.

3. Relationships Between Project Development and Future Options For Resource Development

The fuel, power, and manpower, and construction materials required for project construction and operation would not be available for other uses. Federal funds committed to the Project could not be put to any other uses.

The development of a portion of Colorado's and New Mexico's allocated share of water in the Upper Colorado River Basin for the

**Animas-La Plata Project would preclude the development and use of this amount of water for other areas in these States.**

**The inundation of land and streams would eliminate any alternative uses of these areas, such as wildlife habitat, pasture, cropland, homesites, and recreation. The inundation of prehistoric and historic sites would make their future investigation more difficult and expensive.**

# CHAPTER G

# IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

## G. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

A total of about 13,684 acres of land now committed primarily to wildlife habitat would be acquired for project uses. An estimated 4,183 acres of this land would be irreversibly committed to reservoir storage, canals, roads, and other structures. The remaining 9,501 acres would be committed to such long-term project uses as recreational areas, wildlife management areas, and rights-of-way. Although this commitment would not necessarily be irreversible, a restoration to present conditions would be quite difficult.

The construction materials irretrievably committed to use would include 9,606,400 cubic yards of soil, sand, gravel, cobble, and riprap needed for dam embankments and including about 27,400 cubic yards for fill material for La Plata and Southern Ute diversion dams and about 922,600 cubic yards of the same materials required for canal banks, roadbeds, and other features. Cement and manufactured materials would be irretrievably committed to the project features. Construction would involve the consumption of energy in the form of fuels, explosives, and electrical power. After construction, electricity would be consumed for the length of the project, primarily for the pumping plants. Approximately 165,000,000 kilowatt hours would be consumed annually.

With full project development, the use of project water would involve an irretrievable depletion of the Lower Colorado River of 154,700 acre-feet each year. Water uses could be changed in the future, however. Prehistoric resources would be irreversibly disturbed through the process of scientific testing or excavation or through damage during project construction. Prehistoric sites that would be entirely excavated would represent a total commitment of the resource. Partial commitment, since some information would be preserved and retrievable, would occur at sites in cultivated areas and in reservoir pools.

The project would irreversibly alter the aesthetics in local areas by the intrusion of man-made structures and canal embankments onto the landscape. The visual impact would be permanent.

# CHAPTER H

# ALTERNATIVES TO PROPOSED ACTION

## H. ALTERNATIVES TO THE PROPOSED PLAN

### 1. Introduction

The alternatives presented in this chapter describe the significant plans considered during plan formulation. Minor variations of the plans presented were considered and rejected for economic reasons; however, the impacts would be essentially the same as for the alternatives described. The alternatives described are (1) without project development, and (2) those plans that accomplish all purposes of the proposed plan: the plan at authorization, the Teft diversion plan, and the Bondad diversion plan. The plan at authorization and the Teft diversion plan divert water from the Animas River 25 miles north of Durango, and Bondad diversion plan diverts Animas River water 20 miles south of Durango. The proposed plan diverts water at Durango. Table H-1 compares these three alternatives with the proposed plan.

The plan at authorization was developed in the 1960's; however, when advance planning and public involvement began in 1971, several economic and environmental problems were found with the plan as discussed in the following sections. The Teft diversion plan is a modification of the plan at authorization that resolved many of those problems. It did not, however, alleviate the environmental problems associated with depleting the Animas River 25 miles north of Durango and the 48-mile-long system of canals, siphons, and tunnels to get water to the irrigated area.

The Bondad diversion plan would have a dam constructed on the Animas River. Water would be pumped from the reservoir to the land to be irrigated. The pump lift would be 30 percent greater than with the proposed plan, and the pumping costs would be significantly greater. This plan did not meet economic criteria because of the pumping costs.

Power production potential in the project area was investigated during plan formulation. Two hydro powerplants, both north of Durango, and a solar powerplant were considered. The powerplants could have been included with the proposed plan or any of the alternatives. All the powerplant alternatives had benefit-to-cost ratio of about one-half to one and were, therefore, not included.

### 2. Without Project Development

Without the project, the municipal and industrial water needs of the communities and the Indian Tribes would probably be developed individually.

Table H-1
Summary of alternatives

| | Proposed plan | Authorized plan | Teft diversion | Bondad diversion |
|---|---|---|---|---|
| | | Alternatives that accomplish all purposes of proposed plan | | |
| Project land (acres) | 70,100 | 72,120 | | 70,100 |
| Full service | 48,620 | 46,520 | | |
| Colorado | 43,710 | 35,320 | | |
| Non-Indian | 30,310 | 29,500 | | |
| Indian | 13,400 | 5,820 | | |
| New Mexico | 4,910 | 11,200 | | |
| Non-Indian | 4,530 | 9,500 | | |
| Indian | 380 | 1,700 | | |
| Supplemental service | 21,480 | 25,600 | | |
| Colorado | 17,760 | 20,100 | | |
| Non-Indian | 17,300 | 20,100 | | |
| Indian | 460 | | | |
| New Mexico | 3,720 | 5,500 | Same as | |
| Non-Indian | 3,720 | 5,500 | | |
| Project water supply | | | in | |
| (average annual--acre-feet) | 198,200 | 265,100 | | 190,000 |
| Irrigation | 118,100 | 188,900 | proposed | 118,100 |
| Colorado | 61,470 | 138,900 | | |
| Full service | 83,460 | 104,500 | plan | |
| Non-Indian | 54,600 | | | |
| Indian | 28,860 | | | |
| Supplemental service | 17,800 | 34,400 | | |
| Non-Indian | 17,600 | | | |
| Indian | 200 | | | |
| New Mexico | 16,840 | 50,000 | | 16,840 |
| Full service | 12,740 | 40,400 | | |
| Non-Indian | 11,900 | | | |
| Indian | 840 | | | |
| Supplemental service | 4,100 | 9,600 | | |
| Non-Indian | 4,100 | | | |
| Municipal and industrial water (acre-feet) | 80,100 | 76,200 | | 71,900 |
| Colorado | 41,700 | 62,700 | | 1/ 33,500 |
| New Mexico | 38,400 | 13,500 | | 38,400 |
| Reservoirs (acre-feet) | | | | |
| Ridges Basin | 280,040 | | 23,000 | |
| Southern Ute | 70,000 | | 70,000 | 70,000 |
| Howardsville | | 78,000 | | |
| Hay Gulch | | 55,000 | 55,000 | |
| Ute Meadows | | 16,500 | | |
| Animas Mountain | | 17,000 | | |
| Three Buttes 2/ | | 43,000 | | |
| Bondad | | | | 130,000 |
| Diversion dams (number needed) | 2 | 4 | 3 | 2 |
| Canals (number needed) | 3 | 9 | 3 | 3 |
| Total length (miles) | 33.7 | 134 | 58 | 40 |
| Pumping plants (number needed) | 2 | 0 | 2 | 3 |
| Sprinkler irrigation pumping plants (number needed) | 5 | 0 | 5 | 5 |
| Recreation developments (number) | 2 | 5 | 3 | 2 |
| Environmental evaluation | | | | |
| Beneficial effects | | | | |
| Wildlife management areas | Yes | No | Yes | Yes |
| Fisheries provided | Yes | Yes | Yes | Yes |
| Streamflow enhancement down-stream of reservoir | No | No | No | Yes |
| Recreation provided | Yes | Yes | Yes | Yes |
| Increased agricultural land | Yes | Yes | Yes | Yes |
| Adverse effects | | | | |
| Loss of natural vegetation and wildlife habitat | Yes | Yes | Yes | Yes |
| Free flowing stream lost to reservoir inundation | No | Yes | No | Yes |
| Impact on housing and services | Yes | Yes | Yes | Yes |
| Visual impacts | Yes | Yes | Yes | Yes |
| Salinity increase at Imperial Dam (mg/l) | 17.9 | 22 8 | 17.9 | 17.9 |

1/ Under this alternative, Durango would not receive municipal and industrial water

2/ This reservoir basin has been renamed and is the site now referred to as Southern Ute Reservoir.

The municipal and industrial water needs to be met by the project are based on increased population in the project area and resource development on the Indian reservations. The population increase will be the same with or without the project so municipal water to meet the needs of the population will have to be developed with or without the project. The coal resources on the Indian reservations are economically mineable today and will probably be developed in the near future. Water to develop an industrial facility such as a generating station would have to be developed by a utility, private company, or one of the Tribes.

Many of the urban areas the project would serve are considering conservation measures, such as water meters and lining of small storage reservoirs, as a means of postponing the time when additional water would have to be developed. These conservation measures are necessary with or without the project because most of these areas are presently at the capacity of their water systems.

For municipal and industrial needs the future question is not whether water would be developed but how the water supplies would be developed. The most likely method of development is that each of the user groups would build separate facilities. There are three sources of water for municipal and industrial needs; (1) the San Juan River, (2) the La Plata River, and (3) the Animas River.

The San Juan River is a potential source of water for communities along the river but water from this source would only be available until the Navajo Indian Irrigation Project is fully developed. This time the communities would no longer be able to use the San Juan River.

The La Plata River is a potential source of water for rural development and for Indian resource development. In either case water would have to be converted from irrigation use either by buying rights owned by an irrigator or obtaining a court ruling putting the municipal and industrial water rights ahead of irrigation rights. Such a ruling is not likely for rural water because that water could be bought fairly easily although it would be costly. The Indians could potentially get rights on the La Plata River through the courts based on the date the reservation was formed. If this occurred it could take all of the flows in the La Plata River to develop Indian resources. Irrigation along the La Plata River would not exist.

A more likely source of water for Indian industrial needs and the needs of communities which would receive water from the proposed project is the Animas River. Unlike the La Plata River, the Animas River could be developed without jeopardizing other water uses. If the Animas-La Plata Project is not developed there would be an additional 118,100 acre-feet of project irrigation water available for other uses. There is adequate water in the Animas River for all municipal and industrial needs but since each group would probably build separate facilities, the question of who gets the highest priority water rights would arise.

Storage is needed to develop Animas River water but the group with the higher water right would require less storage than the group with the lower priority right. This directly affects the cost of water. Two issues would have to be resolved to determine the order of water rights. There would need to be a court decision on Indian water rights based on the date the reservation was formed, and an interstate compact between Colorado and New Mexico for the Animas River water would have to be negotiated. Once these issues were resolved, the water users would proceed to develop water to meet their needs. In most cases the water would cost more than project water because each group would build separate facilities.

Irrigation, both Indian and non-Indian, would probably not be developed beyond that which presently exists. The cost of developing additional water supplies for irrigation alone, which must come from the Animas River, exceed the irrigators' repayment capability. There is some possibility that the State of Colorado may provide funds to improve existing irrigation systems on Red Mesa, thus somewhat increasing the irrigation efficiency. The net result of the no project alternative would be for agriculture to decrease in importance economically as other economic sectors expand. Since population would be increasing, pressure would increase to sell agricultural lands for housing developments.

Reservoir recreation is very important in the area and the need for reservoir recreation demands are expected to continue to grow as the population increases. Stream fishing would be the same with or without the project. Without the project the recreation demands would result in overcrowding of existing reservoir facilities.

The development of facilities to supply municipal and industrial water would occur but development of these facilities would not always be subject to mitigating wildlife disturbances as the project would. Private reservoirs probably would not be developed for recreation and fishing. Wildlife would continue to receive increasing pressure from the expanding human population. There would be less disruption of archaeological resources without the project, though amateur destruction would continue and probably would increase as the area population increases. There would not be a multi-million dollar program to salvage some of the resources and study the life patterns of the Anasazi, as is included in the proposed plan. Benefits from the expenditure of project construction funds would not be realized, nor would the negative impacts associated with an influx of people during the construction period.

## 3. Alternatives That Accomplish All Purposes of the Proposed Plan

### a. Plan of Authorization

The plan at authorization would utilize a reservoir near Silverton for main storage and a 48-mile system of canals, tunnels, and siphons to convey Animas River water to the La Plata River drainae. The plan would have significant environmental impacts because the Animas River would be seriously depleted at the diversion; serious environmental problems would be associated with the main reservoir and conveyance system, and an excessive amount of salt would be contributed to the Colorado River from some of the land to be irrigated.

(1) Plan Description

This plan was described in the Animas-La Plata Project Feasibility Report of 1962, with a supplement published in 1966. Congress authorized the plan for construction in 1968. The plan of authorization would have served about the same number of acres and provided the same volume of municipal and industrial water to the same user groups as the proposed plan. The distribution of water and land between the user groups has changed significantly as have the features to provide the water. Figure H-1 on the following page shows intended facilities of the plan.

Non-Indian land in Colorado is about the same but Indian land has increased nearly 7,500 acres in the proposed plan. New Mexico non-Indian land is 7,000 acres less in the proposed plan and Indian land in New Mexico is about 1,000 acres less in the proposed plan. Municipal and industrial water for the Indian Tribes is 20,000 acre-feet less in the proposed plan than the plan at authorization. New Mexico municipal and industrial water is increased 25,000 acre-feet. The amount of municipal and industrial water for Durango is unchanged.

The water supply developed for the irrigated land in the plan of authorization is 70,000 acre-feet greater, 60 percent more than the proposed plan. The reason for the larger water supply is primarily because the plan at authorization used gravity irrigation while the proposed plan would provide a sprinkler irrigation supply. Sprinkler irrigation applies water more evenly and is much more efficient than gravity irrigation through open ditches.

The features to supply the water are considerably different from those in the proposed plan. The greatest difference is the features to convey water from the Animas River to the La Plata River drainage. The plan at authorization would use gravity to convey water to the La Plata drainage rather than pumping. Durango and Ridges Basin pumping plants and Ridges Basin Reservoir are replaced by a series of canals, siphons, and tunnels and two reservoirs. The plan at authorization does not use any electric power.

The plan at authorization would have a reservoir a little larger than Southern Ute Reservoir on the Animas River near Silverton. Releases from this reservoir would be used mostly for irrigation; however, New Mexico municipal and industrial water would also be stored there. A diversion dam on the Animas River about 25 miles north of Durango would divert Animas River flows and releases from the reservoir near Silverton into a 48-mile series of canal, tunnels, and siphons.

The diversion dam would be capable of diverting about 50 percent more water than the proposed Durango Pumping Plant. Some water would be taken from the canal near Durango for storage in a reservoir one-fourth the size of Southern Ute Reservoir about a mile north of Durango for use by Durango municipal and industrial water users.

Most of the water in the canal would be conveyed westward for use on Red Mesa irrigated land, releases into the La Plata River for downstream water needs, and finally for storage at a reservoir on Hay Gulch. This reservoir, a little smaller than Southern Ute Reservoir, would regulate water to be used on Dry Side lands and Ute Mountain Ute Indian industrial water.

La Plata River flows and releases to the river from the major canal could be diverted into either the Three Buttes,1/ half the size of Southern Ute Reservoir, or Ute Meadows Reservoir, one-fourth the size of Southern Ute. The Ute Meadows Reservoir would be filled via a diversion dam on the La Plata River and a 16-mile canal; the canal would also be used to irrigate land along the way. Three Buttes Reservoir would be filled by a 3.5-mile canal from a diversion dam on the La Plata River. Both reservoirs would provide water to land in New Mexico. Southern Ute Reservoir would provide Southern Ute Indian industrial water.

All the irrigated land would be served by extensive systems of small canals and laterals. The proposed plan would serve the land by buried pressure pipe laterals. The proposed plan has about one-fourth the miles of canals that are in the plan of authorization.

(2) Environmental Impacts

Since this plan is a larger construction project than the proposed plan, construction would extend about 2 years longer. The adverse impacts that an influx of temporary workers would have on the area's services and facilities would, therefore, extend for a longer period of time. The benefits of increased employment opportunities and increased payrolls in the local economy would also be extended through the 2-year period. The additional 20,000 acre-feet of municipal and industrial water this plan would provide for the Indian Tribes could mean more extensive mineral development if more water needs developed for this purpose in the future, or the water could be used for some other industrial development by Tribal planners. Total irrigation benefits would be about the same as those of the proposed plan, although the Indian Tribes would benefit proportionately less under the authorized plan, with about 7,500 fewer acres to be developed while non-Indian land would be about 7,000 acres more. Recreation facilities and fishing opportunities would be included in all five reservoirs, with a total water surface about the same as in the two reservoirs in the proposed plan.

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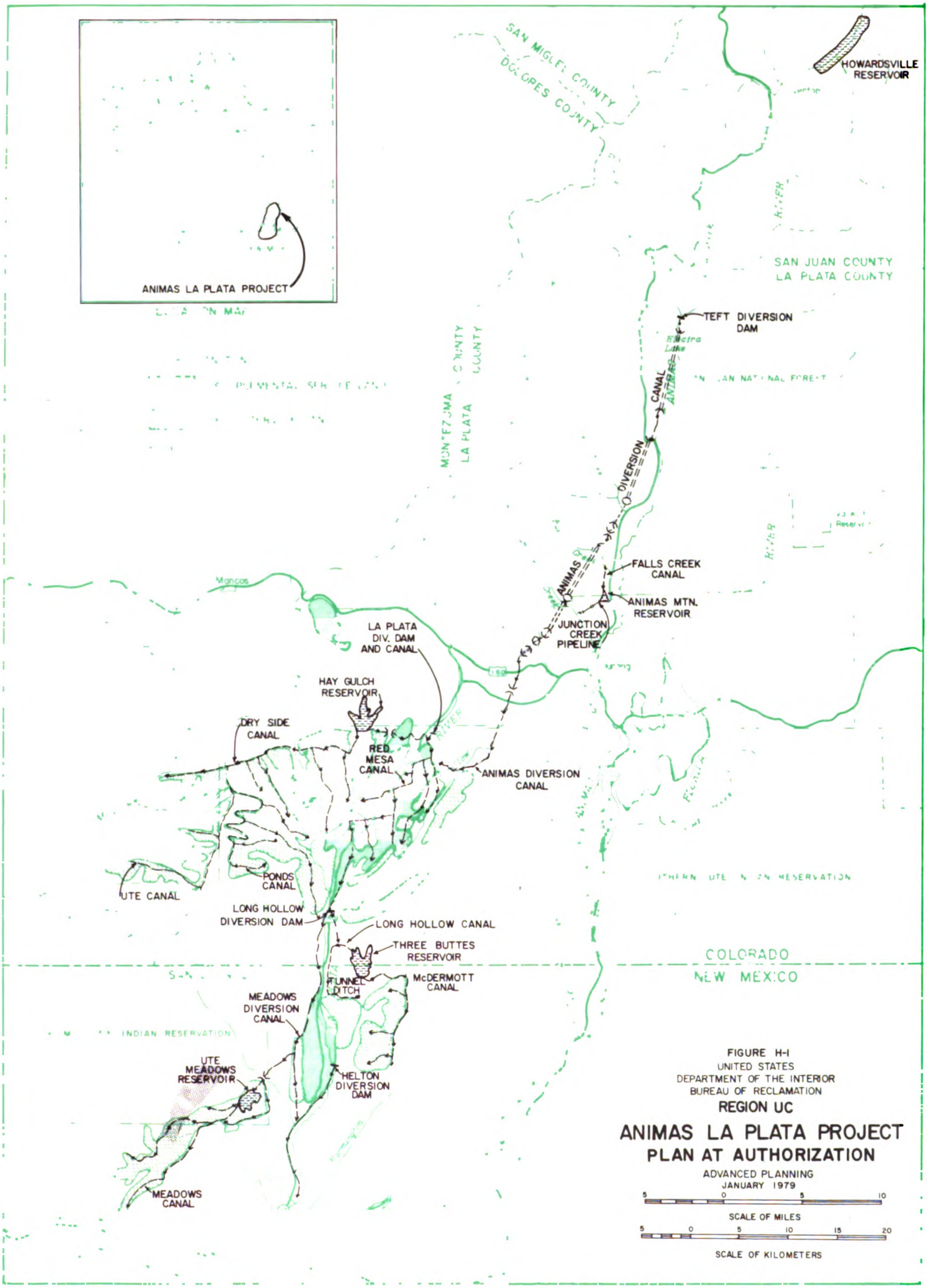
1/ Same location as Southern Ute Reservoir in the proposed plan.


HOWARDSVILLE RESERVOIR
SAN MIGUEL COUNTY
DOLORES COUNTY
SAN JUAN COUNTY
LA PLATA COUNTY
ANIMAS LA PLATA PROJECT
TEFT DIVERSION DAM
Electra Lake
MONTEZUMA COUNTY
LA PLATA COUNTY
CANAL
DIVERSION
ANIMAS
FALLS CREEK CANAL
ANIMAS MTN. RESERVOIR
JUNCTION CREEK PIPELINE
Mancos
LA PLATA DIV. DAM AND CANAL
HAY GULCH RESERVOIR
DRY SIDE CANAL
RED MESA CANAL
ANIMAS DIVERSION CANAL
PONDS CANAL
UTE CANAL
LONG HOLLOW DIVERSION DAM
LONG HOLLOW CANAL
THREE BUTTES RESERVOIR
COLORADO
NEW MEXICO
TUNNEL DITCH
McDERMOTT CANAL
MEADOWS DIVERSION CANAL
INDIAN RESERVATION
UTE MEADOWS RESERVOIR
HELTON DIVERSION DAM
MEADOWS CANAL
FIGURE H-I
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION UC
ANIMAS LA PLATA PROJECT
PLAN AT AUTHORIZATION
ADVANCED PLANNING
JANUARY 1979
5 0 5 10
SCALE OF MILES
5 0 5 10 15 20
SCALE OF KILOMETERS

Bureau of Mines studies (1960, 1961) indicated that no known mineral resource would be affected by the Animas, Hay Gulch, and Meadows Reservoirs. At the Howardsville Reservoir site, although there are no active mines in the reservoir basin or immediately adjacent to it at the present, most of the site has been patented for mineral development, and an evaluation of the claims would be required. The Bureau of Mines concluded that availability of low-cost water could possibly stimulate mineral development in the Silverton area. The possibility of coal resources at the Three Buttes site would also have to be investigated.

The potential disturbance of cultural resources would be shifted generally north of that from the proposed plan and would involve a larger number of reservoir sites and generally more potential construction disturbance along canal alignments. However, the major cultural resources are on the Indian Reservations, particularly on the Ute Mountain Ute Reservation, and would receive less adverse impact under the plan at authorization because fewer acres of Indian land are included. The old mining townsite of Howardsville, which would be inundated by Howardsville Reservoir, is shown on the State inventory of historic places but, as yet, has not been given any significant status by the State or the National Register of Historic Places and would have to be evaluated as a historic site.

The stream depletion in the San Juan River would be about the same as the depletion with the proposed plan. The Animas River would be depleted more in total, and also for a longer reach, because diversion would take place north of the area to be served instead of near Durango as with the proposed plan. The operation studies of the project showed that the flow would be reduced to the minimum of 25 cubic feet per second at Baker's Bridge, 17 river miles north of Durango, 13 percent of the time, and would fall below 140 cubic feet per second, 54 percent of the time. Operation studies of the proposed plan show that the flow would fall below 140 cubic feet per second, 40 percent of the time, south of the Durango Pumping Plant; pumping would be stopped at 125 cubic feet per second in the winter and 225 cubic feet per second in the summer.

Increase in salinity at Imperial Dam from stream depletion would be 17.6 mg/l compared to 18.6 mg/l with the proposed plan. Salt loading effects would increase the salinity at Imperial Dam by about 8 mg/l annually, principally because of return flows from highly saline soils in the McDermott and Meadows areas. In the proposed plan these areas would not be served, and the effects of salt loading from irrigated land would amount to about 1.3 mg/l.

Pollution from mining activity would have more of an effect on this alternative than in the proposed plan because the diversion would be close to the spill, and there would be less warning time to stop diversions.

In the five reservoir basins in the plan at authorization, approximately 4,000 acres of grassland, with minor amounts of mountain shrub or coniferous tree growth on slopes would be inundated, about the same acreage and general habitat as in the proposed plan. Consultation with the U.S. Fish and Wildlife Service (1961) at the time of feasibility studies indicated that inundation of the five reservoir sites would not significantly affect wildlife. The reservoir sites provide summer range, which is not a critical need in the area. Ridges Basin Reservoir site in the proposed plan, however, is critical winter range for deer and elk.

The 47.6-mile Animas Diversion Canal would traverse rugged mountain terrain, replacing approximately 330 acres of ponderosa pine, oak brush, and juniper. The total length of all canals would be about 133 miles; some vegetation would be lost where there is flowing water, but side slopes and construction damaged areas would be reseeded to natural vegetation. Temporary disruption would occur while about 31 miles of pipe sections of canals were being buried. About 133 miles of the canals would remain open and would be a potential hazard to humans and wildlife. According to the Fish and Wildlife Service the distribution system would cover an area of little general significance to wildlife, but would have an effect on big game during migration seasons across about 27 miles of the Animas Diversion Canal in scattered sections between Teft Diversion Dam and Hay Gulch Reservoir. The plan at authorization provided for five game crossings across this canal. Project land and the unlined stretches of canals in the service areas would provide an improvement for upland game and waterfowl, as with the proposed plan. This plan would create about the same amount of lacustrine wetlands as the proposed plan and more riverine wetlands because of the long canal and open lateral system.

The Howardsville area inundation would mean loss of what the U.S. Fish and Wildlife Service termed a modest stream fishery. Significant loss of the limited stream fishery on the Animas River would occur below the Teft Diversion Dam because of severe depletions. Substantial increases would occur in reservoir fisheries.

Endangered species in the general area are the bald eagle, peregrine falcon, and the Colorado River squawfish. Consultation under Section 7 of the Endangered Species Act would have to be undertaken with the U.S. Fish and Wildlife Service if this alternative were selected.

The features in the plan at authorization would have impacts from northeast of Silverton to Durango, an area not involved in construction of the proposed plan. Much local opposition has been expressed to construction of features marring the mountain landscape to the north, and to any curtailment of mineral development. The Forest Service concluded that anticipated increased recreation use, particularly at Howardsville Reservoir area, would extend onto adjoining and nearby National Forest land, and additional facilities financed by the Forest Service would be needed. That agency also believed that the Animas

Diversion Canal would affect access to National Forest areas, spoil potential recreation sites, and mar the natural scenery. A major resort area now exists in part of the area through which the canal alignment extends. The severe reduction of flow in the Animas River downstream of the Teft diversion would reduce the value of the experience of riding the narrow gauge railroad between Durango and Silverton, a major economic resource to the area.

b. Teft Diversion Plan

The Teft Diversion Plan is a modification of the plan at authorization. Animas River water is diverted at the same location, but Howardsville Reservoir and the land which contributed excessive salinity have been removed. The plan would have significant environmental impacts associated with depleting the Animas River north of Durango.

(1) Plan Description

The Teft Diversion alternative would use a gravity system to convey Animas River water to the La Plata River drainage, rather than a pumping system. The same water user groups would receive exactly the same amount of water and have the same land as in the proposed plan. There is very little pumping associated with this alternative. Figure H-2 on the following page shows intended facilities of the plan.

The Teft Diversion alternative would divert flows of the Animas River about 25 miles north of Durango into a 48-mile conveyance system consisting of canals, tunnels, and siphons. This conveyance system would replace the Durango and Ridges Basin Pumping Plants, the large Ridges Basin Reservoir, and the Dry Side Canal from its beginning to Hay Gulch. Diversions would not reduce the Animas River flow to less than 125 cubic feet per second.

A small amount of water would be released from the long conveyance system into Basin Creek just before crossing into the La Plata River drainage. This water would be collected in a small Ridges Basin Reservoir, about one-tenth the size of Ridges Basin Reservoir in the proposed plan. The small Ridges Basin Reservoir would be used for Durango and New Mexico municipal and industrial water. Durango water would have to be pumped from the reservoir to Durango via the Durango trunk line. New Mexico water would be released into Basin Creek.

Water from the long conveyance system could also be released to serve lands on Red Mesa and into the La Plata River for use downstream. The conveyance system would finally put water into Hay Gulch Reservoir. Hay Gulch Reservoir, a little smaller than Southern Ute Reservoir in the proposed plan, would provide storage for water for the Dry Side irrigated lands plus the La Plata rural water and Ute Mountain Ute Indian municipal and industrial water. Water for the Dry Side land and Ute Mountain Ute Indian municipal and industrial water would be conveyed westward by a canal.

The Southern Ute Reservoir system in this alternative is identical to the Southern Ute Reservoir system in the proposed plan. The Southern Ute Indian municipal and industrial water and the New Mexico irrigation water would be served with exactly the same facilities as in the proposed plan. Southern Ute Reservoir would be filled from La Plata River flows, return flows from irrigated land, and releases to the La Plata River from the Animas River water conveyance system.

All land in this plan would be served a sprinkler irrigation supply from buried pressure pipe laterals as in the proposed plan.

The construction cost of the Teft Diversion Alternative would be about 35 percent greater than the proposed plan but the operation and maintenance costs would be about half the proposed plan because there would be very little power purchase. The construction period would be 12 years rather than 10 years in the proposed plan.

(2) Environmental Impacts

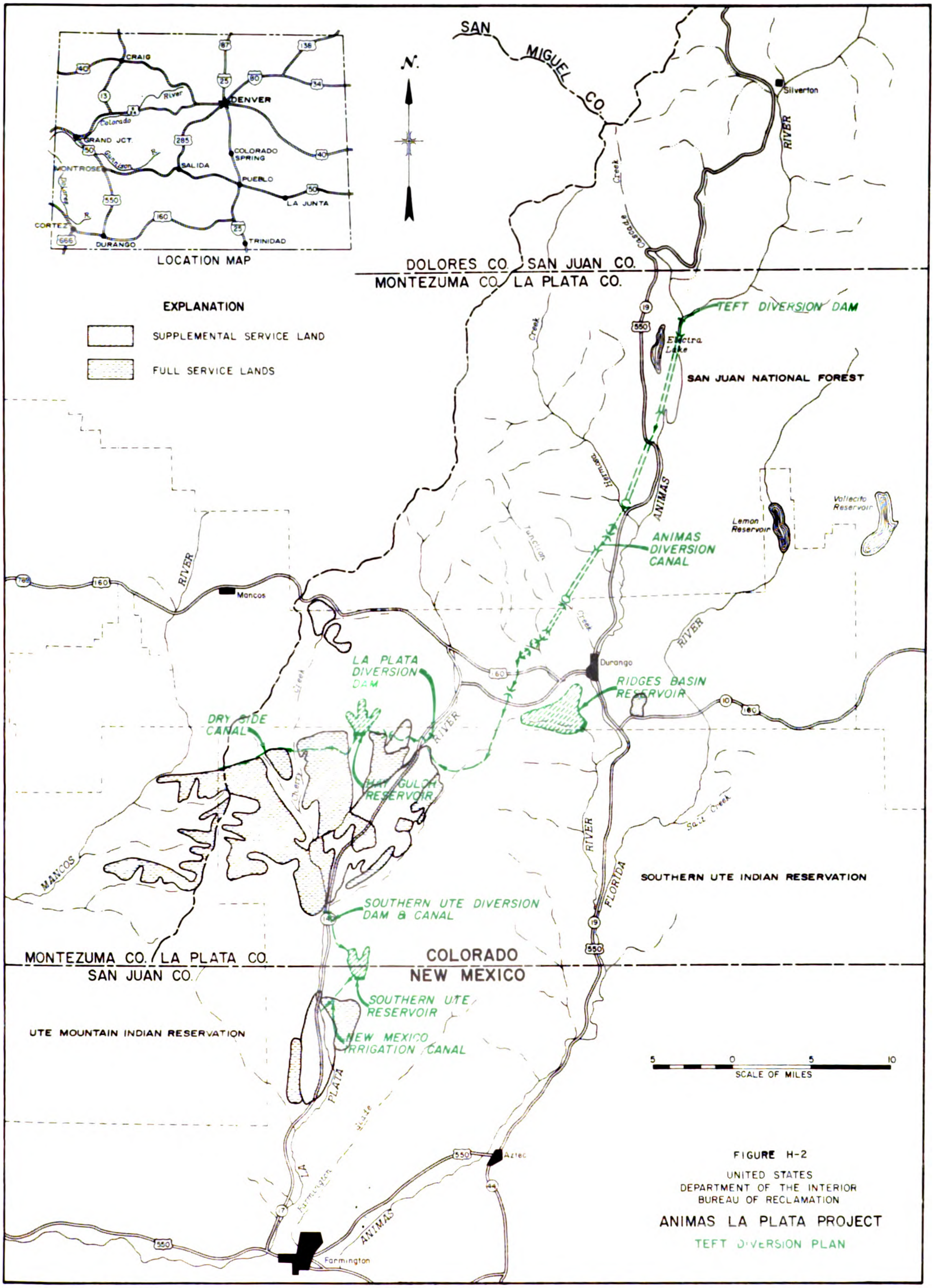
Since this plan is a larger construction project than the proposed plan, construction would extend about 2 years longer. The adverse impacts that an influx of temporary workers would have on the area's services and facilities would, therefore, extend for a longer period of time. The benefits of increased employment opportunities and increased payrolls in the local economy would also be extended through the 2-year period. The land to be served and the amount of water to be developed would be the same as in the proposed plan, so in general the social and economic effects would be the same as in the proposed plan.

Some potential disturbance of cultural resources would be shifted generally north of that from the proposed plan and would involve a larger number of reservoir sites and generally more potential construction disturbance along canal alignments. The major cultural resources are on the Indian Reservations, particularly on the Ute Mountain Ute Reservation as in the proposed plan. A cultural resources program would have to be developed as with the proposed plan.

The Bureau of Mines (1960, 1961) did not indicate that there were known mineral reserves at the Hay Gulch Reservoir site. The Southern Ute Reservoir site would affect two producing gas wells as in the proposed plan, and the wellheads would have to be raised to prevent inundation.

The Ridges Basin Reservoir is smaller in this alternative than in the proposed plan; however, the Lewis Shale on the south shore of the reservoir would still be susceptible to sliding when wet. Undercutting of slopes from wave action would not be significant because of the smaller water surface area.

The stream depletion in the San Juan River would be about the same as the depletion with the proposed plan. The Animas River


LOCATION MAP
EXPLANATION
SUPPLEMENTAL SERVICE LAND
FULL SERVICE LANDS
N.
SAN MIGUEL CO.
DOLORES CO. SAN JUAN CO.
MONTEZUMA CO. LA PLATA CO.
Silverton
TEFT DIVERSION DAM
Electra Lake
SAN JUAN NATIONAL FOREST
ANIMAS DIVERSION CANAL
Lemon Reservoir
Vallecito Reservoir
Mancos
Durango
LA PLATA DIVERSION DAM
RIDGES BASIN RESERVOIR
DRY SIDE CANAL
HAY GULCH RESERVOIR
SOUTHERN UTE INDIAN RESERVATION
SOUTHERN UTE DIVERSION DAM & CANAL
MONTEZUMA CO. LA PLATA CO.
SAN JUAN CO.
COLORADO
NEW MEXICO
SOUTHERN UTE RESERVOIR
NEW MEXICO IRRIGATION CANAL
UTE MOUNTAIN INDIAN RESERVATION
SCALE OF MILES
Aztec
Farmington
FIGURE H-2
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ANIMAS LA PLATA PROJECT
TEFT DIVERSION PLAN

would be depleted more in total, and also for a longer reach, because diversion would take place north of the area to be served instead of near Durango as with the proposed plan. The Animas River flows downstream of Durango would be greater with this alternative than the proposed plan becuse bypasses at the more northerly diversion would be observed in the same amounts as in the proposed plan and there are several tributaries between the diversion and Durango which would add to the flow.

The effects of salinity with this alternative would be identical to the proposed plan.

The impacts on fish in the Animas, La Plata, Mancos, and San Juan Rivers with this alternative would be as with the proposed plan. The 25 additional miles of Animas River depleted in this alternative are not a productive fishery. Recreation and fisheries would be available at three reservoirs, but the water surface area would be less than the area of the two reservoirs in the proposed plan.

The 47.6-mile Animas Diversion Canal would traverse rugged mountain terrain, replacing approximately 330 acres of ponderosa pine, oak brush, and juniper. The total length of all canals would be about 133 miles; some vegetation would be lost where there is flowing water, but side slopes and construction damaged areas would be reseeded to natural vegetation. Temporary disruption would occur while about 31 miles of pipe sections of canals were being buried.

The small Ridges Basin Reservoir would not have as great an impact on wildlife as with the proposed plan, but since the land is now managed by the State for wildlife and is critical winter habitat, plans to mitigate the impact would have to be developed. About 133 miles of the canals would remain open and would be a potential hazard to humans and wildlife. According to the Fish and Wildlife Service the distribution system would cover an area of little general significance to wildlife, but would have an effect on big game during migration seasons across about 27 miles of the Animas Diversion Canal in scattered sections between Teft Diversion dam and Hay Gulch Reservoir. There would be five game crossings across this canal. Project land and the unlined stretches of the canal would provide an improvement for upland game and waterfowl, as with the proposed plan. Under this plan less lacustrine wetland habitat would be created and about the same amount of riverine habitat would be lost or created as with the proposed plan.

The U.S. Forest Service believes that the Animas Diversion Canal would affect access to National Forest areas, spoil potential recreation sites, and mar the natural scenery. A major resort area now exists in part of the area through which the canal alignment extends. The reduction of flow in the Animas River downstream of the Teft diversion would reduce the value of the experience of riding the narrow gauge railroad between Durango and Silverton, a major economic resource to the area.

The endangered species in the regional area are the bald eagle, peregrine falcon, and Colorado River squawfish. Section 7 consultation with the U.S. Fish and Wildlife Service would be undertaken if this alternative were considered.

c. Bondad Diversion Plan

The Bondad Diversion Plan would provide a reservoir on the Animas River for flood control and a municipal and industrial water supply for the New Mexico communities. Water for irrigation would be pumped from the reservoir to the La Plata River drainage. The main reservoir would be located near the Colorado-New Mexico State line.

The major negative impacts would be relocation of the people living in the reservoir basin, the energy required for pumping, and elimination of 10 miles of stream habitat.

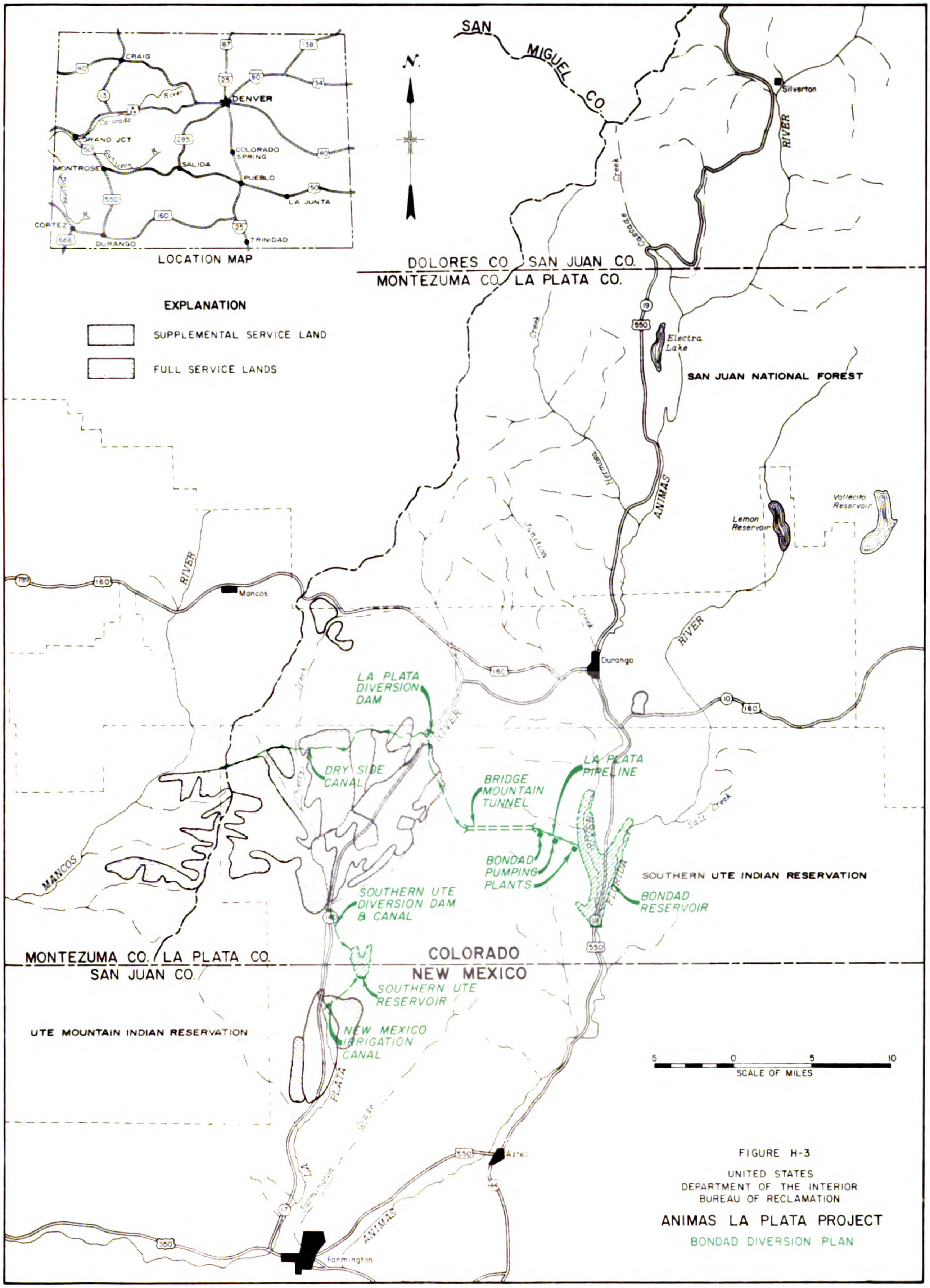
(1) Plan Description

The Bondad Diversion alternative would serve exactly the same amount of water and land to the same groups as in the proposed plan except for Durango, which could not be economically served in this alternative. Without Durango the municipal and industrial water supply is reduced 8,200 acre-feet, about a 10 percent reduction. Figure H-3 on the following page shows intended facilities of the plan.

The Bondad Diversion alternative would include a major dam and reservoir on the Animas River about 20 miles south of Durango. The reservoir would replace Ridges Basin Reservoir in the proposed plan, as the major storage reservoir. This reservoir, in addition to serving irrigation and municipal and industrial uses, would also provide flood control to the cities of Aztec and Farmington. Farmington and Aztec lie next to the Animas River and are very susceptible to flooding during high flows. The reservoir on the Animas River could also have offered the opportunity to create a fishery below the dam in New Mexico.

Municipal and industrial water for New Mexico would be released directly to the Animas River. Irrigation water, Indian industrial water, and La Plata rural water would be pumped from the north end of the reservoir into a long buried pipeline. There would be two booster pumps along the pipeline to provide additional lift. The pumps and pipeline would have the same capacity as the Ridges Basin Pumping Plant in the proposed plan. The lift associated with this alternative would be about 30 percent greater, thus the power costs would be 30 percent greater than the proposed plan.

At the end of the pipeline the water would pass through a tunnel and daylight about where the Dry Side Canal in the proposed plan meets at the end of the Long Hollow Tunnel. From this point the Bondad Diversion alternative is identical to the proposed plan. The Dry Side Canal, buried pipe laterals, and Southern Ute Reservoir system are the same as the proposed plan.



LOCATION MAP
EXPLANATION
SUPPLEMENTAL SERVICE LAND
FULL SERVICE LANDS
N.
SAN MIGUEL CO.
DOLORES CO. SAN JUAN CO.
MONTEZUMA CO. LA PLATA CO.
Silverton
Electra Lake
SAN JUAN NATIONAL FOREST
Lemon Reservoir
Vallecito Reservoir
Mancos
Durango
LA PLATA DIVERSION DAM
DRY SIDE CANAL
BRIDGE MOUNTAIN TUNNEL
LA PLATA PIPELINE
BONDAD PUMPING PLANTS
SOUTHERN UTE DIVERSION DAM & CANAL
BONDAD RESERVOIR
SOUTHERN UTE INDIAN RESERVATION
MONTEZUMA CO. LA PLATA CO.
SAN JUAN CO.
COLORADO
NEW MEXICO
SOUTHERN UTE RESERVOIR
UTE MOUNTAIN INDIAN RESERVATION
NEW MEXICO IRRIGATION CANAL
SCALE OF MILES
Aztec
Farmington
FIGURE H-3
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ANIMAS LA PLATA PROJECT
BONDAD DIVERSION PLAN

The construction cost of this alternative is about 20 percent greater than the proposed plan. The annual operation and maintenance is about 10 percent greater because of the higher pump lift. The increased operation and maintenance causes the annual costs to the irrigators to rise above their repayment capability. The construction period would be the same as the proposed plan.

(2) Environmental Impacts

The effects of the influx of construction workers would probably still be felt in Durango and the other areas of La Plata County that would receive this influx with the proposed plan, although it is possible more workers would choose to live in San Juan County, N. Mex. for construction of the more southerly features. The construction period and money into local economies would be similar to the proposed plan except for the possible shift of some indirect benefits from the Durango area to the Farmington area.

Cultural resources at Ridges Basin would not be involved but an evaluation of Bondad Reservoir site and the tunnel and canal alignment to Breen would be necessary and could locate some resources. The remainder of the area would be the same as with the proposed plan.

A major impact would be from the dam being located on the river. Most seriously, about 100 people would have to relocate. It would require relocation of a major highway in the area, create a major visual impact, and present significant water quality problems because any pollution from spills in the northern mining area could not be stopped from entering the reservoir. Two serious mine spills have occurred in the past 5 years and no steps have been taken to prevent future spills.

The river would be unaffected above the reservoir, thereby affecting a lesser reach than with the proposed plan. Salt loading and increased flow in the La Plata and Mancos Rivers would be the same as with the proposed plan, but depletion of the Animas and San Juan Rivers would be about 4,200 acre-feet less.

Controlled cold water releases from the dam could create a good trout stream for several miles downstream where one does not now exist. Rough fish introduction to the reservoir could not be controlled as with the off-stream reservoirs. Ten miles of existing pool quality stream fishery would be inundated.

About 2,600 acres of irrigated farmland would be inundated. The natural vegetation in the area is sparse so the effect of the other project features on vegetation would be small. Less lacustrine wetland habitat would be formed than with the proposed plan, with about the same potential for riverine wetland habitat.

Wildlife would be little affected by Bondad Reservoir and the construction of conveyance features to Breen, compared to Ridges Basin disruption with the proposed plan. The area is not critical winter habitat and with the pipeline buried only the pumping plants would be above ground. Endangered species in the general area are the bald eagle, peregrine falcon, and Colorado River squawfish. The reservoir would eliminate 10 miles of stream that provides habitat for roosting and feeding for bald eagles. Section 7 consultation with the U.S. Fish and Wildlife Service would be undertaken if this alternative were selected.

## 4. Alternatives Within the Project Plan

### a. Durango Pumping Plant Alternative Sites

The proposed site for the Durango Pumping Plant is located on a bench of the Animas River that was used as a disposal area for waste solutions from a vanadium-uranium mill in the 1960's. The waste material is radioactive. At the time the feasibility design for the pumping plant was completed, the owners of the site had applied for a license to remove the radioactive wastes for reprocessing. The material was to have been entirely removed. The company, however, has recently withdrawn their license request. Unless the material is completely removed before construction of the pumping plant, an alternative site would have to be chosen. Preliminary investigations have identified two sites that appear to meet the requirements of adequate size, maintaining the necessary pumping head, and keeping construction costs about the same as with the proposed site. One site is located about 750 feet east of the proposed site, on the opposite side of the river, and the other about 1,200 feet south of the proposed site. Investigations are continuing on the two sites.

Environmental impacts at either alternate site would be identical to those at the site in the proposed plan.

### b. Transmission Line Alternatives

Additional power facilities would be needed in the area to operate the Durango and Ridges Basin Pumping Plants and the project sprinkler pumping plants. Several sources or combination of sources might be available in the near future. A 345-kilowatt (kV) line is being considered through the project area to Shiprock, N. Mex. If this line is developed, power might be purchased for the project needs. Smaller lines exist in the area and one or a combination of these might be purchased if the 345-kV line provides power for service the lines are now supplying. Because the 345-kV line is not definite, a 115-kV line that would be constructed by the Bureau of Reclamation was studied as part of the project plan. This line would extend from the Colorado River Storage Project (CRSP) Shiprock Substation 12 miles west of Farmington through the project area to the Durango Pumping Plant. The proposed route was defined to assess possible costs and environmental impacts. This

Shiprock-Durango Transmission Line corridor is shown on the General Map. The alternatives would be less costly and have fewer environmental impacts than construction of a separate line. If it is determined that the project line would have to be built, NEPA compliance for the alignment would be undertaken at that time.

# CHAPTER I

# CONSULTATION AND COORDINATION

## I. CONSULTATION AND COORDINATION

### 1. Development of the Proposal

To assist the Bureau of Reclamation in formulating the proposed plan, the La Plata Water Conservancy District in Colorado, the La Plata Conservancy District in New Mexico, and the Southwestern Colorado Water Conservation District formed an advisory team in late 1973 consisting of many diverse groups that needed a forum to express their various interests, concerns and needs. Representatives from the following groups participated on the advisory team.

Bureau of Reclamation
Southwestern Colorado Water Conservation District
La Plata Conservancy District
La Plata Water Conservancy Board
Colorado Water Conservation Board
Colorado Division of Water Resources
New Mexico Interstate Stream Commission
City of Bloomfield, New Mexico
City of Aztec, New Mexico
City of Farmington, New Mexico
City of Durango, Colorado
San Juan Council of Governments
Animas Regional Planning Commission
San Juan Ecological Society
Sierra Club
Southern Ute Indian Tribe
Ute Mountain Ute Indian Tribe
Navajo Nation
Bureau of Indian Affairs
Bureau of Land Management

With the Bureau of Reclamation providing the necessary water resource planning expertise, the advisory team met 12 times between January 1974 and June 1977 to examine about 30 alternative plans for developing the project. The advisory team considered the quantity of water and the amount of land that could be included in the project plan. As a result of this public involvement, all members of the advisory team agreed that the authorized plan should be altered because of environmental and economic concerns. At the 1976 meeting, the advisory team endorsed essentially the proposed plan as described in Chapter A.

In addition to the advisory team's contribution, a public workshop at Fort Lewis College attended by about 100 people, sponsored by the San Juan Ecological Society, examined the various alternatives to develop the project. The participants studied the alternatives in relation to such factors as potential growth in the area, environmental considerations, economic stability, food production, and recreation needs. At the conclusion, the workshop participants recommended the same proposed plan of development as that recommended by the advisory team.

The Bureau of Reclamation also held numerous meetings between 1963 and 1977 with the general public, such as the irrigators, city councils, residents of potential service areas, and Indian Tribes. Some of the topics of discussion included land that could be served, the effects on existing water rights and supply, municipal and industrial water needs, and participation in the project.

In 1978, the Bureau began a public information program on the project, which still continues. The program consists of contributing information when requested to newspapers, television, and radio stations and making presentations to interested community organizations.

In formulating the proposed plan, the Bureau of Reclamation also received planning assistance and evaluations of project purposes from several Federal and State agencies and local entities, including the U.S. Fish and Wildlife Service, Bureau of Mines, Forest Service, Public Health Service, Corps of Engineers, and Colorado Division of Wildlife.

## 2. Preparation of the Draft Environmental Statement

The Bureau of Reclamation received information from various Federal and State agencies concerning the present environment and anticipated impacts of the Project, and several organizations have provided substantial data under contracts for the project. The U.S. Fish and Wildlife Service conducted an inventory of fish and wildlife on the Southern Ute and Ute Mountain Ute Indian Reservations. The Colorado Division of Wildlife provided a similar study on the Colorado portion of the project area. Fort Lewis College prepared reports on the flora, small birds and mammals, reptiles, and amphibians of the project area, and Eastern New Mexico State University inventoried the streams in the New Mexico portion of the project area. The Bureau consulted with the State of Colorado's Region 9 on the Areawide Waste Treatment Management Plan (Section 208 of PL 92-500); a draft report on Region 9's water quality management plan is scheduled for completion in the fall of 1979. The Bureau also discussed the project with the consultants for the City of Durango concerning the city's expansion of its wastewater treatment facilities under Title II, Grant for Construction of Treatment Works (Section 201 of the Amendment to the Clean Water Act, 1977).

The University of Colorado and Centuries Archeological Research, Inc., under contract with the Bureau of Reclamation, have reported on the cultural resources of the area. The State Historic Preservation Officers of Colorado and New Mexico, Advisory Council on Historic Preservation, State Archeologists of Colorado and New Mexico, the U.S. Bureau of Land Management, National Park Service, Forest Service, Bureau of Indian

Affairs, and Southern Ute and Ute Mountain Ute Indian Tribal Councils reviewed and commented on the proposed actions concerning cultural resources.

Information on the geology soils and vegetation, and mineral resources of the project area and air and water quality data came from such agencies as the U.S. Geological Survey Soil Conservation Service, Bureau of Mines, Environmental Protection Agency, Colorado Department of Health, and New Mexico Environmental Improvement Agency. In addition, the Bureau of Reclamation obtained information from published materials of various agencies. Copies of the advance draft of this environmental statement were also sent to the Environmental Protection Agency and the U.S. Fish and Wildlife Service for their information and review.

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ATTACHMENTS

| | End-of-month-content | | | | | |
|---|---|---|---|---|---|---|
| | Wet year (1973) | | Normal year (1947) | | Dry year (1934) | |
| Month | Content (acre-feet) | Surface area (acres) | Content (acre-feet) | Surface area (acres) | Content (acre-feet) | Surface area (acres) |
| | | Ridges Basin Reservoir | | | | |
| January | 246,000 | 2,120 | 252,800 | 2,151 | 220,100 | 1,996 |
| February | 255,800 | 2,165 | 256,500 | 2,168 | 221,600 | 2,003 |
| March | 269,600 | 2,227 | 262,400 | 2,196 | 225,100 | 2,016 |
| April | 280,000 | 2,271 | 269,900 | 2,229 | 232,100 | 2,049 |
| May | 280,000 | 2,271 | 279,100 | 2,267 | 240,000 | 2,094 |
| June | 280,000 | 2,271 | 271,800 | 2,238 | 214,100 | 1,972 |
| July | 269,600 | 2,227 | 260,600 | 2,188 | 177,300 | 1,786 |
| August | 265,800 | 2,212 | 256,100 | 2,166 | 164,500 | 1,728 |
| September | 264,100 | 2,204 | 258,300 | 2,177 | 159,300 | 1,707 |
| October | 271,600 | 2,236 | 268,700 | 2,223 | 156,400 | 1,693 |
| November | 276,100 | 2,255 | 280,000 | 2,271 | 158,100 | 1,701 |
| December | 280,000 | 2,271 | 280,000 | 2,271 | 158,600 | 1,704 |
| | | Southern Ute Reservoir | | | | |
| January | 44,200 | 1,087 | 46,300 | 1,123 | 48,700 | 1,163 |
| February | 43,600 | 1,076 | 44,800 | 1,096 | 47,100 | 1,136 |
| March | 44,600 | 1,092 | 43,600 | 1,076 | 45,700 | 1,112 |
| April | 55,600 | 1,241 | 46,200 | 1,121 | 49,700 | 1,177 |
| May | 65,600 | 1,344 | 52,600 | 1,209 | 49,400 | 1,174 |
| June | 66,200 | 1,350 | 47,400 | 1,141 | 42,000 | 1,047 |
| July | 64,700 | 1,335 | 43,000 | 1,065 | 37,500 | 965 |
| August | 66,900 | 1,357 | 46,100 | 1,119 | 42,800 | 1,063 |
| September | 64,900 | 1,337 | 48,200 | 1,154 | 45,200 | 1,103 |
| October | 63,800 | 1,326 | 52,600 | 1,209 | 46,700 | 1,130 |
| November | 62,300 | 1,310 | 51,300 | 1,195 | 44,700 | 1,094 |
| December | 60,700 | 1,294 | 49,600 | 1,176 | 42,700 | 1,060 |

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | SITE TYPE | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| ENM10729 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| ENM10730 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| LA10152 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10153 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | BASKETMAKER III |
| LA10154 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10155 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| LA10156 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| LA10157 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA10158 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| LA10159 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO I | BASKETMAKER III |
| LA10160 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10161 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | PUEBLO I |
| LA10162 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | PUEBLO I |
| LA10163 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| LA10164 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | BASKETMAKER III |
| LA10165 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| LA10166 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | PUEBLO I |
| LA10167 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| LA10168 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10169 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10170 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| LA10171 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10172 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| LA10173 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | PUEBLO I |
| LA10174 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10175 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |

ATTACHMENT 2

## ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | SITE TYPE | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| LA10176 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10177 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| LA10178 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10179 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10180 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| LA10181 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |
| LA10182 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| LA10183 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10184 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |
| LA10185 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |
| LA10186 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10187 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10188 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10189 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| LA10190 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10191 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10192 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10193 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO III | PUEBLO II |
| LA10194 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10195 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10196 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |
| LA10197 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10198 | GREAT KIVA | SURFACE STRUCTURE | PUEBLO II | PUEBLO I |
| LA10199 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |
| LA10200 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |
| LA10201 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |
| LA10202 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |
| LA10203 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |
| LA10204 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |

ATTACHMENT 2

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| LA10205 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10206 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA10207 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10208 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| LA10209 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10210 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10211 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10212 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10213 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| LA10214 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10215 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10216 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10217 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10220 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |
| LA10221 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO III | PUEBLO II |
| LA10222 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO III | PUEBLO II |
| LA10223 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO III | ---- |
| LA10224 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO III | ---- |
| LA10225 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO I |
| LA10226 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10227 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10228 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| LA10229 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10240 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| LA10241 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| LA10325 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| LA10326 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| LA10327 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10328 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |

ATTACHMENT 2

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | SITE TYPE | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| LA10329 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | PUEBLO I |
| LA10333 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10334 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO III | PUEBLO II |
| LA10335 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | PUEBLO I |
| LA10336 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10337 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |
| LA10338 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10339 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10344 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO III | PUEBLO II |
| LA10350 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| LA10351 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10352 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA10353 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO III | PUEBLO II |
| LA14165 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| LA14166 | SHERD | LITHIC | PUEBLO III | ---- |
| LA14167 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| LA1897 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| LA1898 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA1900 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA1903 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA1906 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA1911 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA1912 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| LA1918 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA1920 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA1923 | SHERD | ---- | PREHISTORIC | ---- |
| LA1925 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA1926 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA1929 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | SITE TYPE | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| LA1930 | HEARTH | SHERD | PREHISTORIC | ---- |
| LA1933 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA1979 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA3292 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PREHISTORIC | ---- |
| LA3293 | RUBBLE | ---- | UNKNOWN | ---- |
| LA5605 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA5631 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA5632 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| LA5721 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| LA6157 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 29SJ48 | ROCK ALIGNMENTS | CAIRNS | UNKNOWN | ---- |
| 29SJ49 | SHERD | LITHIC | PUEBLO III | PUEBLO II |
| 29SJ50 | SHERD | LITHIC | PUEBLO III | BASKETMAKER III |
| 29SJ51 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO III | PUEBLO II |
| 29SJ52 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO III | PUEBLO II |
| 29SJ53 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO III | PUEBLO II |
| 29SJ54 | SURFACE STRUCTURE | ---- | BASKETMAKER III | ---- |
| 29SJ55 | CAIRNS | ---- | UNKNOWN | ---- |
| 29SJ56 | RANCH | ---- | EUROAMERICAN | ---- |
| 29SJ57 | HEARTH | ---- | EUROAMERICAN | ---- |
| 29SJ58 | ROCK ALIGNMENTS | ---- | EUROAMERICAN | ---- |
| 5LP168 | INDUSTRIAL | ---- | EUROAMERICAN | ---- |
| 5LP169 | LITHIC | ---- | PREHISTORIC | ---- |
| 5LP170 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP171 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP172 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP173 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP174 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP175 | LITHIC | ---- | PREHISTORIC | ---- |

ATTACHMENT 2

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | SITE TYPE | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| 5LP176 | SUBSURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP177 | SUBSURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP178 | SURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP179 | RUBBLE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP180 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP181 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP182 | HOGAN ET AL | ---- | UTE-NAVAJO | ---- |
| 5LP183 | SURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP184 | SURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP185 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP186 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP187 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP188 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP189 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP190 | STRUCTURES | ---- | EUROAMERICAN | ---- |
| 5LP191 | STRUCTURES | ---- | EUROAMERICAN | ---- |
| 5LP192 | RANCH | ---- | EUROAMERICAN | ---- |
| 5LP193 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP194 | LITHIC | ---- | PREHISTORIC | ---- |
| 5LP195 | RANCH | ---- | EUROAMERICAN | ---- |
| 5LP196 | STRUCTURES | ---- | EUROAMERICAN | ---- |
| 5LP197 | HOMESTEAD | LITHIC | EUROAMERICAN | PREHISTORIC |
| 5LP198 | STRUCTURES | ---- | EUROAMERICAN | ---- |
| 5LP199 | LITHIC | ---- | PREHISTORIC | ---- |
| 5LP200 | HOMESTEAD | ---- | EUROAMERICAN | ---- |
| 5LP201 | HOMESTEAD | STRUCTURES | EUROAMERICAN | ---- |
| 5LP202 | STRUCTURES | ---- | EUROAMERICAN | ---- |
| 5LP203 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP204 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |

ATTACHMENT 2

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | SITE TYPE | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| 5LP205 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP206 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP207 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP208 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO I | BASKETMAKER III |
| 5LP209 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | BASKETMAKER III | ---- |
| 5LP210 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP211 | SHERD | LITHIC | BASKETMAKER III | ---- |
| 5LP212 | SHERD | LITHIC | PUEBLO III | ---- |
| 5LP213 | SHERD | LITHIC | PUEBLO IV | ---- |
| 5LP214 | SHERD | LITHIC | PREHISTORIC | ---- |
| 5LP215 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP216 | STRUCTURES | ---- | EUROAMERICAN | ---- |
| 5LP217 | LITHIC | ---- | PREHISTORIC | ---- |
| 5LP218 | SHERD | LITHIC | PREHISTORIC | ---- |
| 5LP219 | SHERD | ---- | PUEBLO IV | ---- |
| 5LP220 | HEARTH | ---- | UNKNOWN | ---- |
| 5LP221 | RANCH | OVERHANG | EUROAMERICAN | PREHISTORIC |
| 5LP222 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP223 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP224 | SHERD | LITHIC | PUEBLO IV | ---- |
| 5LP225 | RANCH | SHERD | EUROAMERICAN | BASKETMAKER III |
| 5LP226 | SHERD | LITHIC | PUEBLO IV | ---- |
| 5LP227 | SHERD | LITHIC | PUEBLO I | ---- |
| 5LP228 | RANCH | LITHIC | EUROAMERICAN | PREHISTORIC |
| 5LP229 | SHERD | LITHIC | PUEBLO IV | ---- |
| 5LP230 | SHERD | LITHIC | PUEBLO III | PUEBLO I |
| 5LP231 | SHERD | LITHIC | PUEBLO IV | ---- |
| 5LP232 | CAIRNS | ---- | UNKNOWN | ---- |
| 5LP233 | ROCK ALIGNMENTS | ---- | UNKNOWN | ---- |

ATTACHMENT 2

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | SITE TYPE | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| 5LP234 | RANCH | ---- | EUROAMERICAN | ---- |
| 5LP235 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5LP236 | SUBSURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP237 | SUBSURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP238 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO I | BASKETMAKER III |
| 5LP239 | SUBSURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP240 | SUBSURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP241 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO I | BASKETMAKER III |
| 5LP242 | SUBSURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP243 | SUBSURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP244 | SUBSURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP245 | SUBSURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP246 | SURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP247 | SUBSURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5LP248 | SUBSURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5MTUMR1001 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1002 | SHERD | LITHIC | PREHISTORIC | ---- |
| 5MTUMR1003 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1004 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1005 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1006 | SHERD | LITHIC | PREHISTORIC | ---- |
| 5MTUMR1007 | SHERD | ---- | PREHISTORIC | ---- |
| 5MTUMR1008 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1009 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1010 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1011 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1012 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1013 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1014 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |

ATTACHMENT 2

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | | CULTURE PERIOD | |
|---|---|---|---|---|
| 5MTUMR1015 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1016 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1017 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1018 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1019 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1020 | SHERD | ---- | PREHISTORIC | ---- |
| 5MTUMR1021 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1022 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1023 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1024 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1025 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1026 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1027 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1028 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1029 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1030 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1031 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1032 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1033 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1034 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1035 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1036 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1037 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1038 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1039 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1040 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1041 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1043 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1044 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |

ATTACHMENT 2

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | | CULTURE PERIOD | |
|---|---|---|---|---|
| 5MTUMR1045 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1046 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1047 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1048 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1049 | RUBBLE | ---- | PREHISTORIC | ---- |
| 5MTUMR1050 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1051 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1052 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1053 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1054 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1055 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1056 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1057 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1058 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1059 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1060 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR1061 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1062 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR1063 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR1064 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1065 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1066 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1069 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1070 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1071 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1072 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1073 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1074 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1075 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| 5MTUMR1076 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1077 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1078 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1079 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1080 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1081 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO I |
| 5MTUMR1082 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR1083 | RUBBLE | ---- | PUEBLO II | ---- |
| 5MTUMR1084 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1085 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1086 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1087 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1088 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1089 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1090 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1091 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1092 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1093 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1094 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1095 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1096 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1097 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1098 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1099 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1100 | SURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5MTUMR1101 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1102 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1103 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1104 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |

ATTACHMENT 2

## ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| 5MTUMR1105 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1106 | SURFACE STRUCTURE | ---- | ---- | PUEBLO II |
| 5MTUMR1107 | SURFACE STRUCTURE | ---- | PUEBLO I | BASKET MAKER III |
| 5MTUMR1108 | SURFACE STRUCTURE | ---- | PUEBLO I | BASKET MAKER III |
| 5MTUMR1109 | RUBBLE | ---- | PUEBLO II | ---- |
| 5MTUMR1110 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR1111 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1112 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1113 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1114 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1115 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1116 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1118 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1119 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1120 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1121 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1122 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR1123 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1124 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| 5MTUMR1125 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1126 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1127 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| 5MTUMR1128 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| 5MTUMR1129 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1130 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1131 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| 5MTUMR1132 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1133 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1134 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |

ATTACHMENT 2

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| 5MTUMR1135 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1136 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1141 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| 5MTUMR1142 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| 5MTUMR1143 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| 5MTUMR1148 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1151 | SURFACE STRUCTURE | ---- | PUEBLO III | ---- |
| 5MTUMR1152 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| 5MTUMR1154 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO I |
| 5MTUMR1157 | SHERD | ---- | PUEBLO II | ---- |
| 5MTUMR1161 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1162 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1163 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1171 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1172 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1174 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1175 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1176 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1177 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR1178 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR1179 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR1180 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO I |
| 5MTUMR1181 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR2150 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2154 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2155 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2156 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2157 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2158 | CLIFF DWELLING | ---- | PUEBLO II | ---- |

ATTACHMENT 2

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | SITE TYPE | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| 5MTUMR2159 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2552 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2553 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2554 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2566 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2567 | SHERD | LITHIC | PUEBLO III | PUEBLO I |
| 5MTUMR2568 | HOGAN, BURIAL | ---- | UTE-NAVAJO | ---- |
| 5MTUMR2569 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2570 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2571 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2572 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2573 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2574 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR2575 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2576 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2577 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2578 | HEARTH | ---- | PUEBLO II | ---- |
| 5MTUMR2579 | HEARTH | ---- | PUEBLO II | ---- |
| 5MTUMR2580 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2581 | SURFACE STRUCTURE | RUBBLE | PUEBLO II | ---- |
| 5MTUMR2582 | HEARTH | ---- | PREHISTORIC | ---- |
| 5MTUMR2583 | AGRICULTURAL | ---- | PREHISTORIC | ---- |
| 5MTUMR2584 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO I |
| 5MTUMR2585 | SURFACE STRUCTURE | RUBBLE | PREHISTORIC | ---- |
| 5MTUMR2586 | SURFACE STRUCTURE | RUBBLE | PUEBLO II | ---- |
| 5MTUMR2587 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO I | ---- |
| 5MTUMR2588 | HEARTH | ---- | PREHISTORIC | ---- |
| 5MTUMR2589 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO I | ---- |
| 5MTUMR2590 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |

## ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | SITE TYPE | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| 5MTUMR2591 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR2592 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2593 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2594 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2595 | SURFACE STRUCTURE | RUBBLE | PUEBLO II | PUEBLO I |
| 5MTUMR2596 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2597 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2598 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2599 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2600 | SURFACE STRUCTURE | ---- | PREHISTORIC | ---- |
| 5MTUMR2601 | SHERD | LITHIC | BASKETMAKER III | ---- |
| 5MTUMR2602 | SURFACE STRUCTURE | RUBBLE | PUEBLO II | ---- |
| 5MTUMR2603 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2604 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2605 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2606 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2607 | SURFACE STRUCTURE | RUBBLE | PREHISTORIC | ---- |
| 5MTUMR2608 | SURFACE STRUCTURE | RUBBLE | PUEBLO II | ---- |
| 5MTUMR2609 | SURFACE STRUCTURE | RUBBLE | PUEBLO II | ---- |
| 5MTUMR2610 | HEARTH | ---- | PREHISTORIC | ---- |
| 5MTUMR2611 | SHERD | LITHIC | PUEBLO I | BASKETMAKER III |
| 5MTUMR2612 | SURFACE STRUCTURE | ---- | PUEBLO I | BASKETMAKER III |
| 5MTUMR2613 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2614 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2615 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2616 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| 5MTUMR2617 | HEARTH | ---- | PREHISTORIC | ---- |
| 5MTUMR2618 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2619 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |

ATTACHMENT 2

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | SITE TYPE | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| 5MTUMR2620 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2621 | SURFACE STRUCTURE | RUBBLE | PUEBLO II | ---- |
| 5MTUMR2622 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2623 | SURFACE STRUCTURE | RUBBLE | PUEBLO II | ---- |
| 5MTUMR2624 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2625 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2626 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2627 | AGRICULTURAL | ---- | PREHISTORIC | ---- |
| 5MTUMR2628 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2629 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2630 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2631 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2632 | SURFACE STRUCTURE | RUBBLE | PREHISTORIC | ---- |
| 5MTUMR2633 | ROCK ALIGNMENTS | ---- | PREHISTORIC | ---- |
| 5MTUMR2634 | CLIFF DWELLING | ---- | PUEBLO II | ---- |
| 5MTUMR2635 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO III | PUEBLO II |
| 5MTUMR2749 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2803 | SURFACE STRUCTURE | RUBBLE | BASKETMAKER III | ---- |
| 5MTUMR2804 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2805 | SURFACE STRUCTURE | RUBBLE | BASKETMAKER III | ---- |
| 5MTUMR2806 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO I | ---- |
| 5MTUMR2807 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2808 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2809 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | BASKETMAKER III | ---- |
| 5MTUMR2810 | SURFACE STRUCTURE | RUBBLE | BASKETMAKER III | ---- |
| 5MTUMR2811 | SURFACE STRUCTURE | ---- | BASKETMAKER III | ---- |
| 5MTUMR2812 | AGRICULTURAL | ---- | PUEBLO II | ---- |
| 5MTUMR2813 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2814 | SHERD | LITHIC | PUEBLO I | ---- |

ARCHEOLOGICAL SITES IN THE ANIMAS-LA PLATA PROJECT VICINITY

| SITE | SITE TYPE | SITE TYPE | CULTURE PERIOD | CULTURE PERIOD |
|---|---|---|---|---|
| 5MTUMR2815 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2816 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR2817 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2818 | SURFACE STRUCTURE | RUBBLE | PUEBLO I | ---- |
| 5MTUMR2819 | SURFACE STRUCTURE | RUBBLE | PUEBLO I | ---- |
| 5MTUMR2820 | AGRICULTURAL | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2821 | AGRICULTURAL | ---- | PUEBLO II | PUEBLO I |
| 5MTUMR2822 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | BASKETMAKER III |
| 5MTUMR2823 | AGRICULTURAL | ---- | PUEBLO II | ---- |
| 5MTUMR2824 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO I | ---- |
| 5MTUMR2825 | SURFACE STRUCTURE | ---- | PUEBLO I | ---- |
| 5MTUMR2826 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO I | ---- |
| 5MTUMR2827 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | PUEBLO I |
| 5MTUMR2828 | SURFACE STRUCTURE | RUBBLE | PUEBLO I | ---- |
| 5MTUMR2829 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO I | ---- |
| 5MTUMR2830 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO I | ---- |
| 5MTUMR2831 | GREAT KIVA | SURFACE STRUCTURE | PUEBLO III | PUEBLO I |
| 5MTUMR2832 | SURFACE STRUCTURE | ---- | PUEBLO III | PUEBLO II |
| 5MTUMR2833 | SURFACE STRUCTURE | ---- | PUEBLO II | ---- |
| 5MTUMR2834 | SURFACE STRUCTURE | SUBSURFACE STRUCTURE | PUEBLO II | ---- |
| 5MTUMR2835 | AGRICULTURAL | ---- | PUEBLO II | ---- |
| 5MTUMR2836 | RANCH | ---- | EUROAMERICAN | ---- |
| 5MT4048 | SURFACE STRUCTURE | ---- | PUEBLO II | PUEBLO I |

Recommended water quality criteria

| Parameter | Water use: Water supply[1/] | Water use: Aquatic life[2/] |
|---|---|---|
| Physical and chemical | | |
| Suspended solids | | 25 mg/l, median |
| Total dissolved solids | 500 mg/l[3/] | |
| pH | 6.5-8.5[3/] | 6.5-9.0 |
| Coliform, fecal | 1,000 mpn/100 ml[4/] | |
| Dissolved oxygen | | 5.0 mg/l (minimum for fish) Aerobic at the water-sediment interface |
| Alkalinity ($CaCO_3$) | | 20 mg/l (minimum) |
| Magnesium | 125 mg/l[4/] | |
| Chloride | 250 mg/l[3/] | |
| Sulfate | 250 mg/l[3/] | |
| Nitrogen (as N) | | |
| Ammonia | 0.5 mg/l[4/] | 0.02 mg/l[5/] |
| Nitrate (as N) | 10 mg/l | |
| Phosphate, ortho | | 25 ug/l, lakes |
| Trace elements | | |
| Arsenic (total) | 0.05 mg/l | |
| Barium (total) | 1.0 mg/l | |
| Beryllium (total) | | 11 ug/l (soft, fresh water); 1.1 mg/l (hard, fresh water) |
| Cadmium (total) | .01 mg/l | 0.4-4.0 ug/l (soft water); 1.2-12.0 ug/l (hard water) |
| Chromium (total) | .05 mg/l | 100 ug/l |
| Copper (total) | 1.0 mg/l[3/] | 0.1 x 96-hour LC50 |
| Cyanide | .2 mg/l[4/] | 5 ug/l |
| Fluoride | 1.4-2.4 mg/l[6/] | |
| Iron (total) | | 1.0 mg/l |
| Dissolved | .3 mg/l[3/] | .3 mg/l |
| Lead (total) | .05 mg/l | .01 x 96-hour LC50 |
| Manganese, dissolved | .05 mg/l[3/] | |
| Mercury (total) | .002 mg/l | .05 ug/l |
| Nickel (total) | | .01 x 96-hour LC50 (0.1 mg/l) |
| Selenium (total) | .01 mg/l | .01 x 96-hour LC50 |
| Silver, dissolved | | .01 x 96-hour LC50 (0.1 ug/l) |
| Zinc (total) | 5 mg/l[3/] | .01 x 96-hour LC50 (0.03 mg/l) |
| Radionuclides[7/] | | |
| Alpha (total) | 15 pc/l[8/] | |
| Beta (total) | 50 pc/l[8/] | |

1/ National Interim Drinking Water Standards, Environmental Protection Agency, 1975.

2/ Quality criteria for water, 1976, Environmental Protection Agency (Redbook).

3/ Physical and chemical, secondary maximum contaminant levels or the advisable maximum level as delivered to the user. EPA (40 CFR Part 143, 1977).

4/ Recommended drinking water criteria for the State of Colorado.

5/ Recommended level for ammonia is for the un-ionized form, which for these waters is generally less than 15 percent of the total ammonia given in the tables.

6/ Recommended limits and maximum permissible concentrations for fluoride vary with the annual average of maximum daily air temperature, from the lowest concentrations at 79.3-90 5° F to the highest at 50.0-53-7° F.

7/ Environmental Protection Agency (water supply above) part 2 drinking water regulations (radionuclides), Federal Regulations, Volume 40, No. 133, Part 141 Interim Primary Drinking Water Regulations, July 9, 1976.

8/ If alpha or beta are measured in excess of 15 or 50 pc/l, respectively, it will be necessary to determine by specific analysis the specific radionuclides responsible.

Summary of water quality data
Animas River above Durango[1]

| Constituent | Unit | Date (years) | Minimum | Unweighted mean | Maximum | Number exceeding drinking water standards/total |
|---|---|---|---|---|---|---|
| **Physical and chemical** | | | | | | |
| Temperature | °C | 1969-76 | 0.0 | 5.6 | 16.1 | 0/36 |
| Turbidity | FTU | 1969-76 | 1.0 | 8.2 | 16.0 | 0/28 |
| pH | SU | 1969-76 | 6.9 | 7.9 | 8.9 | 0/32 |
| Dissolved oxygen | mg/l | 1973-76 | 7.4 | 10.5 | 12.2 | 0/13 |
| $BOD_5$ | mg/l | 1969-76 | .0 | 1.3 | 8.0 | 0/22 |
| Coliforms | | | | | | |
| Total | MPN/100 ml | 1970-76 | 2 | 216 | 2,400 | 0/29 |
| Fecal | MPN/100 ml | 1970-76 | 0 | 101 | 2,200 | 1/29 |
| Hardness ($CaCO_3$) | mg/l | 1969-76 | 59.0 | 146.2 | 233.0 | 0/29 |
| Sodium | mg/l | 1969-76 | 1.0 | 10.0 | 29.3 | 0/29 |
| SAR | ratio | 1969-76 | .0 | .107 | .5 | 0/28 |
| Chloride | mg/l | 1969-76 | 1.0 | 4.55 | 12.0 | 0/29 |
| Fluoride | mg/l | 1969-76 | .20 | .43 | .90 | 0/28 |
| Sulfate | mg/l | 1969-76 | 25.0 | 90.76 | 157.0 | 0/29 |
| **Nutrients** | | | | | | |
| Nitrate (as N) | mg/l | 1969-76 | .000 | .134 | .800 | 0/29 |
| Nitrite (as N) | mg/l | 1969-76 | .000 | .002 | .010 | 0/28 |
| Ammonia (as N) | mg/l | 1969-76 | .000 | .064 | [3].720 | 1/29 |
| Phosphorus (total) | mg/l | 1974-76 | .000 | .068 | .230 | 0/12 |
| **Trace elements[2]** | | | | | | |
| Arsenic | µg/l | 1969-76 | .0 | .0 | .0 | 0/27 |
| Barium | µg/l | 1969-76 | .0 | 11.03 | 100.0 | 0/29 |
| Cadmium | µg/l | 1969-76 | .0 | .16 | [3]3.0 | 0/25 |
| Chromium (hex.) | µg/l | 1969-76 | .0 | .0 | .0 | 0/27 |
| Copper | µg/l | 1969-76 | .0 | .74 | 20.0 | 0/27 |
| Cyanide | µg/l | 1969-76 | .0 | .0 | .0 | 0/26 |
| Iron | µg/l | 1969-76 | 50.0 | 512.0 | [3]1,610.0 | 0/30 |
| Lead | µg/l | 1969-76 | .0 | 14.18 | [3]125.0 | 2/27 |
| Manganese | µg/l | 1969-76 | 50.0 | 221.0 | 800.0 | 0/30 |
| Mercury | µg/l | 1971-72 | .0 | [3].13 | [3].5 | 0/4 |
| Molybdenum | µg/l | 1971-76 | .0 | .93 | 10.0 | 0/16 |
| Selenium | µg/l | 1969-76 | .0 | .0 | .0 | 0/26 |
| Silver | µg/l | 1969-76 | .0 | .0 | .0 | 0/10 |
| Zinc | µg/l | 1969-76 | .0 | [3]179.0 | [3]740.0 | 0/3 |
| **Radioactivity** | | | | | | |
| Alpha, dissolved | Pc/l | 1974-75 | 7.60 | 8.83 | 10.20 | 0/4 |
| Beta, dissolved | Pc/l | 1969-75 | .44 | 7.35 | 11.90 | 0/3 |

1/ Samples collected by the Colorado Department of Health over a period from April, 1969 to June 1976.

2/ Total concentration.

3/ Value exceeds recommended criteria for aquatic wildlife.

Summary of water quality data
Animas River at Durango[1/]

| Constituent | Unit | Date (years) | Minimum | Unweighted mean | Maximum | Number exceeding drinking water standards/total |
|---|---|---|---|---|---|---|
| Physical and chemical | | | | | | |
| Streamflow | cfs | 1967-78 | 131 | 709 | 6,400 | 0/129 |
| Temperature | °C | 1967-78 | 0 | 8.8 | 21.7 | 0/128 |
| Total dissolved solids | mg/l | 1967-78 | 67 | 316 | 557 | 3/127 |
| pH | SU | 1967-78 | 7.1 | 7.8 | 8.7 | 1/126 |
| Dissolved oxygen | mg/l | 1977-78 | 7.8 | 8.0 | 11.0 | 0/7 |
| Alkalinity ($CaCO_3$) | mg/l | 1977-78 | 87 | 144 | 232 | 0/9 |
| Hardness ($CaCO_3$) | mg/l | 1977-78 | 142 | 263 | 320 | 0/9 |
| Calcium | mg/l | 1967-78 | 21 | 77 | 970 | 0/127 |
| Magnesium | mg/l | 1967-78 | 1.1 | 9.5 | 18.7 | 0/126 |
| Sodium | mg/l | 1967-78 | 1.5 | 17.1 | 44.0 | 0/127 |
| Potassium | mg/l | 1967-78 | 0.4 | 3.1 | 7.7 | 0/119 |
| SAR | ratio | 1967-77 | 0.1 | .4 | .9 | 0/127 |
| Bicarbonate | mg/l | 1967-78 | 46 | 148 | 740 | 0/127 |
| Carbonate | mg/l | 1967-78 | 0.0 | 9.6 | 10.4 | 0/126 |
| Chloride | mg/l | 1967-78 | .4 | 19.0 | 46.4 | 0/126 |
| Fluoride | mg/l | 1977-78 | .17 | .30 | .48 | 0/126 |
| Sulfate | mg/l | 1967-78 | 17.6 | 113.7 | 212.0 | 0/8 |
| Nutrients | | | | | | |
| Nitrate (as N) | mg/l | 1977-78 | 0.19 | .15 | .27 | 0/9 |
| Nitrite (as N) | mg/l | 1977-78 | 0.001 | .005 | .012 | 0/9 |
| Phosphorus | | | | | | |
| Total | mg/l | 1977-78 | 0 0 | .010 | .019 | 0/9 |
| Ortho | mg/l | 1977-78 | 0.001 | .003 | .004 | 0/9 |
| Trace elements[2/] | | | | | | |
| Aluminum | µg/l | 1977-78 | 80 | 560 | 1,040 | 0/8 |
| Arsenic | µg/l | 1977-78 | 1 | 1 | 1 | 0/7 |
| Barium | µg/l | 1977-78 | 129 | 158 | 184 | 0/3 |
| Cadmium | µg/l | 1977-78 | [3/]5 | [3/]24 | [3/]129 | 3/8 |
| Chromium (hex.) | µg/l | 1977-78 | 1 | 1 | 1 | 0/9 |
| Copper | µg/l | 1977-78 | 10 | 22 | [3/]64 | 0/8 |
| Cyanide | µg/l | 1977-78 | [3/]10 | [3/]18 | [3/]78 | 1/8 |
| Iron | | | | | | |
| Total | µg/l | 1977-78 | 19 | 397 | 836 | 0/8 |
| Dissolved | µg/l | 1977-78 | 16 | 41 | 90 | 0/8 |
| Lead | µg/l | 1977-78 | 1 | 1 | 1 | 0/3 |
| Manganese | | | | | | |
| Total | µg/l | 1977-78 | 96 | 142 | 203 | 0/8 |
| Dissolved | µg/l | 1977-78 | 76 | 130 | 203 | 7/7 |
| Mercury | µg/l | 1977-78 | .0 | [3/]4 | [3/]28 | 2/8 |
| Molybdenum | µg/l | 1977-78 | 3 | 11 | 26 | 0/8 |
| Nickel | µg/l | 1977-78 | 4 | 23 | 77 | 0/8 |
| Selenium | µg/l | 1977-78 | 1 | 1 | 4 | 1/8 |
| Silver | µg/l | 1977-78 | 1 | 7 | 15 | 0/8 |
| Zinc | µg/l | 1977-78 | 27 | [3/]395 | [3/]1,629 | 0/8 |
| Radioactivity | | | | | | |
| Alpha, dissolved | Pc/l | 1969-70 | .60 | .86 | 1.10 | 0/5 |
| Beta, dissolved | Pc/l | 1969-70 | .60 | 5.20 | 9.20 | 0/5 |

1/ Samples collected by the U.S. Bureau of Reclamation over a period from March, 1967 to February 1978.
2/ Total concentrations unless otherwise indicated.
3/ Value exceeds recommended criteria for aquatic wildlife.

Summary of water quality data
Animas River at Cedar Hill[1/]

| Constituent | Unit | Date (years) | Minimum | Unweighted mean | Maximum | Number exceeding drinking water standards/total |
|---|---|---|---|---|---|---|
| Physical and chemical | | | | | | |
| Streamflow | cfs | 1960-73 | 134.0 | 828.0 | 4,550.0 | 0/417 |
| Temperature | °C | 1960-75 | .0 | 10.0 | 24.5 | 0/284 |
| Suspended solids | mg/l | 1970-72 | 5.1 | 3/154.4 | 810.0 | 0/17 |
| Total dissolved solids | mg/l | 1969-73 | 148.0 | 278.2 | 462.0 | 0/29 |
| pH | SU | 1960-73 | 7.2 | 8.1 | 8.9 | 0/280 |
| Dissolved oxygen | mg/l | 1960-73 | 3/4.3 | 9.1 | 13.8 | 0/225 |
| $BOD_5$ | mg/l | 1960-72 | .0 | 1.94 | 8.6 | 0/183 |
| Coliforms | | | | | | |
| Total | MPN/100 ml | | .0 | 3,923 | 180,000 | 0/65 |
| Fecal | MPN/100 ml | 1969-73 | .0 | 390 | 15,000 | 1/46 |
| Alkalinity ($CaCO_3$) | mg/l | 1960-73 | 3/.0 | 116.5 | 280.0 | 0/297 |
| Hardness ($CaCO_3$) | mg/l | 1960-73 | 50.0 | 210.6 | 1,500.0 | 0/297 |
| Calcium | mg/l | 1969-73 | 34.0 | 61.0 | 88.0 | 0/29 |
| Magnesium | mg/l | 1969-73 | 4.8 | 9.8 | 22.0 | 0/29 |
| Sodium | mg/l | 1962-73 | 5.0 | 17.4 | 35.0 | 0/29 |
| Potassium | mg/l | 1962-73 | .9 | 2.58 | 4.50 | 0/29 |
| SAR | ratio | 1969-73 | .2 | .5 | 1.0 | 0/29 |
| Bicarbonate | mg/l | 1969-73 | 79.0 | 140.3 | 203.0 | 0/29 |
| Carbonate | mg/l | 1969-73 | .0 | 1.04 | 8.99 | 0/28 |
| Chloride | mg/l | 1960-73 | 3.0 | 26.9 | 210.0 | 0/294 |
| Fluoride | mg/l | 1962-73 | .1 | .43 | .8 | 0/27 |
| Sulfate | mg/l | 1960-73 | 24.0 | 124.9 | 380.0 | 17/279 |
| Nutrients | | | | | | |
| Nitrate (as N) | mg/l | 1969-70 | .0 | .17 | .4 | 0/19 |
| Nitrite (as N) | mg/l | 1970 | .0 | .0 | .0 | 0/2 |
| Ammonia (as N) | mg/l | 1960-73 | .02 | .14 | 3/2.40 | 6/180 |
| Phosphorus | | | | | | |
| Total | mg/l | 1964-73 | .01 | .11 | .85 | 0/28 |
| Dissolved | mg/l | 1964-73 | .05 | .05 | .05 | 0/1 |
| Silica, dissolved | mg/l | 1969-73 | 4.4 | 7.97 | 18.0 | 0/29 |
| Trace elements[2/] | | | | | | |
| Aluminum, dissolved | µg/l | 1963, '68, '73 | 5.0 | 29.3 | 110.0 | 0/23 |
| Arsenic, dissolved | µg/l | 1962-71 | 10.0 | 46.6 | 100.0 | 8/31 |
| Barium, dissolved | µg/l | 1962-73 | 10.0 | 47.1 | 135.0 | 0/24 |
| Boron, dissolved | µg/l | 1962-73 | 11.0 | 62.7 | 196.0 | 0/35 |
| Cadmium, dissolved | µg/l | 1962-73 | 2.0 | 3/12.6 | 3/65.9 | 7/31 |
| Chromium, dissolved | µg/l | 1962-73 | 1.0 | 9.0 | 96.9 | 2/27 |
| Copper | µg/l | 1962-73 | 2.0 | 8.2 | 3/44.0 | 0/25 |
| Iron | | | | | | |
| Total | µg/l | 1962-70 | 2.0 | 12.3 | 50.0 | 0/28 |
| Dissolved | µg/l | 1969-73 | .0 | 33.9 | 290.0 | 0/21 |
| Lead, dissolved | µg/l | 1962-73 | 4.0 | 24.6 | 3/52.0 | 1/31 |
| Manganese | | | | | | |
| Total | µg/l | 1962-70 | 4 | 12.0 | 90.0 | 0/30 |
| Dissolved | µg/l | 1969-73 | 23.0 | 44.22 | 89.9 | 4/9 |
| Molybdenum, dissolved | µg/l | 1962-73 | 2.0 | 21.4 | 88.0 | 0/25 |
| Nickel, dissolved | µg/l | 1962-73 | 2.0 | 10.4 | 30.0 | 0/31 |
| Selenium | µg/l | 1962-63 | .01 | .01 | .01 | 0/2 |
| Silver, dissolved | µg/l | 1962-73 | 3/.2 | 3/1.7 | 3/7.0 | 0/25 |
| Zinc, dissolved | µg/l | 1962-75 | 3.0 | 3/35.9 | 3/300.0 | 0/33 |
| Radioactivity | | | | | | |
| Alpha, dissolved | Pc/l | 1960-71 | .0 | 4.56 | 37.0 | 70/402 |
| Beta, dissolved | Pc/l | 1960-71 | 0 | 15.79 | 114.0 | 80/397 |

1/ Samples collected by the U.S. Geological Survey over a period from February, 1960 to August, 1973.
2/ Total concentrations unless otherwise indicated.
3/ Value exceeds recommended criteria for aquatic wildlife.

Summary of water quality data
Animas River at Farmington[1]

| Constituent | Unit | Date (years) | Minimum | Unweighted mean | Maximum | Number exceeding drinking water standards/total |
|---|---|---|---|---|---|---|
| Physical and chemical | | | | | | |
| Streamflow | cfs | 1959-76 | 40.6 | 913.4 | 7,620.0 | 0/552 |
| Temperature | °C | 1959-76 | .0 | 12.2 | 27.8 | 0/243 |
| Suspended solids | mg/l | 1959-75 | 8.0 | 3/3,123.1 | 3/27,900.0 | 0/155 |
| Total dissolved solids | mg/l | 1967-76 | 114.0 | 380.8 | 682.0 | 37/126 |
| pH | SU | 1954-76 | 7.0 | 7.8 | 3/9.1 | 0/512 |
| Dissolved oxygen | mg/l | 1970-76 | 6.0 | 6.6 | 13.0 | 0/68 |
| $BOD_5$ | mg/l | 1970-72 | .6 | 1.4 | 2.8 | 0/24 |
| Coliforms | | | | | | |
| Total | MPN/100 ml | 1970-71 | 90.0 | 2,813.0 | 7,300.0 | 1/13 |
| Fecal | MPN/100 ml | 1970-71 | 10.0 | 339.9 | 1,520.0 | 0/12 |
| Alkalinity ($CaCO_3$) | mg/l | 1965-76 | 53.0 | 131.3 | 220.0 | 0/218 |
| Hardness ($CaCO_3$) | mg/l | 1959-76 | 82.0 | 241.0 | 608.0 | 0/476 |
| Calcium | mg/l | 1959-76 | 24.0 | 79.0 | 211.0 | 0/481 |
| Magnesium | mg/l | 1959-76 | 1.7 | 11.0 | 55.0 | 0/472 |
| Sodium | mg/l | 1959-76 | 1.1 | 33.4 | 98.0 | 0/448 |
| Potassium | mg/l | 1959-76 | .90 | 2.97 | 6.40 | 0/126 |
| SAR | ratio | 1959-76 | .2 | .9 | 14.0 | 0/475 |
| Bicarbonate | mg/l | 1959-76 | 60.0 | 152.2 | 268.0 | 0/483 |
| Carbonate | mg/l | 1959-76 | .4 | 2.3 | 15.0 | 0/59 |
| Chloride | mg/l | 1959-76 | 1.8 | 17.3 | 42.0 | 0/163 |
| Fluoride | mg/l | 1959-76 | .10 | .42 | .70 | 0/158 |
| Sulfate | mg/l | 1959-76 | 36.0 | 153.3 | 368.0 | 9/158 |
| Nutrients | | | | | | |
| Nitrate (as N) | mg/l | 1969-75 | .0 | .18 | .45 | 0/62 |
| Nitrite (as N) | mg/l | 1970-75 | .0 | .01 | .04 | 0/38 |
| Ammonia (as N) | mg/l | 1971-73 | .01 | .056 | .14 | 0/9 |
| Phosphorus | | | | | | |
| Total | mg/l | 1970-76 | .0 | .21 | 2.80 | 0/65 |
| Ortho | mg/l | 1971-76 | .0 | .044 | 3/.40 | 0/67 |
| Silica, dissolved | mg/l | 1959-76 | 4.90 | 8.22 | 17.00 | 0/158 |
| Trace elements[2] | | | | | | |
| Aluminum, dissolved | µg/l | 1971 | 5.0 | 5.0 | 5.0 | 0/1 |
| Arsenic | µg/l | 1975-76 | 1.0 | 12.5 | 45.0 | 0/4 |
| Barium, dissolved | µg/l | 1971-74 | .0 | 66.7 | 200.0 | 0/9 |
| Boron | µg/l | 1975 | 100.0 | 100.0 | 100.0 | 0/1 |
| Cadmium | µg/l | 1975-76 | 0 | 3/6.67 | 3/10.0 | 0/3 |
| Chromium (hex.) | µg/l | 1975-76 | .0 | 34.0 | 92.0 | 1/3 |
| Copper | µg/l | 1975-76 | 10.0 | 3/72.9 | 3/160.0 | 0/7 |
| Iron | | | | | | |
| Total | µg/l | 1959-76 | .0 | 30.6 | 3/33,820.0 | 0/35 |
| Dissolved | µg/l | 1967-76 | .0 | 31.2 | 3/600.0 | 2/93 |
| Lead | µg/l | 1971-76 | 19.0 | 3/154.4 | 3/700.0 | 11/17 |
| Manganese | | | | | | |
| Total | µg/l | 1975-76 | 110.0 | 1,206.7 | 3,300.0 | 0/3 |
| Dissolved | µg/l | 1971-76 | .0 | 34.3 | 100.0 | 4/13 |
| Mercury | µg/l | 1971-76 | .0 | 3/.36 | 3/4.0 | 1/13 |
| Molybdenum, dissolved | µg/l | 1971 | 2.0 | 2.0 | 2.0 | 0/1 |
| Nickel, dissolved | µg/l | 1971 | 5.0 | 5.0 | 5.0 | 0/1 |
| Selenium | µg/l | 1975-76 | 1.0 | 2.75 | 7.0 | 0/4 |
| Silver | µg/l | 1975 | 10.0 | 10.0 | 10.0 | 0/4 |
| Zinc | µg/l | 1975-76 | 10.0 | 3/444.3 | 3/870.0 | 0/7 |
| Radioactivity | | | | | | |
| Alpha, dissolved | Pc/l | 1971-72 | 1.4 | 3.1 | 4.8 | 0/2 |
| Beta, dissolved | Pc/l | 1971-74 | 4.0 | 5.3 | 7.3 | 0/8 |

1/ Samples collected by U.S. Geological Survey over a period from October, 1959 to October, 1976.
2/ Total concentration unless otherwise indicated.
3/ Value exceeds recommended criteria for aquatic wildlife.

Summary of water quality data
La Plata River at Hesperus 1/

| Constituent | Unit | Date (years) | Minimum | Unweighted mean | Maximum | Number exceeding drinking water standards/total |
|---|---|---|---|---|---|---|
| Physical and chemical | | | | | | |
| Streamflow | cfs | 1956-78 | 4.1 | 40.9 | 398.0 | 0/53 |
| Temperature | °C | 1956-78 | .0 | 7.8 | 22.2 | 0/77 |
| Total dissolved solids | mg/l | 1956-78 | 28.0 | 98.0 | 124.0 | 0/53 |
| pH | SU | 1956-78 | 5.4 | 8.1 | 8.8 | 1/72 |
| Dissolved oxygen | mg/l | 1973-76 | 7.5 | 9.3 | 12.4 | 0/21 |
| $BOD_5$ | mg/l | 1971-76 | .3 | .8 | 1.0 | 0/16 |
| Coliforms | | | | | | |
| Total | MPN/100 ml | 1971-76 | 2.2 | 1,270.6 | 2,400.0 | 0/24 |
| Fecal | MPN/100 ml | 1971-76 | 2 2 | 1,133.7 | 2,400.0 | 2/24 |
| Alkalinity ($CaCO_3$) | mg/l | 1971-78 | 3/ 12.0 | 65.1 | 84.0 | 0/30 |
| Hardness ($CaCO_3$) | mg/l | 1971-78 | 39.0 | 96.1 | 178.0 | 0/30 |
| Calcium | mg/l | 1956-78 | .0 | 24.8 | 36.0 | 0/52 |
| Magnesium | mg/l | 1956-78 | .0 | 4.4 | 21.0 | 0/73 |
| Sodium | mg/l | 1956-78 | .7 | 12.9 | 124.0 | 0/73 |
| Potassium | mg/l | 1956-78 | .1 | .7 | 3.7 | 0/52 |
| SAR | ratio | 1956-78 | .0 | .10 | 1.0 | 0/65 |
| Bicarbonate | mg/l | 1956-78 | .0 | 65.4 | 86.0 | 0/53 |
| Carbonate | mg/l | 1956-78 | .0 | .0 | 2.7 | 0/53 |
| Chloride | mg/l | 1956-78 | .0 | 1.8 | 9.0 | 0/73 |
| Fluoride | mg/l | 1971-78 | .10 | .22 | .47 | 0/28 |
| Sulfate | mg/l | 1956-78 | .0 | 23.5 | 53.0 | 0/72 |
| Nutrients | | | | | | |
| Nitrate (as N) | mg/l | 1971-78 | .0 | .11 | .4 | 0/29 |
| Nitrite (as N) | mg/l | 1971-78 | .0 | .002 | .021 | 0/28 |
| Ammonia (as N) | mg/l | 1971-76 | .0 | .01 | .2 | 0/20 |
| Phosphorus | | | | | | |
| Total | mg/l | 1974-78 | .0 | .01 | .1 | 0/21 |
| Ortho | mg/l | 1977-78 | .001 | .002 | .004 | 0/9 |
| Trace elements 2/ | | | | | | |
| Aluminum | µg/l | 1977-78 | 50 | 228 | 451 | 0/8 |
| Arsenic | µg/l | 1971-78 | 0 | .2 | 1 | 0/27 |
| Boron | µg/l | 1971-76 | .0 | 10.4 | 120.0 | 2/22 |
| Cadmium | µg/l | 1971-78 | 0 | 3/ 4.0 | 3/ 57 | 2/26 |
| Chromium (hex.) | µg/l | 1971-76 | .0 | .0 | .0 | 0/19 |
| Copper | µg/l | 1971-78 | 0 | 15.7 | 3/ 320 | 0/27 |
| Cyanide | µg/l | 1971-78 | 0 | 3/ 6.2 | 3/ 80 | 0/26 |
| Iron | | | | | | |
| Total | µg/l | 1971-78 | 0 | 66.2 | 286 | 0/29 |
| Dissolved | µg/l | 1977-78 | 6 | 14 | 21 | 0/8 |
| Lead | µg/l | 1971-78 | 0 | 4.5 | 3/ 65 | 1/22 |
| Manganese | | | | | | |
| Total | µg/l | 1971-78 | 0 | 4.0 | 26 | 0/28 |
| Dissolved | µg/l | 1977-78 | 3 | 7 | 10 | 0/8 |
| Mecury | µg/l | 1971-78 | 0 | 3/ .8 | 3/ 4 | 1/12 |
| Molybdenum | µg/l | 1971-78 | 0 | 2.1 | 19 | 0/28 |
| Nickel | µg/l | 1977-78 | 2 | 18 | 58 | 0/8 |
| Selenium | µg/l | 1971-78 | 0 | 1.1 | 7 | 0/26 |
| Silver | µg/l | 1972-72 | 0 | 3.2 | 11 | 0/17 |
| Zinc | µg/l | 1971-78 | 0 | 3/ 60.1 | 3/ 493 | 0/26 |
| Radioactivity | | | | | | |
| Alpha, dissolved | Pc/l | 1971-75 | 6.6 | 7 3 | 7.8 | 0/3 |
| Beta, dissolved | Pc/l | 1972 | 4.2 | 4.2 | 4.2 | 0/1 |

1/ Samples collected by U.S. Bureau of Reclamation over a period from July 1956 to January 1978, and by the Colorado Health Department over a period from August, 1971 to June, 1976.
2/ Total concentrations unless otherwise indicated.
3/ Value exceeds recommended criteria for aquatic wildlife.

Summary of water quality data[1]
La Plata River at Stateline

| Constituent | Unit | Date (years) | Minimum | Unweighted mean | Maximum | Number exceeding drinking water standards/total |
|---|---|---|---|---|---|---|
| **Physical and chemical** | | | | | | |
| Streamflow | cfs | 1955-78 | 0.05 | 31.4 | 362.0 | 0/229 |
| Temperature | °C | 1955-78 | 0 | 9.8 | 32.2 | 0/281 |
| Total dissolved solids | mg/l | 1955-78 | 202.0 | 872.0 | 1,640.0 | 194/227 |
| pH | SU | 1955-78 | 7.4 | 8.0 | 8.7 | 3/227 |
| Dissolved oxygen | mg/l | 1973-78 | 7.0 | 9.5 | 12.0 | 0/19 |
| $BOD_5$ | mg/l | 1968-76 | .5 | 1.4 | 3.0 | 0/23 |
| Coliforms | | | | | | |
| Total | MPN/100 ml | 1968-76 | 33.0 | 1,548.1 | 24,000.0 | 0/48 |
| Fecal | MPN/100 ml | 1968-76 | 2.0 | 794.5 | 24,000.0 | 4/46 |
| Alkalinity ($CaCO_3$) | mg/l | 1977-78 | 173.6 | 200.1 | 221.0 | 0/8 |
| Hardness ($CaCO_3$) | mg/l | 1968-78 | 204.0 | 788.5 | 1,904.0 | 0/50 |
| Calcium | mg/l | 1955-78 | .0 | 118.2 | 276.0 | 0/228 |
| Magnesium | mg/l | 1955-78 | .0 | 64.4 | 185.0 | 8/268 |
| Sodium | mg/l | 1955-78 | .0 | 69.7 | 840.0 | 0/270 |
| Potassium | mg/l | 1955-78 | 1.2 | 2.4 | 11.0 | 0/228 |
| SAR | ratio | 1955-78 | .3 | 1.1 | 9.0 | 0/262 |
| Bicarbonate | mg/l | 1955-78 | 98.0 | 205.8 | 364.0 | 0/229 |
| Carbonate | mg/l | 1955-78 | .0 | 2.4 | 29.0 | 0/229 |
| Chloride | mg/l | 1955-78 | 2.6 | 27.4 | 163.0 | 185/270 |
| Fluoride | mg/l | 1968-78 | .05 | .41 | 1.2 | 0/34 |
| Sulfate | mg/l | 1955-78 | .0 | 443.0 | 1,101.0 | 31/265 |
| **Nutrients** | | | | | | |
| Nitrate (as N) | mg/l | 1968-78 | .0 | .29 | .9 | 0/44 |
| Nitrite (as N) | mg/l | 1968-78 | .0 | .003 | .018 | 0/40 |
| Ammonia (as N) | mg/l | 1968-76 | .0 | .059 | [3].93 | 1/35 |
| Phosphorus | | | | | | |
| Total | mg/l | 1974-78 | .001 | .06 | .6 | 0/19 |
| Ortho | mg/l | 1977-78 | .001 | .003 | .008 | 0/8 |
| **Trace elements**[2] | | | | | | |
| Aluminum | µg/l | 1977-78 | 310 | 1,370 | | 0/8 |
| Arsenic | µg/l | 1968-78 | .0 | 0 | .0 | 0/34 |
| Boron | µg/l | 1968-76 | 0 | 92.3 | 300.0 | 0/31 |
| Cadmium | µg/l | 1968-78 | .0 | [3]5.4 | [3]100.0 | 5/48 |
| Chromium (hex.) | µg/l | 1968-78 | 0 | .0 | 1.0 | 0/33 |
| Copper | µg/l | 1968-78 | 0 | 3.7 | [3]46.0 | 0/34 |
| Cyanide | µg/l | 1968-78 | .0 | [3]7.0 | [3]90.0 | 0/32 |
| Iron | | | | | | |
| Total | µg/l | 1968-78 | .0 | 482.9 | [3]4,396 | 0/47 |
| Dissolved | µg/l | 1977-78 | 15 | 50 | 210 | 0/8 |
| Lead | µg/l | 1968-78 | .0 | .96 | 13.0 | 0/29 |
| Manganese | | | | | | |
| Total | µg/l | 1968-78 | .0 | 45.3 | 420.0 | 0/49 |
| Dissolved | µg/l | 1977-78 | 3.0 | 14.0 | 24.0 | 0/8 |
| Mercury | µg/l | 1970, '72, '77, '78 | .0 | [3].7 | [3]4.0 | 1/16 |
| Molybdenum | µg/l | 1971-78 | .0 | 5.7 | 39.0 | 0/23 |
| Nickel | µg/l | 1977-78 | 2.0 | 39.0 | [3]109 | 0/8 |
| Selenium | µg/l | 1968-78 | .0 | 1.2 | 13.0 | 1/40 |
| Silver | µg/l | 1968-78 | .0 | 2.2 | 11.0 | 0/24 |
| Zinc | µg/l | 1968-78 | .0 | 22.8 | [3]200.0 | 0/40 |
| **Radioactivity** | | | | | | |
| Alpha, dissolved | Pc/l | 1970-76 | .0 | 13.7 | 36.2 | 0/22 |
| Beta, dissolved | Pc/l | 1970-75 | 1.60 | 8.6 | 17.6 | 0/6 |

1/ Samples collected by U.S. Bureau of Reclamation over a period from January, 1955 to January 1968 and by the Colorado Department of Health over a period from January, 1968 to April, 1976.

2/ Total concentration unless otherwise indicated.

3/ Value exceeds criteria for aquatic wildlife.

Summary of water quality data[1]
La Plata River at Farmington

| Constituent | Unit | Date (years) | Minimum | Unweighted mean | Maximum | Number exceeding drinking water standards/total |
|---|---|---|---|---|---|---|
| Physical and chemical | | | | | | |
| Streamflow | cfs | 1958-77 | 0.01 | 17.1 | 338 0 | 0/225 |
| Temperature | °C | 1958-77 | .0 | 14.6 | 34.4 | 0/225 |
| Total dissolved solids | mg/l | 1958-77 | 337.0 | 2,027.0 | 4,630 0 | 181/187 |
| pH | SU | 1958-77 | 7.1 | 7.9 | 8.5 | 0/191 |
| Dissolved oxygen | mg/l | 1958-77 | 7 | 7.8 | 9 | 0/6 |
| Coliforms | | | | | | |
| Total | MPN/100 ml | 1970-71 | 10.0 | 1,404.0 | 10,000.0 | 0/15 |
| Fecal | MPN/100 ml | 1970-71 | 10 0 | 19.2 | 80 0 | 0/13 |
| Alkalinity ($CaCO_3$) | mg/l | 1973-77 | 117.0 | 211.5 | 272.0 | 0/8 |
| Hardness ($CaCO_3$) | mg/l | 1973-77 | 317.0 | 583.0 | 741.0 | 0/8 |
| Calcium | mg/l | 1958-77 | 52.0 | 215.3 | 414.0 | 0/188 |
| Magnesium | mg/l | 1958-77 | .0 | 74.9 | 164.0 | 17/189 |
| Sodium | mg/l | 1958-77 | 23.0 | 292.0 | 791.0 | 0/188 |
| Potassium | mg/l | 1958-77 | 2.0 | 5.0 | 13.0 | 0/188 |
| SAR | ratio | 1958-77 | .6 | 4.1 | 9.0 | 0/182 |
| Bicarbonate | mg/l | 1958-77 | 22.0 | 228.3 | 37[illegible].0 | 0/188 |
| Carbonate | mg/l | 1958-77 | .0 | 1.0 | 17 0 | 0/188 |
| Chloride | mg/l | 1958-77 | 1.0 | 80.5 | 199.0 | 0/188 |
| Fluoride | mg/l | 1973-77 | .30 | .49 | .78 | 0/8 |
| Sulfate | mg/l | 1958-77 | 138.0 | 1,120.6 | 2,857.0 | 177/188 |
| Nutrients | | | | | | |
| Nitrate (as N) | mg/l | 1977 | .01 | .38 | 1.33 | 0/6 |
| Nitrite (as N) | mg/l | 1977 | .001 | .011 | .031 | 0/6 |
| Phosphorus | | | | | | |
| Total | mg/l | 1977 | .002 | .025 | .089 | 0/6 |
| Ortho | mg/l | 1973-77 | .001 | .006 | .018 | 0/7 |
| Silica, dissolved | mg/l | 1972-73 | 10.0 | 10.5 | 11.0 | -/2 |
| Trace elements[2] | | | | | | |
| Aluminum | µg/l | 1977 | 302 | 3,040 | 12,120 | 0/5 |
| Arsenic | µg/l | 1977 | 1 | 1 | 1 | 0/5 |
| Boron, dissolved | µg/l | 1972-73 | 0 | 40.0 | 800 | 0/2 |
| Cadmium | µg/l | 1977 | 5 | [3]12 | [3]20 | 3/5 |
| Chromium (hex.) | µg/l | 1977 | 1 | 1 | 1 | 0/4 |
| Copper | µg/l | 1977 | 13 | 21 | [3]31 | 0/5 |
| Cyanide | µg/l | 1977 | 4 | 22 | 77 | 0/5 |
| Iron | | | | | | |
| Total | µg/l | 1977 | 19 | [3]1,965 | [3]7,203 | 0/5 |
| Dissolved | µg/l | 1973-77 | 19 | 50.8 | 130 | 1/6 |
| Lead | µg/l | 1977 | 1 | 3 | 5 | 0/2 |
| Manganese | | | | | | |
| Total | µg/l | 1977 | 138 | 646 | 908 | 0/5 |
| Dissolved | µg/l | 1977 | 36 | 601 | 903 | 4/5 |
| Mercury | µg/l | 1977 | 0 | [3]2 | [3]4 | 1/5 |
| Molybdenum | µg/l | 1977 | 11 | 23 | 41 | 0/5 |
| Nickel | µg/l | 1977 | 4 | 67 | [3]119 | 0/5 |
| Selenium | µg/l | 1977 | 1 | 2 | 4 | 0/5 |
| Silver | µg/l | 1977 | 4 | 7 | 9 | 0/6 |
| Zinc | µg/l | 1977 | 18 | 193 | [3]338 | 0/5 |

1/ Samples collected by the U.S. Bureau of Reclamation over a period from January, 1958 to December, 1977 and by the U.S. Geological Survey over a period from July, 1970 to January, 1973.
2/ Total concentration unless otherwise indicated.
3/ Value exceeds recommended criteria for aquatic wildlife.

Summary of water quality data
Mancos River near Towoac[1]

| Constituent | Unit | Date (years) | Minimum | Unweighted mean | Maximum | Number exceeding drinking water standards/total |
|---|---|---|---|---|---|---|
| Physical and chemical | | | | | | |
| Streamflow | cfs | 1964, '72, '78 | 0.0 | 36.0 | 248.0 | 0/22 |
| Temperature | °C | 1964, '76, '78 | .0 | 12.0 | 28.9 | 0/68 |
| Total dissolved solids | mg/l | 1969, '75, '78 | 344 0 | 1,756 1 | 5,612.0 | 4/16 |
| pH | SU | 1968, '76, '78 | 7 3 | 8.2 | [3]9.3 | 1/68 |
| Dissolved oxygen | mg/l | 1970, '76, '78 | 5 8 | 9.6 | 13.3 | 0/21 |
| $BOD_5$ | mg/l | 1968-76 | .6 | 1.6 | 3.0 | 0/21 |
| Coliforms | | | | | | |
| Total | MPN/100 ml | 1968-76 | 2.2 | 2,132.6 | 30,000 | 0/44 |
| Fecal | MPN/100 ml | 1968-76 | 2.0 | 150.2 | 2,300 | 1/42 |
| Alkalinity ($CaCO_3$) | mg/l | 1969, '75, '78 | 76.0 | 167.4 | 224.0 | 0/16 |
| Hardness ($CaCO_3$) | mg/l | 1968, '76, '78 | 226 0 | 914.2 | 2,900.0 | 0/52 |
| Calcium | mg/l | 1968, '76, '78 | 56.0 | 390.5 | 1,620.0 | 0/52 |
| Magnesium | mg/l | 1968, '76, '78 | 3.0 | 99.5 | 330.0 | 12/52 |
| Sodium | mg/l | 1968, '76, '78 | 14.0 | 125.7 | 500.0 | 0/53 |
| Potassium | mg/l | 1969, '75, '78 | 2.0 | 4.9 | 10.5 | 0/16 |
| SAR | ratio | 1968-76 | .3 | 1.5 | 3.0 | 0/49 |
| Bicarbonate | mg/l | 1969, '75, '78 | 76.0 | 193.2 | 273.0 | 0/16 |
| Carbonate | mg/l | 1969, '75, '78 | .0 | 1.1 | 11.0 | 0/15 |
| Chloride | mg/l | 1968, '76, '78 | 3.7 | 18.4 | 69.0 | 0/53 |
| Fluoride | mg/l | 1968, '76, '78 | 156.0 | 857.4 | 1,990.0 | 0/28 |
| Sulfate | mg/l | 1968, '76, '78 | .14 | .37 | .8 | 44/48 |
| Nutrients | | | | | | |
| Nitrate (as N) | mg/l | 1968, '76, '78 | .039 | .073 | .465 | 0/36 |
| Nitrite (as N) | mg/l | 1968, '76, '78 | .002 | .006 | .032 | 0/35 |
| Ammonia (as N) | mg/l | 1968-76 | .0 | .059 | [3].40 | 0/32 |
| Phosphorus | | | | | | |
| Total | mg/l | 1974, '76, '78 | 004 | .20 | 1.340 | 0/14 |
| Ortho | mg/l | 1968, '72, '78 | .001 | .025 | [3].20 | 0/35 |
| Silica, dissolved | mg/l | 1971-75 | 7.30 | 8.64 | 10.0 | 0/7 |
| Trace elements[2] | | | | | | |
| Aluminum | µg/l | 1978 | 275 | 772 | 1,527 | 0/5 |
| Arsenic | µg/l | 1968, '76, '78 | 0 | 559 | 24,000 | 0/43 |
| Boron | µg/l | 1968-76 | 0 | 87 | 350 | 0/26 |
| Cadmium | µg/l | 1968, '76, '78 | .0 | 1.2 | [3]9.0 | 0/29 |
| Chromium (hex.) | µg/l | 1968, '76, '78 | 0 | .14 | 1 | 0/28 |
| Copper | µg/l | 1968, '76, '78 | .0 | 16.9 | [3]260.0 | 0/29 |
| Cyanide | µg/l | 1968, '76, '78 | 0 | [3]11.7 | [3]14 | 0/25 |
| Iron | | | | | | |
| Total | µg/l | 1968, '76, '78 | .0 | [3]2,148.6 | [3]48,000.0 | 0/45 |
| Dissolved | µg/l | 1978 | 19 | 23 | 27 | 0/5 |
| Lead | µg/l | 1968, '76, '78 | 0 | 3.4 | 25 | 0/27 |
| Manganese | | | | | | |
| Total | µg/l | 1968, '76, '78 | .0 | 77.9 | 1,200.0 | 0/46 |
| Dissolved | µg/l | 1978 | 11.0 | 128.0 | 425.0 | 2/5 |
| Mercury | µg/l | 1970, '73, '78 | .0 | [3].56 | [3]2.0 | 0/14 |
| Molybdenum | µg/l | 1971, '76, '78 | .0 | 5.55 | 33.0 | 0/18 |
| Nickel | µg/l | 1978 | 2 | 60 | 192 | 0/5 |
| Selenium | µg/l | 1968, '76, '78 | .0 | 2.06 | 7.0 | 2/44 |
| Silver | µg/l | 1968, '76, '78 | .0 | 2.10 | 13.0 | 0/19 |
| Zinc | µg/l | 1968, '76, '78 | .0 | [3]129.2 | [3]1,600.0 | 0/39 |
| Radioactivity | | | | | | |
| Alpha, dissolved | Pc/l | 1968-76 | 1.3 | 20.4 | 73.2 | 0/22 |
| Beta, dissolved | Pc/l | 1969-75 | 1.8 | 13.5 | 21.8 | 0/10 |

1/ Samples collected by U.S. Geological Survey over the period of August, 1969 to October, 1975, the U.S. Bureau of Reclamation over the period May, 1977 to January, 1978, and the Colorado Department of Health over the period March, 1968 to April, 1976.

2/ Total concentration unless otherwise indicated.

3/ Value exceeds recommended criteria for aquatic wildlife.

Summary of water quality data
San Juan River near Archuleta[1]

| Constituent | Unit | Date (years) | Minimum | Unweighted mean | Maximum | Number exceeding drinking water standards/total |
|---|---|---|---|---|---|---|
| Physical and chemical | | | | | | |
| Streamflow | cfs | 1954-74 | 51.0 | 1,436.0 | 13,140.0 | 0/607 |
| Temperature | °C | 1955-76 | .0 | 9.8 | 25.6 | 0/249 |
| Total dissolved solids | mg/l | 1954-76 | 83.0 | 181.0 | 397.0 | 0/129 |
| pH | SU | 1954-76 | 6.9 | 7.8 | 3/ 9.5 | 0/515 |
| Dissolved oxygen | mg/l | 1970-76 | 8.6 | 11.3 | 15.3 | 0/84 |
| $BOD_5$ | mg/l | 1970-71 | .10 | .78 | 1.80 | 0/38 |
| Coliforms | | | | | | |
| Total | MPN/100 ml | 1970-71 | 5.0 | 153.0 | 1,160.0 | 0/28 |
| Fecal | MPN/100 ml | 1970-71 | .0 | 25.0 | 360.0 | 0/29 |
| Alkalinity ($CaCO_3$) | mg/l | 1954-76 | 49.0 | 94.7 | 185.0 | 0/308 |
| Hardness ($CaCO_3$) | mg/l | 1954-76 | 40.0 | 114.0 | 250.0 | 0/474 |
| Calcium | mg/l | 1954-76 | 10.0 | 36.0 | 75.0 | 0/475 |
| Magnesium | mg/l | 1954-76 | .6 | 6.2 | 21.0 | 0/475 |
| Sodium | mg/l | 1954-76 | 4.1 | 20.6 | 65.0 | 0/462 |
| Potassium | mg/l | 1954-76 | 1.20 | 2.24 | 5.00 | 0/143 |
| SAR | ratio | 1954-76 | .10 | .81 | 2.60 | 0/473 |
| Bicarbonate | mg/l | 1954-76 | 54.0 | 112.5 | 236.0 | 0/478 |
| Carbonate | mg/l | 1957-76 | .0 | 1.4 | 36.0 | 0/235 |
| Chloride | mg/l | 1954-76 | 1.00 | 3.70 | 14.00 | 0/158 |
| Fluoride | mg/l | 1954-76 | .00 | .28 | .80 | 0/155 |
| Sulfate | mg/l | 1954-76 | 16.0 | 55.0 | 131.0 | 0/155 |
| Nutrients | | | | | | |
| Nitrate (as N) | mg/l | 1969-70 | .0 | .05 | .20 | 0/10 |
| Nitrite (as N) | mg/l | 1970 | .0 | .0 | .0 | 0/2 |
| Ammonia (as N) | mg/l | 1972-76 | .0 | .03 | .10 | 0/46 |
| Phosphorus | | | | | | |
| Total | mg/l | 1969-76 | .0 | .03 | .12 | 0/67 |
| Ortho | mg/l | 1971-76 | .0 | .03 | 3/ .15 | 0/66 |
| Silica, dissolved | mg/l | 1954-76 | 1.30 | 12.45 | 29.0 | 0/155 |
| Trace elements[2] | | | | | | |
| Aluminum, dissolved | µg/l | 1971 | 7.9 | 8.49 | 8.99 | 0/2 |
| Arsenic | µg/l | 1975-76 | .00 | 1.25 | 2.00 | 0/4 |
| Barium, dissolved | µg/l | 1971-74 | .0 | 45.3 | 100.0 | 0/12 |
| Boron, dissolved | µg/l | 1959-76 | .00 | 45.10 | 640.00 | 0/118 |
| Cadmium, dissolved | µg/l | 1971-76 | .00 | 3.27 | 3/ 35.0 | 0/15 |
| Chromium (hex.) | µg/l | 1971-74 | .00 | .00 | 00 | 0/9 |
| Copper | µg/l | 1975-76 | 10.00 | 10.00 | 10.00 | 0/3 |
| Iron | | | | | | |
| Total | µg/l | 1954-76 | .0 | 68.3 | 860.0 | 0/42 |
| Dissolved | µg/l | 1967-76 | .00 | 20.00 | 120.00 | 0/90 |
| Lead | µg/l | 1971-76 | 0 | 3/ 54.43 | 3/ 100.00 | 0/14 |
| Manganese | | | | | | |
| Total | µg/l | 1975-76 | 20.0 | 26.67 | 30.0 | 0/3 |
| Dissolved | µg/l | 1971-76 | .0 | 10.64 | 40.00 | 0/14 |
| Mercury | µg/l | 1971-76 | .0 | 3/ .071 | 3/ 300 | 0/14 |
| Molybdenum, dissolved | µg/l | 1971 | .99 | .99 | .99 | 0/2 |
| Nickel, dissolved | µg/l | 1971 | 3.00 | 3.00 | 3.00 | 0/2 |
| Selenium, dissolved | µg/l | 1971-76 | .0 | 2.61 | 8.0 | 0/13 |
| Silver, dissolved | µg/l | 1971-74 | .0 | 3/ .58 | 3/ 3.0 | 0/12 |
| Zinc | µg/l | 1971-76 | .0 | 16.67 | 30.0 | 0/15 |

1/ Samples collected by U.S. Geological Survey over the period of December 1954 to October, 1976.
2/ Total concentration unless otherwise indicated.
3/ Value exceeds recommended criteria for aquatic wildlife.

Summary of water quality data
San Juan River above Animas at Farmington[1/]

| Constituents | Unit | Date (years) | Minimum | Unweighted mean | Maximum | Number exceeding drinking water standards/total |
|---|---|---|---|---|---|---|
| Physical and chemical | | | | | | |
| Streamflow | cfs | 1964-74 | 112.0 | 1,109.4 | 4,099.9 | 0/114 |
| Temperature | °C | 1966-76 | .0 | 11.6 | 28.0 | 0/139 |
| Total dissolved solids | mg/l | 1969-76 | 178.0 | 309.0 | 1,270.0 | 0/93 |
| pH | SU | 1964-76 | 6.8 | 7.9 | 3/9.0 | 0/128 |
| Dissolved oxygen | mg/l | 1974-76 | 5.5 | 9.8 | 12.5 | 0/20 |
| Coliforms | | | | | | |
| Total | MPN/100 ml | 1970-71 | 100.0 | 1,882.0 | 4,299.0 | 0/7 |
| Fecal | MPN/100 ml | 1970-71 | 10.0 | 88.0 | 210.0 | 0/6 |
| Alkalinity ($CaCO_3$) | mg/l | 1967-76 | 75.0 | 101.0 | 226.0 | 0/102 |
| Hardness ($CaCO_3$) | mg/l | 1964-76 | 76.0 | 156.0 | 350.0 | 0/129 |
| Calcium | mg/l | 1968-76 | 31.0 | 49.0 | 120.0 | 0/93 |
| Magnesium | mg/l | 1968-76 | 2.4 | 7.4 | 12.0 | 0/93 |
| Sodium | mg/l | 1968-76 | 18.0 | 41.0 | 270.0 | 0/93 |
| Potassium | mg/l | 1969-76 | 1.7 | 2.3 | 6.3 | 0/74 |
| SAR | ratio | 1968-76 | .7 | 1.4 | 6.3 | 0/93 |
| Bicarbonate | mg/l | 1964-76 | 70.0 | 122.0 | 275.0 | 0/129 |
| Carbonate | mg/l | 1964-76 | .0 | .61 | 12.0 | 0/127 |
| Chloride | mg/l | 1964-76 | 1.3 | 4.5 | 18.0 | 0/129 |
| Fluoride | mg/l | 1969-76 | .0 | .30 | 1.40 | 0/71 |
| Sulfate | mg/l | 1968-76 | 58.0 | 133.0 | 700.0 | 0/93 |
| Nutrients | | | | | | |
| Nitrate (as N) | mg/l | 1969-70 | .0 | .21 | .70 | 0/11 |
| Ortho phosphorus | mg/l | 1973-76 | .0 | .008 | .03 | 0/13 |
| Silica, dissolved | mg/l | 1968-76 | 8.2 | 10.9 | 17.0 | 0/93 |
| Trace elements[2/] | | | | | | |
| Arsenic | µg/l | 1975 | 2.0 | 2.0 | 2.0 | 0/2 |
| Boron, dissolved | µg/l | 1975 | 40.0 | 40.0 | 40.0 | 0/1 |
| Iron, dissolved | µg/l | 1969-76 | .0 | 50.47 | 220.0 | 0/19 |
| Lead | µg/l | 1975 | 3/100.0 | 3/100.0 | 3/100.0 | 0/2 |
| Mecury | µg/l | 1975 | .00 | .00 | .00 | 0/1 |
| Selenium | µg/l | 1975 | 1.0 | 1.0 | 1.0 | 0/2 |

1/ Samples collected by U.S. Geological Survey over the period from October, 1964 to September, 1976.
2/ Total concentration unless otherwise indicated.
3/ Value exceeds recommended criteria for aquatic wildlife.

Summary of water quality data
San Juan River near Bluff[1]

| Constituent | Unit | Date (years) | Minimum | Unweighted mean | Maximum | Number exceeding drinking water standards/total |
|---|---|---|---|---|---|---|
| **Physical and chemical** | | | | | | |
| Streamflow | cfs | 1928-76 | 12.0 | 2,473.0 | 52,800.0 | 0/2,908 |
| Temperature | °C | 1952-77 | .0 | 14.7 | 29.0 | 0/564 |
| Total dissolved solids | mg/l | 1928-77 | 157.0 | 648.0 | 1,866.0 | 0/1,204 |
| pH | SU | 1945-77 | | 7.7 | 8.9 | 0/1,223 |
| Dissolved oxygen | mg/l | 1969-77 | [3] 1.3 | 9.3 | 14.4 | 0/74 |
| Coliforms, fecal | MPN/100 ml | 1974-76 | 1.0 | 427.0 | 4,000.0 | 0/23 |
| Alkalinity ($CaCO_3$) | mg/l | 1928-77 | 46.0 | 147.7 | 7,440.0 | 0/1,831 |
| Hardness ($CaCO_3$) | mg/l | 1928-77 | 102.0 | 337.6 | 1,030.0 | 0/1,909 |
| Calcium | mg/l | 1928-77 | 0 | 192.6 | 845.0 | 0/1,830 |
| Magnesium | mg/l | 1928-77 | 2.7 | 24.3 | 68.0 | 0/1,829 |
| Sodium | mg/l | 1928-77 | 7.6 | 81.6 | 353.0 | 0/1,375 |
| Potassium | mg/l | 1928-77 | 1.1 | 4.5 | 16.0 | 0/1,122 |
| SAR | ratio | 1928-77 | .3 | 1.9 | 6.2 | 0/1,471 |
| Bicarbonate | mg/l | 1928-77 | 56.0 | 180.0 | 9,077.0 | 0/1,911 |
| Carbonate | mg/l | 1958-77 | .0 | .5 | 47.0 | 0/528 |
| Chloride | mg/l | 1928-77 | 2.0 | 21.6 | 325.0 | 0/1,912 |
| Fluoride | mg/l | 1932-77 | 0 | .36 | 1.30 | 0/995 |
| Sulfate | mg/l | 1928-77 | 29.0 | 323.9 | 1,070.0 | 0/1,911 |
| **Nutrients** | | | | | | |
| Nitrate (as N) | mg/l | 1928-71 | .02 | .8 | 9.7 | 0/1,367 |
| Nitrite (as N) | mg/l | 1942-43 | 3.0 | 34.2 | 120.0 | 0/54 |
| Ammonia (as N) | mg/l | 1977 | .04 | .05 | .07 | 0/3 |
| Phosphorus | | | | | | |
| Total | mg/l | 1974-77 | .0 | 1.14 | 18.0 | 0/38 |
| Ortho | mg/l | 1971-74 | .0 | .02 | [3] .12 | 0/46 |
| Silica, dissolved | mg/l | 1928-76 | 1.0 | 13.2 | 33.0 | 0/1,769 |
| **Trace elements[2]** | | | | | | |
| Aluminum | µg/l | 1967 | 800.0 | 800.0 | 800.0 | 0/1 |
| Arsenic | µg/l | 1974-77 | .0 | 20.2 | 180.0 | 0/13 |
| Barium | µg/l | 1977 | 400.0 | 400.0 | 400.0 | 0/1 |
| Boron | µg/l | 1947-48 | .0 | 13.9 | 40.0 | 0/36 |
| Cadmium | µg/l | 1974-77 | .0 | [3] 10.2 | [3] 20.0 | 0/14 |
| Chromium | µg/l | 1974-77 | .0 | 38.7 | [3] 250.0 | 0/14 |
| Copper | µg/l | 1974-77 | 10.0 | [3] 107.9 | [3] 500.0 | 0/14 |
| Iron | | | | | | |
| Dissolved | µg/l | 1970-77 | .0 | 51.6 | [3] 410.0 | 0/18 |
| Lead | µg/l | 1974-77 | [3] 100.0 | [3] 178.6 | [3] 800.0 | 0/14 |
| Manganese | | | | | | |
| Total | µg/l | 1974-77 | 30.0 | 2,156.4 | 4,000.0 | 0/14 |
| Dissolved | µg/l | 1970-77 | .0 | 4.7 | 10.0 | 0/19 |
| Mecury | µg/l | 1974-77 | .0 | [3] .18 | [3] 1.60 | 0/12 |
| Selenium | µg/l | 1974-77 | 2.0 | 4.7 | 12.0 | 0/13 |
| Silver, dissolved | µg/l | 1977 | .0 | 0 | .0 | 0/1 |
| Zinc | µg/l | 1974-77 | 10.0 | [3] 284.3 | [3] 1,700.0 | 0/14 |

1/ Samples collected by U.S. Geological Survey over the period June, 1928 to November, 1977.
2/ Total concentration unless otherwise indicated.
3/ Value exceeds recommended criteria for aquatic wildlife.

# Considerations for safety of dams

## 1. Introduction

In accordance with Bureau of Reclamation policy, the final design of Ridges Basin and Southern Ute Dams would include full consideration of such factors as seismic history, geology, hydrology, and material composition. During the feasibility phase of the project, sufficient field explorations were made to determine the adequacy of Ridges Basin and Southern Ute Dam sites, identify potential problems influencing design considerations, and provide the basis for establishing additional and more detailed investigations for the final design stage. Serious foundation problems are not anticipated at either site (Bureau of Reclamation, 197).

When completed, the final design would be reviewed by geotechnical and earth dam design specialists within the Bureau of Reclamation and/or by independent outside consultants. This policy has been adopted by the Bureau of Reclamation to ensure the safety of its structures. Criteria for filling the reservoirs and monitoring the safety of the dams during filling would be developed by the Bureau of Reclamation and strictly followed.

## 2. Geology

Further site investigations would be made to obtain detailed geologic data suitable for final design and construction would include the following:

> Additional geologic mapping of the reservoir areas would be prepared and would include data to further evaluate reservoir rim stability and water-holding capability.
>
> A detailed surface geologic map of the dam site would be prepared and sufficint exploratory drilling would be accomplished to permit a detailed assessment of foundation conditions.
>
> Core samples of bedrock would be obtained from these drill holes, and water tests would be performed (gravity tests in surficial material and pressure tests in bedrock) to refine and determine the permeability of the foundation materials. A stabilized ground-water level will be determined in each hole.
>
> Where possible, the drill holes would be preserved for geophysical logging and for continued measurement of ground-water levels.

Locations, attitudes, and physical character of known faults that may pass through the dam sites or reservoir basins would be determined by detailed geologic mapping, geophysical exploration, drilling, and by trenching where appropriate.

Engineering properties of the foundation materials with special emphasis on density, compressibility, permeability, and shear strength would be verified by laboratory testing. Final design features would include modifications to the original designs based on the results of the testing.

Additional geologic mapping and sufficient exploration drilling would be accomplished to delineate the location and lateral extent of coal beds, and to determine the extent of an abandoned coal prospect in the right abutment at Ridges Basin Dam site.

This information would be used to evaluate geologic implications related to reservoir water-holding capability and rim stability; stability, permeability, and deformability of foundation materials; ground-water occurrence and behavior; and structural discontinuities at the sites.

Although the dam sites are located in an area considered to be subject to only minor seismicity (U. S. Geological Survey, 1976), a thorough study of the seismic potential of the area would be made. This study would consider the seismic and tectonic history of the region as well as an evaluation of known faults in the reservoir basins and would result in selection of an appropriate maximum credible earthquake for use in the specifications design. The seismic program would consist of up to three phases, with each phase designed to provide a greater degree of detail if warranted by preliminary information from the preceding stage. The first phase would consist of a basic literature search to evaluate seismic data; the second phase would consist of a field reconnaissance and a preliminary analysis of aerial photographs; and the third phase would consist of detailed field studies, mapping, and aerial photograph analysis.

3. Design

The dams would have a rolled earthfill embankment with an impervious clay core for water retention and outer shells of sand, gravel, and cobble materials. A sand and gravel chimney drain and filter blanket are incorporated to safely control seepage through the embankment and foundation, to reduce embankment pore pressures, and to protect against the piping of fine material into the downstream shell. The proposed shell materials would be more permeable than the core and provide added stability from its greater shear strength.

4. Seepage and Drainage

Permeability tests on foundation materials reveal no apparent seepage problems. Grouting of bedrock and placement of a positive cutoff trench to bedrock would control foundation seepage. The chimney drain, horizontal drainage blanket, and toe drains would control seepage within the embankments and provide for its safe exit from the dam. Coal seams would be carefully tested for seepage potential, and foundation treatment (removal of coal seams or grouting) provided as necessary to eliminate potential problems. Based on a thorough examination of preliminary data, serious seepage problems are not expected at either dam site.

5. Hydrology and Hydraulics

For Ridges Basin Dam site, two inflow design floods were considered, one of maximum probable thunderstorm floods of 1 percent and 2 percent probability magnitudes. This type of flood condition develops the maximum peak inflow that can be expected. The second consisted of a maximum probable spring rain flood in combination with a 1 percent probability snow flood. This type of flood condition develops the maximum volume of inflow. The second type of flood condition was the most critical for design. It has a peak of 1,950 cubic feet per second and a 15-day volume of 9,200 acre-feet. A surcharge of 9,200 acre-feet (maximum water surface elevation 6968.0) is provided to protect against the flood. The feasibility design provides for an emergency spillway to ensure that the maximum water surface does not exceed elevation 6968.0.

For Southern Ute Reservoir, a surcharge of 3,300 acre-feet (maximum water surface elevation 6078.6) and a river outlet discharge of 730 cubic feet per second is provided in designs to protect against the inflow design flood which has a peak of 30,200 cubic feet per second and a 4-day volume of 4,100 acre-feet. The inflow design flood considered consisted of a maximum probable thunderstorm flood preceded by a 1 percent probability thunderstorm flood which would be expected to occur during the summer and fall seasons. A spillway was not included in the feasibility design be cause the maximum probable flood inflow could be handled by a combination of surcharge and outlet works discharge. Further analyses of final hydrologic data would be made to verify the designs.

6. Embankment Materials

Sources of embankment materials have been located and sufficient quantities appear to be available for the construction of the embankment. Further testing of materials from the proposed borrow sources would be needed to verify the quality of the available construction materials and to determine their engineering properties (specific gravity, soil consistency limits, gradations, densities, moisture content, strength, deformation, and permeability). Adjustments to the final design would be made on the basis of this testing as necessary; however, based on preliminary testing in the field and laboratory, serious problems with these construction materials are not expected.

7. Stability

Based on past experience with this type of dam and the construction materials available, stability problems are not expected for the two dams. The embankment would incorporate design features to ensure stability under all possible reservoir operating conditions. During final design, strength parameters for all embankment and foundation materials, as determined by laboratory testing, would be used in static stability analyses for various construction and reservoir operating conditions to assure embankment stability. A state-of-the-art evaluation of the dynamic stability of the embankment when subjected to the maximum credible earthquake would be performed. Seismic design features such as additional freeboard, increased crest width, self-healing crack stopping zones, extra wide filter zones, and increased embankment densities could be incorporated into the final design as necessary.

# SECTION 404(b) (P.L. 92-500) EVALUATION
# ANIMAS-LA PLATA PROJECT
## Bureau of Reclamation

## I. INTRODUCTION

Chapter A of the environmental statement contains details of the project plan. Construction of the project includes the placement of fill in conjunction with the construction of two concrete diversion dams with protective dikes on the La Plata River in Colorado. Construction of concrete vanes in the Animas River would also be required for the Durango Pumping Plant intake. The evaluation was accomplished following the evaluation guidance in 40 CFR 230.4, in conjunction with evaluation considerations in 40 CFR 230.5.

Construction of the project would also involve a number of pipeline crossings of the Animas and La Plata Rivers. The Durango Municipal and Industrial Pipeline would cross the Animas River near the Durango Pumping Plant intake. The Dry Side Canal would have a siphon crossing the La Plata River near the La Plata Diversion Dam site. In addition, there would be eleven crossings of the La Plata River by the proposed pipeline distribution systems. The pipe lateral crossings were determined according to tentative lateral design layouts. The lateral alinements might change in the specifications designs and there could be a change in the number of river crossings. The tentative locations of the pipeline crossings are marked on the location map (No. 69-406-1661) at the end of this attachment. All pipeline river crossings are included under the nationwide permit program, (33 CFR 323.4-3(a)(1) for utility crossings. For all crossings any excess materials beyond that needed to restore the bottom contour of the rivers to their preconstruction status would be removed to an upland disposal area.

Also covered by the nationwide permit regulations are Ridges Basin and Southern Ute Dams. These two features would create the reservoirs that would provide all the storage for the project. Ridges Basin Dam would be constructed on Basin Creek, which is a tributary of the Animas River. Southern Ute Dam would be constructed on Cinder Gulch which drains into McDermott Arroyo, a tributary of the La Plata River. These are discussed in detail in Sections A-4b and A-4c of the environmental statement. Both dams are located above the headwaters of their respective streams according to the definition of headwaters in the July 19, 1977 Federal Register (33 CFR 323). Since there is very little data on actual stream flows in Basin Creek and Cinder Gulch, the method for determining headwaters suggested in the July 19, 1977 Federal Register was used. Average flows in Basin Creek and Cinder Gulch were calculated as 4.6 cfs and 1.9 cfs, respectively. This calculation was based on the average annual precipitation and the drainage area for each stream up to the dam sites.

## II. PROJECT DESCRIPTION

### A. Description of the Proposed Discharge of Fill Material

This evaluation is concerned with the La Plata and Southern Ute Diversion Dams and the Durango Pumping Plant intake structure.

The La Plata Diversion Dam would consist of a concrete overflow section with a gated sluiceway and intake structure with an approach floor at elevation 7,186. The overflow spillway crest would be 50 feet long and would have a crest elevation of o,194.5. A low protective dike would extend 450 feet upstream on each side of the river at angles of 306 feet with the river. The dike would be a compacted earth section with a maximum height of 10 feet, a crest width of 16 feet, an upstream slope of 3 to 1, and a downstream slope of 2 to 1. The upstream slope would be protected by a 24-inch layer of riprap on a 12-inch layer of sand and gravel bedding. A feasibility design drawing (No. 69-D-29) of the structure has been included at the end of this attachment.

The Southern Ute Diversion Dam would consist of a concrete overflow spillway section with a gated sluiceway and intake structure with an approach floor at elevation 6,121. The overflow spillway crest would be 100 feet long and would have a crest elevation of 6,130.5. A protective dike would extend about 500 feet on the left abutment and 200 feet on the right abutment. The dike would be a compacted earth section with a maximum height of 8 feet, a crest width of 16 feet, an upstream slope of 3 to 1, and a downstream slope of 2 to 1. The upstream slope would be protected by a 24-inch layer of riprap on a 12-inch layer of sand and gravel bedding. A feasibility design Drawing (No. 69-D-25) of the structure has been included at the end of this attachment.

The Durango Pumping Plant would take water directly from the Animas River through an intake consisting of a trash-rack, sediment trap, a 10-foot by 15.33-foot radial gate and a settling basin, all totaling about 1,000 feet in length. The part that would be in the Animas River would be the concrete pad and bottom vanes that would aid in excluding sediment from the pumping units. The pad would cover an area of about 8,200 square feet. A feasibility design Drawing (No. 69-D-26) is included at the end of this attachment.

1. General characteristics of material
   See Section A-4g of the environmental statement.

2. Quantity of material proposed
   La Plata Diversion Dam - 1,300 cubic yards of concrete
   1,150 cubic yards of riprap
   10,000 cubic yards of compacted embankment

Southern Ute Diversion Dam - 2,400 cubic yards of concrete
1,250 cubic yards of riprap
15,000 cubic yards of compacted embankment

3. Source of material
See Section A-4g of the environmental statement.

B. Description of the Proposed Disposal Sites for Fill Material

1. Location.

See Sections A-4b(1)(a), 4b(1)(f), 4C(1)(a) of the environmental statement. A map (No. 69-406-1661) is included in this attachment to show the locations of the two diversion dams and the pumping plant intake.

2. Type of disposal sites.

See the design drawings at the end of this attachment.

3. Method of discharge.

Placement of fill would be into dry (temporarily dewatered) streambed section.

4. When disposal will occur.

Construction of the La Plata and Southern Ute Diversion Dams would begin in the eighth year of construction and would require one construction season to complete. Construction of the Durango Pumping Plant would commence in the second year of construction. Construction of the concrete pad and bottom vanes for the intake could be completed in one construction season. Project construction program is discussed in Section A-5 of the environmental statement.

5. Projected life of disposal site.

The expected minimum life of the project is 100 years.

6. Bathymetry--N/A.

## III. PHYSICAL EFFECTS

### A. Potential Destruction of Wetlands

No destruction of wetlands would result from construction of the two diversion dams and the Durango Pumping Plant intake. Between the La Plata and Southern Ute Diversion Dams, wetland areas are supported mostly from return flow from presently irrigated land. Under project operations, flows would be increased in this section of the La Plata River as a result of return flows and releases from the Dry Side Canal. Below the Southern Ute Diversion Dam, average flows would be reduced about 85 percent; however, most of this flow is the high spring runoff. Water presently entering the La Plata River below the Southern Ute Diversion Dam site comes primarily from return flow from presently irrigated land and is all rediverted for irrigation in New Mexico. Under project conditions a steady supply of return flow would be available and would increase the potential for the establishment of wetland areas. Directly below the Durango Pumping Plant intake the average wetted perimeter of the Animas River would be reduced only slightly. The area that would be reduced supports no wetlands areas, and there would be no destruction of wetlands as a result of the pumping plant intake structure. There is the potential of adding about 15 acres of palustrine habitat behind Southern Ute Diversion Dam. Effects of the project on wetlands are discussed in Section C-7 of the environmental statement.

Effects on:

1. Food chain production--N/A
2. General habitat--N/A
3. Nesting, spawning, rearing and resting sites for aquatic or land species--N/A
4. Wetlands set aside for aquatic environment study or sanctuaries refuges--N/A
5. Natural drainage characteristics--N/A
6. Sedimentation patterns--N/A
7. Salinity distribution--N/A
8. Flushing characteristics--N/A
9. Current patterns--N/A
10. Wave action, erosion, or storm damage protection--N/A

11. Storage areas for storm and flood waters--N/A.

12. Prime natural recharge areas--N/A.

B. Impact on Water Column

1. Reduction in (1) light transmission, (2) aesthetic values, and (3) direct destructive effects on nektonic and planktonic populations.

Construction of the diversion dams would most likely take place during very low or non-existent flows in the La Plata River and should have no major effects on the water column in the river. Some slight increased turbidity from construction could reduce light transmission slightly, but the aesthetic values would remain basically unchanged. No decrease in the nektonic and planktonic populations would occur, since the populations would probably increase as a result of increased flow between the two diversion dams. Below the Southern Ute Diversion Dam there would also probably be an increase in the population. Although the average annual flow would be reduced, there would be a nearly continuous flow generated by operation of the project, whereas the river is dry much of the year under present conditions.

Construction of the concrete pad and bottom vanes for the Durango Pumping Plant intake in the Animas River would result in some increased turbidity and a slight reduction in the light transmission of the water column. This would also have a minor temporary effect on the aesthetic value of the river. Water removed from the river by project operation at the intake site would decrease the average depth of the river by 15 percent. There would probably be some reduction in the nektonic and planktonic populations because of the reduced flows.

C. Covering of Benthic Community

1. Actual covering of benthic communities.

Less than one acre of benthic (stream) habitat would be covered by the construction of the diversion structures. Approximately 7.5 acres of benthic community would be created by the backing up of water at the La Plata Diversion Dam and 17 acres at the Southern Ute Diversion Dam. Less than 0.25 acre of benthic habitat would be covered by the construction of the bottom vanes for the Durango Pumping Plant intake. No water would be backed up, since no diversion structure would be built. See Section C-6d of the environmental statement.

2. Changes in community structure or function.

At the La Plata Diversion Dam site the water would only back up during high spring flows, but would be dry most of the year. No additional fish habitat would be created by the diversion structure. The community at the Southern Ute site would be changed from one associated with a rocky substrate and flowing stream to one associated with occasional periods of standing water which could provide some fish habitat. There would be no change to the benthic community at the Durango Pumping Plant intake.

D. Other Effects

1. Changes in bottom geometry and substrate composition.

The effects on the substrate composition of rivers are discussed in Section III-C(2) of this attachment. The general geometry/ topography would be unchanged in both rivers.

2. Water circulation.

Section C-4b(2) of the environmental statement has details on the stream effects of the diversion structures.

The volume of water going down the Animas River would be reduced by 131,200 to 164,300 acre-feet annually with the Durango Pumping Plant in operation. Section C-4b(1) of the environmental statement has details on stream effects as a result of the pumping plant.

3. Salinity gradients--N/A.

4. Exchange of constituents between sediments and overlying water with alterations of biological communities--N/A.

## IV. CHEMICAL-BIOLOGICAL INTERACTIVE EFFECTS

### A. Exclusion Requirement

The materials to be used in the construction of the protective dikes for the diversion structures meet the exclusion criteria as outlined in the 404 guidelines. The materials are of the naturally occurring rock material in the area with most particle sizes larger than silt and are from a source that is removed from sources of pollutants. Also, they would not be moved by currents away from their site of deposit. The inner, impervious core of the protective dikes would consist of clay deposits, but these materials would be protected by the riprap and the sand and gravel blankets.

The concrete materials for the diversion structures and the vanes for the pumping plant intake would not result in pollutants being discharged into the rivers.

### B. Water Column effects of Chemical Constituents

Not required under 40 CFR 230.4-1(b)(1).

### C. Effects of Chemical Constituents on the Benthic Community

Not required under 40 CFR 230.4-1(b)(1).

V. DESCRIPTION OF SITE COMPARISON

A. Total Sediment Analysis

Meets exclusion requirements.

B. Biological Community Structure Analyses

A comparison of the total chemical constituents in the sediments of the placement sites with those of the fill materials, and an analysis of specific biological community structures are not considered necessary due to the low potential for contamination by the fill materials.

## VI. REVIEW APPLICABLE WATER QUALITY STANDARDS

### A. Compare Constituent Concentration

Except for temporary increases in turbidity during the construction period, constituents would meet applicable State and Federal water quality standards. See Section A-9 and D-2.

### B. Consider Mixing Zone

During constructin the impacts associated with mixing of fill with stream water should not be significant. The sites of fill would be dewatered, if necessary, during construction. The fill would not be placed directly in the stream. Section VII-C of this attachment contains additional information on stream care during construction.

### C. Conformance with Applicable Standards

A request for water quality certification as required by Section 401, Public Law 92-500, as amended, would be submitted to the Colorado Department of Health and would be obtained prior to construction activities that require a Section 404 permit.

## VII. SELECTION OF DISPOSAL SITES

### A. Need for the Proposed Activity

See Section A of the environmental statement.

### B. Alternatives

Alternatives considered were different project plans, different diversion dam sizes, and other pumping plant locations. The proposed La Plata Diversion Dam site is the one practical site where the Dry Side Canal would cross the river. The proposed Southern Ute Diversion Dam is located and sized to allow adequate flow by gravity to provide the necessary water for the Southern Ute Reservoir. Based on economic and engineering criteria, it is located in the most feasible site.

The present location of the Durango Pumping Plant is on a bench that was used as a disposal area for waste solutions from a vanadium-uranium mill and contains radio-active materials. This potential problem has resulted in the investigation of alternate sites. Section H-4 of the environmental statement contains more information of alternative studies.

Alternatives to the proposed plan are discussed in Chapter H of the environmental statement.

### C. Objectives Considered in Discharge Determination

1. Impacts on chemical, physical, and biological integrity of aquatic ecosystem;

2. food chain; and

3. diversity of plant and animal species:

The effects of average annual flow as a result of the two diversion dams are detailed in Sections C-4a and C-4b(2) in the environmental statement. Section C-6d of the statement describes the effects of the diversion structures on the aquatic ecosystem. The impoundment behind each dam and its effect is described in this section.

The effects of average annual flow as a result of the Durango Pumping Plant are detailed in Sections C-4a and C-4b(1) of the environmental statement. In Section C-5a(1) of the statement details are given on water quality effects on the Animas River as a result of the project. Section C-6b gives details on the effect on fish and aquatic invertebrates.

4. Impact on movement into and out of feeding, spawning, breeding and nursery areas.

There are no such areas.

5. Impact on wetland areas having significant functions of water quality maintenance.

There are no wetland areas that have this function.

6. Impact on areas that serve to retain natural high waters or flood waters--N/A.

7. Methods to minimize turbidity.

Turbidity increases during construction shall be kept to permitted increases under the prescribed water quality standards for the affected stream. Construction of the La Plata and Southern Ute Diversion Dams would take place when there would normally be very little or no flow in the La Plata River and should, therefore, cause no harmful increases in turbidity. There is flow in the Animas River all year and construction activities would result in some increased turbidity in the river. There would be the possibility of cofferdams being constructed while the vanes were installed. The material for the cofferdams would be removed after the vanes were in place.

8. Methods to minimize degradation of aesthetic, recreational, and economic values.

The Durango Pumping Plant would be designed to be as unobtrusive as possible. Other construction measures can be found in Sections A-9, and D-2 of the environmental statement.

9. Threatened and endangered species.

See Section B-9 and C-9 of environmental statement.

10. Avoid degradation of water quality.

In accordance with the Bureau's Standard Specifications Paragraphs the contractor would be responsible for diversion and care of the streams and prevention of stream pollution during construction. Prior to beginning any work on the diversion structures or the pumping plant intake, the contractor shall submit to the Bureau for approval a water control plan showing the proposed method for the diversion and care of the stream during construction. The contractor's construction activities shall be performed in a manner that would prevent entrance or accidental spillage of solid matter, contaminants, debris, and other objectionable pollutants into the stream or dry watercourse. See Section A-9 and D-2(b) of environmental statement.

D. <u>Impacts on Water Uses at Proposed Disposal Sites</u>

The State of Colorado's present classification of the La Plata River south of Hesperus is secondary recreation, warm water fishery, and irrigation/stock supply. The changes in the river would be a slight increase in dissolved solids, hardness, and nutrients after the project was fully developed.

The Animas River, from Durango to the Colorado-New Mexico State line, is classified as secondary recreation, warm and cold water fishery, irrigation/stock supply, and potable water supply. Changes in the river would be a slight increase in dissolved solids, hardness, bacterial counts, and nutrients after the project was fully developed. The effects on water quality are given in Section C-5 of the environmental statement.

1. Municipal water supply intakes--N/A.

2. Shellfish--N/A.

3. Fisheries.

The effects on fisheries would be minimal. Details are given in Sections C-6(b) and C-6(d) of the environmental statement.

4. Wildlife.

The three sites of discharge would have no effects on wildlife. Project impacts on wildlife are discussed in Section C-8 of the statement.

5. Recreation activities.

The impacts of the project on recreation are discussed in Section C-1(e) of the environmental statement.

6. Threatened or endangered species.

Section C-9 of the environmental statement discusses project effects on endangered species.

7. Benthic life.

No adverse effects on the benthic community are expected to occur from fill material placement as discussed in Section IV-C of this attachment.

8. Wetlands.

See Section III-A of this attachment.

9. Submersed vegetation.

The effects of the project on vegetation are discussed in Section C-8 of the environmental statement.

10. Size of disposal sites

The sizes of the disposal sites are discussed in Section III-C(1) of this attachment.

11. Coastal zone management programs--N/A

E. Considerations to Minimize Harmful Effects

Details on (1) water quality (2) alternatives, and (3) characteristics of alternative sites can be found in Section VII-B and C of this attachment.

4. Ocean dumping--N/A

5. Investigate covering contaminated dredged material with cleaner material--N/A

6. Methods to minimize effects of runoff from confined areas on the aquatic environment. Sections II-A and VII-C of this report discuss protecting the structures from eroding into the streams after construction and the contractor's responsibilities for stream care during construction.

7. Coordinate potential monitoring activities at disposal site with EPA.

Contractor would be required to perform monitoring required by NPDES permit. Bureau of Reclamation would monitor construction to verify contractor's compliance with permit. See Section A-9 of environmental statement.

ATTACHMENT 5

## VIII. STATEMENT AS TO CONTAMINATION OF FILL MATERIAL IF FROM A LAND SOURCE

The fill material to be used in construction of the diversion structures is removed from sources of pollutants and would be free of contaminants.

## IX. DETERMINE MIXING ZONE

Section VI-B of this report discusses mixing zones.

RECOMMENDED WATER QUALITY CRITERIA

| Constituent | Water use: Water Supply[1/] | Water use: Aquatic Wildlife[3/] |
|---|---|---|
| I. Physical and Chemical | | |
| Suspended Solids | ---- | 25 mg/L, median |
| Total Dissolved Solids | 500 mg/L[2/] | ---- |
| pH | 6.5-8.5[2/] | 6.5-9.0 |
| Coliform, Fecal | 1000 MPN/100 ml[4/] | ---- |
| Dissolved Oxygen | ---- | 5.0-6.0 mg/L (Minimum) |
| Alkalinity ($CaCO_3$) | ---- | 20 mg/L (Minimum) |
| Magnesium | 125 mg/L[4/] | ---- |
| Chloride | 250 mg/L[2/] | ---- |
| Sulfate | 250 mg/L[2/] | ---- |
| Nitrogen (as N) | | |
| Ammonia | 0.5 mg/L[4/] | 0.02 mg/L[5/] |
| Nitrate | 10 mg/L | ---- |
| Phosphate, Ortho | ---- | 25 ug/L, lakes |
| II. Trace Elements | | |
| Arsenic, Total | 0.05 mg/L | ---- |
| Barium, Total | 1.0 mg/L | ---- |
| Beryllium, Total | ---- | 11 ug/L (Soft fresh water)<br>1.1 mg/L (Hard fresh water) |
| Cadmium, Total | 0.01 mg/L | 0.4-4.0 ug/L (Soft water)<br>1.2-12.0 ug/L (Hard water) |
| Chromium, Total | 0.05 mg/L | 100 ug/L |
| Copper, Total | 1.0 mg/L | 0.03 mg/L |
| Cyanide | ---- | 5 ug/L |
| Flouride | 1.4-2.4 mg/L[6/] | |
| Iron, Total | ---- | 1.0 mg/L |
| Iron, Dissolved | 0.3 mg/L[2/] | 0.3 mg/L |
| Lead, Total | 0.05 mg/L | 0.03 mg/L |
| Manganese, Dissolved | 0.05 mg/L[2/] | ---- |
| Mercury, Total | 0.002 mg/L | 0.05 ug/L |
| Nickel, Total | ---- | 0.1 mg/L |
| Selenium, Total | 0.01 mg/L | 0.05 mg/L |
| Silver, Dissolved | ---- | 0.1 ug/L |
| Zinc, Total | 5 mg/L[2/] | 0.03 mg/L |

1/ National Interim Drinking Water Standards, E.P.A., 1975 unless footnoted otherwise.

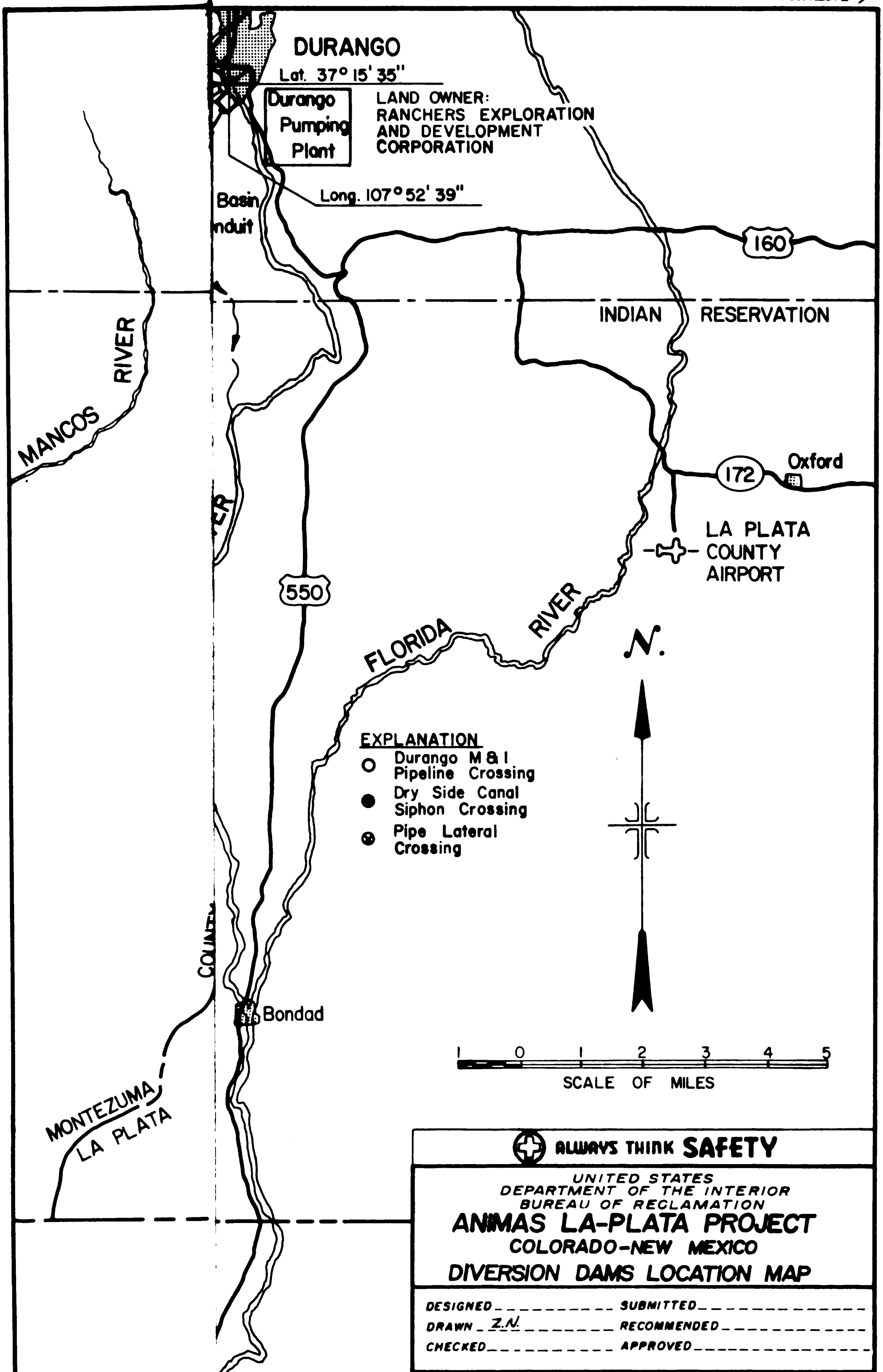
2/ Secondary Maximum Contaminant levels or the advisable maximum level as delivered to the user.

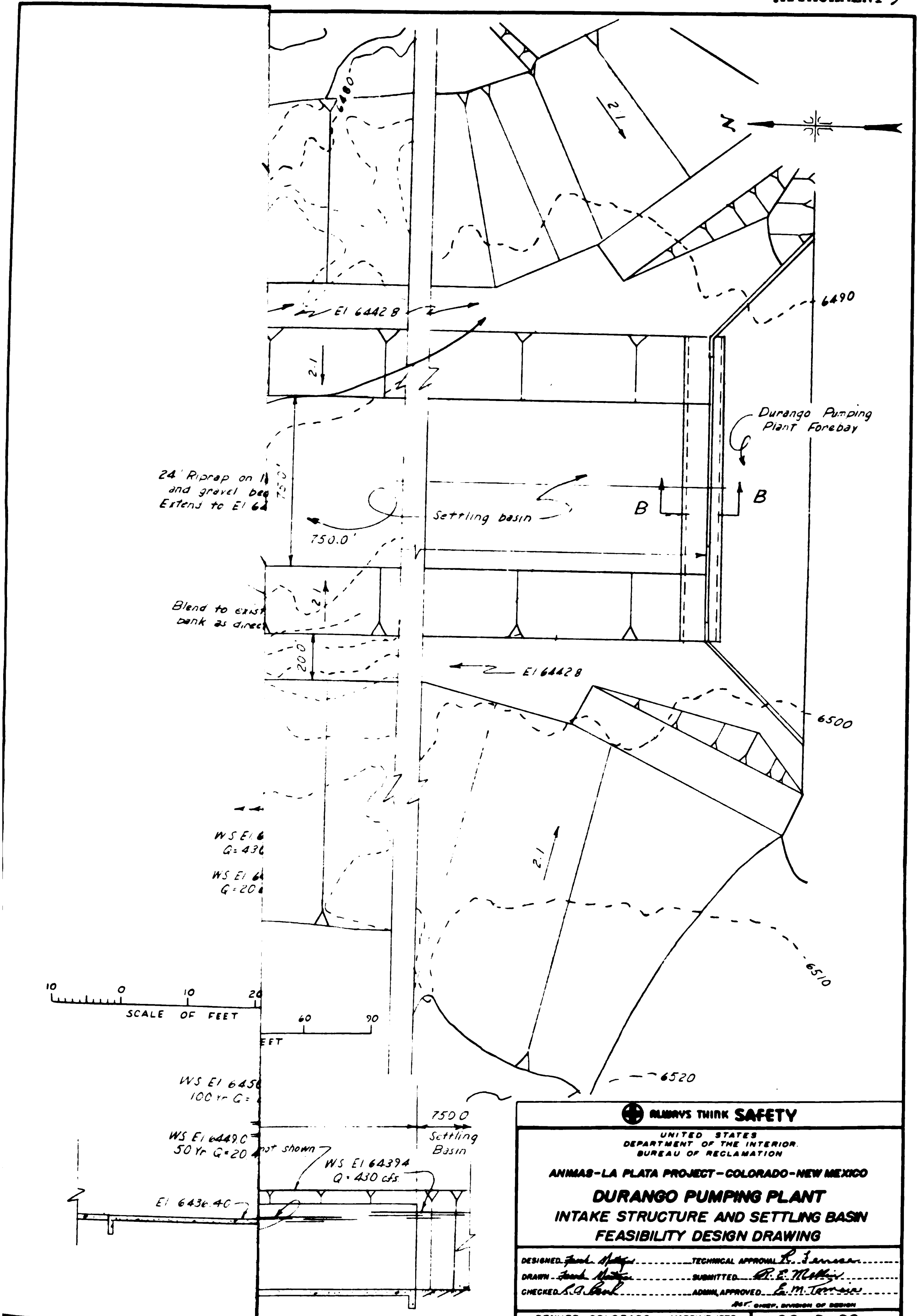
3/ Quality Criteria for Water, 1976, E.P.A. (Redbook)

4/ Recommended Water Quality Criteria for the State of Colorado

5/ Recommended level for ammonia is for the un-ionized form, which for these waters is generally less than 15% of the total ammonia given in the tables.

6/ Recommended limits and maximum permissible concentrations for fluoride vary with the annual average of maximum daily air temperature, from the lowest concentrations at 79.3-90.5°F to the highest at 50.0-53.7°F.


DURANGO
Lat. 37° 15' 35"
Durango Pumping Plant
LAND OWNER:
RANCHERS EXPLORATION AND DEVELOPMENT CORPORATION
Long. 107° 52' 39"
Basin
nduit
160
INDIAN RESERVATION
MANCOS RIVER
172
Oxford
LA PLATA COUNTY AIRPORT
550
FLORIDA RIVER
N.
EXPLANATION
Durango M & I Pipeline Crossing
Dry Side Canal Siphon Crossing
Pipe Lateral Crossing
Bondad
MONTEZUMA
LA PLATA
1 0 1 2 3 4 5
SCALE OF MILES
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ANIMAS LA-PLATA PROJECT
COLORADO-NEW MEXICO
DIVERSION DAMS LOCATION MAP
DESIGNED
SUBMITTED
DRAWN Z.N.
RECOMMENDED
CHECKED
APPROVED
DURANGO, COLORADO 4·4·79
69-406-1661




ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

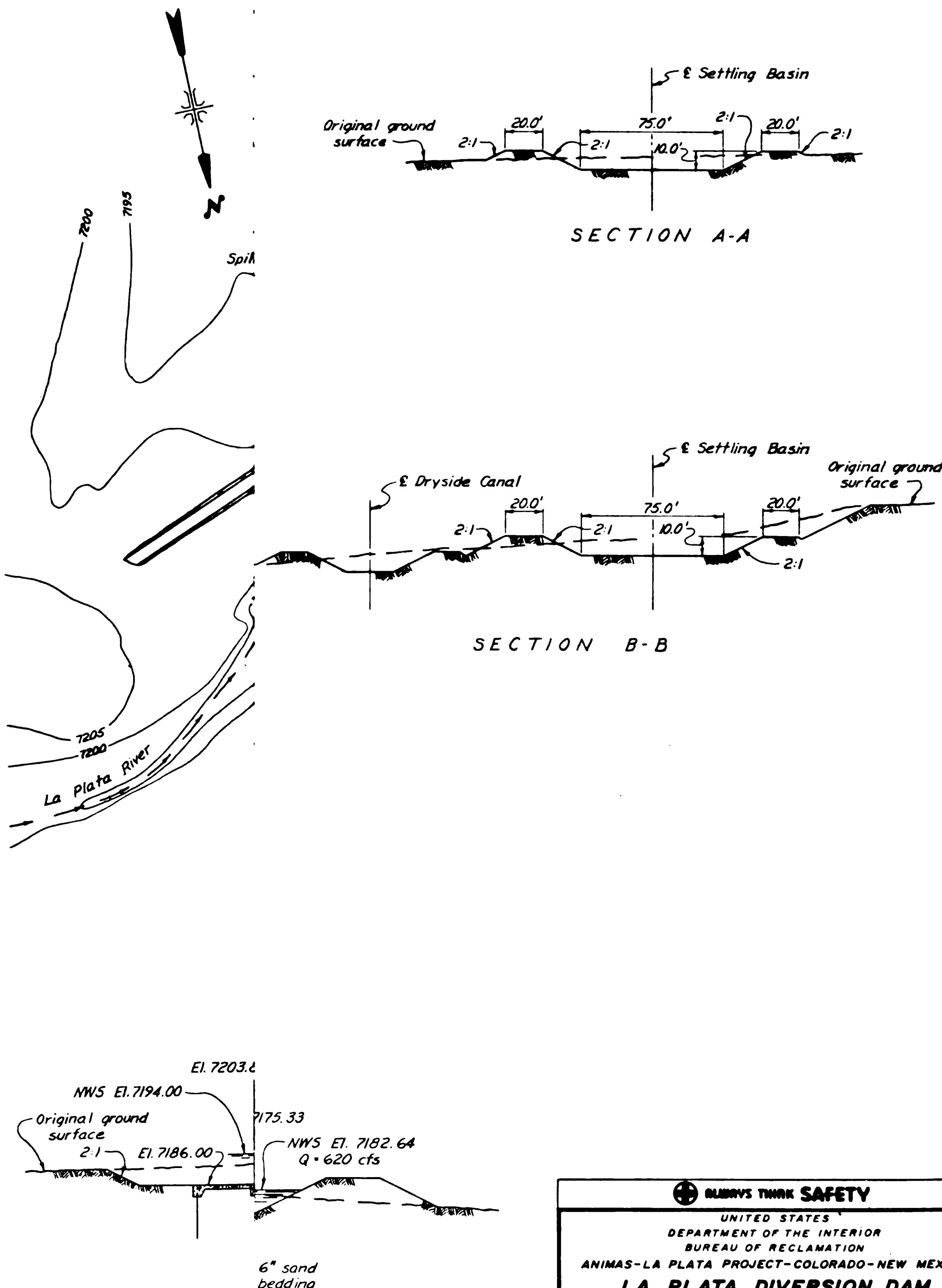
ANIMAS-LA PLATA PROJECT-COLORADO-NEW MEXICO

**DURANGO PUMPING PLANT**

**INTAKE STRUCTURE AND SETTLING BASIN**

**FEASIBILITY DESIGN DRAWING**

| | |
|---|---|
| DESIGNED [signature] | TECHNICAL APPROVAL [signature] |
| DRAWN [signature] | SUBMITTED R. E. Mathis |
| CHECKED R. A. Bock | ADMIN. APPROVED E. M. Tomsic |
| | ASST. CHIEF, DIVISION OF DESIGN |
| DENVER, COLORADO MARCH 13, 1979 | 69-D-26 |

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UNITED STATES
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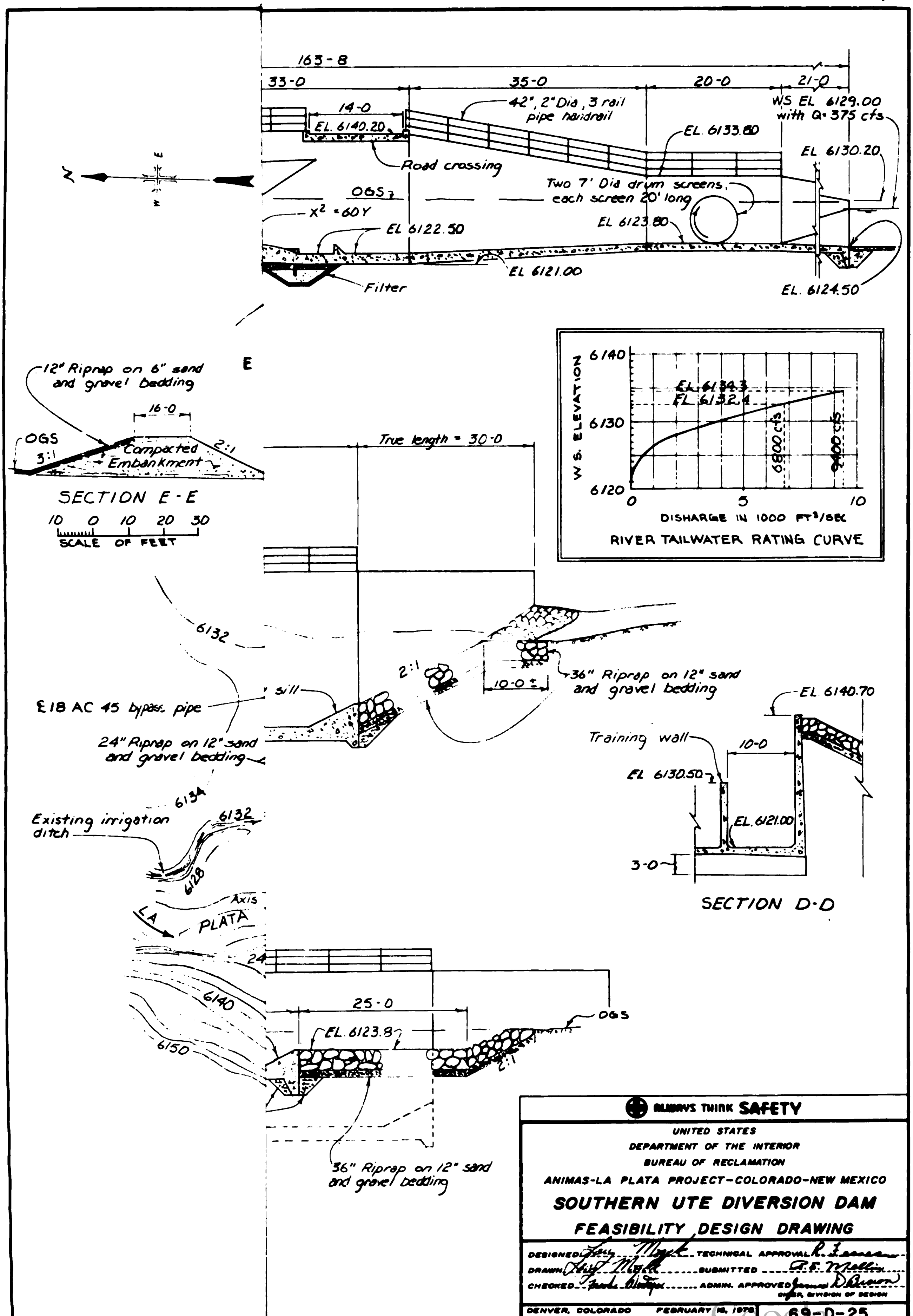
BUREAU OF RECLAMATION
ANIMAS-LA PLATA PROJECT-COLORADO-NEW MEXICO

**LA PLATA DIVERSION DAM**
**GENERAL PLAN AND PROFILE**
**FEASIBILITY DESIGN DRAWING**

DESIGNED R.E. Strausburger TECHNICAL APPROVAL R. [illegible]
DRAWN D.J. Walker SUBMITTED [illegible]
CHECKED [illegible] ADMIN. APPROVED [illegible]
CHIEF, DIVISION OF DESIGN

DENVER, COLORADO MAY 3, 1978 SHEET 1 OF 3 69-D-29

ATTACHMENT 5

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ANIMAS-LA PLATA PROJECT-COLORADO-NEW MEXICO

SOUTHERN UTE DIVERSION DAM
FEASIBILITY DESIGN DRAWING

| | |
|---|---|
| DESIGNED *[signature]* | TECHNICAL APPROVAL *R. [signature]* |
| DRAWN *[signature]* | SUBMITTED *[signature]* |
| CHECKED *[signature]* | ADMIN. APPROVED *[signature]* CHIEF, DIVISION OF DESIGN |
| DENVER, COLORADO FEBRUARY 16, 1978 | 69-D-25 |