Chapter II.—General description

Throughout the Gunnison-Arkansas Interim Report, the Gunnison and Roaring Fork River diversion areas are referred to as the "Western Slope diversion area", and the area where the imported water is to be used is referred to as the "Eastern Slope project area". Although the diversion area for the Initial Development is limited to the upper Roaring Fork Basin, the general discussion of the Western Slope diversion area includes also the upper Gunnison Basin which is considered in plans for possible expansion of the Initial Development.

The area within the Colorado River drainage basin in Colorado is being investigated by Region 4, Bureau of Reclamation, and potential development of the Western Slope proposed by that region is to be integrated with the Gunnison-Arkansas Project. Consequently, the economics of the Western Slope area are treated only briefly and are limited to the diversion area.

PHYSICAL GEOGRAPHY

Location

The Gunnison-Arkansas Project area is located in west-central, central, and southeastern Colorado on the eastern and western slopes of the Continental Divide. The total area which would be affected by project development embraces about 30,898 square miles, or 19,775,000 acres.

The Western Slope diversion area is located in west-central Colorado in the counties of Gunnison, Pitkin, and parts of Hinsdale and Saguache. The area is bounded on the north by the Colorado River drainage; on the west and downstream by the Gunnison and North Fork of the Gunnison Rivers; on the south and east by the Continental Divide, beyond which lie the Rio Grande and Arkansas River drainages, respectively. The area is approximately 106 miles long and 64 miles wide, embracing 4,748 square miles, or 3,039,000 acres.

The Eastern Slope project area is located in central and southeastern Colorado east of the Continental Divide and comprises nearly a fourth of the entire area of the State of Colorado. About 28,150 square miles, or 16,736,000 acres are contained within the area which is 340 miles long and 170 miles wide. It is larger than the combined areas of New Hampshire, Connecticut, Massachusetts, Rhode Island, and Delaware.
(Chapter II.--General description)

(Physical Geography)

From right to left, in counterclockwise direction from the headwaters of the Arkansas River, the area is bounded by the Continental Divide and then by river drainage basins in the following sequence: Rio Grande; Canadian; Cimarron; Arkansas beyond the Colorado-Kansas boundary; Smoky Hill; Republican; and South Platte.

Physical Features

The physiography of the area which would be affected by project development ranges from lofty mountains of the Continental Divide to the high plains region in the eastern portion of the area. Principal streams are the Roaring Fork and Gunnison Rivers tributary to the Colorado River on the Western Slope and the Arkansas River which drains the Eastern Slope project area.

On the Western Slope the Roaring Fork River and its tributaries rise in the high mountains of the Continental Divide and the Elk Mountains at altitudes upward of 14,000 feet elevation and descend to about 5,800 feet at Glenwood Springs where the Roaring Fork River joins the Colorado River. Streams in the Fryingpan River diversion area proper are all above 9,000 feet altitude and are typical mountain torrents that have cut through rough terrain to form extremely steep narrow canyons. The upper Gunnison River Basin lies entirely within the high mountain and plateau region. Elevations vary from over 14,000 feet on the highest peaks to about 6,700 feet at the confluence of the Cimarron and Gunnison Rivers. High mountain streams prevail in the diversion area, many flowing through deep canyons, although several relatively flat, narrow valleys are present.

About 17 percent of the Eastern Slope project area is at an altitude above 9,000 feet and is principally mountainous; about 45 percent ranges in altitude from 5,000 to 8,000 feet and is hilly except for small scattered areas of land suitable for cultivation; and the remaining 38 percent, below 5,000 feet altitude, is relatively level and is suitable for cultivation.

The Arkansas River is the principal stream in the area. It is formed by the juncture of Tennessee Fork and East Fork Rivers about 3 miles west of Leadville at an altitude of 9,700 feet. The headwaters originate at elevations of 10,500 feet to 14,400 feet on the east side of the Continental Divide. The river descends south and east about 126 miles through mountainous terrain to Canon City. En route it flows
through the spectacular Royal Gorge—a mighty chasm gouged through sheer granite—over which the world's highest swinging bridge has been erected 1,053 feet above the river. From Canon City the river flows eastward through foothills to Pueblo where it enters the high plains region. The river continues its general eastward course through the high plains of southeastern Colorado to the Colorado-Kansas boundary where it leaves the Eastern Slope project area at an altitude of about 3,350 feet. The river empties into the Mississippi River about 60 miles southeast of Pine Bluff, Arkansas.

The tributary streams above Canon City are typical steep mountain streams. They are above 5,400 feet altitude, flow through deep gorges and canyons, and drain small but highly contributory runoff areas. Principal tributaries in the foothill and high plains section rise in the mountains above 10,000 feet altitude. In the middle and lower reaches, these tributary streams are in the high plains region where the foothills gradually merge into the broad, comparatively level Arkansas Valley.

Climate

Wide variations in climate exist in the area. In the mountainous regions on both slopes the climate is subhumid, and an extremely short growing season and considerable precipitation of low intensity prevail. Although in the high plains region the length of growing season and temperature are favorable to agricultural production, the precipitation is not sufficient to carry the crops to full maturity, and only by irrigation may continuous high crop production in the area be assured. Pertinent climatological data from representative Weather Bureau stations in area are shown in table 1.

The climate of most of the Western Slope diversion area is subhumid. Protracted and extreme cold spells; precipitation in the form of low intensity rainfall; low mean annual temperatures; and an extreme range in daily and seasonal temperatures are not uncommon. The recorded precipitation varies from 10.09 inches at Gunnison to 35.97 inches at Ruby. The area has an extremely short growing season. Frost-free periods range from 41 days at Crested Butte to 103 days at Aspen, but in many localities freezing temperatures may be expected throughout the year. Average maximum and minimum temperatures at Gunnison are 105° and -47°.
Table I -- Summary of climatological data

<table>
<thead>
<tr>
<th>Station</th>
<th>General location</th>
<th>Elevation (m.a.s.l.)</th>
<th>Years record</th>
<th>Average annual (in.)</th>
<th>Percent April to October</th>
<th>Years record</th>
<th>Average annual (deg.)</th>
<th>Max.</th>
<th>Min.</th>
<th>Years record</th>
<th>Avg. date last killing frost in Spring</th>
<th>Avg. date first killing frost in Fall</th>
<th>Average length growing season</th>
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<td>Pitkin</td>
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<td>9,212</td>
<td>36</td>
<td>16.01</td>
<td>64.1</td>
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<td>20</td>
<td>July 6</td>
<td>Aug. 16</td>
<td>141</td>
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<tr>
<td>Crested Butte</td>
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<td>8,550</td>
<td>36</td>
<td>21.77</td>
<td>55.8</td>
<td>29</td>
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<td>July 6</td>
<td>Aug. 16</td>
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<td>-47</td>
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<td>-37</td>
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<td>-26</td>
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<td>Oct. 12</td>
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<td>81.5</td>
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<td>52.6</td>
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<td>April 30</td>
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<td>Oct. 7</td>
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<td>81.2</td>
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<td>54.0</td>
<td>109</td>
<td>-20</td>
<td>41</td>
<td>April 26</td>
<td>Oct. 11</td>
<td>168</td>
</tr>
</tbody>
</table>

There are two general types of climate on the Eastern Slope. In the mountains the climate is subhumid with an extremely short growing season. From the Rocky Mountain front range to the Colorado-Kansas boundary the climate is arid.

The climate in the mountainous portion of the project area is characterized by a decrease in the mean and maximum temperatures as the altitude increases. Relatively little difference in extreme temperatures exists compared with the plains country. Minimum temperatures depend more upon air drainage than upon altitude. Precipitation is considerable, but it is generally of low intensity and varies largely with altitude and exposure to the moisture-laden atmosphere. Protracted cold spells and short frost-free periods are noticeable.

The climate of the Arkansas Valley proper, where most of the farming is practiced, is similar throughout. It is characterized by a large number of sunny days, relatively low humidity, few protracted cold spells, extreme ranges in daily and seasonal temperatures, little snow, and high intensity rainfall in the summer. Although about 85 percent of the annual precipitation occurs from April through October, it is insufficient to carry the crops to full maturity.

Precipitation varies considerably throughout the project area. At Leadville the annual average is 18.63 inches; at Buena Vista, 40 miles southeastward, 8.78 inches; and at Pueblo, 11.67 inches. From Pueblo eastward the precipitation increases somewhat to 16.05 inches at Lamar. The precipitation record at Las Animas, which clearly indicates the wide fluctuations and poor distribution in annual precipitation in the plains region, is shown in exhibit 2. 1/  

Extreme temperatures in the project area vary from 114 degrees to -64 degrees Fahrenheit. In the plains region the average mean temperature is about 53 degrees. Average lengths of the frost-free period vary from 83 days at Leadville to 173 days at Pueblo. Within the expansive agricultural plains region the average frost-free period is about 165 days.

1/ Most complete and extensive records in the Arkansas Valley were those available for Las Animas.
PRECIPITATION - LAS ANIMAS, COLORADO 1868-1946
UPPER ARKANSAS RIVER BASIN
COLORADO

CALENDAR YEAR

PRECEPITATION IN INCHES

AVERAGE 12.31 in.

January 0.20 in. February 0.40 in. March 0.55 in. April 1.40 in. May 1.93 in. June 1.46 in. July 2.12 in. August 1.68 in. September 1.03 in. October 0.75 in. November 0.36 in. December 0.38 in.

AVERAGE MONTHLY DISTRIBUTION OF PRECIPITATION
Geology

The mountainous area was formed by ancient geologic upheavals and structural disturbances which resulted in an extensive uplift and subsequent erosion. This area is extremely folded and faulted. Along the east base of the mountains where sedimentary beds have been tilted, the less resistant formations have been eroded leaving ridges or hogbacks exposed. The Great Plains area contains a regional dip of the strata to the north. The strata vary considerably in thickness, and many are folded and exposed at the surface due to the flexure of the rock layers with subsequent erosion.

Igneous, metamorphic, and sedimentary rocks occur throughout the area. Sedimentary rocks predominate in the Great Plains area, whereas in the mountainous regions complex igneous and metamorphic rocks are common.

Igneous rocks of Tertiary or Pre-Cambrian age are common in the Western Slope diversion area. Granite is found in large masses at the head of the Fryingpan River in the Roaring Fork River Basin and also at the head of the Taylor River and Quartz Creek in the Gunnison River Basin. Metamorphic rocks are found on the west face of the Sawatch Range at the head of the Fryingpan and Roaring Fork Rivers; they are found also in the Gunnison River Basin. The oldest sedimentary deposits in the diversion area are found in the Gunnison Basin. Glacial moraines and terrace deposits of more recent age are found on the Taylor, Roaring Fork, and Fryingpan Rivers.

On the Eastern Slope the region above Canon City consists almost entirely of complex igneous and metamorphic rocks overlain in part by intrusive material, glacial moraine, and terrace deposits. Between Canon City and the Colorado-Kansas boundary the rocks are mostly sedimentary and consist of sandstone, limestone, and shale. Rocks in this part of the area are relatively young in age.

POPULATION AND HISTORY

Population growth

Since 1880 the Eastern Slope counties, where agriculture and manufacturing are the basic industries, have generally increased in population; however, all Western Slope counties and a few counties on the
Eastern Slope have declined in population due to a reduction in mining operations. The total population of the area was 287,210 in 1940; 278,700 on the Eastern Slope and 8,510 in the diversion area. The population of the Western Slope counties was only 3 percent of that of the entire area. Only about one-half of the total population of the Eastern and Western Slope areas was urban. Population growth of principal towns and cities in the area is shown in table 2 together with the total population of the Western Slope diversion area and the Eastern Slope project area.

**History of Western Slope diversion area**

All of the towns in the diversion area owe their inception to prospecting and mining activity during the period 1873 to 1884. With the decline in mining some of the towns were abandoned and became "ghost towns".

During this time many people turned from mining to farming and livestock raising. Irrigation, which dates from 1870, was of minor importance until the large ranches were established. Much of the valley land areas along the various streams were then developed into irrigated native hay meadows and pastures. The increase in irrigated area was gradual from about 1870 to 1910 with the greatest expansion occurring from about 1890 to 1910. The even economic balance between livestock raising and irrigation of hay and native grazing lands resulted in a relatively static condition in the population after 1910. The population trend for the diversion area from 1880 to 1940 clearly reflects these conditions.

**History of Eastern Slope project area**

The first history of the Eastern Slope project area dates back to the Plains Indians and to the Spanish explorers who settled in the area after Coronado's expedition in 1540-1542. Although the buffalo provided practically all of the necessities of life for these Indians—food, clothing, shelter, and even fuel—small dry-farmed tracts were tilled on which corn was the principal crop.
Table 2.—Population growth: Gunnison-Arkansas Project area

<table>
<thead>
<tr>
<th>City</th>
<th>1880</th>
<th>1890</th>
<th>1900</th>
<th>1910</th>
<th>1920</th>
<th>1930</th>
<th>1940</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WESTERN SLOPE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pitkin</td>
<td>1,891</td>
<td>371</td>
<td>203</td>
<td>250</td>
<td>165</td>
<td>228</td>
<td>156</td>
</tr>
<tr>
<td>Crested Butte</td>
<td>886</td>
<td>1,106</td>
<td>1,200</td>
<td>1,026</td>
<td>1,329</td>
<td>1,415</td>
<td>2,177</td>
</tr>
<tr>
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<td>5,106</td>
<td>5,303</td>
<td>1,854</td>
<td>1,265</td>
<td>705</td>
<td>777</td>
<td></td>
</tr>
<tr>
<td>Aspen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **EASTERN SLOPE** |      |      |      |      |      |      |      |
| Leadville       | 14,820| 10,384| 12,455| 7,508| 4,959| 3,771| 4,774|
| Salida          | 2,565 | 5,623 | 5,345 | 10,204| 10,906| 11,732| 13,223|
| Canon City      | 1,601 | 2,828 | 3,775 | 5,162| 4,551| 5,937| 6,690|
| Florence        | 3,777 | 2,712 | 2,629 | 2,473| 2,652|      |      |
| Walsenburg      | 377   | 928   | 1,033 | 2,423| 3,565| 5,503| 5,855|
| Trinidad        | 2,228 | 5,623 | 5,345 | 10,204| 10,906| 11,732| 13,223|
| Colo. Springs   | 4,226 | 11,140| 21,085| 29,078| 30,105| 35,237| 36,769|
| Pueblo          | 3,217 | 24,568| 28,167| 41,747| 43,060| 50,096| 52,162|
| Fowler          |      |      | 681   | 925   | 1,062| 968  | 922  |
| Manzanola       |      |      | 719   | 428   | 662  | 576  | 551  |
| Ordway          | 148   |      | 138   | 706   | 1,186| 1,159| 1,150|
| Rocky Ford      | 468   |      | 2,018 | 3,230| 3,746| 5,426| 3,494|
| La Junta        |      |      | 1,439 | 2,613 | 4,154| 4,964| 7,193| 7,040|
| Las Animas      |      |      | 1,192 | 2,006| 2,252| 2,617| 3,232|
| Lamar           | 566   |      | 967   | 2,977| 2,612| 4,165| 4,445|
| Holly           | 192   |      | 364   | 724   | 940  | 971  | 864  |

Source: Census of population.
The project area was a part of the Louisiana Purchase acquired by the United States from France in 1803. That portion of the area south and west of the Arkansas River was claimed by Texas, but those claims were relinquished when Texas was admitted to the Union in 1845.

The first official exploration by the United States was that of Lt. Zebulon Pike in 1806-1807. Prior to 1860, particularly during the 1820's, and 1830's, many trappers poured into the area as a result of a demand from the English for beaver pelts. As the demand for fur slackened and the streams became depleted, a few trappers settled down and began to farm the valleys.

Irrigation was first introduced to the area by some of the early French, Spanish, and English settlers who brought various irrigation practices and regulations to the country. The French and Spanish came from areas where irrigation was an established practice and where the Civil Law concerning water and its utilization had been derived from the old Roman Laws. With that foundation and because of the scanty rainfall, irrigation received a healthy start. The first recorded use of irrigation in the area was along the Purgatoire River near the present site of Trinidad, where in 1846 John Hatcher grew the first irrigated crops produced in that area. Another instance of early irrigation was recorded by Ruxton in his book, "Wild Life in the Rocky Mountains". In 1847 he observed an irrigated tract of land near Crew, Pueblo County. That land is still irrigated. Many appropriations of water from the Arkansas River were made during the period 1860 to 1870. As the fact became more widely recognized that areas along the Arkansas River and its tributaries could be made to grow crops by means of irrigation, and as the technical knowledge spread, more and more people began to settle on this land, and irrigation began to expand rapidly.

The discovery of gold in 1858 in the Cherry Creek district near the present site of Denver, led to the establishment of the first permanent settlements. Other settlements were sparked by the "Pikes Peak or Bust" migration and by the discovery of silver near Leadville in the late 1870's, and the discovery of lead deposits near the head of the Roaring Fork of the Colorado River in 1880.

Many immigrants, attracted to Colorado and the project area by the mining booms, soon turned to agricultural pursuits along the streams and undertook to produce foods required to support the expanded population. The mining camps furnished excellent markets.
The romantic livestock era began in the late 1860's as a result of the wholesale destruction of buffalo on the plains and the completion of railroads from the East. In 1867 the first herds of cattle were driven from Texas to Abilene, Kansas, for shipment to Eastern markets. The luxuriant and apparently unlimited grass was utilized so that within a decade the range cattle industry with its large ranches had spread over the entire Great Plains region. Until the panic of 1873 the cattle business expanded without interruption. By 1876 the demand for beef was again on the increase and reached the proportions of a great cattle boom in the early 1880's. Not only Easterners, but Canadians, Englishmen, Scotchmen, and Australians entered the game. However, the free and apparently unlimited grass land became over-grazed, and the tall grass began to give way to buffalo and grama. When thousands of cattle perished throughout the Great Plains in the winter of 1886-1887, the bottom fell out of the cattle ranching era. Thereafter, windmills made fenced pastures practical; sheep began to invade the summer ranges; homesteaders began to fence and to plow up the winter range; and livestock men were forced to concentrate on a more intensive type of ranching.

Since 1880 there has been a general growth in the population of the area, although population of several counties has declined due to reduced mining operations. In Lake and Custer Counties, for example, the populations have never returned to the level of the "boom" days of 1880 at Leadville and Silver Cliff. Other counties show a growth typical to areas that have agriculture and a limited amount of manufacturing as basic industries.

The entire period between the first settlement and World War I was an alternate cycle of good and bad years in the Eastern Slope area. During the droughts many homesteaders failed, and in a wave of speculation, much of the land became absentee-owned. An arid spell from 1901 to 1904 was followed by the discovery of new dry-farm methods and a period of resettlement. During World War I and until 1929, dry farming increased, boosted by the perfection of the tractor which increased twenty-fold the amount of land that could be worked. However, the economic crash in 1929 followed by the drought and dust storms in the 1930's seemingly spelled the end of the wheat kings and the extensive dry farms in the area. From the beginning of World War II to the present time (1947), crop prices have been relatively high and favorable climatic conditions have prevailed. This more recent condition has revived dry-land farming and has resulted in the planting of large acreages of wheat, beans, and other crops on abandoned crop land. The areas where dry farming can be practiced successfully are largely outside of the irrigable project area.
A recapitulation of the development of the area shows gold and other metals being dug out of the hills, cattle ranching and then dry farming becoming entrenched on the plains, commercial farming being established in the valleys, and most significant, towns growing along the base of the mountains and along the Arkansas River.

The entire Eastern Slope area showed a general increase in population until the 1930-1940 decade. Then adverse economic conditions of the "depression", prolonged drought, and acute "dust-bowl" seasons resulted in a decrease in population of those counties in which agriculture is the principal industry. During that period most of the cities and towns grew as a result of an influx of people from rural to urban areas.

Since 1940 the population of counties, cities, and towns in the area has shown the effect of the national emergency. The growth of Pueblo, Colorado Springs, and La Junta, has been particularly rapid because of the establishment of nearby military facilities and increased manufacturing. Lamar owes its recent growth to the stabilizing effect of irrigation storage in the John Martin Reservoir. These increases in population due to manufacturing activities attendant upon the national emergency may not be permanent unless an adequate and dependable water supply and hydroelectric power become realities.

LAND AND WATER DEVELOPMENTS

Land uses

Of the total 19,775,000 acres within the Western Slope diversion area and the Eastern Slope project area, 3,039,000 acres lie on the Western Slope and 16,736,000 in the Arkansas Valley. In this vast area an average of only about 1,850,000 acres are cultivated--9 percent of the entire area. The major land use is for grazing. Much of the area in the mountainous region is timberland which is also used for grazing. The remaining area is devoted to such uses as mineral land, culture land (town and city lots, railway and utility right-of-ways, etc.), and reserved land (power reserves, stock driveways, water reserves, and miscellaneous reserves).

Only 2.6 percent of the Western Slope diversion area is cultivated. Grazing land comprises 28.6 percent, and timberland, a large percent of which is national forest and is used for grazing, covers 65.2 percent of
amortization of the net Federal project investment at 2-1/2 percent over the anticipated useful life of the project, which is 100 years for the Initial Development.

94. A comparison of the annual equivalent project costs and monetary benefits of the Initial Development is presented below:

<table>
<thead>
<tr>
<th>Annual benefits</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroelectric power</td>
<td>$5,859,000</td>
</tr>
<tr>
<td>Irrigation</td>
<td>2,830,000</td>
</tr>
<tr>
<td>Flood control</td>
<td>1,002,000</td>
</tr>
<tr>
<td>Municipal water</td>
<td>319,000</td>
</tr>
<tr>
<td>Sediment control</td>
<td>135,000</td>
</tr>
<tr>
<td>Recreation</td>
<td>109,000</td>
</tr>
<tr>
<td>Fish and wildlife</td>
<td>~42,000</td>
</tr>
<tr>
<td>Construction expenditures</td>
<td>1,348,000</td>
</tr>
<tr>
<td>Total annual benefits</td>
<td>$11,656,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Equivalent project costs</td>
<td>$3,954,000</td>
</tr>
<tr>
<td>Operation, Maintenance &amp; Replacement</td>
<td>1,469,000</td>
</tr>
<tr>
<td>Total annual costs</td>
<td>$5,423,000</td>
</tr>
</tbody>
</table>

Ratio of benefits to costs with
Arkansas River winter water . . . . 2.13 to 1.00
Ratio of benefits to costs without
Arkansas River winter water . . . . 1.93 to 1.00

95. The farm return-farm cost ratio for the Initial Development is 1.77 to 1.00. That ratio indicates the ability of the irrigators to pay assessments. In other words, for every dollar of increased farm costs, an additional 77 cents may be available to cover repayment and contingencies.

96. Preliminary computations for the Maximum Gravity Diversion indicate that the annual benefits would average $33,926,000. The annual equivalent project costs would be $19,329,000, resulting in a benefit-cost ratio of 1.76 to 1.00.

Reimbursement

97. Reimbursable construction costs of the Initial Development, amounting to $115,546,000 could be repaid in full over a 60-year period. Nonreimbursable construction costs of $24,925,000 allocated to flood control and recreation represent less than 16 percent of the total. Additional nonreimbursable allocations for sediment control may be recommended later when additional data become available.

98. The operating plan for the project involves the formation of a Conservancy District. Such a district would contract with the Federal Government for the reimbursement of certain irrigation costs. The
Table 4.--Land use: Eastern Slope project area (generalized)

<table>
<thead>
<tr>
<th>Land use type</th>
<th>Area</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(acres)</td>
<td>(sq. mi.)</td>
</tr>
<tr>
<td>Cultivated land</td>
<td>424,000</td>
<td>662</td>
</tr>
<tr>
<td>Irrigated</td>
<td>1,348,000</td>
<td>2,106</td>
</tr>
<tr>
<td>Dry-farm</td>
<td>13,591,000</td>
<td>21,238</td>
</tr>
<tr>
<td>Grazing land</td>
<td>1,112,000</td>
<td>1,738</td>
</tr>
<tr>
<td>Timberland a/</td>
<td>135,000</td>
<td>211</td>
</tr>
<tr>
<td>Mineral land</td>
<td>104,000</td>
<td>163</td>
</tr>
<tr>
<td>Culture land b/</td>
<td>22,000</td>
<td>34</td>
</tr>
<tr>
<td>Reserved land c/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>16,736,000</td>
<td>26,150</td>
</tr>
</tbody>
</table>

Source: Modified from basic data in the Colorado Year Book 1941-1942.

a/ A major portion is national forest, used for grazing.
b/ Town and city lots, railway and utility rights-of-way, etc.
c/ Power reserves, stock driveways, water reserves, and miscellaneous reserves.

Water uses

Irrigation

Statistics concerning the area of irrigated land within the Gunnison-Arkansas Project vary widely; even data on apparently identical areas differ by reporting agencies. Furthermore some data are county-wide (agricultural statistics in particular) which results in seeming discrepancies with other data that have been obtained for portions of counties within the drainage basin. A general reconciliation has been accomplished, and for the purpose of this report, the average acres of irrigated land included in the diversion area and in the Eastern Slope project area are as follows:
Chapter II.--General description

(LAND AND WATER DEVELOPMENTS)

EASTERN SLOPE:
- Area irrigated directly by Arkansas River: 322,000 acres
- Area irrigated by tributary streams: 102,000 acres
  * Subtotal: 424,000 acres

WESTERN SLOPE:
- Roaring Fork River Basin: 15,000 acres
- Gunnison River Basin: 63,000 acres
  * Subtotal: 78,000 acres

*Total, project area: 500,000 acres

The irrigated lands in the Western Slope diversion area which would be affected by the Initial Development are located in the Roaring Fork River Basin in Pitkin County. Other irrigated areas in the diversion area are located along the Snake and East Rivers and the Gunnison River between Almont and Sapinero, but these areas would not be affected until the expansion of the Initial Development into the Maximum Gravity Diver- sion.

According to the Colorado Year Book, approximately 98 percent of the land under cultivation in the Western Slope diversion area is irrigated. Shortage of water is seldom experienced. According to census reports, in Pitkin County an average of 6.9 acre-feet are delivered to each acre of irrigated land. In Gunnison County even more water is delivered—7.1 acre-feet per acre. Studies made by the Bureau of Reclamation and the Colorado Water Conservation Board indicate that the consumptive use for irrigated areas is only about 1.2 acre-feet per acre.

Three small transmountain diversion projects in the diversion area deliver water to the Gunnison and Rio Grande River Basins. These are in addition to the eight diversions to the Arkansas Valley. The Taylor Park Reservoir with a capacity of 106,230 acre-feet is located on the Taylor River northeast of Gunnison. It was constructed by the Bureau of Reclamation to provide storage capacity for the Uncompahgre Project. Further discussion of this reservoir will be found in a subsequent chapter.

A breakdown of the irrigated area in the Eastern Slope project area given previously for the main river counties and the tributary stream counties is as follows:
Area irrigated by Arkansas River:

<table>
<thead>
<tr>
<th>Location</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadville-Salida</td>
<td>6,000</td>
</tr>
<tr>
<td>Salida-Canon City</td>
<td>3,000</td>
</tr>
<tr>
<td>Canon City-Florence</td>
<td>7,000</td>
</tr>
<tr>
<td>Pueblo-State line</td>
<td>306,000</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>322,000</strong></td>
</tr>
</tbody>
</table>

Area irrigated by tributary streams:

<table>
<thead>
<tr>
<th>Tributary</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penrose</td>
<td>5,000</td>
</tr>
<tr>
<td>Fountain Valley</td>
<td>15,000</td>
</tr>
<tr>
<td>Remaining tributary areas</td>
<td>82,000</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>102,000</strong></td>
</tr>
<tr>
<td><strong>Total, project area</strong></td>
<td><strong>424,000</strong></td>
</tr>
</tbody>
</table>

The drainage area of the Arkansas River and its tributaries in Colorado includes principally 11 of the 14 water districts comprising Irrigation Division No. 2.

Arkansas Valley.--Small tracts of land from the headwaters of the Arkansas River to Canon City are irrigated by small direct diversion ditches, operated usually without diversion dams. Nine ditches with excellent water rights service about 7,000 acres in the Canon City-Florence area. Five small ditches serve a few acres between Florence and the Pueblo County line. Irrigated lands, totaling 970 acres, from Pueblo west to the county line, are supplied by seven small direct diversion ditches.

Between Pueblo and the Colorado-Kansas boundary the irrigated areas are served by 24 canals and ditches. Approximately 306,000 acres are irrigated with an average of about 584,800 acre-feet of water during the irrigation season, April 1 to October 31.

At present, the water supply from the Arkansas River and its tributaries is supplemented by eight small transbasin diversions. An average of 43,000 acre-feet of water is diverted each year from the Colorado River Basin to the headwaters of the Arkansas River. The largest diversion is made by the Independence Pass (Twin Lakes) system which imports an average of 33,000 acre-feet each year to the Arkansas Valley. The collective total diversions of the remaining systems, which are small open ditches with inadequate collection systems diverting annually 150 to 4,000 acre-feet, average 10,000 acre-feet per year. All of the water diverted is used for irrigation with the exception of the Wurts Ditch water which is used for municipal purposes by the city of Pueblo. Reservoirs principally used for the storage of diverted water, directly or by exchange procedure, are the Sugar Loaf, the Twin Lakes, the Clear Creek (Otero), and the Mount Piasah (Wrights).
From Pueblo eastward eight off-stream reservoirs, supplied with water from the Arkansas River, have a total capacity of about 307,500 acre-feet and furnish irrigation water for lands below by direct application or by exchange procedures.

Table 5.--Reservoirs between Pueblo and the Colorado-Kansas boundary

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Estimated capacity 1945</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Henry</td>
<td>6,100</td>
</tr>
<tr>
<td>Lake Meredith</td>
<td>37,400</td>
</tr>
<tr>
<td>Dye</td>
<td>3,500</td>
</tr>
<tr>
<td>Holbrook</td>
<td>4,500</td>
</tr>
<tr>
<td>Horse Creek</td>
<td>20,100</td>
</tr>
<tr>
<td>Adobe Creek</td>
<td>66,200</td>
</tr>
<tr>
<td>Thurston</td>
<td>2,800</td>
</tr>
<tr>
<td>Great Plains system</td>
<td>167,700</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>307,500</strong></td>
</tr>
</tbody>
</table>

Note:--Due to sedimentation, the active capacity at present is less than shown.

The above reservoirs were constructed by individuals or by irrigation companies at the beginning of the century to relieve a critical shortage of irrigation water brought about by over-appropriation of Arkansas River water. It is estimated, however, that 25 percent of the combined original capacities have been filled with sediment. If these reservoirs continue to fill with sediment at the present rate, it will not be many years before their capacities are entirely depleted and the irrigators will be forced to rely once again upon an over-appropriated streamflow of the Arkansas River for their entire water supply. The Gunnison-Arkansas Project would materially alleviate any such danger.

The John Martin Reservoir, located on the Arkansas River, was constructed principally for flood control. Of the 665,000 acre-feet capacity, about 100,000 acre-feet were temporarily allocated for irrigation use during the years 1943 to 1947, inclusive. The dam is now completed, and approximately 385,000 acre-feet of capacity minus the space filled with sediment is now available for irrigation use.
Tributary areas.--The irrigated areas along the South Arkansas River near Salida and other tributaries of the Arkansas River consist of small tracts of land. Small direct diversion ditches provide the water for irrigation.

Several reservoirs with limited capacities store water for irrigation uses. The DeWeese Reservoir on Crape Creek in the Wet Mountain Valley, has a storage capacity of about 4,500 acre-feet and supplies water to a small area south of Canon City. The Mount Pisgah Reservoir, which is located north of Canon City on Oil Creek and has a capacity of 3,000 acre-feet, furnishes water to a small area in its vicinity. Northeast of Florence, the Brush Hollow Reservoir, an off-stream structure which has a storage capacity of about 4,100 acre-feet and is supplied from Beaver Creek, serves about 5,000 acres in the Penrose area. The Teller Reservoir northwest of Pueblo has a storage capacity of about 12,300 acre-feet, but the water supply usually is deficient; hence only a few acres along Turkey Creek are irrigated. During the late summer months a large portion of the lands in these tributary areas is short of water.

Below Pueblo most of the tributary areas are served by direct diversion ditches that have unregulated and unreliable water supplies. Small storage reservoirs, such as the Cucharas Reservoir on the Cucharas River, and the Model Reservoir—an off-stream structure supplied by the Purgatoire River—are utilized in some instances. Along the upper reaches of mountainous tributaries small scattered tracts, principally meadow, are irrigated with unregulated supplies. Along the middle and lower reaches of tributaries in the plains and foothills, large tracts of productive soil are irrigated, but the water supply is inadequate and undependable.

The tributary area which would receive the greatest benefits from the Gunison-Arkansas Project is located along the Fountain River where approximately 15,000 acres are presently irrigated. This land would benefit from the use of return flow derived from additional municipal water to be provided the city of Colorado Springs by the potential project development. Compensation for the depletion of the Beaver Creek supply by the city of Colorado Springs for municipal use would be made to the Penrose area and other appropriation through an exchange procedure in the Initial Development.
Industries

Numerous industries are dependent upon the available water in the area for their industrial supply. A few of the more important users are discussed in the following paragraphs.

Railroads.--The principal industrial consumer of water in the Western Slope diversion area is the Denver and Rio Grande Western Railroad.

Throughout the Eastern Slope project area, the Denver and Rio Grande Western Railroad, the Colorado and Southern Railway, the Missouri Pacific Railroad, and the Atchison, Topeka and Santa Fe Railway obtain water from their own systems—principally wells. All water that has a hardness of more than 4 grains per gallon (69 parts per million) is treated before being used in boilers.

Manufacturing.--Industrial use of water in the diversion area is limited primarily to mining.

On the Eastern Slope a steel mill, owned and operated by the Colorado Fuel and Iron Corporation at Pueblo, obtains about 44,200 acre-feet of water annually from the Arkansas and St. Charles Rivers, principally for cooling purposes, but returns to the Arkansas River approximately 83 percent of the water. The water returned to the river contains iron rust which could be removed from the water, thereby making available for non-consumptive industrial uses a critically needed water supply.

Numerous small or seasonal industries are located throughout the project area which utilise water from the municipal systems and from wells. These industries include mining, beet sugar factories, canning factories, breweries, brick and tile manufacturers, packing plants, and many others.

Powerplants.--The two hydroelectric powerplants in the Western Slope diversion area have a combined installed capacity of 2,550 kilowatts. These plants are located at Crested Butte and Aspen. In addition, several mining developments have operated or are operating small hydroelectric plants intermittently for the generation of electric power.

The hydroelectric power resources of the Eastern Slope project area are relatively undeveloped, as only 8,740 kilowatts of hydroelectric generating capacity are installed at present. There are five hydroelectric generating plants in operation—Buena Vista on the main river and Skaguay, Salida, Manitou, and Ruxton on tributary streams.
Several powerplants on the Eastern Slope require water for cooling purposes or for steam generation. The Southern Colorado Power Company has plants at Canon City and Pueblo which use water obtained from the Arkansas River and from wells in the valley alluvium. The Frontier Power Company (successor to the Trinidad Electric, Transmission, Railway and Gas Company) at Trinidad and Walsenburg uses water from the municipal supply. The Lamar Powerplant obtains water from surface wells; future supplies will be taken partly from the Lamar Canal Company by exchange methods.

Municipal and rural areas

Municipal water supplies for cities and towns in the area are obtained from mountain streams, springs, or shallow wells. The quality of water on the Western Slope varies from excellent to good, and supplies are adequate for present and anticipated needs. The quantity available on the Eastern Slope, is barely adequate at the present, and shortages are expected in most of the larger cities. In general the quality is poor, and in many towns the water must be treated for industrial use. With the future population increase expected to result from potential agricultural and industrial developments, additional water supplies will be needed by many municipalities, particularly Pueblo and Colorado Springs.

Domestic water for rural areas is generally obtained from wells, springs, streams, or lakes. Stock water supplies are derived from wells, springs, streams, lakes, irrigation canals, storage reservoirs, and stock ponds. About 1,066 small stock ponds with a total capacity of 4,475 acre-feet have been constructed on the Eastern Slope across water courses that have small intermittent flows. In the diversion area there are only 33 ponds with a total capacity of 199 acre-feet.

Recreation--fish--wildlife

Recreational benefits usually accrue from the storage and control of water. The mountain storage reservoirs provide swimming, boating, and fishing, as well as scenic beauty. The reservoirs in the plains region, however, are less desirable and are often not suitable for recreational purposes because of high mineral content, wide fluctuation of water surfaces, and unattractive surrounding territory. They often, however, indirectly provide recreational benefits in connection with upland game and duck hunting.
Fish and wildlife conservation has been incidental in most of the present water use and control projects. Developments in the mountainous regions consist of a few reservoirs, and in each of these, suitable environment is provided for fish. In the foothills and plains there are many reservoirs and stock ponds. Although some of these developments are beneficial to fish, their greatest benefit is to game and fowl. Agricultural development by irrigation provides food and shelter for wildlife.

**Flood control**

Two major flood control developments have been constructed on the Arkansas River; one is located at Pueblo and the other near Lamar. The development at Pueblo consists of a barrier dam west of the city and an improved floodway channel through the city. The other is the John Martin Reservoir located 16 miles west of Lamar.

Along the Arkansas River and many of its tributaries, including Monument Creek and the Fountain River in the vicinity of Colorado Springs, minor flood control works consisting of channel changes, riprap, revetments, etc., have been constructed by various municipalities, railroads, county and state highway departments, and irrigation companies.

Flood control improvements authorized for construction by the Corps of Engineers are the Tompleton Gap Project near Colorado Springs and the Trinidad Floodway Project at Trinidad.

Further discussion of existing and potential flood control structures may be found in Chapter VIII, "Flood Control".

**INDUSTRIAL DEVELOPMENT**

One of the most important industries in the Gunnison-Arkansas Project area is mining and smelting. Manufacturing industries are of minor importance in the mountainous regions; however, in other areas, particularly on the Eastern Slope, manufacturing is becoming increasingly important. Many of the raw materials which previously were shipped outside the area in a crude state for manufacture and consumption elsewhere are being processed in the manufacturing centers of Pueblo and other towns in the Arkansas Valley. The total value of products on both slopes in 1939 were: mining, $28,980,000; added by manufacturing, $22,432,000.
Mining

Coal, gold, silver, copper, and lead are the principal minerals produced on the Western Slope. The total value of production in 1939 was $1,493,000.

The surrounding mountain areas on the Eastern Slope are noted for their production of molybdenum, gold, silver, copper, lead, zinc, and coal. These minerals are produced in abundance and many other metals and nonmetals, such as feldspar, mica, tungsten, feldspar, manganese, aluminum, petroleum, etc., are produced in smaller quantities. The 1939 production was valued at $27,487,000.

Molybdenum, an extremely vital element for alloy steels, is one of the region's most valuable minerals. The Climax Molybdenum Company, sole producer of this metal in the area, has the largest development in the world, located at Fremont Pass on the Continental Divide, northeast of Leadville. In 1939 this development yielded 10,898 tons, which was 72 percent of the total domestic production and 66 percent of the world output for that year. The 1941 production was 13,876 tons, 69 percent of the domestic output. The cumulative value of mined molybdenum through 1941 was $115,399,000.

Gold and silver comprise a large part of the value of all minerals mined on the Eastern Slope. The major minerals produced in the area through 1941 and their value are gold, $463,084,000; silver, $202,771,000; lead, $100,715,000; zinc, $47,912,000; and copper, $16,572,000.

The value of coal mined annually exceeds that of any other mineral mined on the Eastern Slope. Sub-bituminous or black lignite and high-grade bituminous coal are found in various parts of the area, and a high-grade coal used for making coke is found in the Trinidad field in Las Animas County. During the period 1935 to 1941, inclusive, the average annual production of coal in El Paso, Fremont, Huerfano, and Las Animas Counties was 2,646,000 tons.

Petroleum was discovered in the Florence-Canon City oil field in 1862; it is the second oldest in the United States and the largest producing field in the project area. From the time of its discovery to 1942, more than 13,700,000 barrels have been produced from this pool. The 1941 production was about 53,500 barrels.
Helium gas is found in Las Animas County but has been held in reserve for future use since acquisition of the field by the government.

Large quantities of ceramic clay suitable for fire brick, building brick, tile, and pipe exist throughout the project area and have been exploited to some extent.

Manufacturing

Major manufacturing industries on the Western Slope include the processing of dairy products for local consumption; printing; lumbering; and construction and assembling of minor agricultural implements. Most raw materials produced in the diversion area, except coal and lumber, are not processed or consumed there but are shipped to the more highly industrialized centers. In 1939 the four manufacturing establishments in the diversion area, all of which are located in Gunnison County, employed 46 wage earners, paid out $41,400 in wages, and manufactured products valued at $161,000, of which $108,000 was value added by manufacture.

Except for steel, manufacturing has been slow to develop on the Eastern Slope. Most raw materials are exported for manufacture and consumption elsewhere. The census lists 259 manufacturing establishments in 1939 that had 6,931 wage earners who earned a total of $8,657,000. Value of manufactured products was $53,283,000, of which $22,000,000 represented value added by manufacture. Four fifths of the total value of manufactured products was from Pueblo County.

The largest manufacturing establishment in the project area is the Colorado Fuel and Iron Corporation which operates a steel mill at Pueblo. Products manufactured from ore imported from Wyoming and Utah, to a large extent, consumed outside of the area. The Golden Cycle Corporation operates a large modern mill near Colorado Springs for the treatment and extraction of gold and other ores. The Ideal Portland Cement Company operates a large cement plant at Portland; the Ramapo-Ajax Plant of the American Brake Shoe and Foundry Company has a plant at Pueblo for the production of railroad frogs, switches, etc.; and two firms at Pueblo manufacture tile, bricks, etc. Other small industries, located at various points throughout the area include smelting, lumbering, oil refining, brewing, dairy products processing, and broom and curio manufacturing.

World-War II was a stimulant to industrial development in the project area. The mining of critical materials was accelerated and old industries were expanded. Many small machine shops were enlarged, and some industries were re-established. In general, however, much of the wartime
expansion was temporary—particularly in those industries directly related to war production. When the plan for a reliable water supply and the tremendous electric power generation materializes as presented in this report, greater industrial development on a permanent basis will undoubtedly result.

Plants and facilities for processing agricultural products are scattered throughout the Eastern Slope area. Three beet sugar factories—located at Sugar City, Swink, and Rock Ford—process sugar beets grown on irrigated lands. The area has 3 flour mills; 4 meat packing plants, including a large plant at Pueblo that sends its products to the East through chain-store affiliations; 7 vegetable packing houses; 5 canning factories; 9 alfalfa mills; 8 feed mixing and grinding mills; 3 sugar factories; and 23 grain elevators that have a combined storage capacity of 566,000 bushels.

Utilities

Transportation

The Denver and Rio Grande Western Railroad and bus and truck lines furnish freight and passenger service to the Western Slope area. County, State, and Federal highways serve most of the accessible area. Monarch Air Lines has a stop at Gunnison on route to Salt Lake City from Denver.

The Eastern Slope is traversed by main and feeder lines of railroads, highways, and airlines. Pueblo is a division point of four major railroads: the Denver and Rio Grande Western, the Colorado and Southern, the Missouri Pacific, and the Atchison, Topeka and Santa Fe. U. S. Highway No. 50 traverses the entire Arkansas Valley from the Continental Divide to the Colorado-Kansas boundary. The combined U. S. Highways Nos. 85 and 87 cross the area from north to south. U. S. Highway No. 35 leaves Highway No. 50 at La Junta and extends southwest into New Mexico and westward to the Pacific coast. The area is traversed by three major airlines (Continental, Braniff, and Monarch) that have a common junction point at Pueblo and which, with connecting lines, carry air traffic to all parts of the country. Air freight places perishable fruits and vegetables on Eastern markets within twenty-four hours.

Natural gas is not available to the Western Slope diversion area but is supplied to the Eastern Slope by pipeline from fields near Amarillo, Texas and Hugoton, Kansas.
(Chapter II.--General description)
(INDUSTRIAL DEVELOPMENT)

Power

Power facilities on the Western Slope consist principally of non-interconnected individual plants. No important power transmission systems exist in the area. Some Rural Electrification Association power systems have recently been installed to serve the rural areas.

The Eastern Slope project area is served by public and private utilities which distribute power throughout most of the region. Generators are powered, on the basis of installed capacity, 83 percent by steam, 11 percent by water, and 6 percent by internal combustion engines. A few plants have dual installations, i.e., two types of prime movers. During the past few years several Rural Electrification Association power systems have been installed to serve the rural areas. During 1941, 195,313,000 kilowatthours of electricity were sold to consumers. Of that total, 87 percent, or 169,072,000 kilowatthours, were generated in the area, and 26,241,000 kilowatthours were transmitted into the Eastern Slope area. A small amount of power produced in the area is exported to towns lying outside of the project area proper.

The larger industrial plants on the Eastern Slope produce large blocks of power; however, much of it is seasonal and most of it is used within the industries. Some mining companies have developed power to supply their own needs. The most important industrial power installations are at the Colorado Fuel and Iron Corporation, Pueblo; the Golden Cycle Mining Company, Colorado Springs; the Ideal Portland Cement Company, Portland; the Pikeview Coal Company, Pikeview; and beet sugar factories at Swink, Rocky Ford, and Sugar City.

Communications

Communication systems on the Western Slope are adequate; no radio stations are located in the diversion area.

 Adequate and modern communication systems serve the entire Eastern Slope project area. Two major telephone companies, operating facilities in all cities and towns, have interconnections with smaller rural lines. Telegraphic communications are provided to most towns by the Western Union Telegraph Company and by two smaller companies. Five radio stations, with national network affiliations, operate in the area.
ECONOMIC CONDITIONS

General conditions

Western Slope diversion area

The total 1940 population of the three principal counties (Pitkin, Gunnison, and Hinsdale) in the Western Slope diversion area was 8,377. The total county valuation in 1944 was $11,957,000 from which $430,400 was collected in county revenue. The average county levy was 37.08 mills. Bonded indebtedness for counties, school districts, and municipalities was $591,500 as of January 1, 1942. Tax collections during the past few years have been high.

Since 1941 Gunnison County has had the only bank in the diversion area. In that year loans and discounts totaled $500,400, deposits $1,492,000, and total assets $1,654,000. Ratio of deposits to loans and discounts was about 3 to 1 which compares favorably with the State ratio for the same period.

The 1939 per capita averages for Gunnison County show $3 in postal receipts, $49 in wholesale trade, and $301 in retail trade, all of which are below the State averages.

In 1940 the three counties in the diversion area contained 3,699 dwelling units, of which 1,301 were owner-occupied, 1,155 were tenant-occupied, and 1,243 were vacant.

Eastern Slope project area

The total 1940 county population for the 18 principal counties lying mostly within the Eastern Slope area was 289,051. The average per capita assessed valuation was $974 or a total county valuation of $281,553,800 in 1940. In 1944 the total county revenue on a valuation of $306,988,000 was $10,989,000. The average mill levies for 1944 were 8.66, county; 17.89, municipal; and 16.46, school. The weighted average total county levy for all purposes was 35.57 mills. Tax collections averaged 90 percent for the 1930-1940 period in the counties containing large areas of
irrigated land but were lower in the dry-land counties. Local government indebtedness was relatively high in 1941 as a result of an expanded building program in the 1920's, the ensuing depression, and the drought years in the 1930-1940 decade when very little of the debt could be retired.

As of December 1941 banks in the area had $16,237,000 in loans and discounts, $82,491,000 in deposits, and a total of $90,502,000 in assets. The ratio of deposits to loans and discounts was 5.1 to 1 compared to a State ratio of 3.1 to 1 for the same year. The stabilization of agriculture and development of industry and business resulting from adequate and dependable water supplies, hydroelectric power, flood control, and related developments would provide a basis for sound investments which would in turn increase the prosperity of the area.

Retail and wholesale business and postal receipts were slightly below those of other counties in the State in 1940. Average annual per capita figures for Fremont, Pueblo, Crowley, Otero, Bont, and Prowers Counties show $3 in postal receipts, $170 in wholesale trade, and $304 in retail trade compared to the average State per capita figures of $6, $387, and $564, respectively.

The entire Eastern Slope area in 1940 had 89,370 dwelling units, of which 39,057 were occupied by owners, 40,241 were occupied by tenants, and 9,872 were vacant.

**Relief problems**

Western Slope relief problems have not been particularly extensive. The census of 1940 shows that the total labor force of 3,107 was composed of 2,628 employed workers, 209 unemployed workers, and 190 persons engaged in public emergency work. The ratio of employed to totally unemployed and public emergency workers was about 7 to 1. Unemployment compensation payments for Western Slope counties decreased from $73,400 in 1939 to $14,900 in 1941.

Relief problems in the Eastern Slope project area are similar to those existing elsewhere in the State and the Nation. In 1937, 11,658 employable workers were totally unemployed, and 6,328 were partially unemployed. At that time, 8,774 of the employable workers were engaged on public emergency work projects. Unemployment in all counties in the project area was proportional to the population. By 1940 the number of emergency workers increased to 9,844 with 10,444 unemployed. The ratio
of employed to totally unemployed and public emergency workers was about 4 to 1. The situation improved in 1941, and after the United States entered the war the Eastern Slope counties became labor shortage areas. In the project area unemployment compensation payments amounting to $808,070 in 1939 decreased to $400,900 in 1941 and have continued to decrease materially since that time.

Community needs

Community needs of the Western Slope diversion area are relatively few but are directly dependent upon the control of streamflow. The construction of reservoirs would provide controlled water supplies for improved irrigation practice and water for more irrigated pasture land which would restore the balance between irrigated hay meadowland and pasture. Industrial and municipal water supply problems are not critical. Acute stream pollution problems do not exist in the diversion area and none are conceivable even after water is diverted to the Eastern Slope. Control of streamflow and construction of reservoirs would improve fishing and enhance recreational facilities. Sedimentation below potential reservoirs would be materially reduced by sediment retention in project structures. Damaging floods are extremely rare, and structures for the control of water for transbasin diversion would reduce the existing minor flood problems resulting from local storms or abnormal spring runoff. Most of the runoff from the Gunnison and Roaring Fork Rivers is lost to the State of Colorado, and the importance of utilizing this water to benefit the State is paramount. Ample water would remain for use in the Western Slope area after optimum development for transbasin diversions to meet the needs of the Eastern Slope.

The Eastern Slope is in need of a water project to assist in the most beneficial development and utilization of all natural resources. The desired expansion and development of industry, commerce, and agriculture throughout the area are dependent upon many related and interwoven factors. Irrigation agriculture, dry-land agriculture, the livestock business, commerce, and industry; water shortages, floods, electric power, mineral and nonmineral resources, land resources—all are factors in the equation of the area. Water appears to be the least common denominator that affects all factors, directly or indirectly.

Much of the land now irrigated in the project area is in urgent need of supplemental irrigation water in order that optimum production may be realized each year. A large amount of new hydroelectric energy would foster and encourage the development and expansion of present and new industries and commercial activities. Existing municipal water supplies
in some instances are inadequate and in most instances are of poor quality. A critical municipal water supply situation could readily occur, particularly in Pueblo and Colorado Springs, with any great population growth. New and enlarged industries also would require additional water for their operations. Sediment control; flood control; drainage; stream-pollution abatement; recreation and fish and wildlife facilities; conservation of winter flows and reservoir evaporation; and watershed improvement and timber stand protection are general needs of the area that are considered in the development of the project.

UNDEVELOPED RESOURCES

Natural resources in the Gunnison-Arkansas Project are plentiful and must be developed to the fullest extent consistent with planned conservation and economic balance if maximum development of the area is to be attained.

Lands

A few large, unified tracts of arable land 1/ exist in the Western Slope diversion area, most of which are being utilized at present. A larger amount of irrigated pasture land is needed for better balance between livestock raising and the grazing areas. Irrigation of sagebrush flats on slopes and benches to provide the additional pasture required, can be accomplished with the available water supply even after diversion of water to the Eastern Slope.

The Arkansas Valley has far more arable land than water supply for its development. Between Leadville and the Colorado-Kansas boundary, 322,000 acres of land are irrigated more or less inadequately from the Arkansas River. In addition, over a million acres could be productive if furnished an adequate and reliable water supply. The provision of adequate water for the existing irrigation systems is of first importance, after which additional water may be supplied to the best remaining arable acres with due consideration to the most effective use, consistent with plans for the overall development of the Eastern Slope.

1/ Land which, in adequate units and when properly provided with the essential improvements of leveling, drainage, buildings, irrigation facilities and the like, will have a productive capacity under sustained irrigation agriculture sufficient to meet all production expenses, including a reasonable return on investment; repay reasonable irrigation and improvement costs; and provide a satisfactory level of living for the farm family.
(Chapter II.—General description)
(UNDEVELOPED RESOURCES)

Water

Groundwater

The presence of groundwater in the valley alluvium, especially along the Arkansas River, provides a source of water for farm and municipal use. The quality of this water in the eastern extremity of the project area is usually impaired due to the increasing amount of dissolved solids carried by the Arkansas River as it flows eastward from Canon City. Other geologic formations yield water in varying amounts and quality, but yields have not been sufficient to justify large pumping installations. Numerous springs in the foothills and mountains on both Slopes are utilized for stock and domestic purposes. No thorough investigations have been made along the tributaries, but existing resources generally tend to be negligible. Further development of groundwater for irrigation may be possible in eastern Colorado, but any sound program must include legislative control to insure effective and dependable water use. Generally speaking, the groundwater recharge is accomplished by direct flow from contiguous streams.

Surface water

Runoff in the diversion area occurs primarily from melting snow. Flooding resulting from rainfall are rare. Seasonal and annual variations of streamflow are great but do not materially affect the present development in the Gunnison and Roaring Fork River Basins. Streamflow on the Western Slope is in excess of possible utilization for the region. Each year thousands of acre-feet of water which could have been used to develop the arid Eastern Slope are lost to Colorado because of the lack of additional transbasin diversions.

Streamflow on the Eastern Slope results from melting snow, rainfall, and return flow from irrigated lands. Runoff from melting snow is seasonal and often coincides with rainfall which results in damaging floods and undivertible flows. Thus, storage is imperative to retain water for irrigation use. Flows of tributary streams are erratic, and generally only abnormal flows ever reach the Arkansas River because the normal flows are diverted for irrigation projects along the tributaries.
Control of the Arkansas River alone with reasonable hold-over storage would not provide sufficient water to fully supply the irrigated land under existing ditches. The only prospect of providing an adequate water supply to the Eastern Slope lies in the importation of water from the upper Gunnison and Roaring Fork Basins.

Conservation of winter flows and reservoir evaporation

The conversion of winter flows of the Arkansas River, not including those presently captured for reservoir storage, to more beneficial summer irrigation use is desirable in the Arkansas Valley. The capture and transfer of water from off-season to seasonal use, however, could be accomplished only by agreement among the present appropriators, which subject is discussed under "Water Rights" in Chapter IV. Streamflow records indicate that these winter flows amount to an average of 97,000 acre-feet which, when corrected for evaporation, would average about 86,000 acre-feet of water per year. Assuming that a mutual agreement among the appropriators could be accomplished, storage capacity would be provided in the potential project reservoirs for hold-over storage of winter flows. The flows thus stored would be in lieu of and equal to the direct diversions to winter irrigation as distinct from reservoir storage and would belong to the ditches with direct diversion rights which would forego winter diversions to irrigated lands in order to have the winter flow available for summer use.

Losses of irrigation water to evaporation are enormous in the shallow valley reservoirs. As shown in table 5 previously presented in this chapter, the total reported active capacity of these reservoirs in the high evaporation area below Pueblo is 507,500 acre-feet. The average amount of water in storage on April during the 25-year period 1922-1947 was 104,000 acre-feet. Average yearly evaporation over this same period amounted to 45,000 acre-feet varying from a high of 80,000 acre-feet in 1924 to a low of 5,000 acre-feet in 1934 which was during the drought period when very little water was available for storage. Evaporation losses are closely correlated with yearly precipitation on the watershed, which determines the amount of water in storage as well as the amount of irrigation water delivered to the land. Optimum use of project reservoirs, located in higher elevations where evaporation is greatly reduced, would materially increase the water available for irrigation.
Watershed improvement and timber stand protection

Control of evaporation of moisture from forest growths would produce additional runoff for irrigation use. Proper watershed management is one of the important problems in the Gunnison-Arkansas Project area. Studies made by the Department of Agriculture in the management of timber resources indicate that under favorable conditions the production of water from a watershed could be increased. Experiments toward this end are now in progress and prospects for increasing the runoff appear to be favorable.

Reservoir and hydroelectric sites

Reservoir and dam sites of easy access to the river in the Eastern Slope area are to a large extent developed but some are capable of enlargement. Suitable sites on the Western Slope to control transbasin water for delivery to the Eastern Slope are almost entirely lacking for the Initial Development. Although they are available for the expansion of the Initial Development, known as the Maximum Gravity Division, their construction would be relatively expensive. In an effort to find the best possible reservoir sites for development, the Eastern Slope area and the Western Slope diversion area were carefully investigated. As a result, sufficient reservoir sites were selected on both slopes to meet the needs of the Gunnison-Arkansas Project.

Numerous hydroelectric power sites are located along that reach of the Arkansas River from its headwaters to the mouth of the Fountain River which embraces a difference in elevation of over 5,000 feet. Lack of streamflow regulation and control precludes extensive hydroelectric power development from Arkansas River water alone. No power development along the main stream below Pueblo is anticipated because of low river gradients and lack of suitable sites.

Minerals and timber

Abundant mineral resources exist in the area, and reserves of oil and gas in the subsurface strata may yet be discovered. Large quantities of gold, silver, lead, and zinc exist in the mountainous regions. Copper is less plentiful. Molybdenum reserves are known to exceed
100,000,000 tons which is deemed sufficient to meet the world demand for 200 years. Other metals are found in smaller quantities throughout the area.

The Eastern Slope has known reserves of sub-bituminous and anthracite coal estimated at 23 billion tons, most of which are in the Trinidad-Walsenburg area. Natural gas is produced in small quantities, and larger deposits may be developed. Helium and carbon dioxide have been discovered in Las Animas County. Small producing petroleum areas exist in the Arkansas Valley, and present increased land-leasing activities by large petroleum corporations indicate potentialities that may be productive in the future. Large deposits of ceramic clay suitable for brick and tile have been exploited to some extent. Other nonmetal minerals are found in varying quantities.

All or parts of five national forests, consisting of 2,264,000 acres, lie within the Western Slope diversion area. A total of 5,596 million board-feet of merchantable saw timber exists in these forests, and an average of 2,400,000 board-feet are cut annually.

Parts of two national forests, covering approximately 1,441,000 acres, lie in the project area on the Eastern Slope. These forests support an estimated total of 2,184 million board-feet of merchantable saw timber. The present average annual cut is approximately 3,950,000 board-feet. Under strict management of the Forest Service a continuous supply of timber is assured without impairing recreational, wildlife, watershed, and other values.

INVESTIGATIONS AND REPORTS

Past investigations

Studies, estimates, designs, and conclusions presented in this report are the result of long and intensive economic and scientific investigations carried on by the Bureau of Reclamation in cooperation with various Federal, State, and county agencies and other interested parties. Studies were begun in 1936 by the Bureau of Reclamation, but the most intensive work has been in progress since about 1941. Investigations have included topographic surveys of dam and reservoir sites; classification of project lands; canal and tunnel alignment surveys; geological explorations; damsite foundation drilling; water supply,
Chapter II—General description

(INVESTIGATIONS AND REPORTS)

sedimentation, and economic studies; designs and cost estimates; and
benefit and repayment determinations. These data, varying in accord-
ance with the different phases of investigation from reconnaissance
to detail, have been assembled for this report on the Gunnison-Arkansas
Project. Preliminary studies have been virtually completed for the
Initial Development, and early commencement of work on detail and pre-
construction investigations is desirable. Funds have been inadequate
for investigation of the Maximum Gravity Diversion plan in sufficient
detail to test its feasibility.

Cooperation

Grateful acknowledgment is made of the cooperative assistance and
contributions in time and effort rendered during the investigation and
preparation of this report by the following: Corps of Engineers, War
Department; Geological Survey, National Park Service, Fish and Wildlife
Service, and Bureau of Mines, Department of the Interior; Soil Conserva-
tion Service, Forest Service, Bureau of Agricultural Economics, Ex-
tension Service, and Land Use Coordinator, Department of Agriculture;
Bureau of the Census and Weather Bureau, Department of Commerce; Federal
Power Commission; Federal Land Bank of Wichita; Public Works Administra-
tion; Works Progress Administration; Civil Works Administration; Federal
Emergency Relief Administration; Rural Electrification Association;
Isaac Walton League; Colorado Water Conservation Board; Colorado State
Planning Commission; Colorado State Engineer's Office, including Div-
ision Irrigation Engineers and District Water Commissioners; Colorado
Game and Fish Commission; Colorado State Highway Department; Arkansas
Valley Ditch Association; Water Development Association of Southeastern
Colorado; Colorado River Water Conservation District; Uncompahgre Water
Users' Association; several other Government, State, county and civic
organisations; and various railroads, corporations, municipalities,
canal and irrigation companies, chambers of commerce, business estab-
ishments, farmers, ranchers and individuals interested in project
development.
Chapter III.—Designs and estimates

The plan for the Initial Development is discussed in the first chapter. This chapter describes the various features in greater detail, geology, design and construction problems, and estimates of cost. All construction costs are based on July 1947 prices.

Total costs involved in the Initial Development are summarized in the following tabulation:

<table>
<thead>
<tr>
<th>Reservoirs:</th>
<th>Construction cost</th>
<th>Annual cost O.M. &amp; R.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacement</td>
<td>$ 3,174,000</td>
<td>$ 2,290 a/</td>
</tr>
<tr>
<td>Storage and regulation</td>
<td>$ 57,670,000</td>
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<td>Collection system</td>
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<td>Divide tunnel</td>
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<tr>
<td>Recreation</td>
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</tr>
<tr>
<td>Total</td>
<td>$140,471,000</td>
<td>$ 1,433,060</td>
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</tbody>
</table>

a/ Cost borne by Blue-South Platte shown in paragraph below.

b/ Powerplants, penstocks, transmission systems, etc.

PROJECT WORKS

Replacement reservoir

Water supply demands for replacement on the Western Slope could be met by construction of the Ruedi Reservoir on the Fryingpan River or by construction of the Bridgeport Reservoir on the Gunnison River near the mouth of Hanah Creek and a canal from that reservoir to the Colorado River above Palisade. Either reservoir could be used jointly with the Blue-South Platte Project and would be a Western Slope development for the benefit of interests in western Colorado.

Ruedi Dam and Reservoir

The damsite is located on the Fryingpan River about 15 miles above its confluence with the Roaring Fork River. Specifically, it would be in T. 8 S., R. 64 W., near the village of Ruedi. Colorado State Highway
No. 104 gives ready access to the area during the summer months. The nearest railway facilities to the reservoir site are at Basalt, 16 miles west of Ruedi.

Total storage capacity of the reservoir would be 100,000 acre-feet at normal water surface elevation, of which 25,000 acre-feet would be chargeable to the Gunnison-Arkansas Project and the remainder to the Blue-South Platte Project. The reservoir, which would inundate an area of 1,060 acres, would be created by an earth dam about 270 feet high.

The reservoir would necessitate relocation of about 7-1/2 miles of gravel-surfaced secondary State Highway No. 104 which would be re-routed to follow the south side of the potential reservoir above the high-water line.

Total construction cost of the Ruedi Reservoir is estimated to be $12,695,000, of which $3,174,000 would be chargeable to the Gunnison-Arkansas Project and the remainder to the Blue-South Platte Project. Of the total $9,160 for operation, maintenance and replacement, $2,290 would be charged against the former project. The estimate for the Ruedi Reservoir was used in the determination of project repayment.

No geologic investigations have been made of the site. However, preliminary inspection indicates that the abutments are stable and percolation losses would be small. The reservoir area is blanketed with alluvial deposits. Suitable pervious and impervious materials could be obtained in the area.

A construction camp at Thomasville could house workers employed in the construction of the Fryingpan Collection System and the Ruedi Reservoir.

Some of the reservoir area is in private ownership, but no difficulty in obtaining rights-of-way is anticipated. The remainder of the area is national forest.

About 3 years would be required for the completion of the Ruedi Reservoir.

Bridgeport Reservoir and canal

The damsite is located on the Gunnison River about 15 miles above its confluence with the Colorado River at Grand Junction and would be
near the small village of Bridgeport. Access to the reservoir site is provided by U. S. Highway No. 50 between Grand Junction and Montrose. The Denver and Rio Grande Western Railroad runs through the reservoir area.

A canal would be constructed from the reservoir northward to serve the irrigated area in the vicinity of Palisade, thereby furnishing replacement to that area for the water diverted from the Fryingpan Basin to the Eastern Slope.

The reservoir would be created by an earth dam about 265 feet high and would inundate an area of 9,750 acres. The total storage capacity would be 845,000 acre-feet.

Construction of the dam and reservoir would require relocation of the railroad outside the reservoir area.

The total construction cost of the Bridgeport Reservoir and canal is estimated to be $26,511,000, and annual operation, maintenance, and replacement costs are estimated to be $89,120. The cost of the canal would be $3,500,000 of the total $26,511,000. Part of this cost would be chargeable to replacement and the remainder would be repaid by other means.

Geologic features of the area are exposed and simple. It is believed that the reservoir area and abutments would be tight. Suitable pervious and impervious materials exist in the area.

No construction camp would be necessary as the personnel engaged in construction could be accommodated in Grand Junction.

The reservoir and canal areas are in private ownership and State grazing land, and no difficulty should be encountered in obtaining rights-of-way.

About 3 years would be required for the completion of the Bridgeport Reservoir and canal.
(Chapter III.--Designs and estimates)

Sugar Loaf Dam and Reservoir

Description

The dam site is located downstream from the present Sugar Loaf Dam on Lake Fork Creek, 3-1/2 miles west of Leadville, in T. 9 S., R. 80 W., sixth principal meridian. The site can be reached via the gravel-surfaced secondary State Highway No. 104. The nearest railhead is at Malta which is about 7 miles from the dam site by secondary road.

The total storage capacity of the enlarged Sugar Loaf Reservoir would be 117,000 acre-feet at normal water surface elevation. The enlarged reservoir which would inundate an area of 1,550 acres would be created by an earth dam about 140 feet high.

The reservoir enlargement would necessitate relocation of about 3 miles of gravel-surfaced secondary State Highway No. 104, which would be re-routed to cross the dam and follow the west and south side of the potential reservoir above the high-water line.

Total construction cost of the Sugar Loaf Reservoir is estimated to be $6,424,000 and annual operation, maintenance, and replacement costs, $5,270.

Geology

The surrounding topography is the result of glaciation which has left high, curved lateral moraines forming the sides of the present reservoir basin. The stream has cut a narrow channel through a large terminal moraine at the proposed dam site. The abutments are large lateral moraines consisting of many large boulders, gravel, sand, and silt. The deposits are more than 100 feet deep. The bottom of the present lake is blanketed by stream silt, and it is believed that the basin area is reasonably tight.

Three churn drill holes ranging in depth from 57 to 100 feet were drilled at the proposed site. Sand, gravel, and clay were consistently encountered in all drill holes; and granite boulders and residual granite showed up at intervals. Preconstruction exploration will show the amount of seepage that might be expected under the proposed dam and the extent of the protective clay blanket to be provided.

The Sugar Loaf Dam would be constructed mostly of pervious glacial
material which could be obtained in the vicinity. An impervious core would be provided from selected material also obtainable locally. Rock for riprap is available from granite cliffs located about 3 miles from the damsite.

For a designs and specifications estimate it is recommended that a series of churn drill holes be placed across the cut-off line, in which drive samples and percolation tests can be taken. This should be done also along abutment moraines for the determination of permeability. An exploration program to obtain samples of construction materials for laboratory testing and determination of quality should be undertaken. Materials are believed to be available at and near the damsite in sufficient quantity.

This site is suitable for a dam to create a reservoir of 117,000 acre-foot capacity.

Design and construction problems

A camp to house construction workers could be built near the damsite. The reservoir area consists mostly of national forest and grazing lands. Although a few cabins used for recreational purposes are located within the area, most of the land is of little value, and no difficulty is anticipated in securing the necessary rights-of-way. The design flood of the potentially enlarged Sugar Loaf Reservoir was based on flood hydrographs received from the Division of Hydrology which show a peak flow of 17,000 second-feet. The routing of these floods through the reservoir gave a maximum discharge of 2,000 second-foot through the spillway.

The Sugar Loaf Reservoir enlargement would require about 3-1/2 years for completion of construction.

Difficulty may be encountered in making the enlarged Sugar Loaf Reservoir completely tight because of the glacial moraines on which the dam would be located. Because of the demand for base flow, water tightness beyond the stability point would not be required.
Twin Lakes Dam and Reservoir

Description

The damsite is located about one-quarter mile below the present dam at Twin Lakes Reservoir in T. 11 S., R. 80 W., sixth principal meridian. The enlarged reservoir would be located along Colorado State Highway No. 82 about 2 miles above the junction of that highway with U. S. Highway No. 24. The small village of Granite about 3 miles south of the junction of Highway Nos. 24 and 82 is the nearest railhead.

The potential earth and rock-fill dam would be 105 feet high. The total reservoir storage of 260,000 acre-feet would inundate 4,240 acres of land.

It would be necessary to relocate 7 miles of State Highway No. 82 by re-routing the highway around the north side of the reservoir above high water elevation. The town of Twin Lakes and several resort cabins would be moved. Very little clearing would be required on forest and grazing lands.

The total construction cost of the Twin Lakes Dam and Reservoir enlargement has been estimated to be $8,468,000. Annual operation, maintenance, and replacement costs would be $7,590.

Geology

The present lakes were formed by a glacial depression underlain at unknown depth by granite and schist. The floor of the basin consists of a mixture of boulders, gravel, sand, and rock. The abutments consist of high, steep lateral moraine, and a large portion of the abutment moraines appears to be made up of coarse gravel and sand. Due to the composition of the abutments, probable percolation losses are anticipated and provided for in the design. Thorough exploration studies on percolation should be made to determine the amount of losses and the drainage required.

Three holes, ranging in depth from 100 to 230 feet, were drilled at this proposed damsite. Large boulders, gravel, and fine sand were encountered in all holes. No solid foundation, such as granite or
schist, was encountered. The composition of both abutments is essentially the same as that of the valley floor, and the probable percolation losses through abutments might be high. The presence of a deep percolation path beneath the right abutment should be given careful consideration in future exploration. The present plans call for an extensive clay blanket to cover the area between the present impervious lake bed and the project damsite.

Impervious and pervious materials could be obtained from the moraines in the vicinity, but screening would be required. Some rock screenings may prove satisfactory for riprap, but most riprap material should be obtained from granite cliffs about 6 miles from the Twin Lakes Damsite.

The damsite is located entirely on lateral and terminal moraines. Before a design and specifications estimate is made, it is recommended that a series of churn drill holes be placed across the cut-off line for obtaining drive samples and making percolation tests. Test pits spaced between the drill holes are recommended in order to obtain undisturbed samples. Additional test pits should also be dug about 40 feet deep on each abutment, and field density and percolation tests made on each pit. As percolation around the ends of the dam is expected, a permeability test is essential in order to determine the amount of seepage as well as the most desirable impedance measures which should be undertaken.

This site is the best location available, and if all the above explorations are completed and favorably reported on before designs and specifications are made, any major difficulties in the enlargement of the existing reservoir to 260,000 acre-foot capacity should be overcome.

Design and construction problems

A construction camp near Granite could serve both the dam and the upper canal system.

Except for the small village of Twin Lakes and several resort cabins, the reservoir area consists chiefly of grazing and forest lands. No difficulty in securing rights-of-way is anticipated.

The hydrograph for the potential Twin Lakes Reservoir enlargement shows a maximum inflow of 3,100 second-feet. Studies by the office of
the Chief Engineer on routing these flows through the reservoir, gave a maximum spillway discharge of 2,640 second-feet.

About 4 years has been allowed for the completion of the Twin Lakes Reservoir enlargement.

Because of the glacial moraines on which the dam would be located, difficulty may be encountered in making the Twin Lakes Reservoir enlargement completely tight.

Pueblo Dam and Reservoir

Description

The dam site is located on the Arkansas River 6 miles west of Pueblo in T. 20 S., R. 66 W. The site can be reached by driving west from Pueblo on Colorado State Highway No. 96 to the existing flood control barrier dam across the Arkansas River. The highway is an all-weather, gravel-surfaced road. The main line of the Denver and Rio Grande Western Railroad from Pueblo to Canon City traverses the Arkansas Valley parallel to the river and passes through an opening in the existing barrier dam.

The reservoir, which would be created by an earth-fill dam 180 feet high, would have a storage capacity of 400,000 acre-feet.

Construction of the Pueblo Reservoir would require the relocation of 20 miles of double track on the main line of the Denver and Rio Grande Western Railroad. The relocation could be accomplished by shifting the tracks northward on higher bench land above the high-water line. Maximum grades of 0.6 percent could be maintained, and the degree of curvature for the entire line could be reduced.

Colorado State Highway No. 96 would be relocated above the high-water line on the south side of the reservoir. About 6 to 9 miles of highway relocation would be required.

The estimated construction cost of the dam and reservoir is $42,778,000. Annual operation, maintenance, and replacement costs are anticipated to be $20,710.