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**REPORT**  
**ON**  
**WATER RUNOFF AND STREAM DEPLETION**  
**OF THE**  
**MAIN STEM COLORADO RIVER BASIN IN COLORADO**

**Prepared For**  
**COLORADO WATER CONSERVATION BOARD**  
**By**  
**CLIFFORD H. JEX ENGINEERS**

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June, 1965







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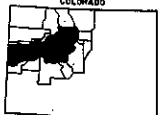
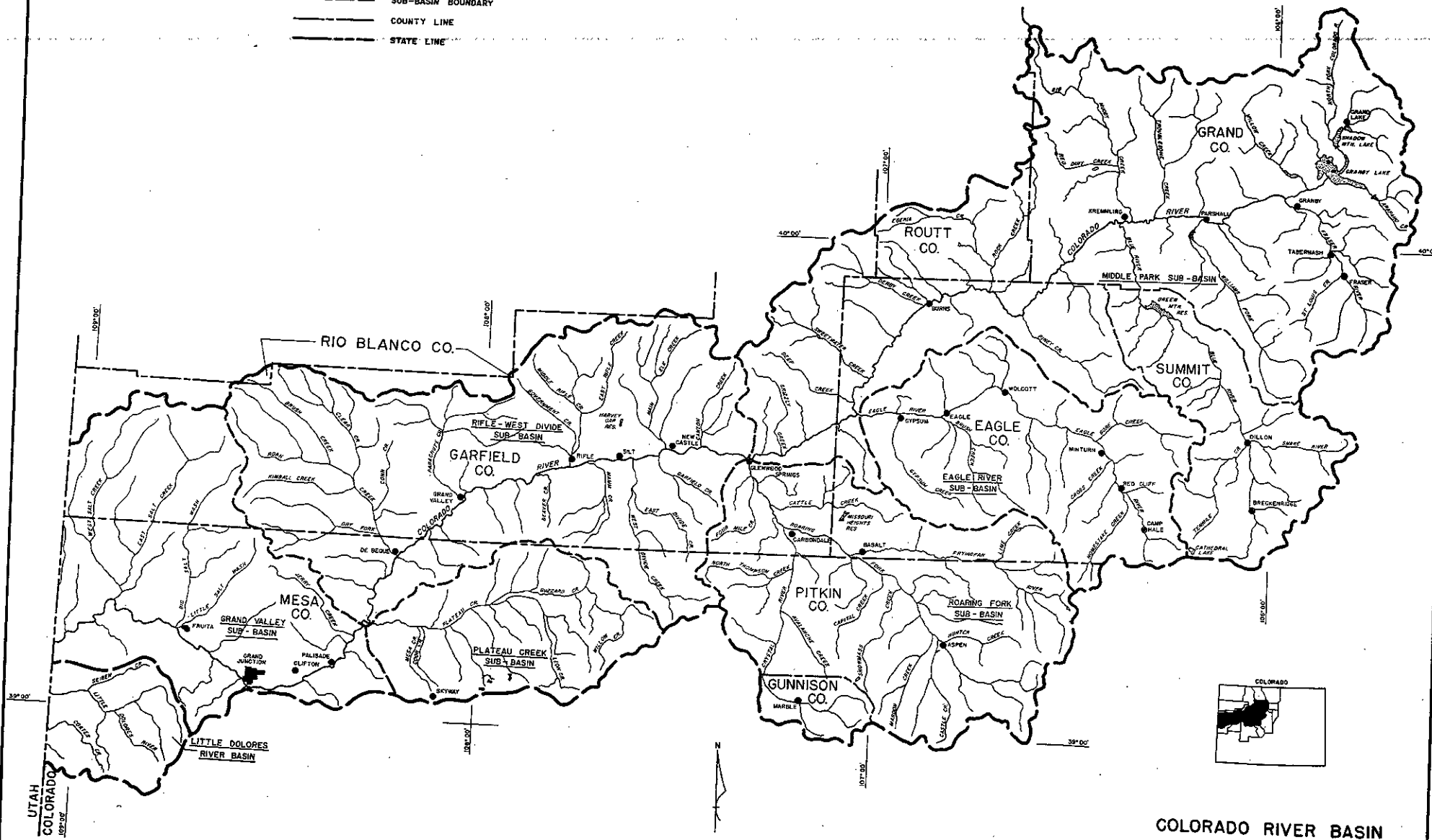
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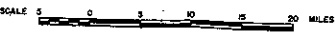
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LEGEND

-  CITIES AND TOWNS
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-  BASIN BOUNDARY
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-  COUNTY LINE
-  STATE LINE



COLORADO RIVER BASIN  
COLORADO



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REPORT ON  
WATERSHED RUNOFF AND STREAM DEPLETION  
MAIN STEM COLORADO RIVER BASIN IN COLORADO

I N T R O D U C T I O N

Scope and Purpose

This report presents information on watershed runoff and stream depletion for the main stem Colorado River Basin in Colorado. The information was compiled from independent reconnaissance field study, river basin study cooperative work with the Department of Agriculture under the leadership of the Soil Conservation Service and from analysis of the work of other Federal and State agencies engaged in water and related resource planning and development work. A report on the results of the river basin study cooperative work with the Department of Agriculture entitled "Water and Related Land Resources - The Colorado River Basin in Colorado" was issued under date of May 24, 1965. In order to have information on the entire watershed area tributary to the Colorado River in the State of Colorado, information on the drainage basins of the Little Dolores River and Coates Creek is included.

The purpose of the study and report at this time is the presentation of basic water supply data and an analysis of the same in terms of the present use and the anticipated

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future use requirement. From time to time the information here reported may require refinement and adjustment as basin development moves forward.

Data on watershed area, the origin of runoff and basin water yield is discussed under the heading INTRODUCTION. The basin has been divided into seven subbasins, each representing one segment of the basin. Information on individual stream runoff, present stream depletion and anticipated future water use requirements are discussed under the appropriate subbasin headings. A map showing the location and boundary of each of the subbasins and the Little Dolores River and Coates Creek basins is made a part of this report. A summary of the findings of study and the effect of stream depletion on the water supply of the river basin is discussed under the heading SUMMARY.

#### Drainage Basin

The basin of the main stem of the Colorado River is the watershed area of the Colorado located upstream from the Colorado-Utah state line and is one of the principal tributary stream basins of the Colorado River. It is located in the West Central part of Colorado. The Gunnison River basin, although tributary to the main stem of the Colorado, is for study purposes considered a separate river basin. Unless otherwise noted in this report, all reference to river drainage basin and water runoff will refer to the main stem of the

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Colorado River basin with the Gunnison excepted.

The Little Dolores River and Coates Creek both originate in Colorado. They extend across the state line and discharge separately into the Colorado River in Utah. These two stream basins in Colorado are bounded on the north by the drainage basin of the Colorado River, on the south by the drainage basin of the Dolores River and on the east by the drainage basin of the Gunnison River.

The drainage basin encompasses an area of 10,162 square miles (9,912 for the Colorado River basin and 250 for the Little Dolores River and Coates Creek basins) and includes all or portions of Grand, Summit, Routt, Eagle, Garfield, Pitkin, Gunnison, Rio Blanco and Mesa Counties. The basin is approximately 200 miles long east and west and 76 miles wide north and south at maximum sections. It encompasses about 10% of the land area of the State of Colorado and 26% of the drainage basin of the entire Colorado River in the State of Colorado.

Climatic conditions vary from that of near desert in the lower section (elevation of 4,300 feet) to heavy precipitation in the high altitude area of the upper perimeter of the basin. The Continental Divide forms the east boundary; the Elk Mountains, Grand Mesa and the Uncompahgre Plateau form the south boundary; and the White River Plateau and the Bookcliff Mountains form the north boundary. The west bound-

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ary is the Colorado-Utah state line. The basin watershed includes several mountain peaks with altitudes in excess of 14,000 feet.

The basin is 69.4% public land and 30.6% private land. A large portion of the land area is either high elevation mountainous watershed, or low elevation near desert type watershed. The status of public and private land ownership has remained almost static for the past twenty years. An increase in irrigation involving the use of private land and an increase in recreation development primarily involving the use of public land is anticipated. A summary of the status of the management and the ownership of basin land is given in the following table:

#### Land Ownership

<u>Public Land</u>			
National Forest	2,642,710 Acres	40.6	Percent
Bureau of Land Management	1,635,310 "	25.1	"
National Parks	128,650 "	2.0	"
Total Federal Land	<u>4,406,670</u> Acres	<u>67.7</u>	Percent
State & Local Government Land	<u>107,170</u> Acres	<u>1.7</u>	Percent
Total Public Land	<u>4,513,840</u> Acres	<u>69.4</u>	Percent
<u>Private Land</u>			
Irrigated Land	303,770 Acres	4.7	Percent
Grazing & Dry Farmed	<u>1,686,390</u> "	<u>25.9</u>	"
Total Private Land	<u>1,990,160</u> Acres	<u>30.6</u>	Percent
<u>Basin Total</u>	6,504,000 Acres	100.0	Percent

#### Water Runoff

The historic runoff of the Colorado River, including the Gunnison, at the Colorado-Utah state line for



the 32 year period, 1914-1945, as reported by the Upper Colorado River Compact Commission averaged 5,469,900 acre feet per year. For the 18 year period of study, 1943-1960, the runoff averaged 4,543,800 acre feet per year. This is 926,100 acre feet or 16.9% less than the reported runoff for the earlier 32 year period.

The 18 year period of study, 1943-1960, includes the higher than average 10 year period of 1943-1952 and the lower than average 8 year period of 1953-1960. The average annual historic Lee Ferry runoff of the Colorado River for the 18 year period was 11,318,000 acre feet while the average for the 35 year period, 1930-1964, was 11,559,000 acre feet.

The discharge of the Gunnison River to the Colorado at Grand Junction during the 18 year study period averaged 1,706,500 acre feet per year. Subtracting this from the Colorado River State line flow of 4,543,800 acre feet leaves 2,837,300 acre feet which represents the runoff of the main stem Colorado River basin. If the estimated runoff of the Little Dolores River and Coates Creek of 15,000 acre feet is added to the 2,837,300 acre feet for the main stem Colorado River, the total basin runoff is 2,852,300 acre feet. Data on the main stem Colorado River basin runoff in relation to the runoff of the Colorado River at Lee Ferry is given in the following table:

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## Annual Historic Watershed Runoff - Units 1000 Acre Feet

Year	Runoff of the Main Stem Colo. River Basin	Runoff of the Colo. River at Lee Ferry	Main Stem in Percent of River at Lee Ferry
1943	2,864	11,260	25.4
1944	2,783	13,220	21.1
1945	3,016	11,540	26.1
1946	2,532	8,744	29.0
1947	3,811	13,510	28.2
1948	3,420	13,690	25.0
1949	3,446	14,360	24.0
1950	2,538	11,060	22.9
1951	2,743	9,839	27.9
1952	4,222	17,980	23.5
1953	2,442	8,805	27.7
1954	1,422	6,116	23.2
1955	1,871	7,307	25.6
1956	2,232	8,750	25.5
1957	4,317	17,340	24.9
1958	3,042	14,260	21.3
1959	2,025	6,756	30.0
1960	2,359	9,192	25.7
18 yr. av. 1943-1960	2,837	11,318	25.0
Gunn. River	1,707	11,318	15.1
Total River	4,544	11,318	40.1

Records of the historic runoff of basin streams show that over 91% of the basin runoff originates on the watersheds of the three subbasins of Middle Park, Eagle River and Roaring Fork located upstream from Glenwood Springs. The watershed area of the three subbasins is 61% of the total river basin watershed area. The annual runoff of each subbasin is given in the following table. The figure of -152,200 acre feet for the Grand Valley subbasin is a negative figure showing that the subbasin stream depletion is greater than the natural runoff.

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Historic Average Runoff for Study Period 1943-1960

Units 1000 Acre Feet

Subbasin	Historic Runoff		#Historic Runoff Adjusted to Reflect Water Export Cap- ability of 1960	
Middle Park	1,263.5		1,136.0	
Eagle River	429.3		429.3	
Roaring Fork	900.4		900.4	
Runoff Above Glenwood	<u>2,593.2</u>	2,593.2	<u>2,465.7</u>	2,465.7
Rifle - West Divide	263.8		263.8	
Plateau Creek	132.5		132.5	
Grand Valley	-152.2		-152.2	
Runoff Below Glenwood	<u>244.1</u>	<u>244.1</u>	<u>244.1</u>	<u>244.1</u>
Runoff Main Stem Colorado River		2,837.3		2,709.8
Runoff Gunnison River		<u>1,706.5</u>		<u>1,706.5</u>
Runoff State Line Gaged Flow		4,543.8		4,416.3
*Runoff Little Dolores & Coates Creek		<u>15.0</u>		<u>15.0</u>
Total State Line Runoff		4,558.8		4,431.3

\*Estimated Runoff

#Water export capability of 1960 is the estimated amount of water that would have been exported during the study period by the use of the transmountain diversion facilities as constructed and in use for the year 1960

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## MIDDLE PARK SUBBASIN

Location and Description

The Middle Park Subbasin includes the watershed of the Colorado River from Glenwood Springs to the Continental Divide with the exception of the drainage basin of Eagle River above Dotsero. The principal tributary streams are the main river above Granby, Willow Creek, Fraser River, William Fork River and Blue River. Over 97% of the watershed area is above an elevation of 7000 feet with several watershed peaks extending to elevations in excess of 14,000 feet.

The subbasin includes all or parts of the five western Colorado Counties of Grand, Summit, Eagle, Routt and Garfield. The subbasin watershed area comprises 35.3% of the river basin and produced 44.3% of the historic runoff.

Watershed Runoff

The average annual historic runoff of the subbasin at Glenwood Springs for the 18 year study period of 1943-1960 was 1,263,500 acre feet. The following table gives the runoff for each year of the study period:

Historic Runoff Middle Park Subbasin - Units 1000 Acre Feet

Year	Runoff	Year	Runoff
1943	1,353.3	1953	1,183.5
1944	1,132.7	1954	662.2
1945	1,294.8	1955	731.1
1946	1,164.7	1956	1,074.8
1947	1,710.6	1957	1,783.5
1948	1,460.7	1958	1,290.2
1949	1,585.2	1959	927.3
1950	1,077.1	1960	1,090.5
1951	1,381.2		
1952	1,857.7	Average	1,263.5

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During the 18 year period, the natural undepleted subbasin water supply averaged 1,544,400 acre feet. The export of subbasin runoff was expanded from an average of 60,000 acre feet per year for the first five years of the study period to an average of 367,000 per year for the last five years of the study period. The average subbasin runoff and the status of water use under historic conditions and a condition reflecting the water export capability of transmountain water diversion facilities as operative for the year 1960 is summarized in the following table:

Undepleted Middle Park Subbasin Runoff  
Average for 18 Year Period 1943-1960  
Units 1000 Acre Feet

	Historic Conditions	Export Capability Operation
River Runoff at Glenwood Springs	1,263.5	1,136.1
Inbasin Stream Depletion	74.8	74.8
Exported Water (Eastern Colo.)	206.3	333.7
Imported Water (Yampa River)	- 2.7	- 2.7
Exported (Roaring Fork Subbasin)	<u>2.5</u>	<u>2.5</u>
Net Undepleted Subbasin Water Supply	1,544.4	1,544.4

Under historic flow conditions, the five headwater streams of the subbasin (source of supply for export diversions) consisting of the Colorado River above Granby, Willow Creek, Fraser River, Williams Fork River and Blue River contributed 670,100 acre feet or 53.0% of the subbasin runoff. The historic annual runoff of the five streams at or near the junctions with the Colorado River is given in the following table:

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## Historic Runoff - Units 1000 Acre Feet

Year	Colo. River	Willow Creek	Fraser River	Williams Fork	Blue River	Total
1943	211.5	57.0	90.3	89.1	288.8	736.7
1944	185.4	32.4	78.9	77.8	281.2	655.7
1945	228.6	58.8	75.3	86.5	338.2	787.4
1946	176.8	30.8	68.7	83.9	320.0	680.2
1947	171.8	53.8	115.5	128.0	473.7	942.8
1948	187.1	44.3	86.6	89.4	401.5	808.9
1949	248.4	59.6	102.0	110.2	393.8	914.0
1950	21.7	38.8	62.6	73.4	377.9	574.4
1951	26.6	53.7	109.9	108.4	474.0	772.6
1952	43.6	75.2	120.2	130.3	493.1	862.4
1953	33.1	35.6	65.9	82.5	397.5	614.6
1954	26.1	10.6	33.0	30.3	266.5	366.5
1955	25.6	9.2	47.2	46.7	209.7	338.4
1956	25.7	13.9	55.4	68.5	400.8	564.3
1957	24.7	26.7	124.5	126.8	468.2	770.9
1958	25.3	42.7	104.4	93.2	392.2	657.8
1959	25.1	9.9	50.7	68.0	319.6	473.3
1960	25.8	9.8	71.8	84.3	350.6	542.3
Average	95.1	36.8	81.3	87.6	369.3	670.1

An examination of the figures given in the above table and a comparison of the same with the figures of the table under the heading "Water Exported From Middle Park Subbasin" shows that since the year 1950 the runoff of the Colorado River above Granby, the runoff of Willow Creek and to some extent the runoff of the Fraser River have been depleted by export diversions. The average historic runoff of the river streams adjusted to include the exported water is 876,400 acre feet. This is 56.8% of the undepleted runoff of the subbasin.

Present Water Use

A study of the arable land of the subbasin conducted

by the Bureau of Reclamation shows that a total of 58,010 acres were irrigated in 1939. A later Bureau of Reclamation study shows that irrigation by the year 1951 had been expanded to a total of 83,584 acres. A field reconnaissance study indicates that the amount of land presently irrigated is 80,320 acres, an expansion of 22,310 acres for an increase of 38.5% in the 25 year period 1939 to 1964.

A study of the location of the irrigated land in relation to the availability of water indicates that approximately 61,670 acres of the 80,320 acres receives a full or nearly full supply of irrigation water and 18,650 acres are in need of additional water for full crop production.

The population of the subbasin as given in the 1960 census reports is 6,546. This includes the population of the several cities and towns as well as the ranch population. The subbasin 1930-1960 population growth was 2,621 for a 67% increase. The stream depletion chargeable to domestic, municipal and industrial use of water and reservoir evaporation is estimated to be 7,400 acre feet, including allowance for transient population.

The transmountain diversion of water for use in Eastern Colorado has expanded until in the more recent years, it far exceeds the use of water in the subbasin. During the last 5 years of the study period ending in 1960, the water exported averaged 367,000 acre feet per year. This included the unusually high runoff year of 1957. The average annual

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diversion for the study period 1943-1960 was 206,300 acre feet. The following table will show the water annually exported from the basin for the study period 1943-1960.

Water Exported From Middle Park Subbasin - Units Acre Feet

Year	*Colo. R. & Willow Cr.	Fraser River	Williams River	Blue River	Total Exported
1943	17,660	33,040	4,060	360	55,120
1944	16,740	16,820	3,860	0	37,420
1945	23,490	37,640	11,050	0	72,180
1946	18,970	33,020	11,000	0	62,990
1947	46,270	23,770	2,070	0	72,110
1948	15,370	24,820	2,050	0	42,240
1949	45,570	24,990	1,890	0	72,450
1950	91,480	30,050	9,090	70	130,690
1951	265,840	34,520	11,140	180	311,680
1952	308,290	31,960	6,810	2,390	349,450
1953	197,050	35,660	7,420	5,110	245,240
1954	135,950	19,760	5,480	3,690	164,880
1955	206,510	37,480	10,300	6,720	261,010
1956	284,230	53,830	8,880	9,550	356,490
1957	445,550	48,750	4,540	7,580	506,420
1958	254,970	14,080	0	6,670	275,720
1959	241,690	58,770	1,040	8,700	310,200
1960	320,500	54,380	2,880	8,400	386,160
18 yr.av. 1943-1960	163,118	34,074	5,753	3,301	206,246

\*All figures represent water withheld from the stream including reservoir evaporation.

Water is imported to the Middle Park Subbasin from the Yampa River drainage basin by two ditches and used in the vicinity of Toponas for irrigation purposes.

The following table is a summary of the estimated present stream depletion of the Middle Park Subbasin:



## Present Stream Depletion - Units Acre Feet

	Historic Conditions	Present Capability
*Average annual stream depletion by irrigation	67,400	67,400
Average annual stream depletion by municipal and industrial use and reservoir evaporation	7,400	7,400
Average annual stream depletion by transmountain diversion	<u>206,300</u>	<u>333,700</u>
Total annual stream depletion	281,100	408,500

\*Includes allowance for natural vegetation seeped land and water surfaces without limitation to man-made depletion.

Potential Use

The transmountain diversion of water for use in the South Platte River basin of Eastern Colorado is also the major potential use of subbasin runoff. After years of intensive study and water development planning, the pattern of the ultimate diversion of water to Eastern Colorado is now well defined. The original system of high elevation open ditches and canals has been supplemented by a system of tunnels with associated water diversion facilities designed for the interception and diversion of the available runoff of the main Colorado River and tributaries above Granby, Willow Creek and tributaries, the Fraser River and tributaries, the Williams Fork River and tributaries and the Blue River and tributaries.

Water runoff and water diversion records on these streams have been analyzed to show the amount of water diverted historically, the amount of water divertable after completion

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of the facilities now under construction and the water potentially divertable by possible ultimate expansion of diversion facilities. The water potentially divertable by ultimate expansion of diversion facilities is in large measure presently used by water users located within the Colorado River basin. In estimating this potentially divertable water, it is assumed that water rights supporting the diversion of the additional water to Eastern Colorado could be acquired by providing replacement water for the release of the inbasin rights attached to the divertable water.

The following table shows the average annual historical diversion for the 16 year study period, the average annual divertable water during the same period after the completion of diversion facilities now under construction and the potential divertable water by the ultimate expansion of these facilities.

Source of Supply	Annual Diversion in Acre Feet		
	Historical Diversion	Anticipated Diversion	Potential Ultimate
Willow Creek & Colorado River tributaries	163,100	263,600	308,000
Fraser River and tributaries	34,100	86,300	86,300
Williams Fork River and tributaries	5,800	36,400	36,400
Blue River and tributaries	<u>3,300</u>	<u>204,000<sup>(1)</sup></u>	<u>310,500<sup>(2)</sup></u>
Total	206,300	590,300	741,200

A review of studies of potential new irrigation indicates that about 36,030 acres of new irrigation may be anticipated. This added to the 80,320 acres presently irrigated

<sup>(1)</sup> The 204,000 acre feet of anticipated diversion for the East Gate Range Canal with a 14' head.

<sup>(2)</sup> Assuming 36,030 acres of new irrigation.

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would make a total of 116,350 acres. It is estimated that 1,350 acres of the 116,350 will be required for industrial development and urbanization leaving 115,000 acres as the net irrigated land. In addition to the new irrigation potential, it is anticipated that supplemental water service for 18,650 acres of land will be provided. The larger areas of new irrigation and also the areas of supplemental water service are located in the drainage basins of Troublesome Creek, Muddy Creek, Williams Fork River and the Colorado River tributaries located downstream from Gore Canyon.

The anticipated stream depletion for the Middle Park subbasin is summarized in the following table:

Anticipated Total Stream Depletion - Units Acre Feet		
Present annual stream depletion		281,100
*Anticipated annual stream depletion for expanded irrigation	42,400	
Anticipated annual stream depletion for expanded municipal and industrial use and reservoir evaporation	11,100	
#Anticipated annual stream depletion for expanded transmountain diversion	<u>384,000</u>	
Sub-total	437,500	<u>437,500</u>
Total		<u>718,600</u>

\*Includes allowance for natural vegetation, seeped land and water surfaces without limitation to man-made depletion.

#With transmountain diversion limited to the water divertable by the facilities presently under construction.

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## EAGLE RIVER SUBBASIN

Location and Description

The Eagle River Subbasin includes the drainage basin of the Eagle River upstream from its junction with the Colorado River at Dotsero. The principal tributaries in addition to the main Eagle River are Homestake Creek, Cross Creek, Gore Creek, Brush Creek and Gypsum Creek. Ninety-four percent of the watershed area is above an elevation of 7,000 feet with a number of peaks extending to elevations in excess of 14,000 feet.

The subbasin watershed area comprises 9.6% of the river basin above the Colorado-Utah State line and produced 15.1% of the historic runoff of the basin. Ninety-eight percent of the subbasin is located in Eagle County and 2% in Pitkin County.

Watershed Runoff

The average annual historic discharge of the Eagle River to the Colorado River at Dotsero for the 18 year study period is 429,300 acre feet. The following table gives the runoff for each year of the 18 year period.

Historic Runoff Eagle River Subbasin - Units 1000 Acre Feet

Year	Runoff	Year	Runoff
1943	441.7	1953	405.5
1944	377.3	1954	223.7
1945	422.2	1955	294.9
1946	391.3	1956	394.2
1947	550.4	1957	625.5
1948	478.3	1958	432.8
1949	462.8	1959	368.7
1950	398.9	1960	409.5
1951	466.8		
1952	583.3	Average	429.3

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During the same 18 year period, the undepleted annual subbasin water supply averaged 455,500 acre feet. Figures on water runoff, water use and the undepleted water supply of the subbasin are given in the following table. The quantity of water exported from the basin has remained about the same over the 18 year period.

Undepleted Eagle River Subbasin Runoff	
Average for 18 Year Period 1943-1960-Units Acre Feet	
River Runoff at Dotsero	429,300
Inbasin Stream Depletion	22,200
Exported Water	4,000
Net Undepleted Subbasin Water Supply	<u>455,500</u>

Present Water Use

A study of the arable land of the subbasin conducted by the Bureau of Reclamation shows a total of 15,271 acres of land irrigated in 1939. A study also conducted by the Bureau of Reclamation in 1951 shows that irrigation had expanded to 17,814 acres. A field reconnaissance study indicates that the irrigated land now totals 17,760 acres. This is an increase of 2,489 acres from that irrigated in 1939 or an increase of 16.3% in the 25 year period.

The land located in the main valley of the Eagle River has an adequate water supply for full crop production. Water shortages are limited to the land irrigated in the Brush Creek Basin, the Gypsum Creek Basin and some of the other smaller tributary stream basins. It is estimated that the land of short water supply would amount to about 8,000 acres.

The amount of water diverted from the basin for use in in the Arkansas River Basin has remained about the same over the study period. New facilities for expanded transmountain

diversion of water for use in the Arkansas and the South Platte River Basins of Eastern Colorado are under construction. The following table is a summary of the exported water for the period 1943-1960.

Water Exported From Eagle River Subbasin - Units Acre Feet

Year	Diversion	Year	Diversion
1943	3,720	1953	4,190
1944	1,930	1954	2,250
1945	3,720	1955	2,920
1946	4,490	1956	3,780
1947	4,220	1957	5,110
1948	2,480	1958	3,380
1949	4,030	1959	4,320
1950	4,040	1960	5,380
1951	6,100		
1952	5,790	Average	3,992

The population of the subbasin as given in the 1960 census reports is 3,760. This includes the population of the cities and towns as well as the ranch population. The increase in population for the period 1930 to 1960 is 538, which is a 17% increase for the 30 year period.

The following table is a summary of the estimated present stream depletion of the Eagle River Subbasin:

Present Stream Depletion - Units Acre Feet

*Average annual stream depletion by irrigation	21,300
Average annual stream depletion by municipal and industrial use and reservoir evaporation	900
Average annual stream depletion by transmountain diversion	4,000
Total annual stream depletion	<u>26,200</u>

\*Includes allowance for natural vegetation, seeped land, and water surfaces without limitation to man-made depletion.

Potential Use

The results of studies of potential new irrigation indicate that irrigation expansion may be limited to about 7,240 acres. This added to the 17,760 acres of land presently irrigated gives a total of 25,000 acres for the subbasin. Of this it is estimated that 500 acres will be used for other purposes leaving 24,500 acres as the net area of irrigated land. The studies also indicate that 7,750 acres of the 17,760 acres of presently irrigated land could well be provided with supplemental water. The anticipated irrigation expansion will be in the general area of the towns of Eagle and Gypsum.

Studies indicate the exportation of water from the Eagle River Subbasin to Eastern Colorado will ultimately exceed the consumptive use of water within the subbasin. The completion of facilities of the projects now under construction will provide for an increase of 74,600 acre feet in the annual diversion of water to Eastern Colorado. This could be increased by an additional 28,500 acre feet by the ultimate expansion of water diversion facilities.

The following table shows the average annual historical diversion of water for the 18 year study period, the average annual divertable water during a similar period of years after the completion of facilities now under construction and the potential divertable water by the ultimate expansion of facilities.

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Source of Supply	Annual Diversion in Acre Feet		
	Historical Diversion	Anticipated Diversion	Potential Ultimate
Main Eagle River	4,000	14,600	14,600
Honestake Creek	0	64,000	64,000
Gore Creek	0	0	28,500
Total	<u>4,000</u>	<u>78,600</u>	<u>107,100</u>

The anticipated stream depletion for the Eagle River Subbasin is summarized in the following table:

Anticipated Total Stream Depletion - Units Acre Feet

Present annual stream depletion		26,200
*Anticipated annual stream depletion for expanded irrigation	11,000	
Anticipated annual stream depletion for expanded municipal and industrial use and reservoir evaporation	1,400	
#Anticipated annual stream depletion for expanded transmountain diversion	<u>74,600</u>	
Sub-total	<u>87,000</u>	<u>87,000</u>
Total		<u>113,200</u>

\*Includes allowance for natural vegetation, seeped land and water surfaces without limitation to man-made depletion.

#With transmountain diversion limited to the water divertable by the facilities presently under construction.



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## ROARING FORK SUBBASIN

Location and Description

The Roaring Fork Subbasin is the drainage basin of the Roaring Fork River upstream from Glenwood Springs. The principal tributary streams are the Roaring Fork above Aspen, the Fryingpan River and Crystal River. The entire watershed is above an elevation of 5,800 feet with a number of peaks extending to elevations in excess of 14,000 feet. The unit runoff of the subbasin watershed area is the highest of any in the basin and about  $1\frac{1}{2}$  times that of the Middle Park subbasin.

Sixty-six percent of the subbasin is located in Pitkin County, 13% in Eagle County, 13% in Garfield County and 8% in Gunnison County. The watershed area comprises 14.3% of the river basin above the Colorado-Utah State line and produced 31.7% of the historic runoff at the State line.

Watershed Runoff

The average discharge of the Roaring Fork River to the Colorado at Glenwood Springs for the 18 year study period is 900,400 acre feet. The following table gives the annual runoff for each year of the 18 year period.

Historic Runoff Roaring Fork Subbasin - Units 1000 Acre Feet

Year	Runoff	Year	Runoff
1943	933.5	1953	800.1
1944	884.4	1954	477.9
1945	895.7	1955	660.8
1946	798.3	1956	717.4
1947	1,156.0	1957	1,521.0
1948	1,087.0	1958	897.4
1949	958.6	1959	736.0
1950	798.0	1960	772.4
1951	872.7		
1952	1,239.0	Average	900.4

During the same 18 year period, the undepleted sub-basin water supply averaged 988,500 acre feet per year. Figures on watershed runoff, inbasin water use, water exported from the basin to Eastern Colorado and the undepleted water supply of the subbasin are given in the following table. The amount of water exported from the basin has remained about the same over the 18 year study period.

Undepleted Roaring Fork Subbasin Runoff  
Average For 18 Year Period 1943-1960 - Units Acre Feet

River Runoff at Glenwood Springs	900,400
Inbasin Stream Depletion	48,700
Exported Water	41,900
Imported (Middle Park Subbasin)	- 2,500
Net Undepleted Subbasin Water Supply	988,500

Present Water Use

A study of the land of the subbasin by the Bureau of Reclamation in 1939 showed a total of 34,590 acres irrigated prior to the study period. A study also conducted by the Bureau of Reclamation showed that irrigation by 1951 had been expanded to a total of 37,032 acres. A recent field reconnaissance check of subbasin land indicates that the presently irrigated subbasin land amounts to about 37,820 acres. This is an increase of 3,230 acres over that irrigated prior to the study period or an increase of 9.3% in the 25 year period since 1939.

A major portion of the irrigated land receives an adequate supply of water. Irrigation investigations indicate that as much as 7,750 acres of the 37,280 acres irrigated are

in need of supplemental water for full crop production. The lands of short water supply are located along the smaller tributary stream valleys and in the Cattle Creek or the Basalt Project area. The present stream depletion chargeable to irrigation use of subbasin water is 46,500 acre feet.

The population of the subbasin as given in the 1960 census report is 8,553. This figure includes the population of the cities and towns as well as ranch and rural area population and reflects a 61% growth in the 30 year period 1930 to 1960. The water diverted annually from natural streams for the service of subbasin population is 2,000 to 3,000 acre feet and of this amount, less than 1,000 acre feet is consumptively used. The annual stream depletion resulting from municipal, domestic, industrial use of water and reservoir evaporation is estimated to average 2,200 acre feet.

Two transmountain diversion water tunnels are used for the exportation of water from subbasin streams to the Arkansas River basin of Eastern Colorado. The tunnels were both constructed prior to the beginning of the study period and have remained in continuous service since that time. No material enlargement or expansion of the tunnels or associated diversion facilities have been made since the beginning of the study period. The water annually exported by the two tunnels is given in the following table:

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## Water Exported From Roaring Fork Subbasin - Units Acre Feet

Year	Busk Ivanhoe Tunnel	Twin Lakes Tunnel	Total Diversion	Year	Busk Ivanhoe Tunnel	Twin Lakes Tunnel	Total Diversion
1943	4,850	48,020	52,870	1953	5,080	40,300	45,380
1944	2,100	37,730	39,830	1954	3,200	27,470	30,670
1945	4,900	44,780	49,680	1955	5,270	35,060	40,330
1946	4,640	39,320	43,960	1956	4,400	36,440	40,840
1947	1,440	37,310	38,750	1957	5,510	32,740	38,250
1948	1,000	25,030	26,030	1958	2,650	24,030	26,680
1949	4,300	38,190	42,490	1959	5,180	40,420	45,600
1950	3,410	34,880	38,290	1960	5,310	41,920	47,230
1951	5,130	44,920	50,050				
1952	6,340	51,360	57,700	Average	4,151	37,773	41,924

The estimated present stream depletion of the Roaring Fork Subbasin is summarized in the following table:

## Present Stream Depletion - Acre Feet

*Average annual stream depletion by irrigation	46,500
Average annual stream depletion by municipal and industrial use and reservoir evaporation	2,200
Average annual stream depletion by transmountain diversion	<u>41,900</u>
Total annual stream depletion	<u>90,600</u>

\*Includes allowance for natural vegetation, seeped land and water surfaces without limitation to man-made depletion.

Potential Use

Study of the irrigation potential of the subbasin by the Bureau of Reclamation and the Soil Conservation Service over a period of years shows that new land irrigation will likely be limited to about 17,860 acres. The study also shows that 7,750 acres of subbasin irrigated land with short water supply may well be provided supplemental water for full crop productions. The additional new land together with the land

presently irrigated totals 55,680 acres. Of this total it is estimated that 2,420 acres will be required for industrial development and urbanization leaving an ultimate irrigated area of 53,260 acres. This expanded new land irrigation and the anticipated supplemental water service would result in an additional annual stream depletion of 21,800 acre feet.

The potential of new transmountain diversions of water from subbasin streams has likewise been investigated over a period of years. It appears at this time that the exportation of additional water from subbasin streams may be confined to the water divertable by the Fryingpan-Arkansas Project as now under construction. Project facilities provide for the diversion of water from the head tributary streams of the Fryingpan River, Hunter Creek and an increase of water diversion by the existing Twin Lakes Tunnel. The increase in diverted water would average 80,100 acre feet per year.

Estimates of anticipated population growth indicates that the 1960 subbasin population of 8,553 may well be expanded to 36,000. This estimate of growth is based on the development of a shale oil industry in the Colorado River valley downstream from Glenwood Springs, expanded recreation, coal mining and processing and the irrigation expansion previously discussed. The annual water diversion requirement for a population of 36,000 is 9,000 to 12,000 acre feet. It is estimated that of this amount, 3,600 acre feet will be consumptively used with the balance returned to the natural stream.

In addition to the municipal and domestic use as discussed, it is anticipated that industrial and associated uses will deplete the streams of the subbasin by an additional 14,500 acre feet. On this basis, the annual municipal, domestic and industrial stream depletion may well reach 18,100 acre feet.

The estimated present and potential stream depletion for the Roaring Fork subbasin is summarized in the following table:

\*Anticipated Total Stream Depletion - Acre Feet

Present annual stream depletion		90,600
#Anticipated annual stream depletion for expanded irrigation	21,800	
Anticipated annual stream depletion for expanded municipal and indus- trial use and reservoir evaporation	18,100	
Anticipated annual stream depletion for transmountain diversion	80,100	
Sub-total potential stream depletion	<u>120,000</u>	<u>120,000</u>
Anticipated total annual stream depletion		<u>210,600</u>

\*The stream depletion resulting from the water exported from this subbasin for use in the Rifle - West Divide subbasin is reported as a depletion in the Rifle - West Divide subbasin.

#Include allowance for natural vegetation, seeped land and water surfaces without limitation for man-made depletion.

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## RIFLE - WEST DIVIDE SUBBASIN

### Location and Description

The Rifle-West Divide Subbasin is the drainage basin of the Colorado River between Glenwood Springs and the mouth of Plateau Creek near Cameo, Colorado. The principal tributary streams include Canyon Creek, Elk Creek, Divide Creek, Rifle Creek, Parachute Creek and Roan Creek. Since the watershed is of somewhat lower altitude (5000 to 11,000 feet) the streams of the subbasin produce a less firm useable water supply with a higher variation of annual stream runoff than some of the other subbasins. A large portion of basin tributary stream runoff originates on the watershed north of the river and east of the Town of Rifle.

The subbasin includes parts of three counties with 83.4% in Garfield County, 16.0% in Mesa County and 0.6% in Rio Blanco County. The watershed area comprises 19.6% of the river basin above the Colorado-Utah State line and provides only 9.2% of the historic runoff at the State line.

### Water Runoff

The average annual historic runoff of the subbasin for the 18 year study period of 1943-1960 was 263,800 acre feet. The following table gives the annual runoff of the Colorado River at Cameo, the combined annual runoff of the Colorado River and the Roaring Fork River at Glenwood Springs and the subbasin watershed inflow taken as the difference between the subbasin river inflow at Glenwood Springs and the river dis-

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charge at Cameo.

## Historic Runoff Rifle-West Divide Subbasin - Units 1000 Acre Feet

Year	Colorado River at Cameo	Colorado R.& Roaring Fork R.at Glenwodd	*Subbasin Runoff	Year	Colorado River at Cameo	Colorado R.& Roaring Fork R.at Glenwood	*Subbasin Runoff
1943	2,885.0	2,710.5	174.5	1953	2,573.0	2,389.1	183.9
1944	2,715.0	2,394.4	320.6	1954	1,552.0	1,363.8	188.2
1945	2,957.0	2,612.7	344.3	1955	1,976.0	1,686.8	289.2
1946	2,576.0	2,354.3	221.7	1956	2,416.0	2,186.4	229.6
1947	3,747.0	3,417.0	330.0	1957	4,213.0	3,930.0	283.0
1948	3,325.0	3,026.0	299.0	1958	2,902.0	2,620.4	281.6
1949	3,341.0	3,006.6	334.4	1959	2,188.0	2,032.0	156.0
1950	2,557.0	2,274.0	283.0	1960	2,462.0	2,272.4	289.6
1951	2,911.0	2,720.7	190.3				
1952	4,130.1	3,680.0	450.0	Average	2,857.0	2,593.2	263.8

\*The subbasin runoff is the Colorado River flow at Cameo less the Colorado River & Roaring Fork River Flow at Glenwood Springs.

During the 18 year study period, the water consumed within the basin is estimated to have averaged 85,800 acre feet per year. Figures on watershed runoff, stream depletion and the undepleted water yield of the subbasin are given in the following table.

Undepleted Rifle - West Divide Subbasin Runoff  
Average for 18 Year Period 1943-1960 - Units Acre Feet

Subbasin Runoff	263,800
Stream Depletion	85,800
Imported (Gunnison River)	- 2,200
Net Undepleted Subbasin Water Supply	347,400

Present Water Use

The irrigated land of the subbasin as measured by the Bureau of Reclamation in 1939 totaled 52,470 acres. The results of re-study of the land in 1951 also by the Bureau of Reclamation show that irrigation had been expanded to a total of 55,944 acres of land. A recent check on irrigated land indicates that the presently irrigated land is about 57,480 acres.



This is an increase of 5,010 acres over that irrigated prior to the study period for an increase of 9.5% in the 25 year period since 1939.

The irrigated land is about evenly divided between the land receiving a full supply of irrigation water and the land requiring additional water for full crop production. In general, the land located in the tributary stream basins requires additional water while the land located along the Colorado River has a full irrigation water supply. The annual stream depletion of subbasin runoff resulting from irrigation is estimated to be 83,600 acre feet.

The population of the subbasin in 1960 was 6,369. The water diverted annually from natural stream runoff for municipal, domestic and industrial use is estimated to not exceed 3,000 to 3,500 acre feet of which about 2,200 acre feet are consumptively used with the balance returning as a part of the river flow downstream.

The estimated present stream depletion of the Rifle-West Divide Subbasin runoff is summarized in the following table:

Present Stream Depletion - Acre Feet	
*Average annual stream depletion by irrigation	83,600
Average annual stream depletion by municipal and industrial use and reservoir evaporation	<u>2,200</u>
Total annual stream depletion	85,800

\*Includes allowance for natural vegetation, seeped land and water surfaces without limitation to man-made depletion.

Potential Use

Study of the irrigation potential of the subbasin indicates that the area of irrigated land will ultimately reach 87,590 acres. It is estimated that this will be decreased by about 6,800 acres by industrial development and urbanization, leaving an ultimate irrigated area of about 80,750 acres. This would be a net increase of new land irrigation of 23,270 acres. It is estimated that 26,380 acres of land in need of additional water can be provided a supplemental supply. This additional new land irrigation together with the supplemental irrigation would result in new annual stream depletion of 56,300 acre feet.

Estimates of future municipal and industrial water requirements of the subbasin include allowance for a shale oil industry in the general area of the towns of Rifle, Grand Valley and DeBeque. The estimates are based on water use data reported to the State of Colorado by engineer consultants Cameron and Jones.

Stream depletion figures provide for an increase in the subbasin population from the 1960 population of 6,369 to a total population of 224,000 and also an industrial water consumptive use of 100,000 acre feet per year. The annual diversion requirement for municipal, domestic and industrial water use is estimated to be about 200,000 acre feet, of which 122,800 acre feet would be consumptively used with the balance returned to the river for downstream use.

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The estimated present and potential stream depletion for the Rifle-West Divide Subbasin is summarized in the following table:

Anticipated Total Stream Depletion - Acre Feet

Present annual stream depletion		85,800
*Anticipated annual stream depletion for expanded irrigation	56,300	
Anticipated annual stream depletion for expanded municipal and industrial use and reservoir evaporation	<u>122,800</u>	
Sub-total potential stream depletion	179,100	<u>179,100</u>
Anticipated total annual stream depletion		264,900

\*Includes allowance for natural vegetation, seeped land and water surfaces without limitation to man-made depletion.

## PLATEAU CREEK SUBBASIN

Location and Description

The Plateau Creek Subbasin is the drainage basin of Plateau Creek and tributaries. Plateau Creek joins the Colorado River in DeBeque Canyon 7 miles upstream from the Town of Palisade and 51 miles upstream from the Colorado-Utah State line. The principal subbasin streams drain the north slope watershed of Grand Mesa at a maximum elevation of 10,500 feet. A total of 99.4% of the subbasin is in Mesa County with the balance of .6% being located in Garfield County.

Water Runoff

The average annual historic discharge of Plateau Creek at its junction with the Colorado River near Cameo is 132,500 acre feet. The subbasin runoff is 4.6% of the historic runoff of the river basin while the watershed area is 5.9% of the river basin watershed area. The following table gives the annual historic discharge of Plateau Creek to the Colorado River.

Historic Runoff Plateau Creek Subbasin - Units 1000 Acre Feet

Year	Runoff	Year	Runoff
1943	120.7	1953	103.0
1944	191.6	1954	72.3
1945	167.4	1955	93.0
1946	111.7	1956	69.8
1947	163.0	1957	210.5
1948	182.4	1958	201.6
1949	160.6	1959	75.8
1950	117.2	1960	90.2
1951	71.5		
1952	183.4	Average	132.5

The estimated stream depletion for the 18 year study period amounted to 32,300 acre feet. This depletion is 19.6% of the subbasin undepleted runoff and somewhat higher than the percentage water supply depletion of any of the other subbasins. Figures showing the undepleted water yield of the subbasin is given in the following table:

Undepleted Plateau Creek Subbasin Runoff  
Average for 18 Year Period 1943-1960 - Units Acre Feet

Runoff of Plateau Creek	132,500
Stream Depletion	32,300
Net Undepleted Subbasin Water Supply	164,800

Present Water Use

The Bureau of Reclamation reported 26,300 acres of land irrigated in the Plateau Creek Subbasin in 1939. In 1960 or prior to use of Collbran Project water, the irrigated land amounted to 29,100 acres. This is an increase of 10.6% over that irrigated in 1939. Of the total area of 29,100 acres irrigated in 1960, less than 10,000 acres received a full irrigation water supply. The annual stream depletion is estimated to be 29,800 acre feet.

The population of the subbasin in 1960 was 1,569. Census figures show a loss of 546 persons or 26% for the 30 year period 1930-1960. The water used for municipal and domestic purposes would not exceed 400 to 500 acre feet a year with the stream depletion for these purposes limited to less than 200 acre feet. The stream depletion for municipal and domestic use together with reservoir evaporation is

is estimated to have averaged 2,500 acre feet per year for the study period. Data on present stream depletion is summarized in the following table:

Present Stream Depletion - Acre Feet

*Average annual stream depletion by irrigation	29,800
Average annual stream depletion by municipal and industrial use and reservoir evaporation	<u>2,500</u>
Total annual stream depletion	32,300

\*Includes allowance for natural vegetation, seeped land and water surfaces without limitation to man-made depletion.

Potential Use

Collbran Project water will increase the irrigated land in Plateau Valley by 2,200 acres. Project water is also being supplied to 17,680 acres of the irrigated land of the valley in need of a supplemental supply of water. Studies by the Bureau of Reclamation indicate that an additional 6,120 acres of new land and also 2,770 acres of the irrigated land of the subbasin may well be provided irrigation water. This additional new land irrigation and the supplemental water supply would provide for the full irrigation of 37,420 acres of land. This may be decreased by 920 acres at such time as the full recreation development of the basin is realized, leaving 36,500 acres as the total area of irrigated land. The increase in stream depletion from irrigation would be 21,700 acre feet per year.

Except for expanded irrigation as discussed above, new water use in the valley will be small. The Ute domestic

water system presently near completion will export water from the valley for use in the Grand Valley Subbasin. Stream depletion resulting from this use of water is provided for in the Grand Valley Subbasin section of this report.

The recreation attraction of the north slope of Grand Mesa together with the irrigation expansion discussed above would justify a subbasin population of about 4,000. The increase in stream depletion resulting from new municipal, domestic and recreation water use and subbasin reservoir evaporation is estimated to be 3,300 acre feet annually. The anticipated ultimate stream depletion of the Plateau Creek Subbasin is summarized in the following table:

Anticipated Total Stream Depletion - Acre Feet

Present annual stream depletion		32,300
*Anticipated annual stream depletion for expanded irrigation	21,700	
Anticipated annual stream depletion for expanded municipal and industrial use and reservoir evaporation	<u>3,300</u>	
Sub-total potential stream depletion	<u>25,000</u>	<u>25,000</u>
Anticipated total annual stream depletion		<u>57,300</u>

\*Includes allowance for natural vegetation, seeped land and water surfaces without limitation to man-made depletion.

## GRAND VALLEY SUBBASIN

Location and Description

The Grand Valley Subbasin includes the drainage area of the Colorado River from the mouth of Plateau Creek down to the Colorado-Utah State line except for the Gunnison River Basin. The altitude varies from an elevation of 4,300 feet at the State line to about 8,000 feet on the Colorado River-White River divide north of Grand Junction. Subbasin watershed streams are intermittent. Seventy percent of the subbasin is located in Mesa County and 30% in Garfield County.

The subbasin contains only about 12.9% of the river basin drainage area but in terms of basin development it accounts for about 26.1% of the irrigated land and 64.1% of the basin population. The agriculture income amounts to 44% of the total for the entire river basin.

Water Runoff

The river runoff discharged from the subbasin at the Colorado-Utah State line for the 18 year study period averaged 152,200 acre feet per year less than the total amount of water entering the subbasin from the Rifle-West Divide Subbasin, the Plateau Creek Subbasin and the Gunnison River. The water runoff of each of these subbasins along with the net subbasin inflow is given in the following table:



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## Historic Runoff Grand Valley Subbasin - Units 1000 Acre Feet

Year	Colo. R. at Cameo	Plateau Cr. at Cameo	Gunn.R. at Gr.Jct.	Total Inflow	Colo. R. at State Line	Subbasin Net Loss
1943	2,885.0	120.7	1,761.0	4,766.7	4,625.0	141.7
1944	2,715.0	191.6	2,237.0	5,143.6	5,020.0	123.6
1945	2,957.0	167.4	1,804.0	4,928.4	4,820.0	108.4
1946	2,576.0	111.7	1,278.0	3,965.7	3,810.0	155.7
1947	3,747.0	163.0	1,849.0	5,759.0	5,660.0	99.0
1948	3,325.0	182.4	2,445.0	5,952.4	5,860.0	92.4
1949	3,341.0	160.6	2,119.0	5,620.6	5,560.0	60.6
1950	2,557.0	117.2	1,387.0	4,061.2	3,922.0	139.2
1951	2,911.0	71.5	1,127.0	4,109.5	3,870.0	239.5
1952	4,130.0	183.4	2,625.0	6,938.4	6,847.0	91.4
1953	2,573.0	103.0	1,331.0	4,007.0	3,773.0	234.0
1954	1,552.0	72.3	663.5	2,287.8	2,086.0	201.8
1955	1,976.0	93.0	1,032.0	3,101.0	2,903.0	198.0
1956	2,416.0	69.8	1,113.0	3,598.8	3,345.0	253.8
1957	4,213.0	210.5	3,208.0	7,631.5	7,525.0	106.5
1958	2,902.0	201.6	2,383.0	5,486.6	5,425.0	61.6
1959	2,188.0	75.8	951.0	3,214.8	2,975.0	239.8
1960	2,462.0	90.2	1,390.0	3,942.2	3,749.0	193.2
Average	2,857.0	132.5	1,705.7	4,695.2	4,543.0	152.2

The consumptive use of water within the subbasin for the 18 year study period is estimated to have averaged 214,700 acre feet per year. This, less the subbasin runoff deficiency of 152,200 acre feet and the imported water of 6,600 acre feet leaves 55,900 acre feet as the undepleted water runoff of the subbasin as shown in the following table:

Undepleted Grand Valley Subbasin Runoff  
Average for 18 Year Study Period - Units Acre Feet

Colorado River Runoff at Cameo	2,857,000
Plateau Creek Runoff at Cameo	132,500
Gunnison River Runoff at Grand Junction	1,705,700
Sub total	<u>4,695,200</u>
Colorado River Runoff at State Line	4,543,000
Grand Valley Subbasin Runoff Deficiency	- 152,200
Grand Valley Subbasin Stream Depletion	214,700
Sub total difference	<u>62,500</u>
Imported (Gunnison 6,100, White 500)	6,600
Net Undepleted Subbasin Runoff	<u>55,900</u>

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Present Water Use

Three canal systems consisting of the Grand Valley Project Canal, the Grand Valley Irrigation Company Canal and the Redlands Water and Power Canal provide water service to the irrigated land of the subbasin. The Redlands Canal diverts water from the Gunnison River. The source of water supply for the other two canals is the Colorado River. The land served by the three canal systems is all located in the drainage basin of the Colorado River. Therefore, the stream depletion resulting from the irrigation is estimated as a single depletion figure regardless of the source of water supply.

A review of the land acreage records of the canal companies shows that 66,276 acres of land were irrigated in 1939 prior to the study period. The land irrigated at the present time is 79,100 acres, an increase of 12,824 acres or 19.3% since 1939. All land receives an adequate supply of water for full crop production. The annual stream depletion chargeable to irrigation is 207,000 acre feet.

The population of the subbasin for the year 1960 was 47,999. This includes the City of Grand Junction, the Towns of Fruita and Palisade as well as the rural and suburban area of the subbasin. The water used by Grand Junction and Fruita, averaging 6,100 acre feet per year for the study period was imported to the subbasin from tributary streams of the Gunnison River. Also, about 500 acre feet per year

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were imported from the White River by the American Gilsonite Company. Other water used for municipal, domestic and industrial purposes was secured from wells or diverted from subbasin streams. Stream depletion for the above water uses is estimated as a single figure regardless of the source of supply.

The total water used for municipal, domestic and industrial purpose averaged about 16,000 acre feet per year. Of this amount, it is estimated 7,700 acre feet represents stream depletion with the balance returned to the Colorado River downstream. The estimated annual stream depletion of the Grand Valley subbasin is summarized in the following table:

Present Stream Depletion - Acre Feet

*Average annual stream depletion by irrigation	207,000
Average annual stream depletion by municipal and industrial use and reservoir evaporation	<u>7,700</u>
Total annual stream depletion	214,700

\*Includes allowance for natural vegetation, seeped land and water surfaces without limitation to man-made depletions.

Potential Water Use

Land of the subbasin suitable for irrigation consists of relatively small, somewhat isolated tracts located above the canals of the valley. The service of this limited acreage of land can best be accomplished by the construction of small pumps using existing canals as source of water supply. Anticipated irrigation expansion is 7,500 acres. With this expansion, the subbasin irrigated land would total

86,600 acres. It is estimated that 4,600 acres of this will ultimately be used for industrial purposes and urbanization leaving 82,000 acres as the net area of irrigated land. The increase in stream depletion resulting from expanded irrigation would be 13,900 acre feet per year.

Subbasin population expanded from 22,242 in 1930 to 47,999 in 1960. This is a 30 year growth of 25,757 persons or 116% over the population of 1930. Estimates of future growth indicate the population may well reach 126,000 about the year 2000. This would be a 40 year growth of 78,000 persons. This anticipated growth provides allowance for shale oil development in the Rifle-West Divide Subbasin as previously discussed. Based on a population of 126,000, the municipal, domestic and industrial water use would be about 40,000 acre feet per year. The increase in stream depletion resulting from this expanded municipal, domestic, industrial and associated use of water would amount to 11,300 acre feet per year.

The estimated present and potential stream depletion for the Grand Valley Subbasin is summarized in the following table:

Anticipated Total Stream Depletion - Acre Feet

Present annual stream depletion		214,700
*Anticipated annual stream depletion for expanded irrigation	13,900	
Anticipated annual stream depletion for expanded municipal and industrial use and reservoir evaporation	<u>11,300</u>	
Sub-total potential stream depletion	25,200	<u>25,200</u>
Anticipated total annual stream depletion		239,900

\*Includes allowance for natural vegetation, seeped land and water surfaces without limitation to man-made depletion.

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## LITTLE DOLORES RIVER AND COATES CREEK SUBBASIN

### Location and Description

The Little Dolores River and Coates Creek both head in Colorado. The two streams cross the Colorado-Utah State line and discharge separately into the Colorado River in Utah. The watershed is located on both sides of the State line south of the Colorado River and north of the Dolores River. The upper portion of the watershed and the land used for irrigation is located in Colorado.

The section of the subbasin located in Colorado contains 160,000 acres or 250 square miles, all in Mesa County. The watershed heads at an altitude of 9,500 feet with the State line located at an elevation of about 5,400 feet. The 1960 population of the subbasin was 140, and the number of operating ranch units was 30.

### Water Supply

Water runoff information on the Little Dolores River or Coates Creek is unavailable. Estimates of the combined discharge of the two streams based on the water yield of other comparable streams indicate the discharge of the two at the State line would average about 15,000 acre feet per year for the 18 year study period. The capacity of watershed reservoirs is about 1,500 acre feet. The water annually consumed in the two basins is estimated to be 3,000 acre feet, and the undepleted water yield of the two streams is summarized in the following table:

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Undepleted Little Dolores River and Coates Creek Runoff  
Average for 18 Year Period 1943-1960 - Units Acre Feet

Estimated Runoff at State Line	15,000
Stream Depletion	<u>3,000</u>
Net Undepleted Water Supply	18,000

Present and Potential Water Use

Records indicate that irrigation in the two stream basins has declined from about 3,100 acres in 1939 to a present total of about 2,190 acres. The water is used for irrigated crops and for livestock pasture. All irrigated lands receive less than a full all season water supply. The present and future use of water is expected to remain about the same as there appears to be little opportunity for any new development. The estimated stream depletion is summarized in the following table:

Present and Anticipated Stream Depletion - Units Acre Feet

*Average annual stream depletion by irrigation	2,600
Average annual stream depletion by domestic and livestock use and reservoir evaporation	<u>400</u>
Total annual stream depletion	3,000

\*Includes allowance for natural vegetation, seeped land and water surfaces without limitation to man-made depletions.

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## SUMMARY

### Irrigation Use of Water

The total area of irrigated land in the main stem Colorado River basin and the Little Dolores and Coates Creek basins upstream from the Colorado-Utah State line is 303,770 acres. This is an increase of 47,753 acres over that reported by the Bureau of Reclamation as irrigated in 1939. The increase is largely the result of enlargement and extension of ditches and the clearing of land under existing ditches. The Collbran Project provided for the only large project type expansion during the 1939-1964 period. A somewhat larger portion of the expansion occurred in the upper basin of higher altitude than the lower basin.

A review of the work of the Bureau of Reclamation and the Soil Conservation Service indicates that irrigation in the basin may well be expanded by an additional 107,060 acres of land. This together with the land presently irrigated would make a total of 410,830 acres. It is estimated that about 16,630 acres of the irrigated land will be required for such purposes as new road rights-of-way, reservoir storage of water, industrial plant sites and home subdivisions, leaving 394,200 acres as the net area of basin irrigated land remaining in crop production. As a part of the expanded irrigation, a supplemental supply of water would be provided for a minimum of 80,980 acres of irrigated land in need of additional water for full crop production. A major portion of the anti-

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anticipated expansion would be Federal project type development.

The present stream depletion resulting from the irrigation of land is estimated to be 458,200 acre feet per year. Anticipated irrigation expansion would result in an additional stream depletion of 167,100 acre feet, making the total anticipated stream depletion, resulting from irrigation use, 625,300 acre feet per year.

The following two tables summarizes the present and anticipated irrigated land acreage and the estimated stream depletion resulting from irrigation use of basin water supply.

Irrigated Land - Units Acres

Subbasin	Irrigated Land 1939	Irrigated Land 1960	Anticipated New Irrig.	Total Irrigation
Middle Park	58,010	80,320	36,030	116,350
Eagle River	15,271	17,760	7,240	25,000
Roaring Fork	34,590	37,820	17,860	55,680
Rifle-West Divide	52,470	57,480	30,110	87,590
Plateau Creek	26,300	29,100	8,320	37,420
Grand Valley	66,276	79,100	7,500	86,600
Sub-total	<u>252,917</u>	<u>301,580</u>	<u>107,060</u>	<u>408,650</u>
Little Dolores & Coates Creek	3,100	2,190	- 0 -	2,190
Sub-total	<u>256,017</u>	<u>303,770</u>	<u>107,060</u>	<u>410,830</u>
Loss of land to Industrial Sites, Roads & Residential Use				<u>16,300</u>
Total Ultimate Irrigated Land				394,200



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## \*Irrigation Stream Depletion - Units Acre Feet

Subbasin	Present	Anticipated	Total
Middle Park	67,400	42,400	109,800
Eagle River	21,300	11,000	32,300
Roaring Fork	46,500	21,800	68,300
Rifle-West Divide	83,600	56,300	139,900
Plateau Creek	29,800	21,700	51,500
Grand Valley	<u>207,000</u>	<u>13,900</u>	<u>220,900</u>
Sub-total	455,600	167,100	622,700
Little Dolores & Coates Creek	<u>2,600</u>	<u>- 0 -</u>	<u>2,600</u>
Total	458,200	167,000	625,300

\*Includes allowance for natural vegetation, seeped land and water surfaces without limitation to man-made depletion.

Municipal and Industrial Use and Reservoir Evaporation

The 1960 population of the basin including that of the Little Dolores and Coates Creek basins is 74,938, which is an increase of 30,391 persons or 68% growth in the 30 year period from 1930 to 1960. This increase in population has occurred primarily in the larger cities and towns with some decreases experienced in many of the rural farming areas of the basin.

The anticipated industrial expansion of the basin including shale oil, coal and other lesser industrial developments, indicate the population of the basin may well reach a total of from 400,000 to 425,000 persons by the year 2000. It is anticipated that the larger centers of population would be located in the Rifle-DeBeque section of the Colorado River Valley, the Glenwood Springs-Carbondale section of the Roaring

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Fork River Valley and the Grand Junction area of the Grand Valley.

The present stream depletion resulting from municipal and industrial use of water and reservoir evaporation is estimated to be 23,300 acre feet per year. The anticipated additional stream depletion for these same uses is 168,000 acre feet per year, making the total annual stream depletion resulting from municipal and industrial use and reservoir evaporation 191,300 acre feet.

The following two tables summarize the present and anticipated basin population and the present and anticipated stream depletion for municipal and industrial use of basin water supply and reservoir evaporation.

#### Basin Population

Subbasin	<u>1/</u> Present	Anticipated
Middle Park	6,546	11,000
Eagle River	3,760	6,600
Roaring Fork	8,553	36,000
Rifle-West Divide	6,369	224,000
Plateau Creek	1,569	4,000
Grand Valley	<u>47,999</u>	<u>126,000</u>
Sub-total	74,796	407,600
Little Dolores & Coates Creek	<u>142</u>	<u>400</u>
Total	74,938	408,000

1/ Census figures for 1960

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Municipal and Industrial and Reservoir Evaporation  
Stream Depletion - Units Acre Feet

Subbasin	Present	Anticipated	Ultimate
Middle Park	7,400	11,100	18,500
Eagle River	900	1,400	2,300
Roaring Fork	2,200	18,100	20,300
Rifle-West Divide	2,200	122,800	125,000
Plateau Creek	2,500	3,300	5,800
Grand Valley	7,700	11,300	19,000
Sub-total	22,900	168,000	190,900
Little Dolores & Coates Creek	400	- 0 -	400
Total	23,300	168,000	191,300

Transmountain Diversion

The exportation of water from the basin prior to 1951 was a minor use of the basin water supply. Data compiled for the writing of this report indicates that in future years the transmountain diversion of water from the basin to eastern Colorado may well exceed the stream depletion by in-basin use of water.

The following table summarizes the average annual historical diversions for the 18 year study period, the anticipated average annual divertable water after the completion of the facilities now under construction, the average annual divertable water by ultimate expansion of these diversion facilities and the potential ultimate diversion.

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## Transmountain Diversions - Units Acre Feet

Subbasin	Historic Diversions	<u>1</u> /Anticipated Diversions	Conditional Diversions	<u>2</u> /Potential Ultimate
Middle Park	206,300	384,000	150,900	741,200
Eagle River	4,000	74,600	28,500	107,100
Roaring Fork	<u>41,900</u>	<u>80,100</u>	---	<u>122,000</u>
Total	252,200	538,700	179,400	970,300

1/ Additional to historic diversions

2/ Includes conditional diversions requiring the replacement of water for in-basin use.

Basin Runoff and Stream Depletion

The historic annual runoff of the basin for the 18 year study period 1943-1960 averaged 2,852,300 acre feet. This added to the estimated stream depletion for the same 18 year period of 733,700 acre feet gives 3,586,000 as the annual undepleted State line flow. The anticipated future additional stream depletion is estimated to be 873,800 acre feet which if added to the 18 year average depletion of 733,700 makes a total stream depletion for the basin of 1,607,500 acre feet. If anticipated basin development is accomplished with resulting stream depletion, the yearly water discharged from the basin during a period of years comparable to the 18 year period of 1943-1960 would average 2,006,800 acre feet (2,852,300 - 873,800 + \*28,300). This added to the Gunnison River average annual residual flow of 1,502,300 would amount to 3,509,100 acre feet per year as the ultimate downstream contribution of the main stem Colorado River and the Gunnison. This figure

\*Water imported to basin from Gunnison, White and Yampa Rivers.

would compare with 4,558,800 acre feet as the annual historical flow for the 18 year study period.

The following three tables present summaries of the basin undepleted water supply, the basin stream depletion for in-basin and export use of water and the total stream depletion.

Basin Undepleted Annual Runoff - Units Acre Feet

Subbasin	Undepleted Runoff	Subbasin	Undepleted Runoff
Middle Park	1,544,400	Plateau Creek	164,800
Eagle River	455,500	Grand Valley	55,900
Roaring Fork	988,500	Dolores R. & Coates Cr.	18,000
Rifle-West Divide	347,400	Total	3,574,500
Basin Undepleted Runoff			3,574,500
Basin Imported Water:			
Middle Park Subbasin from Yampa River		2,700	
Rifle-West Divide Subbasin from Gunnison River		2,200	
Grand Valley Subbasin from Gunnison River		6,100	
Grand Valley Subbasin from White River		500	
Total Imported		11,500	11,500
Total State Line Flow			3,586,000

Annual Stream Depletion by In-basin and Export Use of Water  
Units Acre Feet

Subbasin	In-basin Use		Export Use		Total Present	Total Anticipated
	Total Present	Total Anticipated	Total Present	Total Anticipated		
Middle Park	74,800	128,300	206,300	590,300	281,100	718,600
Eagle River	22,200	34,600	4,000	78,600	26,200	113,200
Roaring Fork	48,700	88,600	41,900	122,000	90,600	210,600
Rifle-West Divide	85,800	264,900	-	-	85,800	264,900
Plateau Creek	32,300	57,300	-	-	32,300	57,300
Grand Valley	214,700	239,900	-	-	214,700	239,900
Sub-total	478,500	813,600	252,200	790,900	730,700	1,604,500
Little Dolores & Coates Creek	3,000	3,000	-	-	3,000	3,000
Total	481,500	816,600	252,200	790,900	733,700	1,607,500

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## Total Annual Stream Depletion - Units Acre Feet

Subbasin	Present	Anticipated Additional	Ultimate Total
Middle Park	281,100	437,500	718,600
Eagle River	26,200	87,000	113,200
Roaring Fork	90,600	120,000	210,600
Rifle-West Divide	85,800	179,100	264,900
Plateau Creek	32,300	25,000	57,300
Grand Valley	<u>214,700</u>	<u>25,200</u>	<u>239,900</u>
Sub total	730,700	873,800	1,604,500
Little Dolores & Coates Creek	<u>3,000</u>	<u>-</u>	<u>3,000</u>
Total	733,700	873,800	1,607,500