

The Grand river and Roaring Fork canal takes water from Cattle creek, heading at a point 7 miles above Glenwood Springs. It flows on the north side of Cattle creek and on the eastern side of Roaring Fork valley down to Glenwood Springs. It is 7 miles long, 3 feet wide, and cost \$12,000. It was begun in 1887 and used in the following year. Water is diverted from the creek by means of a tight dam of logs and dirt, replaced each year. The canal is owned by a corporation, each stockholder being entitled to water in proportion to the stock held. In 1889 only about 90 acres were irrigated, owing to the fact that other irrigating ditches were taking the water. The Roaring Fork is so far below the land to be irrigated that it is not practicable to take out water, and a supply, usually insufficient, must be obtained from the small streams. Owing to the impossibility of securing water from this canal a trial has been made of using a centrifugal force pump driven by water power, the entire plant costing about \$3,000.

The Last Chance ditch takes water from Grand river near Ferguson, carrying it out on the south side to and below Rifle. It is over 8 miles long, 4 feet wide, and cost about \$8,000. It was begun in 1887, and though not completed was used to a small extent in the census year. Water is diverted by a long cutting, bringing the head sufficiently low to receive water. In 1889 about 75 acres were irrigated, most of this being in forage crops. The water supply is large, ample for the needs of the ditch when completed.

GILPIN COUNTY, the smallest in the state, includes a part of the mining region west of Denver. It is among the high mountains, the valleys being at an elevation of 8,000 feet and upward. There are a few patches of arable land along the streams, but the temperature is so low that forage crops alone are raised, these consisting of grasses and cereals cut before maturity. The ditches within this county have been built for placer mining.

GRAND COUNTY includes the Middle park, situated in the north central part of the state on the head waters of Grand river. This park is partially surrounded by a loop in the continental divide, and although between the North and South park it is on the opposite side of the continental watershed, its streams flowing to the Pacific ocean. The valley lands are at an elevation of about 8,000 feet and the climate is too severe for general agriculture, although with irrigation it is favorable for the production of hay and the hardier vegetables and cereals. Each ranch has its own ditch and sufficient agriculture is practiced to supply common needs. Potatoes are often raised without irrigation, especially near or within the timbered areas, tree growth marking the localities where the supply of moisture is better than usual. As in the other parks the water supply is large, well distributed, and is freely used by the ranchmen. The grass is irrigated almost continuously during the growing season, a great part of this water returning to the stream, thus, apparently, not diminishing the amount below. Besides the native grasses timothy and redtop are grown successfully, but the altitude is regarded as too high for alfalfa. Some of the bottom lands are wet by the annual overflow of Grand river.

GUNNISON COUNTY includes the greater part of the headwaters of Gunnison river above the grand canyon of that stream. It is bounded on the north by the Elk mountains and on the east by the Saguache range, this being a part of the continental divide. As in adjoining counties, mining is the principal industry, and next to this in importance is stock raising, the mountain slopes and hills furnishing excellent grazing. Along the valley of the Gunnison river in the vicinity of Gunnison and up along Ohio creek, Slate river, and Tomichi creek are valley lands containing natural meadows. A great part of this low land has been brought under irrigation by ditches taking water from the streams mentioned. The altitude is about 8,000 feet and agricultural products consist principally of the hardier cereals usually cut for hay, as well as timothy, redtop, and other forage plants. Potatoes are occasionally raised without irrigation, but this may be considered as exceptional. The water supply of the county is abundant at all times of the year, and the area cultivated can be increased without interference with water rights.

HINSDALE COUNTY covers a part of the high mountain region west of the San Luis valley. It includes the upper waters of the Rio Grande, and extending both north and south over the continental divide, takes in a part of the watershed tributary to Lake fork of the Gunnison, and on the south a few of the streams flowing into the San Juan river. There are numerous mines in the county, the mountains containing many deposits of precious minerals. Cattle graze in the high valleys, but there are few places at which agriculture can be successful on account of the great altitude and the short summer. The lowest points in the county are probably considerably over 8,000 feet above sea level. In the vicinity of Lake city and on the Cebolla or White Earth creek a little irrigation has been attempted, mainly for the purpose of raising forage crops, there being plenty of water and but little arable land. Each farmer has his own ditch, and besides hay raises a few of the hardier vegetables.

HUERFANO COUNTY lies along the eastern side of the Sangre de Christo and Culebra ranges, these forming the watershed between the Arkansas and the Rio Grande. The slopes of these mountains are drained by the Huerfano river and its tributaries, which, flowing northeasterly, empties into the Arkansas. Agriculture is carried on mainly along this river in the valleys wherever water can be diverted, the greater number of the farmers being of Mexican descent. In the higher valleys some of the crops are raised without irrigation, mainly on account of the difficulty of obtaining water. The supply as a whole is far below the needs of the land under cultivation, and hopes have been expressed by the majority of the farmers that it will be possible to increase the summer flow of the streams by storage reservoirs.

JEFFERSON COUNTY includes a great part of the plain extending from the foot of the mountains to the city of Denver. This area is crossed by many creeks whose supply of water is large and perennial. As a consequence ditches and canals have been built, covering the comparatively level ground with a network of small water courses and bringing under cultivation nearly all of the arable land within reach. The complexity of these systems is shown on plats prepared by the state engineer of Colorado and on the topographic sheets of the United States Geological Survey. On the western side of the county among the mountains are small areas upon which cereals and vegetables are grown without the artificial application of water, and in the valley lands are places where corn has been raised without irrigation by planting the quick growing varieties and keeping the ground well cultivated. Taking the county as a whole, however, agriculture without irrigation is exceptional.

The water supply of the county comes from the South Platte, which for over 50 miles forms the southeastern boundary, and also from tributaries which, crossing the county, flow into this river. The principal of these in order down stream, namely, from south to north, are the north fork of the South Platte, Deer creek, Bear creek, and Clear creek. The north fork of the South Platte enters through canyons and its waters are used for irrigation only up among the mountains. The waters of the other creeks are diverted immediately after leaving the lower canyons and are carried out on both sides of the stream by canals and ditches, heading in succession at short intervals below each other. The capacity of these systems for distributing water is far greater than the supply usually available, and as the hot weather comes on it is usually necessary to deprive several of the ditches of all or part of the water needed by them in order that persons having prior rights may be supplied. It thus results that the later settlers complain of hardship or even injustice, and the assertion is made that the older settlers receive more water than is justly due them.

The development of irrigation without systematic control has resulted in the construction of many small ditches each so located as to best supply some individual or group of individuals. These have been followed in time by larger canals, in many ways better planned, but whose location and construction have often been modified by the presence of older ditches and water rights. In distributing the water according to priorities of right it necessarily happens that the ditch lowest on the stream and least economical in its use of the water may be entitled to more water than one commanding more land and built to utilize its supply in the best possible manner. It is apparent to the irrigators that the only way of remedying the evils thus arising is by the construction in the mountains of storage reservoirs whose capacity shall be so great as to hold the waters which otherwise run to waste during winter and spring. There are, however, many obstacles arising not only from the difficulty and expense of constructing retaining dams but also in the recovery of the water from the stream in which it must flow and in its distribution. As the matter is at present few of the larger canals can deliver to the irrigators an amount of water sufficient for their demands, and since payment for water is usually made in advance, the farmer may suffer a double loss, namely, in money thus paid and in crops.

Measurements of the amount of water flowing in the South Platte, Bear creek, and Clear creek have been made by the state engineer of Colorado, and the daily discharge during the summer season at least has been computed for a number of years. At the gauging station near Deansbury, in the canyon of the river about 26 miles south of Denver, as stated in the description of Park county, observations were begun in July, 1887. The area of the catchment basin above this point is about 2,600 square miles, the greater portion of this being in the South park. The average discharge from May to October, inclusive, in 1888, was 323 second-feet; in 1889, 297 second-feet, and in 1890, 374 second-feet. Bear creek has been measured at a point 2.5 miles above Morrison, being thus above the heads of all canals, observations being begun in August, 1887. The highest water recorded during the spring and summer months was 195 second-feet, occurring in May, 1889, a flood later in the season, however, being probably of greater quantity. The lowest water of fall and winter was about 15 second-feet. The average discharge of the stream taking the year through is probably not far from 50 second-feet, and the drainage area is approximately 141 square miles. Turkey creek, immediately south of this stream and flowing into it below Morrison, carries probably a less amount of water and has been known to become dry. These streams are included within what is known as water district No. 9.

Clear creek has been gauged at a point in the canyon about 7 miles above Golden, above places where water has been diverted to any notable extent for irrigation purposes. The drainage area above this place is 338 square miles. The average discharge of this stream is probably from 300 to 400 second-feet, falling to 50 second-feet or even lower in time of drought. One flood, as estimated by the state engineer, discharged at the rate of 8,700 second-feet for 2 hours, the river falling immediately to a little over 200 second-feet. The canals and ditches taking water from this creek and its tributary, Ralston creek, are included within water district No. 7. Within the two districts mentioned, Nos. 7 and 9, there are a large number of reservoirs projected or constructed. The object of these is to hold surplus water from the creeks at points convenient to the lands of the irrigators. In this way the problem of distribution of stored waters has been done away with here, since the water is not returned again to the stream, but is drawn back into the canal or to distributaries.

A brief description is herewith given of a few of the many ditches in this county. Arnette ditch takes water from the south side of Bear creek below Morrison and continues in a direction a little south of east out toward the South Platte river. It is 8 miles long, about 10 feet wide, and cost \$20,000. It was begun and first used in 1872.

It is owned by a corporation, and water is divided according to the number of shares held by each owner. The principal crop raised is alfalfa, and next in importance are the cereals. The Ward and Kendrick ditch takes water from the opposite side of Bear creek, carrying it in a general northeasterly direction. The total length of the main ditch is 14.5 miles, average width is 6 feet, and the cost of ditches was \$16,000, to which should be added \$11,000 for the expense of constructing reservoirs. In 1889 about 900 acres were irrigated, the greater part being in alfalfa and cereals. The engineer and part owner of this canal, F. C. Kendrick, estimates that for wheat or oats there are required 0.75 to 0.90 acre-feet and for alfalfa, clover, and timothy from 1.25 to 1.40 acre-feet.

The Golden City and Ralston creek, commonly known as Church ditch, takes water from Clear creek about a mile above Golden, carrying it out on the north side of the stream. The total length is 27 miles, width 12 feet, and the cost was \$65,000. It was begun in 1864 and since that time has been enlarged several times. It is owned by a corporation selling water to irrigators, the value of water right being about \$20 per acre. On the opposite side of the creek and heading at a point higher up is the Golden ditch, 14 miles in length and from 8 to 10 feet in width. This was begun in 1871, and the cost is stated to have been \$85,000. It supplies the town of Golden and in 1889 irrigated about 2,800 acres. Below these ditches are many others, some being longer, but most of them from 1 to 5 miles in length.

KIOWA COUNTY is in the eastern end of Colorado about 12 miles north of the Arkansas river. It is crossed by Adobe and Big Sandy creeks, both of these, however, being dry during the summer. The surface of the county is gently undulating, and there are shallow basins in which water collects after heavy rain, the annual precipitation not being sufficient to erode well defined drainage systems. The county was settled about 1887, and fair crops were raised for 1 or 2 years. There were, however, so many losses from drought in 1889 and 1890 that many of the farmers moved to other parts of the state, and grazing is now the principal occupation.

The Bob Creek canal, owned by the Colorado Land and Water Company, has been extended into the southwestern corner of this county since 1889. Work has been begun also on ditches to take water from Adobe and Big Sandy creeks, reliance being placed upon the water saturating the pervious channels and upon storage reservoirs. It is somewhat doubtful whether irrigation can be satisfactorily practiced on account of the difficulty of obtaining a sufficient supply from the Arkansas for the large canal and carrying it the requisite distance. In the case of the smaller canals also it is questionable whether water can be had at critical times. There are many wells from which water for cattle can be obtained, but the quantity is too small to be of importance in irrigation.

KIT CARSON COUNTY in eastern Colorado, adjoining Kansas, is upon a portion of the central divide of the eastern half of the state, and contains few perennial streams. It is for the most part a nearly level prairie with fertile soil. The principal water supply is from wells sunk to depths of from 100 to 200 feet. The cereals under careful cultivation do fairly well, but the principal occupation is stock raising, cattle feeding both summer and winter on the buffalo grass. Most of the settlers came into the county about 1886 or 1887, and tried to make homes. Their history has been similar to that of the inhabitants of other counties of eastern Colorado and western Kansas. Some have succeeded in adapting themselves to the conditions, while others have failed on account of the prevailing droughts. Irrigation is being attempted in a small way by making use of the springs and small streams at and near the head waters of the tributaries of the Republican river. These trend in a general northeasterly course across the county toward the northwestern corner of Kansas, through which they flow. The streams are dry at times, but near their sources and at a few points below there is usually to be found a small amount of water, which can be diverted for use upon gardens and orchards.

LAKE COUNTY includes the head waters of the Arkansas in the vicinity of Leadville, the southern line of the county being a short distance below Twin Lakes. The valley land ranges from 9,000 to 10,000 feet in altitude, and the only crops of importance are for hay. This commands a price of about \$20 per ton at Leadville. The ditches, deriving an ample supply from the mountain streams, are small and are owned usually by one or two farmers. Hay is made from native grasses and from timothy. The climate is probably too severe for the success of alfalfa, although vegetables are raised to a small extent. The water supply is large for the needs of the county, but it is in such localities as these that great storage works should be constructed for the purpose of increasing the discharge of the Arkansas during summer. All along the river, especially on its course through the Great Plains, there is each year a demand for water and there are losses of crop on account of the small amount available. During and since the census year great canals have been constructed, one or two of which alone could carry the average amount flowing in the stream during summer. Water rights under these canals have been sold to farmers in spite of the fact that more than the amount usually flowing in the river is claimed by individuals and companies, general reliance being placed upon the hope that reservoirs would be constructed in this and other counties of high altitude.

Measurements of the amount of water available for storage were begun in 1889 and carried on by the Geological Survey until October of that year. The gauging stations were on the east fork of the Arkansas, on Tennessee fork, and Lake fork, all of these being not far from Leadville, and also on Twin Lake creek below the lakes. The average discharges at the first three stations for the greater part of spring and summer were respectively 95, 91, and 116 second-feet. On Twin Lake creek, having a drainage area of 102 square miles, the

greatest discharge was 632 second-feet and the least 19 second-feet, the average from April to October being 212 second-feet. Surveys were made for a number of reservoir sites, the most important of these being Twin Lakes. It has been found that water can be conducted to these lakes from a point near Hayden on the Arkansas river, increasing the catchment area tributary to the lakes to 387 square miles. By building a suitable dam across the outlet and deepening the channel between the lakes, the storage capacity could be increased to 121,800 acre-feet. (a)

LA PLATA COUNTY is in the southwestern corner of the state, being south of the San Juan and San Miguel mountains and embracing the catchment area of streams flowing southerly into the San Juan river in New Mexico. The agricultural lands form a relatively small part of the area, being in the valleys along Las Animas, Florida, La Plata and other streams. Their altitude is great, the elevation of Durango, the principal town, being slightly over 6,400 feet. Many of the cereals, including corn, are successfully produced, as well as the ordinary vegetables and the hardier fruits. Nearly all crops are irrigated, although in a few localities dry farming has been attempted. The principal part of the land under irrigation is utilized for the production of hay or for grazing purposes, stock raising being the industry next in importance to mining. The water supply of the county is large, and in most of the valleys there is a greater quantity available than is needed upon the narrow areas of agricultural land. The smaller creeks, as is usually the case, become nearly dry during summer, but the main streams have a large perennial discharge. Many small ditches have been built by the farmers, and there are a few canals owned by corporations, the principal of these being the Animas Valley Ditch Company and the Florida Company.

The Florida Mesa ditch takes water from the west side of Rio Florida and covers land about 5 miles east of Durango. The main ditch is 12 miles long, 8 feet wide, and the cost was \$16,000. The company sells perpetual water rights at the rate of \$500 per second-foot, this being considered sufficient for from 50 to 100 acres. The annual cost of maintaining these water rights was in 1890 \$37.50 per second-foot. In the Animas valley north of Durango are many small ditches covering the valley land, but the bordering mesas near the town have been brought under irrigation to a very small extent, although a number of projects for reaching the higher lands have been suggested. With the throwing open of the Ute Indian reservation and the neighboring military reservation many thousands of acres of good farming land will be brought under cultivation, and the construction and enlargement of irrigation works from the Las Animas and La Plata will be greatly stimulated.

LARIMER COUNTY is in the center of the northern side of Colorado and adjoins Wyoming. It extends from the continental divide easterly beyond the Front range of the Rocky mountains and includes the head waters of the North Platte and Laramie rivers, flowing northerly into Wyoming, and the drainage basins of the principal streams which flow east to form the South Platte. The water supply in the county is widely distributed and is so situated as to be easily employed for irrigation. In the western end of the county is North park, a broad valley having an altitude of 8,000 feet and over, surrounded by mountains rising to 12,000 or even 13,000 feet. The park is about 20 miles in width and 30 miles in length, and receives from all sides the drainage from lofty peaks. The small streams on each side of the park unite and flow northerly, the North Platte, formed by their union, passing out of the park through narrow canyons, which extend into Wyoming. In the park the principal occupation is grazing, about the only crop raised being hay for winter feed. The precipitation during summer even at this altitude is small and irrigation must be employed. The temperature is too low for most of the ordinary crops, but by the application of water timothy and the native grasses attain a heavy growth.

In North park are many ditches dug by the owners of ranches to bring out water for the purpose of raising winter feed, but there are few, if any, incorporated companies. The park is included in water districts Nos. 46 and 47. In the first of these, including the western part of the park, the fifth biennial report of the state engineer enumerates 88 ditches, and in No. 47, which lies on the east side of the park, there is given a list of 159 ditches. In some instances, however, the same ditch is entered twice in these lists. The water supply usually has been ample for all demands and there has been little necessity of interference or regulation by state officials.

The Big Laramie river rises in the Medicine Bow mountains east of North park and flows northerly through narrow valleys into Albany county, Wyoming, where after leaving the mountains it turns toward the east and flows out upon the Laramie plains. Its waters are used to a very small extent, if at all, in Colorado, but there are localities in which the water could be held by storage if so desired by the users upon the plains below.

In the eastern half of the county the streams flow directly out toward the plains, receiving the drainage from the Front range and its northern prolongation, the Laramie hills. A large amount of water comes from this hilly or mountainous region and creeks of great importance in irrigation are formed. The most northerly of these is the Cache la Poudre; south of this in order are the Big Thompson, Little Thompson, St. Vrain, and others in Boulder county, south of Larimer. From the point where these creeks leave the mountains a large number of canals and ditches have been taken, heading in succession on both sides of the creeks and extending out upon the plains. The drainage basin of each of these creeks has been made, according to Colorado law, into a separate water district. The catchment area of the Cache la Poudre is known as district No. 3, and includes the northeastern portion of Larimer county and a part of the western end of Weld county. Big and Little Thompson creeks form district No. 4, thus including the southeastern corner of Larimer county and parts of Boulder and Weld counties.

^a See engineering results of the irrigation survey. Thirteenth Annual Report of the United States Geological Survey, 1892.

Irrigation has reached a very high state of development in the eastern end of Larimer county, and the water supply has been utilized to such an extent that increase of crop area must come mainly by the storage of flood waters. The comparatively large and easily available supply of water made possible the construction by the early settlers of a great number of small ditches. These in time have been succeeded by well-built canals, and the water of the streams has been appropriated so completely that during the summer time, and even in late spring, it becomes a matter of difficulty and expense to apportion the amount available to the legal claimants. To guard against loss a few of the irrigators have constructed reservoirs, which are filled during times of high water, and when the ditches are closed this water is utilized. Many of the farmers state that it will be necessary not only to store water in suitable depressions among the foothills but also to build reservoirs in the mountains, taking advantage of every possible means of regulating the water supply.

Many of the smaller streams become almost if not quite dry at times. Along these streams in the hilly or mountainous part of their course farming is carried on only to a small extent, the principal crop, as in the case of the North park, being winter feed for range cattle. It is only farther down stream, where the elevation is about 5,000 feet or under, that a greater variety of crops is raised. Here, where water has its greatest value, the ordinary supply has long been recognized as being deficient, and there is complaint from the farmers that in spite of this fact irrigation companies are building and extending canals and selling water rights. Some of these companies, however, are providing reservoirs, and in one case at least, where a canal was cut off, it is claimed that the entire crop was saved during 1889 by stored waters.

The daily discharge of Cache la Poudre creek has been computed during the summer months at least since 1884, the figures being based upon gaugings made by the state engineer of Colorado and by Professor L. G. Carpenter, of Fort Collins. The station at which observations are taken is situated about one-half mile above the mouth of the canyon, 12 miles above Fort Collins. Striking features are the relatively large discharge during 1884, 1885, and 1886 and the decreased amount during the succeeding years. (a)

a The following are the gaugings for a series of years:

DISCHARGE OF CACHE LA POUVRE CREEK, ABOVE FORT COLLINS, COLORADO.
(Drainage area, 1,060 square miles.)

MONTHS.	DISCHARGE IN SECOND-FEET.			Total for month in acre-feet.	RUN-OFF.		MONTHS.	DISCHARGE IN SECOND-FEET.			Total for month in acre-feet.	RUN-OFF.	
	Maximum.	Minimum.	Mean.		Depth in inches.	Second-foot per square mile.		Maximum.	Minimum.	Mean.		Depth in inches.	Second-foot per square mile.
1884.							1888.						
March 15 to 31	92	48	67	4,120	0.07	0.06	April	350	100	181	10,770	0.19	0.17
April	707	64	219	13,030	0.23	0.21	May	790	250	483	29,704	0.52	0.45
May	5,393	453	2,537	156,025	2.77	2.39	June	1,490	680	1,113	66,223	1.17	1.05
June	5,611	3,474	4,812	286,314	5.08	4.54	July	690	260	420	25,830	0.46	0.40
July	3,970	862	2,144	131,856	2.34	2.03	August	500	140	213	13,100	0.23	0.20
August	1,231	423	792	48,708	0.37	0.75	September	180	70	109	6,485	0.11	0.10
September	446	230	305	18,147	0.32	0.29	1889.						
October 1 to 16	224	196	205	12,607	0.22	0.19	January	342	71	151	9,286	0.16	0.14
1885.							February	198	69	106	5,883	0.10	0.10
April 4 to 30	822	241	447	26,596	0.47	0.42	March	125	41	46	2,830	0.05	0.04
May	1,965	954	1,419	87,268	1.55	1.35	April	342	48	113	6,723	0.12	0.11
June	3,857	2,235	2,910	173,145	3.07	2.74	May	1,886	215	649	39,913	0.71	0.61
July	3,186	1,076	1,857	114,205	2.02	1.75	June	1,960	837	1,338	79,611	1.41	1.26
August	1,116	369	656	40,344	0.71	0.62	July	844	271	514	31,611	0.56	0.48
September	387	210	273	16,243	0.29	0.25	August	455	67	187	11,500	0.20	0.18
October 1 to 10	210	202	203	12,484	0.22	0.19	September	75	56	67	3,980	0.07	0.06
1886.							October	92	55	69	4,243	0.08	0.06
April 27 to 30	447	369	405	24,097	0.43	0.38	November	122	46	88	5,236	0.09	0.08
May	2,660	404	1,309	80,403	1.42	1.23	December	89	33	64	3,935	0.07	0.06
June	2,584	1,227	1,875	111,562	1.97	1.77	Per annum						
July	1,175	392	717	44,095	0.78	0.68	1,960	33	283	204,757	3.62	0.26	
August	1,476	232	338	20,787	0.37	0.32	1890.						
September	284	115	185	11,007	0.19	0.17	January	101	46	82	5,043	0.09	0.08
October	140	120	129	7,933	0.14	0.12	February	138	37	79	4,384	0.08	0.08
1887.							March	126	47	85	5,227	0.09	0.08
May 18 to 29	2,380	1,159	1,822	112,053	1.98	1.72	April	481	71	200	11,900	0.21	0.19
June 14 to 30	1,970	1,050	1,401	83,360	1.47	1.32	May	1,710	436	1,044	64,206	1.13	0.99
July	1,260	410	735	45,202	0.80	0.69	June	1,804	1,016	1,280	76,158	1.35	1.21
August	430	220	307	18,880	0.33	0.29	July	1,025	336	649	39,950	0.71	0.61
September	300	110	175	10,412	0.18	0.16							

The principal towns are along the eastern edge of the county near the foothills. In the vicinity of each of these the systems of ditches are exceedingly complicated, a number coming out on both sides of the stream and following in the same general direction in tortuous courses according to the slope of the land. In the vicinity of Fort Collins and Loveland irrigation has been most completely developed. The lower lands are well watered by the many ditches, and in some places the ground has been so completely saturated that it is not necessary to irrigate, sufficient moisture coming from seepage. The higher grounds are in many places considered best for agriculture, but unfortunately it is not possible at all times to secure water for these. Since the county lines and the water districts, based on natural divisions, do not coincide, a direct comparison can not be made between the figures contained in the report of the state engineer of Colorado and the results obtained by the census. The water commissioners report that in 1890, in district No. 3, on the Cache la Poudre, 139,222 acres were irrigated by ditches and 10,825 acres by stored water; and in district No. 4, Big Thompson, 89,790 acres were irrigated by ditches and about 12,000 acres by water from reservoirs. No distinction, however, was made in their estimates between lands imperfectly irrigated and those upon which crops were successfully raised.

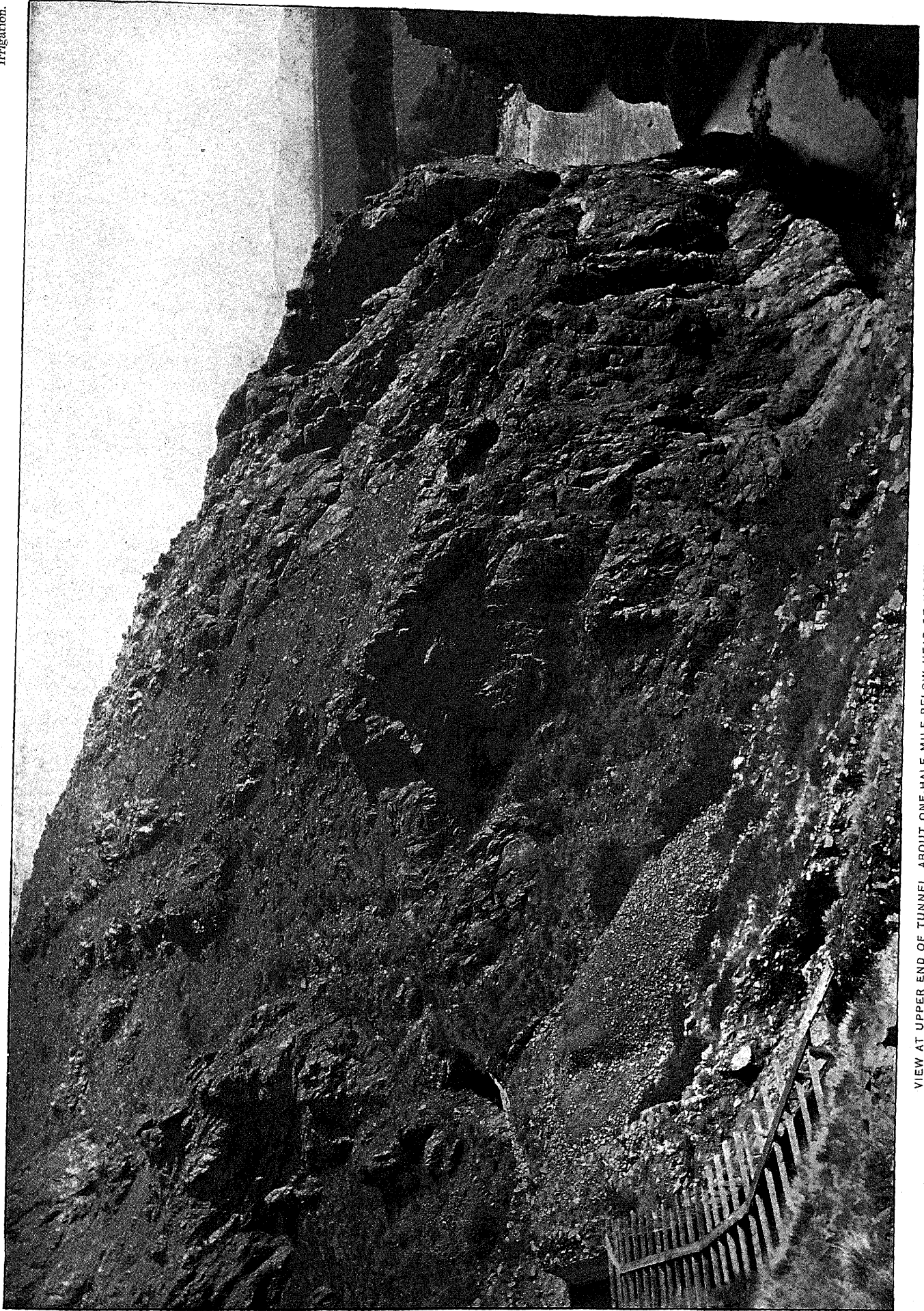
The relative location of the principal canals and irrigating ditches of this county is shown upon a map of portions of water districts Nos. 3 and 4 accompanying the fourth biennial report of the state engineer. Illustrations of this character show the complications due to the topography of the country and to the large number of ditches taking water from the same stream and carrying it out in the same general direction. These in many instances cross each other, and at first glance seem to be involved in hopeless confusion. Many of the longer canals run nearly parallel for many miles, each one losing more or less water by evaporation and seepage.

Among the principal canals in the drainage basin of Cache la Poudre creek may be mentioned the North Poudre, taking water from the north fork, and below the junction of the north and south forks the Highline, Dry Creek, Cache la Poudre, Larimer and Weld canal, Pioneer ditch, Lake canal, and Cache la Poudre canal. All of these are on the north side of the creek, and the latter is almost entirely within Weld county. On the south side of the stream the canals are shorter, since of necessity they run along the foothills toward Big Thompson creek and do not extend out upon the plains. The principal of these are the Pleasant Valley and Lake canal, the Fort Collins canal, the Larimer County canal No. 2, and Boxelder ditch. The North Poudre canal is about the only large canal lying wholly in Larimer county, the others extending out into Weld county. Its length is 20 miles, average width 14 feet, and the cost was \$300,000. It was begun in 1881 and completed in 1884. It is owned by a corporation which sells water rights, the value of these being, it is stated, about \$15 per acre. The ditch is rapidly being improved and more land brought under cultivation. The accompanying illustration shows the character of the diversion line and some of the difficulties overcome in construction. The view is of the upper end of the 627-foot tunnel, being about 3,000 feet below the head gate and dam.

In district No. 4, including in this county the greater part of the drainage area of Big Thompson creek, the canals are secondary in number and size to those named above. The principal irrigating systems on the north side of Big Thompson creek are the Hamaqua, Loudon Irrigating, Loveland and Greeley, and the Farmers Irrigating canals, and on the south side of the creek the Handy, Home Supply, Hillsboro, and the Big Thompson No. 1 ditches. The Loudon canal is about 19 miles long, 14 feet wide, and has cost about \$50,000. It was begun in 1877 and was finished in 1880. Water is diverted by a wing dam of cobblestone. The canal is owned by a

DISCHARGE OF CACHE LA POUDE CREEK, ABOVE FORT COLLINS, COLORADO—Continued.

MONTHS.	DISCHARGE IN SECOND-FEET.			Total for month in acre-feet	RUN-OFF.		MONTHS.	DISCHARGE IN SECOND-FEET.			Total for month in acre-feet.	RUN-OFF.	
	Maxi- mum.	Mini- mum.	Mean.		Depth in inches.	Second- feet per square mile.		Maxi- mum.	Mini- mum.	Mean.		Depth in inches.	Second- feet per square mile.
1890.							1891.						
August	404	150	287	17,650	0.31	0.27	September	158	115	138	8,211	0.15	0.13
September	183	58	103	6,128	0.11	0.10	October	151	104	118	7,257	0.13	0.11
October	118	55	80	4,920	0.09	0.08	November	100	67	83	4,938	0.09	0.08
November	89	41	61	3,630	0.07	0.06	December	109	54	79	4,858	0.09	0.07
December			70	4,365	0.08	0.07	Per annum	5,060	32	390	282,937	5.03	0.37
Per annum	1,894	37	335	243,501	4.32	0.32	1892.						
1891.							1892.						
January	145	44	92	5,658	0.10	0.09	January	98	50	64	3,936	0.07	0.06
February	131	57	79	4,384	0.08	0.08	February	134	98	119	6,842	0.12	0.11
March	76	32	59	3,628	0.06	0.06	March	134	40	80	4,920	0.09	0.08
April	344	39	144	8,568	0.15	0.14	April 1 to 17	112	60	84	4,998	0.09	0.08
May	2,499	355	1,221	75,092	1.33	1.15	May 18 to 31	1,084	270	642	39,483	0.70	0.61
June	5,060	985	1,900	113,050	2.01	1.79	June	2,535	750	1,512	89,964	1.59	1.43
July	1,003	278	541	53,271	0.59	0.51	July	1,392	342	741	45,571	0.81	0.70
August	292	155	228	14,022	0.25	0.21	August 1 to 16	327	192	265	16,297	0.20	0.25



VIEW AT UPPER END OF TUNNEL ABOUT ONE-HALF MILE BELOW HEAD OF NORTH POUDDRE CANAL, LARIMER COUNTY, COLORADO.

corporation composed of farmers who use the water, each share of the stock entitling the holder to a certain portion of the water in the canal, which can be used on as many acres as it will cover. The water right is worth from \$10 to \$15 per acre. Under this canal are a number of reservoirs owned by individuals or by corporations, water being stored in these until it is needed. Many other reservoirs are being constructed to be supplied by this and other canal systems, and greater dependence each year is placed upon these, several large ditches deriving their whole supply from water thus saved. For example, the Home Supply Company has two large reservoirs which are filled before the irrigating season begins and drawn upon to irrigate thousands of acres. Water thus held by storage has been exchanged for an equivalent amount from the stream to be used on higher grounds, while the stored water is allowed to flow down to prior appropriators below.

The Loveland and Greeley canal takes water from Big Thompson creek near Loveland, covering land on the north side of the stream, extending nearly to Greeley. The total length is 35 miles, average width 25 feet, and the cost was \$140,000. The canal was begun in 1880 and used in 1883. Water rights are sold at about \$1,000 each, entitling the owner to 1.44 second-feet of water to be used on an 80-acre tract. The annual assessment is about \$15 on each water right. The principal crop raised is wheat, and next in order of importance is oats, then alfalfa and potatoes. It is stated that on wheat two irrigations of from 3 to 4 inches in depth each time will produce good crops in ordinary seasons, oats requiring a little more water, and alfalfa three irrigations of 5 inches each for three crops or cuttings.

LAS ANIMAS COUNTY is in southern Colorado, adjoining Colfax county, New Mexico, to which it is similar in many respects. The western boundary of the county is formed by the Culebra range, the divide between the head waters of streams flowing into the Arkansas and those tributary to the Rio Grande. In this part of the county are coal mines, and at the towns in the vicinity agricultural products find a ready market. Flowing easterly from the mountain range are a number of creeks and rivers, which after passing through a broad extent of the plain region empty into the Arkansas. Most of these streams have cut their channels to depths of several hundred feet into the higher parts of the plain, forming in this way high mesas whose surface is far above the reach of water.

The principal streams within the county are Apishapa river, Timpas creek, and the Purgatoire river with its branches. This latter stream is sometimes known as Las Animas river, and is commonly called by the ranchmen of the country the Picket Wire, a corruption for Purgatoire. It has its origin among the mountains and in its upper course discharges a large amount of water. In this higher part of the county, corn, beans, pease, potatoes, barley, and flax are raised without irrigation, but wherever possible ditches have been taken out to bring water to the arable lands along the small streams. Stock raising is the principal industry after mining. The agricultural population consists to a large extent of Mexicans, whose operations are carried on according to ancient methods and in a very laborious fashion.

The rivers after leaving the mountains flow for a large part of their course through canyons in the mesas and the quantity of water shrinks rapidly, so that the lower courses during the summer are almost dry. There are usually three or four weeks in late spring during which there is plenty of water. This is diverted upon low lands, and if these receive one good watering it is usually possible to obtain a fair crop of hay. Attempts to place dams in these rivers, especially in the Purgatoire, have not been successful on account of the severity of the floods. The irrigating ditches are mainly in the small valleys near the head waters of the streams and are rarely more than a mile in length. Many of them are very old, having been dug by the early Mexican settlers.

As examples of the largest ditches of the county may be given the following: the Duran and Vigil ditch takes water from the south side of the south fork of Purgatoire river about 6 miles south of Stonewall. It is 4 miles long, 3 feet wide, and cost \$1,500. Water is diverted by means of a dam of brush and stone. The ditch is owned by neighboring farmers, who divide the water proportionally. In 1889 about 640 acres were irrigated, this being mainly in wheat, oats, and barley. Baca Extension ditch takes water from the north side of the Purgatoire river at Trinidad and flows in a general northerly direction. It is 19 miles long, 9 feet wide, and cost \$12,000. Work was begun in the spring of 1888, and the ditch was completed the same year. On account of scarcity of water in the river a very small acreage was irrigated in 1889. The canal is owned by a corporation and the water is distributed to the shareholders. The annual cost of irrigation per acre is usually about \$1, sometimes amounting nearly to \$2. The principal crops raised are alfalfa, oats, and other cereals.

The Chititi ditch heads about 1 mile east of Trinidad and continues out on the south side of the Purgatoire river. The total length is 3 miles, average width 4 feet, and the cost was \$2,000. The ditch was built in 1861. The water is used principally for the irrigation of garden vegetables, together with a small acreage of wheat, corn, and oats. In 1890 there were in all about 135 claims to water rights filed by the various ditch owners. The total amount of 37 of these claims, it is stated, came to 575 second-feet, while the Purgatoire river afforded about one-tenth of this quantity. This affords an illustration of the excessive amount of water claimed from these mountain streams and shows one of the difficulties of apportioning the supply to the many claimants.

LINCOLN COUNTY is east of the center of Colorado, upon the eastern slope of the divide between the Platte and Arkansas basins, and thus includes a portion of the head waters of streams tributary to these rivers. Sheep and cattle raising is about the only industry, since the water supply is too small for any considerable development

of agriculture. The streams shown upon a map of this part of the state are dry for many months of the year, but at long intervals they discharge an amount of water so great as to be almost beyond control. A little farming without irrigation has been attempted, but few crops have been successfully raised. Occasionally some corn is raised for fodder or a few vegetables for home use.

Water is obtained from springs and from wells from 10 to 100 feet in depth. There is an ample supply for cattle, and many of the wells appear to be almost inexhaustible by ordinary pumping machinery. There are a few small irrigating ditches in the county taking water during the spring at least from Big Sandy creek and from Steel fork of Little Horse creek, but both of these are dry at times when the water is most needed. Considerable water is obtained from the bed of the Big Sandy even in times of drought, and by making tight dams extending through the sand it is probable that a valuable perennial flow could be obtained.

LOGAN COUNTY is in the northeast corner of Colorado, upon the plains, its surface being of the general character of that of the adjoining state of Nebraska. The South Platte flows diagonally across the county from the southwest to the northeast corner, receiving in its course the waters of Pawnee creek and other streams which flow during the rainy season.

The conditions of agriculture are similar to those prevailing throughout eastern Colorado. Occasionally a crop can be raised without irrigation, but, with the exception of Indian corn, it is very uncertain and the yield per acre is small. The water supply is intermittent and irregular in character, sudden floods interrupting the long continued droughts. In the years 1885, 1886, and 1887 there was apparently an unusual amount of rain. Settlers flocked into the country and were fairly successful in raising crops. In the two years following there was a return to former conditions of drought, and many of the settlers becoming discouraged abandoned their farms. Those having irrigated lands have been able to make a living, although shortage of water has at times caused considerable losses.

The South Platte furnishes the greater part of the water used in irrigation. The river in this part of its course fluctuates greatly, being at one time a broad, swift stream and at another almost dry. The drainage area is so large that when the snows melt and there are continuous and widespread rains an enormous amount of water is brought into the main channel, but later in the season the almost innumerable canals and ditches along the tributaries divert so much that there is barely enough to moisten the broad, sandy channel. A number of canals and ditches have been built to irrigate land in this county, but these, although some have priority of rights over canals higher on the stream, can rarely obtain water after the spring flood subsides. Priority of right to the water is of little avail to a canal out upon the plains, from the fact that it is almost impossible to prevent the canals and ditches heading many miles above from taking all of the water, and if by the exercise of unusual police powers by the state officers an amount sufficient for this canal is left in the channel at points above, this water is soon lost by evaporation or disappears into the broad, sandy waste.

Water can always be found in the apparently dry bed of the river and many of its tributaries by digging from 1 to 20 feet, furnishing a supply apparently inexhaustible by pumping devices. By suitable dams or deep ditches a considerable amount of this water can be brought to the surface, but the expense is so great that it is still a matter of doubt as to whether it would be profitable. The irrigating systems at present take water from the river without the use of permanent dams, and therefore can receive a supply only when there is considerable water in the channel. There is a widespread complaint among the farmers to the effect that canal companies have sold water rights or shares which have proved to be valueless, and that many have been brought to the verge of ruin by the schemes of speculators, as well as by neglect and bad management of the canals.

A small amount of potatoes, corn, sorghum, broom corn, and beans is occasionally raised without the use of water, but the principal crops of the county are alfalfa and other forage plants raised mainly by spring and fall irrigation. Besides the irrigation ditches, some water is obtained by means of steam pumps and windmills, but the area of land cultivated by this means is inconsiderable. The largest canal of the county is the Pawnee, owned by the Pawnee Land and Cattle Company, taking water from the South Platte out upon the north side at a point above the town of Merino. The length of this canal is 23 miles and the average width about 30 feet. There is no permanent dam in the river, and the sand heaped up at the head works for diverting the water must be replaced after every large flood. The cost of the water right is stated to be \$10 per acre, and the annual cost of cleaning and repairing canal from 12.5 cents per acre upward. The amount of water in the river is insufficient at times, largely owing to the fact that it is taken by other canals.

Beyond the Pawnee canal are a number of others, the principal of which on the north side of the river are the Lowline and the Sterling ditches, also the Arnett and the Iloff and Platte Valley canal, and on the south side of the river the Schneider and the Smith and Henderson ditches. The Lowline ditch is about 6 miles long, 12 feet wide, and the cost was approximately \$2,000. The first cost of the water was about \$100 for each 160 acres covered, and the annual cost is \$6 for each 160 acres. The Sterling ditch No. 1 is about 16 miles long and 20 feet wide, and No. 2, below it, is 6 miles long. The Iloff and Platte Valley canal, heading 3 miles above Iloff, follows along the north side of South Platte river in a northeasterly direction at a distance of from 1 to 4 miles from the channel of the stream. The total length is 25 miles, the average width from 10 to 15 feet, and the cost was \$55,000. There is no permanent dam in the river, earth levees being built when the stream is low. There are about 18 laterals about 2 feet in

width and 1.5 miles long. The ownership is divided into 2,000 shares, 8 shares representing a water right for 80 acres. In 1889 and 1890 there was insufficient water in the river and the canal was allowed to get into bad order, so that a very small amount of land was irrigated, this being mainly for raising hay and for the meadows. The Schneider ditch, on the south side of the stream, is 9 miles long, about 10 feet wide, and the cost was approximately \$5,000. Water is diverted by means of a wing dam of piles and lumber running out into the river 90 feet, and by a permanent dam of brush and earth about 300 feet in length. During low water temporary dams of sand are made across the entire width of the river, a distance of nearly one-half mile. The water right is valued at about \$7.50 per acre and the annual cost is 25 cents per acre. At the time this ditch was built (1876-1877) there was apparently a great surplus of water during the irrigating season, but from that time the amount has gradually decreased until it is difficult to secure one-half the amount originally depended upon.

It is currently believed that patches of land can be brought under irrigation here and there throughout the county by the construction of storage reservoirs at suitable points and by the utilization of flood waters of the intermittent streams and springs. Progress in this direction is slow, as the farmers are too poor to invest an amount of money sufficient to thoroughly test such projects.

MESA COUNTY is at the center of the western side of Colorado and includes the greater part of Grand River valley, the largest body of agricultural land in the western half of the state. The altitude of this valley is about 4,500 feet, and the climate is highly favorable for the production under irrigation of all fruits as well as of various cereals and of vegetables. The water supply is large, the discharge of Grand river being far in excess of any demands made upon it. The valley lands are on the north side of the river, extending from the state line easterly above the junction of the Gunnison, then southerly along the east side of the Gunnison up into Delta county. Irrigation is carried on not only in this valley but also along Plateau creek and its tributaries in the eastern end of the county, this creek rising on the broad plateau south of the Grand river and receiving tributaries from Grand mesa on the south and Battlement mesa on the north.

Although the Grand and Gunnison rivers carry an amount of water far larger than can be used upon the agricultural lands, yet, paradoxical as it may seem, the irrigators as a rule do not have sufficient water to save crops from loss. This arises mainly from the fact that the greater number depend upon water not from Grand river, but from the small streams draining the mesas. The expense of diverting the large river was so great that the early settlers were compelled to utilize the creeks or intermittent streams. These, having a rapid fall and being more easily controlled, were employed to their full extent before the larger streams were touched. The waters of the creeks of Mesa county are completely diverted during the summer and the appropriations along several of them far exceed the amount available. Thus it happens that while the waters of the Grand and Gunnison are flowing to waste farmers are losing crops, while some are constructing reservoirs to attempt to increase the summer discharge of small creeks.

Near Grand Junction, in the Grand River valley, canals have been taken out from the Grand river covering a portion of the arable lands. The principal of these is what is known as the Grand Valley canal, commonly stated to be owned by members of the Travelers Insurance Company of Hartford, Connecticut. The owners of this canal have absorbed into one system large ditches previously built and sell water rights to irrigators at prices of from \$10 to \$12.50 per acre, according to the conditions. The annual assessment is stated to be from 50 cents up to \$1.50 per acre, while the annual cost of obtaining water to persons not owning water right is about \$1.75 per acre. Many complaints have been made by farmers taking water from the canal of insufficiency of supply, owing either to the small capacity or to injury of the main line. At low stages of the river it is difficult to divert water into the canal and it is necessary to maintain cribwork to act as a dam in the stream.

There is opportunity for the construction of a large highline canal to cover 100,000 acres or more of this fertile land. Examinations have been made, showing that with the necessary capital it will be feasible to construct such a canal heading in the canyon above Grand Junction and sweeping around the northern edge of Grand valley north of and above the present systems and covering practically all of the valley. The great obstacles to the construction of such a system are the large amount of money required and the length of time which must elapse before agriculture can develop to the extent necessary to pay interest and annual expenses. Much of the soil through which a large canal must be built is of such a nature that some of the mineral constituents dissolve, causing the ground to sink, resulting in leaks or breaks in the banks. It is only after the water has been turned into the canal for two or three years that there can be a reasonable assurance that these disasters will not occur.

There have been no continuous gaugings of the amount of water in Grand river, the only measurements now at hand being those made by the Hayden survey in 1874. On September 23 the river above the mouth of the Gunnison was discharging at the rate of 4,850 second-feet, and it is stated that at the close of July of that year it must have been carrying at least 6,000 second-feet. Higher on the river, near the east line of Garfield county and below the mouth of Eagle river, the discharge in November, 1874, was 871 second-feet, and in September, at Hot Springs in Middle park, 802 second-feet, as shown in the tenth annual report of the United States Geological and Geographical Survey of the Territories, page 332. None of the small streams have been measured, but it is known that most of these become nearly dry from the latter part of June till the time of

the fall rains. At the head of Kahnah creek, on the Grand mesa, work has been begun on a reservoir whose capacity is estimated to be about 600 acre-feet. Work on this has been very expensive, owing to the difficulty of reaching it, the only practicable means of transportation being by pack animals. There are many other places on Grand mesa where water could be stored if it is found profitable to do so. The ranchmen living along the creeks coming from the mesa state that it is necessary to resort to water storage if they are to save their crops in years of drought and to get summer cuttings of alfalfa. Some of this land could probably be covered by a canal from Gunnison river heading in the vicinity of Delta.

MONTEZUMA COUNTY is in the extreme southwestern corner of the state, adjoining Utah, Arizona, and New Mexico. The water draining from the mountain ranges within the county escapes either to the north in Dolores river or to the west through tributaries of San Juan river. Nearly all of these streams are of considerable size and furnish ample water for the land under cultivation, except perhaps at times of unusual drought. Progress in agriculture has been slow, owing to the remoteness of this area from large markets. Many irrigating ditches have been constructed by farmers, and there are also a few canals of notable size. The principal work of this kind is the canal system of the Colorado Consolidated Land and Water Company, taking water from Dolores river near the town of Dolores. There are two main lines, one running down on the west side of the river for a distance of about 6 miles, the other piercing a ridge by means of a tunnel 5,400 feet in length. This tunnel conducts the water directly from Dolores river into the drainage basin of streams tributary to San Juan river. From the mouth of the tunnel laterals extend northwest and southeast, covering lands north of and in the vicinity of the town of Cortez. The total cost of this system is estimated to have been \$750,000. Water rights are sold at the rate of \$12.50 per acre. This is in general plan one of the most remarkable irrigating systems of the state, the peculiar topography allowing of the diversion of water in this unique manner. It has been found difficult, however, to sell enough water rights to repay the cost of construction. Along Mancos river easterly from Cortez are a large number of ditches owned by individuals. These are as a rule under 5 miles in length and head at short intervals along the main stream and its tributaries.

MONTROSE COUNTY is on the western side of the state, adjoining Utah. The principal areas of agricultural land are along Uncompahgre river, which flows northerly across the western end of the county into Gunnison river. Water is taken out by many ditches and canals covering a great part of the lower lands, but the supply is by no means ample for the area under cultivation. If crops are planted early and reach maturity by the first part of July they can generally be secured without loss, the ditches up to that time receiving plenty of water. Later in the season, however, the streams diminish so that any one or two of the larger irrigating systems could use all the water to be had. While the Uncompahgre and its tributaries can not furnish a supply for the adjacent lands, the other streams to the east, Cimarron creek and Gunnison river, have more water than can be utilized upon their narrow valleys. Schemes have been proposed for bringing surplus water from these streams over into the valley near Montrose, but as yet the feasibility of the matter has not been determined. It will be necessary to resort to some measure of this kind or to water storage in order to bring all of the fertile lands under cultivation. The discharge of Uncompahgre river was measured by the state engineer during the summer of 1890 at a point about 8 miles above Montrose near the head of the Uncompahgre canal, the quantity during the period from July 10 to August 18 varying from 440 to 114 second-feet and averaging for July about 300 second-feet, for August 170 second-feet, for September 125 second-feet, and for October about 150 second-feet.

The climate and soils in the vicinity of Montrose have been found to be well adapted to fruit culture, apples, pears, peaches, plums, apricots, quinces, and grapes growing to perfection. The altitude of the valley is from 5,000 feet upward, but this does not result in lowering the temperature to an unfavorable extent. Owing to the scarcity of water and high annual rates grain raising is reported to be barely profitable, but hopes are centered in the orchards and vineyards. There are several canals of considerable size in the county, principal among which are those of the Montrose Canal Company, the Uncompahgre and Cedar Creek Company, the Delta Chief Company, and others. The works of the Montrose Canal Company take water out on the west side of Uncompahgre river about 6 miles above the town of Montrose. The main canal extends in a northwesterly direction, the total length being about 40 miles and the average width 16 feet. The total cost was \$530,000. The land covered by the canal consists of mesas of various elevations, and as a consequence there are a large number of falls or drops along the line of the canal, one of these being 260 feet in height. On account of the excessive slope of the country and the character of the subsoil it is estimated that there is required 1 second-foot to irrigate 80 acres. The Uncompahgre and Cedar Creek Valley ditch heads on the east side of Uncompahgre river about 7 miles above Montrose and is continued in a northerly direction to the valley lands along Cedar creek. It is about 12 miles long and 10 feet wide.

MORGAN COUNTY is in the northeastern part of the state, lying on both sides of the South Platte. The water supply for irrigation is obtained from the river, which in this portion of its course occupies a broad, sandy channel. Owing to the diversions of water by the almost innumerable canals and ditches above, the channel is sometimes nearly if not quite dry. This was the case during the summer of 1888, 1889, and 1890 at times when there was greatest need of water.

The unusually low stages of the South Platte during the years above mentioned were due in part at least to the irregular fluctuations of climate. It is stated that before irrigation was introduced into this part of Colorado the river was known to be dry during the summer season, for instance, in 1863. Attempts are being made to supply the deficiency by storage reservoirs or shallow lakes filled during April or May. Several localities have been mentioned at which other works of this character might be constructed. The worst crop failure in the county was probably in 1890, when, owing to the apparently large amount of snow in the mountains, the farmers neglected to use water when it could be had early in the season and then were disappointed in the duration of the flood. On the high lands of this county, as in many other places in eastern Colorado and western Nebraska, farmers have taken up land and attempted to raise crops in the belief that the rainfall was steadily increasing each year, but their efforts have been without success.

The principal irrigating ditches in the county are: on the north side of South Platte river, the Weldon Valley, the Deuel and Snyder, and the Tetsel; on the south side: the Bijou, the Putnam, the Fort Morgan, and the Platte and Beaver ditches. The Weldon Valley ditch is 18 miles long, 20 feet wide, and cost about \$64,000. Water is diverted by a wing dam of brush, stones, and sand, replaced in part every year. It is owned by an association of farmers under the ditch, to each of whom water is divided in proportion to his ownership. The Bijou canal is 55 miles long, 30 feet wide, and is stated to have cost \$180,000. It was begun in 1888. (a) It is owned by a corporation, 6 shares of stock in which entitle the holder to water for 80 acres.

OTERO COUNTY is in southeastern Colorado, on the Great Plains, and is crossed from west to east by the Arkansas river, the largest source of water supply. This part of the state, including Pueblo county on the west and Bent and Prowers counties on the east, is a region of great irrigation enterprises, the topography of the country favoring or rather necessitating the construction of long canal lines. The Arkansas in this part of the state is a broad, shallow stream flowing through narrow bottom lands bounded by low bluffs. In order to reach the good agricultural land at the top of these bluffs long canals with gentle slope must be built. There are no perennial side streams from which water can be diverted by small, inexpensive ditches, the tributaries of the river entering within these counties being dry through a great part of the year and at other times discharging enormous quantities of storm water.

The united capacity of the canals is so great that it is a matter of doubt whether the river can supply them all when completed. The owners of some of the canals propose to supply deficiencies by the construction of reservoirs out on the plains. These are to be filled during the fall and winter months and by the excess water of spring floods, to be drawn upon later in the season when necessity arises. These reservoirs have not been in operation for a period long enough to demonstrate their success, nor are there measurements of the quantity of water flowing in the Arkansas sufficient to give data for computing the amount available for storage. Gaugings have been made for a number of years at Canyon city, as stated in the description of Fremont county, and at Pueblo, as noted under Pueblo county. In addition to these a few computations of the daily discharge of the river at La Junta have been made by the United States Geological Survey covering the period from May to August, 1889. The average discharge at this place during these months was 931 second-feet, the greatest flood amounting to 2,620 second-feet and the minimum flow, which occurred in August, was 55 second-feet.

DISCHARGE OF ARKANSAS RIVER AT LA JUNTA, COLORADO.

(Drainage area, 12,200 square miles.)

MONTH.	DISCHARGE IN SECOND-FEET.			Total for month in acre-feet.	RUN-OFF.	
	Maxi-mum.	Mini-mum.	Mean.		Depth in inches.	Second-feet per square mile.
1889.						
May 20 to 31	1,960	605	1,089	66,973	0.10	0.09
June	2,620	825	1,355	89,622	0.12	0.11
July	2,280	345	844	51,906	0.08	0.07
August	1,630	55	435	26,752	0.04	0.04

Several of the larger canals have dams across the river diverting all of the water, but at a point farther down stream there is usually an amount sufficient to partly fill the next canal. This was the case during the low water of 1889, when the Catlin canal apparently took all of the water, but at the dam of the Rocky Ford canal, 10 miles below, there appeared to be a stream of considerable size. There are a few small ditches in the county, deriving water from springs or from small storage reservoirs in depressions on the plains. The Purgatoire, which, flowing from the southwest, empties into the Arkansas at La Junta, is of little value for irrigation, since it is nearly dry during summer and is at all times liable to sudden floods. Measurements of the discharge of this stream are given under the description of Bent county.

a It was used in 1891.

No crops are raised without irrigation, but with it grain, hay, and fruits are successful. The cost of water rights from the large companies is usually from \$10 to \$12 per acre, and the annual charge for delivering water about \$1.50 per acre. Many of the farmers state that their lands are heavily mortgaged in order to pay the \$800 or \$1,000 for an 80-acre water right, and with this debt, bearing interest at 10 per cent, they find difficulty in struggling along. The principal canals constructed in whole or in part are on the north side of the river, the Bob Creek canal, owned by the Colorado Land and Water Company, the Lake canal, and the Arkansas canal, of the Arkansas River Land, Reservoir, and Canal Company. On the south side of the river are the Rocky Ford Highline canal, the Oxford ditch, the Otero canal, the Catlin ditch, with the Fairmount extension, and the Rocky Ford Town ditch.

The Bob Creek canal heads about 2 miles west of Booneville, and after following along near the river for about 20 miles turns off toward the northeast. Construction was begun in February, 1890, and the canal was so planned as to carry 750 second-feet. It has been located for a distance of 118 miles and constructed for 65 miles at a cost of \$270,000. The Arkansas canal heads 3 miles above La Junta and follows along the north side of the river at an average distance of from 2 to 5 miles. This canal was constructed at a point where a small ditch was formerly taken out for the purpose of irrigating a government Indian farm. The enlargement of this ditch was begun in 1888, and the canal thus constructed was extended for a distance of 113 miles, work being completed in 1889. The capacity for the first 7 miles is estimated to be 838 second-feet, then gradually diminishing. A dam 625 feet in length built of piling, timber, rocks, and earth has been constructed across the river, the height being 4.5 feet above the bed of the stream. During the first year or two enormous quantities of water have been required in order to saturate the lands, but it is expected that less and less will be used each year after the subsoil has been filled.

The Rocky Ford Highline canal, owned by the Rocky Ford Canal, Reservoir, Land, Loan, and Trust Company, takes water from the south side of the Arkansas river at a point in Pueblo county about 2 miles above Jackson. It follows along the river at a general distance of from 2 to 5 miles and has a total length of 78 miles. The total cost is reported to have been \$225,000. It was begun in January, 1890, and used in the same year. No dam has been placed in the river, the head of the canal being below the bed of the stream. Shares in the canal are sold at \$100 each, entitling the owner to water for 10 acres, or to 0.18 second-foot. The probable assessment for keeping the canal in repair is about 25 cents per acre. The canal has not been in operation for a time sufficiently long to determine this. For convenience the amount of water is usually expressed in miner's inches, and it is assumed that 1 second-foot equals 38.4 miner's inches. It has been estimated that at first 1.44 second-feet will be required for 80 acres, but that after 1 or 2 years this quantity will be sufficient for 100 acres, the tendency among the better class of farmers being to use a less quantity of water per acre and to cultivate smaller areas with greater care.

The Oxford Farmers ditch takes water from the river at a point about 7 miles below the above canal and 1.5 miles west of Nepesta, Pueblo county, and continues for a distance of 14 miles. The average bottom width is 14 feet, and the cost was \$34,500. The canal was enlarged to its present capacity in 1889. The dam for diverting the water was made by driving piles across the river 4 feet apart and filling the spaces between these with brush held by barbed wire, the piles having been cut off to the level of low water. The canal is owned by a corporation composed of farmers and water is divided in proportion to the ownership of stock.

The Otero canal heads near the western line of the county about a mile above Fowler. It flows along between the Rocky Ford Highline canal and the river, being at an average of about a mile distant from the former. This canal as planned will be over 100 miles in length. It has an average width of 18 feet and is stated to have cost \$200,000 for the first 66 miles. The canal was begun in March, 1890. As in the case of the higher canal, there is no dam in the river. Water is measured through an orifice 6 inches high under a 5-inch head. The cost of water right is \$12.50 per acre and the annual assessment 15 cents per acre.

The Catlin ditch, owned by the Catlin Land and Canal Company, takes water from the Arkansas river at the mouth of Apishapa river or creek. It is at an average distance of from a quarter of a mile to a mile below the Otero canal, these being nearly parallel throughout their course. The canal is 26 miles long, 20 feet wide, and cost \$55,000. It was begun in 1884, finished in 1887, and claims priority over the other canals in this district. The dam in the river consists of sheet piling and stone and is intended to be perfectly tight. Water is usually sold at the rate of \$1.50 per acre each year, a permanent right costing \$10 per acre, with about 15 cents per acre annual assessment. This canal has been continued toward La Junta by farmers who have built what is known as the Fairmount Extension.

The Rocky Ford Town ditch heads about 2 miles east of Catlin and continues in a southeasterly course through Rocky Ford to Timpas creek. It is 14 miles long, 12 feet wide, and cost \$30,000. The dam in the river has been made of piles bound together by wire cable and has been made tight in part by use of brush held in place by barbed wire. The canal is owned by the persons who use the water, and the average expense per acre of maintaining the canal is estimated to be about 25 cents. The canal was begun and first used in 1874, being completed in 1888.

OURAY COUNTY is southwest of the center of Colorado and includes a portion of the head waters of the Uncompahgre river, which, flowing northerly through Montrose county, empties into the Gunnison, a tributary of Grand river. The greater part of the county is mountainous, but in Uncompahgre park and the valley to the

north of this are considerable areas of grazing and farm lands. The water supply is large, and as a rule each irrigator has his own ditch. The general altitude of the farming lands is about 7,000 feet, and the climate is favorable for the production of all of the hardier fruits and vegetables. There is usually a sufficient rainfall to start the crops, irrigation not being employed until the young plants are well under way, as the water, coming directly from the mountains, is very cold. Oats, the principal crop excepting hay, are usually harvested in September, but if the season is unusually rainy they may not be cut until November. The arable land extends in a narrow strip along the river and tributary streams and is easily brought under irrigation. In most cases an excess of water is used, little care being given to its distribution over the fields. There is more or less waste, although a great part returns to the river by seepage.

PARK COUNTY is in the center of the state, and includes within its borders the broad basin like valley known as the South park. This lies at an elevation of from 8,000 to 10,000 feet and is surrounded on all sides by high peaks having an altitude of from 12,000 to 14,000 feet. The principal industry after mining is stock raising, the climate of the valley being too cold and arid for general agriculture. The only crops of importance are those for forage purposes, hay being made mainly from native grasses. A few potatoes and other garden vegetables are produced, some of these without irrigation. The rainfall during the summer is not sufficient to produce good crops of hay and it has been found necessary to practice irrigation. The water supply is large and well distributed, streams coming into the park from all sides, uniting finally to form the South Platte river. Along each of these streams are small ditches utilizing the greater part of the water, especially that which comes after the spring flood. Near the point where they issue from the mountains the streams are never dry, but further out into the park their flow becomes greatly diminished. As a whole there is seldom scarcity of water, but occasionally irrigators on the lower part of the stream do not obtain their share and complaint is made that there is little respect for priority of right.

The flooding of the meadows begins about the first of May, or from that time to the middle of the month, and is carried on continuously until it is time to cut the hay. Great quantities of water are used, much of it returning by seepage, since the evaporation at this altitude is relatively small. Projects have been set on foot to store a part of the floods of spring along streams whose waters have been overappropriated, and one company at least has been formed to utilize a lake as a reservoir. Water storage in and about the park is of far greater importance to irrigators in the counties along the South Platte than to the inhabitants of this region. The losses of crop here on account of scarcity of water are insignificant when compared to those down on the edge of the plains, and it appears essential to the future development of irrigation that works of this kind be constructed near the head waters, where water can be held at a comparatively small expense.

Few measurements have been made showing the amount of water available. During the Hayden survey in 1876 observations were taken showing that on July 3 the middle fork of the South Platte at a point about 6 miles below Fairplay discharged 388 second-feet, and that above the mouth of the Little Platte on June 29 the discharge was 367 second-feet. Below the mouth of Twin creek the discharge on June 23 was 1,015 second-feet, and down at the foot of the canyon on September 8 was 1,400 second-feet. In July, 1887, the state engineer of Colorado established a gauging station near Deansbury in the canyon of the river about 26 miles south of Denver, the drainage area here being 2,600 square miles. The results obtained at this place give the total discharge from the South park and show the amount of water available for use on the lands below. During four years the greatest computed discharge at this place was 788 second-feet and the least 90 second-feet. The average discharge during the 6 months from May to October for the years 1888, 1889, and 1890 was 329 second-feet.

PHILLIPS COUNTY is in the northeastern part of Colorado, south of the South Platte, from which it is separated by Sedgwick county. It is situated upon the rolling prairie, where there are no perennial streams, water being derived from wells of from 100 to 300 feet in depth, usually pumped by means of windmills. Irrigation is not practiced on account of the lack of water. Frenchman river rises in this county, but the channel here is dry during a great part of the year, though in Nebraska it becomes a perennial stream. The soil of the county is remarkably rich, and the climate, though dry, is enjoyable. Were it not for the prevailing droughts the county would be brought under complete cultivation. Many farmers were induced to settle here upon representations that the droughts were diminishing, but after four or five years' ineffectual struggle a number have been compelled to abandon their claims.

PITKIN COUNTY is south of Eagle and includes the head waters of Roaring Fork, a tributary of Grand river, above or south of Fryingpan creek. In the valley along Roaring Fork the altitude is nearly 8,000 feet and the climate is too severe for agricultural products except the hardier cereals and forage plants. Water for irrigation is taken out of the streams which come from Elk mountains on the southwest and from those rising in the Saguache range on the east. The principal of these are Castle, Snowmass, Capital, and Woody creeks, the water supply in which is ample for present needs. At Aspen, the principal mining town in this vicinity, is a good market for everything that can be raised. The ditches of the county are small, mainly under 5 miles in length, and are owned and controlled by the irrigators.

PROWERS COUNTY lies on both sides of the Arkansas river on the eastern side of Colorado adjoining Hamilton county, Kansas. On the west is Bent county, from which come large canals bringing water from the river far out upon the prairie lands. Under these canals are hundreds of thousands of acres to which water can be taken if it is to be had. It has been found difficult, however, to obtain an ample supply at this distance from the head of the canals and many complaints have been made by farmers concerning the management and distribution of the water. It is stated that the ditch companies operating in the Arkansas valley of eastern Colorado have sold more water rights than can be made good by the supply available and have misled settlers by statements regarding probable crops and prices. Many of the farmers have mortgaged their land to the companies and must pay the interest and part of the principal at stated periods. There is no penalty imposed on the company for failure to furnish water, and thus farmers state they are left in the position where, not receiving the water paid for, they can not raise crops and pay off the mortgages. The feeling against the speculators or capitalists who have organized these schemes has been especially bitter in this and adjoining counties toward the west.

This county is unusually well provided with canals and ditches, and wherever they are successfully conducted lands are rapidly being brought under cultivation. The great question, therefore, is as to the extent and permanence of the water supply, and all interest centers on the feasibility of providing suitable storage. There are already under way a number of projects involving the construction of reservoirs in depressions adjacent to channels from which it is hoped to obtain water during times of flood. Many attempts have been made to raise crops without irrigation, but usually without success. The situation here has been similar to that in western Kansas, where during the years 1886 and 1887 settlers poured into the country and after struggling against drought became discouraged to a greater or less extent, many leaving their homes and possessions to avoid starvation. Fair crops of sorghum have been raised, and also under favorable conditions potatoes have done well, but as a rule little confidence can be placed in crops not watered regularly.

On the north side of the Arkansas, and about 8 miles from the river, is the lower part of the Arkansas canal project owned by the Arkansas River Land, Reservoir, and Canal Company, mentioned in the description of Bent county and shown on the map. Nearer the river, and heading 1 mile west of the county line, is the Amity canal. South of the river is the project known as the Colorado and Kansas canal, from which a few water rights have been sold. Below this, and heading near the western county line, is the Bed Rock ditch, supplying Lamar, and in turn down the river are the Lamar Land and Canal Company's ditch, the Black ditch, the X Y Irrigating canal, and a number of others.

The canal of the Bed Rock Mutual Ditch Company heads about 8 miles west of Lamar and takes water out on the south side of the river to lands in the vicinity of that town. The total length is 11 miles, average width 10 feet, and the cost was \$18,000. The ditch was begun in March, 1889, and used to a small extent during that year. It is owned by a corporation, four shares in which entitle the owner to a water right, namely, sufficient water for 80 acres. The average cost of these water rights per acre was about \$5 and the annual assessment 15 cents. The X Y Irrigating ditch heads about a mile north of Carlton and carries the water easterly for a distance of about 14 miles. The average bottom width is 8 feet, and the cost was \$15,000. Water is diverted by a temporary brush dam. The ditch was begun in the fall of 1889 and used in the following year, from 400 to 500 acres being irrigated.

PUEBLO COUNTY is southeast of the center of the state lying on both sides of the Arkansas in the part of its course where it changes from a mountain stream to a broad, shallow river, with gentle fall. There are within the county many small ditches taking water upon narrow valley lands and farther down the stream the head works of large canals designed to cover thousands and even hundreds of thousands of acres. The Arkansas receives both from the north and from the south a number of tributaries heading in the foothills. Taking these in order down stream, there are, on the north side of the river, Turkey and Fountain creeks, and on the south, Rock creek, St. Charles river and its tributary, Greenhorn creek, and Huerfano river. Each of these, like the main stream, supplies water, especially near its head waters, to a number of irrigating ditches.

On the western edge of the county among the mountains, as, for example, near Rye and other localities where the altitude is between 6,000 and 7,000 feet, some of the cereals are raised without irrigation, but taking the county as a whole this is exceptional unless there happens to be an unusually large amount of snow during the winter. The quantity of water available for irrigation falls far short of the demands made upon it. This is especially notable in the case of the tributaries of the Arkansas. In the main stream itself within the limits of the county there is a relatively large amount of water at all times of the year, but all of this, except during the floods, is needed by the canals covering lands in Otero and Bent counties. Measurements of the amount of water in the Arkansas have been continued through several years at the gauging station at Canyon, as given in the description of Fremont county. A shorter series of gaugings has always been made at Pueblo and also at Rock canyon, about 9 miles above the city.

The measurements of the Arkansas at Pueblo were carried on under the direction of the state engineer of Colorado during 1885, 1886, and 1887. The maximum discharge at this place was, in May, 1886, 7,659 second-feet, and the minimum recorded was about 400 second-feet. The average discharge throughout the year, estimating the amount for the winter months, in 1886, was 1,441 second-feet and in 1887 was 1,323 second-feet. The total area of

the catchment basin above this point is 4,600 square miles, and this amount of water discharged from the basin is equivalent to a depth over the whole area of 4.3 inches and 3.9 inches in the two years, respectively.

The measurements made at Rock canyon by the United States Geological Survey during May, June, July, and August, 1889, showed that the greatest discharge during that time was 4,375 second-feet, and the least was 405 second-feet. The average for these 4 months was 1,210 second-feet. Attempts were also made to measure the amount of water in the Huerfano at the outlet of the Cucharas canyon, about 20 miles southerly from Pueblo, but at the times visited, in June and July, 1889, the bed was almost dry, the discharge probably being from 3 to 5 second-feet. Measurements of St. Charles river, or rather creek, at a point in the canyons about 22 miles southwest from Pueblo showed that on September 10 the discharge was only 3.5 second-feet, this discharge coming in equal quantities from the north and south forks.

There have been several attempts made within the county to increase the water supply at various points by laying drains beneath the surface of channels dry throughout a great part of the year. Along Fountain creek at a place below points where the water has been completely diverted, an irrigator has laid a box drain starting at the surface and continuing up stream, with a rise of only about 1 inch per 100 feet. This box is 1,300 feet in length, and finally reaches a depth of 10 feet below the surface. The statement is made that the discharge from this, even during dry weather, is upward of 4 second-feet. In other localities, especially in the vicinity of Pueblo, storage reservoirs have been made and other works of this class are projected.

RIO BLANCO COUNTY is near the northwestern corner of the state, north of Garfield county, of which it formerly was a part. It includes the greater part of the area drained by the White river, this stream flowing through the county in a general westerly course. Much of the surface consists of high plateaus, deeply eroded and cut into cliffs and hills. On these plateaus, or mesa lands, is some grazing, but there is very little water, especially during the hot weather, springs or pools being found only at long distances from each other, and often in deep canyons or narrow gorges. The White river, for a great part of its course, flows through a narrow valley, the arable land seldom attaining a width of a mile. Near the old White River agency the valley expands, and also farther down the stream, at Powell park and Raven park, near Rangely. The river receives a large number of tributaries from the plateau lands on each side, most of these streams having cut canyons into the soft rocks. The water in these during summer diminishes and generally ceases to run, standing in pools or disappearing altogether. Along the principal tributary, Piceance creek, coming in from the south, is a strip of arable land, much of which has been brought under irrigation. The water supply, like that of Routt county, is large for the present amount cultivated, but as farming operations are extended there will be difficulty in the distribution of the water.

The main stream discharges an amount far greater than will be needed to bring all of the tillable land along its valley under irrigation. The expense of constructing canals, however, to use the water is so great that the settlers have been unable to take them out. They have built a few ditches from the river, but most of the small irrigating systems depend upon the tributaries, on account of the ease with which the ditches could be built from these at the points where side streams enter the valley. Thus, although the water supply of the county is large, yet that which can be utilized by present methods is far below the needs of the cultivators.

The greater part of this county is included within water district No. 43, a portion of division VI, which embraces the drainage basin of Green river in Colorado. The ditches in this district were adjudicated shortly before the census year. Most of the ditches in use during the census year were small, less than 2 miles in length, a few being longer. The Coal Creek ditch, taking water from the creek of that name above Meeker, is 5 miles long, 5 feet wide, and cost \$2,500. It was built in 1886 and used in 1887. It is owned by private parties, who, in 1889, irrigated 200 acres, nearly all of this being in wheat, oats, and hay. The Meeker Bridge ditch takes water from White river at Meeker, and covers land on the south side of the river. It is 2 miles long, 3 feet wide, and cost about \$800. About 100 acres were irrigated in 1889, this being in cereals, potatoes, and grass.

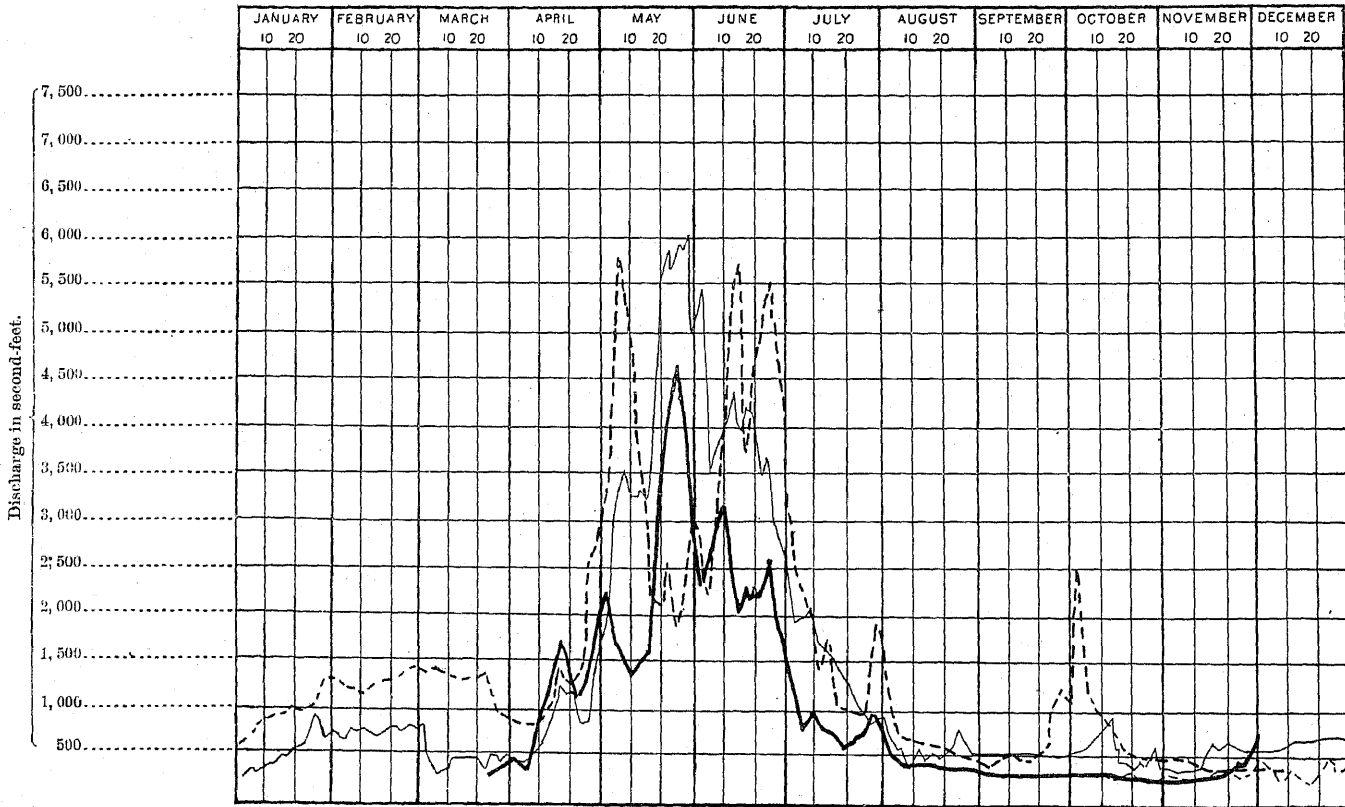
RIO GRANDE county contains some of the largest irrigating canals in the United States, the water being derived from the Rio Grande and carried to the north, east, and south across the broad San Luis valley into the counties of Saguache, Costilla, and Conejos. The banks of the river are low and beyond them the ground falls away gently toward the northeast and southwest, rendering diversion of the water a matter of moderate cost or of relatively slight expenditure of labor. It has thus been possible for many farmers to take out ditches, in some cases the first cost of the main ditch not exceeding \$1.50 per acre supplied, the laterals or distributing ditches aggregating as much more. Only a small proportion of the vast extent of valley land has as yet been cultivated by irrigation, but the diversions or appropriations of water are so complete that there is little more to be had even in wet years. At this high altitude, Del Norte being 7,865 feet above sea, the crops consist mainly of the cereals and of hay.

The principal canals head at or near Del Norte and at points farther down stream. (a) Besides these are numerous ditches taking water from tributaries of the Rio Grande, from Embargo, Pinos, and other creeks.

^a The quantity of water in the river above the head of the large irrigating systems has been measured at a point about 3 miles above Del Norte since 1889, the results of these measurements being shown diagrammatically in the accompanying figure. In this diagram the light broken line indicates the quantity of water

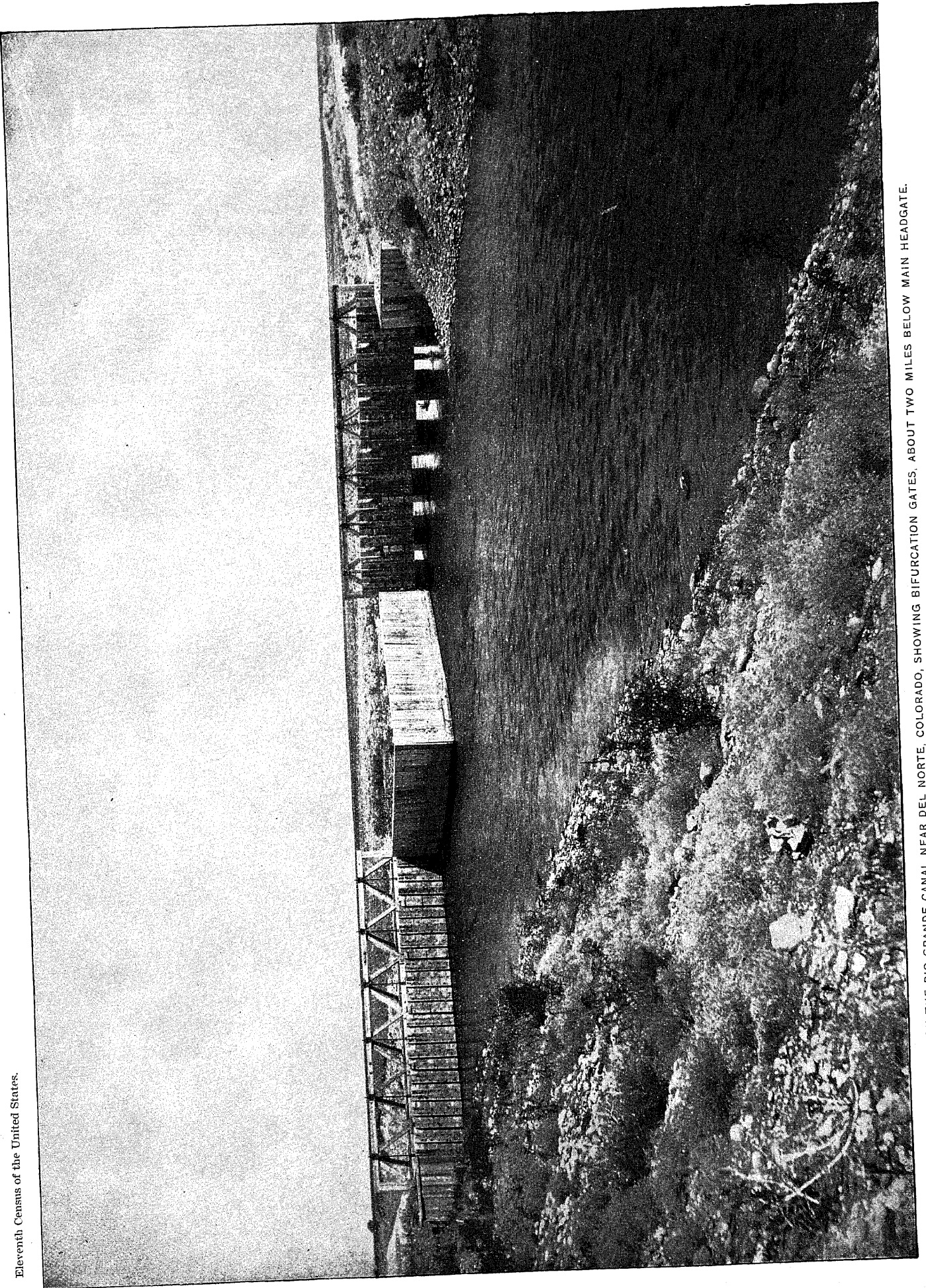
The principal irrigating systems are, as shown by the map, on the northern side of the river, the Del Norte (later known as the Rio Grande) canal, Midland ditch, Farmers Union, North Star, and Fish ditches, the San Luis in 1889, the light continuous line that in 1890, the heavier broken line that in 1891, and the heavy continuous line that in 1892. The gaugings for a series of years are also given.

DIAGRAM OF DAILY DISCHARGE OF RIO GRANDE ABOVE DEL NORTE, RIO GRANDE COUNTY, COLORADO.



DISCHARGE OF THE RIO GRANDE AT DEL NORTE, COLORADO.
(Drainage area, 1,400 square miles.)

MONTHS.	DISCHARGE IN SECOND-FEET.			Total for month in acre-feet.	RUN-OFF.		MONTHS.	DISCHARGE IN SECOND-FEET.			Total for month in acre-feet.	RUN-OFF.	
	Maximum.	Minimum.	Mean.		Depth in inches.	Second-foot per square mile.		Maximum.	Minimum.	Mean.		Depth in inches.	Second-foot per square mile.
1889.							1891.						
October 11 to 31.....	345	214	278	17,007	0.23	0.20	June.....	5,555	2,190	4,146	246,687	3.31	2.96
November.....	364	290	319	18,980	0.25	0.23	July.....	3,565	802	1,693	104,119	1.39	1.21
December.....	364	200	281	17,281	0.23	0.20	August.....	1,460	404	663	40,774	0.54	0.47
1890.							1892.						
January.....	1,000	326	552	33,948	0.45	0.39	September.....	1,234	290	527	31,356	0.42	0.38
February.....	896	745	796	44,178	0.59	0.57	October.....	2,475	450	844	51,906	0.69	0.60
March.....	842	404	487	29,950	0.40	0.35	November.....	450	308	374	22,253	0.30	0.27
April.....	1,380	404	913	54,323	0.73	0.65	December.....			325	19,987	0.27	0.23
May.....	5,930	1,990	4,331	266,356	3.57	3.09	Per annum.....	5,650	290	1,403	1,014,426	13.56	1.00
June.....	5,555	2,550	3,807	226,516	3.03	2.72	1892.						
July.....	2,260	862	1,515	98,172	1.25	1.08	January.....			300	18,450	0.25	0.21
August.....	930	450	612	37,638	0.50	0.44	February.....			300	17,250	0.23	0.21
September.....	450	326	383	22,788	0.31	0.27	March 22 to 31.....	345	290	316	19,434	0.26	0.23
October.....	862	307	470	28,905	0.39	0.34	April.....	2,400	345	1,047	62,296	0.83	0.75
November.....	610	345	478	28,441	0.38	0.34	May.....	4,710	1,510	2,605	160,207	2.15	1.86
December.....	670	475	565	34,747	0.46	0.40	June.....	3,160	1,152	2,187	130,126	1.74	1.50
Per annum.....	5,930	307	1,242	900,962	12.06	0.89	July.....	1,074	554	740	45,510	0.61	0.53
1891.							1892.						
January.....	1,320	670	990	60,885	0.81	0.71	August.....	610	308	444	27,306	0.38	0.32
February.....	1,410	1,196	1,294	71,817	0.96	0.92	September.....	308	243	262	15,589	0.21	0.19
March.....	1,460	930	1,280	78,720	1.05	0.91	October.....	290	243	259	15,928	0.21	0.18
April.....	3,160	796	1,410	83,895	1.12	1.01	November.....	829	243	360	21,420	0.29	0.26
May.....	5,650	1,860	3,245	202,027	2.70	2.34	December.....	1,074	862	922	56,703	0.76	0.66
							Per annum.....	4,710	243	812	590,219	7.92	0.58



SCENE ON THE RIO GRANDE CANAL NEAR DEL NORTE, COLORADO, SHOWING BIFURCATION GATES, ABOUT TWO MILES BELOW MAIN HEADGATE.

and the Kenilworth canals; on the south side the Monte Vista, Rio Grande and San Luis, Empire, Centennial, and other canals. The Del Norte canal, owned by the Rio Grande Land and Canal Company, heads one-half mile above Del Norte and, leaving the river almost at right angles, runs northeasterly into Saguache county. The total length is about 35 miles, the width at the head 60 feet, narrowing gradually until at the terminus it is 12 feet wide on bottom. The characters of canal and of the country traversed are best shown by the accompanying illustration. Besides the main ditch there are 378 miles of laterals, of a bottom width of 8 feet and upward. The total cost of this system has been placed at \$700,000. Water rights are sold at the rate of \$5 per acre near head of canal or \$12 per acre near the lower end. When rented the charges are from 50 cents per acre to \$2 per acre per annum, while the annual assessments on water rights are from 10 cents to 50 cents per acre, according to distance from head gate. Much of the land under these canals is rapidly becoming saturated, so that the question of drainage is assuming more importance than that of irrigation. Crops are raised on a number of farms without irrigation, sufficient water being supplied by percolation or "subirrigation".

The Farmers Union ditch takes water from the northern side of the Rio Grande about 5 miles east of Del Norte, and, like the canal above mentioned, it runs northeasterly. The total length is 24 miles and the average width 35 feet. Work was begun in 1887, the system not being complete in the census year. The ditch is owned by farmers, who divide the water according to the number of shares held by each.

The ditch of the Monte Vista Canal Company, formerly known as the Citizens ditch, heads on the south side of the Rio Grande about 8 miles below Del Norte. It is 44 miles long, 45 feet wide at head, 40 feet wide at 30 miles from head, and 14 feet wide at terminus. The total cost is estimated to have been \$480,000. Water rights are sold at from \$8 to \$12.50 per statutory inch, the annual charge or assessment per statutory inch being from 20 cents to 55 cents. From 80 to 100 of these inches are usually allotted to 160 acres, but after the land is irrigated for a time this quantity is generally found to be excessive. As on the north side of the river, some of the lands are becoming saturated and drainage questions are becoming of prime importance. The Empire canal heads about 2 miles east of Monte Vista, extending from this point in a southerly direction, being thus from 3 to 5 miles east of the Monte Vista canal. It is 30 miles long, 60 feet wide at head, and 20 feet wide at lower end. The cost of the canal has been placed at \$400,000. Work was begun in 1882, the canal being completed to Alamosa creek in 1884 and to Conejos river in 1889. In this latter year the water supply was very poor and the crops were below the average.

ROUTT COUNTY, occupying the northwestern corner of Colorado, has the largest area of any county in the state. It extends from the continental divide westward to Uinta county, Utah, and includes the greater part of the drainage basin of the Yampa river. The service consists of deeply eroded plateaus, or mesa lands, broken by hills and mountain ranges. The altitude of the plateaus ranges from about 7,000 to 8,000 feet, the mountains on the east rising to heights of 11,000 feet and over. The population is scattered, but is mainly in the eastern part of the county in the natural parks near the head waters of the streams. Cattle raising is the principal industry, and small areas are tilled on many of the cattle ranches, the greater part of the water being used, however, for hay and meadow lands.

In nearly all parts of the county it is necessary to irrigate crops and trees in order that they may live through the summer. In the eastern end, however, near Steamboat Springs, and at points higher on the Yampa river the cereals and hardier vegetables are raised without the application of water, the precipitation in the vicinity of the mountains being probably greater than that over other portions of the county. The methods of irrigation are crude, since it has been practiced for but a short time. Nearly all of the ditches have been built by neighboring farmers. In the parks and at other places where the rivers have not cut deep canyons it is comparatively easy to divert the water and cover large areas of valley land. The mesas, however, forming the greater part of the county, are nearly all above the reach of water, and, although having a soil often of great fertility, they are valueless for agriculture. At points where streams can not be diverted by ditches attempts have been made to pump water by hand, horse, and steam power, but without success, the value of the products being too small to justify the required outlay.

Within the county there are no railways or similar methods of transportation, the nearest shipping points being in southern Wyoming, 40 miles or more north of the county. As a consequence the products are for consumption by ranchmen and their families. Large quantities of hay are raised, in a few places alfalfa being successful. Two crops of this have been cut, but on account of the cold nights and early frosts the yield is small. Timothy is reported to thrive remarkably, and under irrigation the native bluestem grass does well for a few years.

Although the county is thinly settled, it is stated that in the more favorable localities much of the land has been brought under irrigation that can readily be supplied, and settlers have taken up every piece of arable ground near springs or perennial streams from which water can be diverted. There are as yet few contests concerning the division of water, although occasionally a farmer at the lower part of the valley has complained of the increasing diversions made above him. There still remain localities where lands can be brought under irrigation by building canals from the larger streams, but such enterprises require the expenditure of more money than the present inhabitants possess. In a few instances high water ditches have been built, these receiving water only in times of flood, and at a few points wheels for elevating the water have been tried. Estimates of the water

supply from the Yampa were made by Henry Gannett, as stated in the Hayden report for 1876, page 338. A gauging made about the middle of November at the ford of the wagon road from White River agency to Rawlins gave a discharge of 364 second-feet, this being at about the lowest stage of the water.

The ditches of the county are short, most of the streams utilized having sufficient fall, so that each farmer or group of irrigators can divert water without long canal lines. Water is taken mainly from Fortification creek and its tributaries, Elk river, and the upper part of the Yampa. A description of a few of the larger ditches will serve to give the general character of all. The Pleasant Valley ditch is on the west side of Yampa river and heads about 15 miles above Steamboat Springs. It is 7 miles long, 7 feet wide, and cost about \$1,200. Work on it was begun in 1889, and water was used in the succeeding year. The Woolery ditch is on the south side of Yampa river, heading about a mile below Steamboat Springs. It is 3 miles long, about 8 feet wide, and cost \$800. The supply of water is ample, and each person having ownership in the ditch uses as much as he wishes. The principal crops are wild hay, with a little timothy, oats, wheat, and barley.

The Reid ditch is on the south side of Yampa river, heading about 5 miles above Hayden. It is 7 miles long, 10 feet wide, and cost \$3,000. Work was begun in 1882 and completed in 1889. It is owned by ranchmen, and is used to irrigate hay and oats. In this valley there are 3 other ditches, similar in many respects. The Big Cut ditch takes water out on the north side of Yampa river, about 3 miles above the town of that name. It is 4 miles long, 8 feet wide, and cost \$3,500. It was begun in 1886 and finished in 1890. At this point the fall of the river is so slight that it is expensive to divert water, but the supply is ample. Little Bear Creek ditch takes water from the creek of this name, about 5 miles above the point where it empties into Fortification creek, covering land between these two streams. It is over 4 miles long, 3 feet wide, and cost \$2,000. The water supply is fairly good except in the latter part of summer. (a) This county and the adjoining county, Rio Blanco, with the exception of small areas, are included within water division VI, this comprising lands within the drainage basin of Green river, or rather within that of its two principal tributaries, White and Yampa. This has been subdivided into water districts numbered 43, 44, 54, 55, 56, 57, and 58. District No. 43 embraces all of the White river drainage, and therefore includes nearly the whole of Rio Blanco county, as previously stated. The remaining districts, excepting 56, are within the watershed of the Yampa and include all of Routt county, excluding a small portion in the southeastern corner, where the county lines extend into the drainage basin of Grand river. The irrigators using water from the Yampa and its tributaries have been very dilatory in securing an adjudication of their water rights or in taking the first steps toward putting their claims upon record as required by state law. In these somewhat remote localities there has been great ignorance as to the objects and value of adjudication of water rights, and even considerable hostility toward such work.

In each water district there are reservoirs commenced or projected. These are usually small and intended to furnish water only for one or two ranches each. Both Routt and Rio Blanco counties are, as previously stated, usually well watered, especially in their eastern parts, and it is safe to assert that the area of land now irrigated can be greatly increased in the future. In the eastern end of Routt county the supply of water if properly conserved and distributed is probably in excess of the irrigable land. In the western parts of both Routt and Rio Blanco counties, for land which can be irrigated directly from the main rivers, White, Yampa, and Green, there is a superabundance of water, but along the tributaries in this part of these counties the irrigable land is probably in excess of the water supply. In the northern and western portions of Routt county, along Little Snake river, there is still a large amount of water unutilized, but it is probable that the supply will fail before all of the irrigable lands can be covered.

Both Routt and Rio Blanco counties were settled by stockmen, who allowed their herds to roam over the government lands. Stock raising is still the most important industry, but the conditions are gradually changing, the herds being smaller and, as a consequence, better kept. The owners are making better preparation every year for raising hay for winter feed, increasing the area of meadows and uplands in forage crops, these depending upon

a A general report upon the condition of irrigation in this and the adjoining county of Rio Blanco has been made by J. C. Kennedy, C. E., under date of March, 1893. The following figures are given by Mr. Kennedy as a close approximation of the number of ditches, their aggregate length, and the acreage irrigated in 1892, the length being that already constructed and not the mileage projected:

DISTRICT NUMBER.	Number of ditches.	Aggregate length in miles.	Acres irrigated.
43 (Rio Blanco county)	142	210	14,700
44 (Routt county)	42	78	7,400
54 (Routt county)	20	46	5,400
55 (Routt county)	15	36	2,900
56 (Routt county)	17	31	2,800
57 (Routt county)	47	101	12,600
58 (Routt county)	134	272	28,300

irrigation. Wild grasses have formed the principal acreage thus watered, but alfalfa and cultivated grasses are displacing these. Next in importance to the forage crops are oats, potatoes, barley, rye, and wheat, all of which are being largely grown.

SAGUACHE COUNTY includes the northern part of San Luis valley or park, the northwestern corner extending over Cochetopah hills, and including a small part of the head waters of Gunnison river. The western boundary of the county is formed by the Sangre de Christo range, beyond which is the valley of the Arkansas. From these mountains and hills streams flow inwardly toward San Luis park, and entering upon the edge of this vast plain tend to form swamps or lakes. Some of the streams unite and flow toward the south, but all ultimately disappear by evaporation from the marshy lands. Since the settlement of the country, however, farmers have begun to divert the water from these streams by means of ditches heading near the foothills and carrying the water out in every direction over the nearly level surface.

The altitude of this part of the valley is from about 7,700 feet to 8,000 feet and over, but the climate, though somewhat cold, is not too severe for most of the ordinary agricultural products of temperate regions. Certain of the cereals and grasses, with water properly applied, reach a high degree of excellence, and potatoes, as well as other common vegetables, are raised with profit. Few, if any, crops can be raised without irrigation except on low lands wet by seepage from streams or canals. Water is obtained for use in the county from creeks and from the Rio Grande, being brought out by large canals heading not far from Del Norte, as mentioned in the description of Rio Grande county. The accompanying illustration shows the size of one of these canals and exhibits the character of the country traversed as well as the methods of controlling and dividing the water for the two main branches. The methods of irrigation in use, especially along the various creeks, are very wasteful of water, and the best results are seldom attained. Far larger areas could probably be cultivated and a heavier yield per acre obtained by the employment of the same amount of water more systematically utilized. Most of the men owning large ranches turn the water out upon the meadows in spring and let it run continuously with little attention until about the time to cut hay. Most of the lands are thus flooded, some spots receiving too much water and others not enough. During the census year cereals were raised on 4,267 acres, of this there being in oats 2,570 acres, with an average production of 24.95 bushels per acre, and in wheat 1,396 acres, with an average production of 20.78 bushels per acre.

In the northwestern corner of the county is Cochetopah creek, flowing northerly from the hills of that name into Gunnison river. Along this creek is a narrow valley at an altitude of about 9,000 feet. Water is taken from this stream by the various ranchmen and carried by ditches along the sides of the valley, the method of irrigation being similar to that practiced in most of these isolated localities where water is abundant. Openings are made in the side of the ditch every hundred feet or so, allowing a portion of the water to escape when the ditch is full. The banks soon become covered with grass, so that the water does not cut them away or enlarge the openings. At the beginning of the irrigating season water is turned into the ditch, and a day or two later the owner rides along the ditch to see that water is coming from the various openings, and whether the high places are being properly wet. After water has been flowing in this way for from one to two weeks the head gate of the ditch is shut for about 2 weeks, allowing the ground to be warmed and dried by the sun, and then water is turned on again. By this method there is a considerable area of waste land in all the meadows, water not reaching all parts alike. The grass raised in this way is in some places native, in others timothy or redtop, all of these furnishing excellent feed for cattle.

SAN JUAN COUNTY, in the southwestern part of the state, includes a portion of the high mountain area north of La Plata county. The altitude at the lowest point is over 8,000 feet, this being in the narrow valley of Las Animas river. Agriculture is not attempted, or at least during the census year there were no farming operations worthy of enumeration. Although there are no arable lands in these high valleys, yet there are apparently many places at which water can be stored for use on farming lands farther to the south, and thus the county may have considerable importance indirectly for the development of agriculture in other localities.

SAN MIGUEL COUNTY is one of the long, narrow counties in southwestern Colorado, extending from the mountains in Ouray and San Juan counties west to the Utah line. Agriculture has made but little progress, the first crop of any considerable size being produced in 1888. The water supply in the eastern end, near the mountains, is large, but the streams as found at lower altitudes are mainly small, or are difficult of diversion. There is an enormous extent of mesa land, much of it fertile, but it is doubtful whether water can be brought to it. A number of ditches have been dug covering lands along San Miguel river, these being owned by the farmers. One corporation, the Naturito Ditch Company, has diverted water from Middle and Little Beaver creeks, selling water rights to irrigators at the rate of \$10 per acre.

SEDGWICK COUNTY is in the extreme northeastern corner of Colorado, north of Phillips county, to which it is similar in many respects. The South Platte flows diagonally through the county, but during the summer and until November it is usually dry. Even at this time, however, water can be found in the sandy channel by digging a few feet below the surface. Many attempts at farming made in this county have not been successful, and the

population steadily decreased from 1887 to 1890. Some of the farmers state that they have tried to raise crops and have failed three or four years in succession. Hopes are entertained that by means of suitable dams or deep ditches the water in the bed of the South Platte can be brought out upon some of the lower lands. It is extremely doubtful, however, whether the quantity realized will repay the expense, for the passage of the water through the sands of the bed of a stream is comparatively slow, and when these are partially drained the inflow is very small. Surveys have been made, however, in the hope of bringing the water out and carrying it far easterly into Nebraska. The wells from which water is at present obtained are in many instances from 250 to 300 feet in depth, are tubed with 2-inch pipe, and pumped by means of windmills. Persons not owning wells buy water at a few cents per barrel.

SUMMIT COUNTY includes a narrow valley through which flows Blue river, a tributary of Grand river. Along the river are small areas of arable land, but the climate is too cold for general agriculture, frosts occurring nearly every month in the year, the altitude of the lower lands being from 8,000 to 9,000 feet. Besides its mineral wealth the county is valuable for stock raising, there being good grazing on the lower slopes. Nearly every ranch in the valley is provided with a small irrigating ditch, the water being used for raising hay. The supply is large, especially from the streams on the south side of Blue river, the principal drawback being that mine tailings are discharged into some of the creeks, lessening the value of the water for irrigation purposes.

WASHINGTON COUNTY is in the northeastern part of the state, including a portion of the rolling prairie south of the South Platte river, the northwestern corner coming down to this stream. The principal towns are near the railroad in what is known as Yuma valley. No irrigation is carried on except near the South Platte on account of the absence of perennial streams. The only source of water supply for the greater part of the county is from wells dug or drilled to depths of from 100 to 200 feet or over. There are a few scattered springs, but these are employed almost exclusively for watering cattle, the surplus being too small for purposes of irrigation.

Cereals and vegetables grow with great luxuriance until the latter part of June or first of July, when the drought begins to affect them. The yield even in good seasons is less than that upon irrigated land. Nevertheless farming in connection with stock raising affords a living to many settlers, and an occasional good year goes far to make up past losses. The crops in 1889 were not particularly good, and in 1890 they were almost an entire failure, about the only thing of value being corn fodder. Attempts have been made to secure water by means of deep wells. One at Akron is 900 feet in depth and has a small amount of water in the bottom. It is stated that the railroad company drilled to a depth of 2,300 feet without success. Along the south side of the South Platte river are several irrigating ditches which cross the county line, the principal of these being the Platte and Beaver, heading in Morgan county, and below this are the Johnson and Edwards ditches, owned by irrigators.

WELD COUNTY is in the northern part of Colorado, east of Larimer county, east of the foothills of the Rocky mountains, and upon the western edge of the Great Plains, the average altitude being about 5,000 feet. The principal town is Greeley, near which are located the irrigating systems deriving water from the Cache la Poudre, as mentioned in the description of Larimer county. South Platte river flows into the county from the south, and during its course receives the waters of St. Vrain creek, which rises in Boulder county, also of Big Thompson creek and Cache la Poudre creek, both coming from Larimer county. Near the junction with that latter creek South Platte river turns toward the east and finally enters Morgan county. The water supply of the county is obtained not only from South Platte river, but also from the creeks above mentioned, together with several minor tributaries.

Irrigating canals and systems of ditches have been constructed in such numbers and with a capacity so great that in the aggregate they could carry far more water than the river and its tributaries supply in ordinary seasons. As in the other counties of this part of the state, there is complaint that farmers have been induced to purchase water rights from companies unable to furnish water except during flood seasons, and, although the supply is far below the necessities of irrigators, new canals are being built and old ones enlarged. The lands at present irrigated are mainly near the river and its tributaries, and thus form but a small proportion of the surface of the county. Back from the streams are thousands of acres with a rich soil, but lying at an altitude too great to be reached by irrigation ditches even if water could be had.

Without irrigation little or nothing can be raised. Attempts have been made at various times to farm without a water supply, but usually this has resulted in loss. Some of the lower lands receive sufficient moisture by the seepage from canals, so that irrigation of the surface is not required. Instances are given where the seepage is so great that lands formerly cultivated are now used for pasturage, and others are ruined by standing water. By thorough systems of drainage in connection with irrigation water could be saved for use on other lands and injury of this kind prevented. In the northern part of the county and above the canals from the South Platte and its tributaries very little farming is now attempted. In 1885 and 1886, through the efforts of land agents, many persons were induced to settle upon the high lands in this county, as well as in the localities farther to the east, it being asserted that the rainfall was increasing and would be sufficient for the crops. Many of these so-called "rain beltters", after trying several years, were literally starved out, having lost everything in the struggle against drought. Others have succeeded in making a living by working for cattle companies or for the owners of irrigated land.

The water supply on lands remote from the streams above mentioned is derived from wells of 100 feet or more in depth or from shafts sunk into the dry channels of intermittent streams. The amount obtained in this way is, however, too small for purposes of irrigation, being sufficient only for cattle and domestic purposes. Along Crow creek, which comes into the county from the north, are a number of ditches, and a little irrigation is practiced, but the amount of water has diminished year by year, owing probably to diversions in Wyoming. To supply the city of Cheyenne, for example, a dam has been built, extending to bed rock and thus taking out the water percolating through the sands and gravels. Farther down the stream channel, in Colorado, enough water returns, however, to supply shallow wells of from 2 to 5 feet in depth. This may be taken as an example of the streams upon the edge of the plains, water being found in their beds a few feet from the surface.

It has been found in this county, as in many others, that the farmers succeed in raising crops with far less water than was used in former years. Not only has the ground been to a certain extent saturated, but the farmers gain skill by practice and observation. Nevertheless the demand for water is rapidly increasing, and as a rule the amount available for the use of each farmer has decreased. It is asserted that farming is not as profitable as it was before so many ditches were built, the farmers who came first not being able, though having law and custom on their side, to secure sufficient water. The increase in the number of irrigating canals, without system or regulation, has thus tended toward scarcity of water and occasional loss of crops.

Relief from crop losses can be gained in part by greater care and economy in the distribution and use of the water supply and by storage of spring floods. The losses from the reservoirs on low ground, however, are very great, and the many unsettled questions regarding water rights cause the irrigators to hesitate in building large storage reservoirs among the mountains. A small amount of water for irrigation is raised by means of steam pumps, and the vacuum pump made at Greeley has been largely employed for this purpose. Several farmers state that they have not been able to raise crops profitably by this means on account of the cost of fuel. There are also a few artesian wells in the county, but these discharge very small quantities of water.

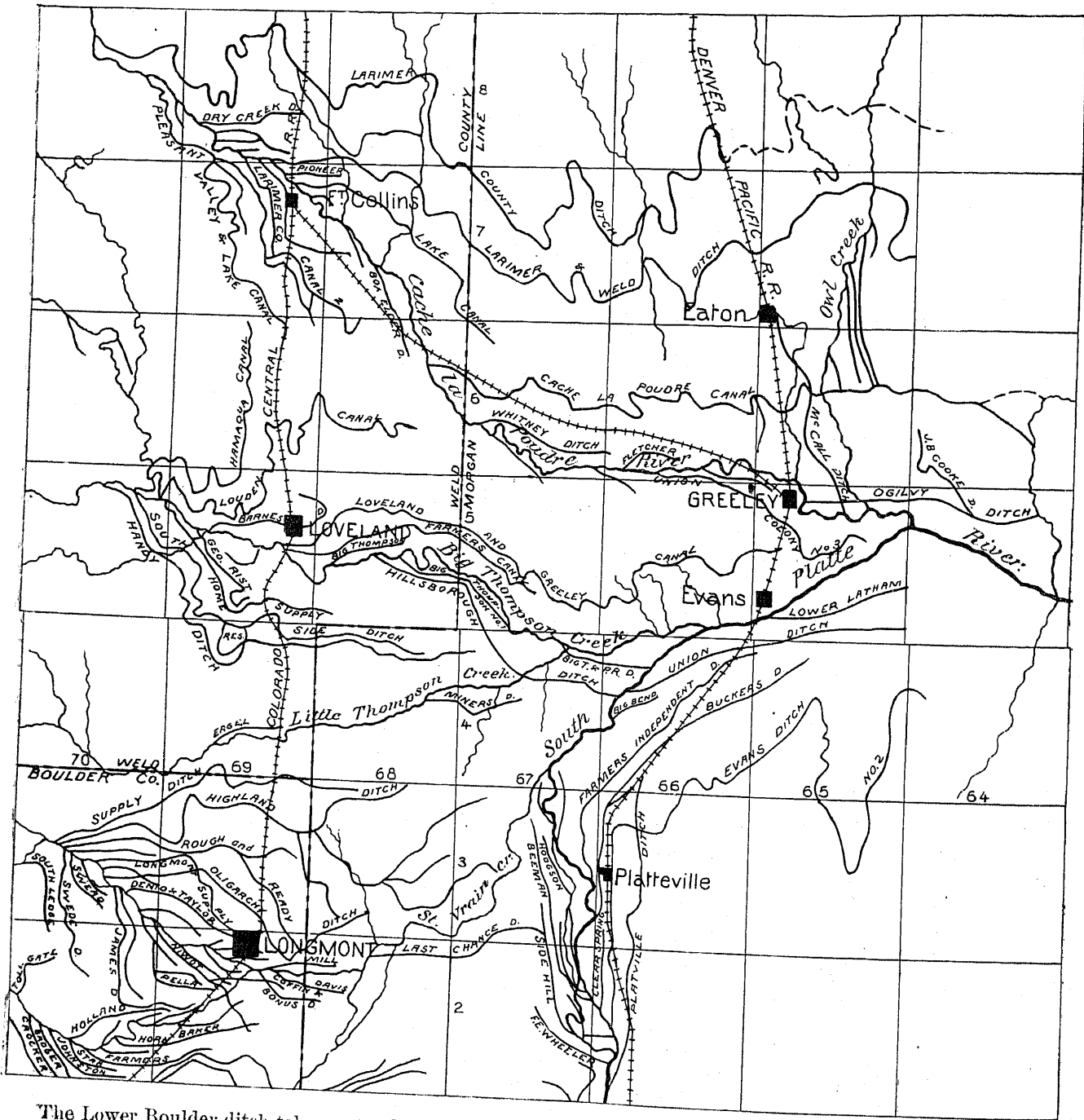
Weld county comprises portions of water districts No. 1 to 5, inclusive. No. 1 includes the streams coming into the South Platte east of Greeley, No. 2 the land along the South Platte above St. Vrain creek, No. 3 the land watered from Cache la Poudre creek, No. 4 from Big Thompson creek, and No. 5 from St. Vrain creek. The principal canals in these divisions and in this county are given below in geographic order down stream, taking the tributaries in succession. On the east and south side of the South Platte river are the Folsom, the Platteville Irrigating and Milling Company's, the Platte Valley, Buckers, the Farmers Independent, the Union, and the Lower Latham ditches. On the west side of the South Platte river above St. Vrain creek are the Brighton, the Fort Lupton Bottom, the Side Hill, the Beeman, and the Hodgson ditches. Along St. Vrain creek are many ditches extending into the county from Boulder county, the principal of these being the Lower Boulder, the Matthews, and the Highland ditches, and further down the Last Chance ditch. From Big Thompson creek come others, among which may be mentioned the Hillsboro ditch and the Loveland and Greeley canal.

In the vicinity of Greeley, and taking water from the Cache la Poudre on the south side, is Union Colony canal No. 3, and north of this stream the Larimer County ditch, the Larimer and Weld canal, the Cache la Poudre canal, or No. 2, the Whitney, the Ogilvy, and other ditches. East of Greeley the irrigating ditches are comparatively small and unimportant, but almost any one of the canals mentioned above would be considered a factor of great importance in the development of most of the counties of the arid region. The great number of expensive irrigating systems in this county makes it difficult to select representative works for description, but the following statements may be taken as fairly typical.

The Platte Valley canal heads on the east side of the South Platte river and carries water in a northerly and northeasterly direction. The total length is 30 miles, the average width 20 feet, and the cost was about \$50,000. It is owned by a corporation, selling water rights to farmers for \$1,000, each right being intended to convey 1.44 second-feet of water for use on 80 acres. The Union ditch heads on the east side of the South Platte river, about 8 miles above the town of Evans. The total length is 16 miles, and the average width for the first 10 miles is 16 feet, and beyond this point is 10 feet on bottom. The total cost of the canal was about \$25,000. It was begun in 1874 and first used in 1880. Water is diverted from the river by a dam made of brush, held in place by piling, having in the center gates 30 feet in width. The canal is owned by a corporation composed mainly of land holders, the ownership being divided into 250 shares, and the water distributed in proportion to the number of shares held. The shares are worth \$100 each, and it is stated that the water distributed to the owner of 10 of these will irrigate 80 acres. The annual assessment has varied from \$2 to \$10 per share.

The Beeman ditch takes water from the South Platte on the west side, about 5 miles above Platteville, carrying it out in a general northerly direction. The total length is about 7 miles, width 10 feet, and the cost was \$2,000. Water is diverted by means of a brush and dirt dam. The ditch is owned by farmers living under it and using the water. There are 40 shares, the ownership of a share entitling the owner to open his measuring box admitting the water to a width of 6 inches. For 2 shares the box is opened 12 inches wide; 3 shares, 18 inches, the depth of water in all measuring boxes being the same. Water is scarce in some years and crops are lost, in 1880 there not being a full crop on any of the land.

MAP OF IRRIGATING CANALS IN THE VICINITY OF GREELEY, WELD COUNTY, COLORADO.



The Lower Boulder ditch takes water from Boulder creek, a tributary of St. Vrain creek, and carries it out on the south side in the vicinity of the town of Erie. The total length of the main ditch and extension is about 18 miles and the average width 10 feet. The cost was approximately \$10,000. The ditch is owned by farmers, who divide the water among themselves. The Last Chance ditch is taken from St. Vrain creek below the mouth of Boulder creek, being on the south side of the stream. The length is 6 miles, width about 12 feet, and the cost was approximately \$8,000. As in the case of other ditches, the water is divided among the owners in proportion to the amount paid in.

Union Colony canal No. 3 takes water from the south side of the Cache la Poudre, about 5 miles above Greeley. It is 10 miles long, 10 feet wide, and cost, probably, \$30,000. Water is diverted by means of a permanent wooden dam. The water is measured out of the canal over weirs 8 inches deep, provided with a slide open to a width proportional to the amount to be discharged to each user. The ditch and the right to use the water is owned by the grantees of the Union Colony of Colorado and is managed by trustees. The water supply is often scanty, and care must be taken to guard against loss of crops.

The Larimer and Weld canal takes water from the Cache la Poudre, near Fort Collins, running out on the north side of the river. The total length is 50 miles and the average width 25 feet. The total cost was \$150,000. Water is diverted by a wing crib dam 177 feet long and 4 feet high above bed of stream. The canal is owned by a corporation, selling water rights at \$1,200 for 80 acres. The annual assessment is about \$10 for each of these rights. The Cache la Poudre Irrigating canal, formerly known as Union Colony canal No. 2, takes water from the Cache la Poudre, about 8 miles below Fort Collins, carrying it easterly a distance of nearly 30 miles. The average width is 30 feet, and the cost was about \$200,000. It was begun in 1870, being used in the following year. The dam in the river is permanent, being made by driving piles in the bed of the stream and covered with plank and stone. The above described canals, as previously stated, form but a small part of the irrigating system of the county and are perhaps not extraordinary or more worthy of note than others.

YUMA COUNTY is east of Washington county, of which it was formerly a part. The north fork of the Republican river rises in this county, and flowing easterly into Dundy county, Nebraska, becomes a stream of considerable size. Three small ditches have been taken from the stream, one near the town of Wray and another covering the land in the vicinity of Laird. The greater part of the land cultivated, however, depends upon rainfall for its water supply. Nearly all kinds of cereals and vegetables are raised, but the yield per acre is often small, as the rainfall is uncertain as to time of occurrence. Many of the settlers not being able to make a living by agriculture have had to abandon their claims and leave the country.

Over the greater part of the country water is obtained by means of wells upward of 200 feet in depth. Some of these are reported as discharging water during or after heavy storms. The north fork of the Republican flows continuously throughout the year, being fed by springs in the sand hills, and the stream is singularly free from sudden floods. The ditches follow the narrow valley, the Wray and Chief Creek ditches being on the south side and the Laird ditch on the north. The total length of these is about 15 miles, the average width 10 feet, and the cost when completed will probably be \$10,000. The water supply is stated to be ample and the soil of great fertility. An annoyance in operating the ditches consists in the fact that great quantities of sand are blown into them, especially during the month of March, if the soil is dry.