Water Resources Survey

Part I:

HISTORY OF LAND AND WATER USE ON IRRIGATED AREAS

and

Part II:

MAPS SHOWING IRRIGATED AREAS IN COLORS DESIGNATING THE SOURCES OF SUPPLY

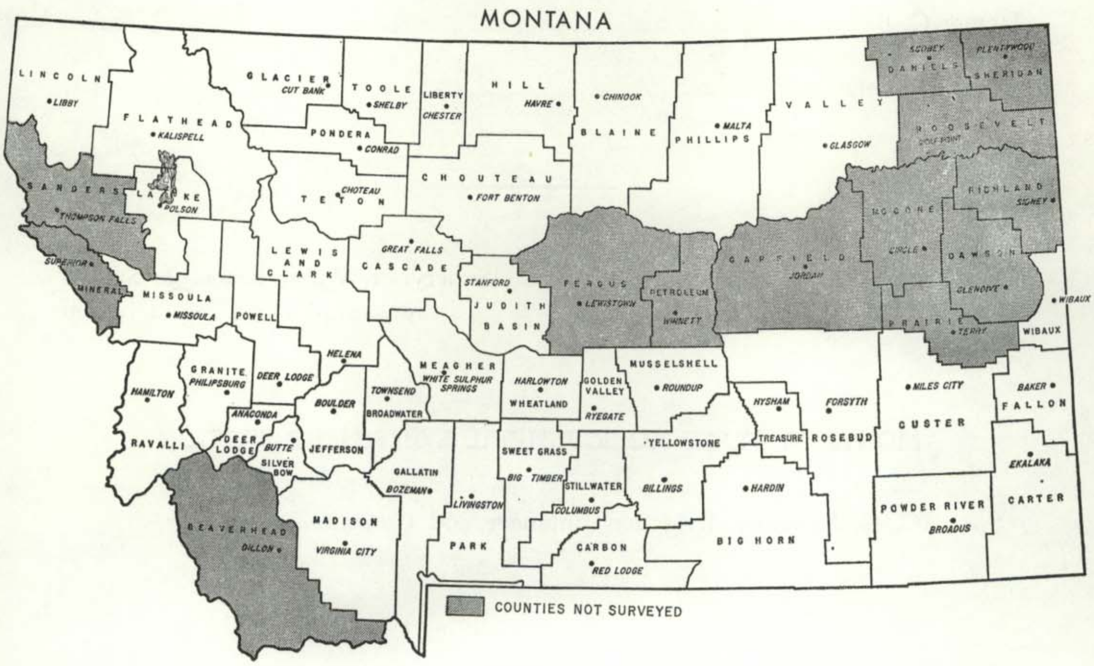
Glacier County, Montana

Published by
MONTANA WATER RESOURCES BOARD
Helena, Montana — September, 1969

WATER RESOURCES SURVEY

GLACIER COUNTY
MONTANA

Part I
History of Land and Water Use on Irrigated Areas



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3 REPORTER PRTG. & SUPPLY CO.

September, 1969

Honorable Forrest H. Anderson
Governor of Montana
Capitol Building
Helena, Montana

Dear Governor Anderson:

Submitted herewith is a consolidated report on a survey of Water Resources for Glacier County, Montana.

The report is divided into two parts: Part I consists of history of land and water use, irrigated lands, water rights, etc., and Part II contains the township maps in the County showing in colors the lands irrigated from each source of canal system.

Surveys have been made in the counties of Big Horn, Blaine, Broadwater, Carbon, Carter, Cascade, Chouteau, Custer, Deer Lodge, Fallon, Flathead, Gallatin, **Glacier**, Golden Valley, Granite, Hill, Jefferson, Judith Basin, Lake, Lewis and Clark, Liberty, Lincoln, Madison, Meagher, Missoula, Musselshell, Park, Phillips, Pondera, Powder River, Powell, Ravalli, Rosebud, Silver Bow, Stillwater, Sweet Grass, Teton, Toole, Treasure, Valley, Wibaux, Wheatland and Yellowstone. Reports are available for all of the counties except a few of the ones which were surveyed a number of years ago and are now out of print. However, reports will again be published on these counties sometime in the future after they have been updated.

The office files contain minute descriptions and details of each individual water right and land use, which are too voluminous to be included herein. These office files are available for inspection to those who are interested.

The historical data on water rights contained in these reports can never become obsolete. If new information is added from time to time as new developments occur, the records can always be kept current and up-to-date.

Respectfully submitted,
DOUGLAS G. SMITH, Director
Montana Water Resources Board

ACKNOWLEDGMENTS

A survey and study of water resources involves many phases of both field and office work in order to gather the necessary data to make the information complete and comprehensive. Appreciation of the splendid cooperation of various agencies and individuals who gave their time and assistance in aiding us in gathering the data for the preparation of this report is hereby acknowledged.

GLACIER COUNTY OFFICIALS

Wm. S. McAlpine, Commissioner

Oscar L. Doane, Commissioner — Frank Krshka, Commissioner

Mrs. M. L. Nanini, Clerk and Recorder

Mrs. Violet D. Durham, Clerk of District Court — N. M. Costello, Assessor

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N. R. Tripp............Chief of Soils and Watershed Management, U. S. Forest Service

Robert Durham............County Extension Agent

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FOREWORD

SURFACE WATER

Our concern over surface water rights in Montana is nearly a century old. When the first Territorial Legislature, meeting in Bannack, adopted the common law of England on January 11, 1865, the Territory's legal profession assumed that it had adopted the Doctrine of Riparian Rights. This doctrine had evolved in England and in the eastern United States where the annual rainfall is generally more than twenty inches. It gave the owners of land bordering a stream the right to have that stream flow past their land undiminished in quantity and unaltered in quality and to use it for household and livestock purposes. The law restricted the use of water to riparian owners and forbade them to reduce appreciably the stream flow, but the early miners and ranchers in Montana favored the Doctrine of Prior Appropriation which permitted diversion and diminution of the streams. Consequently, the next day the legislature enacted another law which permitted diversion by both riparian and non-riparian owners. Whether or not this action provided Montana with one or two definitions of water rights was not settled until 1921 when the Montana Supreme Court in the Mattler vs. Ames Realty case declared the Doctrine of Prior Appropriation to be the valid Montana water right law. "Our conclusion," it said, "is that the common law doctrine of riparian rights has never prevailed in Montana since the enactment of the Bannack Statutes in 1865 and that it is unsuited to the conditions here . . ."

The appropriation right which originated in California was used by the forty-niners to divert water from the streams to placer mine gold. They applied to the water the same rules that they applied to their mining claims—first in time, first in right and limitation of the right by beneficial use. Those who came to Montana gulches brought with them these rules, applying them to agriculture as well as to mining.

The main points of consideration under the Doctrine of Prior Appropriation are:

1. The use of water may be acquired by both riparian and non-riparian landowners.

2. It allows diversion of water regardless of the reduction of the water supply in the stream.

3. The value of the right is determined by the priority of the appropriation; i.e., first in time is first in right.

4. The right is limited to the use of the water. Stream waters in Montana are the property of the State and the appropriator acquires only a right to their use. Moreover, this use must be beneficial.

5. A right to the use of water is considered property only in the sense that it can be bought or sold; its owner may not be deprived of it except by due process of law.

The State Legislature has provided methods for the acquisition, determination of priority and administration of the right. No right may be acquired on a stream without diversion of water and its application to a beneficial use. On unadjudicated streams, the Statutes stipulate that the diversion must be preceded by posting a notice at a point of intended diversion and by filing a copy of it within 20 days in the county clerk's office of the county in which the appropriation is being made. Construction of the means of diversion must begin within 40 days of the posting and continue with reasonable diligence to completion. However, the Montana Supreme Court has ruled that an appropriator who fails to comply with the Statutes may still acquire a right merely by digging a ditch and putting the water to beneficial use.

To obtain a water right on an adjudicated stream one must petition the District Court having jurisdiction over the stream for permission to make an appropriation. If the other appropriators do not object, the court gives its consent and issues a supplementary decree granting the right subject to the rights of the prior appropriators.

Montana laws do not require water users to file official records of the completion of their appropriations; therefore, it becomes advisable as soon as the demand for the waters of a stream becomes greater than its supply, to determine the rights and priorities of each user by means of an adjudication or water right suit. This action may be initiated by one or more of the appropriators who may make all the other claimants parties to the suit. The Judge of the District Court then examines all of the claims and issues a decree establishing priority of the right of each water user and the amount of water he is entitled to use. The court decree becomes in effect the deed of the appropriator to his water right.

Whenever scarcity of water in an adjudicated stream requires an allocation of the supply according to the priority of rights, the Judge, upon petition of the owners of at least 15 percent of the water rights affected, must appoint a water commissioner to distribute the water. Chapter No. 231, Montana Session Laws 1963, Senate Bill 55 amended Section 89-1001 R.C.M. 1947, to provide that a water commissioner be appointed to distribute decreed water rights by application of fifteen percent (15%) of the owners of the water rights affected, or, under certain circumstances at the discretion of the Judge of the District Court—**"provided that when petitioners make proper showing they are not able to obtain the application of the owners of at least fifteen percent (15%) of the water rights affected, and they are unable to obtain the water to which they are entitled, the Judge of the District Court having jurisdiction may, in his discretion, appoint a water commissioner."** After the Commissioner has been appointed the Judge gives his instructions on how the water is to be apportioned and distributed in accordance with the full terms of the decree.

The recording of appropriations in local courthouses provides an incomplete record of the water rights on unadjudicated streams. In fact, the county records often bear little relation to the existing situation. Since the law places no restriction on the number or extent of the filings which may be made on an unadjudicated stream, the total amount of water claimed is frequently many times the available flow. There are numerous examples of streams becoming over-appropriated. Once six appropriators each claimed all the water in Lyman Creek near Bozeman. Before the adjudication of claims to the waters of Prickly Pear Creek, 68 parties claimed thirty times its average flow of about 50 c.f.s. Today, the Big Hole River with an average flow of about 1,000 c.f.s. has filings totaling 173,912 c.f.s. One is unable to distinguish in the county courthouses the perfected rights from the unperfected ones since the law requires no official recording of the completion of an appropriation. Recognition by the courts of unrecorded appropriations adds to the incompleteness of these records. To further complicate the situation, appropriators have used different names for the same stream in their filings. In Montana, many of the streams are found distributed in two or more county courthouses. Anyone desirous of determining appropriations on a certain river or creek finds it difficult and expensive to examine records in several places. In addition, the records are sometimes scattered because the original nine counties of 1865 have now increased to 56. As the original counties have been divided and subdivided, the water right filings have frequently not been transcribed from the records of one county to the other. Thus, a record of an early appropriation in what is at present Powell County may be found in the courthouse of the original Deer Lodge County.

It can readily be seen that this system of recording offers little protection to rights in the use of water until they are determined by adjudication. In other words, an appropriator does not gain clear title to his water right until after adjudication, and then the title may not be clear because the Montana system of determining rights is also faulty. In the first place, adjudications are costly, sometimes extremely costly when they are prolonged for years. It is estimated that litigation over the Beaverhead River, which has lasted more than twenty years, has cost the residents of the valley nearly one-half million dollars. In the second place, unless the court seeks the advice of a competent irrigation engineer, the adjudication may be based upon inaccurate evidence; in the third place, if some claimant has been inadvertently left out of the action, the decree is not final and may be reopened for consideration by the aggrieved party. Another difficulty arises in determining the ownership of a water right when land under an adjudicated stream becomes subdivided in later years and the water is not apportioned to the land by deed or otherwise. There is no provision made by law requiring the recording of specific water right ownership on deeds and abstracts.

The Legislative Session of 1957 passed Chapter 114 providing for the policing of water released from storage to be transmitted through a natural stream bed to the place of use. The owner of the storage must petition the court for the right to have the water policed from the storage reservoir to his place of use. If there are no objections, the court may issue the right and appoint a water commissioner to distribute the water in accordance therewith. This law applies only to unadjudicated streams.

Administration of water on adjudicated streams is done by the District Court, but it has its drawbacks. The appointment of a water commissioner is often delayed until the shortage of water is acute and the court frequently finds it difficult to obtain a competent appointee for so temporary a position. The present administration of adjudicated streams which cross the county boundaries of judicial districts creates problems. Many of the water decrees stipulate head gates and measuring devices for proper water distribution, but in many instances the stipulation is not enforced, causing disagreement among water users.

Since a water right is considered property and may be bought and sold, the nature of water requires certain limitations in its use. One of the major difficulties encountered after an adjudication of a stream is the failure of the District Court to have control over the transfer of water rights from their designated places of use. The sale and leasing of water is becoming a common practice on many adjudicated streams and has created serious complications. By changing the water use to a different location, many of the remaining rights along the stream are disrupted, resulting in a complete breakdown of the purpose intended by the adjudication. Legal action necessary to correct this situation must be initiated by the injured parties as it is their responsibility and not that of the court.

At one time or another all of the Western Reclamation States have used similar methods of local regulation of water rights. Now all of them, except Montana, have more or less abandoned these practices and replaced them by a system of centralized state control such as the one adopted by the State of Wyoming. The key characteristics of the Wyoming system are the registration of both the initiation and completion of an appropriation in the State Engineer's Office, the determination of rights and administration by a State Board of Control headed by the State Engineer. These methods give the Wyoming water users title to the use of water as definite and defensible as those which they have to their land.

When Montana began to negotiate the Yellowstone River Compact with Wyoming and North Dakota in 1939, the need for some definite information concerning our water and its use became apparent. The Legislature in 1939 passed a bill (CH. 185) authorizing the collection of data pertaining to our uses of water and it is under this authority that the Water Resources Survey is being carried on. The purpose of this survey is: (1) to catalogue by counties in the office of the Montana Water Resources Board, all recorded, appropriated and decreed water rights including the use rights as they are found; (2) to map the lands upon which the water is being used; (3) to provide the public with pertinent water right information on any stream, thereby assisting in any transaction involving water; (4) to help State and Federal agencies in pertinent matters; (5) to eliminate unnecessary court action in water right disputes; and (6) to have a complete inventory of our perfected water rights in case of need to defend these rights against the encroachments of lower states, or Wyoming or Canada.

GROUND WATER

Ground water and surface water are often intimately related. In fact, it is difficult in some cases to consider one without the other. In times of heavy precipitation and surface runoff, water seeps below the land surface to recharge underground reservoirs which, in turn, discharge ground water to streams and maintains their flow during dry periods. The amount of water stored underground is far greater than the amount of surface water in Montana, and, without seepage from underground sources it is probable that nearly all the streams in the state would cease to flow during dry periods.

It is believed that Montana's ground water resources are vast and only partly developed. Yet this resource is now undergoing accelerated development as the need for its use increases and economical energy for pumping becomes available. Continued rapid development without some regulation of its use would cause a depletion of ground water in areas where the recharge is less than the withdrawal. Experience in other states has shown that once excessive use of ground water in a specific area has started, it is nearly impossible to stop, and may result in painful economic readjustments for the inhabitants of the affected area.

Practical steps aimed at conserving ground water resources as well as correcting related deficiencies in surface water laws became necessary in Montana. Prior to the Legislative Session of 1961, there was no legal method of appropriating ground water. Proposed ground water codes were introduced and rejected in four biennial sessions of the Montana Legislative Assembly—1951, 1953, 1955, and 1959.

In 1961, during the 37th Legislative Session, a bill was introduced and passed creating a Ground Water Code in Montana (Chapter 237, Revised Codes of Montana, 1961). This bill became effective as a law on January 1, 1962, with the State Engineer of Montana designated as "Administrator" to carry out provisions of the Act. However, the 1965 Legislature abolished the office of the State Engineer and transferred his duties to the State Water Conservation Board, effective July 1, 1965. On July 1, 1967, the name of the State Water Conservation Board was changed to the Montana Water Resources Board. Therefore, the Montana Water Resources Board became the "Administrator" of this Act.

Some of the important provisions contained in Montana's Ground Water Law are:

Section 1. **Definitions or Regulations as Used in This Act.**

(a) "Ground water" means any fresh water under the surface of the land including the water under the bed of any stream, lake, reservoir, or other body of surface water. Fresh water shall be deemed to be the water fit for domestic, livestock, or agricultural use. The Administrator, after a notice of hearing, is authorized to fix definite standards for determining fresh water in any controlled ground water area or sub-area of the State.

(b) "Aquifer" means any underground geological structure or formation which is capable of yielding water or is capable of recharge.

(c) "Well" means any artificial opening or excavation in the ground, however made, by which ground water can be obtained or through which it flows under natural pressures or is artificially withdrawn.

(d) "Beneficial use" means any economically or socially justifiable withdrawal or utilizations of water.

(e) "Person" means any natural person, association, partnership, corporation, municipality, irrigation district, the State of Montana, or any political sub-division or agency thereof, and the United States or any agency thereof.

(f) "Administrator" means the Montana Water Resources Board of the State of Montana.

(g) "Ground Water area" means an area which, as nearly as known facts permit, may be designated so as to enclose a single distinct body of ground water, which shall be described horizontally by surface description in all cases and which may be limited vertically by describing known geological formations, should conditions dictate this to be desirable. For purpose of administration, large ground water areas may be divided into convenient administrative units known as "sub-areas."

Section 2. **Right to Use.**

Rights to surface water where the date of appropriation precedes January 1, 1962, shall take priority over all prior or subsequent ground water rights. The application of ground water to a beneficial use prior to January 1, 1962, is hereby recognized as a water right. Beneficial use shall be the extent and limit of the appropriative right. As to appropriations of ground water completed on and after January 1, 1962, any and all rights must be based upon the filing provisions hereinafter set forth, and as between all appropriators of surface or ground water on and after January 1, 1962, the first time is first in right.

Any ground water put to beneficial use **after** January 1, 1962, **must** be filed with the County Clerk and Recorder in the county where the ground water is withdrawn in order to establish a right to use of the water.

Montana's Ground Water Code now provides for three different types of forms available for filing water rights depending upon the nature of the ground water development. The old Form No. 4 became invalid after January 1, 1966.

Form No. 1 **"Notice of Appropriation of Ground Water"**—shall require answers to such questions as (1) the name and address of the appropriator; (2) the beneficial use for which the appropriation is made, including a description of the lands to be benefited if for irrigation; (3) the rate of use in gallons per minute of ground water claimed; (4) the annual period (inclusive dates) of intended use; (5) the probable or intended date of first beneficial use; (6) the probable or intended date of commencement and completion of the well or wells; (7) the location, type, size, and depth of the well or wells contemplated; (8) the probable or estimated depth of the water table or artesian aquifer; (9) the name, address, and license number of the driller engaged; and (10) such other similar information as may be useful in carrying out the policy of this Act. This form is optional but it has an advantage in that after filing the Notice of Appropriation, a person has 90 days in which to commence actual excavation and diligently prosecute construction of the well. Otherwise, failure to file the Notice of Appropriation deprives the appropriator of his right to relate the date of the appropriation back upon filing the Notice of Completion. (Form No. 2.)

Form No. 2 **"Notice of Completion of Ground Water by Means of Well"**—this form shall require answers to the same sort of questions as required by Form No. 1 (Notice of Appropriation of Ground Water), except that for the most part it shall inquire into accomplished facts concerning the well or means of withdrawal, including (a) information as to the static level of water in the casing or the shut-in pressure if the well flows naturally; (b) the capacity of the well in gallons per minute by pumping or natural flow; (c) the approximate drawdown or pumping level of the well; (d) the approximate surface elevation at the well head; (e) the casing record of the well; (f) the drilling log showing the character and thickness of all formations penetrated; (g) the depth to which the well is drilled; and similar information.

It shall be the responsibility of the driller of each well to fill out the Form No. 2, "Notice of Completion of Ground Water by Means of a Well," for the appropriator, and the latter shall be responsible for its filing.

Form No. 3 **"Notice of Completion of Ground Water Appropriation Without a Well"**—is for the benefit of persons obtaining (or desiring to obtain) ground water without a well, such as by subirrigation or other natural processes so as to enable such persons to describe the means of using ground water; to estimate the amount of water so used; and requiring such other information pertinent to this particular type of ground water use.

Montana's Ground Water Code, as amended by the 1965 Legislature, provides for a period of four (4) years after January 1, 1962, for filing on vested ground water rights (all ground water used prior to January 1, 1962, from water wells, developed springs, drain ditches, sub-irrigation, etc.). Therefore, the deadline was December 31, 1965. A person did not lose his vested ground water rights by failure to file within the four-year period although, in the event of a future ground water dispute, he may be called upon to prove his rights in court. If a person files now on ground water developed prior to January 1, 1962, his date of priority becomes the date of filing, rather than the date when the water was first used.

It shall be recognized that all persons who have filed a Water Well Log Form as provided for under Section 1 and 2 of Chapter 58, Session Laws of Montana, 1957, shall be considered as having complied with the requirements of this Act.

It is important to note that ground water law states, **"Until a Notice of Completion** (form #2 or #3) **is filed with respect to ANY use of ground water instituted AFTER January 1, 1962, NO right to that use of water shall be recognized."**

Copies of the forms used in filing on ground water are available in the County Clerk and Recorder's Office in each of Montana's 56 counties. It shall be the duty of the County Clerk in every instance to file the original copy of the county records; transmit the second copy to the Administrator (Montana Water Resources Board); and the third copy to the Montana Bureau of Mines and Geology; and the fourth copy to be retained by the appropriator (person making the filing).

Accurate records and the amount of water available for future use are essential in the administration and investigation of water resources. In areas where the water supply becomes critical, the ground water law provides that the administrator may define the boundaries of the aquifer and employ inspectors to enforce rules and regulations regarding withdrawals for the purpose of safeguarding the water supply and the appropriators (see wording of the law for establishing a "controlled area").

The filing of water right records in a central office under control of a responsible State agency, provides the only efficient means for the orderly development and preservation of our water supplies and it protects all of Montana's use—on both ground and surface water.

METHOD OF SURVEY

Water resources data contained in Part I and Part II of this report are obtained from courthouse records in conjunction with individual contacts with landowners. A survey of this type involves extensive detailed work in both the office and field to compile a comprehensive inventory of water rights as they apply to land and other uses.

The material of foremost importance used in conducting the survey is taken from the files of the county courthouse and the data required includes: landownership, water right records (decrees and appropriations), articles of incorporation of ditch companies and any other legal papers concerning the distribution and use of water. Deed records of landownership are reviewed and abstracts are checked for water right information when available.

Aerial photography is used by the survey to assure accuracy in mapping the land areas of water use and all the other detailed information which appears on the final colored township maps in Part II. Section and township locations are determined by the photogrammetric system, based on government land office survey plats, plane-table surveys, county maps and by "on-the-spot" location during the field survey. Noted on the photographs are the locations of each irrigation system, with the irrigated and irrigable land areas defined. All the information compiled on the aerial photo is transferred and drawn onto a final base map by means of aerial projection. From the base map, color separation maps are made and may include three to ten overlay separation plates, depending on the number of irrigation systems within the township.

Field forms are prepared for each landowner showing the name of the owner and operator, photo index number, a plat defining the ownership boundary, type of irrigation system, source of water supply and the total acreage irrigated and irrigable under each. All of the appropriated and decreed water rights that apply to each ownership are listed on the field forms with the description of intended place of use. During the field survey, all water rights listed on the field form are verified with the landowner. Whenever any doubt or complication exists in the use of a water right, deed records of the land are checked to determine the absolute right and use.

So far as known, this is the first survey of its kind ever attempted in the United States. The value of the work has become well substantiated in the counties completed to date by giving Montana its first accurate and verified information concerning its water rights and their use. New development of land for irrigation purposes by State and Federal agencies is not within the scope of this report. The facts presented are found at the time of completion of each survey and provide the items and figures from which a detailed analysis of water and land use can be made.

The historical data contained in these reports can never become obsolete. If new information is added from time to time as new developments occur, the records can always be kept current and up-to-date.

Complete data obtained from this survey cannot be included in this report as it would make the text too voluminous. However, if one should desire detailed information about any particular water right, lands irrigated, or the number and amount of water rights diverting from any particular stream, such information may be obtained by writing the Montana Water Resources Board in Helena.

Every effort is being made to ensure accuracy of the data collected rather than to speed up the work which might invite errors.

WATER RESOURCES SURVEY

Glacier County, Montana

PART I

History of Land and Water Use on Irrigated Areas

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September, 1969

HISTORY AND ORGANIZATION

The area that now comprises Glacier County was once a part of what was known as the Blackfeet Nation. Prior to encroachment by the white men, the Blackfeet claimed a vast region from the North Saskatchewan River in Canada to the Musselshell River in central Montana. Along the mountain front their claim extended southward to the present Yellowstone Park.

The three tribes of the Blackfeet Nation, the Piegan, the Blood and the North Blackfeet, were the true Plains Indians, having no history or legend of migration from the forests of northeastern United States. These tribes roamed their Nation for hundreds of years, killing buffalo and other game as their needs dictated and their skills allowed; and warring on neighboring tribes. The Crow Tribe to the south, the Assiniboine and Cree on the east and the numerous tribes to the west of the Rockies were all well aware of their Blackfeet neighbors, and constant reminders came from the war parties and raids of the Blackfeet.

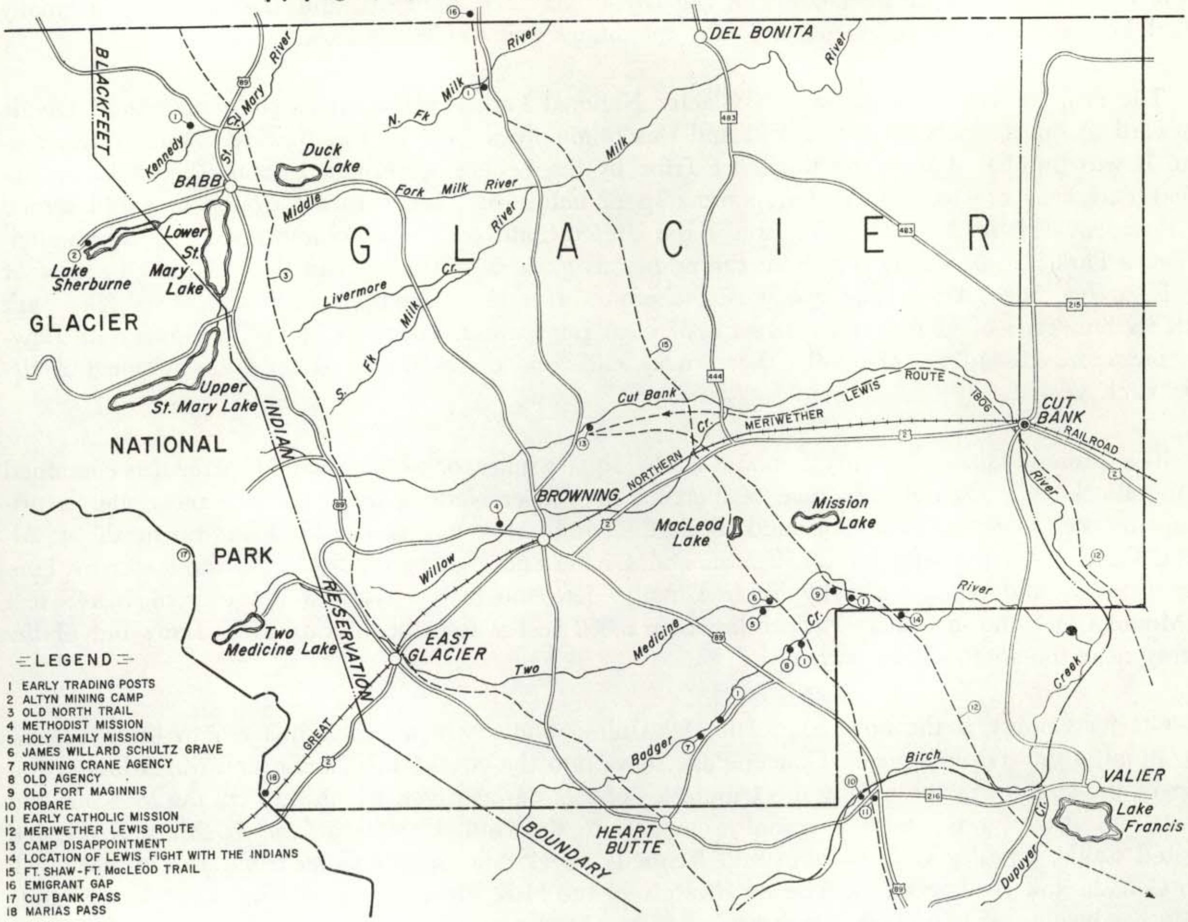
The earliest white men in the Blackfeet Nation were undoubtedly the occasional trappers who drifted in and out of the area in pursuit of their livelihood. The first recorded visit to the area is described in the journals of Lewis and Clark, July, 1806. Meriwether Lewis undertook a side trip with a party of three men to explore the headwaters of the Marias River on their return journey to St. Louis. Lewis hoped to be able to report to President Jefferson that the headwaters of this stream arose north of the 49th parallel, thus extending the boundaries of the newly acquired Louisiana Purchase. The party camped on the Cut Bank River July 22-25, 1806, in a beautiful and extensive valley bottom, deep within the territory of the Blackfeet. Lewis wrote that, "game of every description is extremely wild which led me to believe that Indians had recently been in this neighborhood." Lewis soon discovered that the Marias River arose from the west rather than the north as he had hoped would be the case. Disheartened by this discovery and by the cold rainy weather and shortage of game, Lewis named this farthest point north Camp Disappointment.

In 1830, Kenneth McKenzie sent a party of four men, led by Jacob Berger from Fort Union in search of Indians and to find a suitable location for a trading post. The party finally established a camp at the mouth of Badger Creek and began trading with the Indians in the area. Berger persuaded a number of them to accompany him back to Fort Union, thus opening up trading relations with the Blackfeet which was the beginning of penetration by white men into previously hostile Indian territory.

After the middle of the nineteenth century numerous posts were established to trade with the Blackfeet, and such men as Joseph Kipp, Hugh Monroe, James (Jemmy) Bird, John Kennedy, J. W. Power, Tom McGinnis, A. B. Hamilton, Charles Aubrey, Charles Chouquette, Louis Rivet, Eli Guardipee and C. L. Bristol were prominent in the fur trade in this area. Until the Blackfeet Reservation was established in 1851, fur traders were practically the only white men in the territory.

The extermination of the buffalo marked the end of the most tragic thirty years in Blackfeet history. In 1854 they were the most powerful and independent people in the northwestern plains country. They lived well by hunting buffalo and trading robes to the white men. In the next three decades, the Blackfeet lost the greater part of their land and large numbers of them died in war as well as from disease and starvation. Their independence and culture faded along with disappearance of the buffalo in the early 1880's. It was not without considerable hardship that the Blackfeet finally made the transition from their wild, carefree livelihood to present day society.

HISTORICAL MAP



Several early-day missions were established in or near the Blackfeet Country; the first was a Catholic church built on the non-reservation side of Birch Creek by Father Prando in 1880. The Holy Family Mission was begun in 1889 on the Two Medicine River with funds provided by the Drexel family of Philadelphia and it operated for nearly fifty years. A Methodist Mission was built in the spring of 1893 on Willow Creek near Browning.

When Montana Territory was organized in 1864 this area of Glacier County was a part of Deer Lodge County, and subsequently became a part of Chouteau County and then a part of Teton County until Glacier was created on February 17, 1919. Cut Bank, now the county seat, started as a settlement in 1900 when two houses were built on the west bank of Cut Bank Creek where the Great Northern Railroad crosses this stream. The next spring the town moved across the creek to the top of the bluffs where it is located today. The town of Browning started when the site was chosen for the location of the Blackfeet Agency to bring in bands of roving Indians and establish them on the reservation. The Agency was named for D. M. Browning, who, at that time, was in charge of Indian affairs in Washington, D. C. The Museum of the Plains Indians is also located at Browning.

The town of Babb began around the turn of the century in connection with the copper mining claims in that area, and later the construction of the St. Mary canal system was centered around there. Blackfoot was a division point on the Great Northern Railroad, and East Glacier, originally called Midvale, was an access point to the mountains and to Glacier Park.

The strip of land now known as Glacier National Park extended from the Continental Divide eastward to the foothills of the Rockies and was originally a part of the Blackfeet Indian Reservation. It was purchased from the Blackfeet Tribe by the Federal government about 1895. Glacier National Park was created under the sponsorship of naturalist George Bird Grinnell in a bill signed by President Taft on May 11, 1910, and is the United States section of Waterton-Glacier International Peace Park. It was named not from the numerous glaciers still present in the area, but because of the huge Ice Age glaciers that many years before carved the rugged mountainous scenery. This park with its hundreds of glacial lakes, streams of clear pure water, meadows of brilliant mountain flowers, numerous cascading waterfalls, sheer rocky cliffs and dense forests attract large numbers of visitors each year.

The present Glacier County contains 3,006 square miles, of which about 70 percent is contained in the Blackfeet Indian Reservation, 20 percent in Glacier National Park and the remainder is privately owned. Glacier County, located in north-central Montana, is bounded on the north by Alberta, Canada; on the west by the Continental Divide and Flathead County; on the south by Pondera County; and on the east by Toole County. Extreme land elevations range from 10,448 feet on Mount Cleveland in Glacier Park to less than 3,300 feet where the Marias River flows out of the county near the southeastern corner.

Glacier County is the only county in the United States which has drainage into three oceans. The runoff from Triple Peak in Glacier Park flows into the Arctic, the Pacific and the Atlantic; but most of the streams in the county are tributaries of the Marias River, which through the Missouri and Mississippi Rivers, the waters eventually empty into the Gulf of Mexico. The St. Mary River, fed by Red Eagle, Divide, Swift Current and Kennedy Creeks and many smaller tributaries, drains north into Canada and Hudson's Bay. The headwaters of the Milk River rise on the Blackfeet Reservation, while headwaters of Cut Bank Creek and the Two Medicine River rise in the mountains of western Glacier County and join near the southeastern corner of the county to form the Marias River. Badger Creek is one of the larger tributaries of the Two Medicine River. The water of the St. Mary River is divided between the United States and Canada, and the St. Mary canal carries the United States share, across the Hudson Bay Divide into the North Fork of the Milk River to supply water for the Milk River Irrigation Project in Hill, Blaine, Phillips and Valley Counties, farther to the east.

The main line Great Northern Railroad runs through Glacier County from east to west, and U. S. Highway #2 almost parallels the railroad across the county from Shelby on the east through Cut Bank to Browning to East Glacier on the west to Columbia Falls. U. S. Highway #89 from Great Falls enters the county from the southeast and runs north through Browning, serving Glacier Park, and thence into Canada toward Alberta and Edmonton.

Since the initial discovery of oil in the Cut Bank Field in 1932, the oil industry has been an important factor in the economy of Glacier County. The daily average production of oil is over 11,000 barrels and the cumulative value of the oil and gas produced from this county as of January 1, 1969, is in excess of four hundred million dollars. Union Oil of California is presently operating a 4,000 barrel a day refinery east of Cut Bank. Estimates of the oil and gas yet to be produced in

Glacier County indicate that petroleum will continue as an important economic factor in the future. Stock growing and farming, mostly small grains and hay, are also of major importance to the economy of the county.

CLIMATE

With its western boundary coinciding with the ridge of the Continental Divide, Glacier County has a climate regulated to a large extent by topography. Elevations range from over 10,000 feet MSL on Mt. Cleveland in Glacier National Park down to about 3,200 feet on the Marias River at the southeast corner of the county. From the very mountainous western border the area gradually changes character eastward until one encounters some sections of fairly smooth but rolling land near the Toole County boundary. The county drains generally eastward, except for the St. Mary River which flows northward into Canada. Other main streams are the Milk River, flowing into Alberta east of Del Bonita, and Cut Bank and Two Medicine Creeks which, with Birch Creek, join to form the Marias River near the county's southeast corner.

Within this topographic framework the climate of the county has some large variations in all elements. Precipitation ranges from about 100 inches a year on some of the higher slopes along the Continental Divide, to around 12 inches along the eastern boundary, decreasing generally with distance from the mountains. Annual temperature averages along the eastern boundary are 5°F. or more warmer than along the Rocky Mountain ridge which separates Glacier from Flathead County. Clouds and precipitation are much more common in the higher elevations on the mountains than on the rolling plains of the east half. And annual snowfall ranges from several hundred to locally around 1,000 inches on the Glacier National Park section of the county to as little as 40 inches along the Toole County boundary.

Perhaps the best-known feature of the county's climate is the wind known locally as "chinook." This wind here is probably as strong and persistent as anywhere on the North American Continent, and there is no part of the county which has any appreciable shelter from it. Following the cold invasions of air from Arctic sources, which occur several times each winter, the "chinook" usually starts to blow in about 36 to 48 hours, accompanied by a rapid warming often from well below 0°F. to above 32° in a very few hours. The chinook wind can be quite strong, at times reaching speeds in excess of 60 to 70 m.p.h. Gusts have been reported to have exceeded 100 m.p.h. locally a few times over the years. Strong wind of similar character sometimes precedes an Arctic cold air invasion.

Largely because of the wind influence, which in turn derives from the mountains ridge on the western boundary, low temperature extremes here have not been as cold as one might expect, but on the other hand, really hot weather is rare. The growing season (32°) along the southeast border runs about 108 days a year, averaging from about May 27 to September 12; but this season shortens appreciably in the west half of the county. In the largely agricultural parts of the east half two-thirds to three-fourths of the annual average precipitation falls during the warmer six months of the year. But at Summit and East Glacier (more characteristic of the mountain sections), winter precipitation is greater by quite a margin.

Aside from the sometimes very strong chinook wind, the county experiences very little weather that may be classed as severe. In the west part heavy winter snow occurs nearly every year, but this is normal. Particularly away from the mountains there is much sunshine and clear weather in all seasons of the year. Such things as fog, freezing rain, hail and severe thunderstorms may occur, but not very often. Tornadoes are practically unknown.

The attached table will provide a comparison in some elements between areas of the county:

PRECIPITATION

Station	Years of Record	Elevation	Yearly Average	Growing Season Average	Percent Falling in Growing Season	Wettest Year	Driest Year
Babb	1906-67	4300	19.55	14.08	72	38.07(1951)	9.27(1935)
Browning	1894-67	4355	15.87	10.92	69	28.75(1951)	5.69(1935)
Cut Bank	1904-67	3838	11.59	9.29	80	20.99(1927)	5.36(1935)
Del Bonita	1951-67	4337	14.39	11.23	78	19.78(1964)	9.01(1960)
East Glacier	1950-67	4806	32.11	13.59	42	42.35(1951)	18.91(1960)
Santa Rita	1950-63	3880	11.89	9.33	78	19.05(1951)	6.91(1952)
Summit	1937-66	5213	38.29	15.41	40	55.51(1953)	25.30(1939)

TEMPERATURE

Station	Years of Record	Highest of Record	Lowest of Record	January Average	July Average	Annual Average
Babb	1906-67	96	–53	19.5*	59.7*	39.2*
Browning	1894-67	99	–56	19.3*	62.5*	40.5*
Cut Bank	1904-67	107	–47	18.0*	64.9*	40.9*
Del Bonita	1961-67	100	–32	18.4	62.5	40.5
Summit	1937-66	96	–55	15.3	56.7	35.9

*1938-1967

POTENTIAL IRRIGATION DEVELOPMENT

Glenn R. Smith, Soil Scientist

Dave R. Cawlfield, Consulting Soil Scientist

INTRODUCTION

Many factors determine the desirability of an area for irrigation development. The major ones are soil, water, climate, and markets. The first three determine the capacity of an area to produce; all four determine the kind of **crops** that might be grown and the monetary returns that might be expected. This article is based on a long range projection which **disregards the present available water supply** and **market factors of irrigation.**

Land classification is the systematic appraisal of lands and their designation by categories on the basis of similar characteristics. The Water Resources Board land classification surveys are conducted for the specific purpose of establishing the extent and degree of suitability of lands for sustained irrigation farming. The objective of the survey is to outline the land areas that have a future potential for irrigated agriculture to the ultimate in year 2020. Technological advances in irrigation are considered in this report. The slope and surface topography become less important, because of the rapid expansion of sprinkler irrigation throughout the Western States.

The final test of the success of any irrigation project is the ability of the land to provide economic benefits; it follows, therefore, that land selected for irrigation should ensure that this objective can be achieved. The most important phase of land classification is the separation, according to suitability of the lands satisfactory for irrigation development, which are termed "irrigable" from inferior, non-irrigable lands. The term **"irrigable land"** as used in connection with land classification in the Water Resources Surveys is defined as lands suitable for irrigation by gravity or sprinkler methods. The land must have soil, topography and drainage features which will withstand a sustained irrigated agriculture.

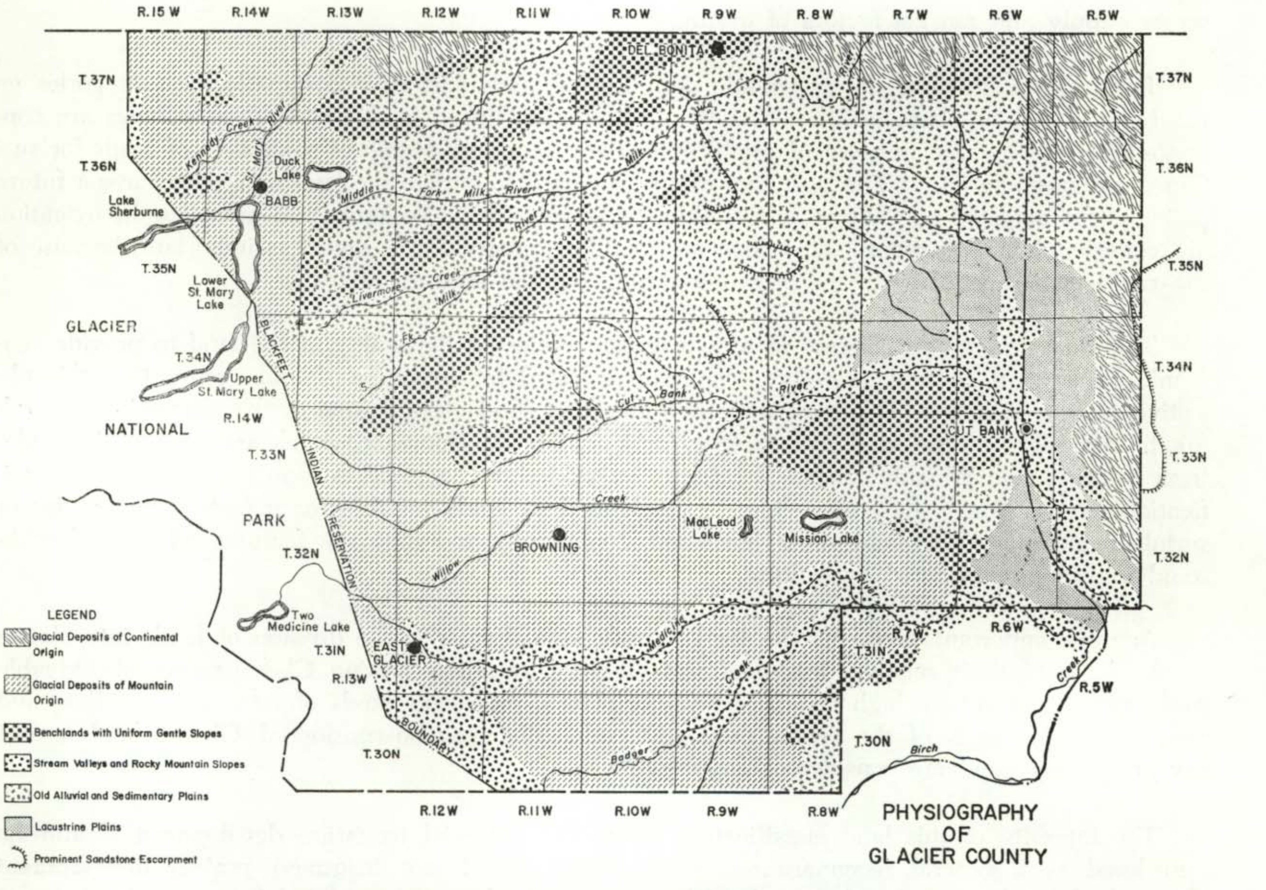
Another important phase of the land classification process is the division of lands into classes on the basis of their relative degree of suitability for irrigation farming. Class 1 represents irrigable lands with a potentially high productive value; class 2 represents lands of intermediate value; and class 3 includes lands of the lowest productive value that may be considered. Class 6 lands are of low productivity and are considered non-irrigable.

The intensity of this land classification survey for potential irrigation development should be conisdered as a general reconnaissance survey, **and any future irrigation project development should be based on a detailed study.** The areas outlined on the potential irrigation development map of this report show irrigable land classes 1, 2 and 3. The presently irrigated lands are shown on another map within this publication.

Before the land classification of Glacier County was started, a standard detailed soil survey had been made. This survey was conducted by the Soil Conservation Service, U. S. Department of Agriculture and the Bureau of Indian Affairs, U. S. Department of the Interior. The soil survey and ensuing studies have not been published, therefore final descriptions of soil series and types are not mentioned in this report. However, draft soil descriptions were used in determining the land characteristics significant to irrigated agriculture. The original soil survey on aerial photographs were made available to the Soil Scientists of the Water Resources Board by the Soil Conservation Service. The soil survey mapping units were studied and correlated into a land classification for the purpose of identifying the soils suitable for a sustained irrigated agriculture. The land classification was then studied and checked in the field.

LAND CLASSIFICATION

For the purpose of evaluating the land characteristics of the county the physiographic features are used to divide the area into six main categories. These are shown on the physiography map of Glacier County. The physiographic features and soils are described by areas shown on this map.



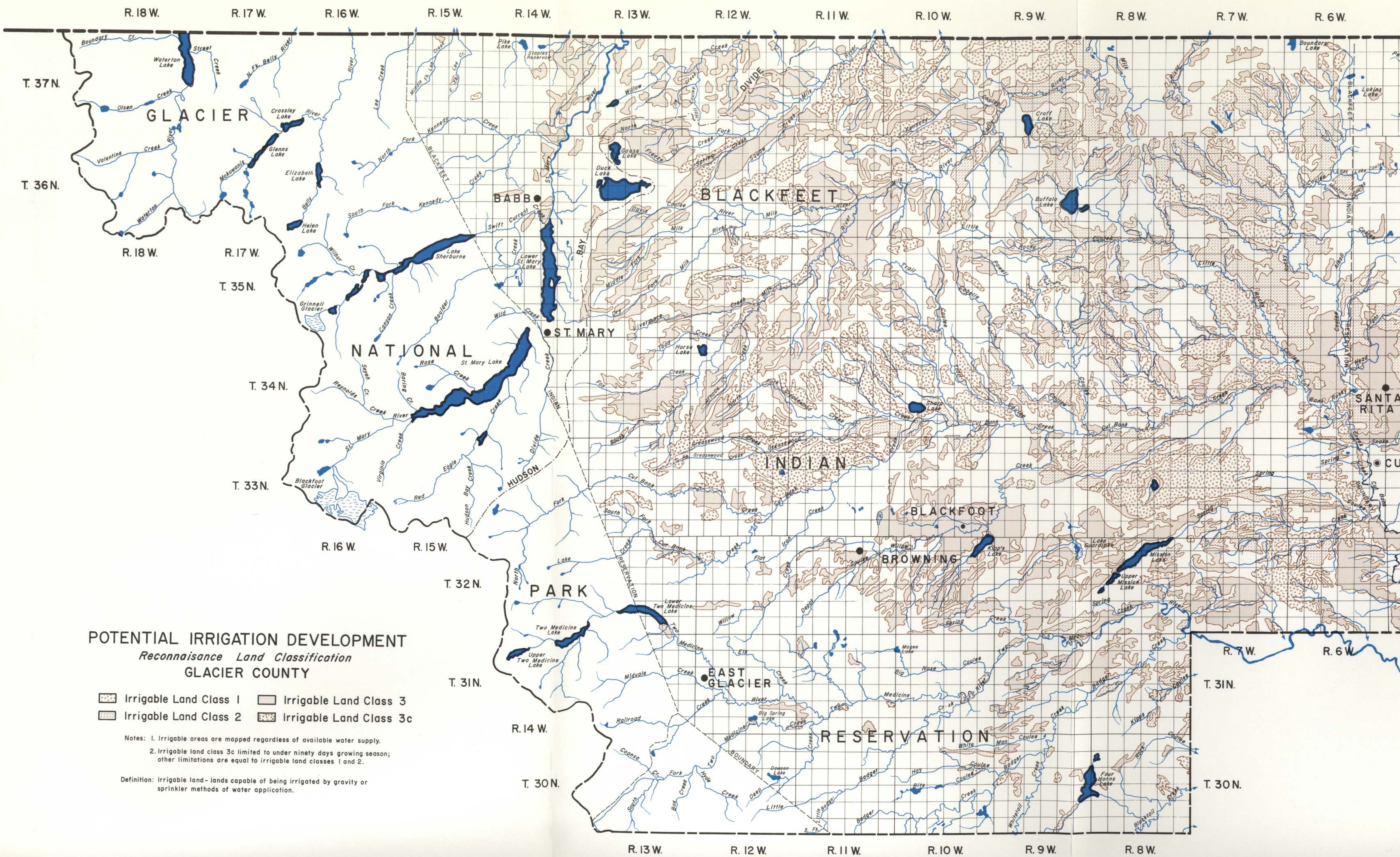
PHYSIOGRAPHY OF GLACIER COUNTY

THE GLACIAL DEPOSITS OF CONTINENTAL ORIGIN

Physiographic Features

During the Wisconsin Glaciation period, the Keewatin Glacier of the north which covered eastern Montana, influenced Glacier County in several areas. The eastern township (Range 5W) was mostly covered with continental glacial till. Along the Canadian border there are glacial till deposits from three lobes of the northern ice sheet which extended into Glacier County for short distances in Ranges 7, 10 and 12 West.

The glacial till along the Canadian line has a moranic topography and in the basin along Wil-



POTENTIAL IRRIGATION DEVELOPMENT

Reconnaisance Land Classification

GLACIER COUNTY

- Irrigable Land Class 1
- Irrigable Land Class 2
- Irrigable Land Class 3
- Irrigable Land Class 3c

Notes: 1. Irrigable areas are mapped regardless of available water supply.

2. Irrigable land class 3c limited to under ninety days growing season; other limitations are equal to irrigable land classes 1 and 2.

Definition: Irrigable land - lands capable of being irrigated by gravity or sprinkler methods of water application.

low Creek the pot holes are filled with water. The covering of till is variable in thickness; there are differences of 100 feet or more, often occurring between the surface of the pot holes and tops of the moranic ridges. The elevations of the Willow Creek Basin varies from 4,500 to 5,000 feet.

In the southeastern part of the county the glacial till has more gentle relief, commonly described as a "swell and saucer" type of topography. The topography becomes more hummocky to the west and around Four Horn Lake. It grades into the moranic ridges of the mountain glacial till. The covering of till commonly does not exceed 20 to 25 feet above the bedrock material. The elevation of the southeastern and eastern glacial plains varies from 3,700 to 4,300 feet.

It is believed that the great ice mass on the eastern edge of Glacier County blocked off the normal eastward drainages and caused a great glacial lake in the vicinity of Cut Bank.

Continental Glacial Soils

Continental glaciation influenced the soils of the glaciated plains; the sand, silt, clay, gravel and boulders were picked up by the ice sheet which mixed them by crushing and then redepositing the mixture as glacial till. This mantle varies from less than one foot to over 100 feet in thickness. Although the glaciers mixed materials it had carried for long distances with materials from underlying bedrock, in the main the largest percentage of till is of local origin, in other words, it strongly reflects the nature of the underlying bedrock.

The movement of the glaciers caused the till to be deposited in a number of different land forms. The rolling hummocky topography represents the glacial till mantled uplands. There are stony mounds separated by shallow depressions that formed at the time glacial movement was temporarily or permanently halted.

The till varies in permeability depending on its chemical and physical composition. For example, texture, salt content and the amount of free carbonates vary.

Because of the combination of undesirable topography and till material large areas of land are unsuited for irrigation. The undesirable till material of the glacial uplands in eastern Glacier County consist of heavy clay loam to clay textures having a high density and slow vertical movement of water. The undesirable drainage factor plus the hummocky rolling topography limits the majority of the continental glaciated areas of Glacier County to dryland agriculture or range use.

The rolling upland areas of undulating topography are irrigable only when tne glacial till is deeper than 36" from the ground surface, and where the glacial till is at least moderately permeable. The topography usually limits the water application to sprinkler irrigation. The areas generally require drainage to allow an adequate root zone over the water table which will tend to perch above the glacial till. The small amount of potentially irrigable land is located along the Toole County line.

THE GLACIAL DEPOSITS OF MOUNTAIN ORIGIN

Physiographic Features

During the Wisconsin Glaciation period, the main divide of the Rocky Mountains was a collecting ground for glaciers. On the eastern slopes of the mountains the glaciers pushed down the canyons and deployed on the tablelands and in the stream valleys. Some of the glaciers left well defined glacial deposits extending out from the mountain front, while others merged with adjoining glaciers. The Two Medicine Glacier (also referred to as the Blackfoot Glacier) is a collection of five valley glaciers and extends for about 50 miles east from the Summit on Marias Pass and about 30 miles south of Browning. This is the largest till-covered area along the mountains.

In the northwestern part of the county, a glacier of great size occupied the valley of St. Mary's River, which extended north across the Canadian border. In the vicinity of Duck Lake, the glacier pushed over the Hudson Bay Divide and extended eastward for several miles. The tremendous pushing action of the glaciers caused a very hummocky topography. These large areas are limited to livestock grazing.

Mountain Glacial Soils

The mountain glaciers originated in the highlands and moved down to lower elevations. The glacial till was deposited in recessional ridges and is variable in depth. The depth increases toward the mountains and in the valleys of some of the glacial streams. The till is very stony and contains the characteristic red, green, white, black, and mottled quartzite (a granular metamorphic rock composed essentially of quartz) and agrillites (a slightly metamorphased rock formed from sediments containing clay and silt) with some diorites and silica conglomerate.

The characteristic features of the glacial material as well as the manner in which the till was deposited has a direct influence on the soils, topography and drainage of the local area.

The St. Mary's Glacier was a huge ice sheet that exerted a pushing action causing a very rough, hummocky topography; an example is the area around Duck Lake. The glacial deposits consist of large cobbles and gravels with little intermixed soil material. There are scattered areas of loamy soils over the till with a sufficient depth to warrant potential irrigable class 3 land. However, the majority of the glaciated area is limited to rangeland for livestock grazing.

The Two Medicine or Blackfoot Glacier spread over a much larger area, the preglacial topography was a more gently rolling type. The glacial till material is generally shallow in depth over the bedrock. The erosion since glaciation has exposed the shale and sandstone parent material in places. The majority of the soils are shallow in depth and are used for rangeland. An exception is the area from northwest of Browning, east to the Two Medicine River in Range 6 West; measuring about 35 miles from east to west at an elevation of 3,900 to 4,500 feet. The soils here developed from a calcareous clay loam till. The soil profile consists of a thin dark colored soft granular "A1" horizon; a dark brown prismatic-blocky clay loam "B" horizon with distinct clay skins on ped surfaces; and a moderately developed horizon of lime accumulation in the upper part of the clay loam-till parent material. The limiting factors are the depth of soil over till; the amount of cobble and gravel in the upper soil profile; the rough or hummocky topography; and drainability of the soil. The majority of the soils that are irrigable are in class 3. Included may be as much as 40 percent class 6 within a delineated area. The main crops under present irrigation are pasture and hayland.

When the advances of the glaciers halted, the ice melted. The melt-water sorted the glacial till. This water-sorted material is called glacial outwash. The size of particles that running water is capable of moving is directly proportional to the velocity of the water. As a result the coarser sediments are deposited when the velocity of the stream is high. The irrigability of the glacial outwash fans and terraces in northwestern and western Glacier County is directly related to the manner in which the material was deposited by the glacial streams. Many areas have large cobbles and very coarse gravel strewn over the surface and within the upper portion of the soil profile. The amount of soil over the gravel and cobble sub-strata varies from a few inches to more than 60" with the very shallow depths predominating. There are large acreages of class 6 land because of the very low water holding capacity of the soil and the difficulty of tillage.

There are small acreages of glacial outwash fans and low terraces that have soils and topography favorable for irrigation. The limiting characteristic is the depth to loose sand, gravel and cobble. Most of the areas are designated as irrigable class 3. The main potential land use is sprinkler-irrigated pasture and hayland.

LACUSTRINE PLAINS

Physiographic Features

The melting of the glacial ice caused an abundance of water either in running streams or in lakes in enclosed basins. The coarse materials, sand and gravel, usually occur near the margins of the glacier, and along short lines of glacial lakes and ponds. The alluvial fans associated with lacustrine beds are generally irrigable. The soils vary from light to heavy textured with the coarser textures usually occurring on the upper part of the fans.

Lacustrine Soils

The sediments that settle out of quiet waters are called lacustrine deposits. The coarser materials generally settle out before entering the quiet waters leaving the finer materials of silt and clay to settle in the lake basin. Soils that are formed from the lacustrine deposits are high in silt and clay.

The lacustrine soils vary in suitability for irrigation according to texture, permeability of the subsoil, and salt and alkali content. The salinity of the water in lakes varies according to the amount of salt present in the formation that the water passed through. There are several lake basins within the county that have an unfavorable salinity level for crop production.

The lacustrine soils that have satisfactory texture, structure, permeability and salt content for irrigation are present in large bodies on very gently sloping lake plain areas north and south of Cut Bank.

A typical soil profile of the irrigable lacustrine soils is as follows:

0" - 6" Dark grayish brown moist strongly calcareous silty clay; fine granular structure soft in the upper 2"; friable, sticky, plastic; abrupt boundary; ph 8.2.

6" - 9" Very dark grayish brown noncalcareous silty clay; weak very coarse prisms separating to coarse and very fine blocks; very hard, friable, very sticky, very plastic; thin continuous clay skins on peds; ph 8.0.

9" - 15" Colors as in the horizon above; mildly calcareous silty clay loam; weak very coarse prisms separating to moderate coarse to very fine blocks; very hard, friable, very sticky, plastic; thin continuous clay skins on all peds; gradual boundary; ph. 8.4.

15" - 28" Very dark grayish brown moist stony calcareous silty clay; compound structure of moderate coarse prisms separating to moderate coarse and medium blocks; extremely hard, firm, very sticky, plastic; clay skins of moderate thickness on prism faces; a few nodules of segregated lime; ph 8.4.

28" - 34" Dark grayish brown moist stony calcareous silty clay with moderate amount of segregated lime in nodules; extremely hard, firm, very sticky, plastic.

Below 3' or more Thinly stratified or varved clay with silt and very fine sand lenses are common. When dry, these sediments are quite hard, but when moist they break easily into weak thin plates that separate into angular blocky structure.

The variable limitations for irrigation are the drainage characteristics of the subsoil. The stratified sand and silts below 3 feet will aid subsurface water movement; while the continuous clay texture may restrict drainage. Whenever irrigation development is planned a detailed study should include deep borings, laboratory analysis for salinity and sodium; and other related studies to determine the drainability of the soil.

Very careful irrigation water management is needed on lacustrine soils. Irrigation water should not be allowed to pond on the surface. Border dikes permit most efficient use of irrigation water if a sufficient head of water is available.

The majority of the lacustrine soils are in irrigable land class 3. This is because of permeability and poor workability.

BENCHLANDS WITH UNIFORM GENTLE SLOPES

Physiographic Features

The higher plateaus of Glacier County are benchlands. They are 400 to 600 feet above the level of the streams and have about the same gradient as the present stream valleys. The stony plateaus are 1 to 5 miles wide and have smooth plain surfaces. They slope to the east and are dissected by wide stream valleys. The plateaus range in elevation from approximately 4,300 feet along the Canadian line north of the South Fork of the Milk River to 6,200 feet on the St. Mary's and Milk River ridges east of Divide Mountain.

The protective covering of these plateaus is well-rounded waterworn resistant quartzite and agrillite gravel and cobbles ranging from 1 to 6" or more in diameter. The gravel and cobbles are of variable thickness and were laid down before glaciation.

A portion of these plateaus form St. Mary's Divide between the St. Mary's River and the Middle and South Forks of the Milk River. They also form Milk River Ridge between the South Fork of the Milk River and Cut Bank Creek. Milk River Ridge which is flat topped, is south of the South Fork of Milk River and extends northeast as far as the mouth of the Middle Fork. In the central part of the county, north of Cut Bank Creek, quartzite gravel and cobbles cap the higher hills and slopes between elevations of 4,300 to 4,500 feet.

The benchlands of Glacier County are at lower elevations than the plateaus. They vary in size from Seville Bench to the small alluvial benchlands near present streams. The characteristic red and green agrillite and quartzite gravels are spread over the surfaces and throughout the soil on all the benches.

Seville Banch is located west of Cut Bank. This large bench borders the valley of Cut Bank Creek on the south. It is about 14 miles long by 3 miles wide and slopes gently to the east. Th bench is at elevations of 3,800 to 4,100 feet and lies 100 to 300 feet above the valley of Cut Bank Creek. It has a plain surface with low gravelly bars rising 1 to 2 feet above the ground level in the western part. The benchland terrace is underlain by as much as 40 feet of unconsolidated materials. The terrace deposits consist of a lower layer, of coarse gravel mixed with finer materials, and an upper layer, of sand, clay, silt and scattered pebbles and cobbles. This bench occupies an erosional surface younger than the high plateaus in front of the mountains, but was eroded to its present level before glaciation.

Soils of the Plateaus and Benchlands

There are several of these plateaus and benches. The majority of irrigable class 1 and irrigable class 2 lands in Glacier County are located on these plateaus, benches and the slopes formed by erosion and recession of the benchlands.

The elevations of the plateaus and benches vary from 3,800 to 6,200 feet which influences the climate. The climate influences the soil forming processes particularly the surface layers. The soil of high plateaus are Cryoborolls (Chernozems) soils. These soils may be in areas with less than a 90 day growing season. The summer temperatures are cool and evaporation is low. The surface is dark-colored for at least 10 inches, with a clay accumulation in the subsoil and a high lime zone below the clay subsoil.

The lower benches below 4,300 feet elevation have Argiborolls, Haploborolls and Calciborolls (Brown-Chestnut and Calcisol) soils. Their presence suggests a transitional climatic condition. These soils are characterized by moderately dark to dark colored surface layers less than 10 inches thick. The clay accumulation on the Argiborolls soils begins at about 3 inches, and extends to about 10. There is a lime zone at depths ranging from 7 to 15 inches.

The soils of the plateaus and benches are quite uniform, however, variable depth of dark colored soils above a high lime-zone occur in parts of the mapped areas. The lime layer is not considered as a limiting factor to irrigability except where the lime-zone occurs within the upper 12 inches of the surface. In this case the irrigable land class is lowered from class 1 to class 2 because of the difficulty of maintaining fertility and germination of some row crops.

The characteristic protective covering of well-rounded waterworn gravel and cobble of the benchland soils may hinder tillage. This is particularly true on the high benches where the accumulation of gravel and cobbles are thickest.

A typical soil profile of the high plateau and benchlands is as follows:

0" - 3" Very dark brown, moist, noncalcareous silt loam; moderate fine crumb structure, very friable.

3" - 5" Dark brown, moist, noncalcareous heavy silt loam; weak medium prismatic separating to strong very fine angular blocks; friable, thin continuous clay skins on all ped surfaces; gradual boundary.

5" - 15" Slightly dark brown moist, noncalcareous silty clay loam; with many cobbles and gravels in the upper 15"; moderate medium prisms and moderate fine subangular blocks; friable; clay skins of moderate thickness on all peds; clear boundary.

15" - 17" Grayish brown coated, moderately calcareous clay loam; moderate medium prisms; friable, sticky, slightly plastic; clear irregular boundary.

17" - 34" White to pale brown strongly calcareous clay loam with much segregated lime as masses of disseminated calcium carbonate with tongues of brown from upper horizon; moderate fine angular blocky structure; friable, sticky, slightly plastic; gradual boundary.

34" - 45" Dark brown, moderate calcareous clay loam; weak fine angular blocky; slightly hard, friable, sticky.

45" - 60" Brown with common large distinct mottlings of light yellowish brown mildly calcareous clay to light clay loam; firm very sticky.

The surface texture may be loam, silt loam, and clay loam soil. The subsoil texture varies from clay loam to silty clay loam with some profiles having a clay texture in the lower depths.

The largest presently irrigated area in Glacier County is on Seville Bench. The Two Medicine Canal runs through the central portion of the bench and supplies irrigation water for an estimated 18,000 acres of land. The project development started in 1910 when the United States Reclamation Service constructed canals from Two Medicine Creek.

The principal irrigated crops are alfalfa, small grains, and pasture. The crops are limited by market demands and climate. Sugar beets were grown but due to the short (116-day) growing season and marketing conditions this crop was abandoned.

The soils of the Seville Bench are similar to other low benchland areas within the county. A typical soil profile is as follows:

0" - 2" Very dark brown, moist, gravelly loam; weak very fine crumb structure; very friable, abrupt smooth boundary.

2" - 8" Dark grayish brown, moist, gravelly clay loam; strong medium prisms separating to moderate fine medium blocks; friable, sticky, moderately thick clay films on ped surfaces; abrupt boundary.

8" - 17" Light brownish gray, moist, many distinct lime mottles, gravelly clay loam; coarse prismatic structure; friable, sticky and plastic; very strongly calcareous with much buckshot lime in spots; clear irregular boundary.

17" - 45" Very pale brown moist clay loam; weak coarse prismatic structure; firm, sticky and plastic; very strongly calcareous as a nearly continuous mass of lime buckshot; clear, irregular and wavy boundary.

45" - 66" Light olive brown, moist, light clay loam; massive; hard, firm, sticky and plastic; strongly calcareous mass but much less presence of segregated lime.

The range in characteristics of the soil are: The solum thickness ranges from 4" to 12" with 8" to 10" being most common. The gravelly loam is the most prominent texture and some areas are very gravelly with many cobble size fragments. Clay content ranges from about 25 to 35 percent. Lime accumulation is distinct, in many places prominent buckshot size concretions are abundant immediately below the solum, or at 15" to 25" these are hard when dry but soft when moist. The underlying material is calcareous clay loam or sandy clay loam containing few to 40 percent of argillite gravels. Loose gravel or earth filled gravel beds underly the soil generally below 5 feet. The gravel beds may be absent in some sloping areas. Gravel beds are most common on Seville Bench and other benchlands in the central part of Glacier County.

Drainage is a limitation under irrigation where soil texture, structure, and chemical composition hinder the downward movement of water. The U. S. Geological Survey study of 1965 established the presence of a high water table on some irrigated land of Seville Bench. They have also determined that this problem can be corrected by construction of drainage ditches.

The U. S. Geological Survey studies reveals that the basic problem is the inadequate transmission of water through the terrace deposits. This results in a water table very near the ground surface during the irrigation season.

The irrigable soils of Seville Bench and other benchlands are considered drainable, and the underlying gravelly deposits usually can be reached by drainage ditches. The construction of drainage ditches prior to and after irrigation development may be necessary for allowing maximum root zones for alfalfa and cultivated crops.

The benchlands and high plateaus may be considered as the best potential irrigable lands within Glacier County. The main restricting factor in many of the areas is water delivery to the high benches which are several hundred feet higher than surrounding areas.

STREAM VALLEYS AND ROCKY MOUNTAIN SLOPES

Physiographic Features

The major streams of Glacier County flow through varying types of terrain. Consequently, there are a number of different kinds of alluvial soils.

The streams that are deeply entrenched in shale and sandstone are the South Fork of the Milk River in Township 37 North, Range 8 West; Cut Bank Creek in Township 34 North, Range 8 West and Township 3 North, Range 6 West to the county line; Two Medicine Creek for the entire length of its flow through the county; and Badger Creek for the majority of flow through Glacier County.

The widths of the stream valleys vary from 1/4 mile to 1 mile. The sandstone and shale breaks are usually abrupt, however, more gently sloping formations occur in some areas.

Stream Valley Soils

In general, the alluvial deposits of the stream bottoms in Glacier County add very little irrigable land for future potential irrigation. The stream valleys of the northern and eastern part of the county are heavy textured surface soils with stratified clay, silt and sand substrata. The soils are generally alkaline and may become seeped if irrigated, except in places along the Milk River and lower stream terraces.

The upland stream valleys of the western portion of the county contain a large amount of cobble and gravel. The limiting soil characteristics are low water holding capacity and a large amount of gravel and cobble in the upper 12 inches. There are several areas which have sufficient soil depth over the gravel and cobble substrata for irrigated pasture and hayland. These class 3 irrigable land areas are located along Cut Bank, Two Medicine, and tributaries of the Milk River.

THE OLD ALLUVIAL AND SEDIMENTARY PLAINS

Physiographic Features

A large portion of Glacier County was not covered by the glacial ice sheets. However, the drainage from the mountain glaciers eroded and altered the land forms of the non-glaciated areas.

There are ancient stream valleys that occur in different parts of the county. Some of these stream courses are of preglacial origin, while others were formed during the time the streams were diverted by ice. The erosion by these streams has, in many places, cut the original bench and plateau to where they are now just remnants or ridges. The processes of erosion formed many gently sloping outwash alluvial terraces, rolling residual plains, and steep sandstone, shale, and colluvial valley slopes.

The ancient stream courses can be identified by gaps in the original geologic land form. Several locations of the ancient stream valleys are as follows:

In T. 37N - R. 7W, is a poorly drained gap, 1/4 to 1/2 mile wide, bordered by high sandstone cliffs, that connects the South Fork of the Milk River with Rock Creek.

Below the sandstone escarpment west of Croffs and Buffalo Lakes is a poorly drained alkali basin connecting the South Fork of the Milk River with Little Rocky Creek. The upper part of the basin is dominantly stony glacial till. The lower part is a broad, clay alkali flat.

In the central part of the county, Cut Bank Creek was diverted from its preglacial valley by mountain glaciers. South of this creek is a basin about 15 miles long by 1 to 2 miles wide, covered with glacial outwash gravel.

Other streams were also locally diverted by the ice sheets in other parts of the county. The sags between the high stony benches north of the North Fork of the Milk River are also called "gaps."

Soils of the Old Alluvial and Sedimentary Plains

Although a large portion of Glacier County was not covered by the glaciers the drainage from the melting ice caused erosion of soil in unglaciated areas. The topography was also altered by glacial melt waters and present streams.

The soil materials within the preglacial plains area are alluvial, colluvial, and residual. The original land forms of plateaus and benches have been identified previously in this report. Other land forms not previously described are alluvial terrace fans, colluvial slopes, and sloping stream valleys.

The majority of the preglacial plains area has rough topography, and shallow residual soils developed from the early sedimentary formations. The main sedimentary deposits are: Colorado shales, Virgelle sandstones, Two Medicine formation, Bearpaw shale, Horsethief sandstones, St. Mary formation and Willow Creek formation.

The soils formed from the sedimentary calcareous shales are light colored, immature and below 3 to 5 inches often have the structure and stratifications of parent sandstones and shales. In the central part of the county the immature soils developed over red shales and sandstones, have distinct reddish color. The soils that occur above the sandstone escarpments on undulating benches in the northern part of the county are dark with carbonate zones below 8 to 12 inches. Red sandstone slabs characterize the surface of these soils.

The soils developed over noncalcareous, dark colored shales have a heavy texture and are underlain by shale at shallow depths. These soils are dominant on breaks of Two Medicine Creek, east of Glacier Park Station. The slightly calcareous surface soil forms a granular mulch. The platy structure of the parent shales is present below 1 to 3 feet. These soils are distributed over the east half of the county at lower elevations.

Residual soils from sedimentary shale and sandstone occupy approximately 397 square miles of Glacier County. The large areas generally coincide with the old alluvial sedimentary plains, but there are also large areas within the Blackfoot Glacier area that has had most of the thin glacial till cover eroded from the surface.

The residual soils formed from the sedimentary shales and sandstones are not suited for irrigation; livestock grazing is the best use.

There are large acreages of alluvial and colluvial soils within the sedimentary plains area.

These soils are located on the slopes of eroded benchlands, alluvial fans and terraces, and in stream bottoms.

A typical profile of sloping and secondary benchlands below the old high benches is as follows:

0″ - 3″	Very dark brown cobbly loam of moderate very fine crumb structure; loose, moist and dry, slightly sticky; clear boundary.
3″ - 5″	Very dark grayish brown loam; weak moderate blocky structure; loose, very friable, slightly sticky; clear boundary.
7″ - 11″	Brown clay loam; moderate coarse prismatic structure, slightly hard, friable, sticky and slightly plastic; gradual wavy boundary.
11″ - 26″	Pale brown clay loam; weak coarse prismatic structure; slightly hard, friable, sticky and plastic, strongly calcareous, gradual boundary.
26″+	Very pale brown clay loam; somewhat stratified; less lime than above.

The range in characteristics of the soil are: The amount of gravel and cobbles in the surface varies but it is quite definitely cobbly in most areas. The depth to shale varies. If irrigation development is planned, a detail study of the soil should be made.

The valley lands along the Milk River and its tributaries have several areas of Argiborolls soils forming on the terraces and bottomlands. The acreage of the irrigable soils is somewhat limited because of poor drainage and alkali; however, the value of the drained areas for hayland is quite high.

The soils have a loam to silt loam surface, underlain by a silty clay loam, "B" horizon to a depth of 9", a calcareous silt loam to 18"; with stratified silt and silty clay loams below. The drainage of these terraces and bottomlands is generally good under dryland conditions; however, drainage problems may develop under irrigation and it might be necessary to provide drains for good crop production.

The shallow gravelly low terraces along the central portion of Cut Bank Creek and other present and ancient stream valleys are considered irrigable. The moisture-holding capacity of the soil is barely adequate to maintain growth of irrigated pasture or hayland. These are class 3 irrigable lands.

CLIMATE

The climate of Glacier County influences the adaptable crops under both irrigation and dryland farming. This is noticeable in the crop pattern of dryland wheat farming. The area near Cut Bank is a high producing wheat area while the area near Browning is grassland. The distance between these two towns is only 35 miles yet the land use pattern differs. The reason for the difference is the length of growing season. "Climate and Man", the U. S. Department of Agriculture 1941 Yearbook, lists the average length of the growing season at Cut Bank at 117 days; at Browning 93 days. The average date of the last killing frost in the spring at Cut Bank is recorded as May 23, and at Browning on June 6. The average date of the first killing frost in the fall is recorded at Cut Bank on September 17 and at Browning on September 7. The successful production of cultivated crops is limited where the length of the frost-free growing season is less than 90 days. The freezing temperatures are highly variable in Glacier County due to the increase in elevation near the Rocky Mountains. The length of the growing season becomes less than 90 days between Cut Bank and Browning at an approximate elevation of 4,300 feet.

The potential irrigation of an area is governed by climatic conditions as well as other limiting factors. The irrigable land classes 1 and 2 will grow locally adapted cultivated crops. Class 3 irrigable lands may not be suited for cultivated crops, but are suited for hay and pasture. The use of these lands for irrigated hay and pasture tends to stabilize the livestock industry. The importance of hayland for ranching must not be overlooked, however, the net returns from an acre of irrigated pasture or hayland is usually not as great as from cultivated crops. Therefore, all irrigable lands with less than a 90 day growing season are classified no higher than class 3. The areas shown on the land classification map show the irrigable class 3C designation for lands that meet the requirements for class 1 and 2 except for the growing season.

SUMMARY

Livestock grazing is the principle agricultural use for much of the land in Glacier County, however, dryland wheat and other small grains are grown extensively in the eastern part of the county. The majority of the irrigated land in Glacier County is located on Seville Bench west of the town of Cut Bank. There are other small tracts of irrigated land near the town of Browning and along the larger streams.

The expansion of irrigation can be accomplished in several areas, the largest is the remaining dryland cultivated and grassland area adjacent to the presently irrigated land on Seville Bench. The small acreages of irrigable land adjacent to the larger streams could be developed by individual land owners and the Blackfeet Indian Tribal Council. The remaining irrigable acreages of the benchlands and high plateaus will be very difficult to irrigate because of high elevation above the existing water supply. It may be possible to install pumps and lift water several hundred feet onto the benchlands and high plateaus, however, the high pumping costs may not be economically feasible at present.

The reconnaissance land classification of Glacier County shows a total of approximately 460,989 irrigable acres suitable for irrigation. There are 67,320 irrigable acres of class 1 land; 113,194 irrigable acres of class 2 land; and 280,475 irrigable acres of class 3 land. The class 3 irrigable acreages includes 53,139 acres which are limited to less than a 90 day growing season; except for this climatic limitation the acreage could be considered as class 1 or 2 lands. The reconnaissance land classification does not attempt to separate the type of irrigation as to sprinkler or gravity. Considering the general nature of a reconnaissance study it is possible that detail studies will show either an increase or decrease in the irrigable areas by as much as 10 to 20 percent in some areas.

The climate of Glacier County is considered a limiting factor for irrigated cultivated crops. The high benches and other areas above an elevation of approximately 4,300 feet have less than a 90 day growing season. Under irrigation these soils will produce hay and pasture but production of cultivated crops is marginal. The soils and topography of the areas may be favorable for irrigable land classes 1 and 2, however, because of the climatic limitation these irrigable lands are in class 3.

Drainage in agriculture is the process of removal of excess water from soil. Excess water discharged by flow over the soil surface is referred to as surface drainage. Water flow through the soil is termed internal or subsurface drainage. The terms "artificial drainage" and "natural drainage" indicate whether or not man has changed or influenced the drainage process. The evaluation of the soils and topography of the irrigated and potentially irrigable lands of Glacier County show that artificial drainage is necessary in many areas.

The high water table on the presently irrigated lands of Seville Bench, and the adjoining area show that artificial drainage is necessary to obtain sustained high crop yields. The construction of open ditch drains should correct much of the high water table difficulties of the presently irrigated lands of Seville Bench.

It is anticipated that the expansion of irrigated agriculture in Glacier County will be developed on a project basis. Whenever an area of irrigation project development is anticipated both a detailed land classification and drainage investigation should be completed prior to construction. The drainage survey will establish the cost of minimizing seepage and salinization of the soil. It should be remembered soil that has become seeped and strongly alkaline or saline to the point where crop production is curtailed, is a waste of arable cropland.

The local Federal and State Agricultural Agencies have soil surveys and experimental information available that help determine areas for future irrigation and management or presently irrigated land within Glacier County. Contacting these Agencies will save individual farmers money and labor, and will also conserve the land for future use.

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Acknowledgements

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CROPS AND LIVESTOCK

Glacier County is located in the western part of north central Montana and borders the southern boundary of the Province of Alberta, Canada. The western portion of Glacier County contains 369,677 acres of Glacier National Park and 25,304 acres of Lewis and Clark National Forest. There are 874,172 acres of Indian trust land in Glacier County which includes tribal trust land and 9,000 acres of government reserved land within the Reservation. From the high mountain peaks of Glacier National Park on the western border of the county, the topography gradually changes from rugged mountainous terrain to fairly smooth but rolling land near the Toole County boundary.

The growing season along the southeast border is about 108 days a year, averaging from about May 27 to September 12. The season shortens appreciably in the western half of the county with two-thirds to three-fourths of the annual average precipitation falling during the warmer six months of the year.

The area contains approximately 1,903,360 acres of which 83.6 percent is in farms. The economy of the area is largely agricultural with some oil and natural gas production. There is also a small lumber industry in the county, and recreational facilities in Glacier National Park. There are, according to the 1960 census, 404 farms with an average size of 3,938.4 acres with 13.4 percent of the farms leased (tenant operated) in 1960. Glacier County has 352,303 acres of cropland of which more than 50,000 acres are classed as irrigable land; 25,348 acres are being irrigated; 1,027,565 acres are classed as range lands; and 151,018 acres are classed as forest land. The western portion of the county is devoted largely to livestock production, principally cattle which graze on high native meadows and irrigated hay lands along the creek bottoms. The eastern half of the county is largely devoted to small grain production, with barley, winter and spring wheat, some mustard, rye and oats also grown.

The Two Medicine Irrigation Project has approximately 24,000 acres under constructed works and the water is supplied from the Two Medicine Dam which has approximately 13,000 acre-feet storage capacity. Water from Badger Creek is diverted to Four Horns Reservoir for storage and use in Badger-Fisher Irrigation Project in Pondera County. For more detailed information on the Blackfeet Irrigation Project see the write-up on page 56 of this report.

From Montana Agricultural Statistics—Volume XI—1967

Crops	Irrigated Acres	Irrigated Yield Per Acre	Non-Irrigated Acres	Non-Irrigated Yield Per Acre	Total Acres	Value
Winter Wheat			30,300	35.0 bu.	30,300	$1,268,900
Durham Wheat			700	26.0 bu.	700	26,200
Spring Wheat	600	36.0 bu.	37,000	30.0 bu.	37,600	1,547,100
Oats	100	50.0 bu.	4,900	39.8 bu.	5,000	102,000
Barley	2,100	60.5 bu.	72,000	43.1 bu.	74,100	2,876,700
Alfalfa Hay	5,500	3.0 t.	6,500	1.40 t.	12,000	512,000
Wild Hay	2,700	1.25 t.	20,300	1.00 t.	23,000	426,400

Livestock on Farms, 1964

All Cattle and Calves	Milk Cows	Sheep	Hogs
42,675	184	85,649	1,771

STREAM GAGING STATIONS

The U. S. Geological Survey measures the flow of streams, co-operating with funds supplied by several state and federal agencies. The results have been published yearly in book form by drainage basin in Water-Supply Papers through the year 1960. Beginning with 1961, the streamflow records have been published annually by the U. S. Geological Survey for the entire state under the title, "Surface Water Records of Montana." Data for 1961-65 and subsequent five year periods will be published in Water-Supply Papers. Prior to general issuance, advance copies of station records may be obtained from the U. S. Geological Survey. That agency's records and reports have been used in the preparation of this resume'.

Data given below cover the stream gaging records, which are available for Glacier County from the beginning of measurements through the water year 1967. The water year begins October 1 and ends September 30 of the following year.

Following are equivalents useful in converting from one unit of measurement to another:

(a) In Montana, one cubic foot per second equals 40 miner's inches.

(b) One acre-foot is the amount of water required to cover an acre one foot deep.

(c) One cubic foot per second will nearly equal two acre-feet (1.983) in 24 hours.

(d) A flow of 100 miner's inches will equal five acre-feet in 24 hours.

(e) One miner's inch flowing continuously for 30 days will cover one acre 1 1/2 feet deep.

For reference purposes, the stream gaging stations are listed in downstream order.

Belly River at international boundary

The water-stage recorder was 200 feet upstream from international boundary, 11 miles southeast of Waterton Park, Alberta, and 15 miles northwest of Babb. The drainage area is 74.8 square miles. Records are available from May 1947 to September 1964 (no winter records after 1957). The maximum discharge was about 12,000 c.f.s. (June 8, 1964) and the minimum daily recorded, 12 c.f.s. (February 12, 13, 1949). The average discharge for 10 years (1947-57) was 262 c.f.s. or 189,700 acre-feet per year. The highest annual runoff was 239,400 acre-feet (1951) and the lowest, 128,100 acre-feet (1949). There is no regulation or diversion. This is one of a number of stations which was maintained jointly by the United States and Canada.

North Fork Belly River at international boundary

The water-stage recorder was three-quarters of a mile south of international boundary, 5 1/2 miles upstream from mouth, 8 miles southeast of Waterton Park, Alberta, and 17 1/2 miles northwest of Babb. The drainage area is 10.1 square miles. Records are available from September 1947 to November 1955 (no winter records after 1952). The maximum discharge was 416 c.f.s. (June 3, 1953) and the minimum recorded, 0.5 c.f.s. (April 3, 1948), February 11-13, 1949). The average discharge for 5 years (1947-52) was 34.2 c.f.s. or 24,760 acre-feet per year. The highest annual runoff was 31,780 acre-feet (1951) and the lowest, 16,320 acre-feet (1949). There is no regulation or diversion. This is one of a number of stations which was maintained jointly by the United States and Canada.

Waterton River near international boundary

The water-stage recorder was 100 feet downstream from Olson Creek, 3 miles south of international boundary and 7 miles south of Waterton Park, Alberta. The drainage area is 61.0 square miles. Records are available from May 1947 to September 1964 (no winter records after 1957). The maximum discharge was 12,400 c.f.s. (June 8, 1964) and the minimum recorded, 8.7 c.f.s. (December 24, 1952). The average discharge for 10 years (1947-57) was 273 c.f.s. or 197,600 acre-feet per year. The highest annual runoff was 244,600 acre-feet (1951) and the lowest, 149,500 acre-feet (1949). There is no regulation or diversion. This is one of a number of stations which was maintained jointly by the United States and Canada.

Street Creek at international boundary

The water-stage recorder was half a mile upstream from mouth, three-quarters of a mile south of international boundary, and 5 miles south of Waterton Park, Alberta. The drainage area is approximately 6.0 square miles. Records are available from October 1947 to October 1955 (no winter records after 1952). The maximum discharge during the period of record was 437 c.f.s. (June 3, 1953) and the minimum daily, 0.2 c.f.s. (November 25-27, 1952). The maximum discharge during the flood of June 8, 1964 was 5,740 c.f.s., from slope-area measurement of peak flow. The average discharge for 5 years (1947-52) was 16.6 c.f.s. or 12,020 acre-feet per year. The highest annual runoff was 14,680 acre-feet (1951) and the lowest, 7,830 acre-feet (1949). There is no regulation or diversion. This is one of a number of stations which was maintained jointly by the United States and Canada.

Boundary Creek at international boundary

The water-stage recorder was a quarter of a mile upstream from the mouth, a quarter of a mile south of international boundary, and 4 miles south of Waterton Park, Alberta. The drainage area is 21.0 square miles. Records are available from October 1947 to June 1964 (no winter records after 1957). The maximum discharge during the period of record was 904 c.f.s. (June 4, 1953) and the minimum recorded, 4.0 c.f.s. (March 15, 1952). The maximum discharge during the flood of June 8, 1964 was 5,930 c.f.s., from slope-area measurement of peak flow. The average discharge for 10 years (1947-57) was 78.0 c.f.s. or 56,470 acre-feet per year. The highest annual runoff was 70,230 acre-feet (1951) and the lowest, 42,900 acre-feet (1949). There is no regulation or diversion. This is one of a number of stations which was maintained jointly by the United States and Canada.

Waterton River near Waterton Park, Alberta*

The water-stage recorder is 300 feet downstream from highway bridge, a quarter of a mile upstream from Crooked Creek and 5 miles northeast of Waterton Park. The drainage area is 238 square miles. Records are available from June to September 1908, April to November 1909, April to November 1910, May to October 1911, March 1912 to May 1931, September 1932, June to August 1933, and April 1948 to date (1968). The maximum discharge was 25,700 c.f.s. (June 9, 1964) and the minimum observed, 14 c.f.s. (February 4, 1955), caused by temporary storage behind ice jam upstream. The average discharge for 37 years was 673 c.f.s. or 487,200 acre-feet per year. The highest annual runoff was 710,000 acre-feet (1927) and the lowest, 290,000 (1926). There is no regulation or diversion. This is one of a number of stations which are maintained jointly by Canada and the United States.

St. Mary River near St. Mary

The water-stage recorder is on downstream side of boat dock, half a mile upstream from lake outlet and 1 mile southwest of St. Mary. The drainage area is 130 square miles. Records are available from October 1960 to October 1961 (no winter records). The maximum discharge during the period was 3,050 c.f.s. (May 27, 1961) and the minimum, 119 c.f.s. (October 5, 1961). There is no regulation or diversion.

St. Mary River above Swiftcurrent Creek, near Babb

The chain gage was half a mile downstream from Lower St. Mary Lake, 1 mile southeast of Babb, and 2 miles upstream from Swiftcurrent Creek. The drainage area is 177 square miles. Records are available from January 1902 to September 1915. The maximum discharge observed was 7,980 c.f.s. (June 5, 1908) and the minimum observed, 4 c.f.s. (February 14, 1911). The average discharge for 13 years (1902-15) was 540 c.f.s. or 390,900 acre-feet per year. The highest annual runoff was 545,-000 acre-feet (1907) and the lowest, 280,700 acre-feet (1905). There is no regulation or diversion.

Grinnell Creek at Grinnell Glacier, near Many Glacier*

The water-stage recorder is a quarter of a mile downstream from Grinnell Glacier, a quarter of a mile upstream from Grinnell Falls, 4 miles southwest of Many Glacier, and 15 miles southwest of Babb. The drainage area is approximately 1.1 square miles. Records are available from July 1959 to date (1968), no winter records. The maximum discharge recorded was 100 c.f.s. (Aug. 3, 1960) and the minimum, no flow at times; probably no flow during most of each winter. There is no regulation or diversion.

Grinnell Creek near Many Glacier*

The water-stage recorder is 500 feet upstream from trail crossing, 1,000 feet downstream from Grinnell Lake, a quarter of a mile upstream from mouth, 3 miles southwest of Many Glacier, and 13 1/2 miles southwest of Babb. The drainage area is 3.47 square miles. Records are available from August 1949 to date (1968). The maximum discharge was 536 c.f.s. (June 8, 1964) and the minimum, probably less than 0.2 c.f.s. at times in winter periods. The average discharge for 18 years was 25.2 c.f.s. or 18,240 acre-feet per year. The highest annual runoff was 21,380 acre-feet (1967) and the lowest, 16,080 acre-feet (1957). There is no regulation or diversion.

Swiftcurrent Creek at Many Glacier*

The water-stage recorder is 100 feet upstream from outlet of Swiftcurrent Lake at Many Glacier, Glacier National Park, and 11 miles southwest of Babb. The drainage area is 31.4 square miles. Records are available from June 1912 to date (1968), incomplete most years prior to 1959. The maximum discharge was 6,700 c.f.s. (June 8, 1964) and the minimum, 8.3 c.f.s. (Mar. 2, 1964). The average discharge for 11 years (1917-19, 1958-67) was 147 c.f.s. or 106,400 acre-feet per year. The highest annual runoff recorded was 129,000 acre-feet (1918) and the lowest, 88,400 acre-feet (1962). There is no regulation or diversion. This is one of a number of stations which are maintained jointly by the United States and Canada.

Canyon Creek near Many Glacier

The water-stage recorder was half a mile upstream from mouth and 1 1/2 miles southeast of Many Glacier. The drainage area is 7.2 square miles. Records are available from July 1918 to October 1937 (no winter records). The maximum discharge was 720 c.f.s. (June 8, 1934) and the minimum, no flow (Sept. 24, 1936), caused by storage behind temporary obstruction upstream. There is no regulation or diversion. This is one of a number of stations which was maintained jointly by the United States and Canada.

Swiftcurrent Creek at Sherburne*

The water-storage recorder is 1,000 feet downstream from outlet of Lake Sherburne Dam at Sherburne and 4 1/2 miles southwest of Babb. The drainage area is 64.3 square miles. Records are available from July 1912 to November 1915 (no winter records), March 1916 to October 1923, May 1924 to date (1968), no winter records. The maximum discharge was 2,360 c.f.s. (June 11, 1964) and the minimum, no flow at times when gates in dam were closed. The average discharge for 7 years (1916-23) was 199 c.f.s. or 144,100 acre-feet per year (unadjusted). The highest annual runoff recorded was 168,000 acre-feet (1922) and the lowest, 115,000 acre-feet (1919). Flow regulated by Lake Sherburne. No diversion. This is one of a number of stations which are maintained jointly by the United States and Canada.

Swiftcurrent Creek near Babb

The wire-weight gage was 1 mile south of Babb and 1 1/2 miles upstream from mouth. The drainage area is 100 square miles. Records are available from April 1902 to May 1910. The maximum discharge was not determined, (occurred about June 5, 1908) and the minimum observed, 14 c.f.s. (Jan. 18-19, 1904). The average discharge for 7 years (1902-9) was 325 c.f.s or 235,300 acre-feet per year. The highest annual runoff was 301,000 acre-feet (1907) and the lowest, 147,200 acre-feet (1905). There is no regulation or diversion.

St. Mary River near Babb*

The water-storage recorder is half a mile upstream from outlet of Lower St. Mary Lake and 2 miles southeast of Babb. The drainage area is 278 square miles. Records are available from July 1901 to October 1902, May 1910 to September 1925, October 1950 to date (1968). The maximum discharge was 16,500 c.f.s. (June 9, 1964) and the minimum, 26 c.f.s. (Jan. 5, 1953, Jan. 8, 1858). The average discharge for 33 years (1901-2, 1910-25, 1950-67) was 793 c.f.s. or 574,100 acre-feet per year, (unadjusted for storage in Lake Sherburne). The highest annual runoff was 776,700 acre-feet (1951) and the lowest, 423,000 acre-feet (1919). Entire flow of Swiftcurrent Creek below Lake Sherburne is diverted into Lower St. Mary Lake above station. Flow of Swiftcurrent Creek regulated by Lake Sherburne since 1919.

St. Mary Canal at intake, near Babb

The water-stage recorder was 600 feet downstream from intake of canal on Blackfeet Indian Reservation and 1 mile southeast of Babb. Seasonal records are available from March 1918 to November 1950. The maximum daily discharge was 871 c.f.s. (May 26-27, 1936) and the minimum, no flow on many days. The highest seasonal diversion was 217,100 acre-feet (1946) and the lowest, 66,460 acre-feet (1921). This is one of a number of stations which was maintained jointly by the United States and Canada.

St. Mary Canal at St. Mary crossing, near Babb*

The water-stage recorder is 50 feet upstream from inlet of St. Mary siphon, 7 miles northeast of Babb, and 9 miles downstream from intake. Seasonal records are available from July 1918 to date (1968). The maximum daily discharge was 767 c.f.s. (June 19, 28, 1936) and the minimum, no flow at times each year. The highest seasonal diversion was 224,200 acre-feet (1963) and the lowest, 55,000 acre-feet (1921). This is one of a number of stations which are maintained jointly by the United States and Canada.

St. Mary Canal at Hudson Bay Divide, near Browning

The water-stage recorder was 3 miles upstream from canal outlet and 30 miles north of Browning on Blackfeet Indian Reservation. Seasonal records are available from March 1917 to October 1966. The maximum daily discharge was 816 c.f.s. (June 8, 1964) and the minimum, no flow at times in each year. The highest seasonal diversion was 219,200 acre-feet (1963) and the lowest, 33,-600 acre-feet (1917). This is one of a number of stations which was maintained jointly by the United States and Canada.

St. Mary River below St. Mary Canal, near Babb

The water-stage recorder was 600 feet downstream from diversion dam and headgates of St. Mary Canal on Blackfeet Indian Reservation and 1 mile southeast of Babb. The drainage area is 279 square miles. Records are available from May 1929 to September 1950 (no winter records). The maximum discharge was 4,930 c.f.s. (June 5, 1948) and the minimum observed, 2 c.f.s. (Oct. 19, 1945), regulated. St. Mary Canal diverts water above the station.

Kennedy Creek near Babb

The chain gage was 50 feet upstream from highway bridge, 1 3/4 miles upstream from mouth, and 4 miles north of Babb. The drainage area is 60.6 square miles. Records are available from January to November 1905 (discharge measurements only in 1901, 1903-4, 1906-7, 1911-12). The maximum and minimum were not determined. There is no regulation or diversion.

St. Mary River at international boundary*

The water-stage recorder is a quarter of a mile north of international boundary, 2 1/2 miles downstream from Boundary Creek, 7 miles southwest of Kimball, Alberta, and 11 miles northeast of Babb. The drainage area is 469 square miles. Records are available from September 1902 to date (1968). The maximum discharge was about 40,000 c.f.s. (June 5, 1908) and the minimum daily, 16 c.f.s. (Nov. 29, 1936). The average discharge for 14 years (1902-16), prior to operation of St. Mary Canal, was 1,003 c.f.s. or 726,100 acre-feet per year; for 51 years (1916-67), 705 c.f.s. or 510,400 acre-feet per year. The highest annual runoff was 982,000 acre-feet (1908) and the lowest, 228,900 acre-feet (1941). There is some regulation by Lake Sherburne on Swiftcurrent Creek. Since 1917, St. Mary Canal has diverted water from river near Babb to North Fork Milk River. This is one of a number of stations which are maintained jointly by Canada and the United States.

Two Medicine River near East Glacier

The water-stage recorder was 85 feet upstream from a timber bridge, 125 feet upstream from Fortymile Creek, a quarter of a mile downstream from Lower Two Medicine Dam, and 3 1/2 miles northwest of East Glacier. The drainage area is 51.1 square miles. Records are available from May to October 1912, May 1918 to September 1924 (seasonal records only for most years), September 1962 to May 1964. The maximum discharge during the period of record was 1,390 c.f.s. (June 11, 1918) and the minimum daily, 9 c.f.s. (Mar. 9, 1964). The flood of June 8, 1964 reached a discharge of 63,500 c.f.s. when Two Medicine Dam failed. Flow completely regulated by Two Medicine Dam. There are no diversions.

Two Medicine Canal near Browning*

The water-stage recorder or staff gages were located at various points downstream from headgates and 11 miles southeast of Browning. Records of monthly and yearly diversions in acre-feet are available for the period May 1951 to date (1968). The canal diverts water from the north bank of Two Medicine Creek for irrigation of about 10,000 acres.

Two Medicine River near Browning*

The water-stage recorder is 800 feet upstream from the bridge on U. S. Highway 89, 11 miles southeast of Browning, and 15 miles upstream from Badger Creek. The drainage area is 317 square miles. Records are available from April 1907 to October 1924, May 1951 to date (1968). The maximum discharge was 100,000 c.f.s. (June 8, 1964) and the minimum, 1.1 c.f.s. (Aug. 16, 1966). The average discharge for 33 years was 384 c.f.s. or 278,000 acre-feet per year. The highest annual runoff was 441,000 acre-feet (1909) and the lowest, 160,000 (1919). Flow affected by storage in Lower Two Medicine Lake. There are diversions for irrigation of about 10,000 acres below the station.

Badger Creek near Browning*

The water-stage recorder is just upstream from point of diversion to Four Horns Canal, 15 miles upstream from the mouth, and 17 miles southeast of Browning. The drainage area is 133 square miles. Records are available from May 1951 to date (1968). The maximum discharge was 49,-700 c.f.s. (June 8, 1964) and the minimum daily 25 c.f.s. (Dec. 11-15, 1963). The average discharge for 16 years was 230 c.f.s. or 166,500 acre-feet per year. The highest annual runoff was 216,000 acre-feet (1964) and the lowest, 131,600 acre-feet (1961). Water is diverted into Four Horns Canal at the station for irrigation of about 6,000 acres below the station.

Badger Creek near Family

The chain gage was at highway bridge, 4 miles southeast of Family. The drainage area is 239 square miles. Records are available from April 1907 to December 1924. The maximum discharge was not determined, (occurred about June 7, 1908) and the minimum observed, 2.0 c.f.s. (Aug. 18, 19, 1919). The average discharge for 7 years (1907-14) was 265 c.f.s. or 191,900 acre-feet per year, and for 10 years (1914-24) was 217 c.f.s. or 157,100 acre-feet per year. The highest annual runoff was 257,000 acre-feet (1916) and the lowest, 87,500 acre-feet (1919). Four Horns Canal began to divert water in 1915 for irrigation above the station.

Cut Bank Creek near Browning

The water-stage recorder was 100 feet upstream from road bridge and 4 1/2 miles north of Browning. The drainage area is 123 square miles. Records are available from April 1918 to October 1924 (no winter records). The maximum discharge was 1,270 c.f.s. (June 5, 1922) and the minimum, not determined. There was no regulation or diversion.

Cut Bank Creek at Cut Bank*

The water-stage recorder is at highway bridge half a mile west of Cut Bank and 17 miles upstream from confluence with Two Medicine River. The drainage area is 1,065 square miles. Records are available from August 1905 to October 1919, May to July 1920, May 1922 to October 1924, May 1951 to date (1968). The maximum discharge was 16,600 c.f.s. (June 9, 1964) and the minimum observed, 4.0 c.f.s. (Dec. 1, 1905). The average discharge for 32 years (1905-19, 1922-24, 1951-67) was 195 c.f.s. or 141,200 acre-feet per year. The highest annual runoff was 202,000 acre-feet (1907) and the lowest, 81,300 acre-feet (1919). There are a few minor diversions for irrigation of hay meadows above the station. The natural flow of the stream is affected by water from Two Medicine Canal which irrigates land above the station.

South Fork Milk River near Babb*

The water-stage recorder is 300 feet upstream from bridge on FAS 464 (Duck Lake Road), 14 1/2 miles southeast of Babb, and 15 1/2 miles northwest of Browning. The drainage area is 68.6 square miles. Seasonal records are available from May 1961 to date (1968). The maximum discharge was 12,000 c.f.s. (June 8, 1964) and the minimum, 1.3 c.f.s. (Aug. 22, 1961). There are several small diversions for irrigation above the station. This is one of a number of stations which are maintained jointly by the United States and Canada.

South Fork Milk River near international boundary, near Browning

The water-stage recorder was just upstream from Kennedy Coulee, 5 miles south of the international boundary, and 27 miles northeast of Browning. The drainage area is 287 square miles. Records are available from May 1905 to October 1930 (no winter records except 1915-19). The maximum discharge was about 13,000 c.f.s. (June 6, 1908) and the minimum, no flow (Aug. 18 to Sept. 2, 1919). The average discharge for 5 years (1914-19) was 97.6 c.f.s. or 70,660 acre-feet per year. The highest annual runoff recorded was 128,000 acre-feet (1916) and the lowest, 15,600 acre-feet (1919). There was no regulation or diversion. This is one of a number of stations which was maintained jointly by the United States and Canada. Records are considered to be equivalent to the following station, Milk River near Del Bonita.

Milk River near Del Bonita

The staff gage was at bridge on State Secondary Highway 483, 3 1/2 miles southeast of Del Bonita Port of Entry. The drainage area is 325 square miles. Records are available for 1961 (occasional low-flow measurements only), April 1962 to November 1964 (seasonal records only). Records are considered to be equivalent to the preceding station. The maximum discharge was 17,300 c.f.s. (June 8, 1964) and the minimum no flow at times. There is no regulation and only minor diversions for irrigation.

Milk River at western crossing of international boundary*

The water-stage recorder is located half a mile north of international boundary, 22 miles upstream from North Milk River, and 23 miles southwest of Milk River, Alberta. The drainage area is 397 square miles. Records are available from March 1931 to date (1968), seasonal records only. Prior to October 1961 published as South Fork Milk River near international boundary. The maximum discharge was 7,930 c.f.s. (June 9, 1964) and the minimum, no flow at times. There are several small diversions for irrigation above the station. This is one of a number of stations which are maintained jointly by Canada and the United States.

North Fork Milk River above St. Mary Canal, near Browning*

The water-stage recorder is 1 1/4 miles upstream from the outlet of canal, 2 miles south of international boundary, and 29 miles north of Browning. The drainage area is 61.8 square miles. Records are available from May 1911 to July 1912 and June to July 1918 (published as "near Browning"), May 1919 to date (1968), seasonal records only. The maximum discharge was 3,090 c.f.s. (May 8, 1967) and the minimum, no flow (Oct. 29, 1942). There are several small diversions for irrigation above the station. This is one of a number of stations which are maintained jointly by the United States and Canada.

North Milk River near international boundary*

The water-stage recorder is 1,500 feet upstream from highway bridge, 1 1/2 miles north of international boundary, 3 miles east of Whiskey Gap, Alberta, and 11 miles southeast of Kimball, Alberta. The drainage area is 91.8 square miles. Records are available from July 1909 to October 1912 (seasonal records only), January 1913 to October 1922 (complete), March 1923 to date (1968) seasonal records only. The maximum discharge was 2,950 c.f.s. (June 17, 1948) and the minimum, no flow (Mar. 1, 2, 1940). There are several small diversions for irrigation above the station. Since 1917, flow increased during irrigation season by water from St. Mary Canal. This is one of a number of stations which are maintained jointly by Canada and the United States.

Partial Record Stations and Miscellaneous Discharge Measurements

In order to provide information on more streams than are covered by stream gaging stations, the U. S. Geological Survey has for several years been collecting some partial records. These are in addition to the miscellaneous discharge measurements which have always been reported. These partial records, when correlated with simultaneous discharges of nearby continuous-record stations give fair indications of available flow.

There are four crest-stage partial-record stations in the Milk River Basin in Glacier County. Stations are now (1968) being operated on Livermore Creek near Babb, Middle Fork Milk River near Babb, Dry Fork Milk River near Babb and Milk River near Del Bonita.

The partial-record stations as well as the miscellaneous discharge measurements are listed at the end of each U. S. Geological Survey Water-Supply Paper or Surface Water Records report.

Reservoirs

Details of operation records of the following reservoirs are available in U. S. Geological Survey publications:

Lake Sherburne at Sherburne*

The water-stage recorder is in the gatehouse at Lake Sherburne on Swiftcurrent Creek, 4 1/2 miles southwest of Babb. The drainage area is 63.7 square miles. Records are available from May 1915 to September 1923 (fragmentary), May 1924 to September 1925, November 1925 to June 1926, September 1926 to March 1936 (no winter records some years), May 1936 to May 1937, July 1937 to date (1968). The maximum contents was 66,570 acre-feet (July 11, 1966) and the minimum, no usable contents at times. The capacity is 66,200 acre-feet between elevations 4,726 feet (6 feet above lowest outlet gate sill) and 4,788 feet (spillway crest). Streambed above gates prevents withdrawal of storage to sill elevation. Dead storage negligible. Water is used for irrigation on Milk River project of Bureau of Reclamation.

Lower Two Medicine Lake near East Glacier

The staff gage was at dam on Two Medicine Creek, 4 miles northwest of East Glacier. The drainage area is 50.2 square miles. Records are available from September 1938 to June 1964. The maximum contents was 20,930 acre-feet (June 8, 1964) when the dam was overtopped and destroyed, and the minimum, probably no storage at times in some years. Reservoir was formed by earthfill dam completed in 1913. The usable capacity was 16,620 acre-feet. Water is used for irrigation and recreation. A new dam has been built (1968) at about the same site and capacity and records will again be published.

Four Horns Lake near Heart Butte*

The staff gage is at dam 7 miles northeast of Heart Butte. Records are available from September 1938 to date (1968). The maximum contents observed was 16,320 acre-feet (Aug. 5, 1958) and the minimum observed, 2,840 acre-feet (July 31, 1949). This is an offstream reservoir formed by earthfill dam completed in 1932. Stored water is diverted from Badger Creek at a point 5 miles north of Heart Butte. Water is used for irrigation and recreation.

*This gaging station is now in operation (1968).

DAMS AND RESERVOIRS

The State of Montana has no statutes governing the design or construction of dams and, except for projects which the Montana Water Resources Board has constructed, the Board has no means of automatically obtaining information concerning design specifications, storage, capacities, locations, or ownerships of dams and reservoirs built throughout the State. Consequently, steps have been taken to make this information available for use by the State, the Federal Government, and private citizens.

By means of a questionnaire, the Montana Water Resources Board recently obtained from the various federal agencies who design structures, the basic engineering data, locations, and ownerships of dams and reservoirs for which they either have, or had, responsibility and which have storage capacities of 50 acre-feet or more. The contributing federal agencies were the Soil Conservation Service, the Forest Service, the Bureau of Reclamation, and the Bureau of Land Management. The Montana Power Company also participated in the study.

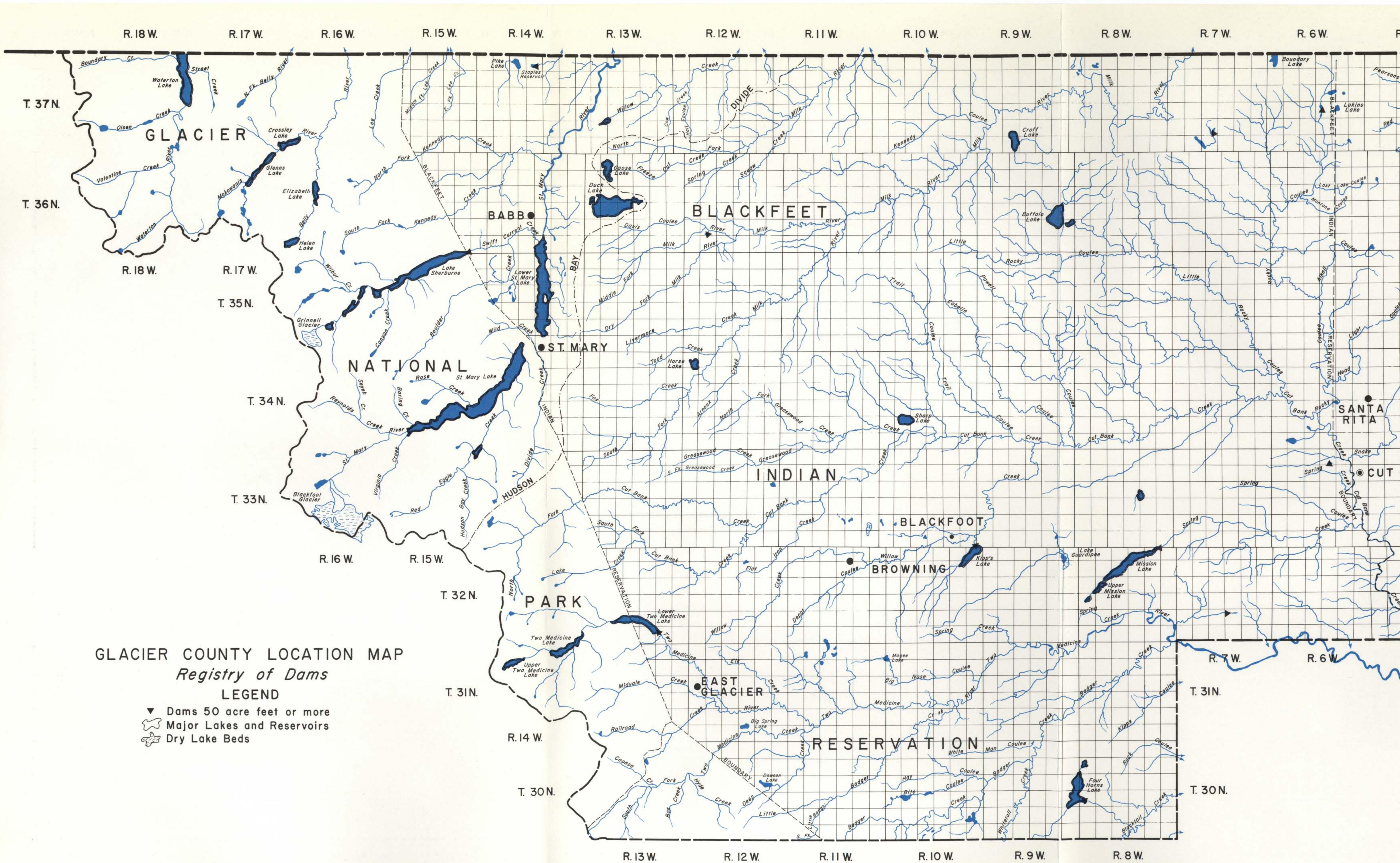
Information on numerous dams and reservoirs constructed by private individuals in Montana is not available and is, therefore, omitted. However, the Board's Water Resources Survey crew, while working in Glacier County, obtained information on private dams and reservoirs within this county. The available information obtained from all sources was compiled by the Board for each county in the State and a list of dams and reservoirs which store 50 acre-feet or more of water was published.

GROUNDWATER

A. J. Mancini, Geologist

GEOLOGY

The primary factor of influence on the present water regimen in Glacier County was the evolution of rugged mountain ranges which are now part of the scenic splendor of Glacier National Park. A more subtle influence was that of the episodic advance and retreat of glaciers which began about 1,000,000 years ago. The "final" retreat of the glaciers took place about 30- or 40- thousand years ago. Continental glaciers which advanced from Canada retreated to the polar region, and alpine glaciers which spread into lower valleys and over foothills retreated back to the higher mountain ranges. The several small mountain glaciers seen in the Glacier National Park are remnants of alpine glaciers which once covered a large portion of the county.



GLACIER COUNTY LOCATION MAP

Registry of Dams

LEGEND

▼ Dams 50 acre feet or more

Major Lakes and Reservoirs

Dry Lake Beds

The natural forces which created the scenic mountains also created a foothills region on the eastern slope, of intensely faulted and fractured sedimentary rocks known as the disturbed belt. The geology of the disturbed belt has been greatly complicated by thick sheets of sedimentary formations having been forced over the tops of other formations, and the entire sequence then having been further compressed and broken into irregular blocks and masses of altered rock strata. A large area of the foothills region is mantled with glacial till (or drift) which masks the underlying disturbed bedrock. East of the foothills the pattern of outcropping bedrock reflects the western edge of the Sweetgrass arch, a broad regional structural flexure trending northwest.

The availability of groundwater in Glacier County is greatly influenced by the history of structural deformation and erosion, and by the development of the present drainage system after the glacial epoch. Structural deformation and erosion have brought potential groundwater aquifers closer to the surface and within economic drilling depths.

A considerable amount of precipitation falls on the mountainous region, and the runoff from this area recharges live lakes and streams in the western part of the county. Eastern Glacier County does not have much live water, and therefore places greater dependence on groundwater supplies.

AQUIFERS

Wells are drilled to find reliable sources of adequate water for domestic, stock, and industrial uses, and irrigation and municipal uses to a lesser extent. The Two Medicine formation and the Virgelle sandstone are the most widely used shallow aquifers, and the Madison limestone is the most widely used deep aquifer. Individual aquifers are described in sequence of geologic age, the youngest or most shallow first and the deepest last. Water well data have been taken from copies of groundwater appropriation forms filed with the Groundwater Code Administrator. Deep well data was obtained from the files of the Oil and Gas Conservation Commission. Water quality data was obtained from the records of the Department of Health and publications of the U. S. Geological Survey. Available data has been accepted as reasonably reliable and accurate.

Alluvium (Quaternary) is a fresh water accumulation of silt, sand, clay, and gravel, mixed and interbedded, normally unconsolidated or only weakly cemented. Alluvium has not everywhere been indicated on the groundwater inventory map due to map limitations, but is present to some extent throughout the county in stream valleys, and may yield small to moderate quantities of water to wells in the valley of Cut Bank Creek. The more extensive alluvial deposits are in the foothills region. Very few wells of record have been drilled in creek or stream alluvium. One well drilled into an alluvial aquifer in Section 6, Township 33 North, Range 10 West, reportedly withdraws water at the rate of 500 gpm (gallons per minute), from a total depth of 45 feet, for livestock and irrigation.

Glacial deposits (Quaternary) are present as remnants of deposits of till (or drift) resulting from both continental and mountain (alpine) glaciation, lake deposits of former Glacial Lake Cut Bank, and outwash deposits associated with glacier meltwater channels.

Glacial till is a heterogeneous collection of unconsolidated silt, clay, sand, gravel, and boulders, which seldom is an extensive aquifer due to inherent poor permeability. A small portion of eastern Glacier County is veneered with glacial till of continental glaciation, from less than 10 to about 100 feet thick. The till is predominantly impervious clay, although one well, in Section 21, Township 37

North, Range 5 West, reportedly yields 45 gpm from a total depth of 80 feet. The aquifer is gravel and probably is part of a meltwater deposit within the till. In south-central Glacier County the till reportedly is at least 55 feet thick locally. Several wells yield 6 to 100 gpm, producing out of gravel aquifers within the till. The till deposited by alpine glaciers apparently contains more sand and gravel than that deposited by continental glaciers. The south-central till may overlie extensive fluvial gravels which collected at the foot of the mountains and were distributed by streams prior to the glacial epoch.

Unconsolidated sediments in the locality once inundated by the Glacial Lake Cut Bank attain a reported maximum thickness in excess of 180 feet and consist of quicksand, sand, gravel, silt, clay, and boulders. Groundwater is present within the lakebed sequence and a few wells pump 10 to 20 gpm from stratified sands and gravels. Some wells which start in the lakebed are drilled into underlying bedrock for water supplies, suggesting that the development of lakebed aquifers is not everywhere satisfactory for the storage and movement of adequate amounts of groundwater.

Terrace gravels (Quaternary/Tertiary) have a wide geographic distribution in the county, both as small isolated patches and relatively large remnants of fluvial deposits. The gravels have been derived mainly of material eroded from the mountains and are mostly unconsolidated or poorly cemented. There are several terrace levels, flat-topped, gently sloping away from the mountains. The highest levels (or benches) are near the mountain front and now rise hundreds of feet above present streams. Sediments that previously have been described as "undifferentiated Tertiary rocks," which were in part laid down in lakes, streams, and alluvial fans at valley elevations, are included in this category.

The larger gravel remnants are sources of groundwater, and well yields of 1 to 25 gpm are reported, from gravel thicknesses of 6 to 80 feet. Many of the springs in Glacier County for which there are records of groundwater appropriations discharge from terrace gravels.

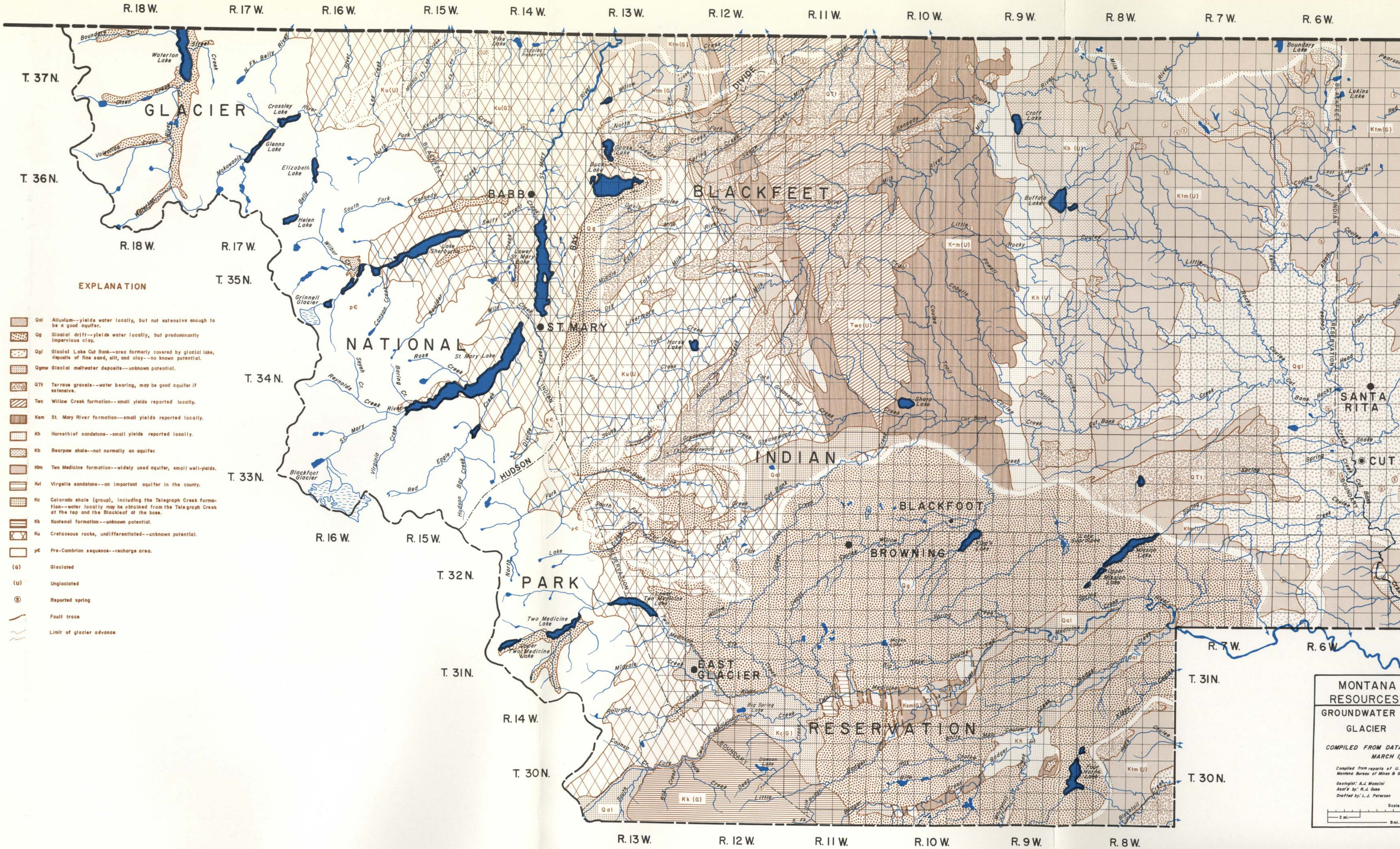
Willow Creek formation (Tertiary) is at least 720 feet thick and consists chiefly of varicolored clay and soft sandstone, predominantly red in color. There are no records of wells completed in this formation.

St. Mary River formation (Cretaceous) is about 1,000 feet of gray and greenish-gray clay and shale, with sandstone interbeds. There is one well of record completed in this formation, reportedly pumping 112 gpm from a total depth of 10 feet.

Horsethief sandstone (Cretaceous) is massive, light-gray, fine-to-coarse grained, 90 to 360 feet thick in the outcrop. Several wells reportedly have been completed in this sandstone, pumping 8 to 15 gpm from total depths of 55 to 240 feet. Based on available information the specific capacity of a well completed in the Horsethief normally is considerably less than 1 gpm per foot of drawdown, although one well reportedly pumps 15 gpm from a depth of 229 feet with no drawdown.

Bearpaw shale (Cretaceous) is about 500 feet of dark colored shale and not normally an aquifer. One well in Section 24, Township 35 North, Range 9 West, reportedly pumps 5 gpm from "blue clay" at a total depth of 150 feet. The well site is practically on the Horsethief-Bearpaw contact, and the source of the water may actually be the Horsethief sandstone.

Two Medicine formation (Cretaceous) varies in thickness from about 300 feet to 2,000 feet. The upper section is greenish-gray shale with irregular sandstone stringers and lenses, while the lower



R. 18 W.
R. 17 W.
R. 16 W.
R. 15 W.
R. 14 W.
R. 13 W.
R. 12 W.
R. 11 W.
R. 10 W.
R. 9 W.
R. 8 W.
R. 7 W.
R. 6 W.
T. 37 N.
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T. 30 N.
GLACIER
NATIONAL
PARK
BLACKFEET
INDIAN
RESERVATION
BABB
ST. MARY
BROWNING
BLACKFOOT
EAST GLACIER
SANTA RITA
CUT
DIVIDE
HUDSON
BAY
Waterton Lake
Crossley Lake
Glenns Lake
Elizabeth Lake
Helen Lake
Grinnell Glacier
Blackfoot Glacier
Lake Sherburne
Lower St. Mary Lake
St. Mary Lake
Duck Lake
Goose Lake
Horse Lake
Two Medicine Lake
Lower Two Medicine Lake
Buffalo Lake
Croff Lake
Boundary Lake
Lukins Lake
Mission Lake
Upper Mission Lake
Dawson Lake
Pike Lake
Stapleys Reservoir
EXPLANATION
Qal Alluvium--yields water locally, but not extensive enough to be a good aquifer.
Qg Glacial drift--yields water locally, but predominantly impervious clay.
Qgl Glacial Lake Cut Bank--area formerly covered by glacial lake, deposits of fine sand, silt, and clay--no known potential.
Qgmw Glacial meltwater deposits--unknown potential.
QTt Terrace gravels--water bearing, may be good aquifer if extensive.
Twc Willow Creek formation--small yields reported locally.
Ksm St. Mary River formation--small yields reported locally.
Kh Horsethief sandstone--small yields reported locally.
Kb Bearpaw shale--not normally an aquifer.
Ktm Two Medicine formation--widely used aquifer, small well-yields.
Kvl Virgelle sandstone--an important aquifer in the county.
Kc Colorado shale (group), including the Telegraph Creek formation--water locally may be obtained from the Telegraph Creek at the top and the Blackleaf at the base.
Kk Kootenai formation--unknown potential.
Ku Cretaceous rocks, undifferentiated--unknown potential.
p€ Pre-Cambrian sequence--recharge area.
(G) Glaciated
(U) Unglaciated
Reported spring
Fault trace
Limit of glacier advance
MONTANA
RESOURCES
GROUNDWATER
GLACIER
COMPILED FROM DAT
MARCH
Compiled from reports of U.
Montana Bureau of Mines & G
Geologist: A.J. Mancini
Asst'd by: R.J. Guse
Drafted by: L.J. Petersen
Scale
2 mi.
8 mi.

250 feet is predominantly buff-colored sandstone equivalent to the upper Eagle formation. The Two Medicine formation outcrops over a large area in eastern Glacier County (partially mantled with glacial till) and is a widely used aquifer. Groundwater is available in several sandstone intervals within the formation but mostly in the Eagle equivalent. The Two Medicine is thought to be hydraulically connected to the underlying Virgelle sandstone at many places. The majority of Two Medicine wells are drilled more than 100 feet deep, and some are in excess of 400 feet. Reported yields are in the range of 2 to 250 gpm. The quality of Two Medicine groundwater varies considerably from well to well. Total dissolved solids have been calculated in amounts of 238 ppm to 5,225 ppm (the latter value may represent water produced from both the Two Medicine and the Virgelle). Total dissolved solids in amounts greater than 1,200 ppm are frequently reported. Two Medicine water is relatively high in amounts of sodium, bicarbonate, and sulfate.

Virgelle sandstone (Cretaceous) is a massive gray to buff sandstone, about 160 to 180 feet thick, and a major aquifer in eastern Glacier County. Wells have been drilled as deep as 400 feet to reach this aquifer and yields of 20 to 120 gpm are reported. Greater yields, probably as much as 250 gpm, could be expected locally from properly constructed wells. At least 8 wells originally were drilled to provide groundwater from the Virgelle for industrial use. In 1967, approximately 113 acre-feet of water from the "Eagle" (Virgelle) were used in the secondary recovery of oil.

The quality of water in the Virgelle is similar to that in the Two Medicine. Amounts of total dissolved solids range from 600 ppm to 5,000 ppm, mostly in the range of 1,000 to 3,000 ppm. Sodium, bicarbonate, and sulfate are of relatively high concentrations. In Township 36 North, Ranges 3, 4, and 5 West, the majority of analyses indicate total dissolved solids in amounts less than 1,000 ppm.

Colorado shale (Cretaceous) is about 1,500 to 2,100 feet thick in the subsurface. In this report the Telegraph Creek formation, 170 feet of gray sandy shale underlying the Virgelle, is included as the uppermost Colorado. Underlying the Telegraph Creek is the Marias River member, which is dark gray shale and not normally an aquifer. The lower 600 to 800 feet of the Colorado has been designated the Blackleaf sandy member and includes sandstone beds 20 to 50 feet thick, which locally are capable of yielding water to wells. At times shallow gas is found in the Colorado, at depths of about 500 to 600 feet below the top. One analysis of water from the Colorado shows total dissolved solids in the amount of 17,000 ppm.

Kootenai formation (Cretaceous) is 500 to 1,200 feet of red and green mudstone, siltstone, and shale, with numerous lenticular beds of greenish-gray, fine-to-coarse grained sandstone. Within the Kootenai are three "sandstones," the **Moulton,** the **Sunburst,** and the **Cut Bank,** all of which contain oil and gas locally, and brackish to saline water. The Moulton is about 100 feet thick, predominantly siltstone with up to 50 feet of sandstone. The porosity of the Moulton sandstone is 2 to 26 percent (average 18 percent) and the maximum reported permeability is 4,170 mds (millidarcies), with an average of 600 mds. The Sunburst has about 10 feet of sandstone and an overall thickness of about 60 feet. Sandstone porosity averages 18 percent and permeability averages 800 mds. The Cut Bank has an overall thickness of 70 feet, with about 35 feet of conglomeratic sandstone having 21 percent maximum porosity (16 percent average) and 950 mds maximum permeability. Kootenai water reportedly has total dissolved solids in amounts of 7,000 to 10,000 ppm.

Cretaceous undifferentiated rocks are present in the disturbed belt area, and shallow sandstones of this sequence are known to be capable of suppporting small yields. This designation is used only in areas where subdivision is difficult or where the geology cannot be mapped otherwise on the basis of available information, and probably includes that part of the Cretaceous section from the Kootenai upwards.

Jurassic interval is 350 to 500 feet of shale, mudstone, and discontinuous sandstone. The interval normally includes the **Morrison, Swift, Rierdon,** and **Sawtooth** formations, but past episodic uplift and erosion have caused the local and areal removal of all or part of formations within this interval and a complete interval has not been recognized in the county. Sandstones within the Swift are significant due to the recovery of hydrocarbons from them. These sandstones (including the **Ribbon**) have an average porosity of about 21 percent and permeability of about 70 to 170 mds. Brackish to saline water is associated with the hydrocarbons in the Swift sandstones.

Madison limestone (Mississippian) is 1,000 to 1,500 feet of predominantly massive light-colored limestone and dolomite sometimes having fracture and cavernous porosity in the upper part. The top of the Madison is locally oil productive. The contact of the Mississippian sequence with overlying Jurassic sediments represents a buried topography, and the movement of groundwater through the uppermost Madison is facilitated locally by solution porosity associated with channels in the limestone, developed on or under this paleotopography. One analysis of Madison water produced with oil reports total dissolved solids in the amount of 7,200 ppm. The depth to the Madison is 3,000 to 3,500 feet. Most of the water used for the secondary recovery of oil in Glacier County comes from the Madison. In 1967, a total of 2,900 acre-feet of Madison water were used by secondary recovery projects in Glacier County.

Devonian interval is about 1,200 feet of anhydrite, limestone, dolomite, and shale. Limestone and dolomite intervals are known to be water-bearing (porosities of 5 percent and extremely low permeabilities are reported) but depth to aquifer has deterred meaningful investigation of this source.

Cambrian interval is about 500 to 725 feet of sandstone, shale, and limestone which could contain water-bearing strata. Depth to aquifer has deterred investigation of this interval.

Pre-Cambrian Belt series is 6,000 to 20,000 feet of metamorphosed sediments and is the rock series which comprises portions of the mountain ranges in Glacier National Park. About 13,000 feet of Belt strata, locally intruded by igneous dikes and sills, are exposed in the Park. The Belt series does not normally include aquifers, although fractures and contact zones may act as conduits for the movement of water into the subsurface.

GROUNDWATER AREAS

Glacier County can physiographically be divided into the mountainous region, the foothills (disturbed belt) area, and the eastern plains area. Based on available information, groundwater development is significant only in the eastern plains area. There are hundreds of wells in this area, most of which get water at relatively shallow depths from the Two Medicine formation and the Virgelle sandstone. Withdrawals from the deeper Madison aquifer also occur in this area. The disturbed belt area probably has a greater potential for groundwater development than is evident at present, but even if the need for groundwater existed, the geologic complexities of the area would be a deterrent to exploratory drilling. The mountainous region is an intake area and supplies water both for surface flows and groundwater recharge.

AVAILABILITY AND USE OF GROUNDWATER

There are records of approximately 400 groundwater appropriations by means of wells in Glacier County, and approximately 100 appropriations by means other than wells (springs). Much of the county is within the boundaries of the Glacier National Park and the Blackfeet Indian Reservation, and there probably are numerous wells, especially on the reservation, that are not included in the totals of record. Most of the appropriations of record have been filed on wells drilled in eastern Glacier County, and practically all of these wells have been completed within the Two Medicine formation and the Virgelle sandstone.

Groundwater is withdrawn primarily for domestic and livestock uses, and for the secondary recovery of oil. It is also used for small-scale irrigation and has been used in the refining of crude oil, as cooling and process water. Industrial users appropriated groundwater from the Virgelle and the Madison, until a conflict developed over falling water levels in shallow wells used by local inhabitants. Almost all the groundwater presently withdrawn for industrial use comes from the Madison limestone, and industrial users of shallow groundwater submit reports of periodic water level measurements to the Montana Water Resources Board.

Very few wells take groundwater from unconsolidated sediments. Alluvial aquifers are not extensive where water is needed, therefore shallow wells are completed in bedrock as much out of necessity as desire. Inhabitants depend on groundwater from the Virgelle sandstone and lower Two Medicine formation more than from any other source for domestic, stock, and some agricultural needs.

Even though the water in these aquifers would not be classified as "good" or even "fair" for domestic use by accepted standards, the aquifers have great extent and therefore are dependable sources of economically obtainable water. Relatively deep wells—about 500 feet below ground level —are sometimes drilled, especially when a flowing well is anticipated. Due to the great extent and thickness of aquifer (the basal Two Medicine and Virgelle locally are considered to be hydraulically connected), the quantity of groundwater in the aquifer that would be available through properly constructed wells is sufficient for present needs. Problems arise when water levels fall due to the overall pattern of groundwater withdrawal.

Industrial withdrawals in the past have caused local concern due to falling water levels in the Virgelle, but the present use of Madison water for industry has alleviated much of this concern. Depth to the Madison water precludes its use at present for anything but industry. The water in the Madison limestone is adequate for the needs of local industry and it is anticipated that the Madison will continue to be a major source of industrial water in Glacier County.

Municipal water apparently comes mostly from surface supplies. The town of Browning reportedly uses a well and springs for municipal water. Cut Bank uses water from Cut Bank Creek normally, and maintains a standby well for emergencies. The quality of surface water in Glacier County is better than that of groundwater, and surface water, if available, most likely would be chosen over groundwater for a municipal supply.

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MONTANA BUREAU OF MINES AND GEOLOGY
GROUNDWATER DIVISION

WATER WELL INVENTORY, GLACIER COUNTY

Year	A	C	D	F	H	I	N	P	S	R	T	U	X	Total
1940+ older	--	1	--	--	33	1	2	2	27	82	--	--	1	149
1941	--	--	--	--	--	--	--	--	--	--	--	--	--	----
1942	--	--	--	--	2	3	--	2	--	4	--	--	--	11
1943	--	--	--	--	1	--	--	1	--	2	--	--	--	4
1944	--	--	--	--	1	--	--	--	--	4	--	--	--	5
1945	--	--	--	--	1	--	2	2	1	--	--	--	--	6
1946	--	--	--	--	2	--	--	--	1	4	--	--	--	7
1947	--	--	--	--	2	--	--	--	3	3	--	--	--	8
1948	--	--	--	--	2	--	1	1	1	3	--	--	--	8
1949	--	--	--	--	1	--	2	--	--	1	--	--	--	4
1950	--	--	--	--	8	--	--	--	2	3	--	--	--	13
1951	--	--	--	--	2	--	1	--	--	1	--	--	--	4
1952	--	--	--	--	3	2	4	--	2	2	--	--	--	13
1953	--	2	--	--	1	--	--	--	--	10	--	--	--	13
1954	--	--	--	--	5	--	--	--	3	3	--	--	--	11
1955	--	1	--	--	5	--	--	--	6	7	--	--	--	19
1956	--	1	--	--	2	--	--	--	3	3	--	2	--	11
1957	--	--	--	--	4	1	--	--	1	2	--	--	--	8
1958	--	--	--	--	5	1	--	--	3	3	--	--	2	14
1959	--	1	--	--	4	1	--	--	2	3	--	--	1	12
1960	--	2	--	--	6	--	--	--	3	7	--	--	--	18
1961	--	2	--	--	5	--	--	--	3	3	--	--	3	16
1962	--	--	--	--	3	1	4	--	4	--	--	--	1	13
1963	--	--	--	--	5	--	5	--	11	4	--	--	--	25
1964	--	--	--	--	2	--	2	--	1	1	--	--	--	6
1965	--	--	--	--	1	--	1	--	--	--	--	--	--	2
1966	--	--	--	--	2	--	1	--	--	--	--	--	--	3
1967	--	--	--	--	2	--	--	--	2	--	--	--	--	4
Totals	--	10	--	--	110	10	25	8	79	155	--	2	8	407

A=Conditioning
C=Commercial
D=Dewatering
F=Fire Protection
H=Domestic

I=Irrigation
N=Industrial
P=Public Supply
S=Stock
R=Domestic and Stock

T=Institutional
U=Unused
X=Unknown

ECONOMIC MINERAL DEPOSITS

Geologic Situation

Glacier County, wholly created from Teton County in 1919, lies within the Great Plains area and the northern Rocky Mountains physiographic province. The northwest part of the county is occupied by the Lewis Range, and here the Flathead-Glacier County boundary follows the Continental Divide; to the east the foothills area borders the Rocky Mountains; and the central and eastern parts of the county are within the northern Great Plains fronting the mountains. Average altitude is 3,800 feet in the plains, 5,000 feet in the foothills, and 9,000 feet in the mountainous sections (Mt. Siyeh, 10,004 ft.). In the northwestern part of the county, the St. Mary and Belly Rivers flow north into Canada. The Milk River, draining the north-central part of the county, flows northeasterly across the International Border. The southern part of the county is drained by Cut Bank and Two Medicine Creeks, both tributaries of the east-flowing Marias River. The larger part of the county is occupied by the Blackfeet Indian Reservation and Glacier National Park, both under jurisdiction of the U. S. Department of the Interior.

In northwest Montana the Belt Series (Precambrian) comprises sedimentary rocks deposited more than a half billion years ago in a shallow depression or depressions containing extensive bodies of saline water. The total Precambrian section exposed in western Glacier County ranges in thickness from 25,000 to 30,000 feet, and includes in ascending order the Altyn Limestone, Appekunny Argillite, Grinnell Argillite, Siyeh Limestone, and the Missoula Group.

Lower and Upper Cretaceous shale and sandstone and Cenozoic deposits crop out in the plains and foothills. Here, the exposed section includes in ascending order the Kootenai Formation (Lower Cretaceous) and the Colorado Shale, Montana Group, and St. Mary River Formation (Upper Cretaceous). The Montana Group, from oldest to youngest, consists of the Virgelle Sandstone, Two Medicine Formation, Bearpaw Shale, and Horsethief Sandstone. The thickness of the Cretaceous section in the county amounts to about 6,500 feet. Quaternary terrace alluvium, glacial deposits, and modern alluvium are virtually confined to the foothills and plains areas.

Sills and dikes of metagabbro are intrusive into Precambrian Belt strata. These igneous rocks crop out in the Lewis Range in Glacier National Park.

The Lewis overthrust, a textbook example of a thrust fault, parallels the base of the mountain front from a point near Marias Pass to the International Boundary. Horizontal displacement along the thrust is a minimum of 12 miles, but may be as great as 40 miles. Chief Mountain, an erosional remnant of the Belt Series and representing the upper plate of the thrust, rests on very much younger (Cretaceous) shale. A large syncline grading into the west limb of the Sweetgrass arch is positioned in eastern Glacier County, and other anticlines, synclines, and structural terraces are present in adjacent areas.

Gas and oil, coal, titaniferous iron deposits, and sparse occurrences of copper and precious metals have been reported in Glacier County.

Metallic Minerals

Titaniferous magnetite-bearing sandstone deposits occur in the Horsethief Sandstone, an Upper Cretaceous continental deposit overlying the Bearpaw Shale and underlying the St. Mary River Formation. Principal deposits are distributed over the west half of the Blackfeet Indian Reservation, on Rimrock Butte, and adjacent to Milk River northwest of Cut Bank. Iron content ranges from 27 to 50 percent, and titanium oxide content from 6 to 13 percent. Titanium minerals identified are ilmenite and titanite. Thickness of beds reach 9 feet, but the average thickness is between 4 and 5 feet.

Copper and gold have been reported east of the Continental Divide in Glacier National Park, but National Park Service regulations prohibit prospecting and mining within National park boundaries.

The Blackfeet Indian Tribal Council has jurisdiction over issuing prospecting permits for mineral resources on Indian Tribal land or on land where mineral rights were reserved for the Tribe. The permit is nonexclusive without option to lease, and leases are obtained at lease sales by sealed bid. On certain allotted lands within the reservation on which individual landowners have mineral rights which they can sell or exchange, permission for exploration must be obtained from the landowner, or in his absence from the reservation, from the land user.

Nonmetallic Minerals

Bentonite beds are known to occur within the Bearpaw Shale and other Cretaceous-age shales. These shales crop out along a north-trending belt in the central part of the county. Expandable shale suitable for use in the manufacture of lightweight aggregate may also occur within the Cretaceous shales of this county.

Quaternary sand and gravel deposits are widespread in the southern part of the county.

Oil and Gas

Glacier County became one of Montana's early producing areas when Cutbank Field was discovered in 1926. Since that time, Cutbank Field has produced well over 100 million barrels of oil and about 140 billion cubic feet of gas.

Exploration activity has resulted in the drilling of more than 1,050 wells and discovery of seven more fields. They are listed with their discovery dates below.

Cutbank—1926
Reagan—1941
Darling—1951
Blackfoot—1955
Red Creek—1958
Bradley—1959
Graben Coulee—1961
Two Medicine Unit—1962

Oil production in 1967 averaged about 11,400 barrels per day from these fields. Production for 1967 was about 4.2 million barrels. Total production since the discovery of Cutbank Field has amounted to about 118.3 million barrels. Total gas production has been about 144 billion cubic feet.

With the history of successful exploration and production of oil and gas that belongs to Glacier County, one can only predict a bright future. Only Cretaceous and Mississippian rocks have been productive, but older beds may also produce in the future.

SOIL AND WATER CONSERVATION DISTRICT

Glacier County is served by the Glacier County Soil and Water Conservation District. The District, which was organized in 1947, is governed by a board of five supervisors who are elected by the land occupiers of the District.

The supervisors carry out a program of complete resource conservation including erosion control, water conservation, soil management, land improvement, wildlife management, recreation, and land use adjustment. This program is accomplished by providing assistance to land owners and operators, on a voluntary basis, to plan and apply sound conservation treatment.

Under State law, the supervisors have the authority to call upon local, State and Federal agencies to assist in carrying out a soil and water conservation program. The Glacier County Soil and Water Conservation District works closely with the Soil Conservation Service, the Farmers Home Administration, the Bureau of Indian Affairs, the Extension Service, and the State Fish and Game Department. The cooperation of these agencies makes a complete and balanced soil and water conservation program possible in the District.

The Soil Conservation Service assists the District by furnishing and interpreting basic data on soils and plant cover and other features of the land. Technical data are interpreted in terms of acceptable alternative uses and treatments to help guide the farm and ranch operator in developing sound conservation plans. It also aids district cooperators in performing operations requiring technical skills beyond the experience of the individuals involved.

The technical assistance is available to any operator in the county without cost upon request to the District by the farmer or rancher. Cost-sharing assistance to help in the cost of applying conservation practices is available through the Great Plains Conservation Program administered by the Soil Conservation Service and the Agricultural Conservation Program administered by the Glacier County Agricultural Stabilization and Conservation Service.

Glacier County comprises 1,947,263 acres of land. Glacier National Park has 376,450 acres and the Lewis and Clark National Forest has 30,723 acres, making a total of 407,173 acres of Federally owned land, or 21 percent of the County. The Blackfeet Indian Reservation covers 1,373,277 acres or 71 percent of the county. The balance of 166,813 acres is the privately-owned, deeded portion along the eastern side, which makes up 8 percent of the total land area of Glacier County.

There are approximately 341,000 acres of cropland, of which 13,000 acres are irrigated. Over half of the county, 1,027,600 acres, is grassland used for range, pasture, or hayland. Almost one-third of the county, 540,000 acres, is forested. This includes the National Park, the National Forest, and 151,000 acres of forested land on the Blackfeet Indian Reservation adjoining the National Park and National Forest. There are 27,260 acres of ponds and lakes in the county. In addition to these water areas, there are over 500 miles of live streams. There are 4,236 acres of "other areas," which include towns and villages, airport, oilfield installations, gravel pits, etc.

The major crops grown in Glacier County are small grains and forage crops. Beef cattle is the major livestock enterprise. There are only small numbers of sheep and there are scattered hog producers. There were several dairy herds in the county at one time, but all have now gone out of business.

The major conservation practices in the District on rangeland are development of dams and springs for livestock water, grass seeding for hay and pasture, and cross fencing of ranges for better management of grazing. Cropland problems are wind and water erosion. Erosion is controlled by the following practices: stripcropping and stubble mulching, grassed waterways and diversions, and farmstead and field shelterbelts.

SNOW SURVEYS

The Soil Conservation Service issues water supply forecasts and coordinates the snow survey measurements. Snow surveys are made throughout the winter and spring months by the SCS and other cooperating federal, state and private agencies. These data provide the main information used to predict streamflow. Water supply forecasts are used by farmers and ranchers to assess the amount of irrigation water that will be available, by irrigation and flood control organizations to manage reservoir operation, by power companies and many other groups and individuals whose operations are related to or dependent on streamflow. This three to six months advance knowledge of spring and summer runoff allows water users and managers time to plan operations according to the expected streamflow. Farmers and ranchers can plan crops for the coming spring. Reservoirs can be operated for maximum efficiency by combining flood control with power generation and irrigation storage. Bankers, railroad managers, farm equipment builders and persons in various other businesses can determine and plan for the effect the anticipated water supply may have on their operation.

A snow survey consists of measuring the depth and amount of water in the snow, or snow water equivalent. Measurements are taken at the same place each year, using standard snow sampling equipment. Almost all courses are measured near the first of March, April and May, with a few courses measured earlier and later in the season. In recent years, snow pillows, a pressure sensing device, have been developed to provide a continuous record of snow water equivalent. Most snow pillow sites have a mountain precipitation storage gage.

Soil moisture and soil temperature is measured at five depths by electrical resistance units at permanently established locations. The total is the amount of water contained in the top four feet of soil.

Current information on snow surveys and streamflow forecasts can be obtained from Soil Conservation Service, Box 970, Bozeman, Montana 59715 or Soil Conservation Service, Box 2215, Cut Bank, Montana 59427.

Snow courses and soil moisture stations in or immediately adjacent to Glacier County are shown in the following tabulation. Other snow courses in adjacent counties are also used to forecast the Marias River and St. Mary River streamflow.

SNOW COURSES AND SOIL MOISTURE STATIONS

Drainage and Name	Elevation	Year Established	Measured[1/]
Marias River			
Marias Pass	5,250	1934	1, 2, 3, 4, 5
Marias Pass Soil Moisture	5,250	1950	Monthly
St. Mary River			
Hudson Bay Divide	5,800	1963	3, 4, 5
Iceberg Lake	5,600	1922	5
Josephine Lower	4,900	1955	5
Mt. Allen	5,700	1922	5
Piegan Pass	5,500	1922	5
Ptarmigan	5,800	1937	5

[1/] Numerals 1, 2, 3, 4, 5 refer to January 1, February 1, March 1, April 1, and May 1 measurements.

FISH AND GAME

The waters of Glacier County offer a variety of hunting and fishing opportunities to the people of the State of Montana, but the three major political divisions of the county, the Blackfeet Indian Reservation, Glacier National Park, and the other private and public lands complicate the pursuit of fish and game.

Hunting of game birds and waterfowl and fishing by non-tribal members is allowed on the Blackfeet Indian Reservation if the recreationist has a Blackfeet Tribal license. A Montana fishing and/or bird license is also necessary. Sportsmen are subject to the rules and regulations of the State of Montana, the Blackfeet Reservation, and the Federal Bureau of Sports Fisheries and Wildlife.

Hunting and fishing on private and public lands in Glacier County are regulated by the Montana Fish and Game Department.

Cut Bank Creek is the main drainage of the county and is an exceptional stream for ling, brown trout, and rainbow trout. It is especially good for trout upstream from the town of Cut Bank. Rainbows may also be taken in Badger Creek, Two Medicine Creek, Willow Creek, and the St. Mary River. Rainbows, cutthroat trout, and brook trout may be taken in the higher lakes and streams in the Park.

Duck Lake in the St. Mary River drainage is nationally known as a consistent producer of record size rainbow trout. Dog Gone Lake also produces rainbows. Lower St. Mary's Lake in the Park produces excellent catches of northern pike, mackinaw, and rainbow trout.

Big game hunting in Glacier County is restricted to the eastern portion of the county and to a small area east and northeast of the town of Summit. In the eastern section whitetail deer may be hunted along the stream bottoms and mule deer and antelope may be hunted throughout the area. Near Summit, whitetail deer, mule deer, elk, and mountain goats may be taken. Occasionally black bear and grizzly bear are hunted here.

Bird hunting is excellent throughout the county east of the Park boundary. Ruffed grouse, blue grouse, and Franklin's grouse inhabit the wooded areas in the western portion of the county and sharptail grouse are found throughout the eastern grassland areas. Some Hungarian partridge will be found near farmsteads with weed cover and pheasants occur with agricultural lands.

The presence of many glacial potholes in the eastern portion of the county and on the Indian Reservation accounts for excellent duck and goose hunting in that area. Waterfowl may be hunted on the reservation by holders of a Tribal license, a Montana bird license and the Federal Migratory Bird Stamp.

Hunting for predators and varmints is an enjoyable way to relax during the closed season. Lynx, bobcats, coyotes, fox, marmots and ground squirrels may be hunted on private and public lands throughout the year.

Trapping is allowed outside Park and Reservation boundaries by non-tribal members, except for beaver which may be trapped on the reservation with permission of the Tribal Council. In the eastern section of the county mink, muskrat, beaver, fox, bobcat, and lynx may be trapped in suitable locations. Near Summit, otter and martin plus the species already mentioned may be trapped.

The opportunity exists in Glacier National Park to easily observe many animals in their native habitats. Moose and whitetail deer are often seen in wet, bottomland areas. Mule deer inhabit drier upland sites. Big horn sheep are common to mountainous outcrops near grassy areas. Mountain goats are found on high, mountainous ledges. Both the black bear and the grizzly bear may be seen throughout the Park, but the black is most common to burned over areas and grizzly to high mountainous valleys. Many of the lesser mammals and birds may also be easily observed in the Park. Although the observational value of mammals and birds is not a dollars and cents figure, it is an important aesthetic value of Glacier County waters to the people of Montana and of the world.

LEWIS AND CLARK NATIONAL FOREST

There are 25,304 acres of National Forest Land in Glacier County, all a part of the Lewis and Clark National Forest.

The Lewis and Clark National Forest was established by presidential proclamation on February 22, 1897. At that time National Forest lands were called Forest Reserves. The Reserve extended to Flathead Lake on the west, Glacier Park to the north along the face of the Rocky Mountains on the east and south to Lewis and Clark Pass. A presidential proclamation on June 9, 1903, enlarged the area by combining the Flathead and Lewis and Clark Reserves. Congress changed Forest Reserves to National Forests in 1907. Large areas of the Lewis and Clark National Forest were transferred July 1, 1908, to the Blackfoot, Flathead and Kootenai National Forests. Further reductions were made in subsequent years. On April 8, 1932, the Lewis and Clark National Forest was consolidated with the Jefferson National Forest. The Jefferson National Forest included the Little Belts, Highwoods, Snowies, and Little Rockies. Trapping lured most early settlers. There was little mining or good agricultural potential in this mountainous area.

This acreage, managed under the multiple use concept by the District Forest Ranger and his assistants based in Choteau, Montana, is classified as mostly grazing land. The number of acres inventoried as suitable for grazing is 20,280 while the balance is chiefly recreational in character.

Over 300 head of cattle and 3,250 head of sheep are permitted to graze upon this portion of the Lewis and Clark National Forest. The forage produced is an important part of local ranch operations. Domestic grazing of these public lands is managed so as to avoid conflict with wildlife needs.

Topography of National Forest land in Glacier County is mostly steep and precipitous with narrow valleys. The Rocky Mountains furnish the streamflow originating in the perpetual snows of the higher elevations. The tentacles of the Two Medicine and Little Badger Creeks originate at these snowbanks along the Continental Divide and flow eastward to irrigate hay producing land as well as furnish domestic water for livestock and many people in Glacier County.

The high rugged Rocky Mountains afford the westward traveler on U. S. Highway #2 a never to be forgotten memory to be taken to his home throughout America and most nations of the world. A modern 21-family unit campground is located adjacent to U. S. Highway #2 at Summit, Montana. Since this area is adjacent to Glacier National Park and readily seen by the many thousands of recreation oriented persons traveling to and from the Park, it is informally visited by uncounted thousands of people.

This portion of Glacier County abounds with wildlife consisting of elk, whitetail and mule deer, mountain sheep, black and grizzly bear. Harvesting of this wildlife population in season entails many hundreds of visits by Glacier County residents as well by tourists from many nations.

National Forest land is managed under the multiple use concept of resource management. Use of the land is not limited to one resource. These public lands are managed for water, wood, forage, wildlife, and recreation.

Of the major divisions of multiple use, only that of timber production is minimal in that portion of the National Forest lying within Glacier County. No commercial timber cutting is now being done nor is any imminent. Only post and pole cutting by local residents for current use is being done.

SUMMARY OF IRRIGATED LAND BY RIVER BASINS IN THE FOLLOWING COUNTIES COMPLETED TO DATE

Big Horn, Blaine, Broadwater Carbon, Carter, Cascade, Chouteau, Custer, Deer Lodge, Fallon, Flathead, Gallatin, **Glacier**, Golden Valley, Granite, Hill, Jefferson, Judith Basin, Lake, Lewis & Clark, Liberty, Lincoln, Madison, Meagher, Missoula, Musselshell, Park, Phillips, Pondera, Powder River, Powell, Ravalli, Rosebud, Silver Bow, Stillwater, Sweet Grass, Teton, Toole, Treasure, Valley, Wheatland, Wibaux, and Yellowstone.

RIVER BASIN	Present Irrigated Acres	Irrigable Acres Under Present Facilities	Maximum Irrigated & Irrigable Acres Under Present Facilities
Hudson Bay Drainage Basin			
*Hudson Bay	0.00	0.00	0.00
Nelson River	0.00	0.00	0.00
Lake Winnepeg	0.00	0.00	0.00
Saskatchewan River	0.00	0.00	0.00
Oldman River	0.00	0.00	0.00
St. Mary River	587.00	0.00	587.00
Unnamed Coulee	26.00	0.00	26.00
Kennedy Creek (Otatso Creek)	0.00	71.00	71.00
Willow Creek	0.00	4.00	4.00
Grand Total Hudson Bay Drainage Basin	**613.00**	**75.00**	**688.00**
Missouri River Drainage Basin			
Missouri River	134,575.50	26,711.33	161,286.83
Jefferson River	61,291.00	9,713.00	71,004.00
Beaverhead River	40,771.00	6,076.00	46,847.00
Big Hole River	23,775.00	1,950.00	25,725.00
Madison River	39,445.00	7,660.00	47,105.00
Gallatin River	112,054.00	21,242.00	133,296.00
Smith River	32,934.00	19,679.00	52,613.00
Sun River	124,474.58	4,385.00	128,859.58
Marias River	149,004.42	20,756.88	169,761.30
Teton River	74,653.00	15,882.33	90,535.33
Musselshell River	64,789.00	57,870.00	122,659.00
Milk River	217,402.62	50,044.76	267,447.38
Yellowstone River**	303,657.00	96,016.00	399,673.00
Stillwater River**	30,423.50	8,028.53	38,452.03
Clark's Fork River**	88,160.97	1,530.83	89,691.80
Big Horn River**	65,005.00	23,858.00	88,863.00
Tongue River	28,170.00	7,762.00	35,932.00
Powder River	35,948.00	2,299.00	38,247.00
Little Missouri River	42,513.00	1,499.00	44,012.00
Grand Total Missouri River Basin	**1,669,046.59**	**382,963.66**	**2,052,010.25**
Columbia River Drainage Basin			
Columbia River	0.00	0.00	0.00
Kootenai (Kootenay) River	99,914.13	968.00	10,882.13
Clark Fork (Deer Lodge) (Hellgate) (Missoula) River	146,287.70	14,934.20	161,221.90
Bitterroot River	111,102.43	3,200.00	114,302.43
Flathead River	135,907.19	4,532.22	140,439.41
Grand Total Columbia River Basin	**403,211.45**	**23,634.42**	**426,845.87**
GRAND TOTAL OF COUNTIES COMPLETED TO DATE	**2,072,871.04**	**406,673.08**	**2,479,544.12**

*Names of streams indented on the left-hand margin indicate that they are tributaries of the first stream named above which is not indented.

**Figures in these River Basins revised by resurvey of Carbon County, 1965.

IRRIGATION SUMMARY OF GLACIER COUNTY BY RIVER BASINS

RIVER BASIN	Present Irrigated Acres	Irrigable Acres Under Present Facilities	Maximum Irrigated & Irrigable Acres Under Present Facilities
Hudson Bay Drainage			
Hudson Bay	0.00	0.00	0.00
Nelson River	0.00	0.00	0.00
Lake Winnepeg	0.00	0.00	0.00
Saskatchewan River	0.00	0.00	0.00
Oldman River	0.00	0.00	0.00
St. Mary River	587.00	0.00	587.00
Unnamed Coulee	26.00	0.00	26.00
Kennedy Creek (Otatso Creek)	0.00	71.00	71.00
Willow Creek	0.00	4.00	4.00
Total of Hudson Bay Drainage	**613.00**	**75.00**	**688.00**
MISSOURI RIVER BASIN			
Missouri River	0.00	0.00	0.00
Marias River	11.00	0.00	11.00
Two Medicine River	19,675.00	2,307.00	21,982.00
Midvale Creek (North Fork) (Kennedy)	64.00	0.00	64.00
Little Badger Creek	0.00	214.00	214.00
Spring Creek	48.00	0.00	48.00
Badger Creek (Big Badger Creek)	511.00	47.00	558.00
White Man Coulee	24.00	0.00	24.00
Unnamed Spring	29.00	0.00	29.00
Birch Creek	134.00	12.00	146.00
Total of Two Medicine River & Tributaries	**20,485.00**	**2,580.00**	**23,065.00**
Cut Bank Creek (River)	1,683.00	327.00	2,010.00
South Fork Cut Bank Creek	512.00	389.00	901.00
Schilt Creek	10.00	0.00	10.00
Unnamed Coulee	18.00	0.00	18.00
Flat Iron Creek	72.00	0.00	72.00
Greasewood Creek	162.00	0.00	162.00
Unnamed Coulee	49.00	0.00	49.00
Finley Spring No. 2	102.00	0.00	102.00
Finley Spring No. 1	14.00	0.00	14.00
Willow Creek	676.00	38.00	714.00
Depot Coulee	11.00	0.00	11.00
Unnamed Coulee	0.00	48.00	48.00
Unnamed Coulee	0.00	65.00	65.00
Head Light Coulee	0.00	19.00	19.00
Snake Coulee	0.00	0.00	0.00
Hay Lake	0.00	23.00	23.00
Total of Cut Bank Creek & Tributaries	**3,309.00**	**909.00**	**4,218.00**
Total of Marias River & Tributaries	**23,805.00**	**3,489.00**	**27,294.00**

RIVER BASIN	Present Irrigated Acres	Irrigable Acres Under Present Facilities	Maximum Irrigated & Irrigable Acres Under Present Facilities
Milk River	0.00	0.00	0.00
South Fork Milk River	580.00	301.00	881.00
Arnoux Creek (Arnold Creek)	64.00	112.00	176.00
Livermore Creek	171.00	166.00	337.00
Middle Fork Milk River	418.00	99.00	517.00
Davis Coulee	24.00	0.00	24.00
Dry Fork Milk River	41.00	0.00	41.00
Unnamed Spring	18.00	0.00	18.00
Unnamed Stream	48.00	0.00	48.00
North Fork Milk River	0.00	0.00	0.00
Freeze Out Creek	0.00	7.00	7.00
Unnamed Coulee	0.00	16.00	16.00
Unnamed Coulee	12.00	0.00	12.00
Unnamed Coulee	8.00	0.00	8.00
Unnamed Coulee	29.00	0.00	29.00
Red River	0.00	0.00	0.00
Fitzpatrick Coulee (South West Branch Red River)	0.00	0.00	0.00
Grassy (F) Lake	0.00	0.00	0.00
Gillette Coulee	0.00	0.00	0.00
Long Lake	17.00	17.00	34.00
Pearsons Coulee (Long) (North Fork Red River Coulee)	21.00	0.00	21.00
Canadian Coulee	8.00	0.00	8.00
Unnamed Coulee	20.00	0.00	20.00
Total of Milk River & Tributaries	**1,479.00**	**718.00**	**2,197.00**
Total Marias River & Tributaries	**23,805.00**	**3,489.00**	**27,294.00**
Total Hudson Bay Drainage	**613.00**	**75.00**	**688.00**
GRAND TOTAL GLACIER COUNTY	**25,897.00**	**4,282.00**	**30,179.00**

*Names of streams indented on the left-hand margin indicate that they are tributaries of the first stream named above which is not indented.

BLACKFEET IRRIGATION PROJECT

HISTORY

The original Blackfeet Indian Reservation was established by the Fort Laramie Treaty of 1851. In 1855 the Treaty set aside a part of the Judith River watershed as a common hunting ground. During the years 1873-1874 and 1888, several Presidential Orders and Congressional Acts effected division of the original reservation into the Fort Belknap, Fort Peck and Blackfeet Reservations. In 1888 further lands were ceded by the Tribes, reducing the three reservations to their existing size.

The topography of the Blackfeet Indian Reservation is composed of the foothills of the Rocky Mountains, lofty divides, deep canyons, extensive areas of rolling plateaus and nearly level bench lands. Elevations vary from an average of 3,800 feet to 4,200 feet above mean sea level in the project area.

The Blackfeet Indian Reservation is located east and southeast of Glacier National Park, in Glacier and Pondera Counties, Montana. The irrigation project lies largely in the eastern portion of the reservation, wholly within the Marias River drainage. The principle streams used for irrigation on the Blackfeet Irrigation Project include the Two Medicine River, Badger Creek, Birch Creek and their tributaries. All three of the active units lie west and south of the town of Cut Bank and west and north of the town of Valier.

Irrigation activities on the Blackfeet Indian Reservation began in 1886 when a number of ranchers built a small ditch diverting water from Birch Creek to irrigate about 1,000 acres. Construction of facilities for the existing project commenced in 1908, under the direction of the United States Reclamation Service. By 1917, the Two Medicine, Badger-Fisher, Birch Creek and Piegan Units were partially constructed and put into operation. The Piegan Unit is no longer a part of the Blackfeet Irrigation Project as it has been turned over to the users under the unit and they now have complete control of the system including the operation and maintenance.

The transfer of the Blackfeet Project to the Bureau of Indian Affairs was directed by the Secretary of the Interior in an order dated January 15, 1924. Operation by the Bureau of Indian Affairs was discontinued with the 1933 irrigation season and was carried on by the water users until the Bureau resumed operations in 1939. Since that time additional acreages have been developed on a year by year basis.

PRESENT STATISTICS

Location: Land irrigated under the Two Medicine Unit is located in Sections 19 and 28-33 inclusive, T. 34N - R. 6W; Sections 21-36 inclusive, T. 34N - R. 7W; Sections 25-35, and 36, T. 34N - R. 8W; Sections 2-10 inclusive, 16-20 inclusive, 28, 29, 30, 32, and 33, T. 33N - R. 6W; Sections 1-6 inclusive, 10-15 inclusive, 19, 21-27 inclusive, and Section 30, T. 33N - R. 7W; Sections 1, 2, 3, 11, 25, 26, 35, and 36, T. 33N - R. 8W; Sections 3, 4, and 9, T. 32N - R. 8W; Sections 35 and 36, T. 32N - R. 9 W; Section 2, T. 31N - R. 9W; Sections 13, 14, 23, and 24, T. 31N - R. 10W. The point of diversion for the Two Medicine Canal is located in the SW¼NE¼ of Section 23, T. 31N - R. 10W.

Land irrigated under the Four Horns Feeder Canal is located in Sections 12, 13, and 14, T. 30N - R. 9W. The point of diversion for the Four Horns Feeder Canal is in the SE¼NE¼ of Section 24, T. 30N - R. 10W.

Land irrigated by the Birch Creek Unit is located in Sections 25, and 36, T. 30N - R. 8W. The point of diversion for the Birch Creek Canal is located in the NW¼NE¼ of Section 27, T. 29N - R. 8W and ending in the SW¼NW¼ of Section 20, T. 30N - R. 7W, both points being in Pondera County.

Length and Capacity of Canals: Two Medicine Unit main canal is approximately 36 miles long with an initial capacity of 500 second-feet. There are approximately 168 miles of laterals under the system.

The Four Horns Feeder Canal is approximately 11 miles long with an initial capacity of 150 second-feet.

The Birch Creek Unit Canal has an initial capacity of 416 second-feet with a total of 19 miles of canals and laterals; 4 1/2 miles of the main canal being located in Glacier County.

Size and Capacity of Reservoirs: The Lower Two Medicine Lake has a usable capacity of 13,500 acre-feet and a surface area of 740 acres at elevation 4,882.2 feet. This reservoir was washed out in June, 1964. It was then rebuilt by the Bureau of Reclamation and returned to use in 1967.

The Four Horns Reservoir has a usable capacity of 19,250 acre-feet and covers a surface area of 785 acres.

The Swift Reservoir has a capacity of 30,000 acre-feet and a surface area of 440 acres at elevation of 4,883.5 feet. This reservoir was also washed out by the flood in June, 1964. It was rebuilt by the Bureau of Reclamation and returned to use in 1966.

Operation and Maintenance: Charges for operation and maintenance for the Two Medicine Unit, Four Horns Feeder Canal, and the Birch Creek Unit is $3.00 per acre.

Present Users: In 1968 the Two Medicine Unit listed 37 users; Four Horns Feeder Canal listed one user; and the Birch Creek Unit listed 2 users in Glacier County.

Acreage Irrigated: In 1968, the Two Medicine Unit had a total of 19,171 acres irrigated and 2,311 acres potentially irrigable under present facilities, making a total of 21,482 maximum irrigable acres.

The Four Horns Feeder Canal had a total of 76 acres irrigated under present facilities with no potentially irrigable acres under the system. This canal is used mainly as a feeder source for the Badger-Fisher Unit in Pondera County.

The Birch Creek Canal had a total of 134 acres irrigated and 12 acres potentially irrigable under present facilities, making a total of 146 maximum irrigable acres.

WATER RIGHT DATA

In effect the Supreme Court has held that rights to the use of water for the irrigation of Indian reservation lands have been impliedly reserved. Moreover, the water right reserved is not limited to that necessary for the irrigation at the time the reservation was established. This decision was upheld in the Henry Winters vs. United States (207 U. S. 564, 576-577) and the United States vs. Conrad Investment Company, Decree No. 720, Ninth U. S. Circuit Court, District of Montana.

In a subsequent ruling, commonly referred to as the Powers' Decision (305, U. S. 527) Tribal lands for which water is expressedly reserved, and lands distributed to individual Indians to whom fee patents were later issued, can be conveyed from Indian ownership to non-Indian ownership, each acre of land being entitled to its prorata share of the natural flow. This ruling was made and put into effect in 1939.

The flow of Birch Creek is controlled by the Pondera County Canal and Reservoir Company, with a storage right above the Blackfeet Project diversion. The Blackfeet Project is entitled to a continuous flow of 41.6 second-feet.

Through an agreement with the Pondera Canal and Reservoir Company the natural flow is bypassed through Swift Reservoir for diversion to the Birch Creek Unit. Such natural flow has been equated to a continuous release during the irrigation season, and is adequate to serve the lands involved under the plan for completion.

The following listed water rights are appurtenant to the Blackfeet Irrigation Project:

An appropriation from Badger Creek dated 10-27-20 for 100,000 acre-feet; (Reference: Book 1, page 25, Water Right Records); from Badger Creek dated 12-6-38 for 2,000 miner's inches; (Reference: Book 1, page 200, Water Right Records); from Badger Creek dated 5-7-10 for 100,000 miner's inches; (Reference: Book A, page 41, Transcribed Misc. Records); from Badger Creek dated 5-7-10 for 30,000 miner's inches; (Reference: Book A, page 37, Transcribed Misc. Records); from Badger Creek dated 12-6-38 for 16,000 miner's inches; (Reference: Book 1, page 202, Water Right Records); from Birch Creek dated 11-5-14 for 20,000 miner's inches; (Reference: Book A, page 159, Transcribed Misc. Records); from Birch Creek dated 10-26-17 for 8,000 miner's inches; (Reference: Book A, page 248, Transcribed Misc. Records); from Blacktail Creek dated 12-6-38 for 20,000 miner's inches; (Reference: Book 1, page 197, Water Right Records); from Two Medicine River dated 10-24-17 for 167,686 acre-feet; (Reference: Book A, page 258, Transcribed Misc. Records); from Two Medicine River dated 12-6-38 for 20,000 miner's inches; (Reference: Book 1, page 211, Water Right Records); from Lower Two Medicine Lake dated 9-6-63 for 100,000 acre-feet; (Reference: Book 1, page 355, Water Right Records); from Middle Two Medicine Lake dated 5-7-10 for 189,633 acre-feet; (Reference: Book A, page 46, Transcribed Misc. Records); from Whitetail Creek dated 5-7-10 for 30,000 miner's inches; (Reference: Book A, page 39, Transcribed Misc. Records); from Whitetail Creek dated 5-7-10 for 100,000 miner's inches; (Reference: Book A, page 40, Transcribed Misc. Records).

The appropriations listed above may be located in the County Clerk and Recorder's Office, Glacier County, Cut Bank, Montana.

(See maps in Part II: Two Medicine Unit, pages 4, 6, 10, 11, 12, 17, and 18; Four Horns Feeder Canal, page 1; Birch Creek Unit, page 1.)

WATER RIGHT DATA—GLACIER COUNTY

APPROPRIATIONS AND DECREES BY STREAMS

STREAMS	APPROPRIATIONS (Filings of Record) No. of Filings	Miner's Inches	Cu. Ft. Per Sec.	DECREED RIGHTS Case No.	No. of Decrees	Miner's Inches	Cu. Ft. Per Sec.
HUDSON BAY DRAINAGE							
Hudson Bay	0	0.00	0.00				
Nelson River	0	0.00	0.00				
Lake Winnepeg	0	0.00	0.00				
Saskatchewan River	0	0.00	0.00				
Oldman River	0	0.00	0.00				
St. Mary River	7	4,180,000.00	104,500.00				
St. Mary Lake	0	0.00	0.00				
Roes Creek (Rose Creek)	2	3,500.00	87.50				
Trail Creek	1	1,000.00	25.00				
Divide Creek	3	2,600.00	65.00				
Lower St. Mary Lake	0	0.00	0.00				
Lewis Creek	1	400.00	10.00				
Harrison Creek	1	400.00	10.00				
Swiftcurrent Creek	10	745,005.58	18,625.14				
North Fork Branch Swift-current (Wilbur) Creek	1	4,000.00	100.00				
Goat Creek (Allen Creek)	1	500.00	12.50				
Appekuny Creek	2	2,000.00	50.00				
Canyon Creek	1	2,000.00	50.00				
Unnamed Coulee	1	200.00	5.00				
Boulder Creek	1	1,500.00	37.50				
St. Mary Reservoir	1	1,000,000.00	25,000.00				
Unnamed Coulee	0	0.00	0.00				
Unnamed Spring	1	80.00	2.00				
A Lake	1	All	---				
Kennedy Creek (Otatso Creek)	4	2,890.00	72.25				
Spider Creek	1	600.00	15.00				
Willow Creek	1	32,000.00	800.00				
Cow Creek	1	32,000.00	800.00				
Total Hudson Bay Drainage	**42**	**6,010,675.58**	**150,266.89**				
MISSOURI RIVER BASIN							
Missouri River	0	0.00	0.00				
Marias River	2	400.00	10.00				
Two Medicine River	9	184,000.00	4,600.00				
Lower Two Medicine Lake	1	100,000.00	2,500.00				

*Names of streams indented on the left-hand margin indicate that they are tributaries of the first stream named above which is not indented.

WATER RIGHT DATA — GLACIER COUNTY

APPROPRIATIONS AND DECREES BY STREAMS

STREAMS	APPROPRIATIONS (Filings of Record) No. of Filings	Miner's Inches	Cu. Ft. Per Sec.	DECREED RIGHTS Case No.	No. of Decrees	Miner's Inches	Cu. Ft. Per Sec.
Two Medicine Creek (Two Medicine Falls)	5	648,000.00	16,200.00				
Two Medicine Lake (Middle)	2	357,319.00A/F.	---				
Forty Mile Creek	1	10,000.00	250.00				
Midvale Creek (North Fork) (Kennedy)	5	2,400.00	60.00				
Railroad Creek	2	1,200.00	30.00				
Spring Creek	1	200.00	5.00				
Elk Creek	1	140.00	3.50				
South Fork Two Medicine River	1	1,000.00	25.00				
Summit Creek	1	5,000.00	125.00				
Deep Creek	1	80.00	2.00				
Little Badger Creek	1	500.00	12.50				
South Fork Little Badger Creek	1	1,000.00	25.00				
Badger Creek (Big Badger Creek)	22	381,020.00	9,525.50				
Beaver Creek (Evans Creek)	2	360.00	9.00				
Whitetail Creek	6	262,120.00	6,553.00				
Birch Creek	5	52,500.00	1,312.50				
Blacktail Creek	2	40,000.00	1,000.00				
Four Horns Reservoir	3	210,000.00A/F.	---				
Total Two Medicine River & Tributaries	**72**	**1,689,520.00**	**42,238.00**				
Cut Bank Creek (River)	**51**	**434,283.00**	**10,857.08**				
North Fork Cut Bank Creek	1	8,000.00	200.00				
South Fork Cut Bank Creek	3	11,200.00	200.00				
Flat Iron Creek	1	20.00	.50				
Greasewood Creek	1	200.00	5.00				
North Fork Greasewood Creek	1	---	---				
Unnamed Creek	1	200.00	5.00				
Spring Creek	1	120.00	3.00				
Finley Spring Creek No. 2	1	All	---				
Finley Spring Creek No. 1	1	All	---				
Unnamed Spring	1	240.00	6.00				
Willow Creek	15	36,780.00	919.50				
South Fork Willow Creek	1	100.00	2.50				
Middle Fork Willow Creek	2	400.00	10.00				
Unnamed Coulee	0	0.00	0.00				
Connolly Springs	1	2,000.00	50.00				
Unnamed Coulee	0	0.00	0.00				
Guardipee Lake (McCloud Lake)	1	38,000.00A/F.	---				

WATER RIGHT DATA — GLACIER COUNTY

APPROPRIATIONS AND DECREES BY STREAMS

STREAMS	APPROPRIATIONS (Filings of Record) No. of Filings	Miner's Inches	Cu. Ft. Per Sec.	DECREED RIGHTS Case No.	No. of Decrees	Miner's Inches	Cu. Ft. Per Sec.
Little Rocky Coulee (Creek)	3	800.44	20.04				
Unnamed Coulee	0	0.00	0.00				
Little Rock Creek Reservoir	1	---	---				
Unnamed Coulee	0	0.00	0.00				
Unnamed Coulee	1	All	---				
Rocky Coulee (Creek)	7	9,687.00	242.18				
Rake Coulee	1	200.00	5.00				
Unnamed Coulee	0	0.00	0.00				
West Varginia Lake	1	200.00	5.00				
Unnamed Coulee	0	0.00	5.00				
Joiners Lake	1	2,000.00	50.00				
Unnamed Coulee	0	0.00	0.00				
Clear Lake (Hope)	2	4,500.00	112.50				
Unnamed Coulee	0	0.00	0.00				
Muskrat Lake	1	500.00	12.50				
Unnamed Coulee	0	0.00	0.00				
Badger Lake	1	1,200.00	30.00				
Lost Lake Coulee	1	400.00	10.00				
Montana Coulee	1	2,000.00	50.00				
Unnamed Coulee	1	300.00	7.50				
Alkali Coulee	1	400.00	10.00				
Highland Coulee	1	1,600.00	40.00				
Snow Coulee	1	400.00	10.00				
Colamity Flats Coulee	1	400.00	10.00				
Middle Head Light Coulee	1	500.00	12.50				
West Head Light Coulee (Small - Little Field)	3	5,000.00	125.00				
Halversen Coulee	1	2,000.00	50.00				
Rocky Coulee Springs	2	80.00	2.00				
Head Light Coulee	1	200.00	5.00				
Lost Lake Coulee	1	800.00	20.00				
Munro Coulee	1	200.00	5.00				
Yunck Coulee	1	100.00	2.50				
Unnamed Coulee	0	0.00	0.00				
A Spring	1	2,000.00	50.00				
A Spring	1	2,000.00	50.00				
Snake Coulee	4	2,200.00	55.00				
Hay Lake	2	3,000.00	75.00				
Anderson Coulee	1	All	---				
Shallow Coulee	1	800.00	20.00				
Baldwin Coulee	2	2,000.00	50.00				
Lakelet Coulee Reservoir	1	400.00	10.00				
Dynamite Coulee Reservoir	1	400.00	10.00				
Dead Horse Coulee	1	1,600.00	40.00				

WATER RIGHT DATA — GLACIER COUNTY
APPROPRIATIONS AND DECREES BY STREAM

STREAMS	APPROPRIATIONS (Filings of Record) No. of Filings	Miner's Inches	Cu. Ft. Per Sec.	DECREED RIGHTS Case No.	No. of Decrees	Miner's Inches	Cu. Ft. Per Sec.
Coyote Coulee	1	1,200.00	30.00				
East Head Light Coulee	1	5,000.00	125.00				
Division Coulee	1	800.00	20.00				
Lukins Coulee	1	400.00	10.00				
Kaplic Coulee	1	1,600.00	40.00				
Unnamed Coulee	1	5,000.00	125.00				
Unnamed Coulee	1	5,000.00	125.00				
Guth Side Coulee	1	500.00	12.50				
Guth Spring Coulee	1	2,000.00	50.00				
Anderson Coulee	1	500.00	12.50				
Zephrin Chabre Coulee	1	400.00	10.00				
Spring Creek	3	740.01	18.50				
Well	1	.29	.05				
Unnamed Coulee	0	0.00	0.00				
A Spring	1	4,000.00	100.00				
Unnamed Coulee	0	0.00	0.00				
Run-Off	1	2,000.00	50.00				
Spring Creek	2	4,000.00	100.00				
Mission (Spring) Lake	1	30,000.00A/F.	---				
Unnamed Coulee	0	0.00	0.00				
Natural Spring	2	400.00	10.00				
Spring Coulee	0	0.00	0.00				
Seepage	1	.02	.01				
Zephyrin Chalee Coulee	1	400.00	10.00				
Unnamed Coulee	1	80.00	2.00				
Unnamed Coulee	1	---	---				
Raglon Coulee	1	100.00	2.50				
Total of Cut Bank Creek & Tributaries	**162**	**575,530.76**	**14,388.36**				
Little Spring Coulee	**0**	**0.00**	**0.00**				
Bugbee Coulee	1	200.00	5.00				
Unnamed Coulee	0	0.00	0.00				
Springs	1	200.00	5.00				
Medicine Rock Coulee	**0**	**0.00**	**0.00**				
Shelby Coulee	0	0.00	0.00				
Spring Coulee	0	0.00	0.00				
Unnamed Coulee	0	0.00	0.00				
Boru Spring	1	All	---				
West Branch Spring Coulee	1	1,000.00	25.00				
Total of Marias River & Tributaries	**238**	**2,266,450.76**	**56,661.36**				
Milk River	**8**	**2,624.00**	**65.60**				
South Fork Milk River	**9**	**18,920.00**	**473.00**				
Arnoux Creek (Arnold Creek)	4	1,800.00	45.00				
Livermore Creek	5	800.00	20.00				
Bostwick Coulee	1	All	---				
Louis Ell Coule	1	All	---				

WATER RIGHT DATA — GLACIER COUNTY

APPROPRIATIONS AND DECREES BY STREAMS

STREAMS	APPROPRIATIONS (Filings of Record) No. of Filings	Miner's Inches	Cu. Ft. Per Sec.	DECREED RIGHTS Case No.	No. of Decrees	Miner's Inches	Cu. Ft. Per Sec.
Middle Fork Milk River	**5**	**9,520.00**	**238.00**				
Dry Fork Milk River	3	880.00	22.00				
Unnamed Stream	1	160.00	4.00				
North Fork Milk River	**2**	**3,100.00**	**77.50**				
Unnamed Creek	0	0.00	0.00				
Unnamed Spring	1	120.00	3.00				
Freeze Out Creek	1	21,000.00	525.00				
Red River	**3**	**800.00**	**20.00**				
Humes Coulee	1	800.00	20.00				
Red River Springs	1	200.00	5.00				
Fitzpatrick Coulee (South West Branch Red River)	2	600.00	15.00				
A Well	1	20.00	.50				
Grassy (F) Lake	0	0.00	0.00				
Indian Coulee	1	400.00	10.00				
Gillette Coulee	1	2,000.00	50.00				
Long Lake	1	2,000.00	50.00				
Unnamed Coulee	0	0.00	0.00				
Fred Joiner Springs	1	200.00	5.00				
Pearsons Coulee (Long) (North Fork Red River Coulee)	6	4,960.00	124.00				
Humes Coulee	1	200.00	5.00				
Paynes Coulee	1	200.00	5.00				
Calhoun Coulee	1	200.00	5.00				
Canadian Coulee	3	800.00	20.00				
Unnamed Coulee	1	All	---				
South Fork Red River (Audreas Coulee)	1	800.00	20.00				
Total Milk River & Tributaries	**67**	**73,104.00**	**1,817.60**				
Total Marias River & Tributaries	**238**	**2,266,450.76**	**56,661.36**				
Total Hudson Bay Drainage	**42**	**6,010,675.58**	**150,266.89**				
GRAND TOTAL GLACIER COUNTY	**347**	**8,350,230.34**	**208,745.85**				

DRAINAGES IN GLACIER COUNTY NOT LOCATED

Stream	No. of Filings	Miner's Inches	Cu. Ft. Per Sec.
Caseys Falls	1	.32	.01
Healy Spring or Coulee	1	400.00	10.00
Rocky Bridge Coulee	1	400.00	10.00
Unnamed Spring	1	10.00	.25
TOTAL	**4**	**810.32**	**20.26**

WATER RESOURCES SURVEY

Glacier County, Montana

PART II

Maps Showing Irrigated Areas in Colors Designating Sources of Supply

Published by
MONTANA WATER RESOURCES BOARD
Helena, Montana
September, 1969

MAP INDEX

All maps have been made from aerial photographs

MAP SYMBOL INDEX

BOUNDARIES

- INTERNATIONAL
- STATE
- COUNTY
- NATIONAL FOREST

DITCHES

- CANALS OR DITCHES
- DRAIN DITCHES

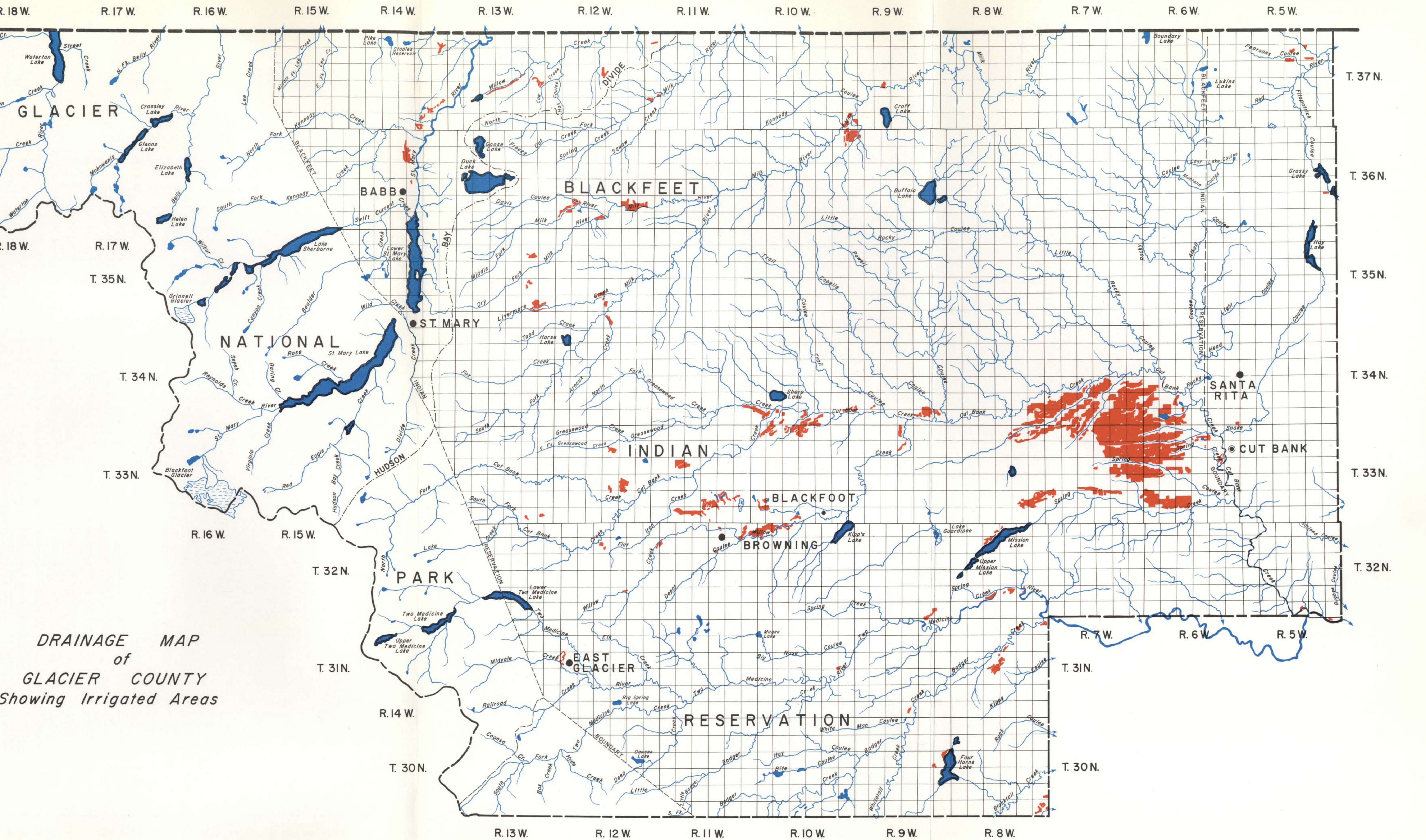
TRANSPORTATION

- PAVED ROADS
- UNPAVED ROADS
- RAILROADS
- STATE HIGHWAY
- U.S. HIGHWAY
- INTERSTATE HIGHWAY
- AIRPORT
- LANDING STRIP

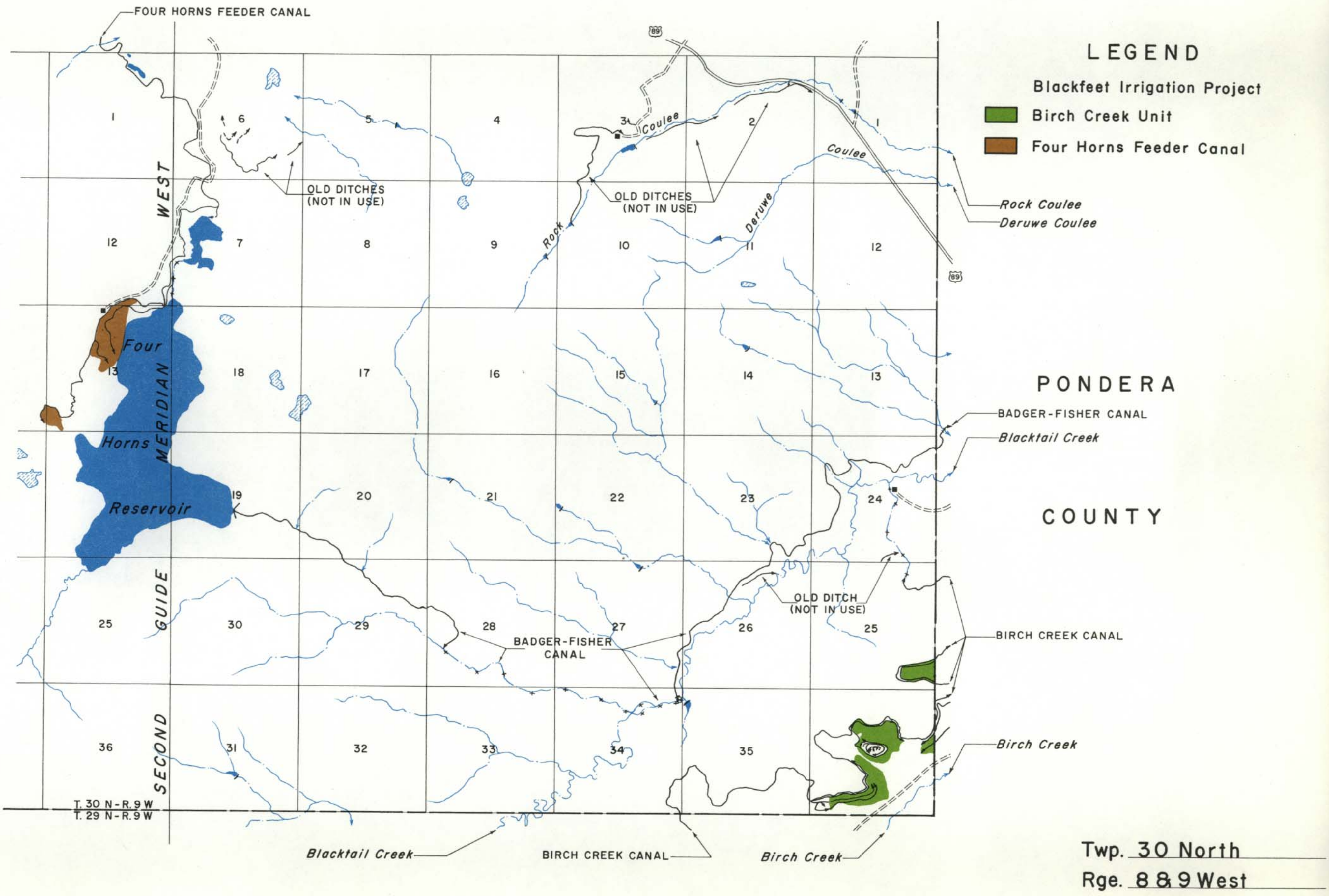
STRUCTURES & UNITS

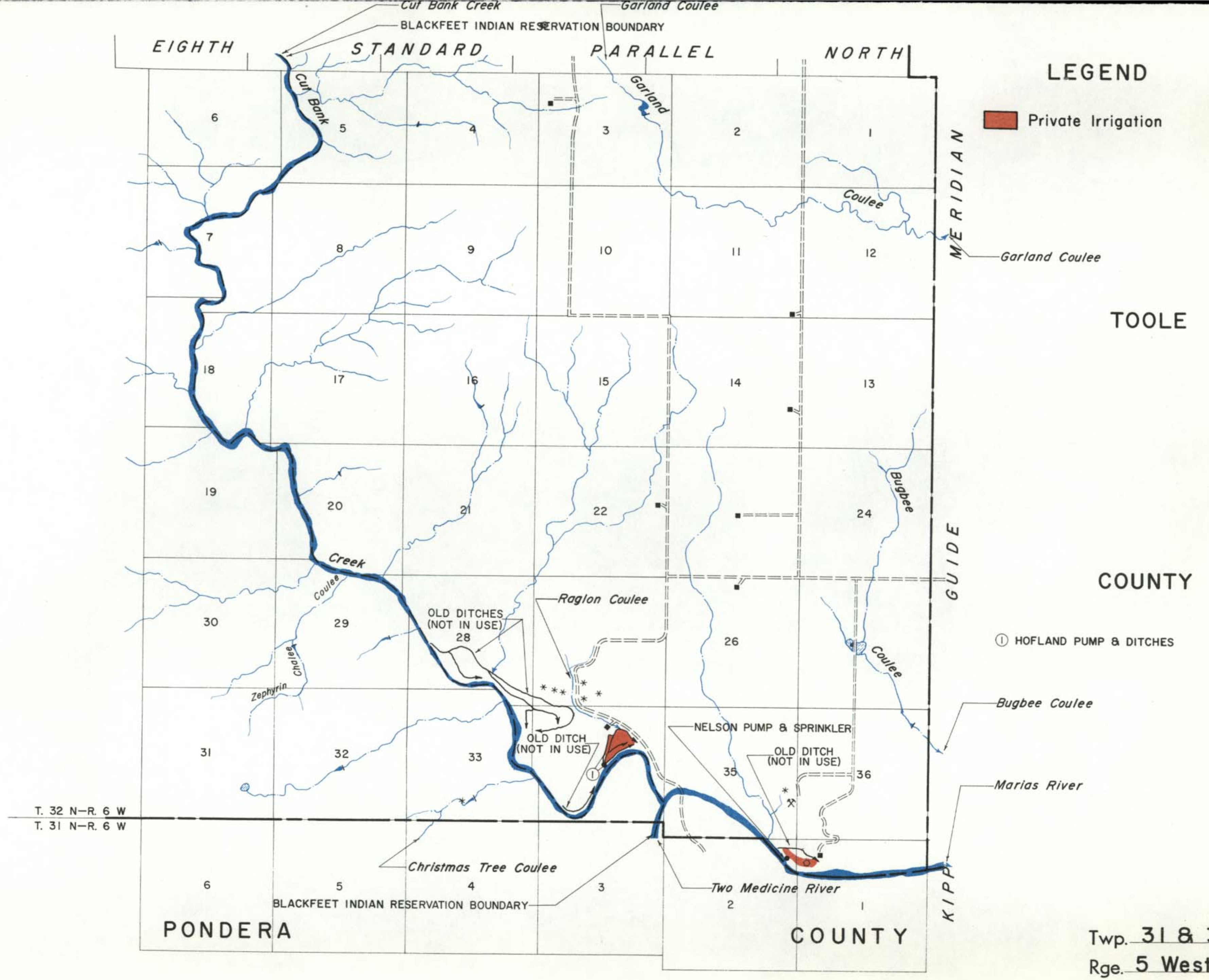
- DAM
- DIKE
- FLUME
- SIPHON
- SPILL
- SPRINKLER SYSTEM
- WEIR
- PIPELINE
- PUMP
- RESERVOIR
- WELL
- ARTESIAN WELL
- NATURAL CARRIER USED AS DITCH
- SPRING
- SWAMP
- GAUGING STATION
- POWER PLANT
- STORAGE TANK
- CEMETERY
- FAIRGROUNDS
- FARM OR RANCH UNIT
- SCHOOL
- LOOKOUT STATION
- RANGER STATION
- BRIDGE
- RAILROAD TUNNEL
- REST AREA
- SHAFT, MINE OR GRAVEL PIT

10-20-69



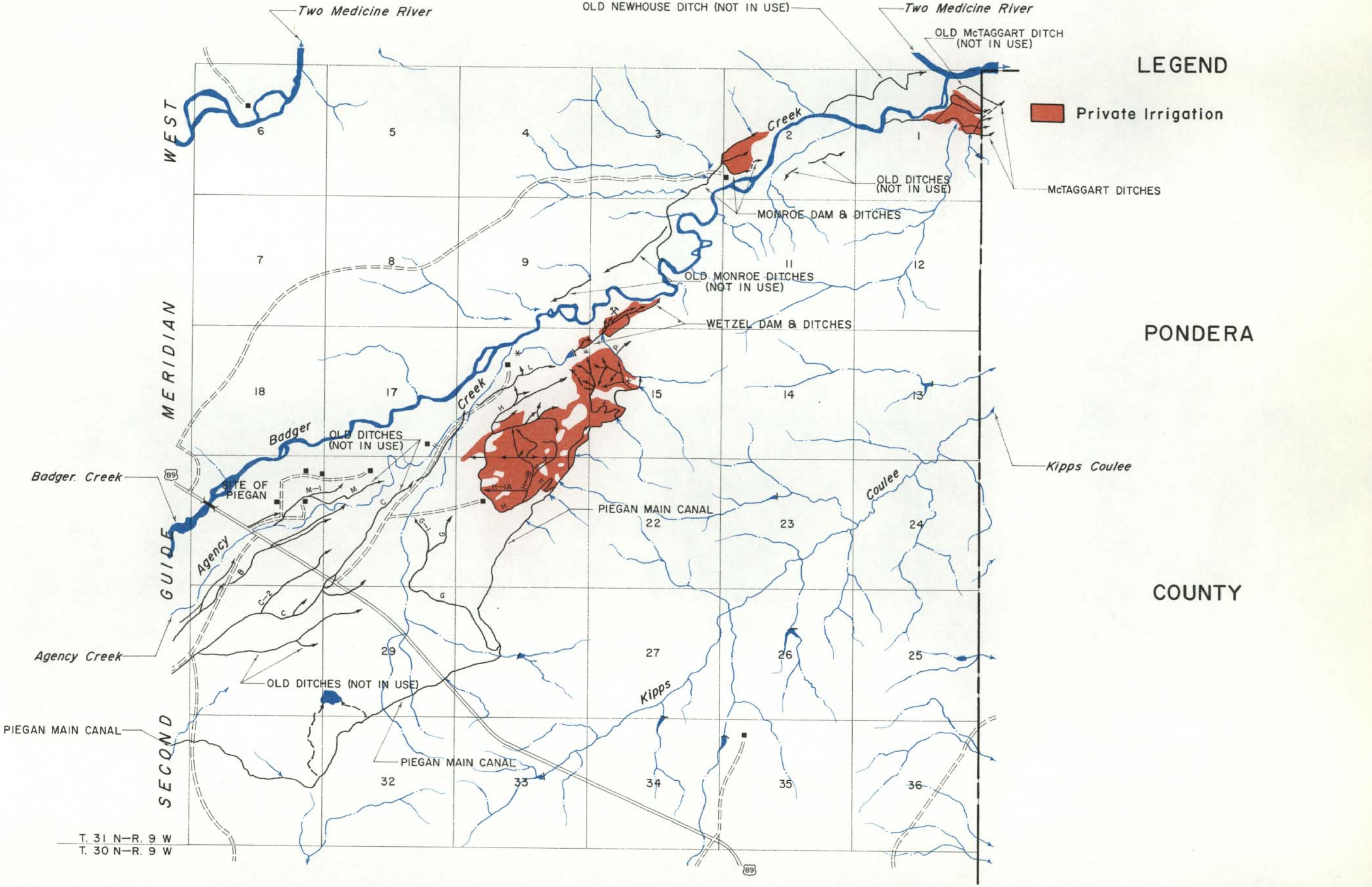
DRAINAGE MAP of GLACIER COUNTY Showing Irrigated Areas

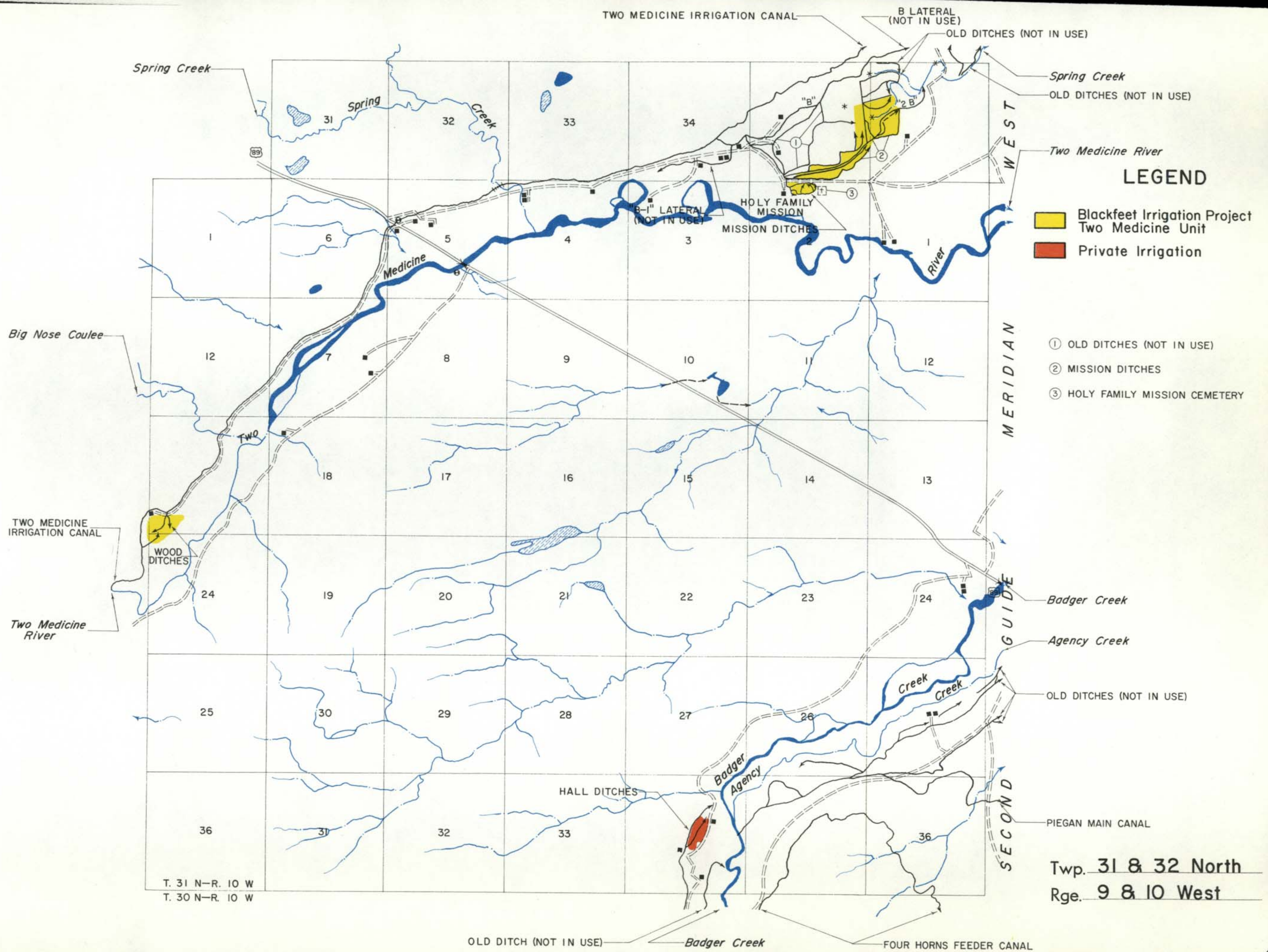

LEGEND
Blackfeet Irrigation Project
Birch Creek Unit
Four Horns Feeder Canal
FOUR HORNS FEEDER CANAL
OLD DITCHES (NOT IN USE)
OLD DITCH (NOT IN USE)
Rock Coulee
Deruwe Coulee
Four Horns Reservoir
SECOND GUIDE MERIDIAN WEST
PONDERA COUNTY
BADGER-FISHER CANAL
Blacktail Creek
BIRCH CREEK CANAL
Birch Creek
T. 30 N - R. 9 W
T. 29 N - R. 9 W
Twp. 30 North
Rge. 8 & 9 West



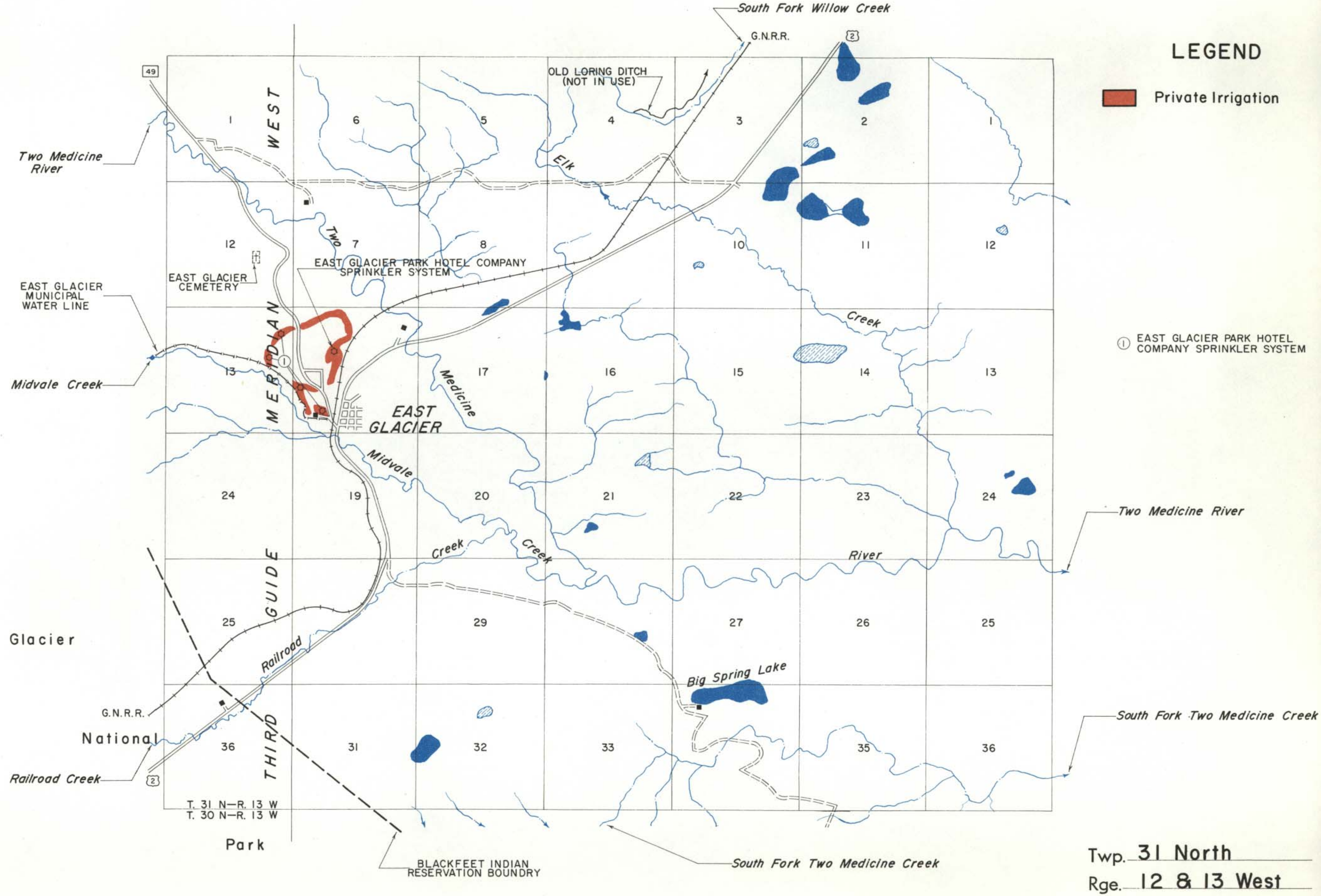
Twp. 31 & 32 North

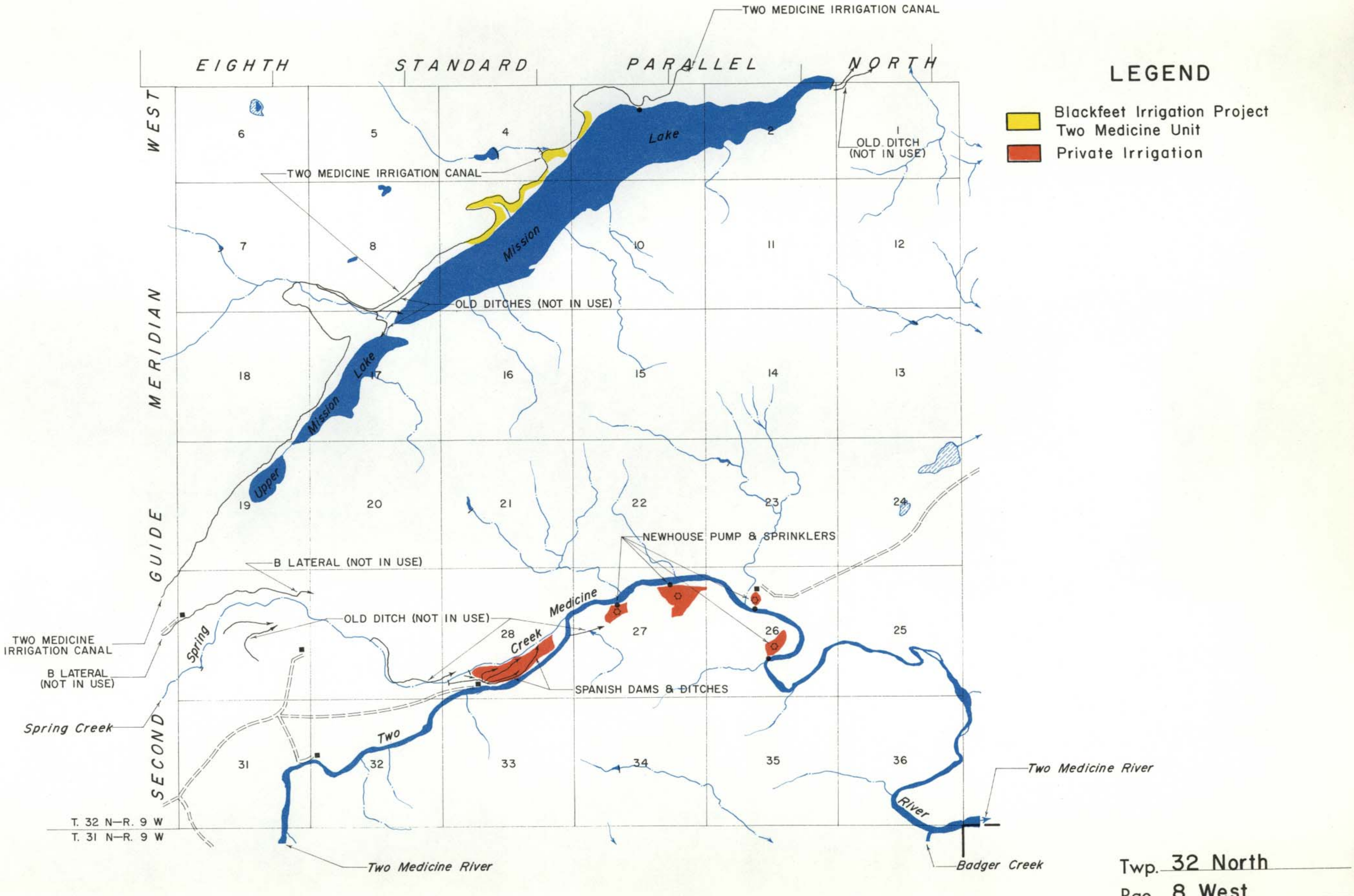
Rge. 5 West

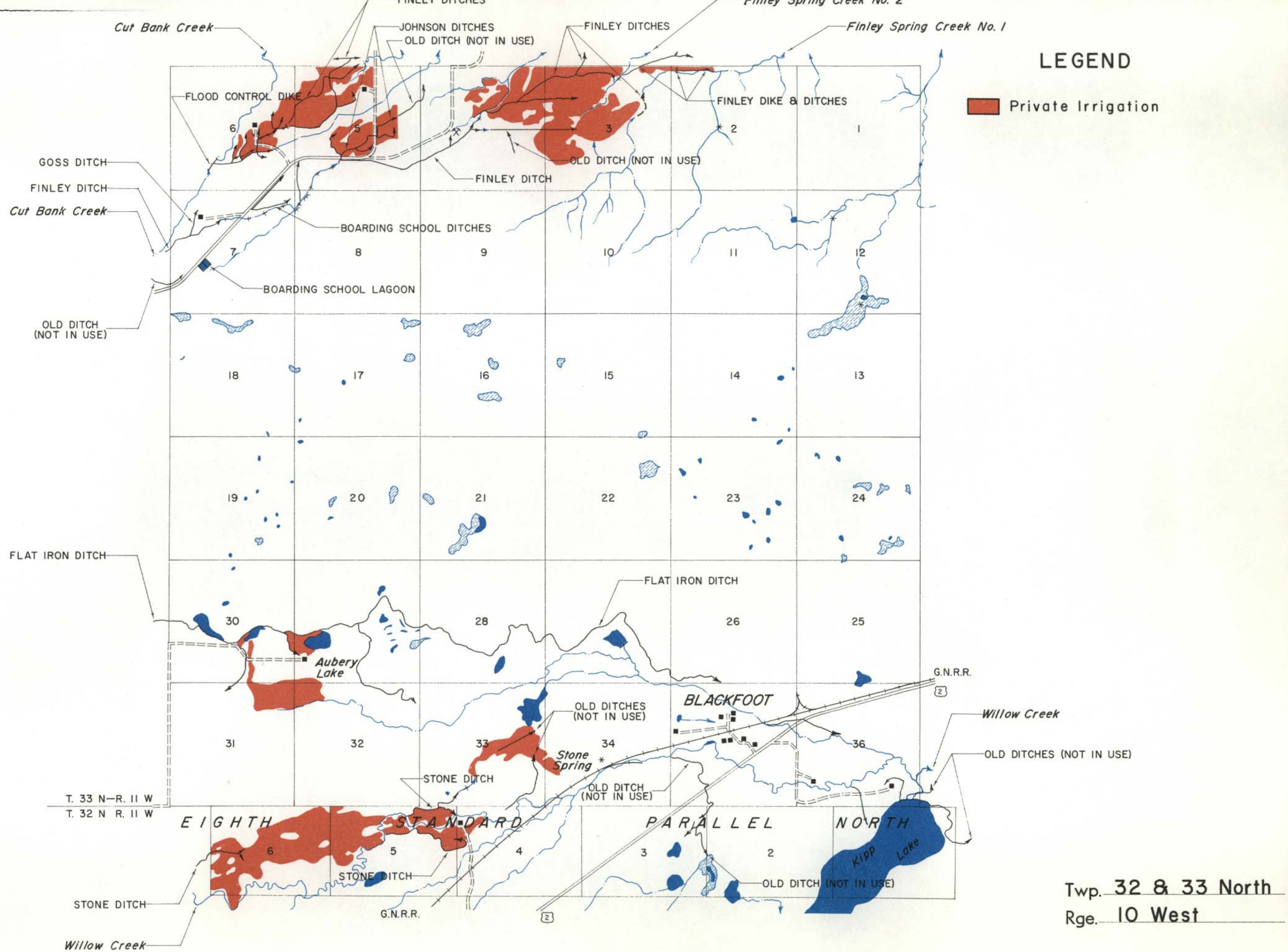

Two Medicine River
OLD NEWHOUSE DITCH (NOT IN USE)
Two Medicine River
OLD McTAGGART DITCH (NOT IN USE)
LEGEND
Private Irrigation
McTAGGART DITCHES
OLD DITCHES (NOT IN USE)
MONROE DAM & DITCHES
OLD MONROE DITCHES (NOT IN USE)
WETZEL DAM & DITCHES
PONDERA
COUNTY
Kipps Coulee
Badger Creek
SITE OF PIEGAN
OLD DITCHES (NOT IN USE)
PIEGAN MAIN CANAL
Agency Creek
OLD DITCHES (NOT IN USE)
PIEGAN MAIN CANAL
PIEGAN MAIN CANAL
WEST MERIDIAN
GUIDE
SECOND
Creek
Badger
Creek
Agency
Coulee
Kipps
T. 31 N—R. 9 W
T. 30 N—R. 9 W
89
Twp. 31 North
Rge. 8 West



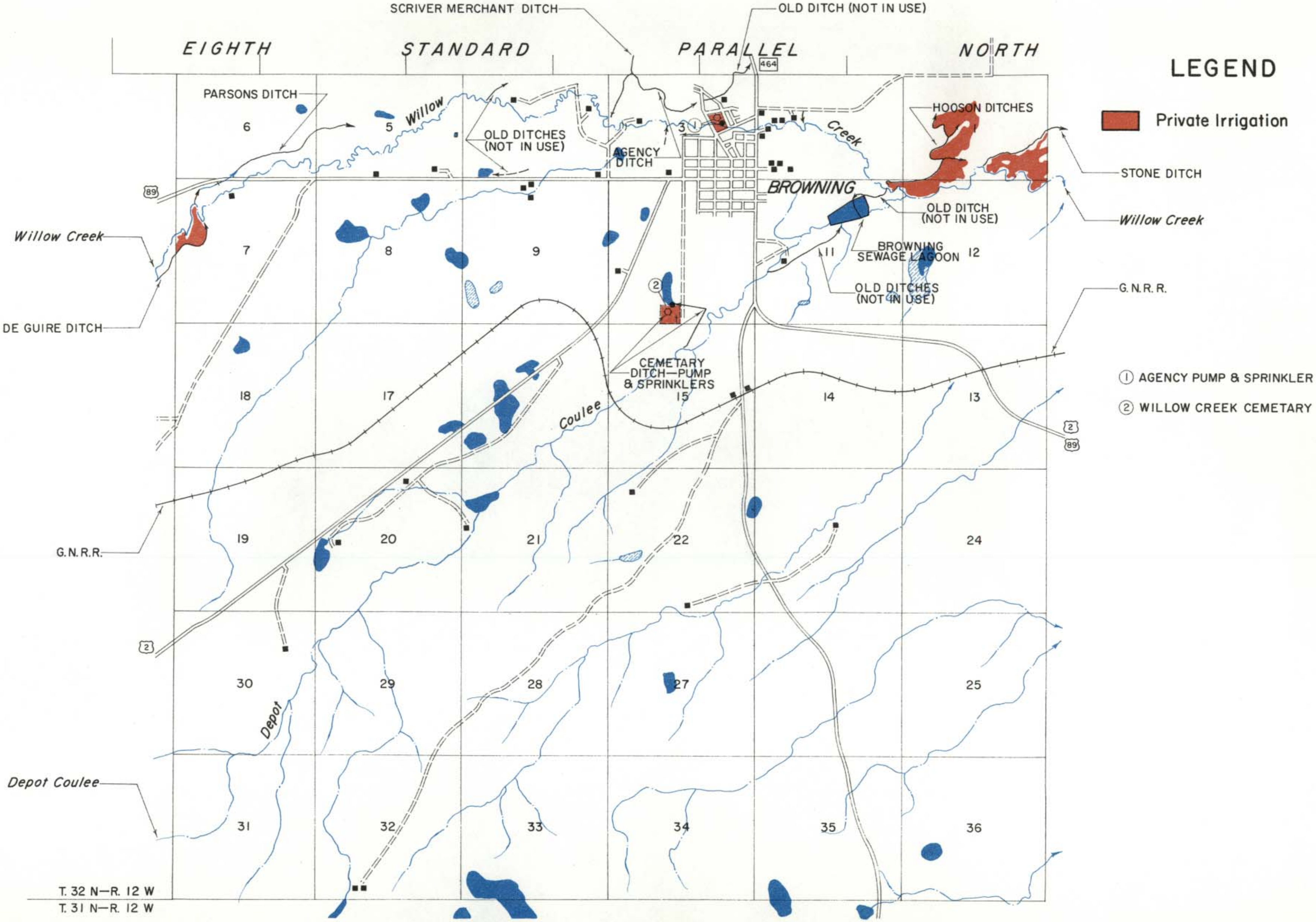
TWO MEDICINE IRRIGATION CANAL
B LATERAL (NOT IN USE)
OLD DITCHES (NOT IN USE)
Spring Creek
OLD DITCHES (NOT IN USE)
Spring Creek
Spring
Creek
Two Medicine River
LEGEND
Blackfeet Irrigation Project Two Medicine Unit
Private Irrigation
"B"
"2 B"
"B-1" LATERAL (NOT IN USE)
HOLY FAMILY MISSION
MISSION DITCHES
Medicine
River
Big Nose Coulee
Two
① OLD DITCHES (NOT IN USE)
② MISSION DITCHES
③ HOLY FAMILY MISSION CEMETERY
TWO MEDICINE IRRIGATION CANAL
WOOD DITCHES
Two Medicine River
Badger Creek
Agency Creek
OLD DITCHES (NOT IN USE)
Creek
Creek
Badger
Agency
HALL DITCHES
PIEGAN MAIN CANAL
SECOND GUIDE MERIDIAN WEST
T. 31 N—R. 10 W
T. 30 N—R. 10 W
OLD DITCH (NOT IN USE)
Badger Creek
FOUR HORNS FEEDER CANAL
Twp. 31 & 32 North
Rge. 9 & 10 West


LEGEND
Private Irrigation
① EAST GLACIER PARK HOTEL COMPANY SPRINKLER SYSTEM
South Fork Willow Creek
G.N.R.R.
OLD LORING DITCH (NOT IN USE)
Two Medicine River
EAST GLACIER CEMETERY
EAST GLACIER PARK HOTEL COMPANY SPRINKLER SYSTEM
EAST GLACIER MUNICIPAL WATER LINE
Midvale Creek
WEST MERIDIAN
THIRD GUIDE
Elk
Two
Creek
Medicine
EAST GLACIER
Midvale
Creek
Creek
River
Two Medicine River
Railroad
Big Spring Lake
South Fork Two Medicine Creek
Glacier
National
Park
Railroad Creek
G.N.R.R.
T. 31 N—R. 13 W
T. 30 N—R. 13 W
BLACKFEET INDIAN RESERVATION BOUNDRY
South Fork Two Medicine Creek
Twp. 31 North
Rge. 12 & 13 West

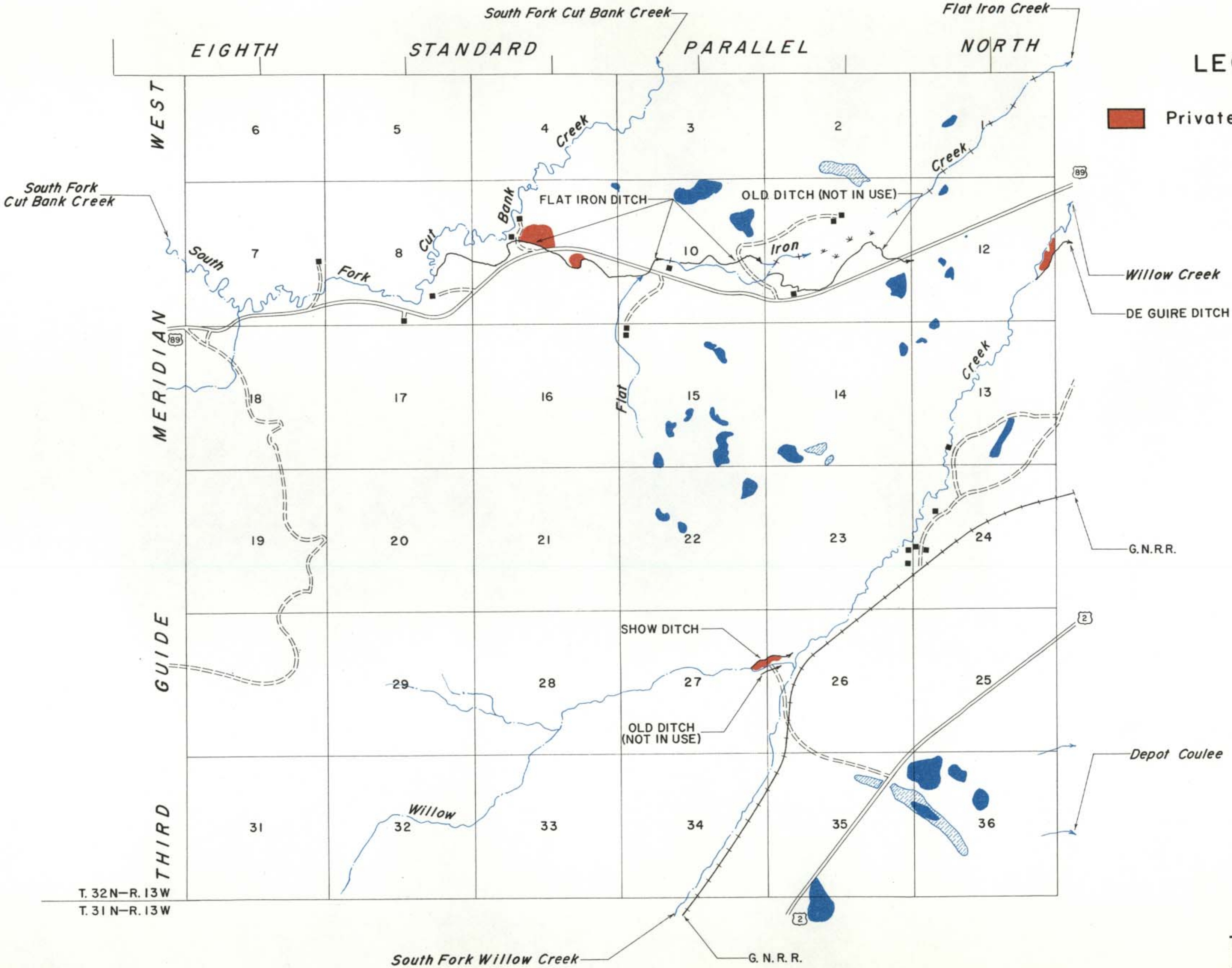

EIGHTH STANDARD PARALLEL NORTH
WEST MERIDIAN
GUIDE
SECOND
LEGEND
Blackfeet Irrigation Project Two Medicine Unit
Private Irrigation
TWO MEDICINE IRRIGATION CANAL
OLD DITCH (NOT IN USE)
OLD DITCHES (NOT IN USE)
Upper Mission Lake
Mission Lake
B LATERAL (NOT IN USE)
OLD DITCH (NOT IN USE)
NEWHOUSE PUMP & SPRINKLERS
SPANISH DAMS & DITCHES
Spring
Spring Creek
Two Medicine Creek
Two Medicine River
River
Badger Creek
T. 32 N—R. 9 W
T. 31 N—R. 9 W
1
2
4
5
6
7
8
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
31
32
33
34
35
36
Twp. 32 North
Rge. 8 West



FINLEY DITCHES
Finley Spring Creek No. 2
Cut Bank Creek
JOHNSON DITCHES
OLD DITCH (NOT IN USE)
FINLEY DITCHES
Finley Spring Creek No. 1
LEGEND
Private Irrigation
FLOOD CONTROL DIKE
FINLEY DIKE & DITCHES
GOSS DITCH
OLD DITCH (NOT IN USE)
FINLEY DITCH
FINLEY DITCH
Cut Bank Creek
BOARDING SCHOOL DITCHES
BOARDING SCHOOL LAGOON
OLD DITCH (NOT IN USE)
FLAT IRON DITCH
FLAT IRON DITCH
Aubery Lake
G.N.R.R.
BLACKFOOT
OLD DITCHES (NOT IN USE)
Willow Creek
Stone Spring
OLD DITCHES (NOT IN USE)
STONE DITCH
OLD DITCH (NOT IN USE)
T. 33 N—R. 11 W
T. 32 N R. 11 W
EIGHTH STANDARD PARALLEL NORTH
Kipp Lake
STONE DITCH
OLD DITCH (NOT IN USE)
STONE DITCH
G.N.R.R.
Willow Creek
Twp. 32 & 33 North
Rge. 10 West



Twp. 32 North
Rge. 11 West

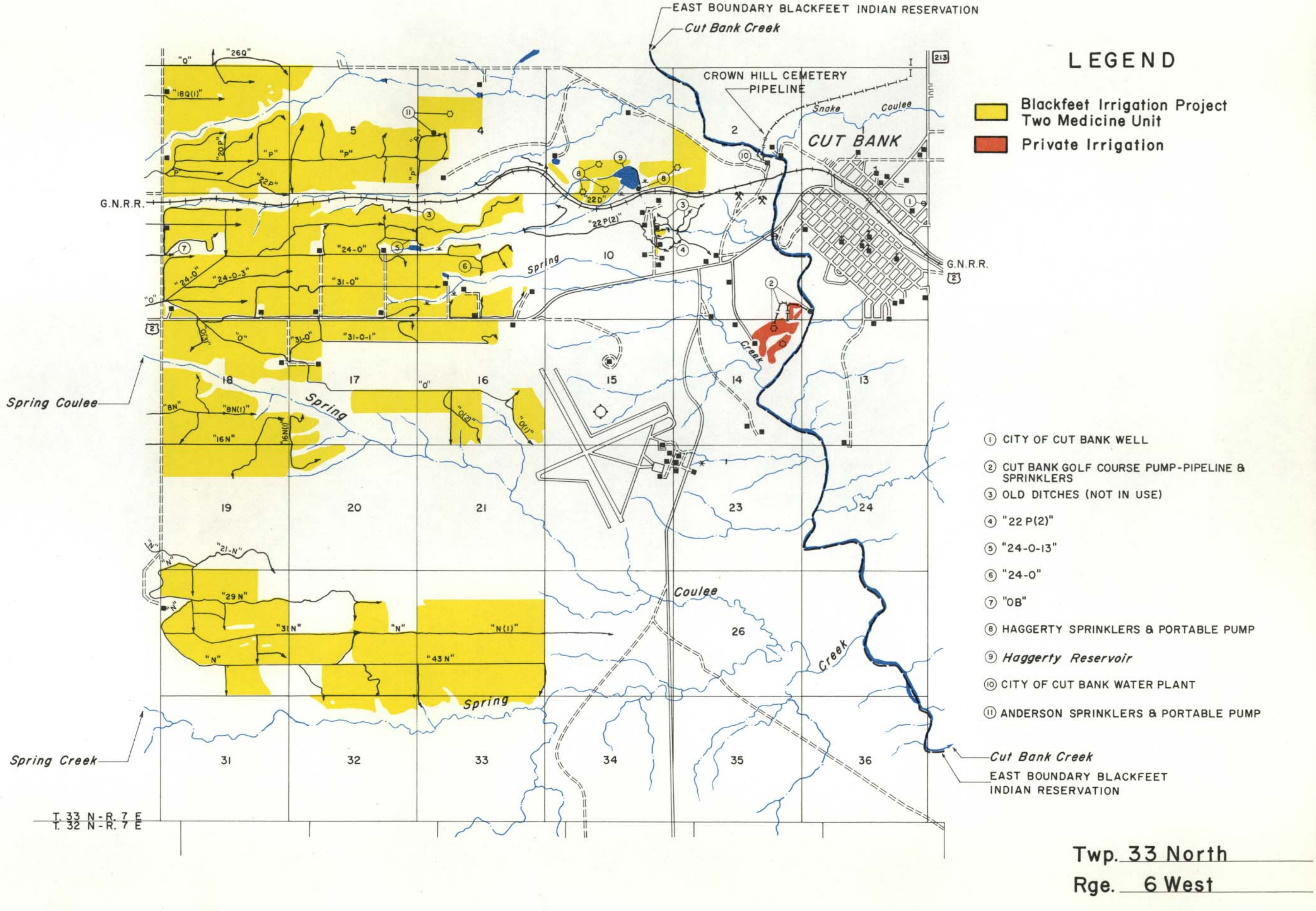


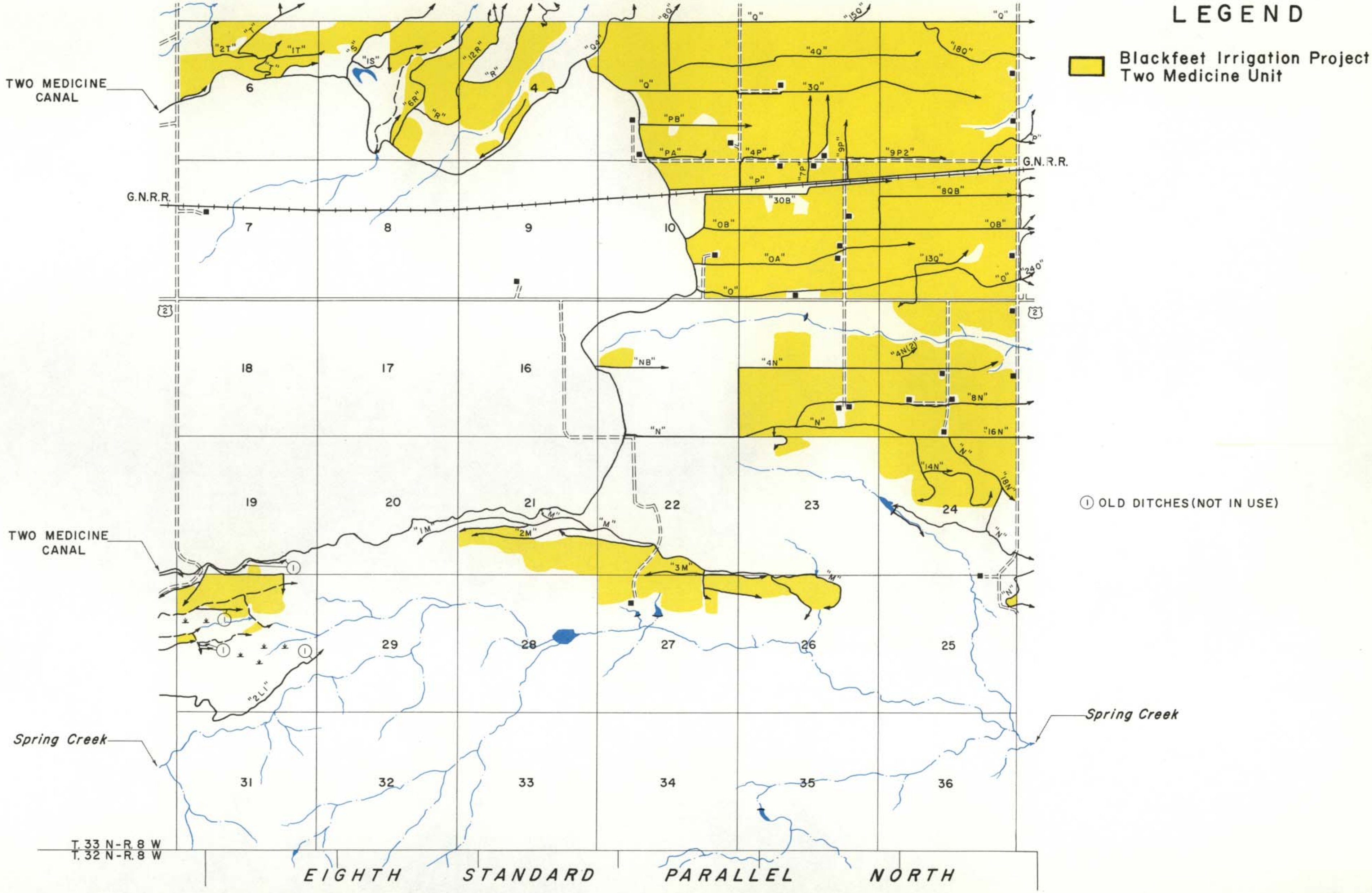
LEGEND

Private Irrigation

Twp. 32 North

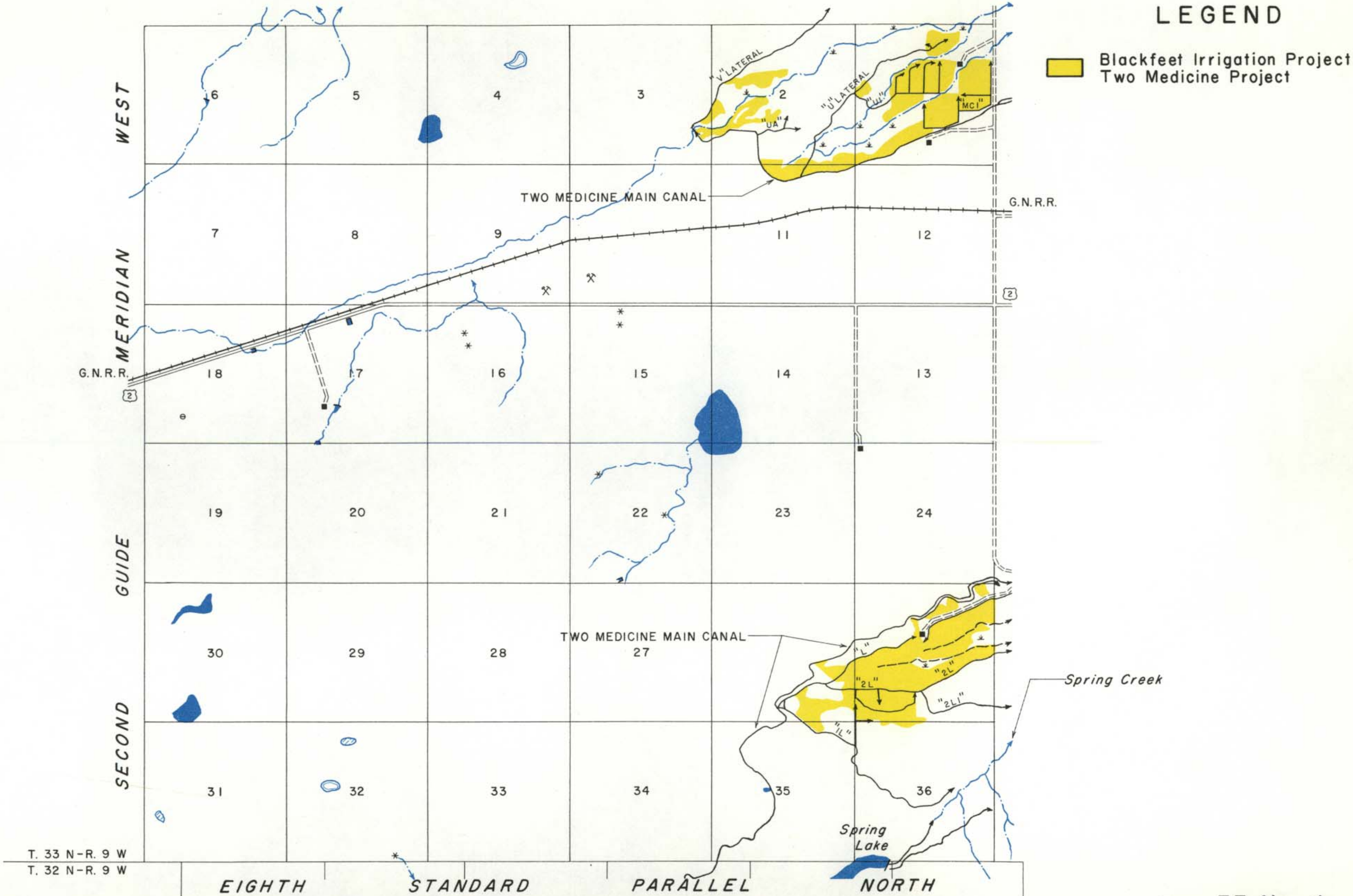
Rge. 12 West


EAST BOUNDARY BLACKFEET INDIAN RESERVATION
Cut Bank Creek
CROWN HILL CEMETERY
PIPELINE
Snake
Coulee
CUT BANK
G.N.R.R.
G.N.R.R.
Spring
Spring
Spring
Spring Coulee
Coulee
Creek
Creek
Spring Creek
Cut Bank Creek
EAST BOUNDARY BLACKFEET INDIAN RESERVATION
T. 33 N - R. 7 E
T. 32 N - R. 7 E
LEGEND
Blackfeet Irrigation Project Two Medicine Unit
Private Irrigation
① CITY OF CUT BANK WELL
② CUT BANK GOLF COURSE PUMP-PIPELINE & SPRINKLERS
③ OLD DITCHES (NOT IN USE)
④ "22 P(2)"
⑤ "24-O-13"
⑥ "24-O"
⑦ "OB"
⑧ HAGGERTY SPRINKLERS & PORTABLE PUMP
⑨ Haggerty Reservoir
⑩ CITY OF CUT BANK WATER PLANT
⑪ ANDERSON SPRINKLERS & PORTABLE PUMP
Twp. 33 North
Rge. 6 West



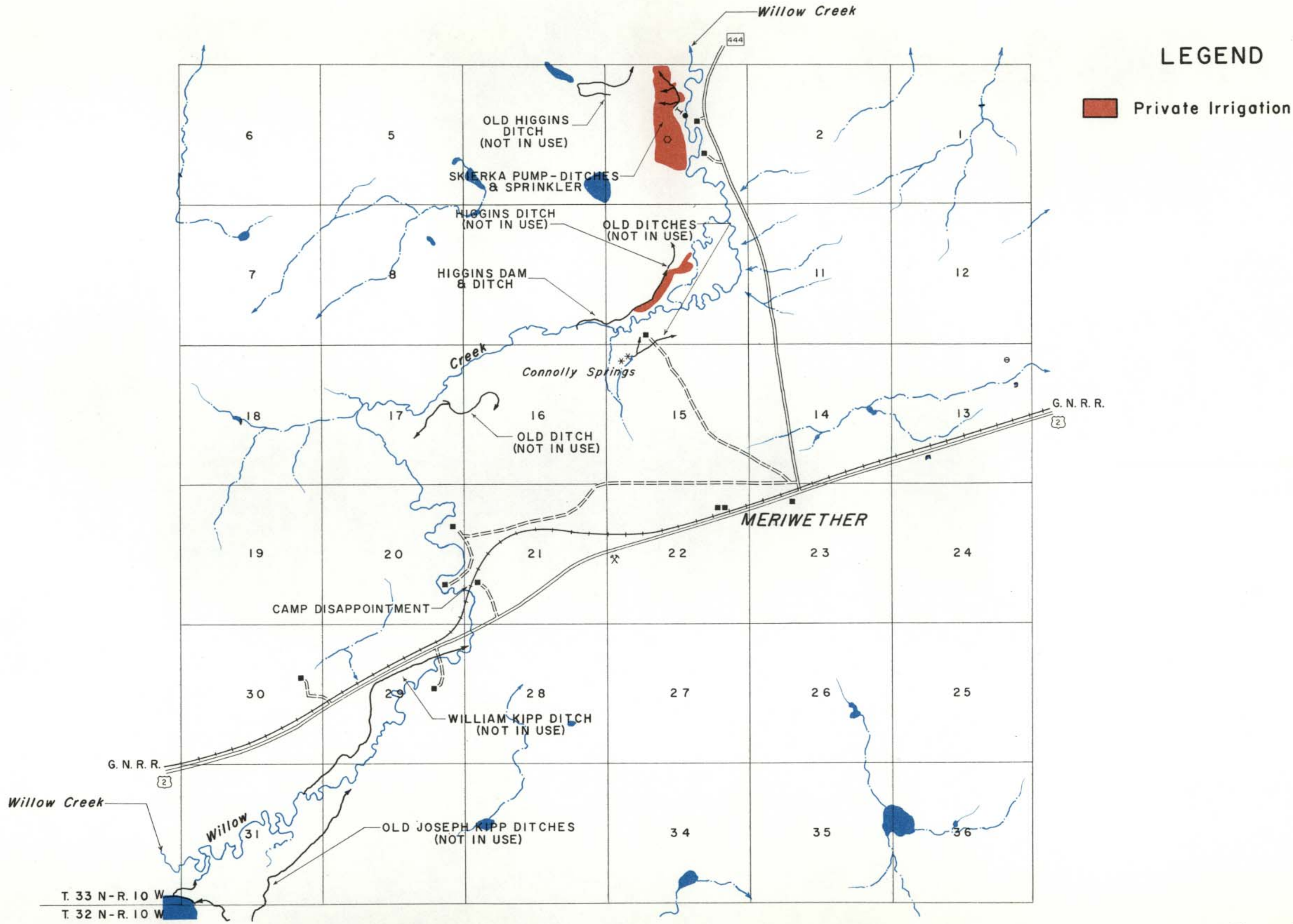
Twp. 33 North

Rge. 7 West



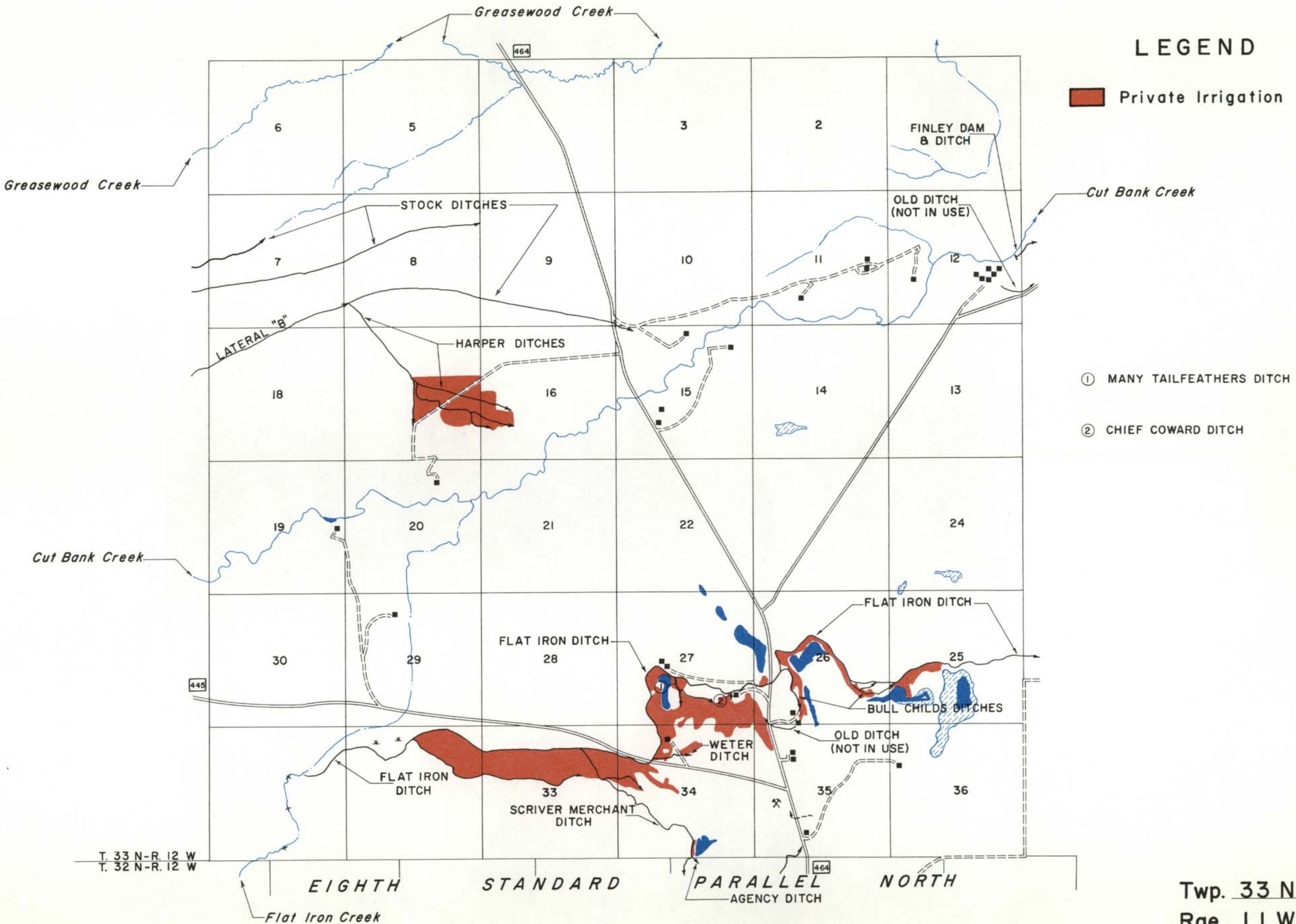
Twp. 33 North

Rge. 8 West

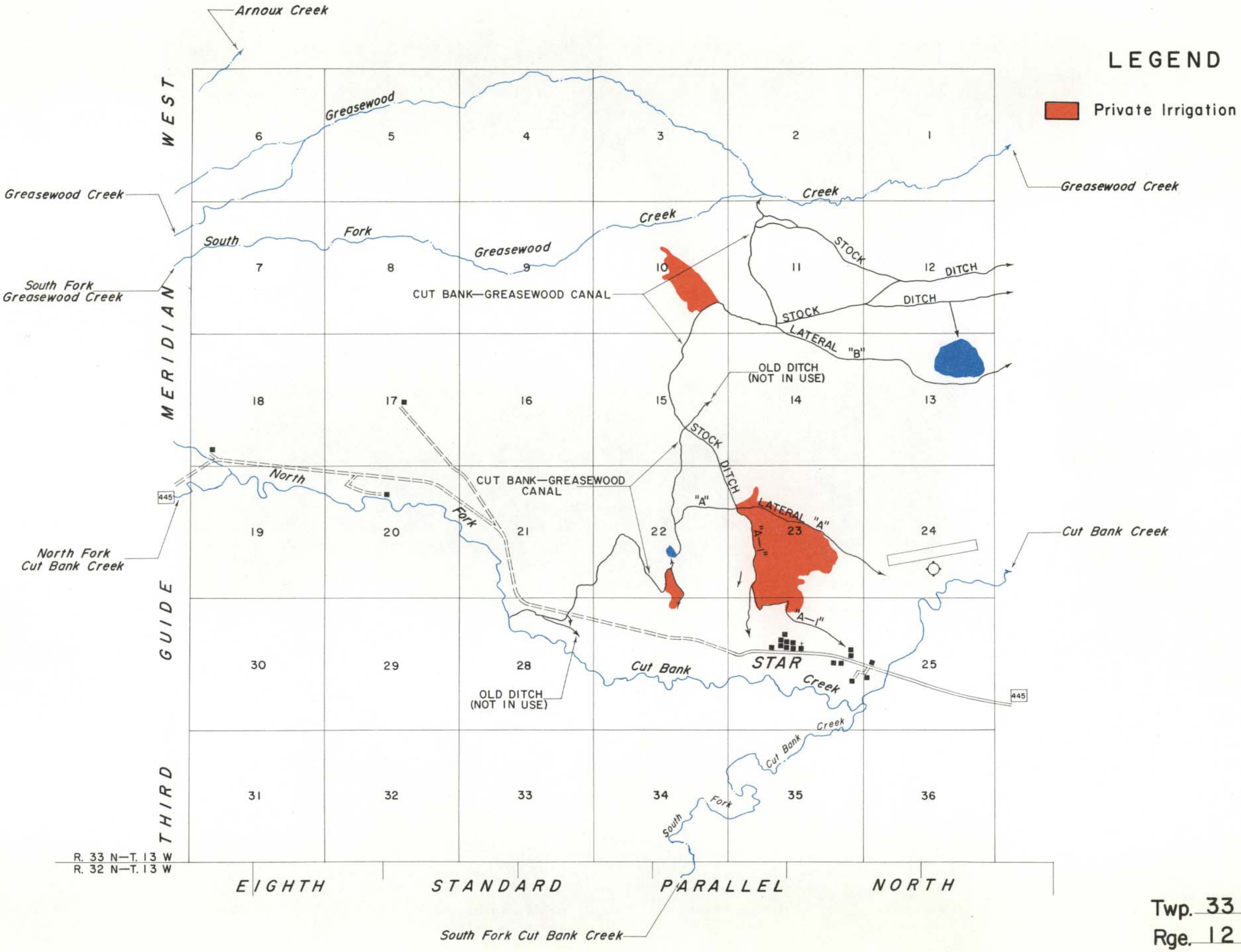


Twp. 33 North

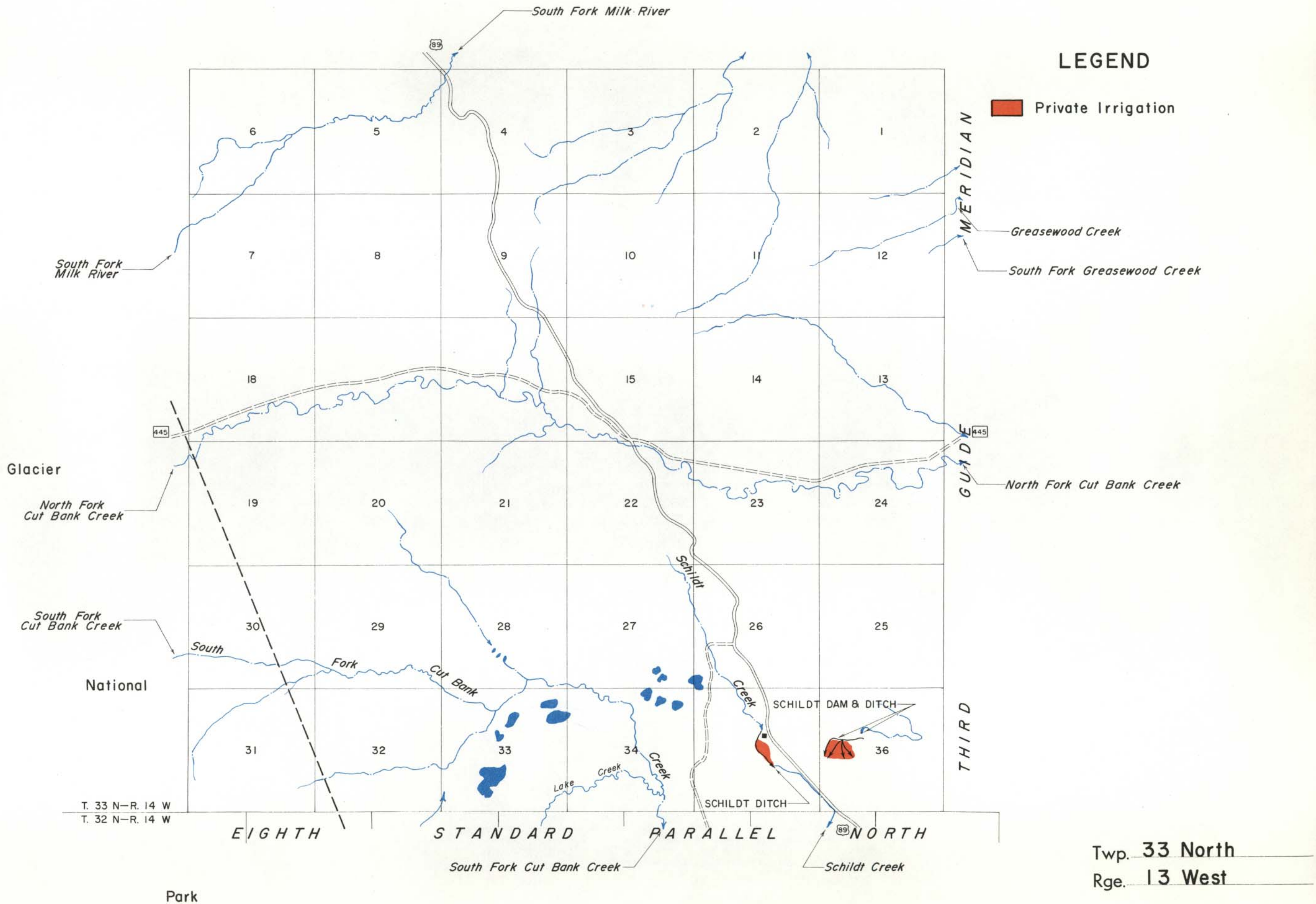
Rge. 9 West

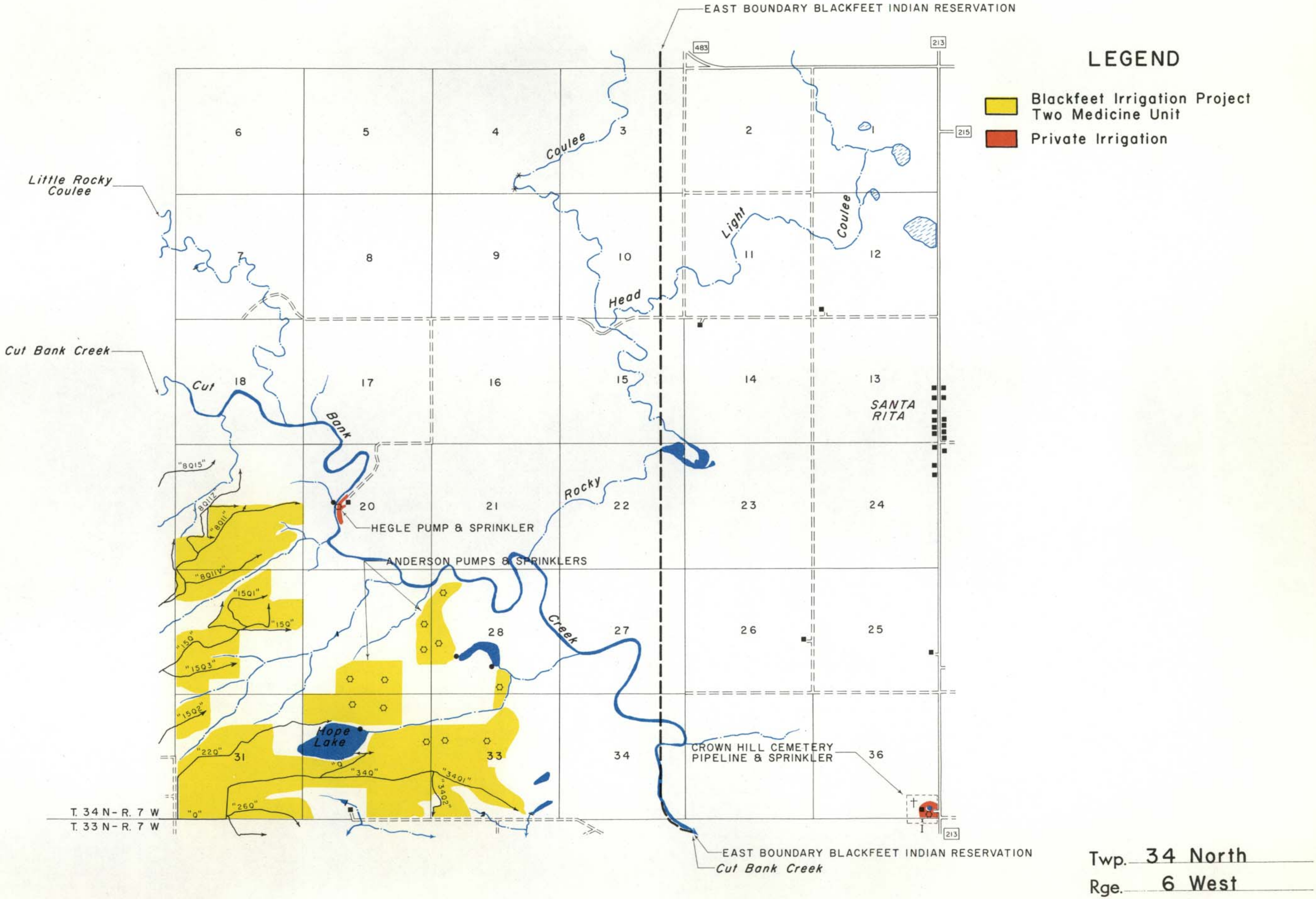


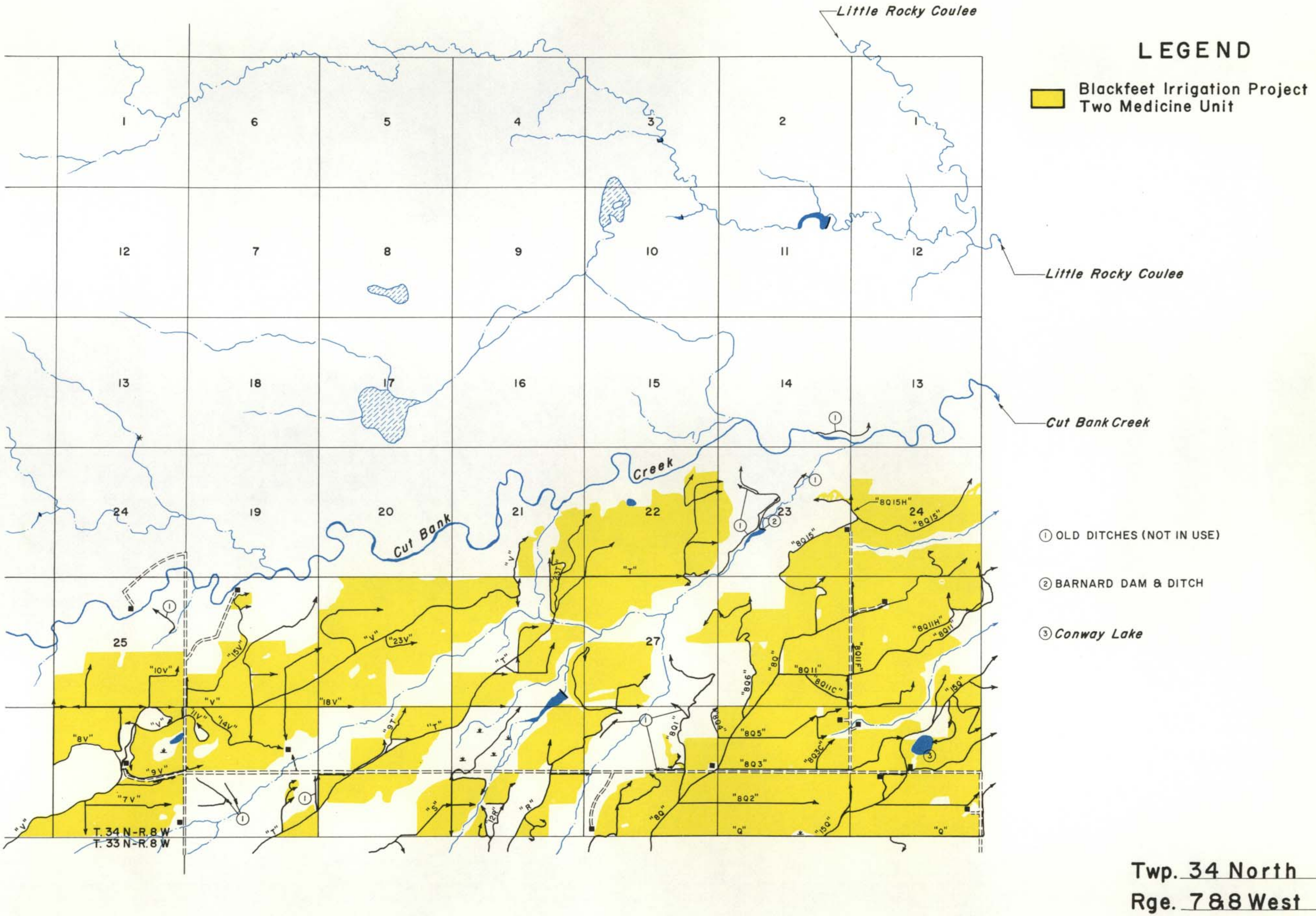
Twp. 33 North
Rge. 11 West



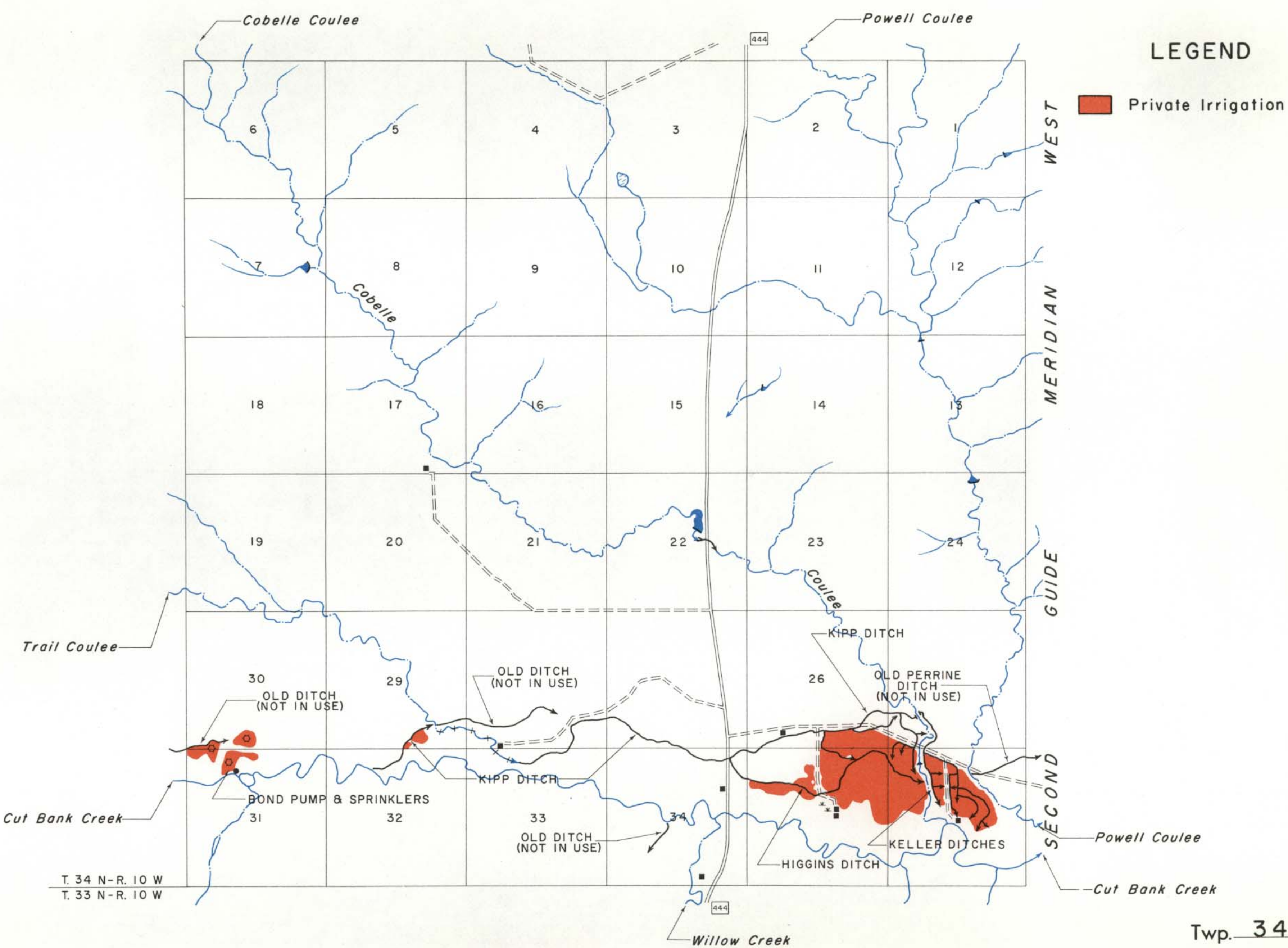
Twp. 33 North
Rge. 12 West


LEGEND
Private Irrigation
South Fork Milk River
Greasewood Creek
South Fork Greasewood Creek
North Fork Cut Bank Creek
South Fork Cut Bank Creek
Schildt Creek
Schildt Creek
SCHILDT DAM & DITCH
SCHILDT DITCH
Lake Creek
Glacier
National
Park
THIRD GUIDE MERIDIAN
EIGHTH STANDARD PARALLEL NORTH
T. 33 N—R. 14 W
T. 32 N—R. 14 W
445
89
Twp. 33 North
Rge. 13 West

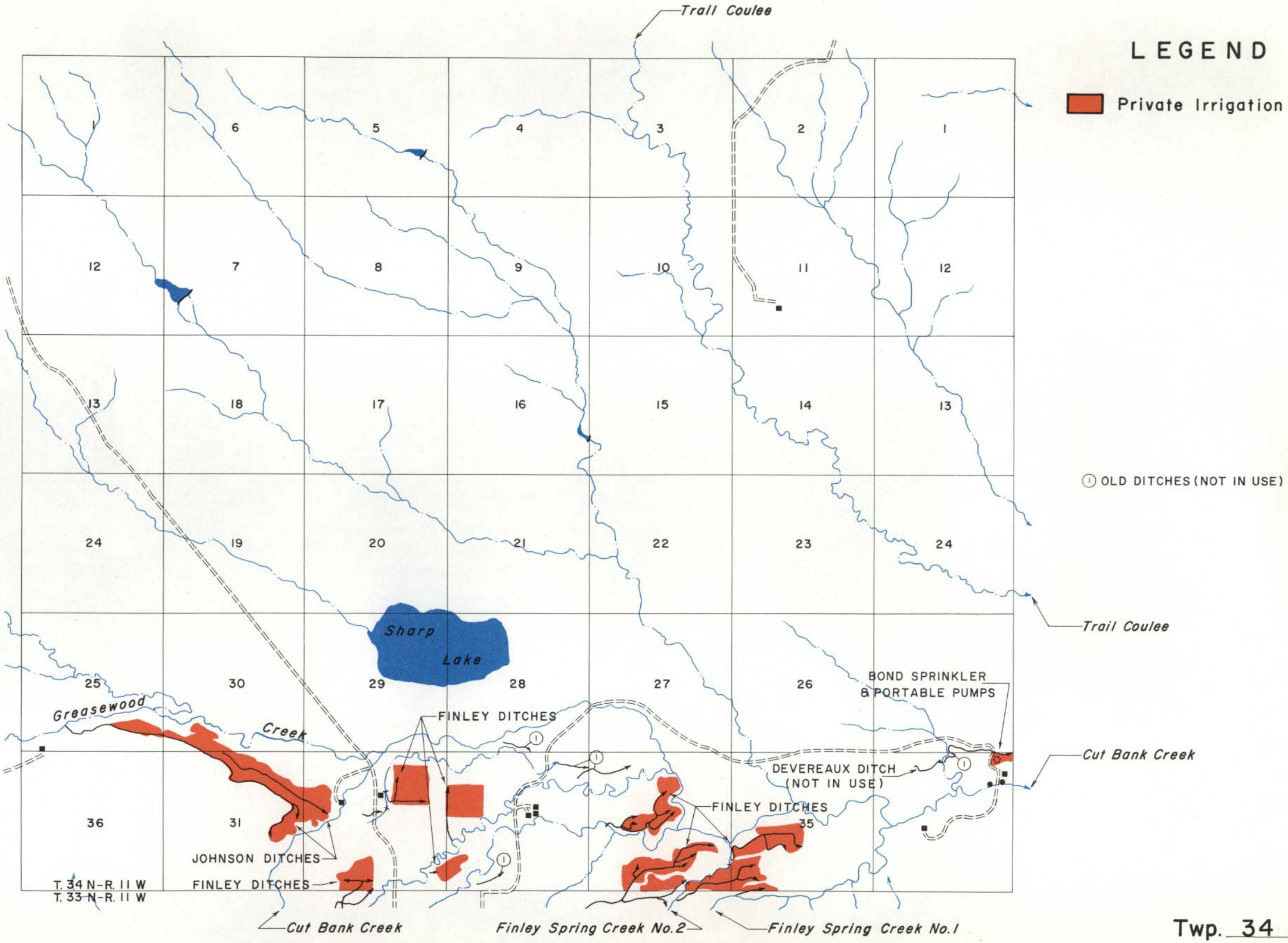

EAST BOUNDARY BLACKFEET INDIAN RESERVATION
LEGEND
Blackfeet Irrigation Project Two Medicine Unit
Private Irrigation
Little Rocky Coulee
Cut Bank Creek
Coulee
Head
Light
Coulee
Cut
Bank
Rocky
Creek
SANTA RITA
HEGLE PUMP & SPRINKLER
ANDERSON PUMPS & SPRINKLERS
Hope Lake
CROWN HILL CEMETERY PIPELINE & SPRINKLER
T. 34 N - R. 7 W
T. 33 N - R. 7 W
EAST BOUNDARY BLACKFEET INDIAN RESERVATION
Cut Bank Creek
Twp. 34 North
Rge. 6 West



Little Rocky Coulee
LEGEND
Blackfeet Irrigation Project
Two Medicine Unit
Little Rocky Coulee
Cut Bank Creek
Creek
Cut Bank
① OLD DITCHES (NOT IN USE)
② BARNARD DAM & DITCH
③ Conway Lake
T. 34 N-R. 8 W
T. 33 N-R. 8 W
Twp. 34 North
Rge. 7&8 West

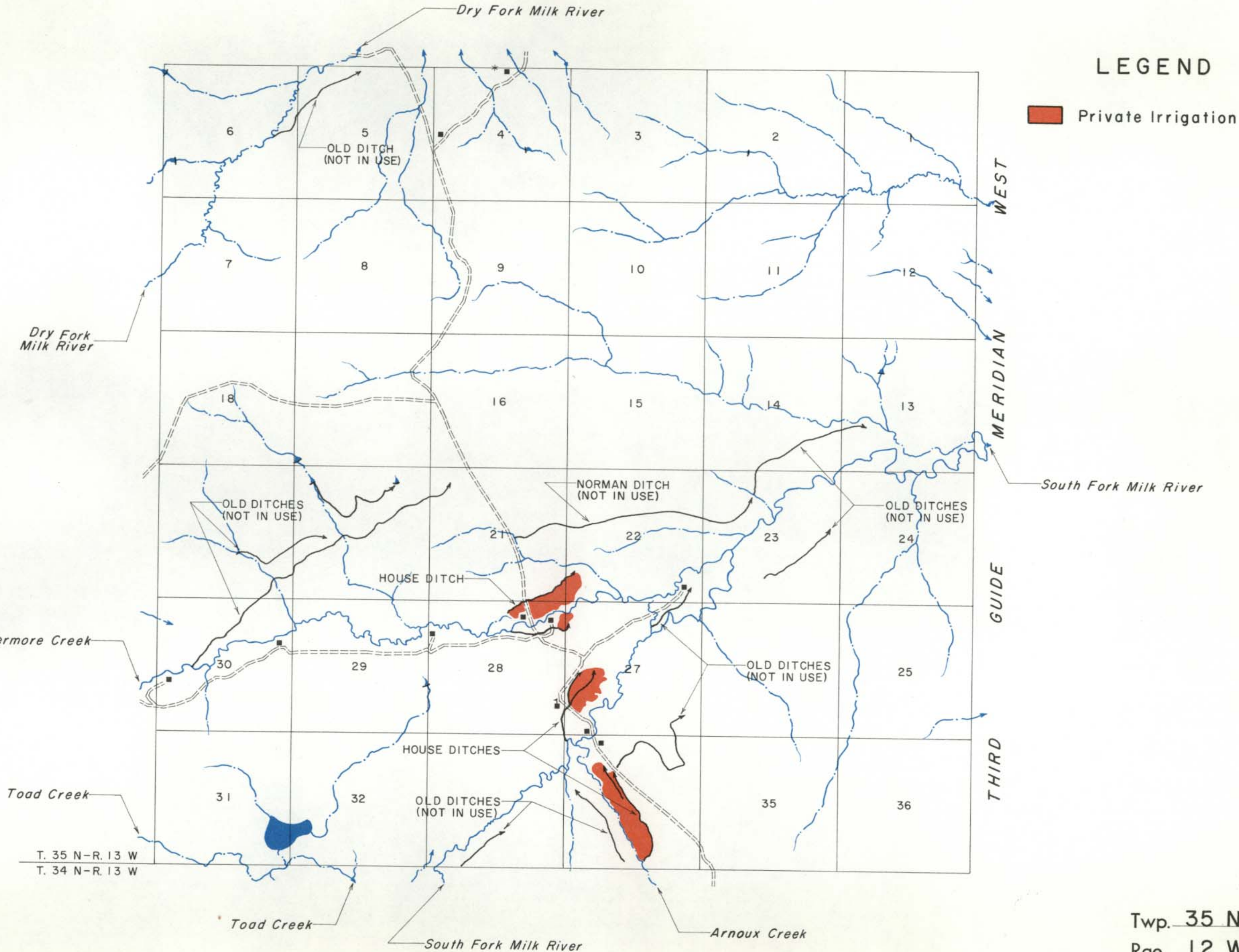


Twp. 34 North
Rge. 9 West



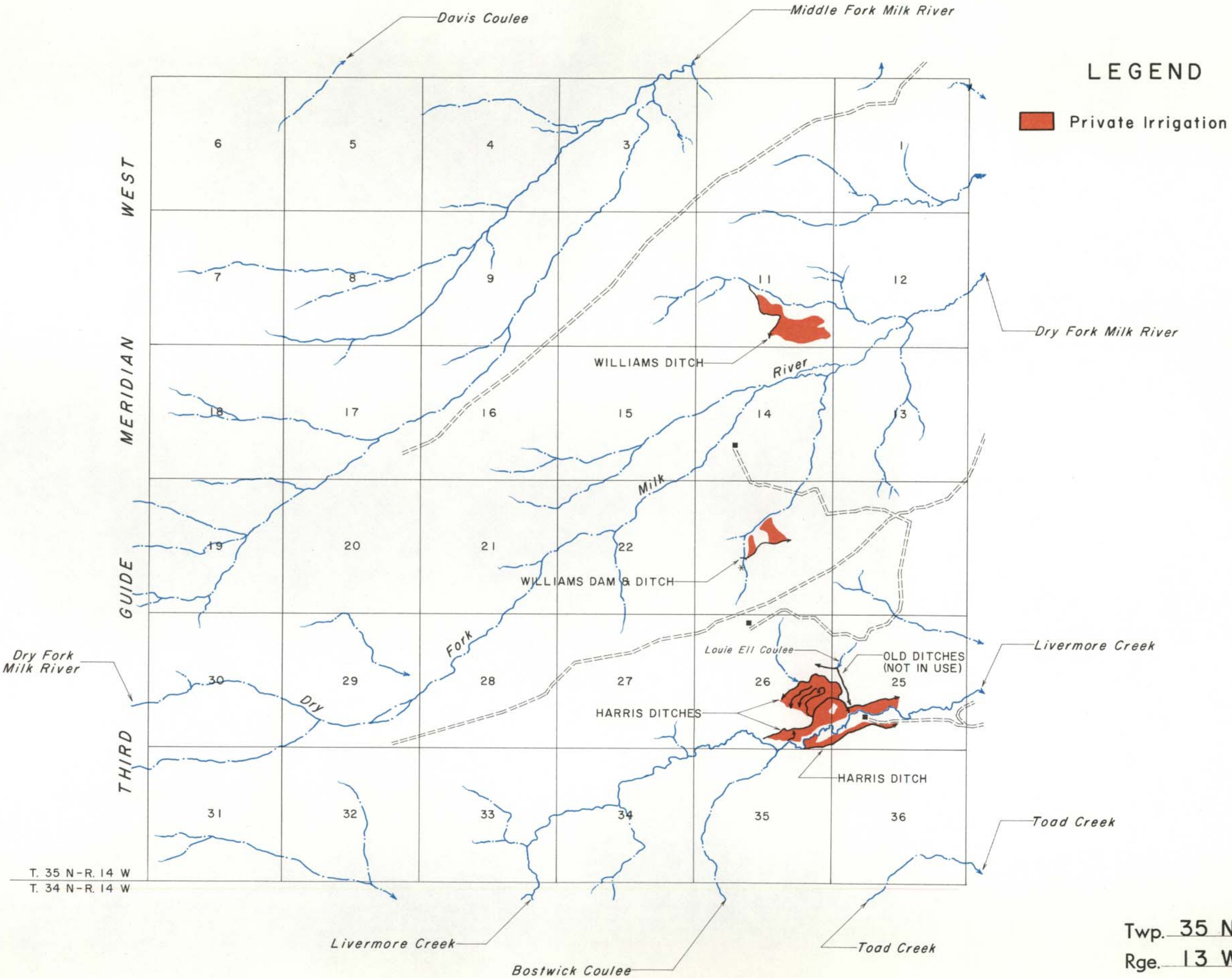
Twp. 34 North

Rge. 10 & 11 West

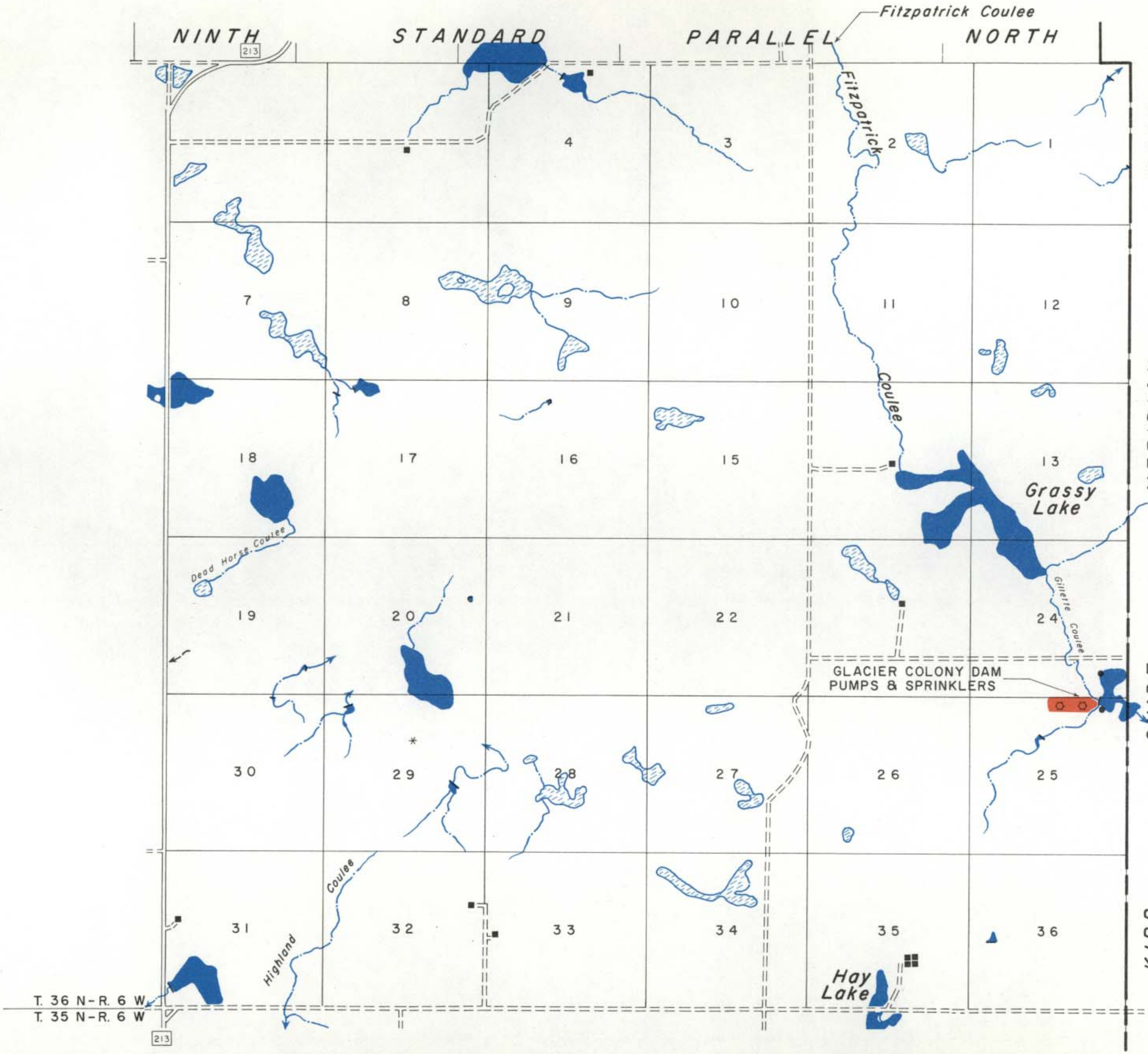


Twp. 35 North

Rge. 12 West



Twp. 35 North
Rge. 13 West



LEGEND

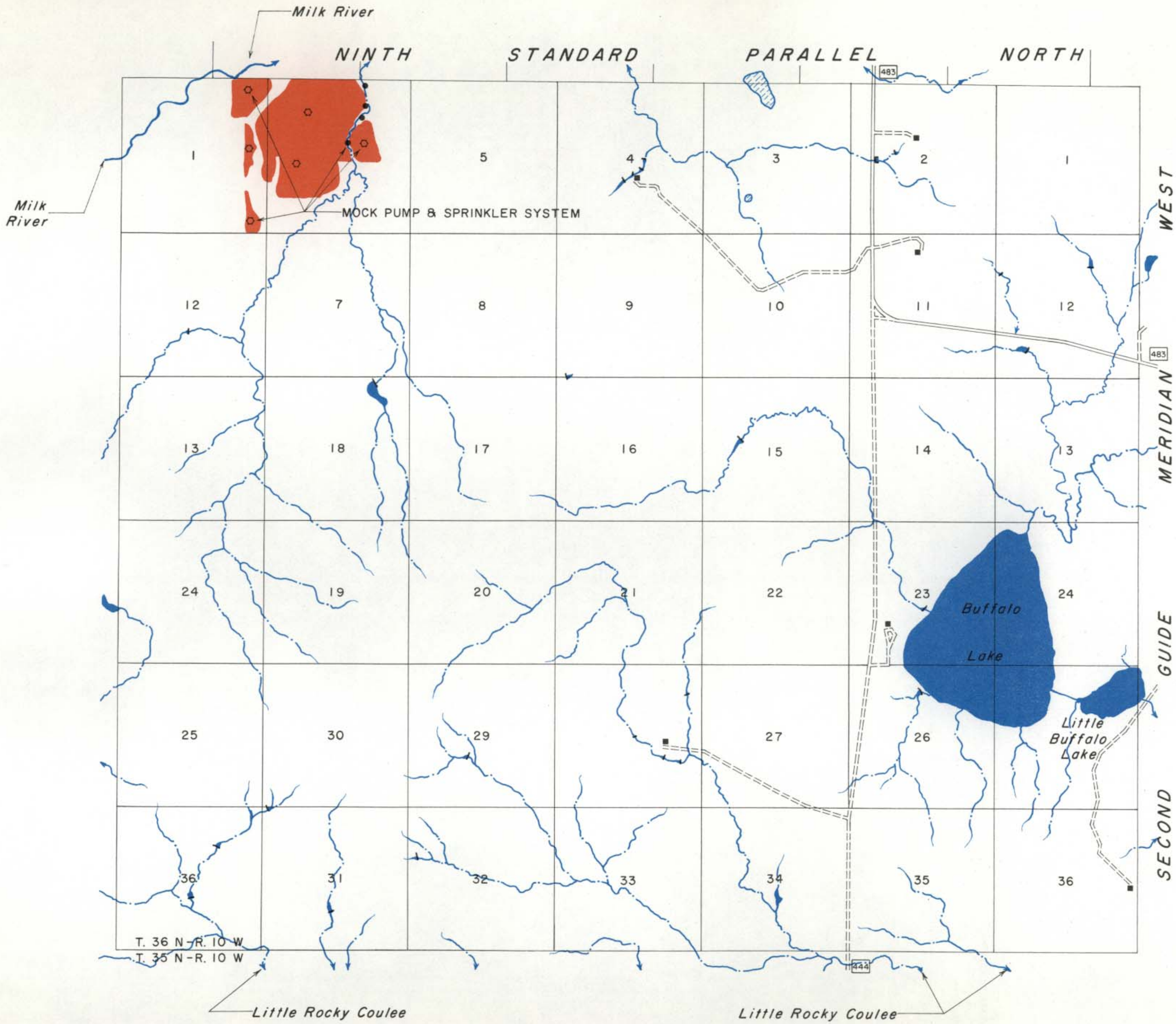
Private Irrigation

TOOLE

COUNTY

Twp. 36 North

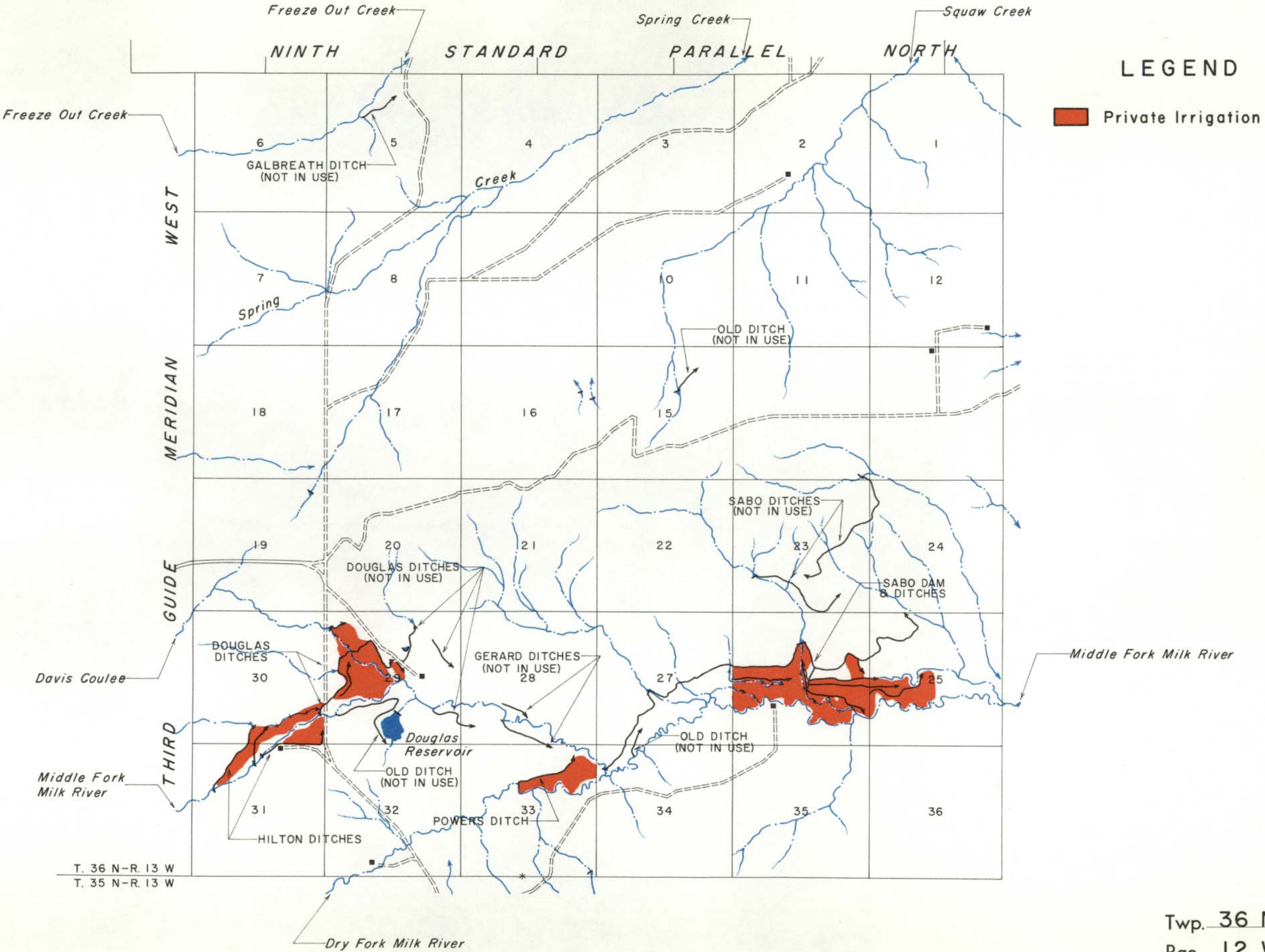
Rge. 5 West



LEGEND

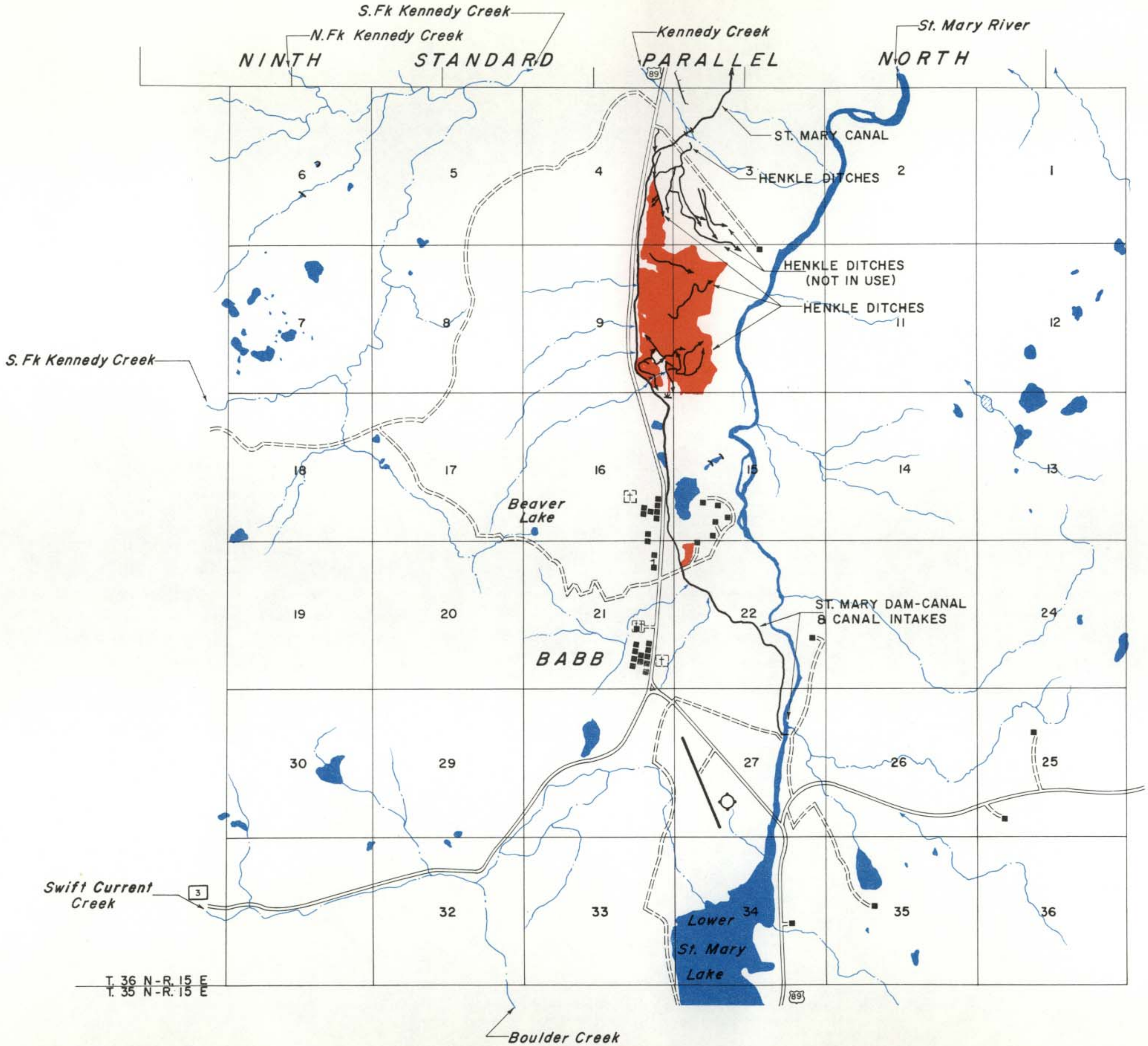
Private Irrigation

Twp. 36 North
Rge. 9 & 10 West



Twp. 36 North

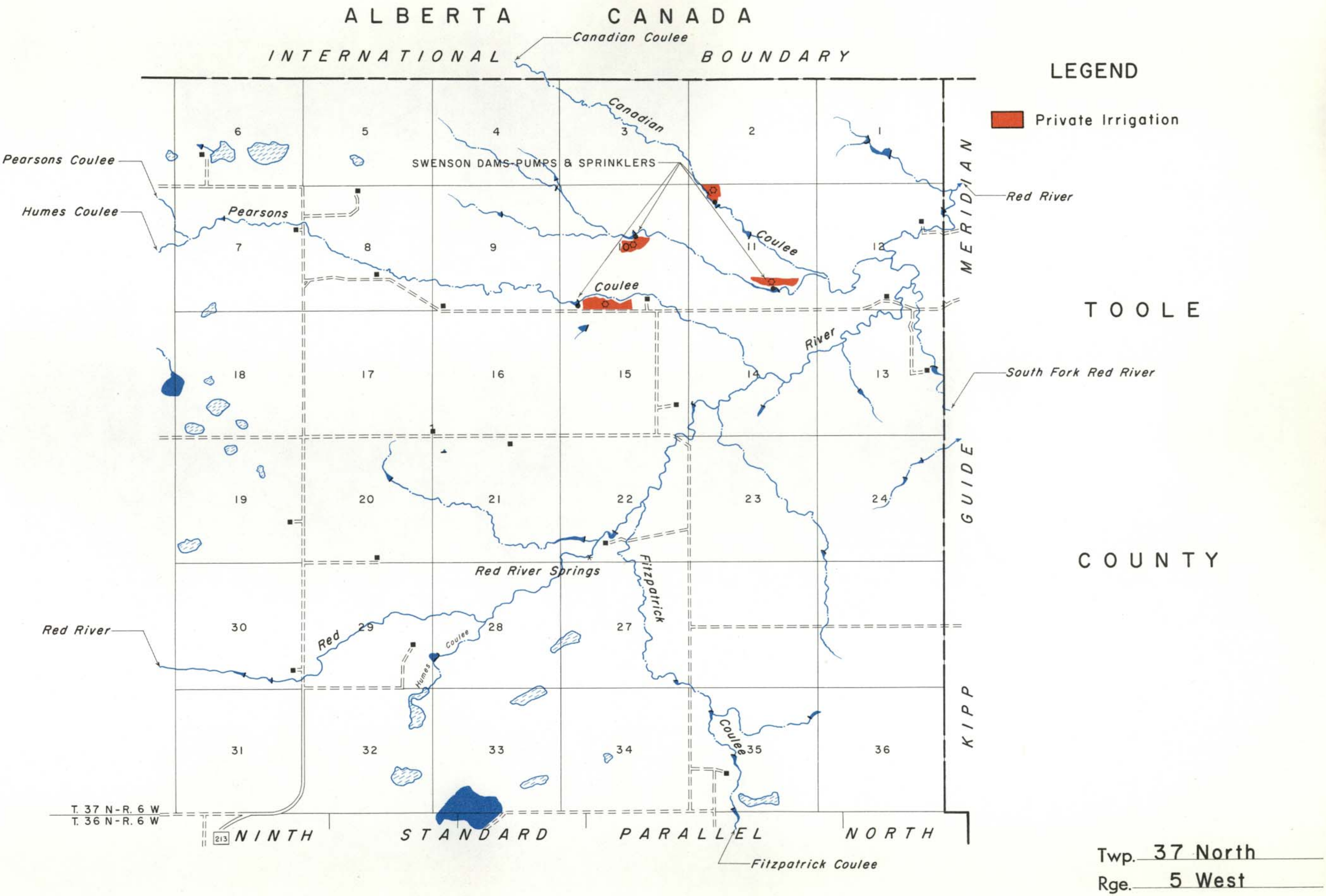
Rge. 12 West

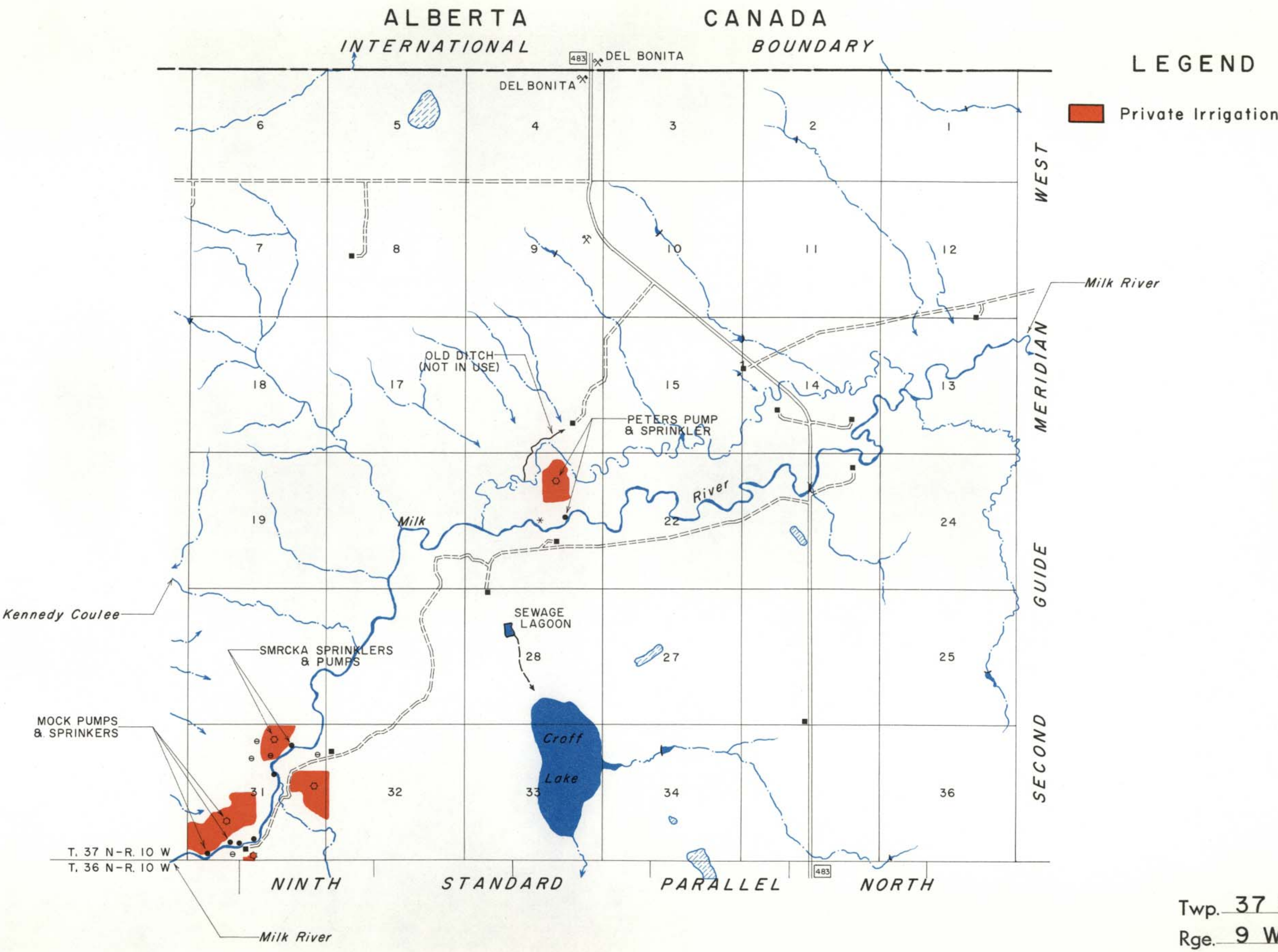


LEGEND

Private Irrigation

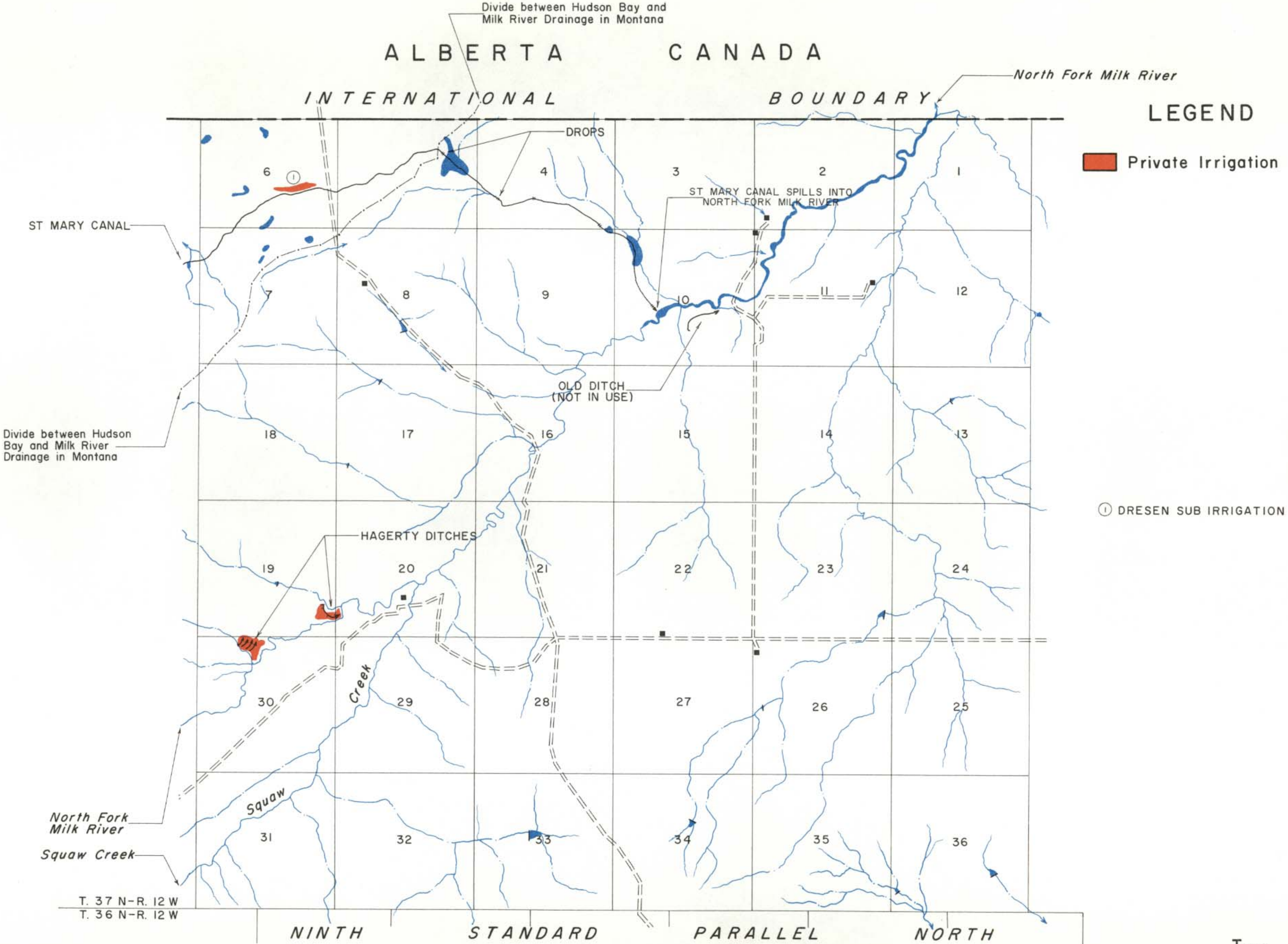
Twp. 36 North
Rge. 14 West


ALBERTA CANADA
INTERNATIONAL BOUNDARY
Canadian Coulee
LEGEND
Private Irrigation
Pearsons Coulee
Humes Coulee
SWENSON DAMS-PUMPS & SPRINKLERS
Canadian
Coulee
Pearsons
Coulee
Red River
River
MERIDIAN
TOOLE
South Fork Red River
Red River Springs
Fitzpatrick
GUIDE
COUNTY
Red River
Red
Coulee
Humes
Coulee
KIPP
T. 37 N-R. 6 W
T. 36 N-R. 6 W
213
NINTH STANDARD PARALLEL NORTH
Fitzpatrick Coulee
6 5 4 3 2 1
7 8 9 10 11 12
18 17 16 15 14 13
19 20 21 22 23 24
30 29 28 27
31 32 33 34 35 36
Twp. 37 North
Rge. 5 West



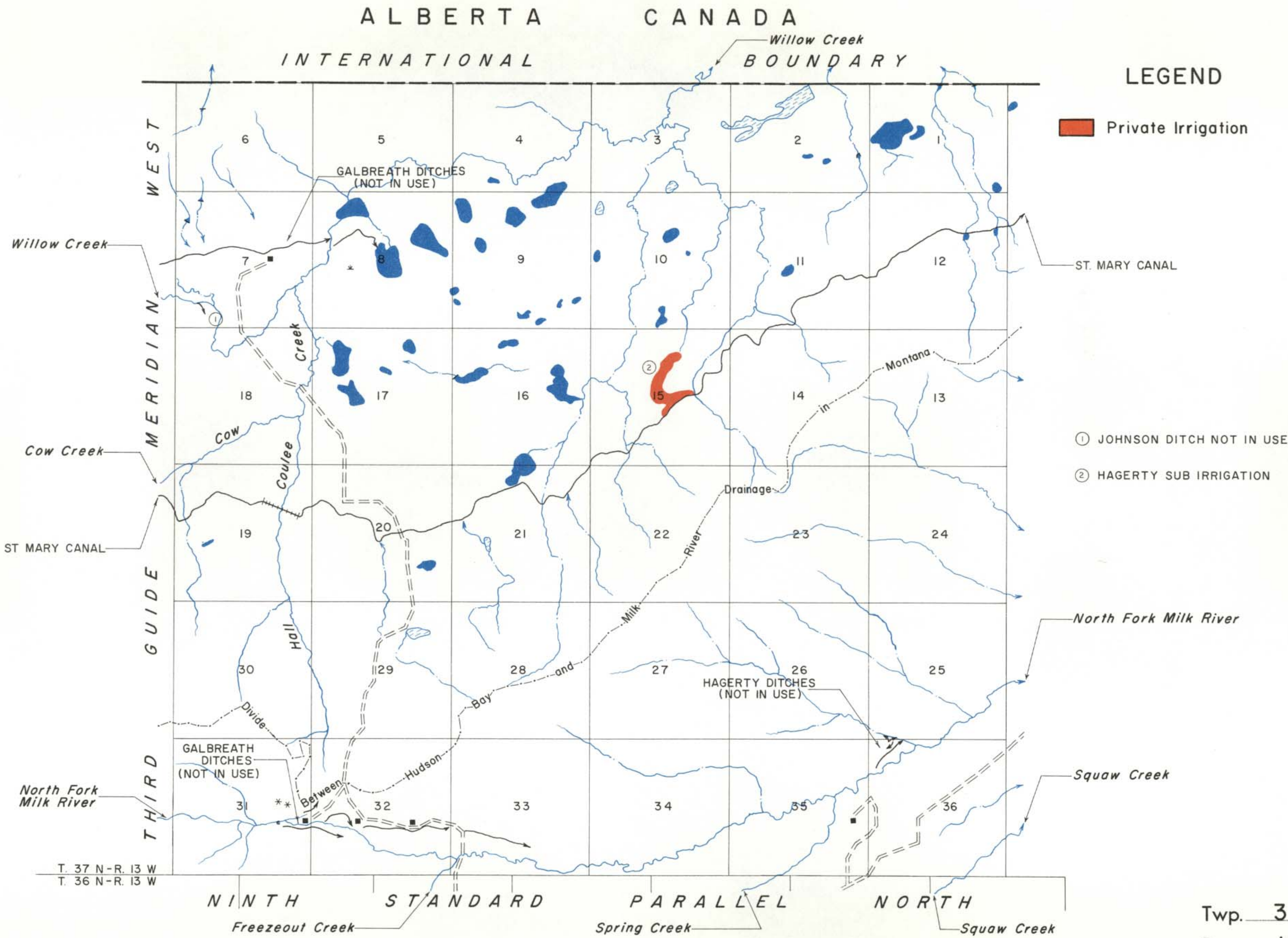
Twp. 37 North

Rge. 9 West

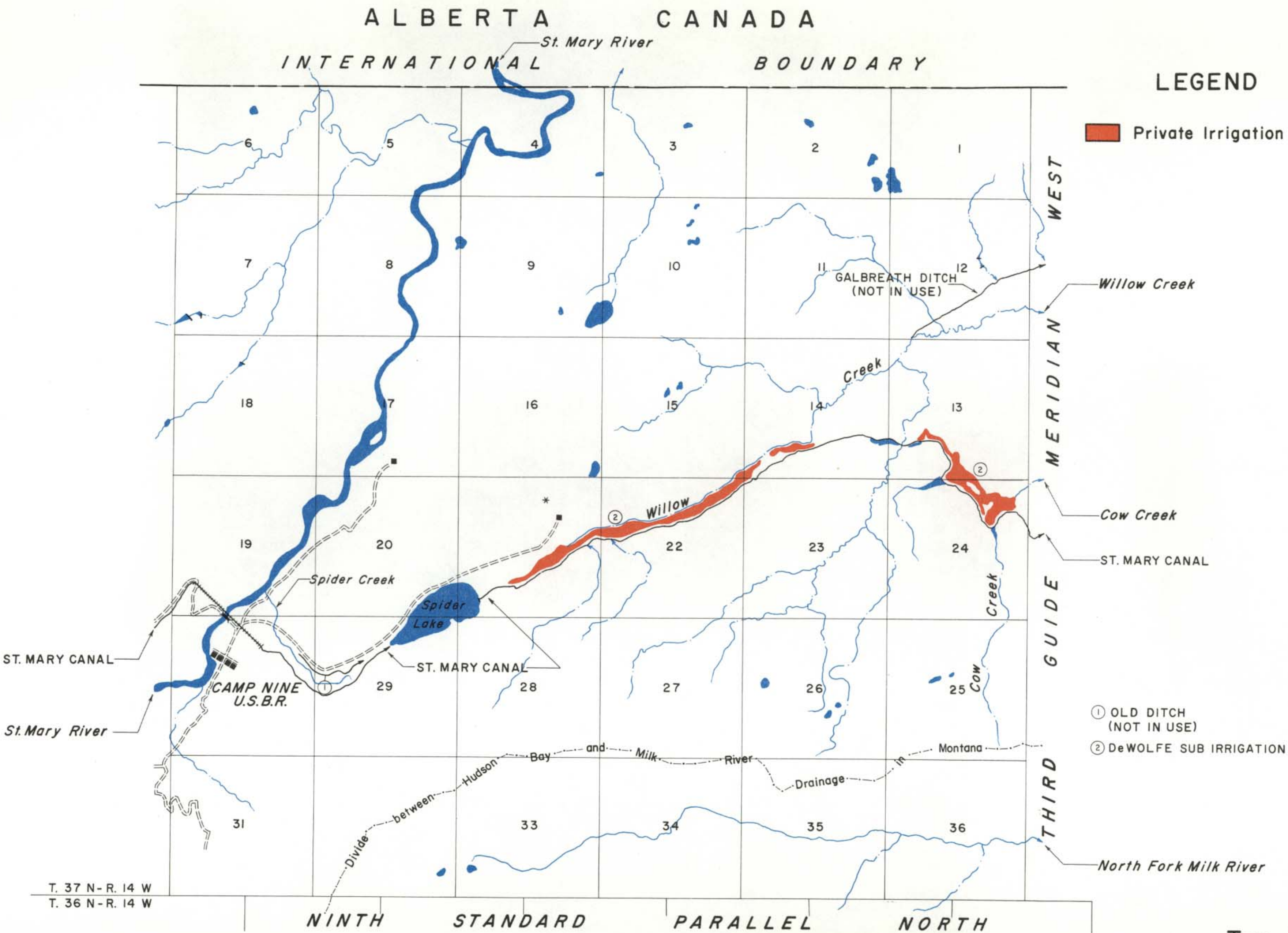


Twp. 37 North

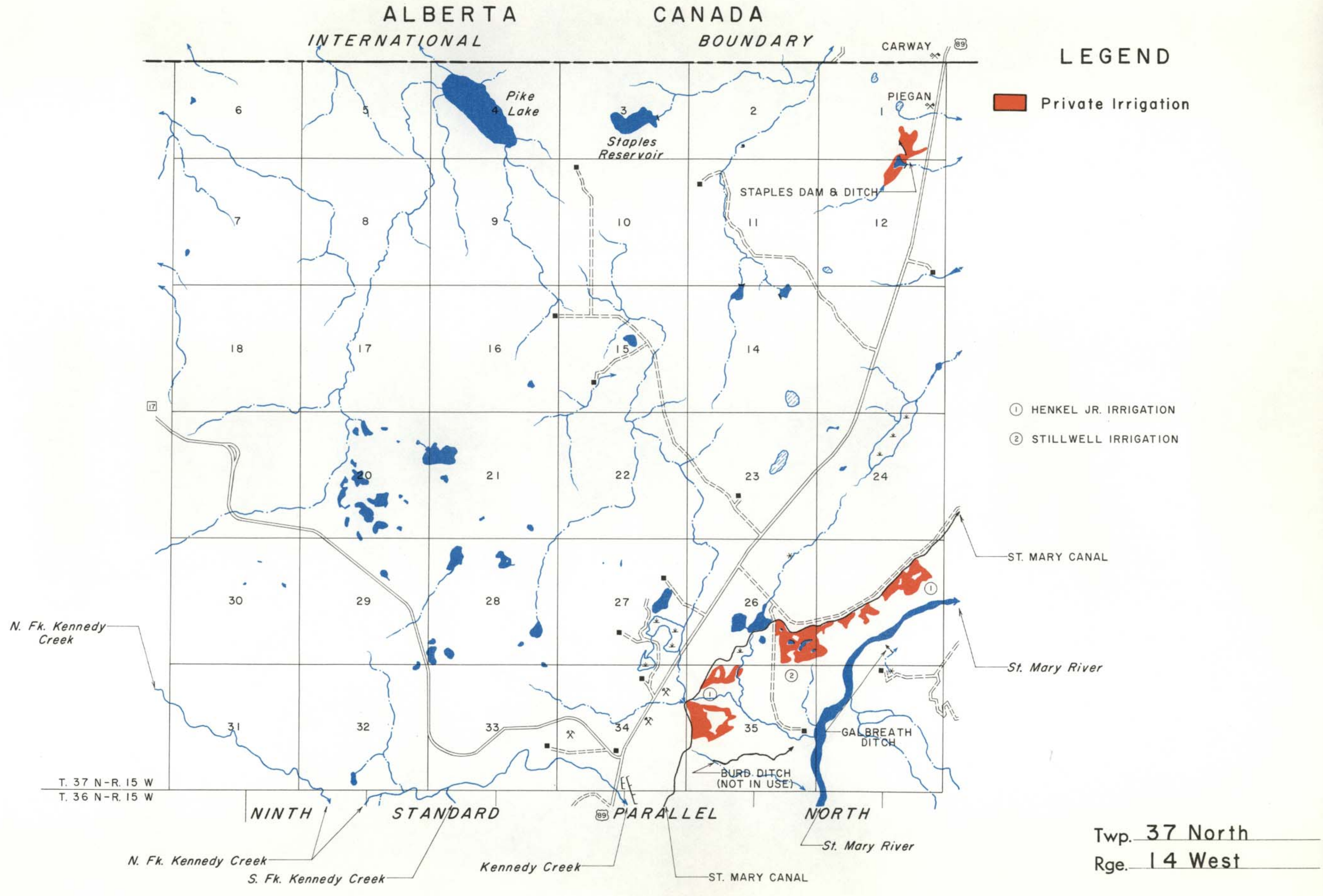
Rge. 11 West



Twp. 37 North
Rge. 12 West



Twp. 37 North
Rge. 13 West


ALBERTA CANADA
INTERNATIONAL BOUNDARY
CARWAY
PIEGAN
Pike Lake
Staples Reservoir
STAPLES DAM & DITCH
LEGEND
Private Irrigation
① HENKEL JR. IRRIGATION
② STILLWELL IRRIGATION
ST. MARY CANAL
St. Mary River
GALBREATH DITCH
BURD DITCH (NOT IN USE)
N. Fk. Kennedy Creek
T. 37 N-R. 15 W
T. 36 N-R. 15 W
NINTH STANDARD PARALLEL NORTH
N. Fk. Kennedy Creek
S. Fk. Kennedy Creek
Kennedy Creek
ST. MARY CANAL
St. Mary River
Twp. 37 North
Rge. 14 West