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RECONNAISSANCE OF THE GEOLOGY AND GROUND-WATER HYDROLOGY OF THE LARAMIE BASIN, WYOMING

WITH SPECIAL REFERENCE TO THE LARAMIE AND LITTLE LARAMIE RIVER VALLEYS

BY

ROBERT T. LITTLETON

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RECONNAISSANCE OF THE GEOLOGY AND GROUND-WATER HYDROLOGY OF THE LARAMIE BASIN, WYOMING

With special reference to
the Laramie and Little Laramie River valleys

By Robert T. Littleton

ABSTRACT

The Laramie Basin, in central-southeastern Wyoming, is drained by the Laramie, Little Laramie, and Medicine Bow Rivers. These streams rise in the Medicine Bow Mountains and flow northward across the floor of the basin. In their courses they traverse a succession of thick shales and thin sandstones and limestones that range from Carboniferous to Tertiary in age.

Vast amounts of coarse alluvium have been deposited since early Quaternary time by these rivers and their tributary creeks where they emerge onto the floor of the basin. The alluvium ranges in texture from boulders and coarse gravel at the upper end to gravel, sand, and silt at the lower end of the basin. These deposits cap mountain pediments and comprise remnants of earlier terraces and thick alluvium both in abandoned stream channels and in present stream valleys.

Ground water occurs under both water-table and artesian conditions within the Laramie Basin.

Shallow ground water is contained under water-table conditions in the alluvium along the principal streams and in places in the gravel cover of pediments and terraces. The zone of saturation in the alluvium is recharged mostly from streams and from irrigation; a high water table is created in periods of high runoff and in the irrigation season. During these periods, the flood plains of the Laramie and Little Laramie Rivers are covered with water, or the water table is close below the surface. In general, the movement of ground water in the alluvium is in the direction of surface drainage. The direction of movement is controlled locally by the configuration of the underlying bedrock surface; thus, in places, the water is diverted to undrained depressions and water-table lakes.

Artesian water is confined within permeable units within the stratified rocks in parts of the basin where structural and stratigraphic conditions are favorable; it moves in the direction of the dip.

Evapo-transpiration from irrigated hay meadows and evaporation from ground-water lakes and ponds of part of the irrigation return flow seem to account for most of the water loss from the Laramie and Little Laramie Rivers. Effluent seepage of stream water into the alluvium and subsequent loss by evapo-transpiration probably account for part of the loss. Stream-flow loss by percolation into deeper aquifers is considered to be negligible.

To obtain a clearer picture of such water losses, additional, more detailed studies are suggested.

INTRODUCTION

Purpose and Scope of the Investigation

This report covers the field investigation in one of several areas selected by the United States Bureau of Reclamation for reconnaissance ground-water studies. The details and scope of this investigation were worked out during conferences between officials of the Bureau of Reclamation and the Geological Survey. Its purpose was to determine whether the stream losses along reaches of the Laramie and Little Laramie Rivers could be explained through geologic and hydrologic investigation. The field investigation on which this report is based was made by the writer between June 10 and August 20, 1948.

This report includes a description of the topography and geology as related to ground-water conditions and data pertaining to the occurrence and movement of ground water in a large segment of the Laramie Basin. An inventory was made of domestic and stock wells; geologic material, including records of shot holes, was compiled from all available sources; and a geologic cross section of the Laramie Basin was prepared. Tables showing stream loss were compiled from records of stream flow made by the Surface Water Branch of the U. S. Geological Survey in cooperation with the Wyoming State Engineer.

This investigation was made under the general supervision of A. N. Sayre, chief of the Ground Water Branch, U. S. Geological Survey, and G. H. Taylor, regional engineer in charge of ground-water studies under the Missouri River Basin development program. S. W. Lohman, district geologist for Colorado and Wyoming, closely supervised the field studies and preparation of this report. The manuscript of the report was critically reviewed by S. W. Lohman, T. G. McLaughlin, and Ray Bentall. The stream-flow records were checked by F. M. Bell, district engineer of the Surface Water Branch for Colorado and Wyoming. The geologic map of Albany County, Wyo., prepared during 1935 by J. D. Love for the Geological Survey of Wyoming, was adapted with little change for this report.

Location and Extent of the Area

The area considered in this report includes all the Laramie River Basin from its upper end to the Wheatland Reservoir. Topographically the Laramie Basin is an intermontane basin; geologically, it is a structural basin. Hydrologic control was established in a general way along 60 miles of the Laramie River Valley from a point 2 miles below the Woods gaging station downstream to the Wheatland Reservoir, and along 18 miles of the Little Laramie River Valley from its confluence with the Laramie River upstream to the Filmore gaging station in sec. 9, T. 15 N., R. 77 W. The geologic studies covered almost the entire Laramie Basin in order that all conditions that may cause stream losses along the principal streams would be taken into account. The location of the area of this report is shown in figure 1.

Previous Studies

The first comprehensive study of the stratigraphy and structure of the Laramie Basin was made by N. H. Darton, Eliot Blackwelder, and C. E. Siebenthal (1910).[1] Since this early study many specific problems have been given careful attention, particularly those pertaining to structure (Wilson and Minturn, 1940). J. D. Love (1935) compiled a geologic map of Albany County, from which plate 1 of this report was taken. A. M. Morgan (1947) studied the geology and ground-water supply of the city of Laramie. Morgan's report contains helpful information on the hydrology of the stratified rocks of Carboniferous age.

In 1947 and 1948, the Stanolind Oil and Gas Co. and the California Co. drilled many shot holes while conducting seismograph operations throughout the basin. Logs of these shot holes have not been released for publication but 219 logs were made available for study by the writer.

Acknowledgments

Special acknowledgment is due all those who contributed to the progress of this investigation. Dr. H. D. Thomas, State Geologist of Wyoming,

1 See references at end of report.

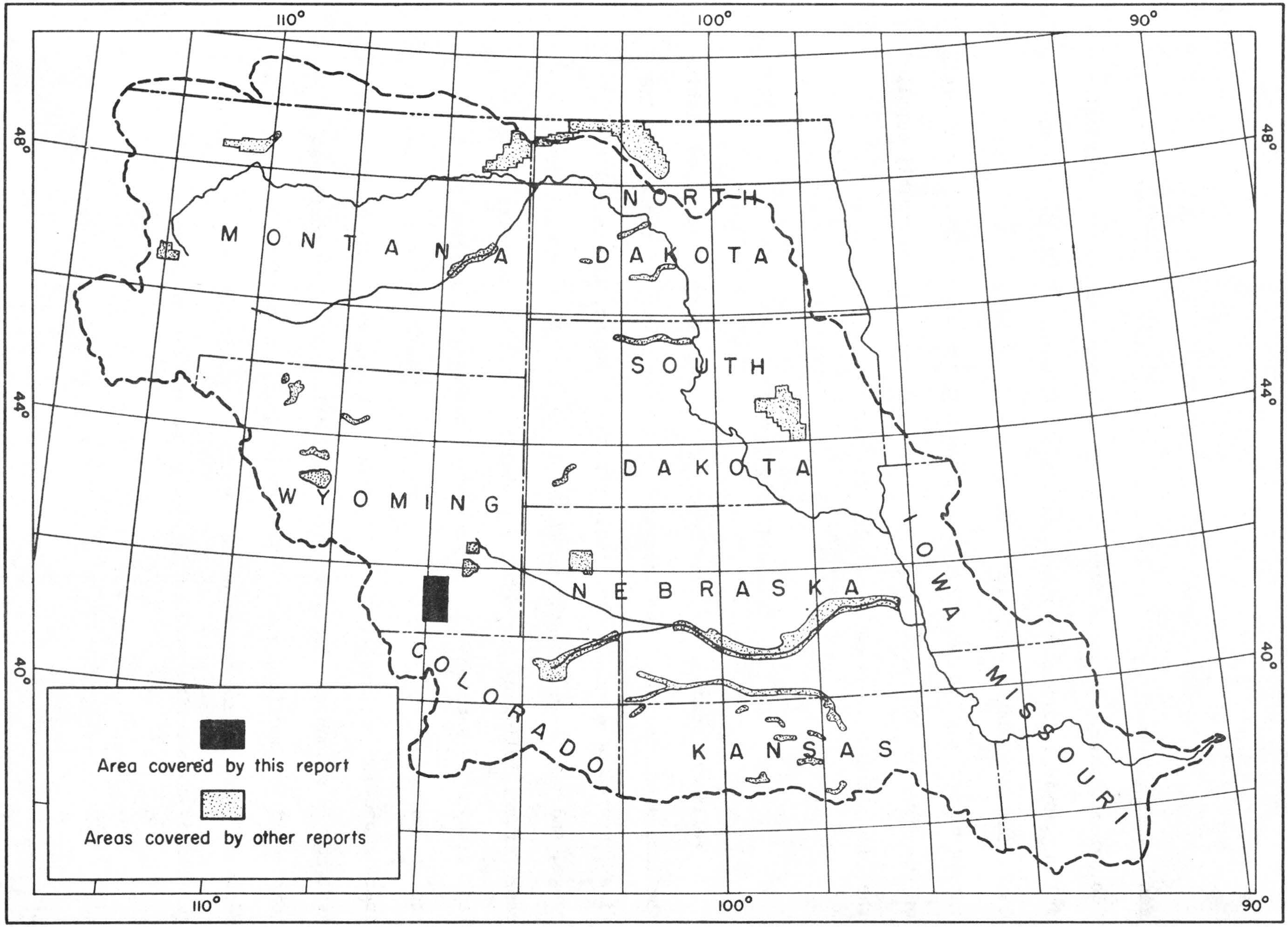

Figure 1 .—Map of the Missouri River Basin showing areas in which ground-water studies have been made under Missouri Basin program.

made available many unpublished data from his files. J. D. Love of the Geological Survey, provided temporary office space and offered many helpful suggestions during the course of the field work. E. H. George and C. H. Humphrey, engineers, and R. D. Dirmeyer, geologist, all of the Bureau of Reclamation, were especially helpful and cooperative. Personnel of the Stanolind Oil and Gas Co. and the California Co. generously supplied the logs and locations of shot holes drilled by those companies.

Well-Numbering System

Wells are numbered in this report according to their location within the land subdivisions of the General Land Office Survey of the area. The first numeral of a well number indicates the township, the second the range, and the third the section in which the well is located. The lower-case letters following the section number indicate the location of the well within the section. The first letter denotes the quarter section, the second the quarter-quarter section, and the third the quarter-quarter-quarter section or 10-acre tract. The letters (a, b, c, and d) are assigned in a counter-clockwise direction beginning in the northeast quarter of the section, quarter-quarter section, or quarter-quarter-quarter section. The numbers of two or more wells in a 10-acre tract are distinguished by consecutive numbers following the lower-case letters. (See fig. 2.)

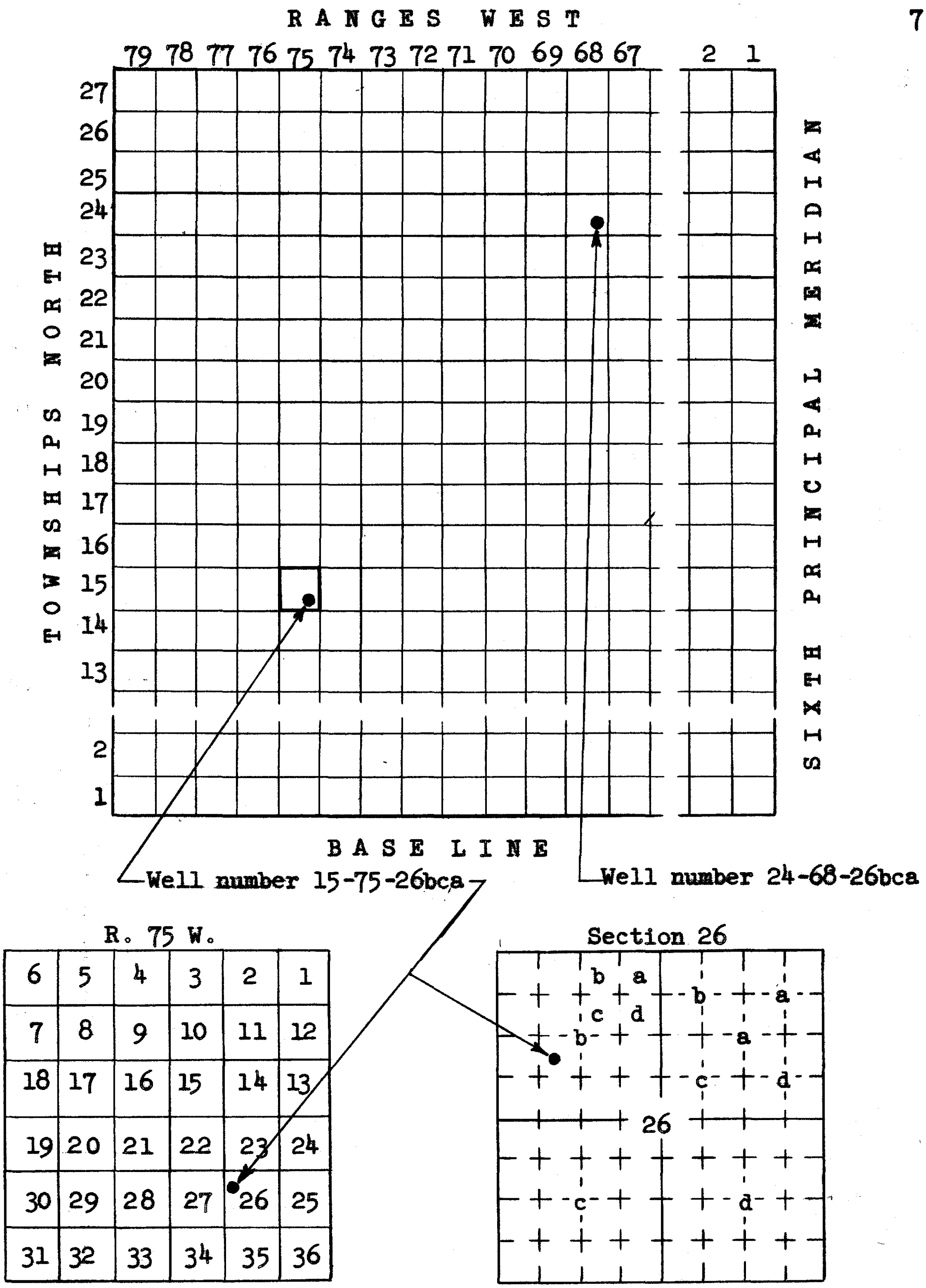

Figure 2.--Sketch showing well-numbering system.

GEOGRAPHY

Topography and Drainage

The Laramie Basin is an intermontane basin open to the northwest. It is bordered on the north and east by the Laramie Range, on the south by the north end of the Front Range of Colorado, and partly on the west by the Medicine Bow Range. Along the foot of the Laramie Range are long mountain pediments (Bryan, 1925) which are covered in most places by thin sheets of coarse gravel.

The floor of the basin is a plain that ranges in altitude from 7,500 feet at the south end to about 6,900 feet where the Laramie River leaves the basin below the Wheatland Reservoir. This plain consists of broad, shallow, terraced valleys which are widely separated by low, flat-topped remnants of older terraces. The basin contains many enclosed depressions of which the most extensive are Big Hollow and Alkali Basin. These large depressions seem to be the result of wind action on the fine-grained weathered materials of the shale formations (Darton, 1910). The shape and size of the depressions seem to have been restricted in part by the surrounding deposits of gravel which prevented removal of the underlying materials by wind. These depressions probably were formed late in the Quaternary period.

The Laramie Basin is drained principally by the Laramie and Little Laramie Rivers. The Laramie River enters the basin at Woods Landing, flows northward across the basin, and leaves at the northeast corner through a canyon cut into the Laramie Range. The gradient of the river averages about 9.7 feet per mile. The Little Laramie River flows northeastward from the Medicine Bow Mountains and joins the Laramie River in sec. 6, T. 17 N., R. 74 W.

Intermittent streams that flow down the slopes of the surrounding mountains supply very little water to the principal streams. This is especially true of Lone Tree and Shell Creeks, the flows of which do not reach the Laramie River except during periods of high runoff. Dutton Creek and Cooper Creek flow into Cooper Lake. Rock Creek, formerly an eastward flowing tributary to the Laramie River, has been captured by a tributary of the Medicine Bow River.

Lakes

There are many lakes throughout the Laramie Basin. The larger lakes and smaller named lakes are shown on plate 1 and their relation to ground water is discussed where appropriate under "Shallow Ground Water." Small ponds occupy the numerous small depressions. Some of these ponds are temporary: they dry up during the fall and winter or during prolonged periods of drought.

Lakes in the valleys of the Laramie and Little Laramie Rivers are fed mostly by ground water. Sevenmile, Soda, Longs, and Ione are water table lakes. Bamforth Lake, which rests on shale in Alkali Basin, lies below the level of the water table in the alluvium to the north but is fed almost entirely by ground water discharged from the alluvium of the Little Laramie River valley.

Lakes farther from the valleys of the Laramie and Little Laramie Rivers are fed mostly from surface water. Examples of such lakes are James and Cooper in the western part of the basin and Hutton and Creighton in the southern part of the basin.

Climate

The Laramie Basin has a cool arid climate characterized by strong westerly winds. The scanty precipitation is insufficient for agriculture and most of the snow that falls is removed from the basin by wind. Irrigation is necessary to raise hay for livestock.

The monthly and annual precipitation was recorded at intervals by the United States Weather Bureau at Laramie between 1869 and 1891; since 1891 continuous records have been kept. (See fig. 3.) The average annual precipitation at Laramie is 11.13 inches.

The normal or "adjusted mean" temperature at Laramie is 41.4° F. The highest recorded temperature is 92° F. and the lowest is -42° F. The length of the growing season ranges from 69 to 152 days; killing frosts have occurred as late as June 23 and as early as August 31.

GEOLOGY

Summary of Stratigraphy

Sedimentary rocks exposed in the Laramie Basin range in age from Mississippian to Recent. (See pl. 1.) The general features of the formations, except the Madison limestone, are listed in table 1. Subsurface

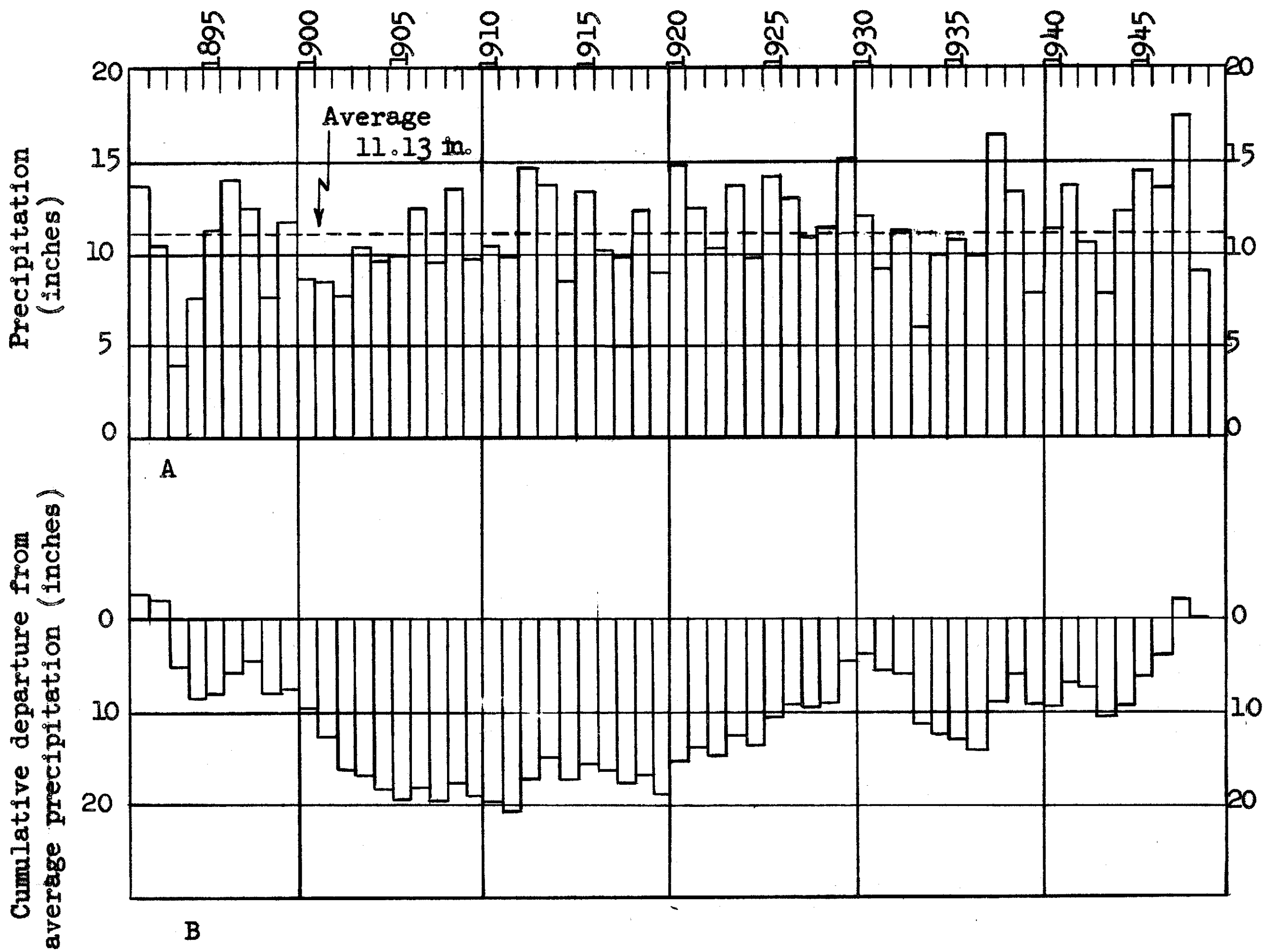

Figure 3.--Graphs showing (A) the annual precipitation at Laramie, Wyoming, and (B) the cumulative departure from average precipitation at Laramie (From the records of the U. S. Weather Bureau.)

Table 1.--Generalized section of rocks exposed in the Laramie Basin

System	Series	Subdivision	Thickness (feet)	General features	Water supply
Quaternary	Recent	Alluvium	10-45	Boulders, gravel, and sand derived from igneous and metamorphic rocks. Gravel clean at upper end of basin but progressively more admixed with silt and clay toward the lower end of the basin.	Contains unconfined ground water in flood plain of Laramie and Little Laramie Rivers. Supplies water to stock and domestic wells.
	Pleistocene	Terrace deposits	?	Chiefly coarse igneous and metamorphic gravel which is residual in places. Occur as remnants of an earlier and well-developed terrace system.	Extensive permanent zones of saturation not present owing to elevated position of deposits.
Tertiary	Oligocene	White River formation	?	Occurs only as remnants in valleys of Laramie Range.	Not known in this area.
	Eocene	Wind River formation	?	Occurs only as remnants.	Do.
		Hanna formation	?	Yellowish-green sandy shale, massive yellowish-brown sandstone, carbonaceous shale, coarse conglomerate, and coal.	Do.
		Medicine Bow formation	?	Present on west side of basin as erosional remnant.	No information obtained as to water supply.

Cretaceous	Upper Cretaceous	Lewis shale	2,500±	Dark marine shale containing several beds of locally-fossiliferous yellowish-brown sandstone. Occurs only as erosional remnants in west-central part of basin.	Probably not important as water-bearing formation.
		Mesaverde formation	1,250	Upper and lower sandstones separated by shale and sandy shale. Occurs only as erosional remnant in west-central part of basin.	No information obtained as to water supply. Upper and lower sandstones probably saturated where recharge is available.
		Steele shale	2,500-3,300	Blue clayey and sandy shale, and includes Shannon sandstone member about 60 feet thick. Comprises a large part of the bedrock underlying the rolling plains of the basin.	Limited supplies of artesian water contained in Shannon sandstone member.
		Niobrara formation	425-700	Gray calcareous shale overlain by thin-bedded chalk; chalk weathers yellow. Contains abundant <u>Ostrea congesta</u> and <u>Inoceramus deformis</u>	Contains water only in a few places where beds are jointed or weathered; water generally of poor quality.
		Frontier formation	413-662	Sandy to clayey shale containing one to three beds of sandstone. Limestone 5 feet thick near base may be equivalent to Greenhorn limestone of Great Plains.	Upper sandstone contains water under artesian pressure in northwestern part of basin; sandstones in southern two-thirds of basin are fine-grained, tightly cemented, and do not contain an appreciable supply of artesian water.
		Mowry shale	120-300	Gray to dark-gray, hard, brittle siliceous shale containing thin beds of bentonite.	Yields little or no water.

Table 1.--Generalized section of rocks exposed in the Laramie Basin--Continued

System	Series	Subdivision	Thickness (feet)	General features	Water supply
Cretaceous	Upper Cretaceous	Thermopolis shale	100-125	Dark-gray clayey to sandy shale (Lower Cretaceous) containing irregular beds of bentonite; capped by lenticular muddy sandstone member (Upper Cretaceous).	Do.
	Lower Cretaceous	Cloverly formation	115-236	Three distinct lithologic units: sandstone caprock, medial shale, and basal sandstone locally conglomeratic; thickness of individual units ranges widely throughout the basin.	Sandstones contain artesian water, which is highly mineralized and generally unfit for domestic use. Sandstones are recharged from saturated alluvium that overlies beveled surface.
Jurassic	Upper Jurassic	Morrison formation	135-222	Variegated shales interbedded with thin fresh-water limestones.	Yields little or no water.
		Sundance formation	0-190	Greenish-gray limy shale in upper part and first and second "Sundance sandstones" separated by gray limy shale in lower part.	Second or basal "Sundance sandstone" contains water at James Lake and Two Rivers domes. Both sandstones potential aquifers.
Triassic	Upper Triassic	Jelm formation	190	Red and white sandstone interbedded with red sandy shale and siltstone. Occurs only in western part of basin.	May contain artesian water.
		Chugwater formation	1,100-1,200	Red shale, siltstone, and fine-grained sandstone.	Yields little or no water to wells in this area.

Permian		Forelle limestone	0-80	Heavy-bedded purple and cream-colored dolomitic limestone containing some thin beds of red shale.	Do.
		Satanka shale	140-300	Red shale, locally gypsiferous, containing some thin beds of red and white fine-grained sandstone.	Persistent sandy zone near middle yields water to stock wells along eastern margin of the basin and to several industrial wells at Laramie.
Carboniferous	Pennsylvanian	Casper formation	500-700	Limestone, sandstone, siltstone, and shale; more sandy westward and contains sandstone similar to Tensleep sandstone on west side of basin; correlation across basin not definite.	Supplies artesian water to wells and springs along west slope of Laramie Range. Limestones contain solution channels for several miles from outcrop. Area of recharge restricted to eastern margin of basin.
		Fountain formation	20-150	Arkosic sandstone and conglomerate 20-50 feet thick on east side of basin; red sandstone, shaly sandstone, and white limestone 150 feet thick on west side of basin.	Not important as artesian aquifer.
Pre-Cambrian				Granite, gneiss, and schist; locally contains coarse-grained basic igneous rocks such as anorthosite.	Yields little or no water.

information recently made available through exploration for petroleum is not wholly in accord with conclusions reached by previous investigators.

Rocks of Mississippian age crop out in the extreme northwest part of the basin but the lithologic characteristics of these rocks were not studied in the field and hence are not included in table 1.

The Carlile shale (Upper Cretaceous) is exposed in the vicinity of the Rock Creek Oil field on the west side of the basin, but there is not sufficient evidence of its presence in the basin to warrant its inclusion in table 1. Further and more detailed study may warrant the assignment of black clayey shale at the top of the Frontier formation (or at the base of the Niobrara formation) to the Sage Breaks member of the Carlile shale.

The Upper Cretaceous formations younger than the Steele shale and the Tertiary formations were not examined in detail in the course of the field investigation; information about them given in table 1 was taken from Dobbin and others (1929). Information on the unconsolidated Quaternary deposits was obtained from the mapping of Love (1935), from logs of wells and shot holes, from observations in the field, and from published reports.

Structure

"The Laramie Basin is formed by a broad syncline trending north and south, with gentle dips on the east side and steep dips or a great fault on the west side" (Darton, 1910). The structure of this syncline is complicated by several domal flexures that are elongated in a wide arc trending northward; on the east limb of the syncline are low anticlinal structures elongated in a direction normal to the regional strike. Thrust faults at depth add to the complexity of individual structures on the west side of the Laramie Basin. Beckwith (1941) mapped and reported the intricate details of thrust faulting west of the Laramie Basin in the Elk Mountain district. The same pattern of thrust faulting is present on the west side of the basin and has been encountered in recent oil tests. In general the direction of thrust is eastward. A geologic cross section of the Laramie Basin is shown in plate 2.

SHALLOW GROUND WATER

Source and Occurrence

Unconfined ground water occurs in the alluvium along the Laramie and Little Laramie Rivers, and along the larger intermittent streams. The alluvium is recharged mainly from stream flow but in part from precipitation. Thin gravel deposits on the terraces and the mountain pediments also contain some unconfined ground water derived directly from the precipitation.

Depth to Water Table

The water table ranges in depth from less than a foot to a few feet below land surface in the valleys and is about 30 feet below the surface of the mountain pediments and terrace deposits. Water levels in wells along the Laramie and Little Laramie Rivers are reported to be highest during and shortly after the spring runoff. At this time the high water table creates many temporary ponds in depressions in the flood plains of the rivers. Increased evaporation and transpiration, and diminishing surface water supply lower the water table so that most of the ponds disappear during the summer.

Movement of Ground Water

Throughout the basin, particularly in the valleys of the Laramie and Little Laramie Rivers, water contained in the alluvium moves in a direction parallel to the general course of the streams. During periods of low stream flow, ground water is discharged into the Laramie and Little Laramie Rivers. The rate of movement of ground water is controlled by the hydraulic gradient and by the permeability of the alluvium.

Practically all the alluvium in the Laramie Basin overlies an undulating and, in part, sharply configurated bedrock surface. As a result the zone of saturation ranges greatly in thickness and in some places is absent; hence, ground water follows irregular channels and in some places is diverted into undrained areas. It moves from the alluvium of the Little Laramie River into Alkali Basin where it ultimately is lost through evaporation from the surface of Bamforth Lake. Ground water moving through the alluvium of a former stream course of the Laramie River discharges into Soda and Sevenmile Lakes and likewise is lost through evaporation.

Long and Ione Lakes are fed partly by ground water from the alluvium of an abandoned stream channel of the Laramie River. Because the alluvium in this vicinity is covered by and mixed with slope wash, it has a low permeability; consequently ground water percolates through it very slowly. These lakes, particularly Ione Lake, receive considerable surface runoff.

Cooper Lake lies within a closed basin formed partly by the structure of the pre-Tertiary formations and partly by erosion of flat-lying Tertiary sediments. There is no evidence of ground-water movement from Cooper Lake eastward toward the Laramie River because movement in this direction is restricted by the Steele shale, which locally forms a broad syncline plunging southwestward. However, the reported chemical quality of the water in Cooper Lake suggests that there is subsurface escape of water from the lake. The expected path of ground water from Cooper Lake would be westward or possibly northwestward. Detailed geologic and hydrologic investigation may reveal that the Tertiary formations are recharged by water from the lake during periods of high water level and that they discharge water into the lake during periods of low water.

ARTESIAN WATER

Source and Occurrence

Conditions are favorable for artesian wells in the Laramie Basin owing to the synclinal structure of the basin and the lithology of the stratified rocks within it. Moderate quantities of water under artesian pressure are obtained from the Casper, Satanka, Sundance, and Cloverly formations and small quantities of water are obtained from the Shannon sandstone member of the Steele shale.

Where these stratigraphic units crop out, recharge is by direct penetration of rainfall and melting snow, and by percolation from overlying saturated alluvium. (See pl. 2.) The sandstones of the Sundance and Cloverly formations are recharged principally from saturated alluvium along the Laramie River.

Relation of Piezometric surface to Land Surface

The piezometric surface of an artesian aquifer is an imaginary surface extending from the intake of the aquifer down the dip, through all points to which water will rise in wells that tap the aquifer. The shape and slope of the piezometric surface are controlled primarily by the dip and permeability of the aquifer, and by the quantity and distribution of the recharge and discharge.

Artesian wells on the east side of the basin generally flow, but not those near the center of the basin where the aquifers are deeply buried. Artesian water was encountered in well 16-74-15cca at a depth of 1,035 feet in the upper sandstone of the Cloverly formation. The water was under sufficient pressure to raise it 928 feet, to a level only 107 feet below land surface. A log of this well was made by the writer from a microscopic study of the well cuttings.

Log of well 16-74-15cca

Formation	Thickness (feet)	Depth (feet)
Niobrara formation		
Shale, calcareous, and limestone	43	43
Shale, gray to dark-gray, clayey to fine sandy, laminated, soft to brittle, containing numerous minute limy pellets having crude linear arrangement, and fragments of Inoceramus. Thin beds of bentonite in interval from 210 to 250 feet	214	257
Frontier formation		
Sandstone, gray to light-gray, fine- to medium-grained, calcareous, composed of rounded and subangular grains of quartz. Numerous fragments of Inoceramus	12	269
Shale, gray, clayey, laminated, calcareous, containing a few crystals of pyrite and a few fragments of Inoceramus	21	290
Sandstone, gray, fine- to medium-grained, soft, poorly cemented, weakly calcareous, composed predominantly of rounded and subangular grains of quartz but with accessory mafic minerals giving the rock a "salt and pepper" appearance	60	350
Sandstone, gray, medium-grained, well-cemented, containing shale partings and some interbedded sandy to clayey shale	10	360
Shale, gray to dark-gray, brittle to soft, fine sandy to clayey, in part micaceous, containing a few beds of fine-grained well-bedded sandstone. Contains abundant fragments of Inoceramus and a few streaks of white and yellow bentonite	190	550
Shale, dark-gray, soft, clayey, micaceous, finely laminated, interbedded with fine-grained sandstone	70	620
Mowry shale		
Shale, gray to dark-gray, hard, brittle, noncalcareous, siliceous, containing irregular streaks of bentonite	290	910
Thermopolis shale		
Muddy sandstone member		
Sandstone, gray, medium- to coarse-grained, poorly to tightly cemented, calcareous, composed principally of angular grains of quartz	5	915
Sandstone, white, cemented with silica, composed of rounded to subangular grains of quartz	15	930
Sandstone, gray to brown, calcareous, fine-grained to silty and shaly, interbedded with siltstone and shale	20	950

Log of well 16-74-15cca--Continued

Formation	Thickness (feet)	Depth (feet)
Thermopolis shale--Continued		
Shale, gray to dark-gray, clayey, interbedded with thin streaks of hard brittle siltstone, containing pencil structures and abundant bentonite....	85	1,035
Cloverly formation		
Upper sandstone member		
Sandstone, gray, soft, poorly cemented, weakly calcareous, composed principally of grains of quartz that are rounded to subangular. (Saturated with water under artesian pressure)......................................	30	1,065

Direction of Movement

Water in artesian aquifers moves in the direction of the maximum slope of the piezometric surface. On the east side of the Laramie Basin this movement is down the east flank of the syncline in a generally northwesterly direction.

WATER LOSS[2] FROM STREAMS

Stream-flow records indicate considerable water loss from the Laramie and Little Laramie Rivers as they cross the basin. Inasmuch as stream-flow records are not obtained regularly during the winter at most of the gaging stations, comparisons of runoff can best be made for the period April through September. Statements that follow in regard to runoff and loss are based on the period April through September during the years 1939 through 1948.

2 Water loss as used in this report includes beneficial consumptive use by crops and loss by natural processes.

Comparison of the combined runoff of the Laramie River at the Woods and Pioneer Canal gaging stations with the runoff of the Laramie River at the Two Rivers gaging station, 42 miles downstream, indicates for the period studied an average seasonal loss of 48,520 acre-feet, or an average of 1,155 acre-feet per mile. (See table 2.) Excluding the water diverted by the Pioneer Canal, the average seasonal losses of the Laramie River

Table 2.--Runoff of the Laramie River at Woods and Pioneer Canal and Two Rivers gaging stations and loss between stations during period April through September, 1939-1948, in acre-feet

April through September	Combined runoff at Woods and Pioneer Canal	Runoff at Two Rivers	Loss between Woods and Pioneer and Two Rivers
1939	70,400	31,800	38,600
1940	77,910	29,540	48,370
1941	83,920	40,330	43,590
1942	129,400	90,790	38,610
1943	116,000	63,850	52,150
1944	74,210	30,990	43,220
1945	130,100	78,210	51,890
1946	102,200	52,310	49,890
1947	150,200	91,640	58,560
1948	104,000	43,680	60,320
Total	1,038,340	553,140	485,200
Average	103,834	55,314	48,520

/From records of the Surface Water Branch of the U. S. Geological Survey obtained in cooperation with the Wyoming State Engineer. Part of the runoff for April is estimated/

during the period studied were 17,086 acre-feet between the Woods and Laramie gaging stations and 8,047 acre-feet between the Laramie and Two Rivers gaging stations, or 25,133 acre-feet between the Woods and Two Rivers gaging stations. (See table 3.) The seasonal loss between the Woods and Two Rivers gaging stations averaged about 600 acre-feet per mile. These

Table 3.--Runoff of the Laramie River at Woods, Laramie, and Two Rivers gaging stations and loss between stations during period April through September, 1939-1948, in acre-feet

April through September	Runoff at gaging stations			Loss between gaging stations		
	Woods	Laramie	Two Rivers	Woods and Laramie	Laramie and Two Rivers	Woods and Two Rivers
1939	53,660	35,730	31,800	17,930	3,930	21,860
1940	57,350	36,950	29,540	20,400	7,410	27,810
1941	64,940	48,370	40,330	16,570	8,040	24,610
1942	108,800	102,000	90,790	6,800	11,210	18,010
1943	91,690	73,130	63,850	18,560	9,280	27,840
1944	55,290	41,640	30,990	13,650	10,650	24,300
1945	108,360	85,210	78,210	23,150	7,000	30,150
1946	77,480	63,280	52,310	14,200	10,970	25,170
1947	115,500	95,230	91,640	20,270	3,590	23,860
1948	71,400	52,070	43,680	19,330	8,390	27,720
Total	804,470	633,610	553,140	170,860	80,470	251,330
Average	80,447	63,361	55,314	17,086	8,047	25,133

/From records of the Surface Water Branch of U. S. Geological Survey obtained in cooperation with the Wyoming State Engineer. Part of the runoff for April is estimated./

losses are greatest during May and June, when the runoff is greatest, but continue from April through September (see figs. 4 and 5) and in reduced amount for some time after September.

Water loss from the 18-mile stretch of the Little Laramie River between the Filmore and Two Rivers gaging stations averaged about 34,000 acre-feet a season during the period studied, an average of about 1,900 acre-feet per mile seasonally. (See table 4.) The distribution of these losses throughout the period April through September (see fig. 6) is similar to that described for the Laramie River.

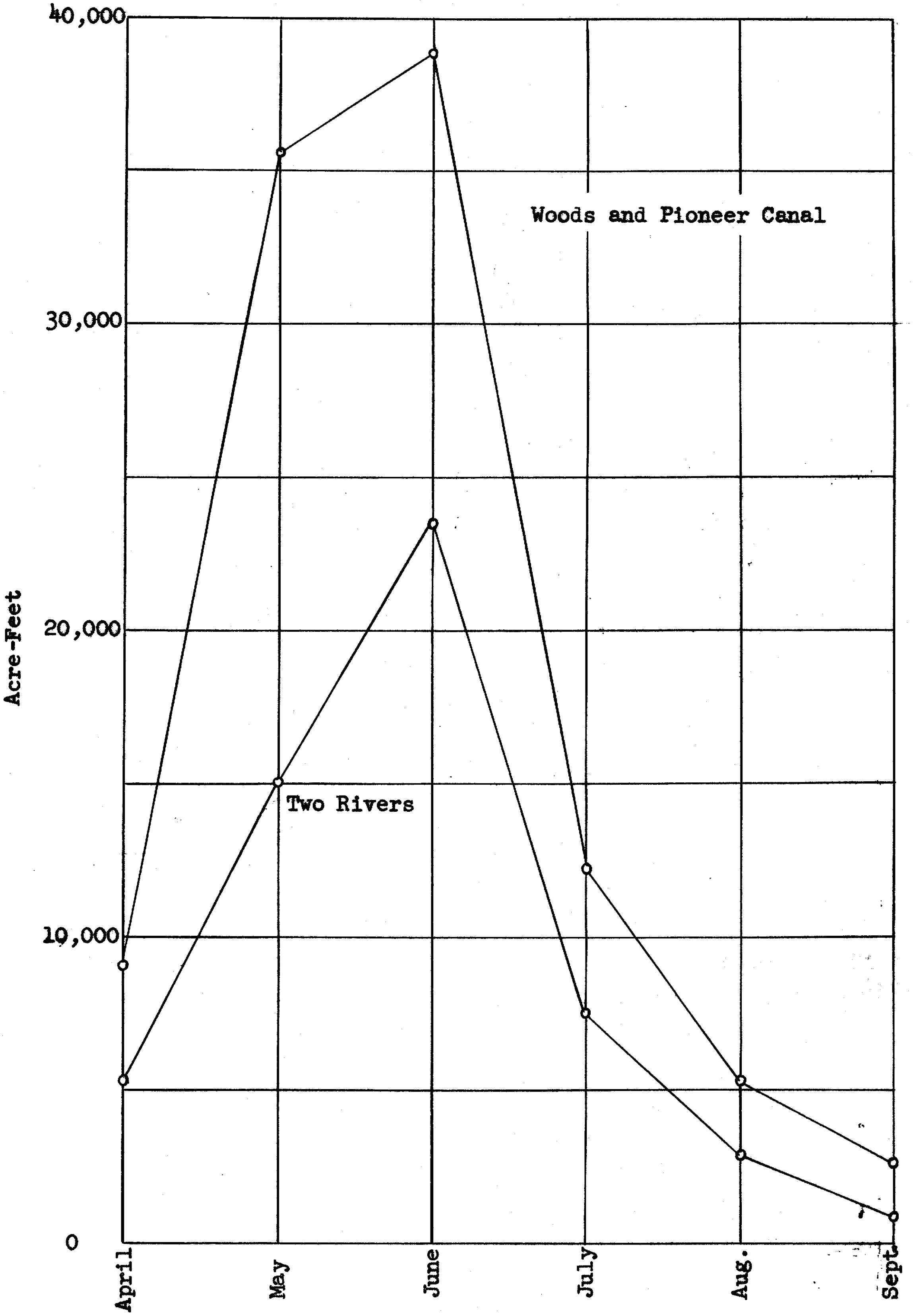

Figure 4.--Average monthly runoff in acre-feet of the Laramie River at Woods and Pioneer Canal and Two Rivers gaging stations, April-September, 1939-1948.

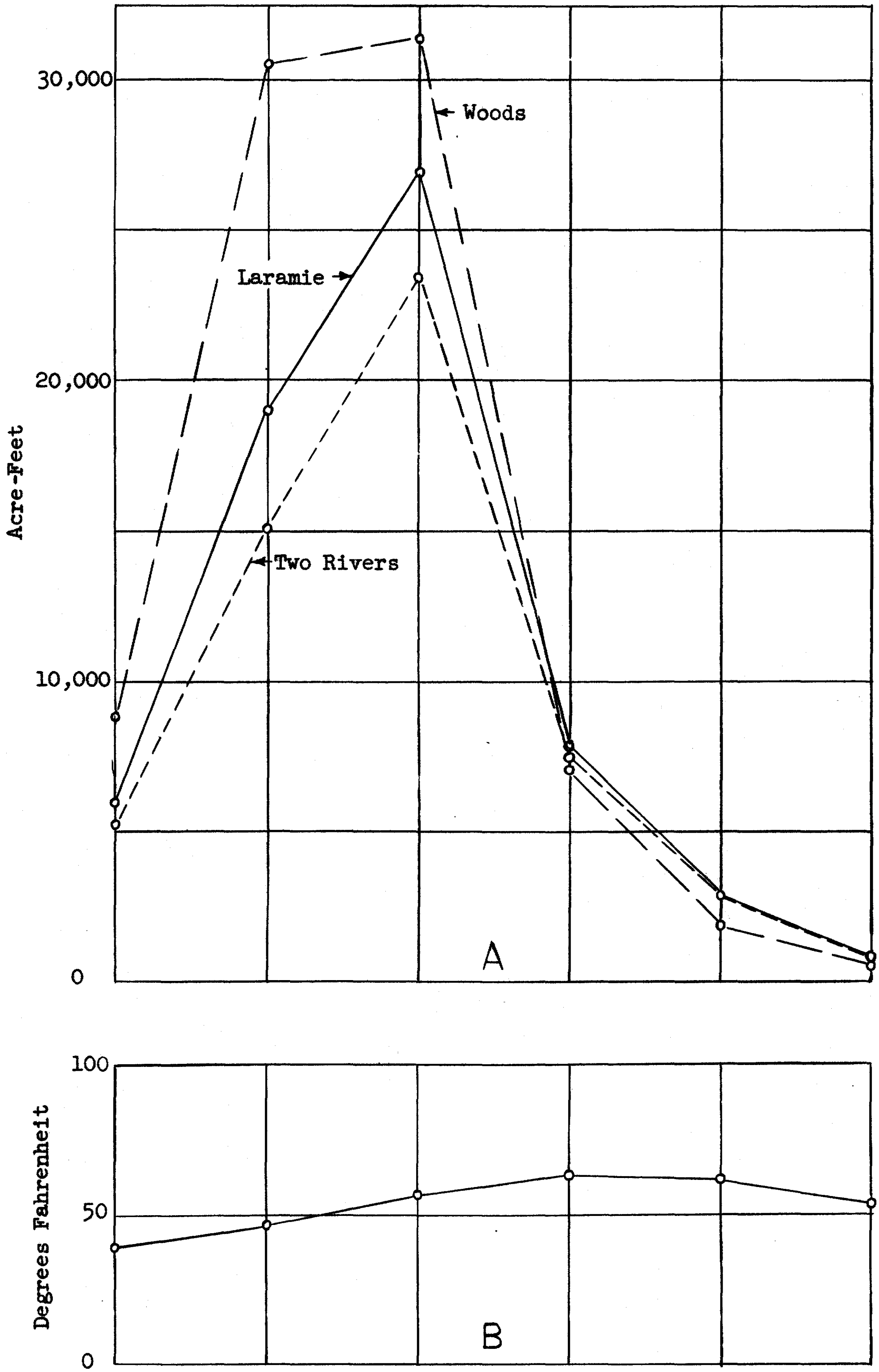

Figure 5.--Graphs showing (A) average monthly runoff in acre-feet of the Laramie River at Woods, Laramie, and Two Rivers gaging stations, April-September, 1939-1948, and (B) monthly normal

Table 4.--Runoff of the Little Laramie River at Filmore and Two Rivers gaging stations and loss between stations during period April through September, 1939-1948, in acre-feet

April through September	Runoff at gaging stations		Loss between Filmore and Two Rivers
	Filmore	Two Rivers	
1939	43,450	8,928	34,522
1940	34,280	3,176	31,104
1941	48,480	11,680	36,800
1942	60,390	25,620	34,770
1943	86,220	42,500	43,720
1944	37,540	8,647	28,893
1945	77,460	44,760	32,700
1946	51,370	13,690	37,680
1947	73,370	46,510	26,860
1948	54,840	19,990	34,850
Total	567,400	225,501	341,899
Average	56,740	22,550	34,190

[From records of the Surface Water Branch of the U. S. Geological Survey obtained in cooperation with the Wyoming State Engineer]

The water loss from the Laramie and Little Laramie Rivers is due mainly to diversion of water for irrigation and the consequent great loss of water by evaporation and transpiration in the irrigated areas. Roush (1937) reported that during the period 1933 through 1936 the annual return flow from irrigation along the Laramie River valley ranged from only 6.8 to 18 percent of the water diverted. The native hay meadows are irrigated by spreading water over them to a depth ranging from a fraction of an inch to several inches. The low percentage of return flow resulting from such irrigation indicates large evapo-transpiration losses. Moreover, part of the return flow from irrigation is evaporated from many ground-water lakes and ponds, such as Soda and Sevenmile Lakes (see pp. 9 and 10). Considerable water is lost also by transpiration from thick stands of trees and

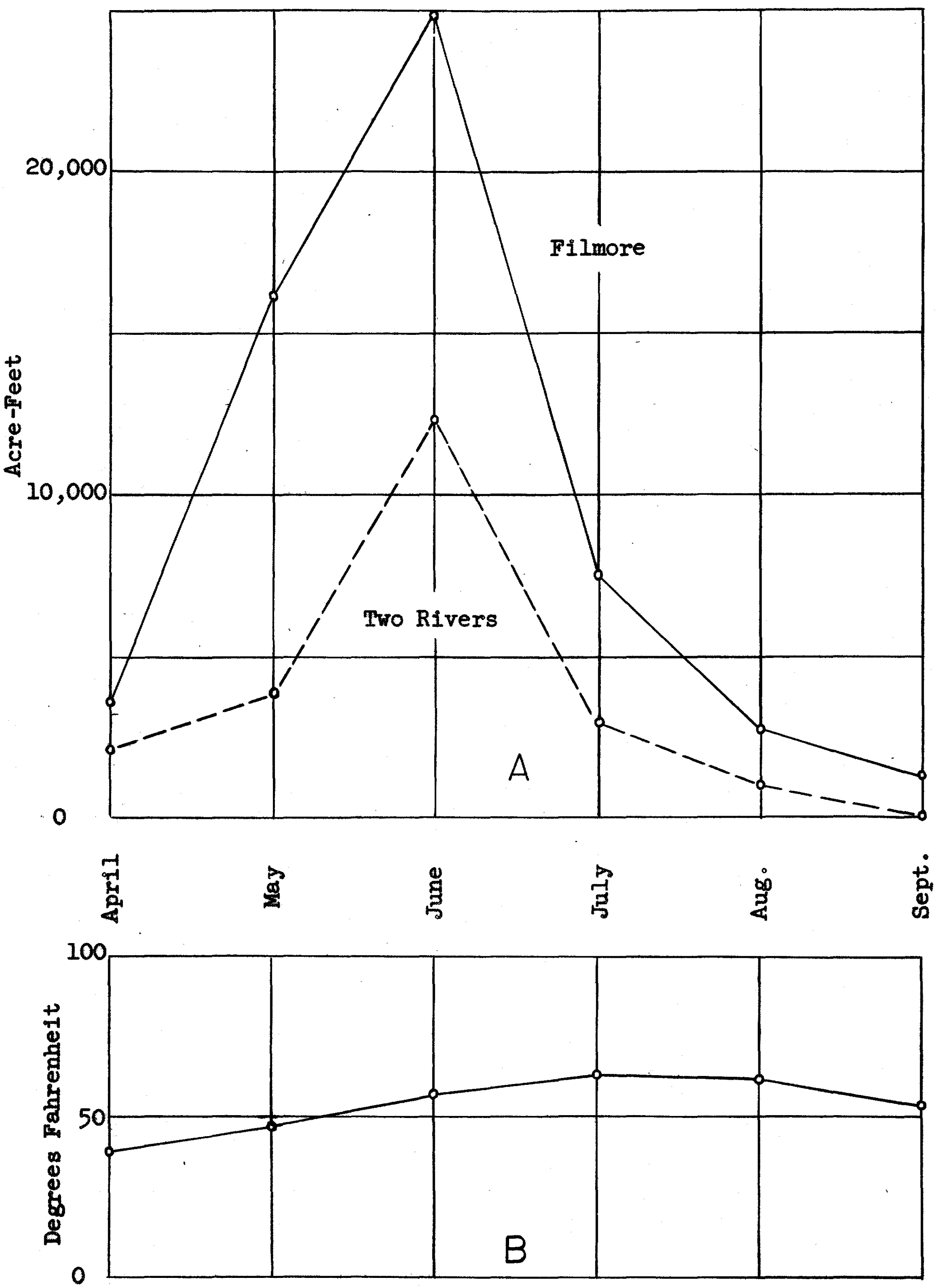

Figure 6.--Graphs showing (A) average monthly runoff in acre-feet of the Little Laramie River at Filmore and Two Rivers gaging stations, April-September, 1939-1948, and (B) monthly normal temperature at Laramie, Wyo.

shrubs that line the meandering channels of the Laramie and Little Laramie Rivers.

A part of the water loss probably results from seepage of water from the streams at high stages into the adjacent alluvium where it is temporarily held in bank storage. Part of this water in bank storage is lost by evapo-transpiration and the remainder returns to the streams during low stages.

The amount of stream water that may percolate into deeper aquifers is considered negligible.

CONCLUSIONS AND RECOMMENDATIONS

The seasonal (April through September) water loss in the Laramie Basin above Two Rivers, including use by crops and natural evapo-transpiration use, is indicated to be about 48,000 acre-feet from the Laramie River (a 42-mile stretch) and about 34,000 acre-feet from the Little Laramie River (an 18-mile stretch), a total of about 82,000 acre-feet. Large evapo-transpiration losses from irrigated hay meadows, evaporation of part of the return flow from ground-water lakes and ponds, and transpiration from trees and shrubs along the streams seem to account for a great part of the water loss from the Laramie and Little Laramie Rivers in the Laramie Basin. Effluent seepage of stream water into the alluvium during periods of high runoff and subsequent loss by evapo-transpiration probably accounts for part of the water loss. Available information is insufficient to divide the water loss into amounts of beneficial and nonbeneficial use. The quantity of water lost by percolation into deeper aquifers is considered negligible.

This reconnaissance study has given good indications of the magnitude of the water losses in the Laramie Basin and of the ways in which the water is lost. It has shown that the existing and readily available data are insufficient in detail, quantity, and accuracy to permit definite conclusions concerning the reduction of nonbeneficial water losses. To reveal the conditions causing water loss in the basin and to determine the quantity of water that can be salvaged, additional detailed field data and comprehensive studies of both existing and additional data are needed.

Further detailed studies are suggested. They should include but not be limited to the following items: (1) Make a detailed inventory of all existing wells; (2) establish a comprehensive network of observation wells through wider use of existing wells and by the construction of new, strategically located observation wells; (3) make periodic measurements of the water level in those observation wells; (4) test drill to determine the character, thickness, and extent of the alluvium in the Laramie and Little Laramie River valleys; (5) make a detailed geologic map of the unconsolidated materials and a bedrock contour map; (6) prepare water table contour maps; (7) obtain detailed records of all surface-water inflow and diversion; (8) compile and study all records of surface-water inflow, outflow, and diversion for irrigation in order to determine total evapo-transpiration; (9) make pumping tests on selected wells to obtain information regarding the hydrologic properties of the principal aquifers;

(10) supplement the pumping-test data wherever possible by making laboratory tests on the hydrologic properties of the principal aquifers; and (11) assemble and study all available data and prepare a comprehensive report.

WATER-LEVEL MEASUREMENTS

Periodic measurements of water levels were made in a few wells during this reconnaissance. The measurements are given in table 5.

Table 5.--Water levels in observation wells, in feet below land-surface datum

14-74-6dac.

Date	Water level	Date	Water level	Date	Water level
June 14, 1948	4.74	May 3, 1949	5.19	Sept.22, 1949	5.10
Aug. 2	5.35	June 21	4.01	Nov. 15	5.70
Dec. 14	5.46	July 8	5.39	Jan. 23, 1950	4.09

14-75-17aac.

Date	Water level	Date	Water level	Date	Water level
July 8, 1948	3.78	May 3, 1949	5.31	Sept.22, 1949	5.87
Aug. 2	5.26	June 21	3.43	Nov. 15	5.93
Dec. 14	6.71	July 8	2.90	Jan. 23, 1950	6.17

14-75-29adb.

Date	Water level	Date	Water level	Date	Water level
July 3, 1948	4.52	May 3, 1949	4.71	Sept.22, 1949	5.28
Aug. 2	4.89	June 21	3.62	Nov. 15	5.64
Dec. 14	4.64	July 8	4.12	Jan. 23, 1950	5.53

14-76-4aab.

Date	Water level	Date	Water level	Date	Water level
July 7, 1948	5.27	May 3, 1949	5.04	Sept.22, 1949	5.76
Aug. 2	5.94	June 21	3.48	Nov. 15	5.26
Dec. 14	6.28	July 8	4.16	Jan. 23, 1950	5.25

Table 5.--Water levels in observation wells, in feet below land-surface datum--Continued

14-77-25dcd.

Date	Water level	Date	Water level	Date	Water level
July 7, 1948	27.38	May 3, 1949	31.09	July 8, 1949	29.47
Aug. 2	27.07	June 21	29.47	Nov. 15	26.07
Dec. 14	26.88				

15-74-1aaa.

June 24, 1948	3.58	June 21, 1949	3.55	Nov. 15, 1949	4.67
Dec. 14	6.04	July 8	3.54	Jan. 23, 1950	5.74
May 3, 1949	4.94	Sept. 22	4.95		

16-73-16bba.

Aug. 6, 1948	6.20	May 3, 1949	5.76	Dec. 14	6.29

16-76-11bbc.

July 16, 1948	0.60	May 3, 1949	1.00	July 8, 1949	0.63
Aug. 2	2.93	June 21	+2.25	Sept. 22	4.44
Dec. 14	2.51				

16-76-18dbb.

July 16, 1948	4.60	May 3, 1949	4.27	Sept. 22, 1949	5.74
Aug. 2	5.52	June 21	.29	Nov. 15	3.92
Dec. 14	5.53	July 8	.00	Jan. 23, 1950	3.83

17-75-34cdd.

July 26, 1948	4.67	June 21, 1949	0.87	Nov. 15, 1949	5.57
Dec. 14	6.42	July 8	3.61	Jan. 23, 1950	6.22
May 3, 1949	3.09	Sept. 22	6.12		

An inventory of 54 wells along the Laramie and Little Laramie Rivers was made during this investigation. (See table 6.) Twenty additional wells were visited or reported, but records of these wells were inadequate for tabulation. The wells visited or reported are only a small percentage of the wells in the Laramie Basin.

Most of the wells visited were drilled but a few were dug. The water in 40 of the wells is from unconfined aquifers under water table conditions, but the water from the remaining wells is under artesian pressure. Wells now in use are equipped with cylinder pumps that are powered by wind or gasoline motors, or are hand-operated.

Table 6.--Records of wells in the Laramie Basin, Wyo.

Well number: See p. 6 and fig. 2 for description of well numbering system.
Type of well: Dr, drilled well; Du, dug well.
Depth of well: Measured depths are given in feet and tenths below measuring point; reported depths are given in feet below land surface.
Type of casing: B, brick; C, concrete; Gal, galvanized steel; Rk, rock; S, steel, T, tile; W, wood.
Geologic source: Cc, Casper formation; Kcl, Upper sandstone member of the Cloverly formation; Ks, Steele shale; Qal, alluvium; Qt, terrace sand and gravel.
Method of lift: Cy, cylinder; F, natural flow; N, none; T, turbine.
Type of power: E, electric; G, gasoline or diesel; H, hand; W, wind.
Use of water: C, cooler; D, domestic; I, irrigation; N, not being used; S, stock.
Depth to water: Measured depths to water level are given in feet, tenths, and hundredths; reported depths to water level are given in feet.

Well number	Owner or tenant	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Geologic source	Method of lift	Use of water	Measuring point		Depth to water level below measuring point (feet)	Date of measurement
									Description	Height above land surface (feet)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
13-76-4aab	Ralph Holland...	Du	.....	48	Rk	Qal	Cy,W	...	Top of concrete....	0.2	4.29	7-12-48
-10cba	U. S. Government	Dr	1,300	10	Gal	Cc	F	...	....	....	......	7-13-48
14-74-6dac	Monolith Quarry.	..	545	4	S	Qt	N	N	Top of casing......	1.6	6.34	6-14-48
-6dcb	.....do..........	Dr	60	4	S	Qt	Cy,H	D	....	....	10	6-14-48
-19caa	Henry Bath......	Dr	100	8	S	Qt	N	N	Top of casing......	.6	4.31	7-13-48
14-75-10bcc	Edward Stitzel..	Du	.....	36	Gal	Qt	Cy,H	...	Top of water-tank casing	2.3	9.81	7- 8-48
-12bca	Alvin Nelson....	Du	12	18	T	Qal	Cy,H	...	Base of pump.......	.1	4.67	7-13-48

-17aac	Ray Moeller.....	Du	8	....	C	Qt	Cy,G	D,S	Crack in board cover	.0	3.78	7- 8-48
-18bcc	....	Du	.....	24	Rk	Qt	Cy,H	...	Top of wood cover...	.2	14.31	7- 9-48
-18ddd	Arnold Mazell...	Du	20	60	Rk	Qt	Cy,H	D,S	Ground surface......	.0	5	7- 8-48
-21bcc	R. H. Thompson..	Dr	175	8	S	Ks	Cy,H	D,S	Top of casing.......	1.0	5.53	7-13-48
-26cca	Oda Mason.......	Du	18	36	T	Qal	N	N	Top of board cover..	.0	6.24	7-13-48
-29adb	.....do.........	Du	9	....	W	Qal	N	I	.....do.............	.6	5.12	7-13-48
14-76-1aad	Mrs. Clark......	Dr	.....	....	S	Qt	F	D	Top of casing.......	.2	19.16	7- 9-48
-2aaa	Elwood Hanson...	Dr	473	8	Gal	Ks	Cy,W	D,S	.....do.............	.6	5.29	7- 7-48
-4aab	....	Dr	.....	6	S	Qt	N	N	.....do.............	1.8	7.07	7- 7-48
-12bcd	A. H. Schott....	..	65	6	S	Ks	....	S	.....do.............	.6	7.32	7- 9-48
-13dbb	.....do.........	Dr	80	6	S	Ks	N	N	.....do.............	.6	17.87	7- 9-48
-22cad	....	..	.....	4	Gal	Qt	....	...	Top of wood cover...	.1	2.69	7- 8-48
-24aaa	Ray V. Matheson.	..	.....	....	...	Qt	Cy,W	S	Top of lower beams..	.6	8.99	7- 8-48
-29bcd	Tarkio Ranch....	Du	12	36	Rk	Qal	Cy,H	D	Top of wood cover...	.4	6.39	7-12-48
14-77-25dcd	Mr. Embree.......	Dr	75	8	S	Qt	Cy,W	N	Top of casing.......	.9	28.28	7- 7-48
15-73-28aba	J. F. Knudsen...	Dr	335	11.5	S	Cc	T,E	I	....	...	......	7-14-48
15-74-1aaa	Maurice Laycock.	Du	.....	24	B	Qal	Cy,W	S	Top of casing.......	1.5	5.08	6-24-48
-10abb	Henry Mazell....	Du	.....	24	Gal	Qal	Cy,H	...	.....do.............	1.4	5.52	6-14-48
-11cbc	.....do.........	Du	17	36	Rk	Qal	Cy,H	D,S	Top of cover........	.3	8.70	7-13-48
-21acc	Willis Brazil...	Du	16	21	Gal	Qal	N	N	Top of casing.......	.0	8.97	7-13-48
-30ccc	Wm. Speagleburg.	Du	10	96	W	Qt	Cy,W	S	Top of wooden platform	.9	6.49	7-14-48
-30ddd	William Robison.	Du	8	48	W	Qt	Cy,H	S	.....do.............	.8	3.34	6-14-48
15-75-27cca	Oral Lovejoy....	Du	13	48	Rk	Qal	Cy,H	D	Land surface........	.0	3.87	7-12-48
-32cca	J. E. Harmon....	Du	11	36	Rk	Qt	Cy,H	N	Top of cover........	.4	3.71	7-12-48
-32daa	.....do.........	Du	12	36	Rk	Qt	Cy,H	S	Top of wooden cover.	.0	4.96	7-12-48
-34dbd	George Dobbins..	Du	.....	....	...	Qal	Cy,H	N	.....do.............	.0	3.76	7-12-48
-36baa	Gordon Palmquist	Dr	30	10	S	Qal	Cy,H	S	Top of casing.......	.5	3.53	7- 9-48
-36bad	.....do.........	Dr	32	10	S	Qal	Cy,G	N	Top of 10 x 10 wooden beam	3.4	7.17	6-14-48
15-76-32cad	....	..	.....	....	...	Qal	Cy,H	N	Top of casing.......	.5	5.21	7- 7-48
-32dbc	Mr. Strong......	..	.....	....	...	Qal	Cy,W	D,S	Top of wooden cover.	.0	5.46	7- 7-48

Table 6.--Records of wells in the Laramie Basin, Wyo.--Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
16-73-16bba	....	..	.....	....	...	Qal	N	N	Board next to pipe.	.2	6.40	8- 6-48
-31dca1	A. L. Baldwin...	Dr	100	10	S	...	Cy,W	I	Top of casing......	.2	10.29	6-24-48
-31dca2	A. K. Baldwin...	Du	14	24	W	Qt	N	N	Top of wooden cover	.1	10.26	8- 2-48
16-74-15cca	Oil test Johnson no. 1	Dr	1,065	12	Gal	Kcl	N	N	Top of casing......	1.3	107.78	6-23-48
-24bcb	W. F. Easterling	Du	6	48	W	Qal	N	N	.....do............	.0	2.39	6-24-48
16-76-5bdd	R. G. Gietz.....	Dr	160	....	...	...	N	N	....	...	110	7-16-48
-8acc	.....do.........	Dr	72	8	Gal	Qal	Cy,G	D,S	Top of casing......	.0	3.41	7-16-48
-11bbc	....	Dr	.....	8	Gal	Qal	Cy,W	N	.....do............	3.9	4.50	7-16-48
-18dbb	Dr. Markley.....	Dr	.....	6	S	Qal	....	N	.....do............	.6	5.20	7-16-48
-24bcb	Phillip Kuntz...	Dr	93	6	...	...	Cy,E	S	Top of wooden plank	1.0	25.58	6-30-48
17-73-30cbb	G. B. Gearhart..	Du	10	....	W	Qal	Cy,G	I,C	Top of wooden cover	.6	6.07	7-26-48
17-74-24ddb	E. E. Fitch.....	Du	10	48	W	Qal	N	C	.....do............	.5	6.32	8- 6-48
-36bbb	Albany County...	Dr	200	6	S	...	N	N	Top of casing......	1.5	34.59	7-26-48
17-75-23cbb	....	Du	.....	48	W	Qal	N	N	Top of wooden cover	.2	4.75	7-26-48
-34cdd	Ralph May.......	Du	8	48	W	Qal	N	N	Top pump hole......	1.0	5.67	7-26-48
19-74-26ccc	O. L. Schmidt...	Dr	65	6	S	...	N	N	Land surface.......	.0	2.15	7-26-48
-27aaa	Clint Wallis....	Du	8	60	Rk	Qal	Cy,H	D	.....do............	.0	5.83	8- 6-48

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