UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

RECONNAISSANCE OF THE GEOLOGY AND GROUND-WATER RESOURCES OF THE CHEYENNE RIVER DRAINAGE BASIN IN NORTHERN CONVERSE COUNTY, WYOMING

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Open-File Report 56-83

Prepared in cooperation with the
Wyoming Natural Resource Board

October 1956

Open-file report
Not reviewed for conformance
with editorial standards of
the Geological Survey

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INTRODUCTION

Purpose and Scope of the Investigation

The demand for irrigation water to increase hay production on the bottom lands along the major tributaries and the main trunk of the Cheyenne River in Converse County, Wyo. has created a need for an appraisal of the quantity and quality of ground water available in the area and of its suitability for irrigation use.

The U. S. Geological Survey in cooperation with the Wyoming Natural Resource Board made a reconnaissance of the area during late April and early May 1956 to determine if adequate ground water suitable for irrigation is available and if the additional geologic and hydrologic study is warranted. The study was limited principally to the valley of the Cheyenne River and its major tributaries where it is thought possible that wells of adequate discharge might be developed. Data relative to wells and the character, extent, and thickness of the water-bearing formations were collected. The well data were obtained by interviewing well owners and drillers. Pumping tests were made on several wells to determine their yield. The geology presented in figure 1 was taken from the Wyoming State geologic map.

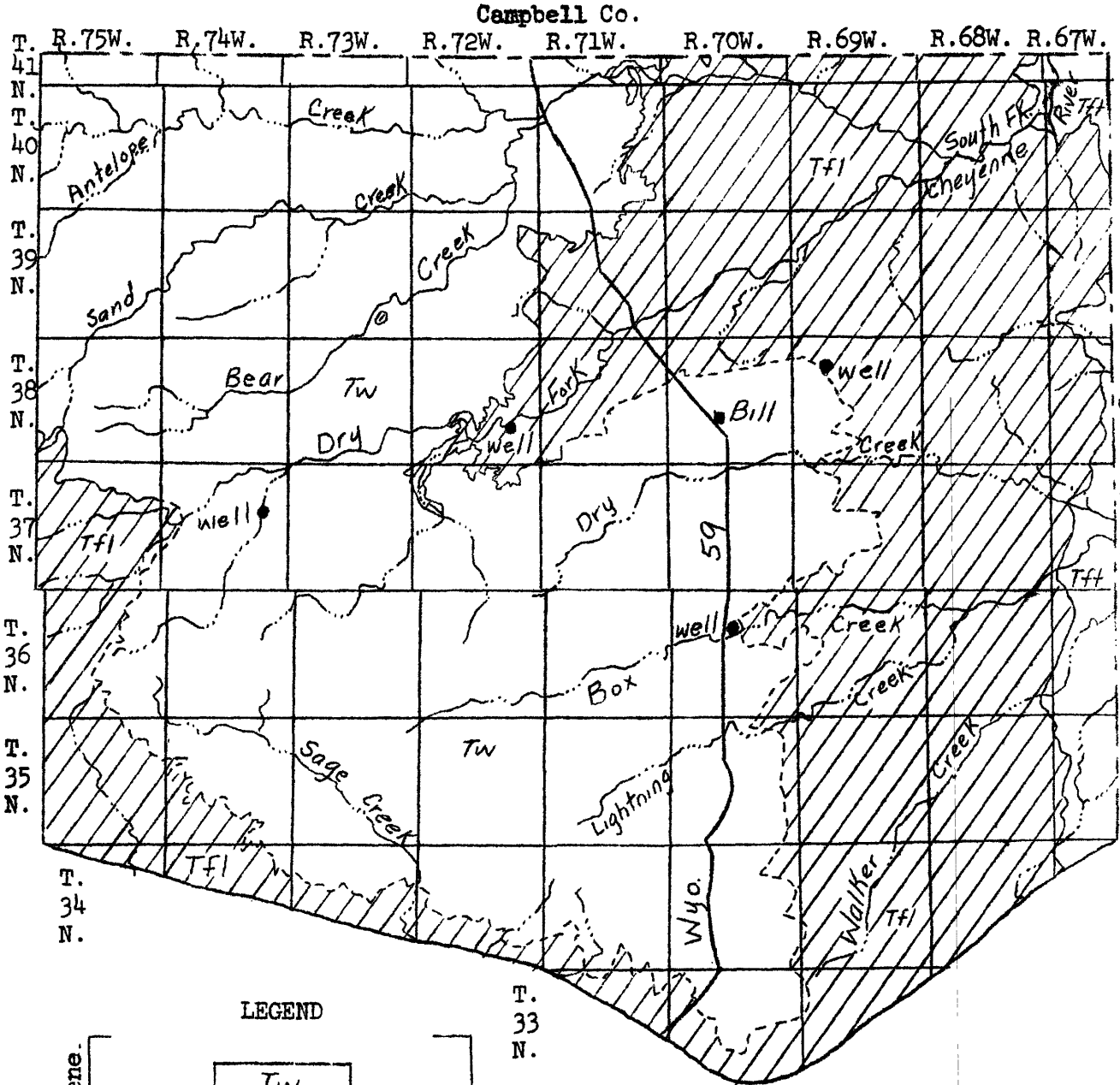
Location of Area

The area studied lies in the southern part of the Powder River structural basin and along the valleys of the Cheyenne River and its tributaries in northern Converse County (within Townships 33 to 41 North

FIGURE 1.

MAP OF THE CHEYENNE RIVER DRAINAGE BASIN IN NORTHERN CONVERSE COUNTY, WYO.,

Showing the general geology



LEGEND

Eocene.

Tw

Wasatch formation

Paleocene

Tfl

Tft

Fort Union formation

Tfl - Lebo shale member

Tft - Tullock member

TERTIARY

Adapted from State Geologic Map of Wyoming, 1955

and Ranges 67 to 75 West). The location of the area within the State is shown on figure 2.

Previous Investigations

No ground-water reports on the area have been prepared but the following two reports on adjacent areas were helpful:

Littleton, R. T., 1950, Ground-water conditions in the vicinity of Gillette, Wyo.: U. S. Geol. Survey Circ. 76, 43 p.

Rapp, J. R., 1949, Reconnaissance of the geology and ground-water resources of the La Prele area, Converse County, Wyo.: U. S. Geol. Survey Circ. 243, 33 p.

In addition to these reports and to the State Geologic Map, several geologic reports and maps were consulted relative to the general geology of the area. These include:

Brown, R. W., 1949, Map showing the Paleocene deposits of the Rocky Mountains and Plains: U. S. Geol. Survey preliminary map.

Love, J. D., and Weitz, J. L., 1951, Geologic map of the Powder River basin and adjacent areas, Wyoming: U. S. Geol. Survey Oil and Gas Map OM 122.

Geography

The topography of the area studied generally is rolling but in places the easily eroded Tertiary rocks have been deeply dissected by streams, which have widened and leveled their valley floors. As the valleys were enlarged, the streams deposited the alluvium which now underlies the surface of the terraces and flood plains. Remnants of terraces occur along the Cheyenne River but these are small and the materials underlying them are fine grained and usually dry. Pediment slopes developed upon bedrock extend from the flood plains or stream terraces to the divides between drainage areas.

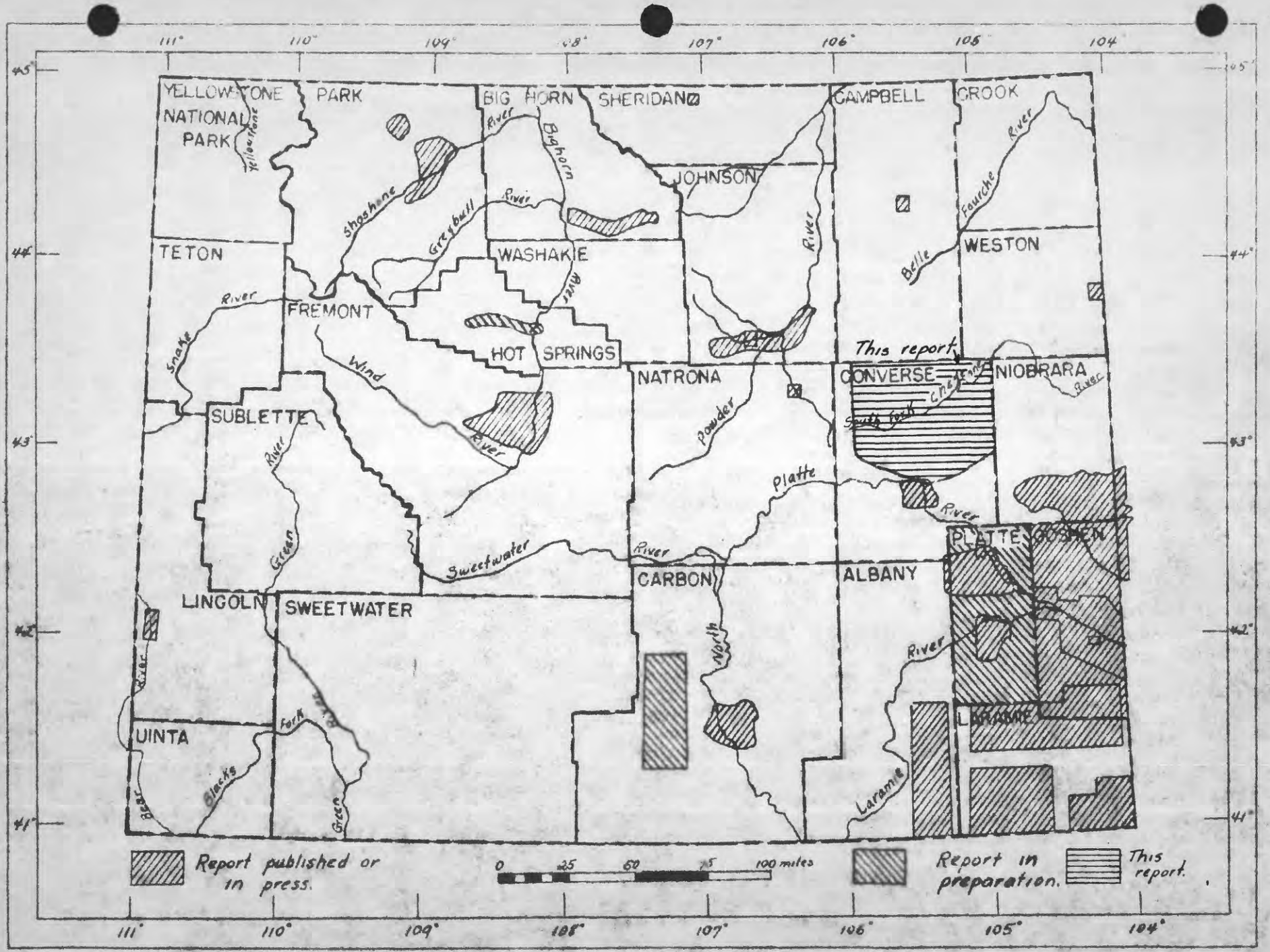


Figure 2.--Area described in this report and other areas in Wyoming for which ground-water reports have been published or are in preparation.

The area is characterized by extremes of temperature; the range in temperature during 1955 was from -21°F to 100°F. The normal annual temperature is about 44°F. Precipitation is rather light, the normal precipitation being approximately 14 inches. The data relative to climate are based on U. S. Weather Bureau records collected at Douglas, Wyo., immediately south of the report area.

The major industry in the area is agriculture, primarily grazing and hay growing, oil is produced nearby, and in the Pumpkin Buttes area to the northwest uranium deposits are now (1956) being developed.

General Geology

The stratified rocks cropping out at the surface in the area of study are those of the Fort Union and Wasatch formations of Tertiary age. They are underlain by the Lance formation of Late Cretaceous age, which generally lies at too great a depth in the area studied to be considered a possible source of ground water. The formations dip gently eastward from the Bighorn Mountains on the west, westward from the Black Hills on the east, and northward from the Laramie Range on the south. The rocks are of fresh-water origin, having been deposited in inland lakes and marshes and on extensive flood plains. During most of Fort Union time the area was characterized by large, shallow inland lakes and marshes. In them were deposited the mud, sand, and carbonaceous material that were later compacted into shale, sandstone, and coal, respectively. During early Wasatch time sluggish meandering streams deposited irregular bodies of fine-grained sand and clay. Throughout Wasatch time deposition by streams alternated locally with the development of marshes in which were formed carbonaceous deposits that now appear as thin beds and lenses

of coal. Erosion has been the dominant geologic process in the region since late Tertiary time, and the Cheyenne River and its tributaries have incised themselves into the Tertiary rocks and deposited a thin mantle of alluvium along their flood plains.

The Fort Union formation consists chiefly of buff to white and brown sandstone containing interbedded dark carbonaceous and arenaceous shale and abundant coal. In many places the sandstone is hard, comparatively thin bedded, and ferruginous; in other places it is soft, massive, and granular in texture. In places in the eastern part of the Powder River basin the formation is subdivided into three members, which are, from bottom to top, the Tullock member, the Lebo shale member, and the Tongue River member. Only the Tullock member (a yellowish sandstone and shale containing lenticular coal beds on the bottom) and the Lebo shale member (a dark-colored shale with some interbedded sandstone) are present within the area of study. The Fort Union formation is exposed in a band of rock along the western, southern, and eastern margins of the area. (See fig. 1.) Its maximum thickness is reported to be about 2,800 feet in the center of the Powder River basin, but it is progressively thinner and finer grained toward the eastern margin of the basin.

The following driller's log of a well in sec. 8, T. 38 N., R. 69 W., shows the general character of the Lebo shale member of the Fort Union formation:

	Thickness (feet)	Depth (feet)
Hardpan	4	4
Gumbo, dark	12	16
Sandstone, fine, hard	16	32
Shale, black	14	46
Shale, coal (water)	16	62
Shale, mixed, dark	38	100
Shale, hard, gray	9	109
Sand, medium, white (water)	11	120
Shale, black	4	124

The Wasatch formation, which in some places resembles the Fort Union formation, generally consists of varicolored but predominantly buff sandstones that contain interbedded light- and dark-colored shales. The many red and pink shale bands that occur throughout the Wasatch formation distinguish it from the Fort Union formation. The sandstone beds are gray and yellowish brown and are poorly to tightly cemented. Beds of red shale or clinker (burned-out coal beds) crop out along the coal horizons in many places. The sandstones that fill old channels in the formation generally are thin and consist of tightly cemented medium-grained sand. However, the channel sandstones locally may be coarse-grained and thick. They rarely persist laterally over any great distance. The Wasatch formation crops out near the center of the Powder River basin and there it may be as much as 1,000 feet thick. However, the formation has been deeply eroded and in many places it is much thinner.

The following driller's log of a well in sec. 14, T. 37 N., R. 74 W., shows the general character of the Wasatch formation:

	Thickness (feet)	Depth (feet)
Soil	8	8
Quicksand (some water)	80	88
Shale, gray	57	145
Shale, brown	10	155
Shale, gray	25	180
Coal (water)	9	189
Shale, brown	5	194
Coal	8	202
Shale, gray	15	217
Quicksand (water)	5	222
Shale, sandy (water)	20	242
Shale, blue	2	244

The alluvium of Quaternary age in the valleys of the Cheyenne River and its major tributaries in Converse County is primarily sand, silt, and clay but in places it contains lenses of gravel and coarse sand. Its thickness is variable, ranging from 20 to 30 feet along Walker, Lightning, Box, and Dry Creeks and from 35 to 50 feet along Antelope Creek and the main trunk of the Cheyenne River. The alluvium is reported to be fine grained and to contain only small amounts of coarse material, except in the lower reaches of the Cheyenne River in the northeastern part of the county and along Box Creek.

The following logs of two wells drilled through the alluvium and into the underlying bedrock formations along the Cheyenne River and Box Creek show the general character and thickness of materials composing the alluvium along these streams:

Driller's log of a well drilled for the Mort Madsen Sheep Co. near the Dry Fork of the Cheyenne River in sec. 26, T. 38 N., R. 72 W.

	Thickness (feet)	Depth (feet)
Alluvium		
Silt, clay, sandy clay	15	15
Gravel	26	41

	Thickness (feet)	Depth (feet)
Fort Union formation		
Shale	41	82
Sand (water)	28	110
Shale	60	170
Shale, sandy	10	180
Shale	80	260
Sand (water)	7	267
Shale	68	335
Sand (water)	22	357
Shale	3	360

Driller's log of well drilled on the Jake Johnson Ranch near Box Creek in sec. 9 (?), T. 36 N., R. 70 W.

Alluvium		
Sand, gravel, loose (fairly clean and coarse)	20	20
Wasatch(?) formation		
Shale	96	116
Sand, medium (water)	21	137
Shale	68	205
Sand, medium (water, flow, 20-30 gallons per minute)	12	217

GROUND WATER

The only rocks within practical drilling depths that can be considered as possible ground-water sources in the area of study are those of the Fort Union and Wasatch formations and the alluvium along the stream valleys. The Fort Union and Wasatch formations contain many lenses of water-bearing sandstone which generally yield water under artesian pressure. Properly constructed wells drilled deep enough to penetrate several of these lenses could be expected to produce 100 to 200 gallons per minute (gpm) by pumping. Tests were made of three wells drilled into these formations to determine their specific capacity, or yield per unit of drawdown; these values ranged from about 0.2 to slightly more than 1 gpm per foot of drawdown. However, these wells were drilled to obtain flows at the land

surface and their casings were not perforated opposite many of the water-bearing sands of low artesian head.

Where thick channel deposits of coarse water-bearing sandstone are penetrated at fairly shallow depth, yields larger than 100 to 200 gpm may be obtained. Such yields are more likely to be available from the Wasatch formation than from the Fort Union, as the Wasatch is reported to contain coarser sandstones. For example: a 12-inch, 267-foot well drilled in the Wasatch formation in the southeastern part of T. 39 N., R. 73 W., was reported to yield 400 gpm. The drill penetrated medium to coarse water-bearing sandstone from 135 to 251 feet and the water rose to within 70 feet of the land surface. Such a thick section of coarse sandstone is uncommon, and considerable exploratory drilling probably would be required to locate other comparable water-bearing sandstones.

Water developed from the Fort Union or Wasatch formations should be analyzed to determine if it is of acceptable chemical quality. Generally, water obtained from deep in the Fort Union or Wasatch formations is very soft and has a higher percent sodium than is usually recommended for irrigation uses.

The alluvium in the valley of the Cheyenne River and its tributaries in Converse County is usually less than a quarter of a mile in width. Nevertheless, it is believed to be the best source in the area of study from which to develop ground water for irrigation. The amount of ground water that can be developed depends in part upon the thickness and areal extent of bodies of saturated coarse water-bearing material in the alluvium, and in part on the availability of recharge. The thickness and character of the alluvium vary considerably from stream to stream and within the flood

plain of the same stream. Therefore, it generally is advisable to drill test holes to locate the thickest and most permeable water-bearing materials before drilling a more expensive large-diameter well. Generally, a buried channel that marks the position of the thickest and most permeable water-bearing materials lies beneath the flood plains of the larger valleys. The buried channel generally has a much straighter course than the present meandering stream. The position of the buried channel is not marked by the position of the present channel, and its width and extent can be determined most easily by test drilling. The only place where there is a possibility of developing large-capacity wells in some of the stream valleys is in the buried channels where the saturated materials are thickest and most permeable. Therefore, these valleys must be carefully prospected to locate the buried channel at minimum cost.

Figure 3 shows schematically the correct and incorrect methods of test drilling; A is a plan view of a typical stream valley showing the flood plain, the bedrock walls of the valley, the buried channel, the present channel, and two lines of test holes--one line parallel to the trend of the valley (A-A') and one line across the valley (B-B'). The cross sections along the two lines are shown in B and C. Although 12 test holes were drilled on line A-A', the buried channel was not located; the alluvium was generally of about the same thickness except in test holes 7, 8, and 9. If additional test holes had been drilled at the same spacing the buried channel would have been encountered in the 14th hole. If the buried channel is narrow, as it is in some valleys, and if the holes are widely spaced, the channel might be missed even though many more test holes were drilled.

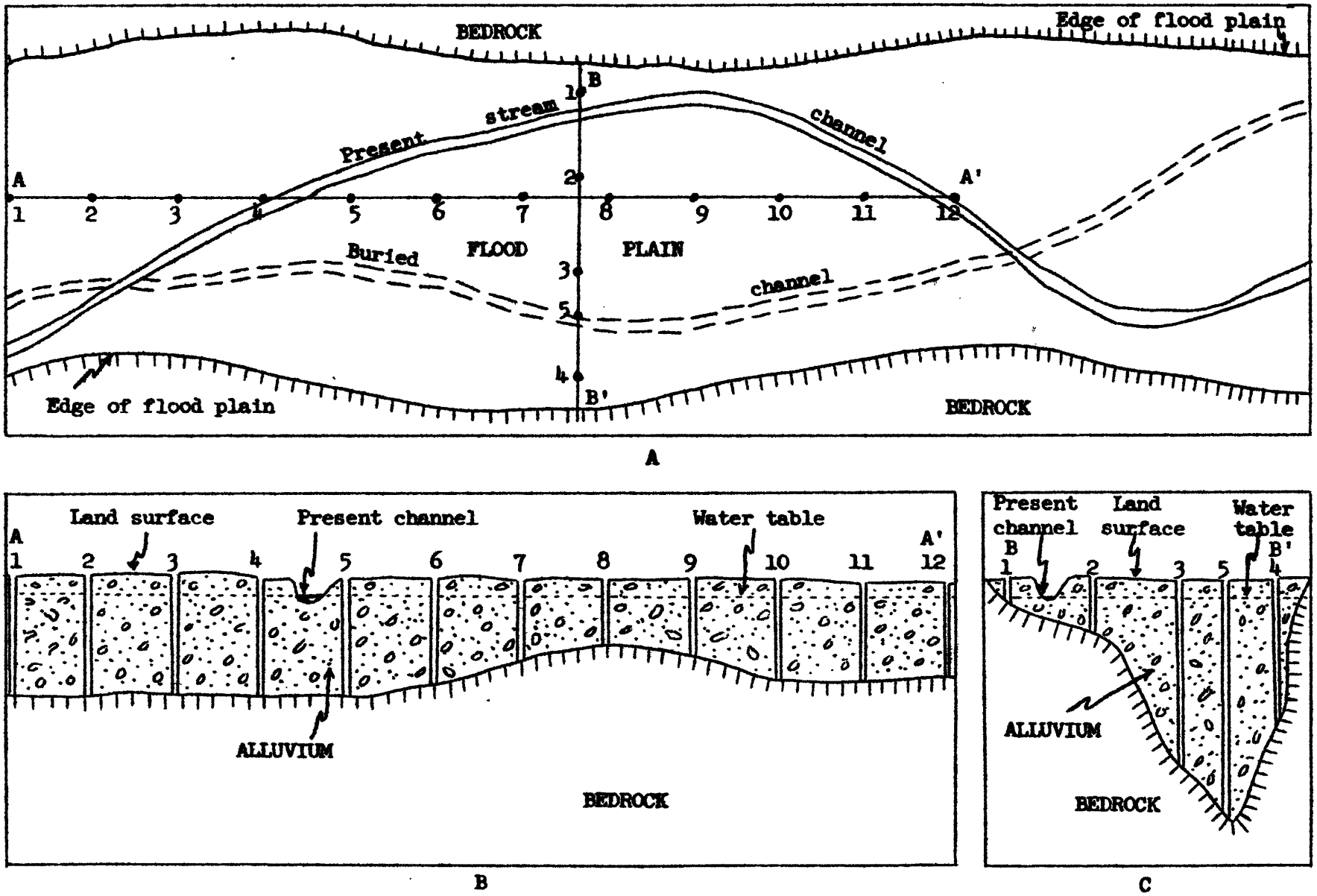


Figure 3.--Method of locating a buried channel in a stream valley by test drilling.

Lines of test holes should be drilled across the flood plain of a valley to locate the buried channel with a minimum of test drilling. Line B-B' was drilled across the flood plain at right angles to the trend of the valley. The number and the spacing of test holes will depend upon the width of the valley. Four holes were drilled along line B-B' and a cross section of the valley was plotted. The thickest water-bearing materials were penetrated in test holes 3 and 4, so test hole 5 was drilled between test holes 3 and 4 and located nearly the deepest part of the buried channel. The channel could be outlined more accurately, if necessary, by drilling additional test holes between 3 and 5 and between 5 and 4.

After determining the most favorable site, a larger diameter well should be drilled, cased with perforated casing or a well screen, and developed for maximum yield. The well should then be pumped to ascertain the discharge-drawdown relationship. If the discharge (gallons per minute) is large compared to the drawdown (lowering of water level during pumping) the alluvium is permeable and the well probably will yield an adequate supply of ground water for at least moderate irrigation use.

No irrigation wells are known to have been drilled in the alluvium along the Cheyenne River in Converse County. Little is known, therefore, of the discharge-drawdown relationship to be expected. However, along the Cheyenne River in southwestern Weston County on the Sherwin Bros. Ranch, a battery of two 27-foot, 30-inch gravel-packed wells are reported to have a combined yield of 350 gpm with a 17-foot drawdown. On the basis of available information it seems unlikely that wells capable of yielding much over 300 gpm could be developed from the alluvium along the streams in northern Converse County. Larger yields could be obtained by drilling

into the underlying bedrock formations and thus developing water from both sources, but it would be necessary to consider the quality of the mixed water, particularly the percent sodium. Also, the effect on existing wells of pumping heavily from wells in bedrock will have to be kept in mind.