DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE MONTANA BUREAU OF MINES AND GEOLOGY

HYDROLOGIC INVESTIGATIONS
ATLAS HA-454 (SHEET 1 OF 2)

INTRODUCTION

The Yellowstone River, which flows from Yellowstone National Park in Wyoming to the Missouri River near Williston, North Dakota, makes the Yellowstone River valley one of the few water-rich areas of eastern Montana. About 15 percent of the State's population lives along the river between Billings and Park City. Billings (population 61,600) is one of the State's largest cities and its population may increase to 120,000–150,000 by 1990 (Clark, Coleman, and Rupeiks, Inc., 1968, p. 21).

The purpose of this study is to inventory the water resources of the Yellowstone River valley from Park City to Billings with particular emphasis on the adequacy and suitability of the water supply for the projected growth of the greater Billings area.

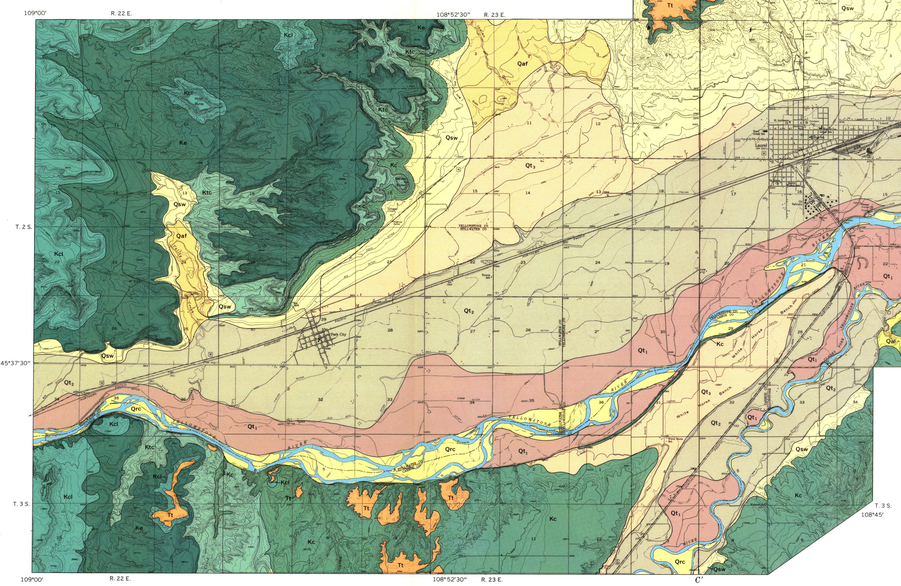
This study describes a 35-mile-long section of the river valley (see index map), which averages 3 miles in width but ranges from 1 to 7 miles wide.

INDEX MAP OF MONTANA SHOWING STUDY AREA

Water-bearing and lithologic characteristics of geologic units

[Partly adapted from Hall and Howard (1929); Knappen and Moulton (1931); Montana Water Resources Board (1969); and Patterson (1966)]

System	Series	Stratigraphic unit	Approximate thickness (feet)	Lithologic characteristics	Water-bearing characteristics
Quaternary	Holocene and Pleistocene	River-channel alluvium	0–20	Well-sorted sand and gravel; contains large cobbles.	Yields more than 50 gpm of good quality water to wells.
		Slopewash deposits	0–120	Silt and silty clay derived by erosion of Cretaceous rocks.	Yields small quantities (< 1 gpm) of highly mineralized water.
		Alluvial-fan deposits	0–100(?)	Silt and silty clay derived by erosion of Cretaceous rocks.	Yields small quantities (1–3 gpm) of highly mineralized water.
		Tributary alluvium	0–30	Silt and silty clay.	Yields small quantities (< 10 gpm) of highly mineralized water.
		Terraces on valley floor	0–60	Gravel and sand layers near the river grading to predominantly silt at north edge of terrace number 3.	Yields 10–60 gpm to wells tapping gravel layers, but silty layers yield very little water.
Tertiary	Miocene to Pleistocene	High-terrace deposits	0–10	Well-sorted sand and gravel.	Usually lies above water table capping topographic highs.
Cretaceous	Upper Cretaceous	Judith River Formation	580	Alternating beds of yellow to brown sandstone and dark-gray shale.	Sandstone layers yield small quantities (< 10 gpm) of water of fair quality to wells.
		Claggett Formation	620	Yellow-gray to light-brown fine-grained sandstone grading to siltstone and gray shale at the base.	May yield highly mineralized water.
		Eagle Sandstone	210	Light-yellow-brown fine-grained sandstone, massive at base and thin-bedded at top.	Yields 5–10 gpm of water of fair quality to wells.
		Telegraph Creek Formation	160	Thin-bedded brown sandstone and shale.	Yields very little water to wells (< 10 gpm).
		Colorado Shale	2,000–2,500	Dark-gray to black shale; contains thin sandy members in the middle and lower sections.	May yield small quantities (< 10 gpm) of highly mineralized water from sandy strata.
	Lower Cretaceous	Cloverly Formation	280	Thick basal sandstone, variegated shale middle member, and sandy shale upper member.	Yields small quantities (< 10 gpm) of highly mineralized water to wells.



Base from U.S. Geological Survey Billings East, 1956; Billings West, 1957; Laurel, 1956; Montague, 1956; Mossmain, 1956; Park City, 1956; Rimrock, 1956; Silesia, 1956; Two Pine School, 1956; and Yegen 1956

SCALE 1:48 000

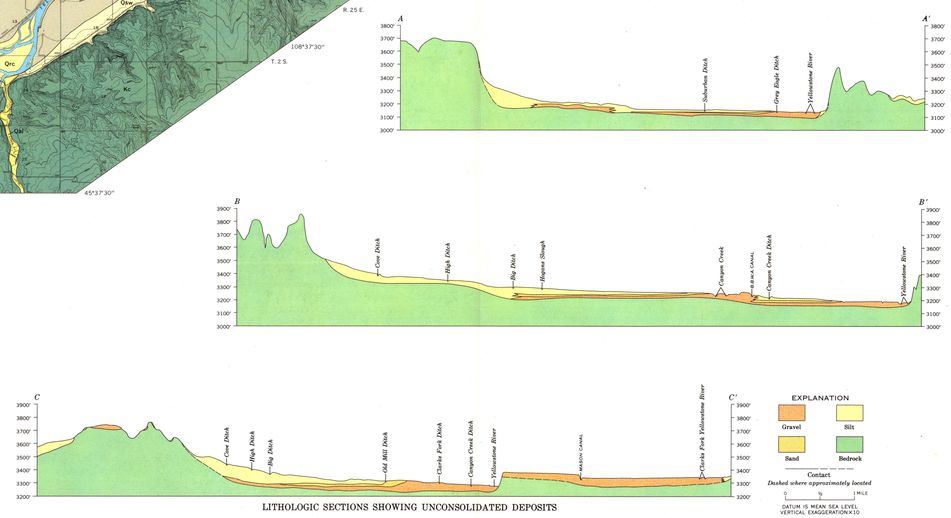
1 0 1 2 3 MILES
1 0 1 2 3 KILOMETERS

CONTOUR INTERVAL 20 FEET
DASHED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

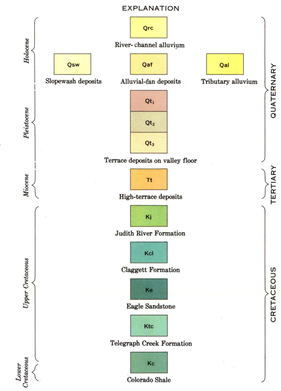
APPROXIMATE MEAN DECLINATION, 1973

GEOLOGIC MAP

Geology adapted from Knappen and Moulton (1931), Alden (1932), Hall and Howard (1929), and Patterson (1961)



LITHOLOGIC SECTIONS SHOWING UNCONSOLIDATED DEPOSITS



GEOLOGY

CRETACEOUS DEPOSITS

Cretaceous sediments with an aggregate thickness of about 4,000 feet are exposed in the region surrounding the study area. Water-bearing and lithologic characteristics of the Cretaceous sediments are summarized in the table. In the upper 3,000 feet of the Cretaceous sediments, sandstone units about 400 feet in aggregate thickness could yield water to wells. Each sandstone unit yields less than 10 gpm (gallons per minute) to wells.

The Yellowstone River valley is bounded on the north by a high cliff capped by the Eagle Sandstone and on the south by low hills underlain by the Colorado Shale (see geologic map). The widening of the valley between Billings and Park City is the topographic expression of the soft Colorado Shale. The valley is less than 1 mile wide west of Park City and at the east edge of Billings where the Yellowstone River cuts through the resistant Eagle Sandstone.

QUATERNARY DEPOSITS

Unconsolidated Quaternary deposits as much as 120 feet thick overlie the Colorado Shale in the valley as shown on the lithologic sections, which are based on test hole and drillers' logs. At the bases of the sandstone cliff and shale hills, silt and silty clay have accumulated as slopewash. Tributary streams have deposited silt to form alluvial fans at the edge of the terraces. The fine-grained alluvial fan and slopewash deposits thin toward the river.

Three prominent terraces roughly parallel the river in the study area (see geologic map). They are separated from one another by district scarps. The scarp between terrace 1 and terrace 2 is 10 to 20 feet high. The scarp between terrace 2 and terrace 3 is 30 to 50 feet high.

Terrace 1 is adjacent to the river but is not continuous throughout the area. This terrace is 10 to 20 feet above the river surface. Deposits beneath the terrace consist of 20 to 40 feet of coarse gravel and sand.

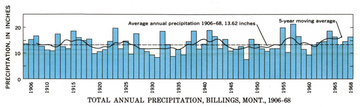
Terrace 2 parallels the Yellowstone River continuously from Park City to Billings. It is 20 to 40 feet above the river. Deposits beneath the terrace consist of 40 to 60 feet of sandy gravel that contains minor amounts of silt and clay.

Terrace 3 is 50 to 90 feet above river level. The deposits beneath this terrace grade from 20 to 30 feet of well-washed gravel at the southern scarp to about 90 feet of silty clay at the north edge. A basal gravel layer thins to less than 10 feet thick 1 mile north of the scarp and 2 to 5 feet thick 2 miles north of the scarp.

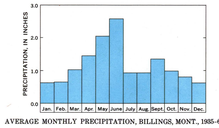
CLIMATE

PRECIPITATION

Annual precipitation, which is the principal source of recharge to the surficial aquifers, at Billings averages about 14 inches per year and ranges from 8 to 21 inches (see annual-precipitation graph). Precipitation occurs in a fairly predictable pattern each year (see monthly-precipitation graph). About 40 percent comes in regional rainstorms during April to June. Lack of sufficient precipitation during much of the growing season has resulted in extensive irrigation of crops.



TOTAL ANNUAL PRECIPITATION, BILLINGS, MONT., 1906–68



AVERAGE MONTHLY PRECIPITATION, BILLINGS, MONT., 1935–66

WATER RESOURCES OF THE YELLOWSTONE RIVER VALLEY, BILLINGS TO PARK CITY, MONTANA

By
Arthur W. Gosling and Emil F. Pashley, Jr.

1973

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