Plate 1: Hydrogeology of the West Billings Area

Introduction

The Yellowstone alluvial valley in the West Billings area is underlain by a shallow, unconfined to semi-confined aquifer system. Ground water is primarily produced from relatively thin (0–30 feet thick) gravel sheets underlying four alluvial terrace surfaces. The gravel sheets are discontinuous at the terrace scarps and form distinct hydrogeologic units (described below). The alluvial gravel is overlain by fine-grained alluvial and colluvial sediment and is underlain by approximately 2,000 feet of Colorado Group Shale. Ground water also is encountered in colluvial deposits near the valley margins. The thickness of the fine-grained sediment, colluvium, and gravel alluvium is shown in cross sections A-A', B-B', and C-C'.

Hydrogeologic units

Terrace 1 (Qat1): Alluvial deposits underlying the recent flood plain and the lowermost terrace (0–20 feet above the present river level (Gosling and Pashley, 1973; Lopez, 2000). The sediment generally consists of 0–10 feet of clayey- to silty-sand overlying 0–20 feet of rounded gravel to cobbles in a silty-to-sandy matrix.

Terrace 2 (Qat2): Alluvial deposits underlying the terrace 20–40 feet above the recent river level (Gosling and Pashley, 1973; Lopez, 2000). The sediment generally consists of 0–50 feet of silty clay, sandy clay, and clay-bound gravel, overlying 0–40 feet of rounded gravel, pebbles, and cobbles in a silty-to-sandy matrix.

Terrace 3 (Qat3): Alluvial deposits underlying the terrace approximately 50–90 feet above the recent river level (Gosling and Pashley, 1973; Lopez, 2000). Sediment consists of 0–150 feet of silty clay, sandy clay, and clay-bound gravel overlying 0–65 feet of rounded gravel, pebbles, and cobbles in a silty-to-sandy matrix.

Terrace 4 (Qat4): Alluvial deposits underlying the terrace(s) approximately 200–300 feet above the recent river level (Lopez, 2000). The sediment generally consists of multiple layers 1–30 feet thick of silty clay and silty-to-sandy gravel.

Colluvial sediments: Locally derived sediment consisting of 30–150 feet of silty clay, sandy clay, and clay-bound gravel, cobbles, and boulders transported by slope-wash, landslides, and minor streams.

Legend

- Ground-water monitor well
- 3401.03• Measured ground-water elevation (August 2000)
- Surface-water station
- Cross-section point
- Direction of ground-water flow
- Cross-section line
- 3420 Ground-water elevation contour in feet above mean sea level. The contour interval is 20 feet.
- Ditches
- Streams
- Roads

2 1 0 2 4 miles

Scale 1:63,360 (1 inch = 1 mile)
Projection: State Plane 1983 (Lambert); Latitude and longitude in North American 1927 projection

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Summary of Pumping Test Results

Location (T-R-S-tr)	Hydrogeologic unit	Hydraulic conductivity (ft/d) Range	Average	Data source
02S-24E-sec 10-BDBA	Qat2	71–77	73	MBMG
02S-25E-sec 4-BABB	Qat1	51–70	54	MBMG
02S-24E-sec 1-CCBA	Qat3	293–355	317	MBMG
01S-25E-sec 15-ACCC	Qat3	14–36	24	MBMG
01S-25E-sec 29-DBAA	Qat3	190–211	201	*Hydrosolutions Inc.
01S-25E-sec 28-BBC	Qat3	569–610	585	*Hydrosolutions Inc.
01S-26E-sec 10-ABDD	Qat2	81–142	127	*UniField Engineering

*Data supplied by others and interpreted by MBMG

Hydraulic Conductivities Estimated from Reported Specific Capacities

Hydrogeologic unit	Number of wells	Specific capacity (gpm/ft) Average *1	Range *2	Aquifer hydraulic conductivity (ft/d) Average *1	Range *2
Terrace gravel	1100	6.0	2–19	90	20–400
Colluvium	64	2.0	1–7	15	2–100

*1 Average of logrithmic distribution
*2 +/- one standard deviation of the log distribution
Hydraulic conductivity calculated by the following formula:
K = [2.3 (Q/s)/(4*pi*B)]*log[2.25*t*B*r/(r**2*S)] (Cooper and Jacob, 1946)
Q/s = specific capacity (in cfd/ft)
Using the follwing values:
pi = 3.14, B = aquifer thickness (assumed to be screen length), t = pumping time, r = well radius, S = aquifer storage (0.1)

Ground-Water Fluctuations

Ground-water elevation change relative to April 20, 2000 (start of irrigation season)