EXPANSION OF THE MONITORING-WELL NETWORK FOR THE ASSESSMENT OF AGRICULTURAL CHEMICALS IN MONTANA GROUND WATER

by James P. Madison, Phyllis A. Hargrave, and James C. Rose

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1.0 INTRODUCTION

The most recent ***National Water Quality Inventory*** from EPA reports that agricultural non-point-source (NPS) pollution is the leading source of water quality impacts to surveyed rivers and lakes, the third largest source of impairments to surveyed estuaries and also a major contributor to ground-water contamination and wetlands degradation (EPA, 2002). One reason for the prevalence of pesticides in ground water is the increased use of chemicals on agricultural land. Another reason is that most new pesticides are water-soluble compounds with higher leaching potentials than the older compounds that were primarily fat soluble. With the water-soluble chemistry of the new pesticides, the potential ecological impact is greater and the potential risks to water resources is increased, particularly in areas where ground-water is vulnerable to near-surface activities.

The amount of pesticide that may reach the ground water is dependent upon many factors: the physical characteristics of the pesticide, the method and amount of pesticide applied, the climatic conditions at the site and the climatic conditions during chemical application, the type of crops being raised, the farming method being used (land treatment), the amount and frequency of irrigation, the characteristics of the soil, the geology at and near the land surface, and depth to the shallow ground water. The primary agricultural activities that contribute to NPS contamination of ground water include: confined animal facilities, grazing, plowing, pesticide spraying, irrigation, fertilizing, planting, and harvesting. Because most surface water in Montana is recharged by ground water, both can be contaminated by pesticides. This contamination can affect water used for human consumption, stockwater, wetland and habitat waters and many types of wildlife.

The Montana Department of Agriculture (MDA) has been assigned the responsibility to: 1) protect ground water and the environment from impairment or degradation due to the use of pesticides; 2) allow for the proper and correct use of pesticides; 3) provide for the management of pesticides to prevent, minimize, and mitigate their presence in ground water; and 4) provide for education and training of pesticides applicators and the general public on ground- water protection, agricultural chemical use, and the use of alternative agricultural methods (rule 80-15-103) (Montana Department of Agriculture, October 1995).

Under rule 80-15-212, the MDA shall develop and implement agricultural chemical ground-water management plans specific to particular pesticides and to a defined geographical area. In order to develop these plans, agricultural chemical concentrations in ground water must be measured, scientifically validated, documented, and compared to a standard; any defined trend of increased presence of agricultural chemicals in ground water must be scientifically validated (Montana Department of Agriculture, October 1995). Ground-water monitoring data is needed when EPA proposes to develop a management plan for registration of new chemicals or suspension or cancellation of existing pesticides. In order to carry out these assignments MDA needs ground-water monitoring data to identify specific needs and problems, to provide information and form solutions, and to develop best management practices (BMP's) for the many and varied crops and all hydrogeologic settings.

Before this project, the MDA had only 16 dedicated wells located throughout the state to monitor for pesticides in ground water (figure 1.1.1). Because of the large cropped acreage, the variety of crops produced, the diversity of agricultural practices used, the multitude of agricultural chemicals applied, and the varied geologic and ground-water settings, the additional wells constructed for this project are needed to evaluate the presence of agricultural chemicals in ground-water under many different crop and hydrogeologic settings.

Past efforts to sample for pesticides in ground water using existing domestic wells experienced a number of problems. The wells were not always accessible, and use by the owner caused fluctuations in the water levels that made water-level monitoring and interpretation of ground-water flow difficult. The wells were typically not situated in the ideal location or were not screened at the ideal depth to obtain the best pesticide-in-ground-water data.

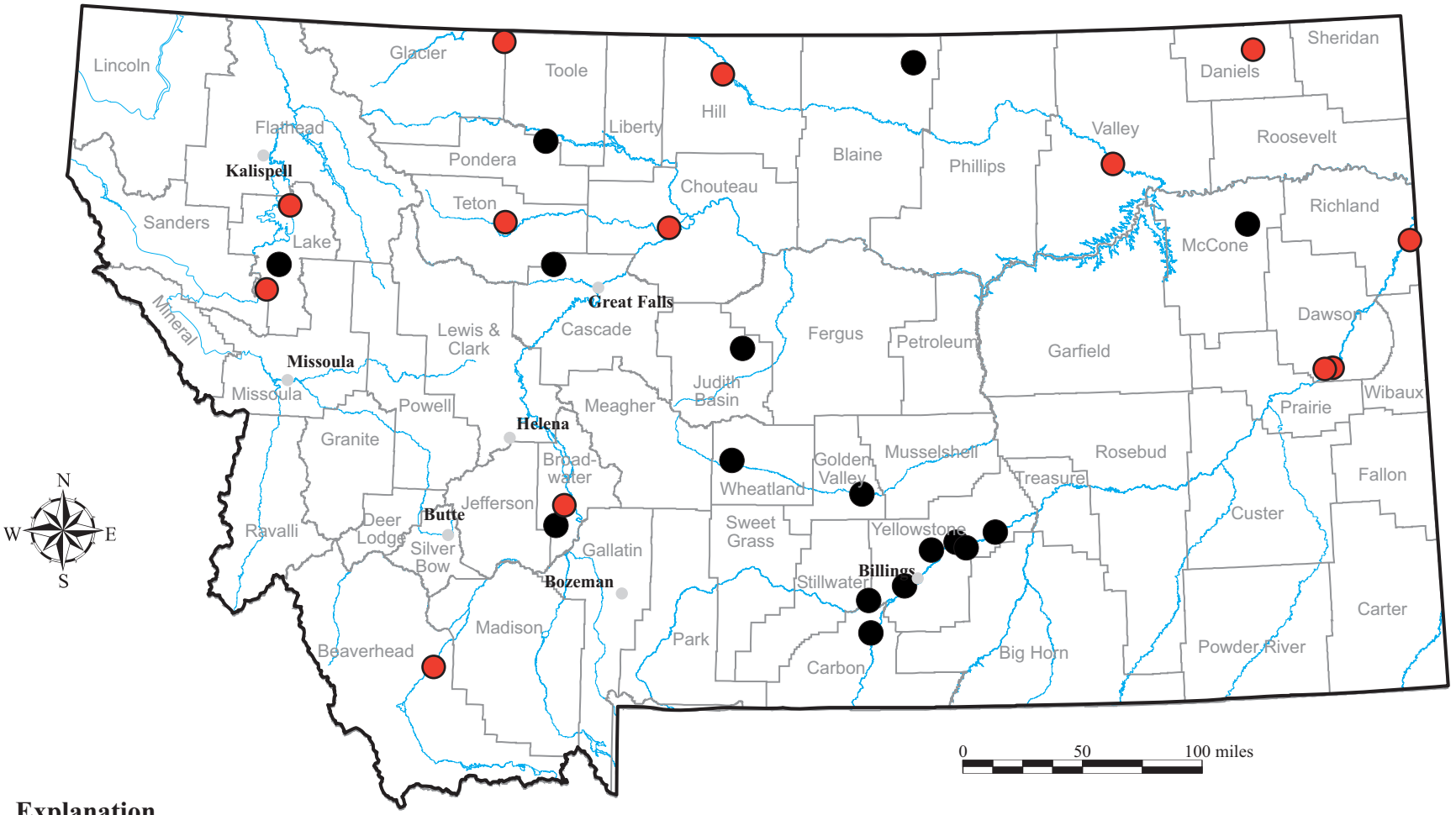
The MDA has been installing monitoring wells to expand the ground-water monitoring network as funds have become available. Between 1992 and 2002, the MDA installed a network of 16 monitoring wells at a variety of agricultural locations within the state (figure 1.1.1). To expand and improve the monitoring well network, the Montana Bureau of Mines and Geology (MBMG) regularly cooperates with MDA in selecting sites for inclusion in MDA's statewide pesticide ground-water database. The MDA has a regular sampling program to routinely sample ground water in each of the monitoring wells.

The 13 wells installed for this project will be used to evaluate additional agricultural sites where the ground water has been identified as potentially vulnerable to NPS contamination. The ultimate goal of the ground-water monitoring program is to identify any hydrogeologic conditions or agricultural practices that may contribute to NPS contamination of ground water. The monitoring-well system is intended to detect concentrations of pesticides well below the action-level concentrations that would require immediate response and correction. The results of the data analysis will allow identification of geologic settings, ground-water conditions and agricultural practices that increase ground-water vulnerability and may contribute to ground-water contamination by pesticides. The monitoring results will also provide viable data to be used for the development of best management practices for specific agricultural and hydrogeologic conditions.

1.1 Purpose and Scope

This report, which presents the study results, describes the installation of 13 dedicated monitoring wells. The purpose of this project was to install permanent ground-water monitoring wells for long-term pesticide monitoring as part of the MDA's ground-water monitoring network program. Specific objectives were to:

1. Locate the monitoring wells in the most advantageous areas to intercept any pesticides that may be in the ground water, or to confidently confirm that pesticides are not present.



Explanation

Pesticide monitoring well installed for this investigation

Existing pesticide monitoring well

Figure 1.1.1--The pesticide monitoring network consisted of 16 wells prior to this investigation. Thirteen monitoring wells were installed at twelve sites as part of this investigation.

2. Construct monitoring wells following construction standards recommended by the Montana Board of Water Well Contractors (Montana Board of Water Well Contractors, 1997).

3. Collect water samples from the wells for laboratory analyses of inorganic constituents and pesticides.

The following criteria were used to select sites for the installation of monitoring wells:

1. where agricultural contamination of ground water has been documented,
2. in areas of specific interest to MDA,
3. in areas where land use has changed,
4. where farming or cropping practice has changed,
5. where no data exist for particular cropping practices,
6. where specific pesticides are in use,
7. where new pesticides have been introduced,
8. where specific types of hydrogeologic settings exist,
9. where urban sprawl has grown into areas adjoining agricultural land, and
10. areas where non-point source (NPS) contamination may be occurring.

Sites were selected in both irrigated cropland and in areas where dryland farming is practiced. The monitoring sites are representative of typical agricultural practices and hydrogeologic settings for particular crops within an agricultural region.

The wells were drilled with either the MBMG Mobile Drill B-50 drill rig or by Hansen Drilling, both using 6-inch diameter hollow-stem augers. The wells were installed using designs and materials evaluated by MDA and MBMG during previous programs of monitoring for pesticides in ground water in Montana. No solvent cements were used in order to prevent possible interference with the analysis for pesticides. PVC casing was determined to be viable for use in agricultural-chemical monitoring wells based on previous ground-water monitoring projects in Montana. Previous studies show that the PVC material does not interfere with the detection of pesticides in the ground water if the wells are properly purged prior to sampling, nor does it appear to react with the chemicals (Kathleen J. Miller, hydrogeologist, MBMG, per. commun., 2002). All monitoring wells were installed following construction standards recommended by the Montana Board of Water Well Contractors (Montana Board of Water Well Contractors, 1997). The wells were constructed using 4-inch diameter schedule 40, flush-thread, polyvinyl chloride (PVC) casing, 0.020-inch slot PVC well screen, and a bottom plug. A gravel pack was installed around the well screen to ensure proper well development; the gravel pack extended at least to the top of the screen or slightly above it. In deeper wells, the annulus above the gravel pack was filled with well cuttings to within a few feet of land surface, and filled the rest of the way to within a few feet of land surface with bentonite. The annulus in shallow wells was filled with bentonite. The purpose of the bentonite was to prevent the migration of surface contaminants along the well annulus and into the ground-water system.

Each well was completed at the surface with a 6-inch steel protective casing that extended as much as 2 feet above the ground surface and at least 2 feet below ground surface; a locking well cap was bolted onto the protective casing to prevent unauthorized entrance into the well.

After completion, each well was pumped to remove sediment from inside the well casing and to develop the filter pack around the well screen. Some of the wells were completed in low-yield geologic materials and were pumped dry even at a low pumping rate; these wells were pumped dry several times to remove sediment and to develop the filter pack to the greatest extent possible.

After adequate development, water samples were collected for laboratory analyses of major anions, major cations, trace-element constituents, and pesticides. The water samples were collected following prescribed guidelines (Knapton, 1985; Montana Department of Agriculture, 1990) and submitted for laboratory analysis. Also collected at the site were depth to water, pH, specific conductance, temperature, and dissolved oxygen. Samples were placed on ice in a cooler and stored at 4° Celsius until submitted to the laboratory.

1.2 Location Numbering System

The locations of wells are designated by location numbers, which are based on the rectangular system for the subdivision of public lands (figure 1.2.1). Each number consists of as many as 14 characters and is assigned according to the location of the site within a given township, range, and section. The first three characters specify the township and its position north (N) of the Montana Base Line. The next three characters specify the range and its position west (W) of the Principal Meridian. The next two characters indicate the section. The next three or four characters indicate the position of the site within the section. The first letter denotes the quarter section (160-acre tract); the second, the quarter-quarter section (40-acre tract); the third, the quarter-quarter-quarter section (10-acre tract); and the fourth, the quarter-quarter-quarter-quarter section (2½-acre tract). The subdivisions of the sections are numbered A,B,C, and D in a counterclockwise direction beginning in the northeast quadrant. The last two characters form a sequence number that is assigned on the basis of order of inventory within that tract. For example in figure 2, the location number 25N04W26BCBD01 refers to the first well (01) inventoried in the SE¼ NW¼ SW¼ NW¼ sec. 26, T. 25 N., R. 4 W.

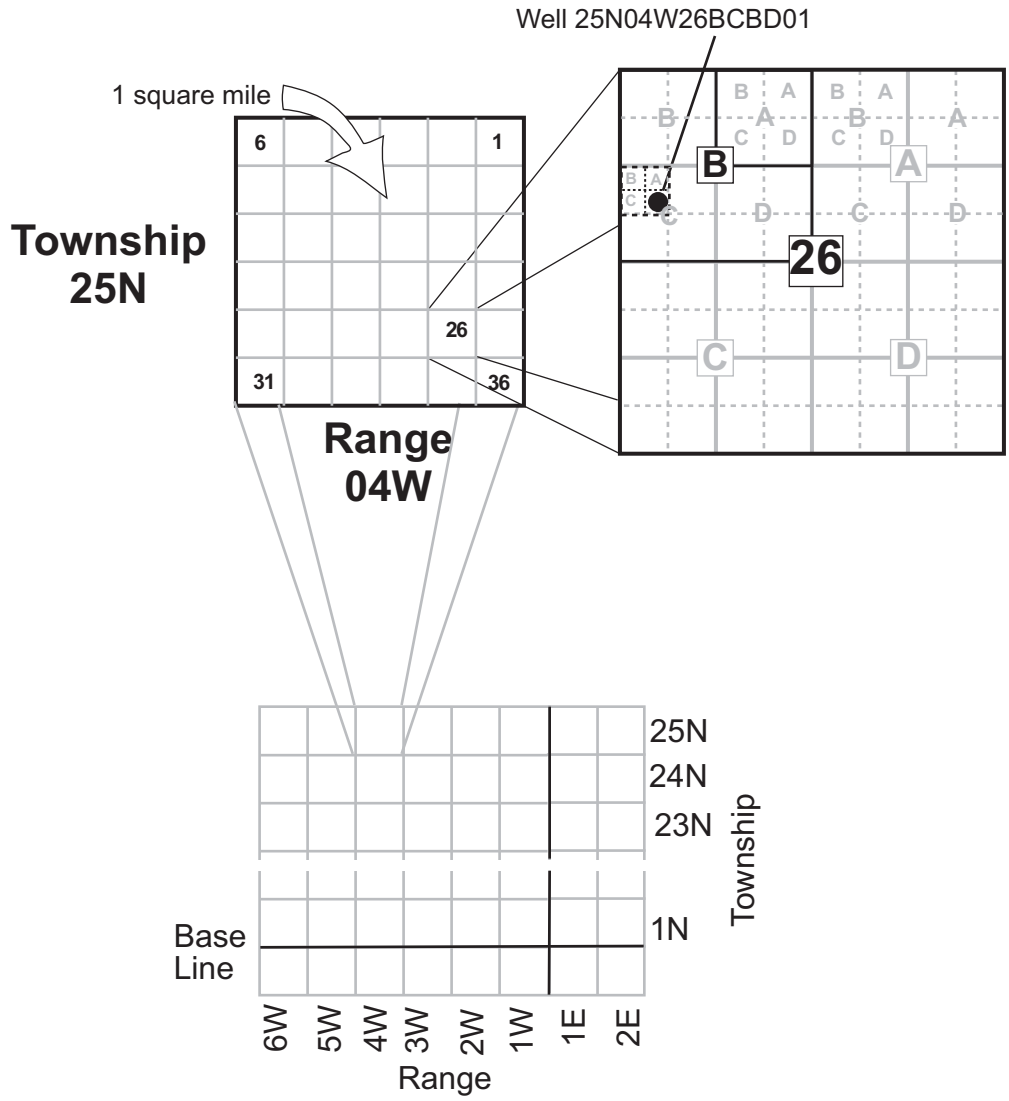


Figure 1.1.1--Location numbering system.

2.0 RESULTS

Thirteen monitoring wells were installed at 12 sites throughout Montana (figure 1.1.1). The following sections present the results at individual sites and are arranged alphabetically by county. Included in each site write-up is location, access, site photos, topographic and geologic maps, well-completion results, water-quality of major cations, anions, and trace elements. The results of samples that were analyzed for pesticides are included in appendix 1.

2.1 BEAVERHEAD COUNTY
07S08W09ABDB01
Well BEA-01

2.1.1 Site Location

A well was drilled in tracts ABDB sec. 9, T.07S., R.08W., at an altitude of 5,035 ft in Beaverhead County (figure 2.1.1). The decimal latitude (NAD 27) is 45.2454 and decimal longitude is -112.5866.The site is about 3 miles northeast of Dillon just east of Highway 41. The well is in the northwest corner of the field (figure 2.1.2).

2.1.2 Well Completion and Water-Quality Details

- Driller: MBMG; Fred Schmidt
- Date: 05/13/2004
- Total depth: originally drilled 25.0 ft; center bit stuck, redrilled; cased to 20.2 ft
- Screened interval: 10-20 ft
- Yield: 1.36 gpm
- SWL: 10.44 ft below measuring point at top of casing (TOC), (9.74 ft below ground level (BGL))

A well log is attached along with a copy of the water-quality data (figure 2.1.3 and tables 2.1.1 and 2.1.2). Completion details and water-quality data also can be obtained online at the Montana Bureau of Mines and Geology's Ground-Water Information Center (GWIC) website at http://mbmggwic.mtech.edu/. The GWIC identification number for this well is 213964. The results of the pesticide analyses and minimum reporting levels are included in appendix 1.

2.1.3 Land Use

As depicted in figure 2.1.1, the land is primarily center-pivot irrigated with crops of wheat, and non-irrigated alfalfa across the highway. The field occasionally has been used to raise potatoes on a rotation basis. The slough and wetland to the west show the ground-water level. The soil appeared to be clayey. A ditch on the property at the upper end of the field receives water from Clark Canyon Reservoir, and is usually filled with water by the end of April.

2.1.4 Geology

The well was completed in Quaternary alluvium of undetermined thickness (figure 2.1.4; Ruppel and others, 1993). Rocks nearby and immediately below the well include Bozeman Group and related valley-fill deposits (Tbz) consisting of moderately to well indurated tuffaceaous sandstone and siltstone. Other rocks include volcanic rocks composed of basaltic andesite, andesite, and rhyodacite (Tv).

a.

b.

Figure 2.1.1–a) MDA and MBMG personnel sampling the well. View looking to the south showing the center pivot. b) View to the west showing the north edge of the field and Highway 41.

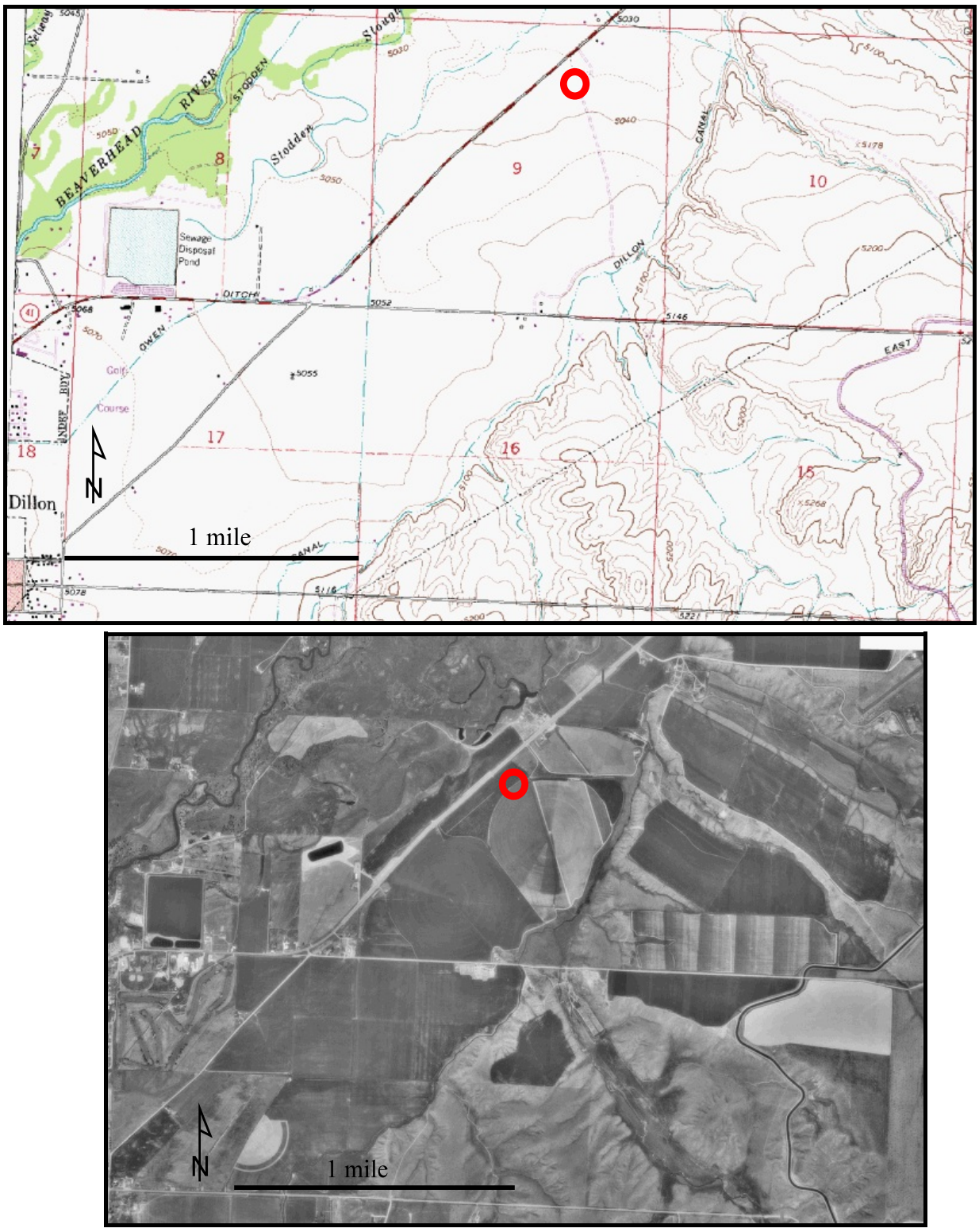


Figure 2.1.2–Well BEA-01 (07N08W09ABDB01) is located about 3 miles northeast of Dillon and just east of Highway 41. The red circle is the approximate location of the well. Modified from Dillon East orthophoto and 7.5-minute quadrangle.

MDA Well Logs

Well name:	**BEA-01**	Casing:	cased to 20.2 ft TOC (19.5 ft below ground level)
GWIC ID:	M:213964	SWL:	10.44 ft from MP (9.74 ft below ground level)
Date Drilled:	5/13/2004		
County:	Beaverhead	MP stick up:	0.70 ft AGL (PVC casing)
TRS location:	ABDB sec. 09, 07S 08W	MP Elevation:	5035.7 ft
			Rotation crops, potatoes, center-pivot irrigation and irrigation canal at upper end of field
DD latitude:	45.2454		
DD longitude:	-112.5866		
Elevation:	5,035 ft		
Logged by:	J. Rose		

Drilling Interval	Depth From (ft)	To (ft)	Lithology	Completion data From	Depth (BGL) To	Casing	Depth (BGL) From	To	Fill
0-5	0.0	1.5	Brown clayey loam	0.0	10.0	blank	0.0	10.0	Bentonite chips
5-10	1.5	10.0	Brown, sticky, plastic clay with rounded pebbles, damp/moist						
	10.0	11.5	Grey, very soft sandy clay with some coarse gravels. Fast drilling. water?	10.0	19.5	screen	10.0	19.5	10/20 filter pack sand
	11.5	12.0	Coarse pebbles, rough drilling						
10-15	12.0	16.0	Grey, sandy clay with rounded river pebbles, very soft clay, moldable.						
15-20.2	16.0	17.0	Brown, sandy clay with coarse, rounded cobbles and pebbles. Damp Rough, slow drilling.						
	17.0	25.0	Clean gravels with pebbles, some grey clay (~10%). Water.						

TD (original) **25.0 ft**

Note: Center-bit stuck, pulled augers out, redrilled hole to 20.2 feet.

Figure 2.1.3. Well log for BEA-01 (07S08W09ABDB01).

Table 2.1.1--Water-quality analyses for well BEA-01 (07S08W09ABDB01).

Ground-Water Information Center **Water Quality Report**

Site Name: MDA WELL BEA-01 **Report Date:** 6/18/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2005Q0205 / 213964
Location (TRS): 07S 08W 09 ABDB
Latitude/Longitude: 45° 14' 43" N 112° 35' 11" W
Datum: NAD27
Altitude: 5035.00
County/State: BEAVERHEAD / MT
Site Type: WELL
Geology:
USGS 7.5' Quad: DILLON EAST
PWS Id:
Project: MDAPESTNET

Sample Date: 9/22/2004 3:30:00 PM
Agency/Sampler: MBMG / JCR
Field Number: 213964
Lab Date: 10/20/2004
Lab/Analyst: MBMG / WO
Sample Method/Handling: PUMPED / 3120
Procedure Type: DISSOLVED
Total Depth (ft): 20.200
SWL-MP (ft): 6.570
Depth Water Enters (ft): 10.000

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	92.100	4.596	Bicarbonate (HCO3)	344.000	5.638
Magnesium (Mg)	30.200	2.485	Carbonate (CO3)	0.000	0.000
Sodium (Na)	26.400	1.148	Chloride (Cl)	18.100	0.511
Potassium (K)	10.900	0.279	Sulfate (SO4)	112.000	2.333
Iron (Fe)	0.010	0.001	Nitrate (as N)	2.010	0.143
Manganese (Mn)	0.031	0.001	Fluoride (F)	0.354	0.019
Silica (SiO2)	40.900		Orthophosphate (OPO4)	<0.05	0.000
Total Cations		8.532	**Total Anions**		8.644

Trace Element Results (µg/L)

Aluminum (Al):	<30	Cadmium (Cd):	<1	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<10	Chromium (Cr):	<10	Molybdenum (Mo):	<10	Titanium (Ti):	<1
Arsenic (As):	14.400	Cobalt (Co):	<2	Nickel (Ni):	<2	Thallium (Tl):	<25
Barium (Ba):	50.500	Copper (Cu):	<5	Silver (Ag):	<5	Uranium (U):	33.400
Beryllium (Be):	<2	Lead (Pb):	<10	Selenium (Se):	14.800	Vanadium (V):	13.800
Boron (B):	61.200	Lithium (Li):	24.000	Strontium (Sr):	739.000	Zinc (Zn):	<2
Bromide (Br):	57.000					Zirconium (Zr):	<10

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	502.460	Field Hardness as CaCO3:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	677.010	Hardness as CaCO3:	354.280	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	725.000	Field Alkalinity as CaCO3:	NR	PCP (µg/L):	NR
Lab Conductivity (µmhos):	870.000	Akalinity as CaCO3:	282.140	Phosphate, TD (mg/L as P):	<0.05
Field pH:	7.340	Ryznar Stability Index:	6.821	Field Nitrate (mg/L):	NR
Lab pH:	7.350	Sodium Adsorption Ratio:	0.610	Field Dissolved O2 (mg/L):	NR
Water Temp (°C):	9.000	Langlier Saturation Index:	0.265	Field Chloride (mg/L):	NR
Air Temp (°C):	NR	Nitrite (mg/L as N):	<0.05	Field Redox (mV):	NR

Notes

Sample Condition: CLEAR.
Field Remarks:
Lab Remarks:

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **ft** = feet; **NR** = No Reading in GWIC

Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions; ***** = Duplicate analysis not within control limits; ****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO3, CO3, SO4, Cl, SiO2, NO3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.

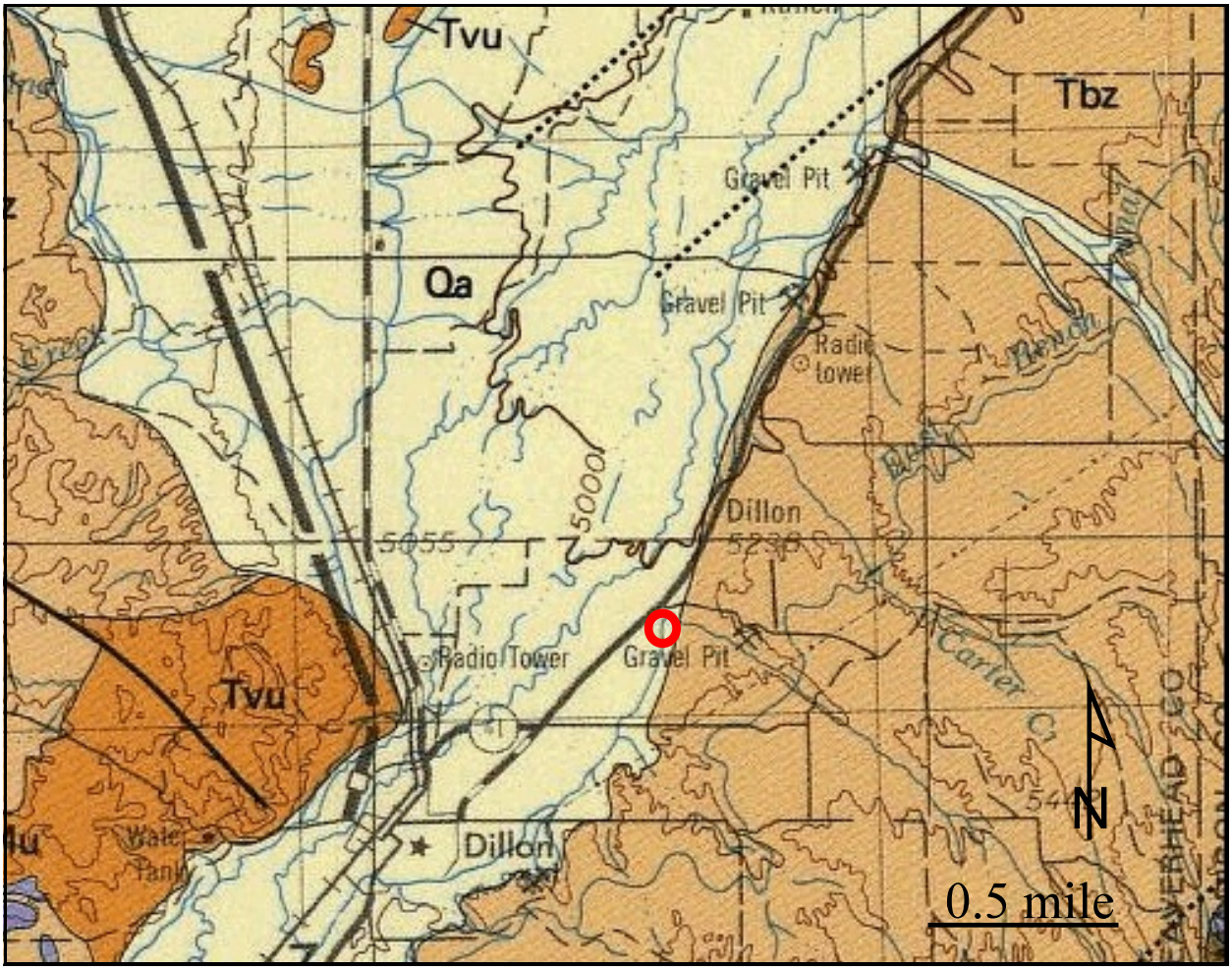
Table 2.1.2--Water-quality comparison for well BEA-01 (07S08W09ABDB01).

Drinking water limits are based on U.S. Environmental Protection Agency primary and secondary standards for public water supplies (view their standards). Stock water and irrigation water recommendations are from U.S. Department of Agriculture Natural Resources Conservation Service water-quality guidelines. The guidelines are general and my vary depending on specific applications. Irrigation guidelines are based on continuous irrigation.

Sample Id	GWIC Id	Sample Date	Site Name	Location	Site Type
2005Q0205	213964	9/22/2004 3:30:00 PM	MDA WELL BEA-01	07S 08W 09 ABDB	WELL

Constituent	This Sample	Drinking Water	Stock Water	Irrigation Water
Calcium (Ca)	92.100 mg/L	---	---	---
Magnesium (Mg)	30.200 mg/L	---	2,000 mg/L	---
Sodium (Na)	26.400 mg/L	250 mg/L [smcl]	2,000 mg/L	see SAR
Potassium (K)	10.900 mg/L	---	---	---
Iron (Fe)	0.010 mg/L	0.3 mg/L [smcl]	---	---
Manganese (Mn)	0.031 mg/L	0.05 mg/L [smcl]	---	2.0 mg/L
Silica (SiO2)	40.900 mg/L	---	---	---
Bicarbonate (HCO3)	344.000 mg/L	---	---	---
Carbonate (CO3)	0.000 mg/L	---	---	---
Chloride (Cl)	18.100 mg/L	250 mg/L [smcl]	1,500 mg/L	---
Sulfate (SO4)	112.000 mg/L	250 mg/L [smcl]	1,500 mg/L	[b]
Nitrate (NO3 as N)	2.010 mg/L	10 mg/L [mcl]	100 mg/L	---
Fluoride (F)	0.354 mg/L	4 mg/L [mcl]	2 mg/L	---
Ortho-Phosphate (as P)	<0.05 mg/L	---	---	---
Aluminum (Al)	<30 ug/L	50-200 ug/L [smcl]	---	1,000 ug/L
Antimony (Sb)	<10 ug/L	6 ug/L [mcl]	---	---
Arsenic (As)	14.400 ug/L	10 ug/L [mcl]	50 ug/L	100 ug/L
Barium (Ba)	50.500 ug/L	2,000 ug/L [mcl]	---	---
Boron (B)	61.200 ug/L	---	---	---
Cadmium (Cd)	<1 ug/L	5 ug/L [mcl]	10 ug/L	5 ug/L
Chromium (Cr)	<10 ug/L	100 ug/L [mcl]	1,000 ug/L	100 ug/L
Cobalt (Co)	<2 ug/L	---	1,000 ug/L	50 ug/L
Copper (Cu)	<5 ug/L	1,300 ug/L [mcl]	500 ug/L	200 ug/L
Lead (Pb)	<10 ug/L	15 ug/L [mcl]	50 ug/L	5,000 ug/L
Lithium (Li)	24.000 ug/L	---	---	2,500 ug/L
Molybdenum (Mo)	<10 ug/L	---	---	5 ug/L
Nickel (Ni)	<2 ug/L	---	---	200 ug/L
Phosphate (P)	<0.05 ug/L	---	---	---
Selenium (Se)	14.800 ug/L	50 ug/L [mcl]	50 ug/L	20 ug/L
Silver (Ag)	<5 ug/L	100 ug/L [smcl]	---	---
Strontium (Sr)	739.000 ug/L	---	---	---
Titanium (Ti)	<1 ug/L	---	---	---
Vanadium (V)	13.800 ug/L	---	---	---
Zinc (Zn)	<2 ug/L	5,000 ug/L [smcl]	24,000 ug/L	2,000 ug/L
Zirconium (Zr)	<10 ug/L	---	---	---

Key: **NR** = No reading in GWIC; **mg/L** = milligrams per Liter; **ug/L** = micrograms per Liter; **---** = Currently no standard for this constituent; **[b]** = High concentrations of sulfate may restrict calcium uptake by crops; **[c]** = Varies with crop, generally dissolved solids should be less than 2,000 mg/L (equivalent to specific conductance of about 2,000 to 3,000 micromhos/cm); **[d]** = Dependent upon other variables such as type of clay in soil and salt content of water. (See SAR); **[mcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999; **[smcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard.



0

Figure 2.1.4– Geologic map from the Dillon 1 degree by 2 degrees quadrangle (Ruppel and others, 1993). The red circle is the approximate well location. Abbreviations: Qa = Quaternary alluvium; Tbz = Bozeman Group and related valley fill deposits; Tvu = Tertiary volcanic rocks.

2.2 BROADWATER COUNTY
05N02E15ACDB01
Well BRO-01

2.2.1 Site Location

A well was drilled in tracts ACDB, sec. 15, T.05N., R.02E., at an altitude of 3,872 ft in Broadwater County (figure 2.2.1). The decimal latitude (NAD 27) is 46.1862 and longitude is -111.4705. Access is by turning west onto the Radersburg Road at the Bunkhouse Bar in Toston, travel west 2 miles to Smith Lane, and then north to the gate at the gravel pit. The well is beyond the gate about ¼-mile on the right side of the road on Smith Lane. The well is in a pasture near the Missouri River west of Radersburg (2.2.2).

2.2.2 Well Completion Details

- Driller: MBMG; Fred Schmidt
- Date: 06/25/2004
- Total depth: 12 ft
- Screened interval: 1.8 ft to 11.8 ft
- Yield: 2 to 5 gpm
- SWL: 8.23 ft TOC, 6.53 ft BGL

A well log is attached along with copy of the water-quality data (figure 2.2.3 and tables 2.2.1 and 2.2.2). Completion details and water-quality data also can be obtained online at the Montana Bureau of Mines and Geology's Ground-Water Information Center (GWIC) website at http://mbmggwic.mtech.edu/. The GWIC identification number for this well is 213967. The results of the pesticide analyses and minimum reporting levels are included in appendix 1.

2.2.3 Land Use

As depicted in figure 2.2.1 the land use is primarily grasslands There was leafy spurge and grass growing in the brown soil. Irrigated hay/grass grows upgradient. The site was about 8-10 ft higher than the Missouri River level.

2.2.4 Geology

The well was completed in Quaternary alluvium (Qa) of undetermined thickness (figure 2.2.4; Reed, 1951). Rocks nearby and immediately below the well include Tertiary lake beds (Tlb), Tertiary volcanic rocks (Tkv) and intrusive rocks (Tki), Cretaceous through Jurassic sedimentary rocks (KJe), Paleozoic rocks (PC), and Belt series slate, shales, and quartzite (pCb). Clay and cobbles were encountered from the surface to 12 ft below land surface.

a.

b.

Figure 2.2.1–a) The well site for BRO-1 (05N02E15ACDB01) looking across field upgradient from well. b) View to the southeast across flowpath.

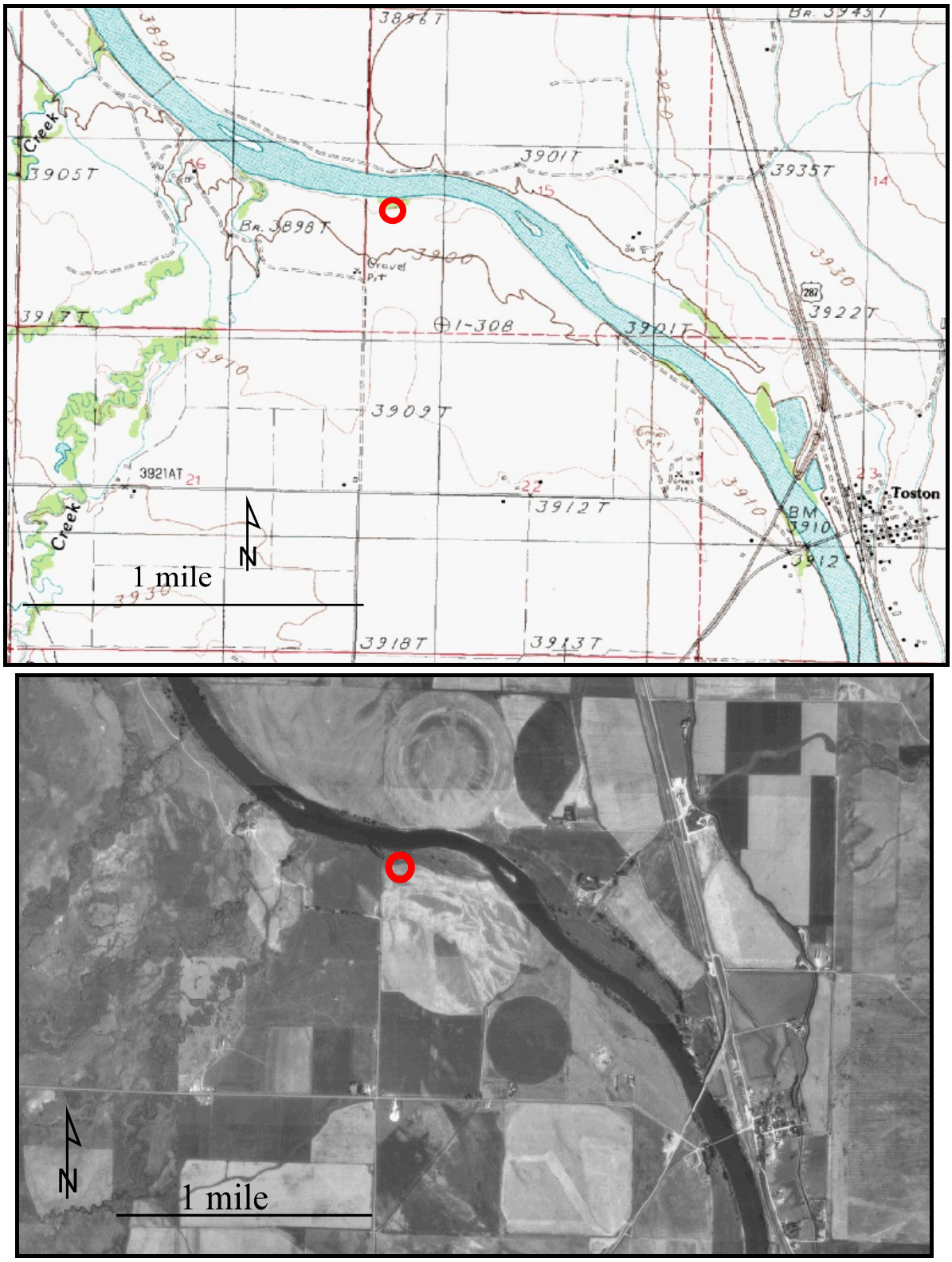


Figure 2.2.2–Well BRO-01 (05N02E15ACDB01) is located about 2-miles northeast of Toston and just south of the Missouri River. The red circle is the approximate location of the well. Modified from Toston orthophoto and 7.5 minute quadrangle.

MDA Well Logs

Well name:	**BRO-01**	TD:	13.5 ft TOC (11.8 ft below ground level)
GWIC ID:	M:213967	SWL:	8.23 ft MP (6.53 ft below ground level)
Date Drilled:	6/25/2004		
County:	Broadwater	MP stick up:	1.7
TRS location:	ACDB sec. 15, T05N, R02E	MP Elevation	3901.7 ft (est.)
			Grass and leafy spurge, irrigated hay grass upgradient. Well is
DD latitude:	46.1862		8-10 feet above Missouri River level.
DD longitude:	-111.4705		
Elevation:	3900 ft		
Logged by:	J. Rose		

	Depth			**Completion data**	**Depth (BGL)**			**Depth (BGL)**	
Drilling Interval	**From (ft)**	**To (ft)**	**Lithology**	**From**	**To**	**Casing**	**From**	**To**	**Fill**
0-5	0.0	4.0	Brown, silt-clay loam. Dry.	0.0	1.8	Blank (3.4 ft total)	0.0	1.0	Cement
	4.0	5.0	Brown, medium-fine grained clay, plastic to very plastic, moldable into balls. Damp.				1.0	3.0	Bentonite grout
	5.0	7.0	Brown clay, very plastic, wet, very soft.				3.0	11.8	10/20 filter pack sand
5-10	7.0	12.0	Large cobbles, rough drilling	1.8	11.8	Screen			
	TD	**12 ft**							

Figure 2.2.3. Well log for BRO-01 (05N02E15ACDB01).

Table 2.2.1--Water-quality comparison for well BRO-1 (05N02E15ACDB01).

Ground-Water Information Center **Water Quality Report**

Site Name: MDA WELL BRO-01 **Report Date:** 6/18/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2005Q0206 / 213967
Location (TRS): 05N 02E 15 ACDB
Latitude/Longitude: 46° 11' 10" N 111° 28' 13" W
Datum: NAD27
Altitude: 3900.00
County/State: BROADWATER / MT
Site Type: WELL
Geology:
USGS 7.5' Quad: TOSTON
PWS Id:
Project: MDAPESTNET

Sample Date: 9/22/2004 11:45:00 AM
Agency/Sampler: MBMG / JCR
Field Number: 213967
Lab Date: 10/20/2004
Lab/Analyst: MBMG / WO
Sample Method/Handling: PUMPED / 3120
Procedure Type: DISSOLVED
Total Depth (ft): 12.000
SWL-MP (ft): 8.720
Depth Water Enters (ft): 1.800

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	81.600	4.072	Bicarbonate (HCO3)	357.200	5.855
Magnesium (Mg)	37.100	3.053	Carbonate (CO3)	0.000	0.000
Sodium (Na)	46.400	2.018	Chloride (Cl)	20.300	0.573
Potassium (K)	5.960	0.152	Sulfate (SO4)	134.000	2.791
Iron (Fe)	0.246	0.013	Nitrate (as N)	0.430	0.031
Manganese (Mn)	0.079	0.003	Fluoride (F)	0.729	0.038
Silica (SiO2)	40.000		Orthophosphate (OPO4)	<0.05	0.000
Total Cations		9.357	**Total Anions**		9.287

Trace Element Results (µg/L)

Aluminum (Al):	127.000	Cadmium (Cd):	<1	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<2	Chromium (Cr):	<2	Molybdenum (Mo):	<10	Titanium (Ti):	5.060
Arsenic (As):	13.300	Cobalt (Co):	<2	Nickel (Ni):	<2	Thallium (Tl):	<5
Barium (Ba):	37.000	Copper (Cu):	<2	Silver (Ag):	<1	Uranium (U):	4.890
Beryllium (Be):	<2	Lead (Pb):	<2	Selenium (Se):	2.890	Vanadium (V):	7.930
Boron (B):	129.000	Lithium (Li):	59.400	Strontium (Sr):	840.000	Zinc (Zn):	<2
Bromide (Br):	97.000					Zirconium (Zr):	<2

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	542.930	Field Hardness as CaCO3:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	724.170	Hardness as CaCO3:	356.460	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	776.000	Field Alkalinity as CaCO3:	NR	PCP (µg/L):	NR
Lab Conductivity (µmhos):	813.000	Akalinity as CaCO3:	292.970	Phosphate, TD (mg/L as P):	0.067
Field pH:	7.240	Ryznar Stability Index:	6.983	Field Nitrate (mg/L):	NR
Lab pH:	7.260	Sodium Adsorption Ratio:	1.070	Field Dissolved O2 (mg/L):	NR
Water Temp (°C):	12.500	Langlier Saturation Index:	0.139	Field Chloride (mg/L):	NR
Air Temp (°C):	NR	Nitrite (mg/L as N):	<0.05	Field Redox (mV):	NR

Notes

Sample Condition: CLEAR.
Field Remarks:
Lab Remarks:

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **ft** = feet; **NR** = No Reading in GWIC

Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions; ***** = Duplicate analysis not within control limits; ****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO3, CO3, SO4, Cl, SiO2, NO3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.

Table 2.2.2--Water-quality comparison for well BRO-1 (05N02E15ACDB01).

Drinking water limits are based on U.S. Environmental Protection Agency primary and secondary standards for public water supplies (view their standards). Stock water and irrigation water recommendations are from U.S. Department of Agriculture Natural Resources Conservation Service water-quality guidelines. The guidelines are general and my vary depending on specific applications. Irrigation guidelines are based on continuous irrigation.

Sample Id	GWIC Id	Sample Date	Site Name	Location	Site Type
2005Q0206	213967	9/22/2004 11:45:00 AM	MDA WELL BRO-01	05N 02E 15 ACDB	WELL

Constituent	This Sample	Drinking Water	Stock Water	Irrigation Water
Calcium (Ca)	81.600 mg/L	---	---	---
Magnesium (Mg)	37.100 mg/L	---	2,000 mg/L	---
Sodium (Na)	46.400 mg/L	250 mg/L [smcl]	2,000 mg/L	see SAR
Potassium (K)	5.960 mg/L	---	---	---
Iron (Fe)	0.246 mg/L	0.3 mg/L [smcl]	---	---
Manganese (Mn)	0.079 mg/L	0.05 mg/L [smcl]	---	2.0 mg/L
Silica (SiO2)	40.000 mg/L	---	---	---
Bicarbonate (HCO3)	357.200 mg/L	---	---	---
Carbonate (CO3)	0.000 mg/L	---	---	---
Chloride (Cl)	20.300 mg/L	250 mg/L [smcl]	1,500 mg/L	---
Sulfate (SO4)	134.000 mg/L	250 mg/L [smcl]	1,500 mg/L	[b]
Nitrate (NO3 as N)	0.430 mg/L	10 mg/L [mcl]	100 mg/L	---
Fluoride (F)	0.729 mg/L	4 mg/L [mcl]	2 mg/L	---
Ortho-Phosphate (as P)	<0.05 mg/L	---	---	---
Aluminum (Al)	127.000 ug/L	50-200 ug/L [smcl]	---	1,000 ug/L
Antimony (Sb)	<2 ug/L	6 ug/L [mcl]	---	---
Arsenic (As)	13.300 ug/L	10 ug/L [mcl]	50 ug/L	100 ug/L
Barium (Ba)	37.000 ug/L	2,000 ug/L [mcl]	---	---
Boron (B)	129.000 ug/L	---	---	---
Cadmium (Cd)	<1 ug/L	5 ug/L [mcl]	10 ug/L	5 ug/L
Chromium (Cr)	<2 ug/L	100 ug/L [mcl]	1,000 ug/L	100 ug/L
Cobalt (Co)	<2 ug/L	---	1,000 ug/L	50 ug/L
Copper (Cu)	<2 ug/L	1,300 ug/L [mcl]	500 ug/L	200 ug/L
Lead (Pb)	<2 ug/L	15 ug/L [mcl]	50 ug/L	5,000 ug/L
Lithium (Li)	59.400 ug/L	---	---	2,500 ug/L
Molybdenum (Mo)	<10 ug/L	---	---	5 ug/L
Nickel (Ni)	<2 ug/L	---	---	200 ug/L
Phosphate (P)	0.067 ug/L	---	---	---
Selenium (Se)	2.890 ug/L	50 ug/L [mcl]	50 ug/L	20 ug/L
Silver (Ag)	<1 ug/L	100 ug/L [smcl]	---	---
Strontium (Sr)	840.000 ug/L	---	---	---
Titanium (Ti)	5.060 ug/L	---	---	---
Vanadium (V)	7.930 ug/L	---	---	---
Zinc (Zn)	<2 ug/L	5,000 ug/L [smcl]	24,000 ug/L	2,000 ug/L
Zirconium (Zr)	<2 ug/L	---	---	---

Key: **NR** = No reading in GWIC; **mg/L** = milligrams per Liter; **ug/L** = micrograms per Liter; **---** = Currently no standard for this constituent; **[b]** = High concentrations of sulfate may restrict calcium uptake by crops; **[c]** = Varies with crop, generally dissolved solids should be less than 2,000 mg/L (equivalent to specific conductance of about 2,000 to 3,000 micromhos/cm); **[d]** = Dependent upon other variables such as type of clay in soil and salt content of water. (See SAR); **[mcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999; **[smcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard.

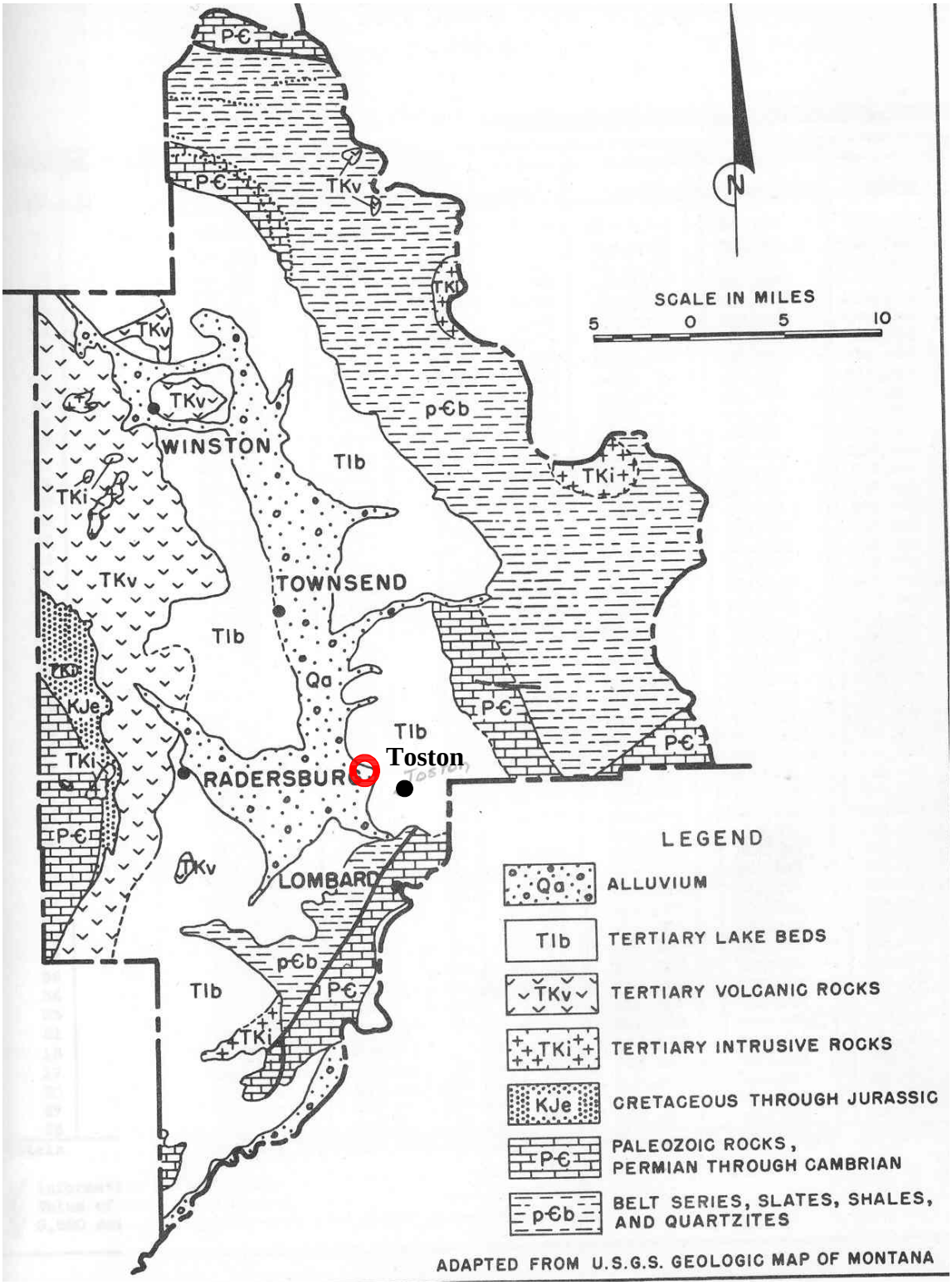


Figure 2.2.4. Geologic map of the area near BRO-1 (05N02E15ACDB01). The red circle is the approximate location of the well, from Reed (1951).

2.3 CHOUTEAU COUNTY
24N08E17CAAA01
Well CHO-01

2.3.1 Site Location

A well was drilled in tracts CAAA sec. 17, T.24N., R.08E., at an altitude of 2,750 ft in Chouteau County (figure 2.3.1). The decimal latitude (NAD 27) is 47.8353 and longitude is -110.7381. The well is located about 4.5 miles northwest of Fort Benton. Access is by Highway 80 to Tanzie Trail Road. The well is located north of Tanzie Trail Road south of the Teton River (figure 2.3.2).

2.3.2 Well Completion Details

- Driller: MBMG; Fred Schmidt
- Date: 06/24/2004
- Total depth: 13 ft
- Screened interval: 3.0 to 12.3 ft
- SWL: 8.97 ft TOC; 6.97 ft BGL

A well log is attached along with copy of the water-quality data (figure 2.3.3 and tables 2.3.1 and 2.3.2). Completion details and water-quality data also can be obtained online at the Montana Bureau of Mines and Geology's Ground-Water Information Center (GWIC) website at http://mbmggwic.mtech.edu/. The GWIC identification number for this well is 213966. The results of the pesticide analyses and minimum reporting levels are included in appendix 1.

2.3.3 Land Use

As depicted in figure 2.3.1, the land use is primarily alfalfa on a center pivot. The well was drilled downgradient from the field in the tall grass and weeds (leafy spurge) and scattered cottonwoods. The topography was at the toe of an alluvial bench at the break to the floodplain.

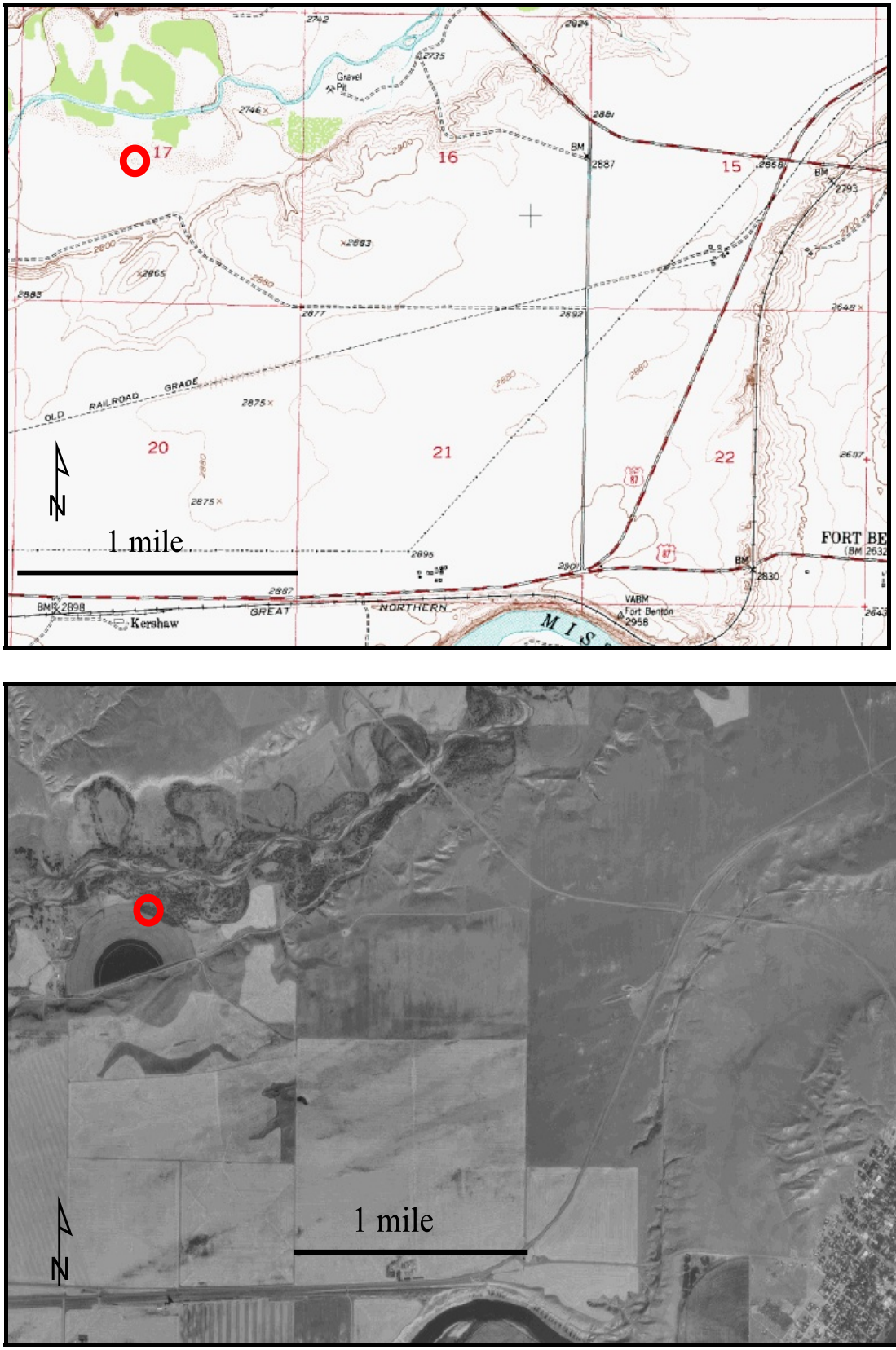
2.3.4 Geology

The well was completed in Quaternary alluvium of undetermined depth associated with the Teton River flood plain (Berg and Vuke, 2002). Rocks nearby and immediately below the well consist of the Cretaceous shale (Kmr). Sand and gravel was encountered from the surface to 13 feet below surface.

a.

b.

Figure 2.1.1– a) Well site CHO-1 (24N08E17CAAA01) showing field upgradient from the well site. b) A protective well casing was cemented around the 4-inch PVC well casing; worker is holding the locking cap while the other worker bails the well.



Figures 2.3.2–Well CHO-01 (24N08E17CAAA01) is located about 4.5 miles northwest of Fort Benton south of the Teton River. The red circle is the approximate location of the well on the Fort Benton orthophoto and 7.5-min quadrangle.

MDA Well Logs

Well name:	**CHO-01**	TD:	14.42 ft TOC (12.42 ft below ground level)
GWIC ID:	M:213966	SWL:	8.97 ft MP (6.97 ft below ground level)
Date Drilled:	6/24/2004		
County:	Chouteau	MP stick up	2.0 ft
TRS location:	CAAA sec. 17, T24N, R8E	MP Elevation	2,752 ft (est.)
			Tall grass and weeds (leafy spurge) below center-pivot
DD latitude:	47.8353		irrigated alfalfa
DD longitude:	-110.7381		
Elevation:	2,750 ft		
Logged by:	J. Rose		

Drilling Interval	Depth From (ft)	To (ft)	Lithology
0-5	0.0	1.5	Very dark brown, loamy-clay soil
	1.5	4.0	Gravelly, rounded fragments of Belt rocks. Gravels are dominantly dark-grey to black.
5-10	4.0	6.5	Dark-brown sand with gravels, damp/wet. Gravels rounded Belt fragments. Damp
	6.5	11.0	Brown-tan, medium-grained sand with gravel, some 2-3 inch cobbles rocking drill rig. Damp sand with water.
10-15	11.0	13.0	Brown/tan medium-grained sand with some pebbles/gravels/and cobbles. Wet cuttings.
	TD	**13.0 ft**	

Completion data	Depth (BGL)			Depth (BGL)		
From	To	Casing		From	To	Fill
0.0	2.3	blank (4.3 ft total)		0.0	1.0	bentonite chips
2.3	12.3	screen		1.0	11.0	natural sand and gravel backfill
				11.0	12.3	10/20 filter sand

Figure 2.3.3. Well log for CHO-01 (24N08E17CAAA01).

Table 2.3.1--Water-quality analyses for well CHO-01 (24N08E17).

Ground-Water Information Center **Water Quality Report**

Site Name: KALANICK, TIM * MDA WELL CHO-01 **Report Date:** 5/20/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2005Q0204 / 213966
Location (TRS): 24N 08E 17
Latitude/Longitude: 47° 50' 7" N 110° 44' 17" W
Datum: NAD27
Altitude: 2750.00
County/State: CHOUTEAU / MT
Site Type: WELL
Geology:
USGS 7.5' Quad: FORT BENTON
PWS Id:
Project: MDAPESTNET

Sample Date: 9/21/2004 1:20:00 PM
Agency/Sampler: MBMG / JCR
Field Number: 213966
Lab Date: 10/20/2004
Lab/Analyst: MBMG / WO
Sample Method/Handling: PUMPED / 3120
Procedure Type: DISSOLVED
Total Depth (ft): 13.000
SWL-MP (ft): 10.290
Depth Water Enters (ft): 2.300

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	210.000	10.479	Bicarbonate (HCO_3)	405.000	6.638
Magnesium (Mg)	114.000	9.381	Carbonate (CO_3)	0.000	0.000
Sodium (Na)	221.000	9.614	Chloride (Cl)	34.500	0.973
Potassium (K)	4.550	0.116	Sulfate (SO_4)	964.000	20.080
Iron (Fe)	0.017	0.001	Nitrate (as N)	0.718	0.051
Manganese (Mn)	0.172	0.006	Fluoride (F)	<0.05	0.000
Silica (SiO_2)	14.400		Orthophosphate (OPO_4)	<0.05	0.000
Total Cations		29.653	**Total Anions**		27.743

Trace Element Results (µg/L)

Aluminum (Al):	<10	Cadmium (Cd):	<1	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<2	Chromium (Cr):	<2	Molybdenum (Mo):	<10	Titanium (Ti):	<1
Arsenic (As):	<1	Cobalt (Co):	<2	Nickel (Ni):	<2	Thallium (Tl):	<5
Barium (Ba):	14.600	Copper (Cu):	<2	Silver (Ag):	<1	Uranium (U):	18.100
Beryllium (Be):	<2	Lead (Pb):	<2	Selenium (Se):	5.200	Vanadium (V):	<5
Boron (B):	130.000	Lithium (Li):	84.200	Strontium (Sr):	1,902.000	Zinc (Zn):	<2
Bromide (Br):	<50					Zirconium (Zr):	<2

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	1,762.860	Field Hardness as $CaCO_3$:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	1,968.360	Hardness as $CaCO_3$:	993.590	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	1,795.000	Field Alkalinity as $CaCO_3$:	NR	PCP (µg/L):	NR
Lab Conductivity (µmhos):	2,140.000	Akalinity as $CaCO_3$:	332.170	Phosphate, TD (mg/L as P):	<0.05
Field pH:	7.200	Ryznar Stability Index:	5.873	Field Nitrate (mg/L):	NR
Lab pH:	7.440	Sodium Adsorption Ratio:	3.050	Field Dissolved O_2 (mg/L):	NR
Water Temp (°C):	11.100	Langlier Saturation Index:	0.784	Field Chloride (mg/L):	NR
Air Temp (°C):	NR	Nitrite (mg/L as N):	<0.05	Field Redox (mV):	NR

Notes

Sample Condition: CLOUDY
Field Remarks:
Lab Remarks:

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **ft** = feet; **NR** = No Reading in GWIC

Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions; ***** = Duplicate analysis not within control limits; ****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO_3, CO_3, SO_4, Cl, SiO_2, NO_3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.

Table 2.3.2--Water-quality comparison for well CHO-01 (24N08E17CAAA01).

Drinking water limits are based on U.S. Environmental Protection Agency primary and secondary standards for public water supplies (view their standards). Stock water and irrigation water recommendations are from U.S. Department of Agriculture Natural Resources Conservation Service water-quality guidelines. The guidelines are general and my vary depending on specific applications. Irrigation guidelines are based on continuous irrigation.

Sample Id	GWIC Id	Sample Date	Site Name	Location	Site Type
2005Q0204	213966	9/21/2004 1:20:00 PM	KALANICK, TIM * MDA WELL CHO-01	24N 08E 17	WELL

Constituent	This Sample	Drinking Water	Stock Water	Irrigation Water
Calcium (Ca)	210.000 mg/L	---	---	---
Magnesium (Mg)	114.000 mg/L	---	2,000 mg/L	---
Sodium (Na)	221.000 mg/L	250 mg/L [smcl]	2,000 mg/L	see SAR
Potassium (K)	4.550 mg/L	---	---	---
Iron (Fe)	0.017 mg/L	0.3 mg/L [smcl]	---	---
Manganese (Mn)	0.172 mg/L	0.05 mg/L [smcl]	---	2.0 mg/L
Silica (SiO2)	14.400 mg/L	---	---	---
Bicarbonate (HCO3)	405.000 mg/L	---	---	---
Carbonate (CO3)	0.000 mg/L	---	---	---
Chloride (Cl)	34.500 mg/L	250 mg/L [smcl]	1,500 mg/L	---
Sulfate (SO4)	964.000 mg/L	250 mg/L [smcl]	1,500 mg/L	[b]
Nitrate (NO3 as N)	0.718 mg/L	10 mg/L [mcl]	100 mg/L	---
Fluoride (F)	<0.05 mg/L	4 mg/L [mcl]	2 mg/L	---
Ortho-Phosphate (as P)	<0.05 mg/L	---	---	---
Aluminum (Al)	<10 ug/L	50-200 ug/L [smcl]	---	1,000 ug/L
Antimony (Sb)	<2 ug/L	6 ug/L [mcl]	---	---
Arsenic (As)	<1 ug/L	10 ug/L [mcl]	50 ug/L	100 ug/L
Barium (Ba)	14.600 ug/L	2,000 ug/L [mcl]	---	---
Boron (B)	130.000 ug/L	---	---	---
Cadmium (Cd)	<1 ug/L	5 ug/L [mcl]	10 ug/L	5 ug/L
Chromium (Cr)	<2 ug/L	100 ug/L [mcl]	1,000 ug/L	100 ug/L
Cobalt (Co)	<2 ug/L	---	1,000 ug/L	50 ug/L
Copper (Cu)	<2 ug/L	1,300 ug/L [mcl]	500 ug/L	200 ug/L
Lead (Pb)	<2 ug/L	15 ug/L [mcl]	50 ug/L	5,000 ug/L
Lithium (Li)	84.200 ug/L	---	---	2,500 ug/L
Molybdenum (Mo)	<10 ug/L	---	---	5 ug/L
Nickel (Ni)	<2 ug/L	---	---	200 ug/L
Phosphate (P)	<0.05 ug/L	---	---	---
Selenium (Se)	5.200 ug/L	50 ug/L [mcl]	50 ug/L	20 ug/L
Silver (Ag)	<1 ug/L	100 ug/L [smcl]	---	---
Strontium (Sr)	1,902.000 ug/L	---	---	---
Titanium (Ti)	<1 ug/L	---	---	---
Vanadium (V)	<5 ug/L	---	---	---
Zinc (Zn)	<2 ug/L	5,000 ug/L [smcl]	24,000 ug/L	2,000 ug/L
Zirconium (Zr)	<2 ug/L	---	---	---

Key: **NR** = No reading in GWIC; **mg/L** = milligrams per Liter; **ug/L** = micrograms per Liter; **---** = Currently no standard for this constituent; **[b]** = High concentrations of sulfate may restrict calcium uptake by crops; **[c]** = Varies with crop, generally dissolved solids should be less than 2,000 mg/L (equivalent to specific conductance of about 2,000 to 3,000 micromhos/cm); **[d]** = Dependent upon other variables such as type of clay in soil and salt content of water. (See SAR); **[mcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999; **[smcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard.

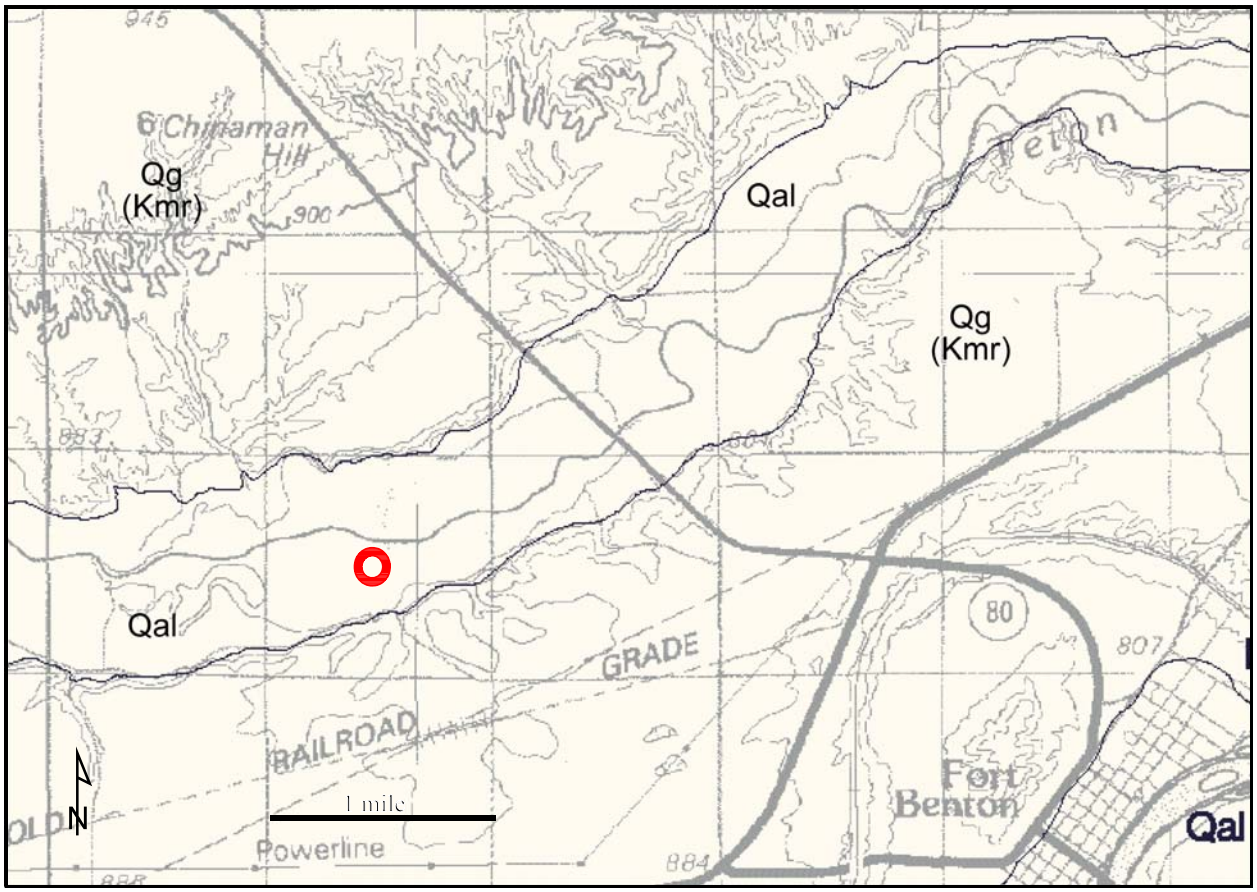


Figure 2.3.4–Geologic map of the area near CHO-1 (24N08E17CAAA01) from the Fort Benton 30' x 60' quadrangle from Berg and Vuke (2002). The red circle is the approximate location of the well.

2.4 DANIELS COUNTY
36N48E16ABAA01
Well DAN-01

2.4.1 Site Location

A well was drilled 6-miles north of Scobey in tracts ABAA sec. 16, T.36 N., R.48E., at an altitude of 2,412 ft in Daniels County. The latitude (NAD 27) is 48.8810 and longitude is -105.4364. Access is via Highway 13 6-miles north of Scobey and west for about 0.5 miles. The well is about 90-feet south of the road.

2.4.2 Well Completion Details

- Driller: MBMG; Fred Schmidt
- Date: 09/29/2004
- Total depth: 29 ft
- Screened interval: 18.5 ft to 28.5 ft
- Yield: 1.5 gpm
- SWL: 17.15 TOC; 15.85 ft BGL

A well log is attached along with copy of the water-quality data (figure 2.4.3 and tables 2.4.1 and 2.4.2). Completion details and water-quality data also can be obtained online at the Montana Bureau of Mines and Geology's Ground-Water Information Center (GWIC) website at http://mbmggwic.mtech.edu/. The GWIC identification number for this well is 214376. The results of the pesticide analyses and minimum reporting levels are included in appendix 1.

2.4.3 Land Use

As depicted in figure 2.4.1, the land use is primarily wheat field in production. The well is south of a wetland/swampy area.

2.4.4 Geology

The well was completed in Tertiary Tullock Member of the Fort Union Formation (Tft) overlain by Quaternary alluvium. Also shown on the map but not encountered is Tfle (Lebo Member of the Fort Union Formation) and Qac (Quaternary colluvium). The well encountered mostly sand and cobbles from 0 ft to 17 ft and from 17 ft to 29 ft only sand and clay were drilled. This is interpreted as the Tullock Member.

a.

b.

Figure 2.4.1– a) The well site of DAN-01 (36N48E16ABAA01) looking upgradient across well. b) The well site looking west across drainage.

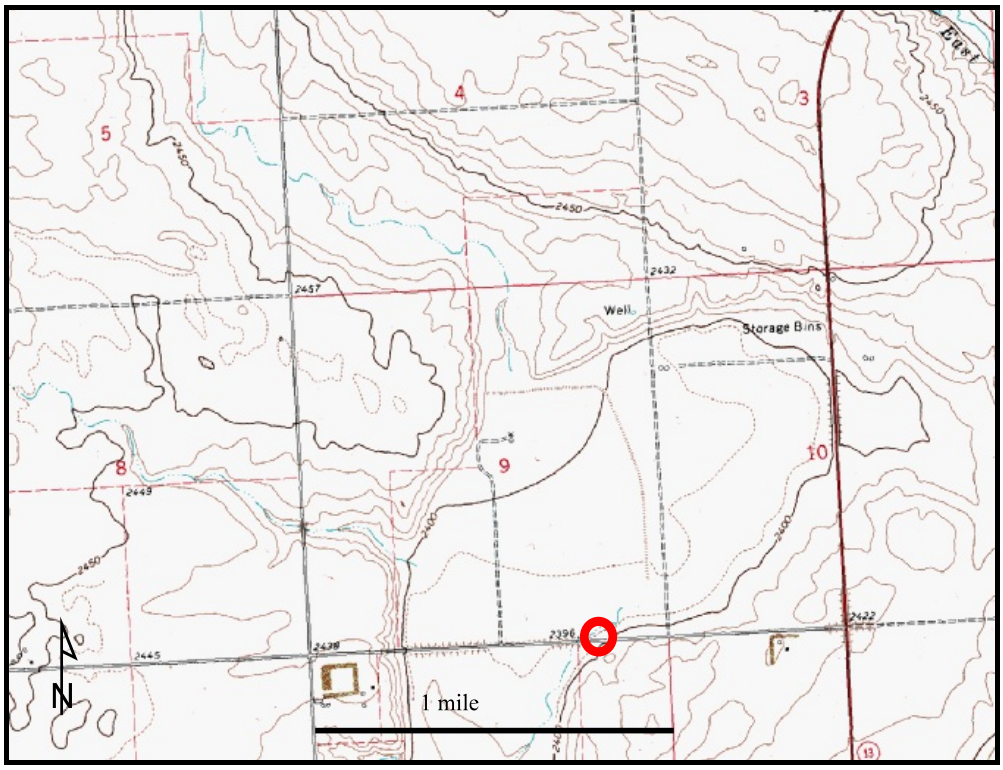


Figure 2.4.2–Well DAN-01 (36N48E16ABAA01) is about 6-miles north of Scobey on the Scobey NW orthophoto and 7.5-min quadrangle. The red circle is the location of the well.

MDA Well Logs

Well name:	**DAN-01**	TD:	30.1 ft TOC (28.8 ft below ground level)
GWIC ID:	M:214376	SWL:	17.15 ft MP/TOC (15.85 ft below ground level)
Date Drilled:	9/29/2004		
County:	Daniels	MP stick up:	1.3 ft AGL
TRS location:	ABAA sec.16, 36N 48E	MP Elevation:	2,396.3 ft (est.)
DD latitude:	48.881		
DD longitude:	-105.4364		Wheat fields, tilled/fallow for winter
Elevation:	2,395.0 ft		
Logged by:	J. Rose		

Drilling Interval	Depth (feet BGL) From (ft)	To (ft)	Lithology
0-5	0.0	4.0	Medium brown, silty-clay loam, very loosely packs in hand. Dry loess, windblown onto fenceline between fields.
	4.0	4.5	Light-brown silty-clay loam,very little sand, not gritty. Dry
5-10	4.5	6.5	Grinding on augers. Medium-light brown, clayey-silt with medium-fine grained rounded gravels. Dry
	6.5	10	Brown, sand with some silt, clay , and gravels. Packs loose in hands. Very slightly damp
10-15		8.0	Some granitic cobbles
			Cobbles in sandy silt. Faster drilling rate.
	10.0	11.0	Grinding on cobbles. More and with increasing gravel content, medium-coarse grained gravels. Dry
	11.0	12.0	Medium-dark brown sand with clay and gravels. Loosely packs in hand. Faster drilling rate. Increasing clay content with depth, grading to very sandy clay with gravels. Very slightly damp.
	12.0	15.0	Brown, very sandy clay with gravels, semi-plastic. Very damp.
15-20	16	17.0	Cobbles binding bit. Sandy clay with gravels and cobbles. Damp
	17	20	Very sandy clay, soft, moldable, loose; fewer gravels and cobbles. Clay is tacky. Damp-wet
	20	24	Brown, semi-plastic, more clay than previous section, with sand. Very few cobbles, black, subrounded. Quiet, moderately easy drilling.
	24	25	Harder drilling, lifting rig, quiet, no rocks or gravels. Damp to very damp sandy clay.
	25	26	Harder drilling, tighter. Quiet, no gravels or rocks.
	26	27	Very tight, hard drilling. Clay
	27	28	Easier drilling, clays
	28	29	Gray, plastic, very stiff clay with sand and gravels.
	TD	**29 ft**	

Completion data	Depth (BGL)		
from	to	casing	
0.0	18.5	blank (19.8 feet total)	
18.5	28.5	screen	
Total casing	28.5		

from	to	fill
0.0	1.5	cement
1.5	4.0	bentonite chips
4.0	13.7	backfill cuttings, clay
13.7	29.0	washed pea gravel

Figure 2.4.3 -- Well log for for DAN-01 (36N48E16ABAA01).

Table 2.4.1-- Water quality for DAN-01 (36N48E16ABAA01).

Ground-Water Information Center **Water Quality Report**

Site Name: MDA WELL DAN-01 **Report Date:** 6/18/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2005Q0278 / 214376
Location (TRS): 36N 48E 16 ABAA
Latitude/Longitude: 48° 52' 54" N 105° 26' 11" W
Datum: NAD27
Altitude: 2395.00
County/State: DANIELS / MT
Site Type: WELL
Geology:
USGS 7.5' Quad:
PWS Id:
Project: MDAPESTNET

Sample Date: 10/25/2004 3:30:00 PM
Agency/Sampler: MBMG / JCR
Field Number: 214376
Lab Date: 12/1/2004
Lab/Analyst: MBMG / WO
Sample Method/Handling: PUMPED / 3120
Procedure Type: DISSOLVED
Total Depth (ft): 30.100
SWL-MP (ft): 17.100
Depth Water Enters (ft): 18.500

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	114.000	5.689	Bicarbonate (HCO3)	382.100	6.263
Magnesium (Mg)	46.300	3.810	Carbonate (CO3)	0.000	0.000
Sodium (Na)	82.200	3.576	Chloride (Cl)	8.540	0.241
Potassium (K)	7.750	0.198	Sulfate (SO4)	241.000	5.020
Iron (Fe)	0.018	0.001	Nitrate (as N)	9.530	0.680
Manganese (Mn)	0.020	0.001	Fluoride (F)	<0.25	0.000
Silica (SiO2)	16.600		Orthophosphate (OPO4)	<0.25	0.000
Total Cations		13.293	**Total Anions**		12.204

Trace Element Results (µg/L)

Aluminum (Al):	<10	Cadmium (Cd):	<1	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<2	Chromium (Cr):	<2	Molybdenum (Mo):	<10	Titanium (Ti):	<1
Arsenic (As):	<1	Cobalt (Co):	<2	Nickel (Ni):	5.290	Thallium (Tl):	<5
Barium (Ba):	59.500	Copper (Cu):	<2	Silver (Ag):	<1	Uranium (U):	9.410
Beryllium (Be):	<2	Lead (Pb):	<2	Selenium (Se):	8.410	Vanadium (V):	<5
Boron (B):	124.000	Lithium (Li):	25.700	Strontium (Sr):	327.000	Zinc (Zn):	<2
Bromide (Br):	<250					Zirconium (Zr):	<2

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	714.180	Field Hardness as CaCO3:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	908.060	Hardness as CaCO3:	475.230	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	1,035.000	Field Alkalinity as CaCO3:	NR	PCP (µg/L):	NR
Lab Conductivity (µmhos):	1,117.000	Akalinity as CaCO3:	313.390	Phosphate, TD (mg/L as P):	<0.05
Field pH:	7.350	Ryznar Stability Index:	6.134	Field Nitrate (mg/L):	NR
Lab pH:	7.760	Sodium Adsorption Ratio:	1.640	Field Dissolved O2 (mg/L):	NR
Water Temp (°C):	7.800	Langlier Saturation Index:	0.813	Field Chloride (mg/L):	NR
Air Temp (°C):	NR	Nitrite (mg/L as N):	<0.25	Field Redox (mV):	NR

Notes

Sample Condition: SLIGHTLY SILTY-NEW WELL.
Field Remarks:
Lab Remarks:

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **ft** = feet; **NR** = No Reading in GWIC

Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions; ***** = Duplicate analysis not within control limits; ****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO3, CO3, SO4, Cl, SiO2, NO3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.

Table 2.4.2 -- Water-quality comparison for well DAN-01 (36N48E16ABAA01).

Drinking water limits are based on U.S. Environmental Protection Agency primary and secondary standards for public water supplies (view their standards). Stock water and irrigation water recommendations are from U.S. Department of Agriculture Natural Resources Conservation Service water-quality guidelines. The guidelines are general and my vary depending on specific applications. Irrigation guidelines are based on continuous irrigation.

Sample Id	GWIC Id	Sample Date	Site Name	Location	Site Type
2005Q0278	214376	10/25/2004 3:30:00 PM	MDA WELL DAN-01	36N 48E 16 ABAA	WELL

Constituent	This Sample	Drinking Water	Stock Water	Irrigation Water
Calcium (Ca)	114.000 mg/L	---	---	---
Magnesium (Mg)	46.300 mg/L	---	2,000 mg/L	---
Sodium (Na)	82.200 mg/L	250 mg/L [smcl]	2,000 mg/L	see SAR
Potassium (K)	7.750 mg/L	---	---	---
Iron (Fe)	0.018 mg/L	0.3 mg/L [smcl]	---	---
Manganese (Mn)	0.020 mg/L	0.05 mg/L [smcl]	---	2.0 mg/L
Silica (SiO2)	16.600 mg/L	---	---	---
Bicarbonate (HCO3)	382.100 mg/L	---	---	---
Carbonate (CO3)	0.000 mg/L	---	---	---
Chloride (Cl)	8.540 mg/L	250 mg/L [smcl]	1,500 mg/L	---
Sulfate (SO4)	241.000 mg/L	250 mg/L [smcl]	1,500 mg/L	[b]
Nitrate (NO3 as N)	9.530 mg/L	10 mg/L [mcl]	100 mg/L	---
Fluoride (F)	<0.25 mg/L	4 mg/L [mcl]	2 mg/L	---
Ortho-Phosphate (as P)	<0.25 mg/L	---	---	---
Aluminum (Al)	<10 ug/L	50-200 ug/L [smcl]	---	1,000 ug/L
Antimony (Sb)	<2 ug/L	6 ug/L [mcl]	---	---
Arsenic (As)	<1 ug/L	10 ug/L [mcl]	50 ug/L	100 ug/L
Barium (Ba)	59.500 ug/L	2,000 ug/L [mcl]	---	---
Boron (B)	124.000 ug/L	---	---	---
Cadmium (Cd)	<1 ug/L	5 ug/L [mcl]	10 ug/L	5 ug/L
Chromium (Cr)	<2 ug/L	100 ug/L [mcl]	1,000 ug/L	100 ug/L
Cobalt (Co)	<2 ug/L	---	1,000 ug/L	50 ug/L
Copper (Cu)	<2 ug/L	1,300 ug/L [mcl]	500 ug/L	200 ug/L
Lead (Pb)	<2 ug/L	15 ug/L [mcl]	50 ug/L	5,000 ug/L
Lithium (Li)	25.700 ug/L	---	---	2,500 ug/L
Molybdenum (Mo)	<10 ug/L	---	---	5 ug/L
Nickel (Ni)	5.290 ug/L	---	---	200 ug/L
Phosphate (P)	<0.05 ug/L	---	---	---
Selenium (Se)	8.410 ug/L	50 ug/L [mcl]	50 ug/L	20 ug/L
Silver (Ag)	<1 ug/L	100 ug/L [smcl]	---	---
Strontium (Sr)	327.000 ug/L	---	---	---
Titanium (Ti)	<1 ug/L	---	---	---
Vanadium (V)	<5 ug/L	---	---	---
Zinc (Zn)	<2 ug/L	5,000 ug/L [smcl]	24,000 ug/L	2,000 ug/L
Zirconium (Zr)	<2 ug/L	---	---	---

Key: **NR** = No reading in GWIC; **mg/L** = milligrams per Liter; **ug/L** = micrograms per Liter; **---** = Currently no standard for this constituent; **[b]** = High concentrations of sulfate may restrict calcium uptake by crops; **[c]** = Varies with crop, generally dissolved solids should be less than 2,000 mg/L (equivalent to specific conductance of about 2,000 to 3,000 micromhos/cm); **[d]** = Dependent upon other variables such as type of clay in soil and salt content of water. (See SAR); **[mcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999; **[smcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard.

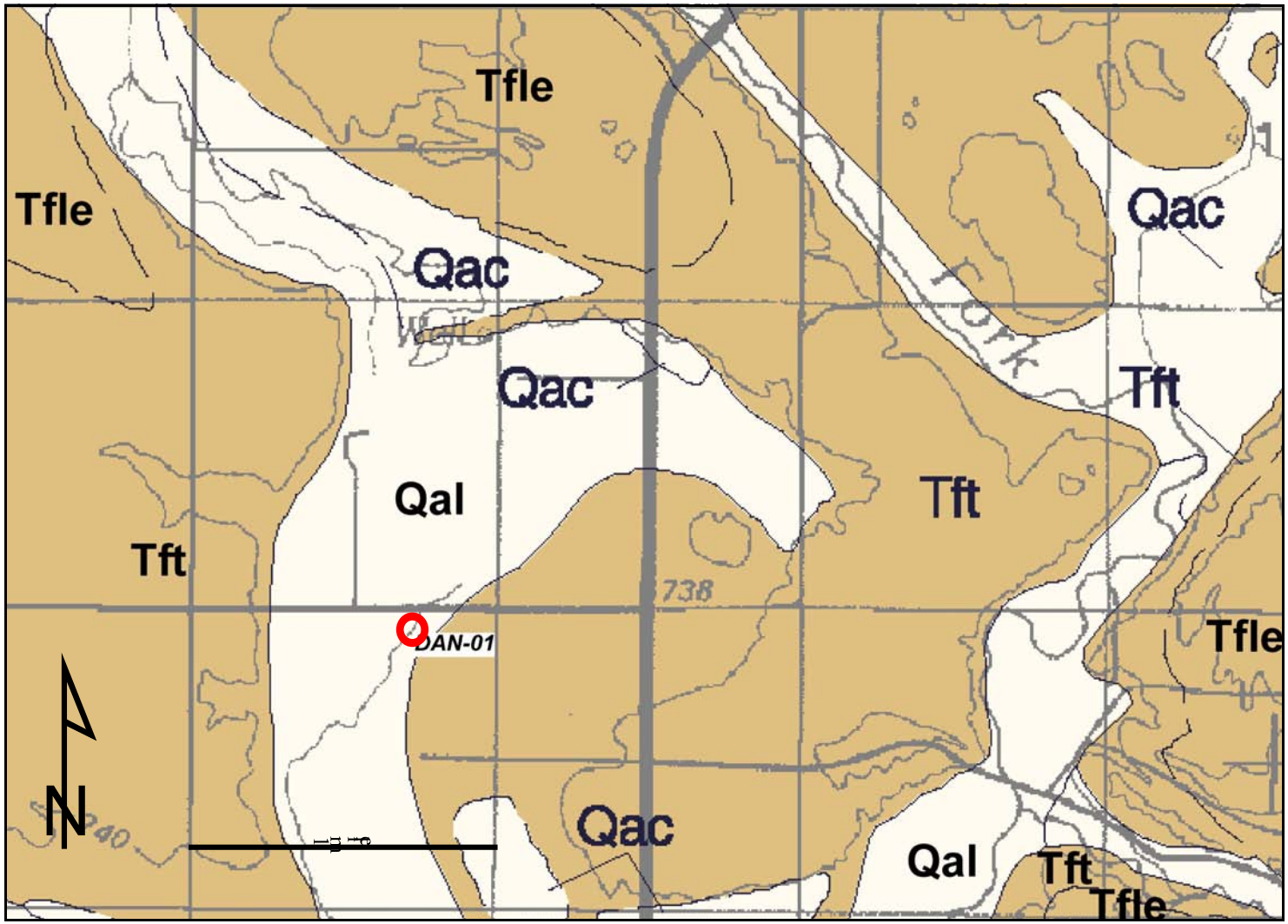


Figure 2.4.4–Geology of the area of well site DAN-01 (36N48E16ABAA01) on the Scobey 30' x 60' quadrangle taken from Bergantino and Wilde (1998). The red circle is the approximate location of the well. Abbreviations: Qal = Quaternary alluvium; Qac = Quaternary colluvium; Tft = Tullock Member of the Fort Union Formation; Tfle = Lebo Member of the Fort Union.

2.5 DAWSON COUNTY
14N54E33AADB01 and -02
Well DAW-01 and -02

2.5.1 Site Location

A well was drilled in tracts AADB sec. 33 T.14N., R.54E, at an altitude of 2,133 ft in Dawson County. The latitude (NAD27) is 46.9300 and the longitude is -104.8786. Access is by I-94, west from Glendive, approximately 18 miles to exit 198 (Cracker Box Road). Then south to gravel road, and west to Road 253. The well was on a hill/ridge along the fence line. The ridge was plowed next to the drainage ditch for the field.

2.5.2 Well Completion Details

	DAW-01	DAW-02
▸ Driller:	MBMG; Fred Schmidt	Hansen Drilling
▸ Date:	07/15/04	01/18/2005
▸ Total depth:	15 ft	25 ft
▸ Screened interval:	4.7 - 14.7 ft	13 - 23 ft
▸ Yield:	<1 gpm	5 gpm
▸ SWL:	12.49 ft BGL	16.03 ft BGL

Well logs are attached along with copy of the water-quality data (figure 2.5.3, 2.5.4 and tables 2.5.1 and 2.5.2). Completion details and water-quality data also can be obtained online at the Montana Bureau of Mines and Geology's Ground-Water Information Center (GWIC) website at http://mbmggwic.mtech.edu/. The GWIC identification number for DAW-01 is 213970 and DAW-02 is 216273. The results of the pesticide analyses and minimum reporting levels are included in appendix 1.

2.5.3 Land Use

As depicted in 2.5.1, the land use is primarily irrigated farming with grass and pasture land on the upland terraces. The site is along the Yellowstone River, about 5-10 feet above river level. A ditch runs across the upper terrace bench.

2.5.4 Geology

The surrounding geology is Quaternary alluvium (Qal) and Quaternary terraces (Qat) in the bottoms and Cretaceous Hell Creek Formation as bedrock (figure 2.5.5). The well was completed in alluvium but is underlain by the Ludlow Member of the Fort Union Formation (Tfld). The well encountered mainly silt with some sand and clay. Also shown on the geologic map is Tftr which if the Tongue River Member of the Fort Union Formation and Qac which is alluvium and colluvium, grouped.

a.

b.

Figure 2.5.1–a) The well sites of DAW-01 (14N54E33AADB01) and DAW-02 (14N54E33AADB02). b) Dedicated Department of Agriculture employee braves chilling temperatures stowing equipment after installing DAW-02.

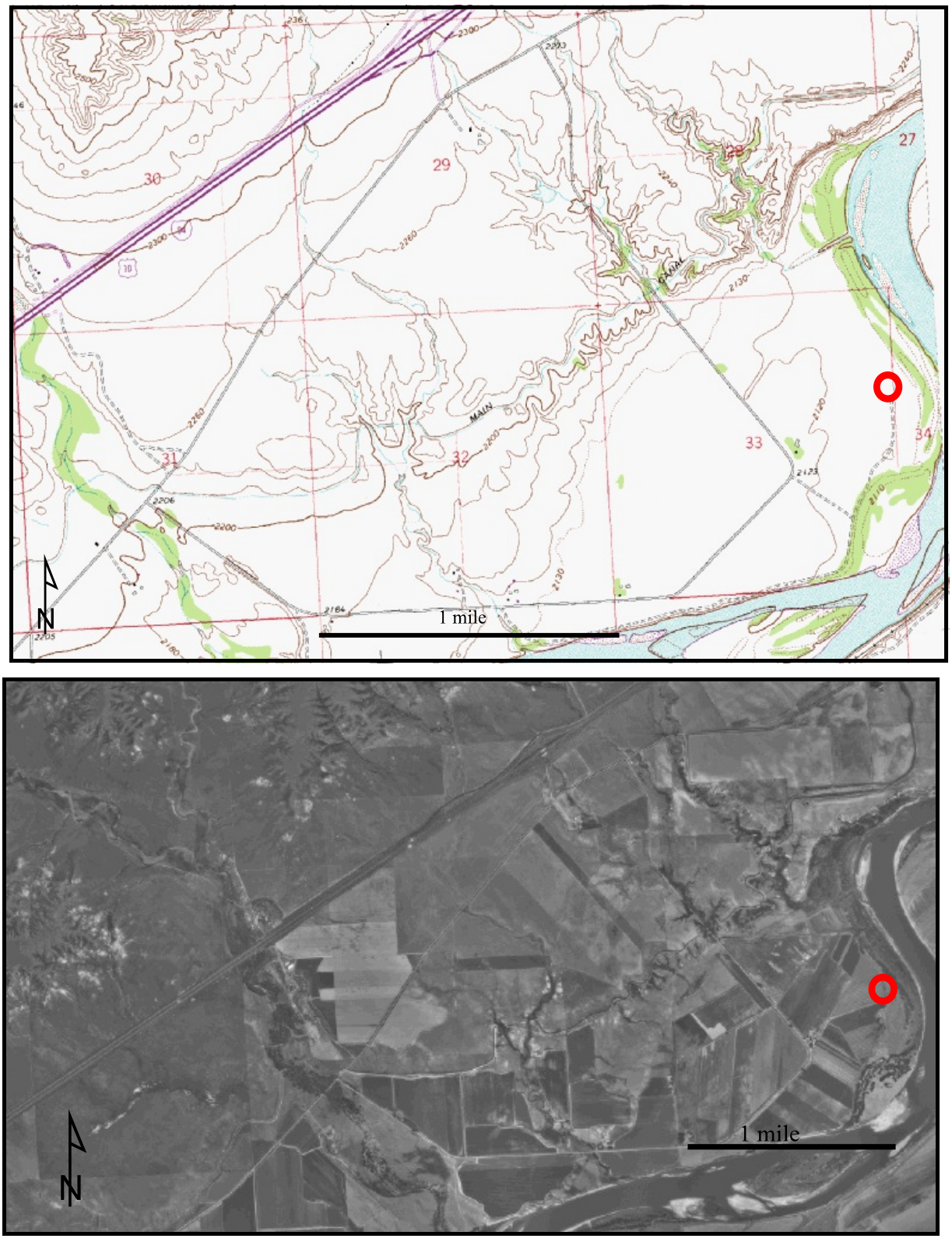


Figure 2.5.2–Wells DAW-01 (14N54E33AADB01) and DAW-02 (14N54E33AADB02), shown by a red circle, west of the Yellowstone River on the Marsh 7.5-min. quadrangle and orthophoto.

MDA Well Logs

Well name:	**DAW-01**	TD: 17.3 ft MP/TOC (15.2 ft below ground level)	
GWIC ID:	M:213970	SWL: 14.59 ft MP/TOC (12.49 ft below ground level)	
Date Drilled:	7/15/2004		
County:	Dawson	MP stick up: 2.1ft AGL	
TRS location:	AADB sec. 33, 14N 54E	MP Elevation ~2,127.1 ft	
DD latitude:	46.93		
DD longitude:	-104.8786		
Elevation:	~2,125 ft		
Logged by:	J. Rose		

Drilling Interval	Depth From (ft)	To (ft)	Lithology	Completion data From	Depth (BGL) To	Casing	Depth (BGL) From	To	Fill
0-5	0.0	2.0	Medium-light brown silt loam. Dry.Windrow dirt along fenceline.	0.0	5.0		0.0	1.5	cement
	2.0	4.0	Light brown, powdery, fine, silt. Dry.			blank (6.8 feet total)	1.5	3.9	bentonite chips
5-10	4.0	9.0	Light-brown, powdery, gritty texture silt with fine-grained sand. Damp.						
	9.0	10.0	Dark-brown silt with fine-grained sand and clay. Easy drilling. Damp.						
10-15	10.0	12.0	Dark brown clayey silt.	5.0	15.0	screen	3.9	15.2	washed pea gravel
	12.0	13.0	Gravels with dark-brown, plastic, sandy silt and clay. Very easy drilling.						
	13.0	15.0	Dark-brown medium-fine grained sand with clay and gravels						
	TD	**15.0 ft**		Total casing	14.7 ft				

2.5.4a

Figure 2.5.3a. Well log for DAW-01 (14N54E33AADB01).

MDA Well Logs

Well name:	**DAW-02**	TD:	25 ft
GWIC ID:	216273	SWL:	17.98 ft TOC (16.03 ft below ground level)
Date Drilled:	1/18/2005		
County:	Dawson	MP stick up:	1.95 ft AGL
TRS location:	AADB sec 33, 14N 54E	MP Elevation:	~2,126.95 ft
DD latitude	46.9266		
DD longitude	-104.8915	Flood irrigated crops. Rotation from corn to beets?, to grass hay.	
Elevation	~2,125 ft		
Logged by	J. Rose		

Drilling Interval	Depth From (ft)	To (ft)	Lithology
0-5	0.0	2.0	Dark brown clayey soil, packs in hand
	2.0	4.5	Light brown, powdery, dry silt with some clay. Grayish-brown 5YR 3/2
5-10	4.5	10.0	Dark brown silt, sandier, some clay. Very fine-grained sand. Easy drilling.
10-15	10.0	11.0	Dark brown, sandy-silt with clay, more clay, packs in hand.
	11.0	15.0	Pebbles and gravels in medium-dark brown, very-fine grained, silty clay, plastic, damp. Pebbles 1-3 inches in diameter.
15-20	15.0	18.0	Rounded coarse gravels and pebbles, 1-3 inches diameter, in dark-brown, fine-grained sand with silt and clay.
		18.0	More gravels. Grinding on augers.
20-25	20.0	23.0	More gravel and pebbles in sand/silt/clay. Tan, fine-grained sand with clay, balls-up loosely. Slower, rough drilling
	23.0	25.0	Very black organic mud, oily appearance. Very fine grained clay-silt with pebbles and coarse gravels. No odor. Auger sinks easily into very soft mud when released from drill string.
	TD	**25.0**	

Completion data	Depth (BGL)		Depth (BGL)		
From	to	Casing	From	To	Fill
			0.0	1.5	cement
			1.5	3.0	bentonite grout
0.0	12.5	blank (5.6 feet total)			
			3.0	10.0	backfill cuttings
12.5	22.5	screen	10.0	23.0	10/20 silica filter pack sand

2.5.4b

Figure 2.5.3b. Well log for DAW-02 (14N54E33AADB01).

Table 2.5.1 Water quality data for DAW-02 (14N54E33AADB01).

Ground-Water Information Center **Water Quality Report**

Site Name: MDA WELL DAW-02 **Report Date:** 6/18/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2005Q0338 / 216273
Location (TRS): 14N 54E 33 AADB
Latitude/Longitude: 46° 55' 54" N 104° 52' 57" W
Datum: NAD27
Altitude:
County/State: DAWSON / MT
Site Type: WELL
Geology:
USGS 7.5' Quad:
PWS Id:
Project: MDAPESTNET

Sample Date: 1/18/2005 1:40:00 PM
Agency/Sampler: MBMG / JCR
Field Number: 216273
Lab Date: 2/22/2005
Lab/Analyst: MBMG / WO
Sample Method/Handling: PUMPED / 3120
Procedure Type: DISSOLVED
Total Depth (ft): 25.000
SWL-MP (ft): NR
Depth Water Enters (ft): 12.500

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	72.000	3.593	Bicarbonate (HCO3)	566.100	9.278
Magnesium (Mg)	62.100	5.110	Carbonate (CO3)	0.000	0.000
Sodium (Na)	110.000	4.785	Chloride (Cl)	12.200	0.344
Potassium (K)	4.200	0.107	Sulfate (SO4)	215.000	4.478
Iron (Fe)	0.013	0.001	Nitrate (as N)	<0.5	0.000
Manganese (Mn)	0.697	0.025	Fluoride (F)	<0.5	0.000
Silica (SiO2)	19.800		Orthophosphate (OPO4)	<0.5	0.000
Total Cations		13.678	**Total Anions**		14.101

Trace Element Results (µg/L)

Aluminum (Al):	<30	Cadmium (Cd):	<1	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<2	Chromium (Cr):	<2	Molybdenum (Mo):	<10	Titanium (Ti):	1.020
Arsenic (As):	<1	Cobalt (Co):	<2	Nickel (Ni):	5.940	Thallium (Tl):	<5
Barium (Ba):	26.000	Copper (Cu):	2.290	Silver (Ag):	<1	Uranium (U):	14.600
Beryllium (Be):	<2	Lead (Pb):	<2	Selenium (Se):	<1	Vanadium (V):	<5
Boron (B):	304.000	Lithium (Li):	71.900	Strontium (Sr):	1,226.000	Zinc (Zn):	17.700
Bromide (Br):	<500					Zirconium (Zr):	<2

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	774.900	Field Hardness as CaCO3:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	1,062.130	Hardness as CaCO3:	435.390	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	1,060.000	Field Alkalinity as CaCO3:	NR	PCP (µg/L):	NR
Lab Conductivity (µmhos):	1,263.000	Akalinity as CaCO3:	464.300	Phosphate, TD (mg/L as P):	<0.05
Field pH:	7.000	Ryznar Stability Index:	6.422	Field Nitrate (mg/L):	NR
Lab pH:	7.530	Sodium Adsorption Ratio:	2.290	Field Dissolved O2 (mg/L):	NR
Water Temp (°C):	10.400	Langlier Saturation Index:	0.554	Field Chloride (mg/L):	NR
Air Temp (°C):	-6.000	Nitrite (mg/L as N):	<0.5	Field Redox (mV):	NR

Notes

Sample Condition: CLOUDY W/BLACK (ORGANIC?) SEDIMENT
Field Remarks:
Lab Remarks:

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **ft** = feet; **NR** = No Reading in GWIC

Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions; ***** = Duplicate analysis not within control limits; ****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO3, CO3, SO4, Cl, SiO2, NO3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.

Table 2.5.2--Water-quality comparison for well DAW-02 (14N54E33AADB01).

Drinking water limits are based on U.S. Environmental Protection Agency primary and secondary standards for public water supplies (view their standards). Stock water and irrigation water recommendations are from U.S. Department of Agriculture Natural Resources Conservation Service water-quality guidelines. The guidelines are general and my vary depending on specific applications. Irrigation guidelines are based on continuous irrigation.

Sample Id	GWIC Id	Sample Date	Site Name	Location	Site Type
2005Q0338	216273	1/18/2005 1:40:00 PM	MDA WELL DAW-02	14N 54E 33 AADB	WELL

Constituent	This Sample	Drinking Water	Stock Water	Irrigation Water
Calcium (Ca)	72.000 mg/L	---	---	---
Magnesium (Mg)	62.100 mg/L	---	2,000 mg/L	---
Sodium (Na)	110.000 mg/L	250 mg/L [smcl]	2,000 mg/L	see SAR
Potassium (K)	4.200 mg/L	---	---	---
Iron (Fe)	0.013 mg/L	0.3 mg/L [smcl]	---	---
Manganese (Mn)	0.697 mg/L	0.05 mg/L [smcl]	---	2.0 mg/L
Silica (SiO2)	19.800 mg/L	---	---	---
Bicarbonate (HCO3)	566.100 mg/L	---	---	---
Carbonate (CO3)	0.000 mg/L	---	---	---
Chloride (Cl)	12.200 mg/L	250 mg/L [smcl]	1,500 mg/L	---
Sulfate (SO4)	215.000 mg/L	250 mg/L [smcl]	1,500 mg/L	[b]
Nitrate (NO3 as N)	<0.5 mg/L	10 mg/L [mcl]	100 mg/L	---
Fluoride (F)	<0.5 mg/L	4 mg/L [mcl]	2 mg/L	---
Ortho-Phosphate (as P)	<0.5 mg/L	---	---	---
Aluminum (Al)	<30 ug/L	50-200 ug/L [smcl]	---	1,000 ug/L
Antimony (Sb)	<2 ug/L	6 ug/L [mcl]	---	---
Arsenic (As)	<1 ug/L	10 ug/L [mcl]	50 ug/L	100 ug/L
Barium (Ba)	26.000 ug/L	2,000 ug/L [mcl]	---	---
Boron (B)	304.000 ug/L	---	---	---
Cadmium (Cd)	<1 ug/L	5 ug/L [mcl]	10 ug/L	5 ug/L
Chromium (Cr)	<2 ug/L	100 ug/L [mcl]	1,000 ug/L	100 ug/L
Cobalt (Co)	<2 ug/L	---	1,000 ug/L	50 ug/L
Copper (Cu)	2.290 ug/L	1,300 ug/L [mcl]	500 ug/L	200 ug/L
Lead (Pb)	<2 ug/L	15 ug/L [mcl]	50 ug/L	5,000 ug/L
Lithium (Li)	71.900 ug/L	---	---	2,500 ug/L
Molybdenum (Mo)	<10 ug/L	---	---	5 ug/L
Nickel (Ni)	5.940 ug/L	---	---	200 ug/L
Phosphate (P)	<0.05 ug/L	---	---	---
Selenium (Se)	<1 ug/L	50 ug/L [mcl]	50 ug/L	20 ug/L
Silver (Ag)	<1 ug/L	100 ug/L [smcl]	---	---
Strontium (Sr)	1,226.000 ug/L	---	---	---
Titanium (Ti)	1.020 ug/L	---	---	---
Vanadium (V)	<5 ug/L	---	---	---
Zinc (Zn)	17.700 ug/L	5,000 ug/L [smcl]	24,000 ug/L	2,000 ug/L
Zirconium (Zr)	<2 ug/L	---	---	---

Key: **NR** = No reading in GWIC; **mg/L** = milligrams per Liter; **ug/L** = micrograms per Liter; **---** = Currently no standard for this constituent; **[b]** = High concentrations of sulfate may restrict calcium uptake by crops; **[c]** = Varies with crop, generally dissolved solids should be less than 2,000 mg/L (equivalent to specific conductance of about 2,000 to 3,000 micromhos/cm); **[d]** = Dependent upon other variables such as type of clay in soil and salt content of water. (See SAR); **[mcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999; **[smcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard.

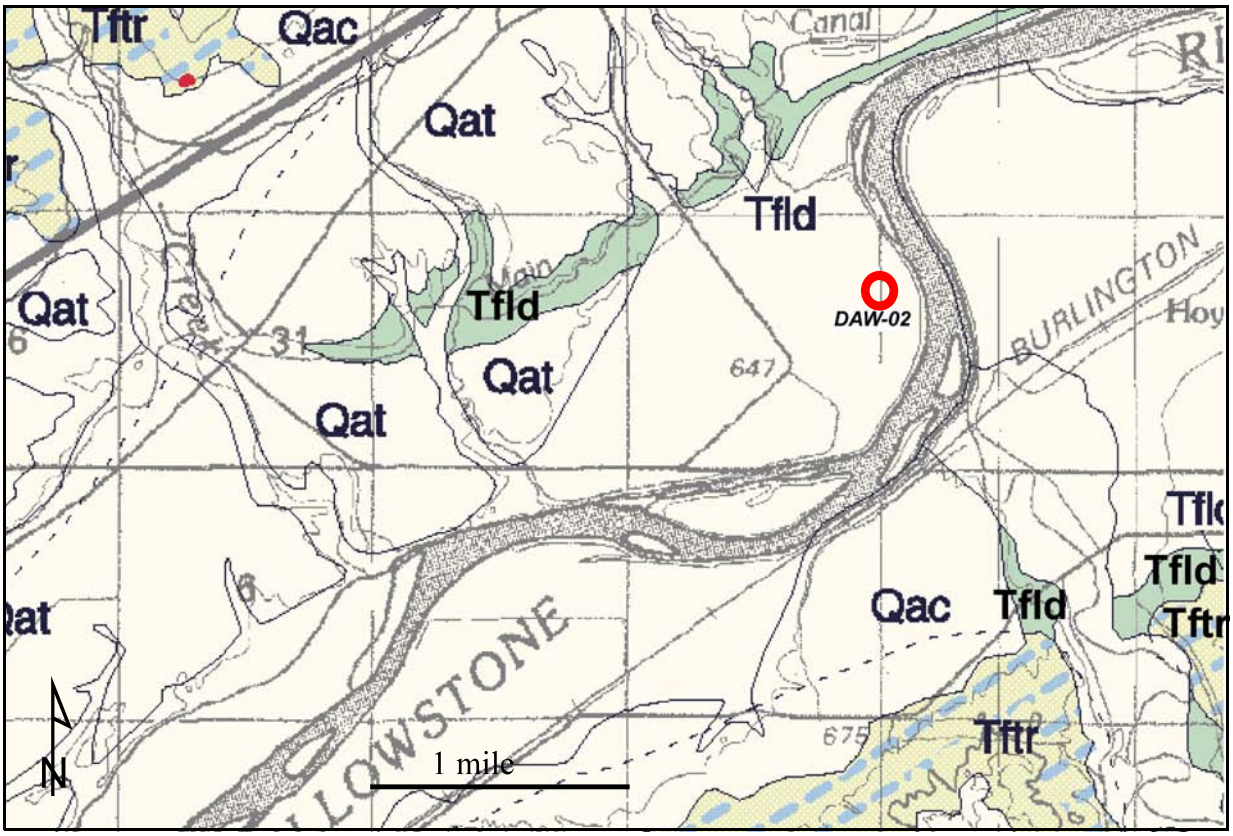


Figure 2.5.5 Geology of the area of well site DAW-01and DAW-02 on the Wibaux 30' x 60' quadrangle taken from Vuke and others (2003). The red circle is the approximate location of the well. Abbreviations: Qal = Quaternary alluvium; Qat = Quaternary terraces; Tfld = Ludlow Member of the Fort Union Formation; Tftr = Tongue River Member of the Fort Union Formation and Qac = alluvium and colluvium, grouped.

2.6 GLACIER COUNTY
37N05W12BDAD01
Well GLA-01

2.6.1 Site Location

A well was drilled in tracts BDAD sec. 12, T.37 N., R.05W, at an altitude of 3680 ft in Glacier County. The latitude (NAD27) is 48.9814 and longitude is -112.2036. Access is by road from Cut Bank Highway 214 north. The well is north of the Red River and east of Pearsons Coulee. It is in the Red Creek Oil Field.

2.6.2 Well Completion Details

- Driller: MBMG; Fred Schmidt
- Date: 09/28/2004
- Total depth: 20.0 ft
- Screened interval: 10.0 to 20.0 ft
- Yield: 1.5 gpm
- SWL: Dry

A well log is attached along with copy of the water-quality data (figure 2.4.3 and tables 2.4.1 and 2.4.2). Completion details and water-quality data also can be obtained online at the Montana Bureau of Mines and Geology's Ground-Water Information Center (GWIC) website at http://mbmggwic.mtech.edu/. The GWIC identification number for this well is 214375. The results of the pesticide analyses and minimum reporting levels are included in appendix 1.

2.6.3 Land Use

As depicted in 2.6.1 the land use is pasture land with dryland wheat upgradient from the site. The well is in a pasture at the fence adjacent to the wheat fields. Oil-well pump jacks are ¼-mile from the site.

2.6.4 Geology

The well was completed in the glacial deposits covering the Cretaceous Two Medicine Formation. Glacial till was at the surface including granitic cobbles and gravels.

a.

b.

Figure 2.6.1 a) The well site of GLA-01 (37N05W12BDAD01), upgradient view. b) Overview of cropland.

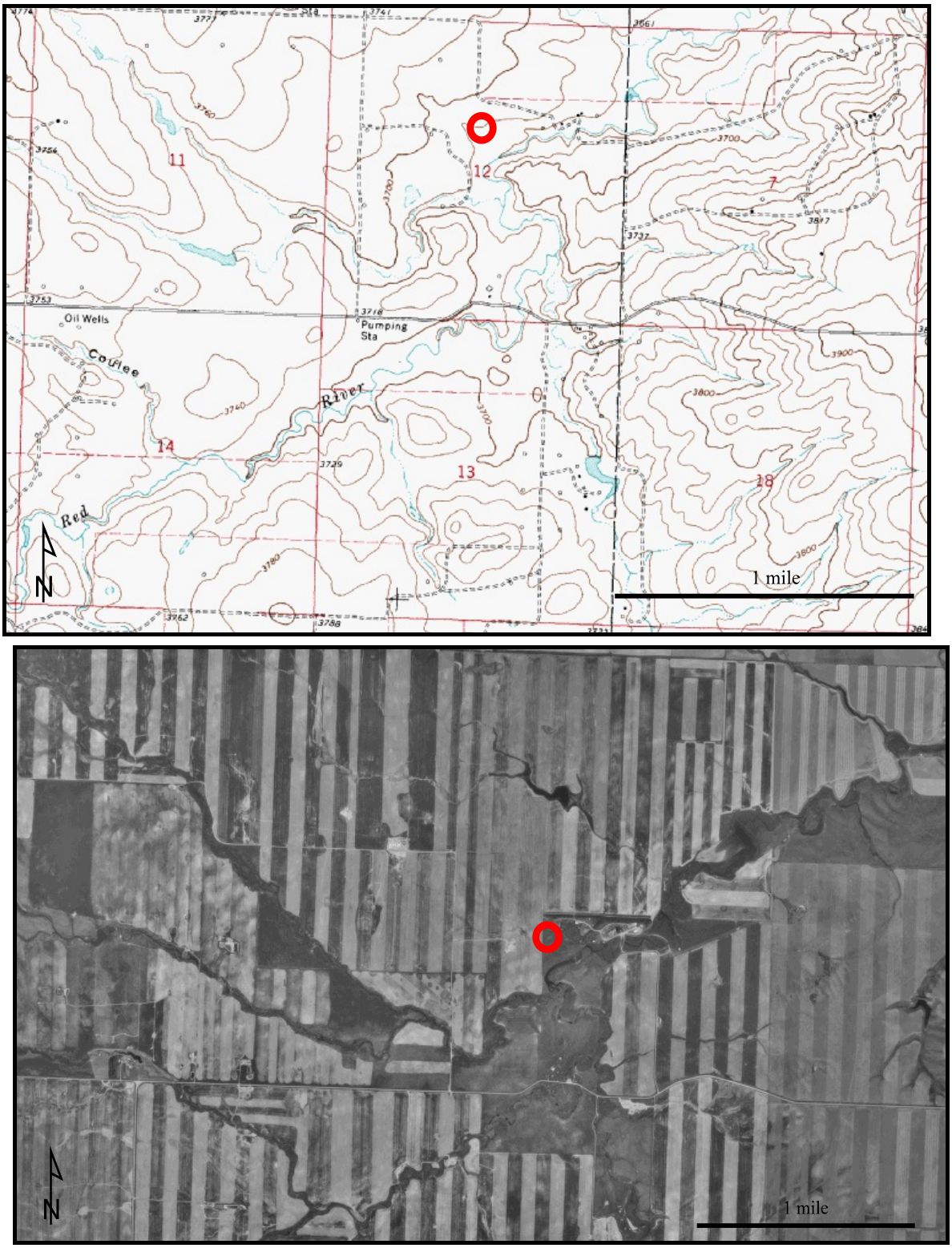


Figure 2.6.2 GLA-01 (37N05W12BDAD01), Fitzpatrick Lake 7.5-min. quadrangle, is located about 1.5 miles south of the US/Canadian border. The red circle is the approximate well location.

MDA Well Logs

Well name:	**GLA-01**	TD:	21.9 ft MP/TOC (20.0 ft below ground level)
GWIC ID:	M:214375	SWL:	DRY
Date Drilled:	9/28/2004		Well was dry at completion.
County:	Glacier	MP stick up:	1.9 ft AGL
TRS location:	BDAD sec. 12, 37N 05W	MP Elevation:	~3,666.9 ft
DD latitude:	48.9814		Dryland wheat upgradient from site. Oil-well pump jacks 1/4 mile from site. Well in pasture at fence to wheat fields. Bedrock sandstone Virgelle? Till at surface, granitic cobbles and gravels. Land surface is reworked till in drainage; at well is field blown silt windrow at fence line.
DD longitude:	-112.2036		
Elevation:	3,665 ft		
Logged by:	J. Rose		

Drilling Interval	Depth From (ft)	Depth To (ft)	Lithology
0-5	0.0	2.0	Silty loam with some clays. Very dry.
	2.0	5.0	Cobble. Grainy loam with clay
5-10	5.0	8.0	Gravels and cobbles in light-brown silt, very dry, caliche layer? Hard drilling. Very dry.
10-15	8.0	12.0	Dark to medium-brown sand from decomposed sandstone with clay, some gravels, and some cobbles. 11-12 feet damp sands at top of clay layer.
	12.0	15.0	Dark to medium-brown clay, soft, damp, balls-up in hand.
15-20	15.0	18.0	Clay with some sand, softer drilling.
	18.0	20.0	Medium-brown clay with some sand and few angular gravels. Clay stiffer but still soft, plastic, and moldable.
	TD	**20.0 ft**	Ground-water seep at bottom of sand unit on top of lower clay unit.

Completion data: Depth (BGL) From	To	Casing
0.0	10.0	blank (11.15 feet total)
10.0	20.0	screen

Depth (BGL) From	To	Fill
0.0	2.0	Cement
2.0	4.0	Backfill, natural materials from well cuttings
4.0	8.0	Bentonite chips
8.0	9.0	Backfill, natural materials from well cuttings
9.0	20.0	10/20 filter pack sand and washed pea gravel (about 10 gallons of gravel)

Figure 2.6.3 -- Well log for well GLA-01 (37N05W12BDAD01).

Table 2.6.1 Water quality for GLA-01 (37N05W12BDAD01).

Ground-Water Information Center **Water Quality Report**

Site Name: MDA WELL GLA-01 **Report Date:** 6/18/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2005Q0378 / 214375
Location (TRS): 37N 05W 12 BDAD
Latitude/Longitude: 48° 58' 53" N 112° 12' 12" W
Datum: NAD27
Altitude:
County/State: GLACIER / MT
Site Type: WELL
Geology:
USGS 7.5' Quad:
PWS Id:
Project: MDAPESTNET

Sample Date: 2/15/2005 1:35:00 PM
Agency/Sampler: MBMG / JCR
Field Number: 214375
Lab Date: 3/31/2005
Lab/Analyst: MBMG / WO
Sample Method/Handling: PUMPED / 3120
Procedure Type: DISSOLVED
Total Depth (ft): 21.900
SWL-MP (ft): NR
Depth Water Enters (ft): 10.000

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	359.000	17.914	Bicarbonate (HCO3)	352.000	5.769
Magnesium (Mg)	121.000	9.957	Carbonate (CO3)	0.000	0.000
Sodium (Na)	97.400	4.237	Chloride (Cl)	289.000	8.153
Potassium (K)	8.580	0.219	Sulfate (SO4)	822.000	17.122
Iron (Fe)	<0.05	0.000	Nitrate (as N)	28.400	2.027
Manganese (Mn)	0.355	0.013	Fluoride (F)	<1.0	0.000
Silica (SiO2)	15.200		Orthophosphate (OPO4)	<1.0	0.000
Total Cations		32.393	**Total Anions**		33.072

Trace Element Results (µg/L)

Aluminum (Al):	<30	Cadmium (Cd):	<1	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<10	Chromium (Cr):	<10	Molybdenum (Mo):	<10	Titanium (Ti):	2.380
Arsenic (As):	5.260	Cobalt (Co):	<2	Nickel (Ni):	3.150	Thallium (Tl):	<25
Barium (Ba):	49.000	Copper (Cu):	<10	Silver (Ag):	<5.0	Uranium (U):	15.500
Beryllium (Be):	<2	Lead (Pb):	<10	Selenium (Se):	<15	Vanadium (V):	<10
Boron (B):	68.300	Lithium (Li):	53.200	Strontium (Sr):	2,007.000	Zinc (Zn):	6.600
Bromide (Br):	<1000					Zirconium (Zr):	<2

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	1,914.340	Field Hardness as CaCO3:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	2,092.940	Hardness as CaCO3:	1,394.460	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	1,870.000	Field Alkalinity as CaCO3:	NR	PCP (µg/L):	NR
Lab Conductivity (µmhos):	2,880.000	Akalinity as CaCO3:	288.700	Phosphate, TD (mg/L as P):	<0.050
Field pH:	7.370	Ryznar Stability Index:	5.279	Field Nitrate (mg/L):	NR
Lab pH:	7.690	Sodium Adsorption Ratio:	1.140	Field Dissolved O2 (mg/L):	NR
Water Temp (°C):	5.600	Langlier Saturation Index:	1.206	Field Chloride (mg/L):	NR
Air Temp (°C):	-4.000	Nitrite (mg/L as N):	<1.0	Field Redox (mV):	NR

Notes

Sample Condition: CLEAR
Field Remarks:
Lab Remarks:

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **ft** = feet; **NR** = No Reading in GWIC

Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions; ***** = Duplicate analysis not within control limits; ****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO3, CO3, SO4, Cl, SiO2, NO3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.

Table 2.6.2--Water-quality comparison for well GLA-01 (37N05W12BDAD01).

Drinking water limits are based on U.S. Environmental Protection Agency primary and secondary standards for public water supplies (view their standards). Stock water and irrigation water recommendations are from U.S. Department of Agriculture Natural Resources Conservation Service water-quality guidelines. The guidelines are general and my vary depending on specific applications. Irrigation guidelines are based on continuous irrigation.

Sample Id	GWIC Id	Sample Date	Site Name	Location	Site Type
2005Q0378	214375	2/15/2005 1:35:00 PM	MDA WELL GLA-01	37N 05W 12 BDAD	WELL

Constituent	This Sample	Drinking Water	Stock Water	Irrigation Water
Calcium (Ca)	359.000 mg/L	---	---	---
Magnesium (Mg)	121.000 mg/L	---	2,000 mg/L	---
Sodium (Na)	97.400 mg/L	250 mg/L [smcl]	2,000 mg/L	see SAR
Potassium (K)	8.580 mg/L	---	---	---
Iron (Fe)	<0.05 mg/L	0.3 mg/L [smcl]	---	---
Manganese (Mn)	0.355 mg/L	0.05 mg/L [smcl]	---	2.0 mg/L
Silica (SiO2)	15.200 mg/L	---	---	---
Bicarbonate (HCO3)	352.000 mg/L	---	---	---
Carbonate (CO3)	0.000 mg/L	---	---	---
Chloride (Cl)	289.000 mg/L	250 mg/L [smcl]	1,500 mg/L	---
Sulfate (SO4)	822.000 mg/L	250 mg/L [smcl]	1,500 mg/L	[b]
Nitrate (NO3 as N)	28.400 mg/L	10 mg/L [mcl]	100 mg/L	---
Fluoride (F)	<1.0 mg/L	4 mg/L [mcl]	2 mg/L	---
Ortho-Phosphate (as P)	<1.0 mg/L	---	---	---
Aluminum (Al)	<30 ug/L	50-200 ug/L [smcl]	---	1,000 ug/L
Antimony (Sb)	<10 ug/L	6 ug/L [mcl]	---	---
Arsenic (As)	5.260 ug/L	10 ug/L [mcl]	50 ug/L	100 ug/L
Barium (Ba)	49.000 ug/L	2,000 ug/L [mcl]	---	---
Boron (B)	68.300 ug/L	---	---	---
Cadmium (Cd)	<1 ug/L	5 ug/L [mcl]	10 ug/L	5 ug/L
Chromium (Cr)	<10 ug/L	100 ug/L [mcl]	1,000 ug/L	100 ug/L
Cobalt (Co)	<2 ug/L	---	1,000 ug/L	50 ug/L
Copper (Cu)	<10 ug/L	1,300 ug/L [mcl]	500 ug/L	200 ug/L
Lead (Pb)	<10 ug/L	15 ug/L [mcl]	50 ug/L	5,000 ug/L
Lithium (Li)	53.200 ug/L	---	---	2,500 ug/L
Molybdenum (Mo)	<10 ug/L	---	---	5 ug/L
Nickel (Ni)	3.150 ug/L	---	---	200 ug/L
Phosphate (P)	<0.050 ug/L	---	---	---
Selenium (Se)	<15 ug/L	50 ug/L [mcl]	50 ug/L	20 ug/L
Silver (Ag)	<5.0 ug/L	100 ug/L [smcl]	---	---
Strontium (Sr)	2,007.000 ug/L	---	---	---
Titanium (Ti)	2.380 ug/L	---	---	---
Vanadium (V)	<10 ug/L	---	---	---
Zinc (Zn)	6.600 ug/L	5,000 ug/L [smcl]	24,000 ug/L	2,000 ug/L
Zirconium (Zr)	<2 ug/L	---	---	---

Key: **NR** = No reading in GWIC; **mg/L** = milligrams per Liter; **ug/L** = micrograms per Liter; **---** = Currently no standard for this constituent; **[b]** = High concentrations of sulfate may restrict calcium uptake by crops; **[c]** = Varies with crop, generally dissolved solids should be less than 2,000 mg/L (equivalent to specific conductance of about 2,000 to 3,000 micromhos/cm); **[d]** = Dependent upon other variables such as type of clay in soil and salt content of water. (See SAR); **[mcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999; **[smcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard.

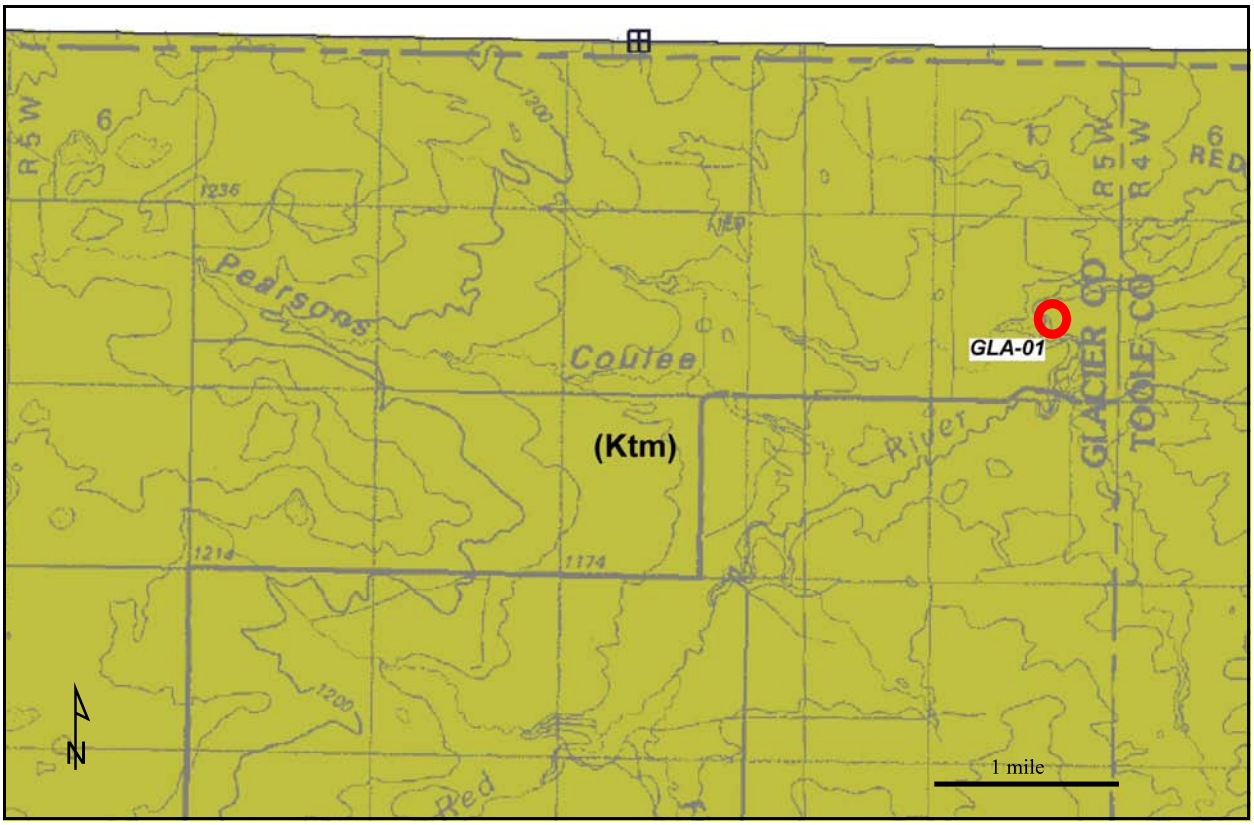


Figure 2.6.4 Geology consists of the Cretaceous Two Medicine Formation covered by glacial deposits in the area of well site GLA-01 on the Cut Bank 30’ x 60’ quadrangle taken from Berg (2002).

2.7 HILL COUNTY
34N11E15DBCC01
Well HIL-01

2.7.1 Site Location

A well was drilled in tracts DBCC sec. 15, T.34 N., R.11E., at an altitude of 2,803 ft in Hill County. The latitude (NAD27) is 48.7003 and longitude is -110.2758. Access is by road. This was the second attempt at drilling a well at this approximate location. The 2nd attempt was in the drainage bottom near a seep discharge east of the previous well on the same drainage. There were grain silos on the east side of the road and an old house foundation on the west side. The well was located down a two-track road to the east. Access is by taking north Gildford road to two grain silos and house foundation; right on 2-track north of section 2 between fields in to Spring Coulee.

2.7.2 Well Completion Details

- Driller: MBMG; Fred Schmidt
- Date: 07/13/2004
- Total depth: 14.0 ft
- Screened interval: 4.0 to 14.0 ft
- Yield: < 1 gpm
- SWL: Dry

A well log is attached along with copy of the water-quality data (figure 2.4.3 and tables 2.4.1 and 2.4.2). Completion details and water-quality data also can be obtained online at the Montana Bureau of Mines and Geology's Ground-Water Information Center (GWIC) website at http://mbmggwic.mtech.edu/. The GWIC identification number for this well is 213968. The results of the pesticide analyses and minimum reporting levels are included in appendix 1.

2.7.3 Land Use

As depicted in 2.7.1, the land use is primarily dryland wheat. Upgradient, was CRP land with alfalfa.

2.7.4 Geology

The well was completed in glacial deposits overlying Judith River Formation (Kjr). The well encountered clay from 0 to 14 ft with very few gravels (figure 2.7.4). Quaternary alluvium and colluvium is in the active stream beds (Qac).

a.

b.

Figure 2.7.1– a) The well site HIL-01 (34N11E15DBCC01). b) Sampling the well in February of 2005.

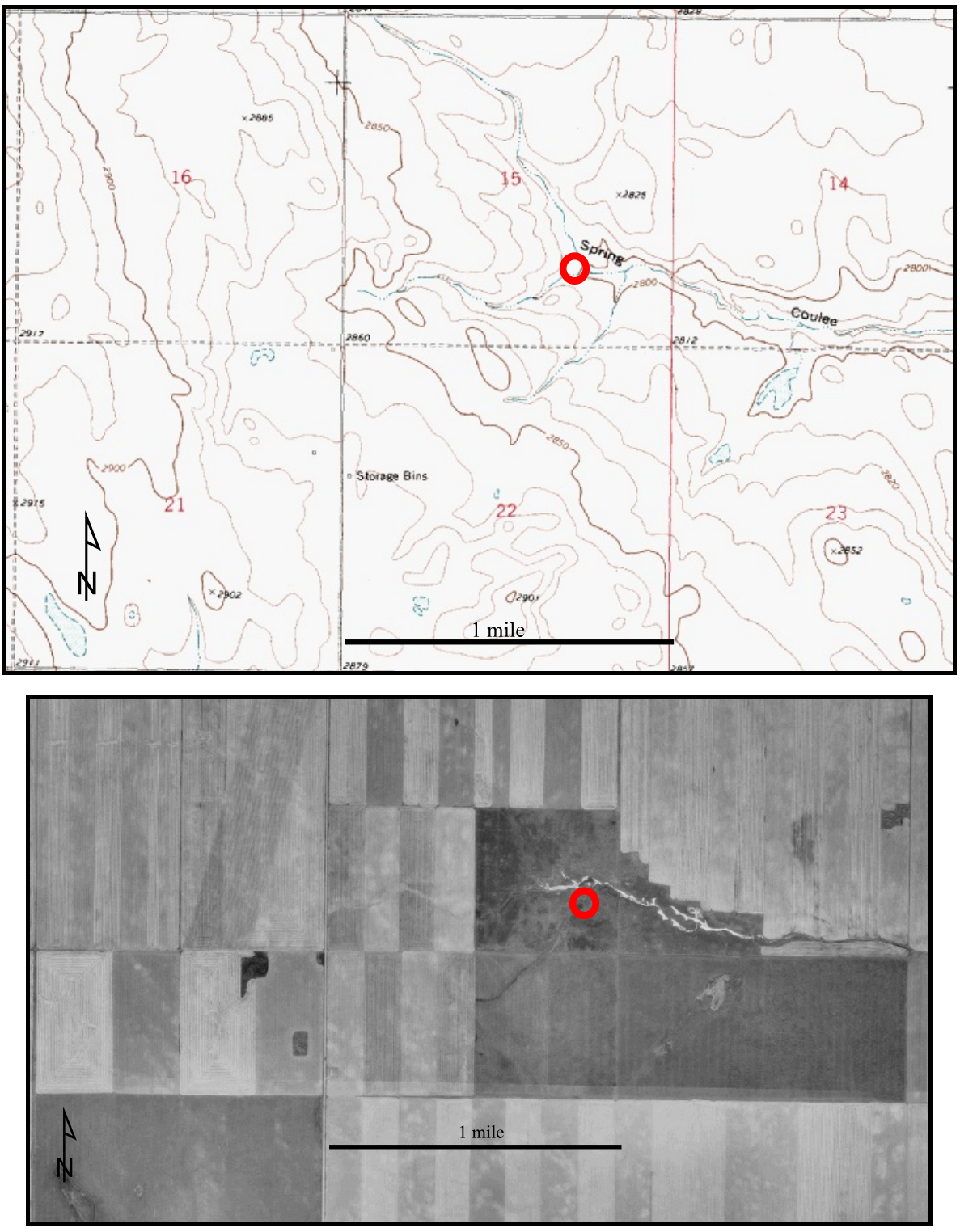


Figure 2.7.2–Well HIL-01 (34N11E15DBCC01) is located about 10-miles north of Gildford on the Gildford NE 7.5-min quadrangle. The red circle is the approximate location of the well.

MDA Well Logs

Well name:	**HIL-01**	TD:	16 ft MP/TOC (14.2 ft below ground level)
GWIC ID:	M:213968	SWL:	Dry
Date Drilled:	7/13/2004		
County:	Hill	MP stick up:	1.8 ft AGL
TRS location:	DBCC sec, 15, 34N 11E	MP Elevation:	2,801.8 ft (est.)
			Well in dryland wheat area. Upgradient is CRP land in alfalfa established to reduce saline seep along drainage near well site. Alfalfa will use near surface water and reduce water infiltration in to ground in well site drainage; its intended purpose.
DD latitude:	48.7003		Till gravels are granitic and arkosic.
DD longitude:	-110.2758		
Elevation:	2,800 ft		
Logged by:	J. Rose		

Drilling Interval	Depth From (ft)	To (ft)	Lithology
0-5	0.0	3.0	Medium-dark brown, Fine-grained powdery, silty loam. Very dry.
5-10	3.0	6.5	Green-brown, silty clay, plastic, balls-up in hand, plastic, gritty. Dry silt.
	6.5	7.0	Same clay, tighter drilling, very few gravels.
	7.0	8.0	Green-brown, silty-sandy clay, plastic. Feels dry.
	8.0	9.0	Green-gray clay, more clay content, plastic, very soft drilling.
10-15	9.0	12.0	Green-brown, gritty, silty-clay, plastic. Feels dry.
	12.0	14.0	Brown, stiff, silty clay. Feels dry.
	TD	**14.0 ft**	On bedrock

Note: First well site, dry hole at 9 feet, to bedrock surface. Moved down hill along drainage for new well site.

Completion data	Depth (BGL) From	Depth (BGL) To	Casing
	0.0	4.0	Blank (total 5.7 feet)
	4.0	14.0	Screen

Depth (BGL) From	Depth (BGL) To	Fill
0.0	3.0	backfill, natural cuttings from well. Cement cap at surface.
3.0	14.0	10/20 Filter pack sand

Figure 2.7.3. Well log for HIL-01 (34N11E15DBCC01).

Table 2.7.1 Water quality for HIL-01 (34N11E15DBCC01).

Ground-Water Information Center **Water Quality Report**

Site Name: MDA WELL HIL-01 **Report Date:** 6/18/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2005Q0377 / 213968
Location (TRS): 34N 11E 15 DBCC
Latitude/Longitude: 48° 42' 1" N 110° 16' 32" W
Datum: NAD27
Altitude: 2800.00
County/State: HILL / MT
Site Type: WELL
Geology:
USGS 7.5' Quad: GILDFORD NE
PWS Id:
Project: MDAPESTNET

Sample Date: 2/15/2005 9:45:00 AM
Agency/Sampler: MBMG / JCR
Field Number: 213968
Lab Date: 3/31/2005
Lab/Analyst: MBMG / WO
Sample Method/Handling: PUMPED / 3120
Procedure Type: DISSOLVED
Total Depth (ft): 14.000
SWL-MP (ft): NR
Depth Water Enters (ft): 4.000

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	428.000	21.357	Bicarbonate (HCO3)	683.000	11.194
Magnesium (Mg)	1,026.000	84.430	Carbonate (CO3)	0.000	0.000
Sodium (Na)	4,655.000	202.493	Chloride (Cl)	80.200	2.262
Potassium (K)	18.300	0.468	Sulfate (SO4)	14,580.000	303.701
Iron (Fe)	<0.05	0.000	Nitrate (as N)	22.000	1.571
Manganese (Mn)	0.030	0.001	Fluoride (F)	<5	0.000
Silica (SiO2)	15.600		Orthophosphate (OPO4)	<5	0.000
Total Cations		309.190	**Total Anions**		318.729

Trace Element Results (µg/L)

Aluminum (Al):	<100	Cadmium (Cd):	<10	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<20	Chromium (Cr):	<20	Molybdenum (Mo):	<100	Titanium (Ti):	<10
Arsenic (As):	<10	Cobalt (Co):	<20	Nickel (Ni):	<20	Thallium (Tl):	<50
Barium (Ba):	<20	Copper (Cu):	61.100	Silver (Ag):	<10	Uranium (U):	403.000
Beryllium (Be):	<20	Lead (Pb):	<20	Selenium (Se):	49.200	Vanadium (V):	<50
Boron (B):	1,860.000	Lithium (Li):	1,811.000	Strontium (Sr):	11,622.000	Zinc (Zn):	59.400
Bromide (Br):	<5000					Zirconium (Zr):	<20

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	21,161.700	Field Hardness as CaCO3:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	21,508.250	Hardness as CaCO3:	5,291.730	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	7,100.000	Field Alkalinity as CaCO3:	NR	PCP (µg/L):	NR
Lab Conductivity (µmhos):	15,180.000	Akalinity as CaCO3:	560.180	Phosphate, TD (mg/L as P):	<0.50
Field pH:	7.610	Ryznar Stability Index:	4.400	Field Nitrate (mg/L):	NR
Lab pH:	7.840	Sodium Adsorption Ratio:	27.840	Field Dissolved O2 (mg/L):	NR
Water Temp (°C):	5.100	Langlier Saturation Index:	1.720	Field Chloride (mg/L):	NR
Air Temp (°C):	-9.400	Nitrite (mg/L as N):	<5.0	Field Redox (mV):	NR

Notes

Sample Condition: CLEAR
Field Remarks:
Lab Remarks:

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **ft** = feet; **NR** = No Reading in GWIC

Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions; ***** = Duplicate analysis not within control limits; ****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO3, CO3, SO4, Cl, SiO2, NO3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.

Table 2.7.2 -- Water-quality comparison for well HIL-01 (34N11E15DBCC01).

Drinking water limits are based on U.S. Environmental Protection Agency primary and secondary standards for public water supplies (view their standards). Stock water and irrigation water recommendations are from U.S. Department of Agriculture Natural Resources Conservation Service water-quality guidelines. The guidelines are general and my vary depending on specific applications. Irrigation guidelines are based on continuous irrigation.

Sample Id	GWIC Id	Sample Date	Site Name	Location	Site Type
2005Q0377	213968	2/15/2005 9:45:00 AM	MDA WELL HIL-01	34N 11E 15 DBCC	WELL

Constituent	This Sample	Drinking Water	Stock Water	Irrigation Water
Calcium (Ca)	428.000 mg/L	---	---	---
Magnesium (Mg)	1,026.000 mg/L	---	2,000 mg/L	---
Sodium (Na)	4,655.000 mg/L	250 mg/L [smcl]	2,000 mg/L	see SAR
Potassium (K)	18.300 mg/L	---	---	---
Iron (Fe)	<0.05 mg/L	0.3 mg/L [smcl]	---	---
Manganese (Mn)	0.030 mg/L	0.05 mg/L [smcl]	---	2.0 mg/L
Silica (SiO2)	15.600 mg/L	---	---	---
Bicarbonate (HCO3)	683.000 mg/L	---	---	---
Carbonate (CO3)	0.000 mg/L	---	---	---
Chloride (Cl)	80.200 mg/L	250 mg/L [smcl]	1,500 mg/L	---
Sulfate (SO4)	14,580.000 mg/L	250 mg/L [smcl]	1,500 mg/L	[b]
Nitrate (NO3 as N)	22.000 mg/L	10 mg/L [mcl]	100 mg/L	---
Fluoride (F)	<5 mg/L	4 mg/L [mcl]	2 mg/L	---
Ortho-Phosphate (as P)	<5 mg/L	---	---	---
Aluminum (Al)	<100 ug/L	50-200 ug/L [smcl]	---	1,000 ug/L
Antimony (Sb)	<20 ug/L	6 ug/L [mcl]	---	---
Arsenic (As)	<10 ug/L	10 ug/L [mcl]	50 ug/L	100 ug/L
Barium (Ba)	<20 ug/L	2,000 ug/L [mcl]	---	---
Boron (B)	1,860.000 ug/L	---	---	---
Cadmium (Cd)	<10 ug/L	5 ug/L [mcl]	10 ug/L	5 ug/L
Chromium (Cr)	<20 ug/L	100 ug/L [mcl]	1,000 ug/L	100 ug/L
Cobalt (Co)	<20 ug/L	---	1,000 ug/L	50 ug/L
Copper (Cu)	61.100 ug/L	1,300 ug/L [mcl]	500 ug/L	200 ug/L
Lead (Pb)	<20 ug/L	15 ug/L [mcl]	50 ug/L	5,000 ug/L
Lithium (Li)	1,811.000 ug/L	---	---	2,500 ug/L
Molybdenum (Mo)	<100 ug/L	---	---	5 ug/L
Nickel (Ni)	<20 ug/L	---	---	200 ug/L
Phosphate (P)	<0.50 ug/L	---	---	---
Selenium (Se)	49.200 ug/L	50 ug/L [mcl]	50 ug/L	20 ug/L
Silver (Ag)	<10 ug/L	100 ug/L [smcl]	---	---
Strontium (Sr)	11,622.000 ug/L	---	---	---
Titanium (Ti)	<10 ug/L	---	---	---
Vanadium (V)	<50 ug/L	---	---	---
Zinc (Zn)	59.400 ug/L	5,000 ug/L [smcl]	24,000 ug/L	2,000 ug/L
Zirconium (Zr)	<20 ug/L	---	---	---

Key: **NR** = No reading in GWIC; **mg/L** = milligrams per Liter; **ug/L** = micrograms per Liter; **---** = Currently no standard for this constituent; **[b]** = High concentrations of sulfate may restrict calcium uptake by crops; **[c]** = Varies with crop, generally dissolved solids should be less than 2,000 mg/L (equivalent to specific conductance of about 2,000 to 3,000 micromhos/cm); **[d]** = Dependent upon other variables such as type of clay in soil and salt content of water. (See SAR); **[mcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999; **[smcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard.

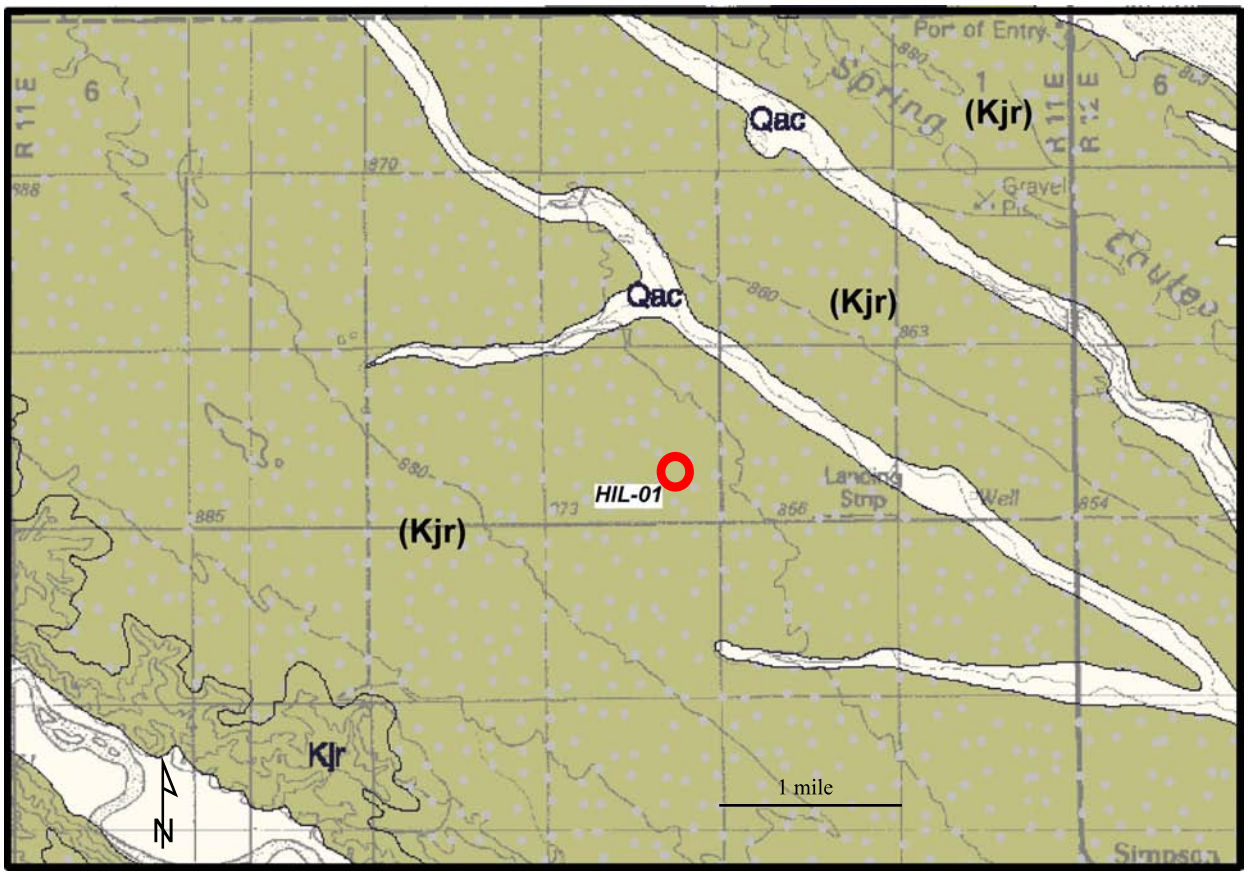


Figure 2.7.4 –Well HIL-01 (34N11E15DBCC01). Geology consists of the Judith River Formation(Kjr) covered by glacial deposits (stippled pattern) and Quaternary alluvium-colluvium (Qac) in the area of well site HIL-01 on the Chester 30’ x 60’ quadrangle taken from Lopez (2001). The red circle is the approximate location of the well.

2.8 LAKE COUNTY
25N19W32DBBC01
Well LAK-01

2.8.1 Site Location

A well was drilled in tracts DBBC sec. 32, T.25 N., R.19W., at an altitude of 2,925 ft in Lake County (figure 2.8.1). The latitude (NAD27) is 47.8802 and longitude is -114.0323. Access is by road from The University of Montana's Flathead Lake Biological Station. The well is on the northwest side of the property on a lower bench above seeps (figure 2.8.2).

2.8.2 Well Completion Details

- Driller: MBMG; Fred Schmidt
- Date: 09/02/2004
- Total depth: 30.0 ft
- Screened interval: 20.0 to 30.0 ft
- Yield: 1 gpm
- SWL: 15.83 ft BGL

A well log is attached along with copy of the water-quality data (figure 2.8.3 and tables 2.8.1 and 2.8.2). Completion details and water-quality data also can be obtained online at the Montana Bureau of Mines and Geology's Ground-Water Information Center (GWIC) website at http://mbmggwic.mtech.edu/. The GWIC identification number for this well is 213971. The results of the pesticide analyses and minimum reporting levels are included in appendix 1.

2.8.3 Land Use

As depicted in 2.8.1, the land use is primarily thinned Lodgepole forest along the Flathead Lake shore. Cherry orchards and a state highway were upgradient.

2.8.4 Geology

The well was completed in glacial gravels covering the faulted Precambrian Helena Formation to the north and Precambrian Spokane Formation to the south (figure 2.8.4). Glacial deposits occur along the shoreline to the east. It encountered mostly clay with some sand and gravel lenses from 0 to 30 ft. Dense clay is a local feature; the static water level is confined by the clay. This clay, from 9.5 to 20.0 ft, is possibly a small lake deposit or near shore lake deposit.

a.

b.

Figure 2.8.1 – a)Well LAK-01 (25N19W32DBBC01) was completed at the U of M Flathead Lake Biological Station in a stand of thinned Ponderosa Pine. b) Orchards are located upgradient from the well.

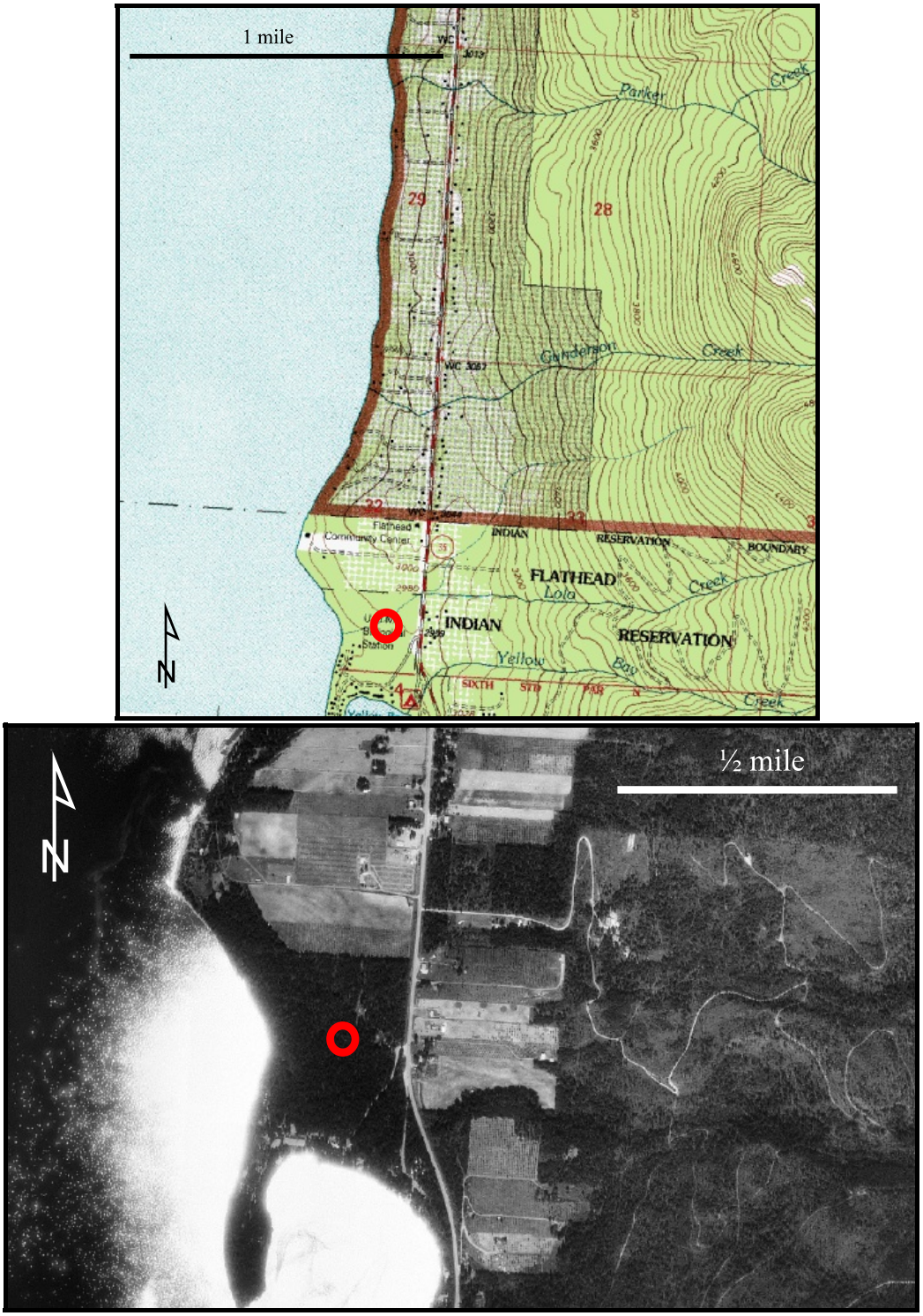


Figure 2.8.2 Well LAK-01 (25N19W32DBBC01) is located at the U of M Flathead Lake Biological Station on the Woods Bay 7.5-min. quadrangle and orthophoto quadrangle. The red circle is the approximate location of the well.

MDA Well Logs

Well name:	**LAK-01**	TD: 32.4 ft MP/TOC (29.5 ft below ground level)	
GWIC ID:	M:213971	SWL: 18.73 ft MP/TOC (15.83 ft below ground level)	
Date Drilled:	9/2/2004		
County:	Lake	MP stick up: 2.9 ft AGL	
TRS location:	DBBC sec. 32, 25N 19W	MP Elevation: ~2,967.9 ft	
DD latitude:	47.8802		
DD longitude:	-114.0323	Site in thinned Lodgepole forest along Flathead lakeshore	
Elevation:	~2,965 ft	upgradient are cherry orchards and state highway.	
Logged by:	J. Rose		
		Dense clay at 9.5-20.0 feet is a local feature, possibly a small lake or pond deposit or near shore lake deposit.	

Drilling Interval	Depth From (ft)	To (ft)	Lithology	split spoon length 2.5 feet split spoon sampler recovery (feet)
0-2.5	0.0	0.5	Black topsoil and forest duff. Fist-sized and larger rounded cobbles on land surface.	0 (cobbles)
	0.5	2.5	Fist-sized and larger rounded cobbles on land surface.	0 (cobbles)
2.5-5.0	2.5	5.0	Tan-grey, soft clay with sand and some gravels.	
5.0-7.5	5.0	7.5	Grey sand with clay, sandy texture, finely layered with local FeO staining dry.	1.5
7.5-10.0	7.5	9.5	Grey, layered, medium-fine grained sand, tightly packed, with some cobbles.	-
10-12.5	9.5	11.0	Grey-pink, dense, plastic, hard and heavy clay with some FeO staining. Wet at bottom 0.2 feet.	2.0
12.5-15.0	11.0	12.5	Gravels and cobbles in grey-pink dense clay. Two thin, medium-fine grained, dry sand layers. Clay is damp.	
10-15	12.5	20.0	Grey-pink, soft clay, very plastic, dense	
15-25	20.0	26.0	Tan, sandy clay, very soft, fast drilling. Wet.	
25-30	26.0	26.5	Cobbles, rough drilling	
	26.5	30.0	Tan, sandy clay with black, medium-fine grained, angular gravels	
	TD	**30.0**		

Used 6-inch diameter augers and split spoon sampled to 15.0 feet. At 15 feet could not get spoon back in casing. Switched to 8-inch augers with center plug bit and redrilled to 12.5 feet.

Completion data	Depth (BGL)		Depth (BGL)		
From	To	Casing	From	To	Fill
			0.0	2.0	bentonite chips and cement at surface.
0.0	20.0 (22.3 feet total blank casing)	blank	2.0	18.0	backfill with cuttings, clay and sandy clay.
20.0	30.0	screen	18.0	30.0	10/20 filter-pack sand

Figure 2.8.3 -- Well log for well LAK-01 (25N19W32DBBC01).

Table 2.8.1 -- Water quality for well LAK-01 (25N19W32DBBC01).

Ground-Water Information Center **Water Quality Report**

Site Name: MDA WELL LAK-01 **Report Date:** 6/18/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2005Q0276 / 213971
Location (TRS): 25N 19W 32 DBBC
Latitude/Longitude: 47° 52' 48" N 114° 1' 56" W
Datum: NAD27
Altitude:
County/State: LAKE / MT
Site Type: WELL
Geology:
USGS 7.5' Quad:
PWS Id:
Project: MDAPESTNET

Sample Date: 10/27/2004 3:15:00 PM
Agency/Sampler: MBMG / JCR
Field Number: 213971
Lab Date: 11/30/2004
Lab/Analyst: MBMG / WO
Sample Method/Handling: PUMPED / 3120
Procedure Type: DISSOLVED
Total Depth (ft): 32.400
SWL-MP (ft): NR
Depth Water Enters (ft): 20.000

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	124.000	6.188	Bicarbonate (HCO3)	415.400	6.808
Magnesium (Mg)	19.300	1.588	Carbonate (CO3)	0.000	0.000
Sodium (Na)	3.190	0.139	Chloride (Cl)	3.270	0.092
Potassium (K)	2.320	0.059	Sulfate (SO4)	7.270	0.151
Iron (Fe)	0.005	0.000	Nitrate (as N)	6.930	0.495
Manganese (Mn)	<0.001	0.000	Fluoride (F)	<0.05	0.000
Silica (SiO2)	25.700		Orthophosphate (OPO4)	<0.05	0.000
Total Cations		7.987	**Total Anions**		7.547

Trace Element Results (µg/L)

Aluminum (Al):	<10	Cadmium (Cd):	<1	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<2	Chromium (Cr):	<2	Molybdenum (Mo):	<10	Titanium (Ti):	<1
Arsenic (As):	<1	Cobalt (Co):	<2	Nickel (Ni):	4.120	Thallium (Tl):	<5
Barium (Ba):	323.000	Copper (Cu):	<2	Silver (Ag):	<1	Uranium (U):	0.898
Beryllium (Be):	<2	Lead (Pb):	<2	Selenium (Se):	<1	Vanadium (V):	<5
Boron (B):	104.000	Lithium (Li):	8.120	Strontium (Sr):	150.000	Zinc (Zn):	<2
Bromide (Br):	<50					Zirconium (Zr):	<2

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	396.620	Field Hardness as CaCO3:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	607.380	Hardness as CaCO3:	389.070	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	520.000	Field Alkalinity as CaCO3:	NR	PCP (µg/L):	NR
Lab Conductivity (µmhos):	655.000	Akalinity as CaCO3:	340.700	Phosphate, TD (mg/L as P):	<0.05
Field pH:	7.300	Ryznar Stability Index:	6.368	Field Nitrate (mg/L):	NR
Lab pH:	7.380	Sodium Adsorption Ratio:	0.070	Field Dissolved O2 (mg/L):	NR
Water Temp (°C):	9.600	Langlier Saturation Index:	0.506	Field Chloride (mg/L):	NR
Air Temp (°C):	NR	Nitrite (mg/L as N):	<0.05	Field Redox (mV):	NR

Notes

Sample Condition: SILTY/TURBID.
Field Remarks:
Lab Remarks:

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **ft** = feet; **NR** = No Reading in GWIC

Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions; ***** = Duplicate analysis not within control limits; ****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO3, CO3, SO4, Cl, SiO2, NO3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.

Table 2.8.2--Water-quality comparison for well LAK-01 (25N19W32DBBC01).

Drinking water limits are based on U.S. Environmental Protection Agency primary and secondary standards for public water supplies (view their standards). Stock water and irrigation water recommendations are from U.S. Department of Agriculture Natural Resources Conservation Service water-quality guidelines. The guidelines are general and my vary depending on specific applications. Irrigation guidelines are based on continuous irrigation.

Sample Id	GWIC Id	Sample Date	Site Name	Location	Site Type
2005Q0276	213971	10/27/2004 3:15:00 PM	MDA WELL LAK-01	25N 19W 32 DBBC	WELL

Constituent	This Sample	Drinking Water	Stock Water	Irrigation Water
Calcium (Ca)	124.000 mg/L	---	---	---
Magnesium (Mg)	19.300 mg/L	---	2,000 mg/L	---
Sodium (Na)	3.190 mg/L	250 mg/L [smcl]	2,000 mg/L	see SAR
Potassium (K)	2.320 mg/L	---	---	---
Iron (Fe)	0.005 mg/L	0.3 mg/L [smcl]	---	---
Manganese (Mn)	<0.001 mg/L	0.05 mg/L [smcl]	---	2.0 mg/L
Silica (SiO2)	25.700 mg/L	---	---	---
Bicarbonate (HCO3)	415.400 mg/L	---	---	---
Carbonate (CO3)	0.000 mg/L	---	---	---
Chloride (Cl)	3.270 mg/L	250 mg/L [smcl]	1,500 mg/L	---
Sulfate (SO4)	7.270 mg/L	250 mg/L [smcl]	1,500 mg/L	[b]
Nitrate (NO3 as N)	6.930 mg/L	10 mg/L [mcl]	100 mg/L	---
Fluoride (F)	<0.05 mg/L	4 mg/L [mcl]	2 mg/L	---
Ortho-Phosphate (as P)	<0.05 mg/L	---	---	---
Aluminum (Al)	<10 ug/L	50-200 ug/L [smcl]	---	1,000 ug/L
Antimony (Sb)	<2 ug/L	6 ug/L [mcl]	---	---
Arsenic (As)	<1 ug/L	10 ug/L [mcl]	50 ug/L	100 ug/L
Barium (Ba)	323.000 ug/L	2,000 ug/L [mcl]	---	---
Boron (B)	104.000 ug/L	---	---	---
Cadmium (Cd)	<1 ug/L	5 ug/L [mcl]	10 ug/L	5 ug/L
Chromium (Cr)	<2 ug/L	100 ug/L [mcl]	1,000 ug/L	100 ug/L
Cobalt (Co)	<2 ug/L	---	1,000 ug/L	50 ug/L
Copper (Cu)	<2 ug/L	1,300 ug/L [mcl]	500 ug/L	200 ug/L
Lead (Pb)	<2 ug/L	15 ug/L [mcl]	50 ug/L	5,000 ug/L
Lithium (Li)	8.120 ug/L	---	---	2,500 ug/L
Molybdenum (Mo)	<10 ug/L	---	---	5 ug/L
Nickel (Ni)	4.120 ug/L	---	---	200 ug/L
Phosphate (P)	<0.05 ug/L	---	---	---
Selenium (Se)	<1 ug/L	50 ug/L [mcl]	50 ug/L	20 ug/L
Silver (Ag)	<1 ug/L	100 ug/L [smcl]	---	---
Strontium (Sr)	150.000 ug/L	---	---	---
Titanium (Ti)	<1 ug/L	---	---	---
Vanadium (V)	<5 ug/L	---	---	---
Zinc (Zn)	<2 ug/L	5,000 ug/L [smcl]	24,000 ug/L	2,000 ug/L
Zirconium (Zr)	<2 ug/L	---	---	---

Key: **NR** = No reading in GWIC; **mg/L** = milligrams per Liter; **ug/L** = micrograms per Liter; **---** = Currently no standard for this constituent; **[b]** = High concentrations of sulfate may restrict calcium uptake by crops; **[c]** = Varies with crop, generally dissolved solids should be less than 2,000 mg/L (equivalent to specific conductance of about 2,000 to 3,000 micromhos/cm); **[d]** = Dependent upon other variables such as type of clay in soil and salt content of water. (See SAR); **[mcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999; **[smcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard.

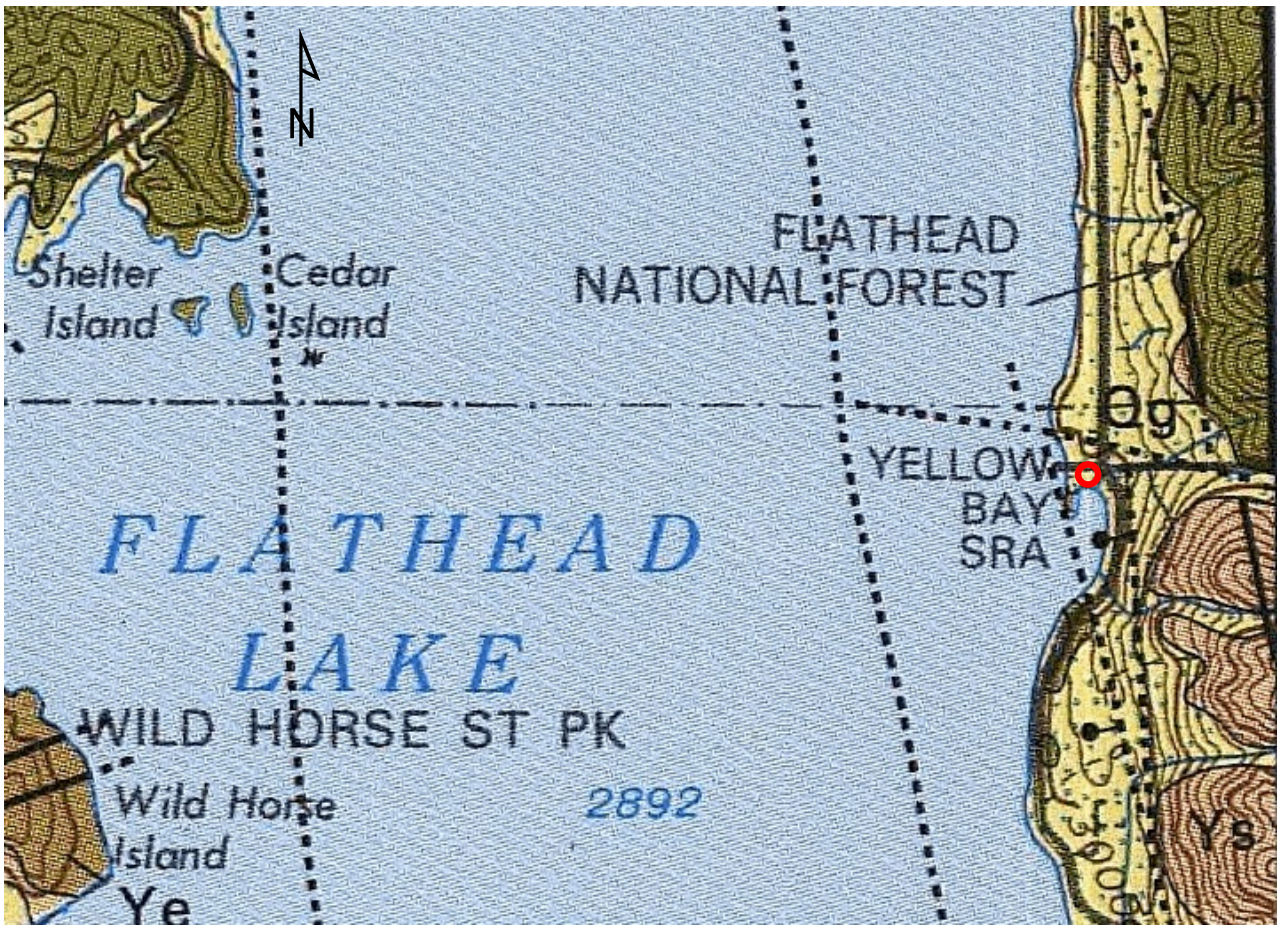


Figure 2.8.4 – Well LAK-01 (25N19W32DBBC01) was completed in glacial gravel as shown on the Wallace 1 degree x 2 degrees quadrangle from Harrison and others (1986). The red circle is the approximate location of the well LAK-01. Abbreviations: Qg = Quaternary glacial deposit; Ys = Spokane Formation; Ye = Helena Formation.

2.9 LAKE COUNTY
19N21W10BDDB01
Well LAK-02

2.9.1 Site Location

A well was drilled in tracts BDDB sec. 10, T.19 N., R.21W., at an altitude of 2,840 ft in Lake County (figure 2.8.1). The latitude (NAD27) is 47.4228 and longitude is -114.2569. The site is about 4 miles west of Charlo and can be accessed by serval roads via HWY 212. The well is on the northwest side of the property on a lower bench above seeps (figure 2.9.2). The well was abandoned on 03/01/2005.

2.9.2 Well Completion Details

- Driller: MBMG; Fred Schmidt
- Date: 03/01/2005
- Total depth: 40.0 ft
- Screened interval: 29.65 ft to 39.65 ft
- SWL: Dry at first, 35.55 after sitting
- Yield: <1gpm

A well log is attached along with copy of the water-quality data (figure 2.9.3 and tables 2.9.1 and 2.9.2). Completion details and water-quality data also can be obtained online at the Montana Bureau of Mines and Geology's Ground-Water Information Center (GWIC) website at http://mbmggwic.mtech.edu/. The GWIC identification number for this well is 216984. The results of the pesticide analyses and minimum reporting levels are included in appendix 1.

2.9.3 Land Use

As depicted in 2.9.1, the land use is primarily grasslands with some cottonwood trees.

2.9.4 Geology

The well was completed in Quaternary glacial gravels. A fault is shown on Harrison and others' (1986) map to the west of the site (figure 2.9.4). The normal fault places the Precambrian Belt Revett Formation on the east against the Burke Formation to the west. The well encountered a mixture of loose material from clay to cobble-sized clasts from 0 ft to 40 ft. Dense clay is a local feature; the static water level is confined by the clay.

Figure – 2.9.1 Well LAK-02 (19N21W10BDDB01) showing view to the northwest.

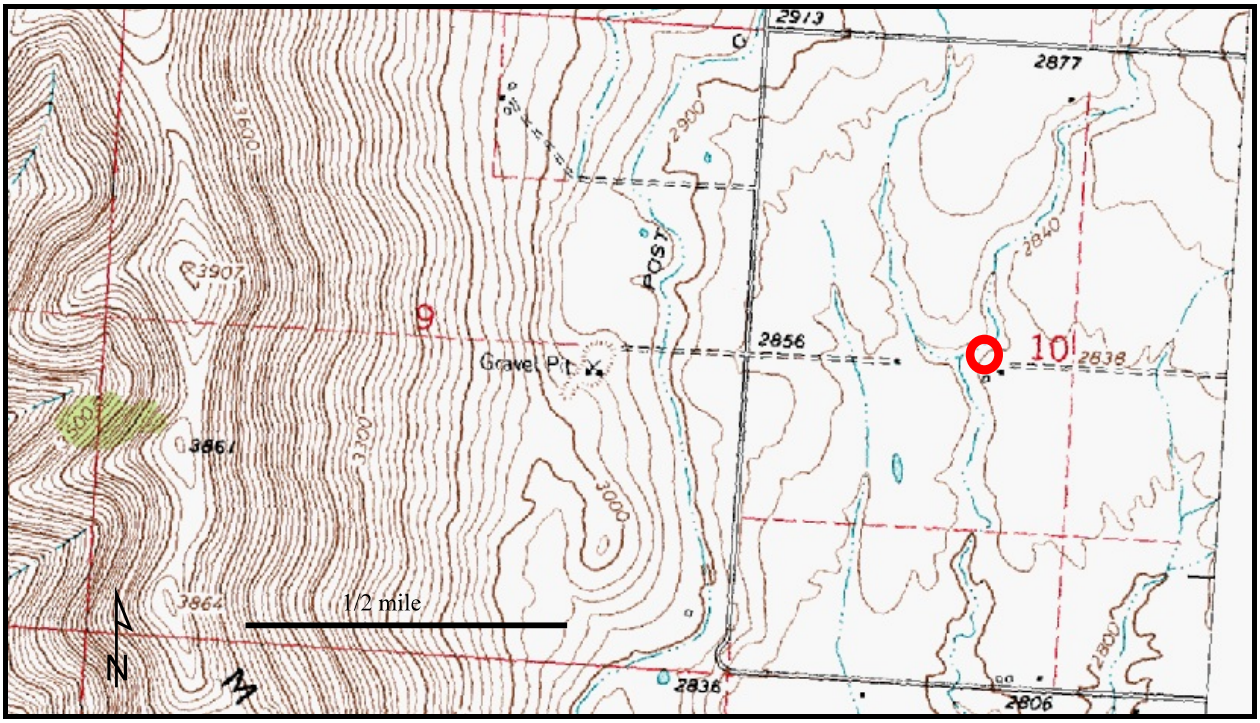


Figure 2.9.2 – Well LAK-02 (19N21W10BDDB01) is located about 4 miles west of Charlo on the Sloan 7.5-min. quadrangle and orthophoto. The red circle is the approximate well location.

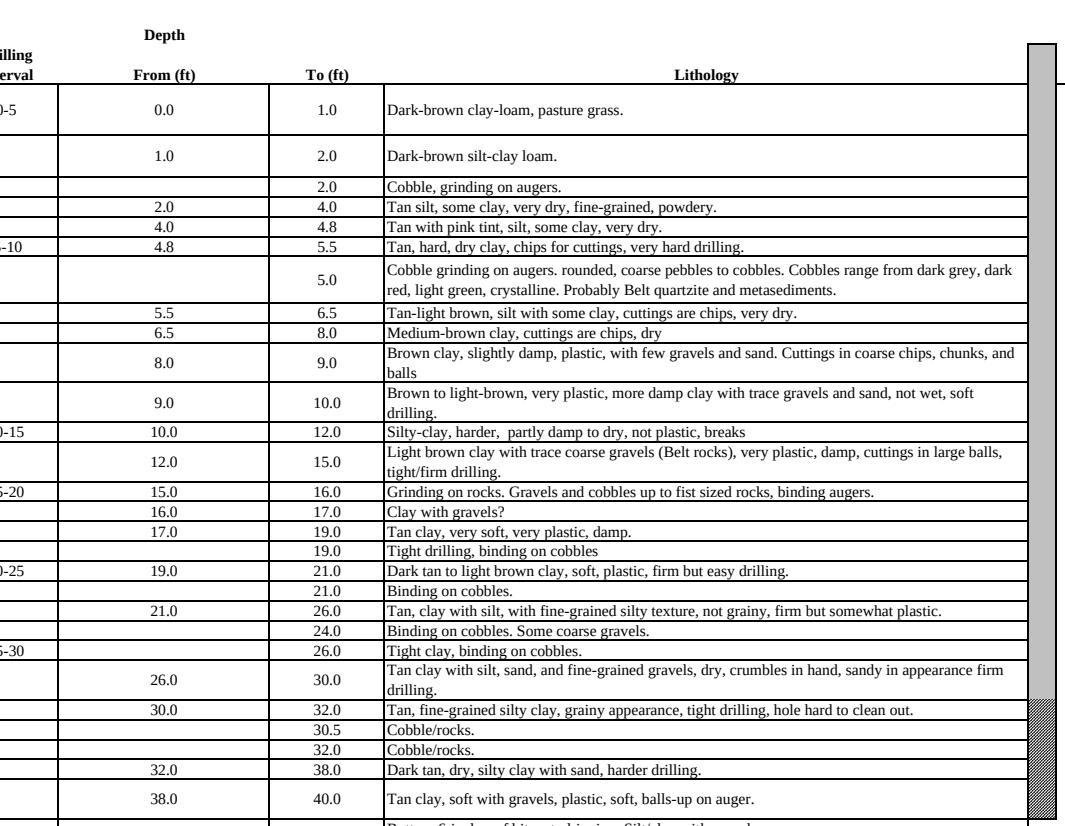
MDA Well Logs

Well name:	**LAK-02**	TD:	40.0 ft MP/TOC (38.25 ft below ground level)
GWIC ID:	216984	SWL:	37.3 ft MP/TOC (35.55 ft below ground level)
Date Drilled:	3/1/2005		
County:	Lake	MP stick up:	1.75 feet AGL
TRS location:	BDDB sec. 10, 19N 21W	MP Elevation:	~2,837.75 ft
DD latitude:	47.4228		
DD longitude:	-114.2569		
Elevation:	~2,836 ft		Pasture, grass.
Logged by:	J. Rose		Sprinkler irrigated, sometimes flood irrigated, as are upgradient areas.

Drilling Interval	Depth From (ft)	Depth To (ft)	Lithology
0-5	0.0	1.0	Dark-brown clay-loam, pasture grass.
	1.0	2.0	Dark-brown silt-clay loam.
		2.0	Cobble, grinding on augers.
	2.0	4.0	Tan silt, some clay, very dry, fine-grained, powdery.
	4.0	4.8	Tan with pink tint, silt, some clay, very dry.
5-10	4.8	5.5	Tan, hard, dry clay, chips for cuttings, very hard drilling.
		5.0	Cobble grinding on augers. rounded, coarse pebbles to cobbles. Cobbles range from dark grey, dark red, light green, crystalline. Probably Belt quartzite and metasediments.
	5.5	6.5	Tan-light brown, silt with some clay, cuttings are chips, very dry.
	6.5	8.0	Medium-brown clay, cuttings are chips, dry
	8.0	9.0	Brown clay, slightly damp, plastic, with few gravels and sand. Cuttings in coarse chips, chunks, and balls
	9.0	10.0	Brown to light-brown, very plastic, more damp clay with trace gravels and sand, not wet, soft drilling.
10-15	10.0	12.0	Silty-clay, harder, partly damp to dry, not plastic, breaks
	12.0	15.0	Light brown clay with trace coarse gravels (Belt rocks), very plastic, damp, cuttings in large balls, tight/firm drilling.
15-20	15.0	16.0	Grinding on rocks. Gravels and cobbles up to fist sized rocks, binding augers.
	16.0	17.0	Clay with gravels?
	17.0	19.0	Tan clay, very soft, very plastic, damp.
		19.0	Tight drilling, binding on cobbles
20-25	19.0	21.0	Dark tan to light brown clay, soft, plastic, firm but easy drilling.
		21.0	Binding on cobbles.
	21.0	26.0	Tan, clay with silt, with fine-grained silty texture, not grainy, firm but somewhat plastic.
		24.0	Binding on cobbles. Some coarse gravels.
25-30		26.0	Tight clay, binding on cobbles.
	26.0	30.0	Tan clay with silt, sand, and fine-grained gravels, dry, crumbles in hand, sandy in appearance firm drilling.
	30.0	32.0	Tan, fine-grained silty clay, grainy appearance, tight drilling, hole hard to clean out.
		30.5	Cobble/rocks.
		32.0	Cobble/rocks.
	32.0	38.0	Dark tan, dry, silty clay with sand, harder drilling.
	38.0	40.0	Tan clay, soft with gravels, plastic, soft, balls-up on auger.
			Bottom 6-inches of bit wet, dripping. Silt/clay with gravels.
	TD	**40.0 ft**	

Confined water in layer overlain by thick, dry clays

Completion data	Depth (BGL)		Depth (BGL)		
From	To	Casing	From	To	Fill
			0.0	1.5	cement
			1.5	2.5	bentonite grout
0	29.65	blank (31.4 ft total)	2.5	27.0	backfill cuttings, clay
29.65	39.65	Screen	27.0	38.0	washed pea gravel
			38.0	40.0	10/120 filter pack silica sand



2.9.4

Figure 2.9.3 -- Well log for well LAK-02 (19N21W10BDDB01).

Table 2.9.1 -- Water quality for well LAK-02 (19N21W10BDDB01).

Ground-Water Information Center **Water Quality Report**

Site Name: MDA WELL LAK-02 **Report Date:** 6/18/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2005Q0379 / 216984
Location (TRS): 19N 21W 10 BDDB
Latitude/Longitude: 47° 25' 22" N 114° 15' 24" W
Datum: NAD27
Altitude:
County/State: LAKE / MT
Site Type: WELL
Geology:
USGS 7.5' Quad:
PWS Id:
Project: MDAPESTNET

Sample Date: 3/1/2005 3:05:00 PM
Agency/Sampler: MBMG / JCR
Field Number:
Lab Date: 3/31/2005
Lab/Analyst: MBMG / WO
Sample Method/Handling: PUMPED / 3120
Procedure Type: DISSOLVED
Total Depth (ft): 40.000
SWL-MP (ft): NR
Depth Water Enters (ft): 29.700

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	84.100	4.197	Bicarbonate (HCO3)	492.900	8.079
Magnesium (Mg)	67.000	5.513	Carbonate (CO3)	0.000	0.000
Sodium (Na)	133.000	5.786	Chloride (Cl)	59.700	1.684
Potassium (K)	4.550	0.116	Sulfate (SO4)	249.000	5.187
Iron (Fe)	1.720	0.092	Nitrate (as N)	0.825	0.059
Manganese (Mn)	0.134	0.005	Fluoride (F)	<0.50	0.000
Silica (SiO2)	18.000		Orthophosphate (OPO4)	<0.50	0.000
Total Cations		15.863	**Total Anions**		15.008

Trace Element Results (µg/L)

Aluminum (Al):	1,310.000	Cadmium (Cd):	<1	Mercury (Hg):	NR	Tin (Sn):	7.920
Antimony (Sb):	<2	Chromium (Cr):	5.050	Molybdenum (Mo):	<10	Titanium (Ti):	15.100
Arsenic (As):	3.530	Cobalt (Co):	<2	Nickel (Ni):	<2	Thallium (Tl):	<5
Barium (Ba):	73.800	Copper (Cu):	5.420	Silver (Ag):	<1	Uranium (U):	37.900
Beryllium (Be):	<2	Lead (Pb):	4.420	Selenium (Se):	7.920	Vanadium (V):	<5
Boron (B):	<30	Lithium (Li):	10.900	Strontium (Sr):	354.000	Zinc (Zn):	11.200
Bromide (Br):	<500					Zirconium (Zr):	<2

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	862.160	Field Hardness as CaCO3:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	1,112.260	Hardness as CaCO3:	485.770	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	1,010.000	Field Alkalinity as CaCO3:	NR	PCP (µg/L):	NR
Lab Conductivity (µmhos):	1,323.000	Akalinity as CaCO3:	404.260	Phosphate, TD (mg/L as P):	0.196
Field pH:	7.350	Ryznar Stability Index:	6.357	Field Nitrate (mg/L):	NR
Lab pH:	7.580	Sodium Adsorption Ratio:	2.630	Field Dissolved O2 (mg/L):	NR
Water Temp (°C):	10.600	Langlier Saturation Index:	0.611	Field Chloride (mg/L):	NR
Air Temp (°C):	11.000	Nitrite (mg/L as N):	<0.5	Field Redox (mV):	NR

Notes

Sample Condition: SILTY-CLOUDY.
Field Remarks:
Lab Remarks:

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **ft** = feet; **NR** = No Reading in GWIC

Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions; ***** = Duplicate analysis not within control limits; ****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO3, CO3, SO4, Cl, SiO2, NO3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.

Table 2.9.2--Water-quality comparison for well LAK-02 (19N21W10BDDB01).

Drinking water limits are based on U.S. Environmental Protection Agency primary and secondary standards for public water supplies (view their standards). Stock water and irrigation water recommendations are from U.S. Department of Agriculture Natural Resources Conservation Service water-quality guidelines. The guidelines are general and my vary depending on specific applications. Irrigation guidelines are based on continuous irrigation.

Sample Id	GWIC Id	Sample Date	Site Name	Location	Site Type
2005Q0379	216984	3/1/2005 3:05:00 PM	MDA WELL LAK-02	19N 21W 10 BDDB	WELL

Constituent	This Sample	Drinking Water	Stock Water	Irrigation Water
Calcium (Ca)	84.100 mg/L	---	---	---
Magnesium (Mg)	67.000 mg/L	---	2,000 mg/L	---
Sodium (Na)	133.000 mg/L	250 mg/L [smcl]	2,000 mg/L	see SAR
Potassium (K)	4.550 mg/L	---	---	---
Iron (Fe)	1.720 mg/L	0.3 mg/L [smcl]	---	---
Manganese (Mn)	0.134 mg/L	0.05 mg/L [smcl]	---	2.0 mg/L
Silica (SiO2)	18.000 mg/L	---	---	---
Bicarbonate (HCO3)	492.900 mg/L	---	---	---
Carbonate (CO3)	0.000 mg/L	---	---	---
Chloride (Cl)	59.700 mg/L	250 mg/L [smcl]	1,500 mg/L	---
Sulfate (SO4)	249.000 mg/L	250 mg/L [smcl]	1,500 mg/L	[b]
Nitrate (NO3 as N)	0.825 mg/L	10 mg/L [mcl]	100 mg/L	---
Fluoride (F)	<0.50 mg/L	4 mg/L [mcl]	2 mg/L	---
Ortho-Phosphate (as P)	<0.50 mg/L	---	---	---
Aluminum (Al)	1,310.000 ug/L	50-200 ug/L [smcl]	---	1,000 ug/L
Antimony (Sb)	<2 ug/L	6 ug/L [mcl]	---	---
Arsenic (As)	3.530 ug/L	10 ug/L [mcl]	50 ug/L	100 ug/L
Barium (Ba)	73.800 ug/L	2,000 ug/L [mcl]	---	---
Boron (B)	<30 ug/L	---	---	---
Cadmium (Cd)	<1 ug/L	5 ug/L [mcl]	10 ug/L	5 ug/L
Chromium (Cr)	5.050 ug/L	100 ug/L [mcl]	1,000 ug/L	100 ug/L
Cobalt (Co)	<2 ug/L	---	1,000 ug/L	50 ug/L
Copper (Cu)	5.420 ug/L	1,300 ug/L [mcl]	500 ug/L	200 ug/L
Lead (Pb)	4.420 ug/L	15 ug/L [mcl]	50 ug/L	5,000 ug/L
Lithium (Li)	10.900 ug/L	---	---	2,500 ug/L
Molybdenum (Mo)	<10 ug/L	---	---	5 ug/L
Nickel (Ni)	<2 ug/L	---	---	200 ug/L
Phosphate (P)	0.196 ug/L	---	---	---
Selenium (Se)	7.920 ug/L	50 ug/L [mcl]	50 ug/L	20 ug/L
Silver (Ag)	<1 ug/L	100 ug/L [smcl]	---	---
Strontium (Sr)	354.000 ug/L	---	---	---
Titanium (Ti)	15.100 ug/L	---	---	---
Vanadium (V)	<5 ug/L	---	---	---
Zinc (Zn)	11.200 ug/L	5,000 ug/L [smcl]	24,000 ug/L	2,000 ug/L
Zirconium (Zr)	<2 ug/L	---	---	---

Key: **NR** = No reading in GWIC; **mg/L** = milligrams per Liter; **ug/L** = micrograms per Liter; **---** = Currently no standard for this constituent; **[b]** = High concentrations of sulfate may restrict calcium uptake by crops; **[c]** = Varies with crop, generally dissolved solids should be less than 2,000 mg/L (equivalent to specific conductance of about 2,000 to 3,000 micromhos/cm); **[d]** = Dependent upon other variables such as type of clay in soil and salt content of water. (See SAR); **[mcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999; **[smcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard.

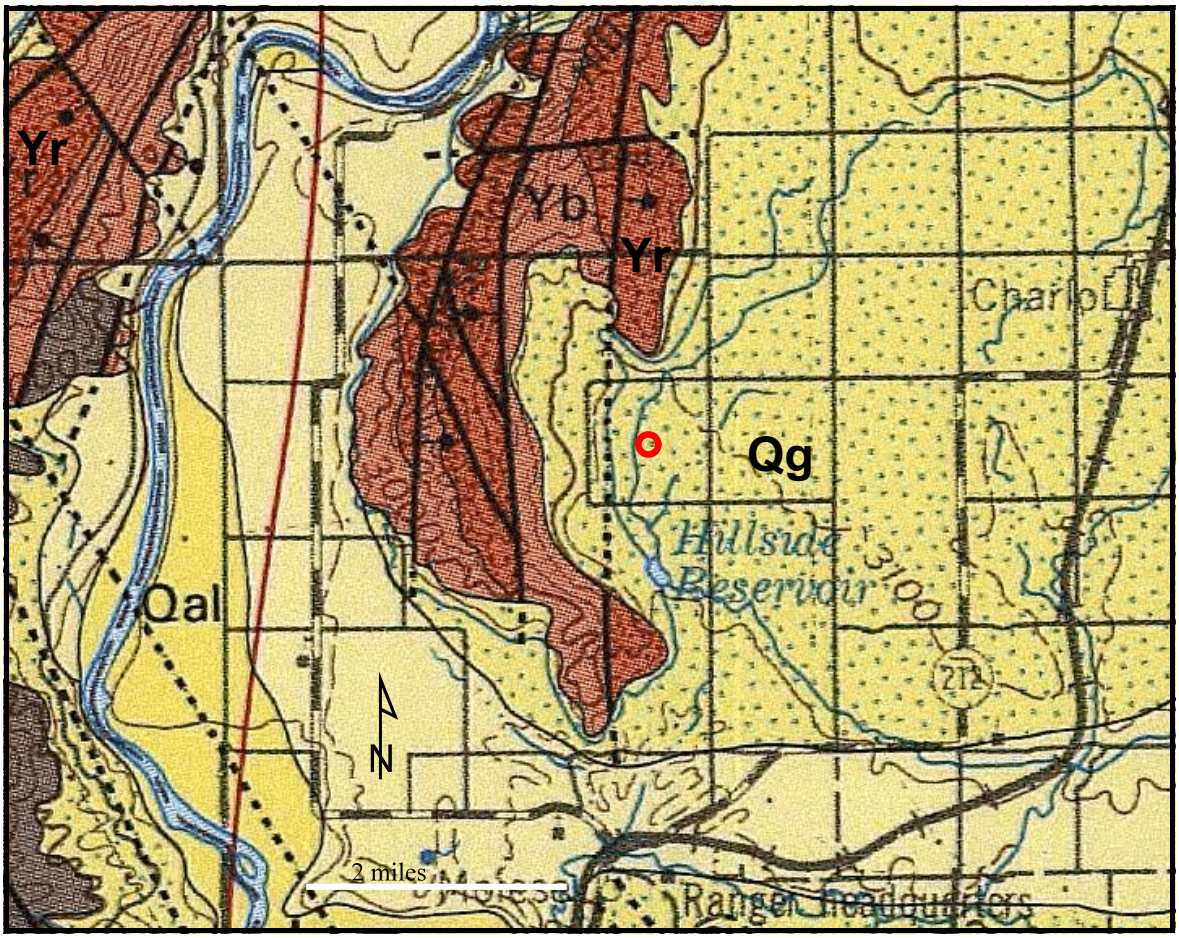


Figure 2.9.4. – Geology of part of the Wallace 1 degree x 2 degrees quadrangle from Harrison and others (1986). The red circle is the approximate location of the well LAK-02. Abbreviations: Qal = Quaternary alluvium; Qg = Quaternary glacial deposits; Yr = Revett Formation; Yb = Burke Formation.

2.10 RICHLAND COUNTY
22N59E16BABA01
Well RIC-01

2.10.1 Site Location

A well was drilled in BABA sec. 16, T.22N., R.59E., at an altitude of 1,892 ft in Richland County (figure 2.10.1). The latitude (NAD27) is 47.6739 and longitude is -104.1556. The site is about 4-miles south of Sydney just off of Highway 23. The site is at the northeast corner of the Sidney Bridge fishing access (FWP) on the south shore of the Yellowstone River. There is an old river channel near the well (figure 2.10.2).

2.10.2 Well Completion Details

- Driller: MBMG; Fred Schmidt
- Date: 09/30/2004
- Total depth: 20.0 ft
- Screened interval: 9.2-19.2 ft
- Yield: 5 gpm
- SWL: 15.32 ft BGL

A well log is attached along with copy of the water-quality data (figure 2.10.3 and tables 2.10.1 and 2.10.2). Completion details and water-quality data also can be obtained online at the Montana Bureau of Mines and Geology's Ground-Water Information Center (GWIC) website at http://mbmggwic.mtech.edu/. The GWIC identification number for this well is 214378. The results of the pesticide analyses and minimum reporting levels are included in appendix 1.

2.10.3 Land Use

As depicted in figure 2.10.1, the land use is primarily used for growing sugar beets but is also used on a rotational basis to grow corn and grain. An irrigation ditch conveys water across the site as well as provides water for flood irrigation.

2.10.4 Geology

The well was completed in Quaternary alluvium associated with the Yellowstone River. It encountered silt, sand and gravel from 0 ft to 20 ft. The underlying bedrock is probably the Tongue River Member of the Fort Union Formation.

.

a

b

Figure 2.10.1 – a) The well site of RIC-01 (22N59E16BABA01) looking upgradient, sugar beets in field, and well at corner fence corner. b) Department of Agriculture folks prepare to put concrete around the well head.

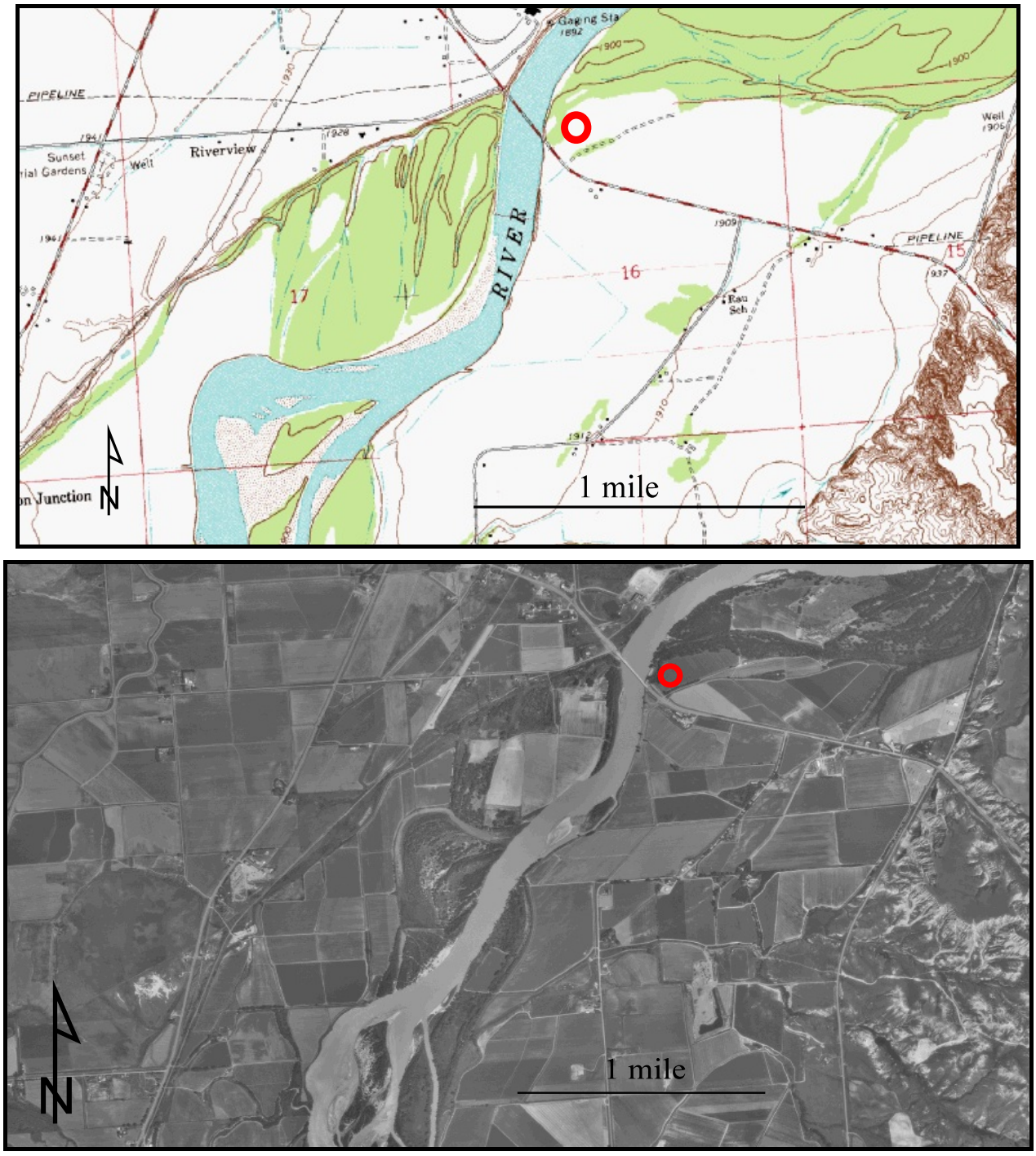


Figure 2.10.2 – Well RIC-01 (22N59E16BABA01), Sidney 7.5-min. quadrangle and orthophoto, is located just off of Highway 23 at the edge of a sugar beet field. Sidney is about 4-miles north. The red circle is the approximate well location.

MDA Well Logs

Well name:	**RIC-01**	TD:	21.16 ft MP/TOC (19.46 ft below ground level)
GWIC ID:	M:214378	SWL:	15.32 ft MP/TOC (13.62 ft below ground level)
Date Drilled:	9/30/2004		
County:	Richland	MP stick up:	1.7 ft AGL
TRS location:	BABA sec. 16, 22N 59E	MP Elevation:	~1893.7 ft
DD latitude:	47.6739		
DD longitude:	-104.1556		Flood irrigated sugar beets in river bottom all around well site.
Elevation:	1892.0 ft		Drilled into old river channel area.
Logged by:	J. Rose		

Drilling Interval	Depth From (ft)	To (ft)	Lithology
0-5	0.0	5.0	Tan, silty-clay loam with minor sand and trace rounded, small gravels.
	5.0	5.5	Brown, sandy silt, gritty texture, some small clay balls off augers.
5-10	5.5	7.0	Sand and silt with gravels, gravelly sand and silt. Soft texture.
		7.0	Grinding on gravels. Brown, very-fine sand with gravels and some rounded chert cobbles. Dry.
10-15	7.0	10.0	Very fine-grained sand with more coarse-grained gravels with depth, some agate cobbles. Slightly damp, fine-grained sand loosely packs in hand.
15-20	10.0	20.0	Brown gravelly, very-fine grained sand with some cobbles, more sandy with depth, very damp, loosely packs in hand. Drilling is fast and easy.
	TD	**20.0**	

Augers settled about 6-inches when center plug pulled; very soft, possibly saturated sand.

Completion data	Depth (BGL)		
From	To	Casing	
0.0	9.2	blank (10.9 feet total)	
9.2	19.2	screen	
Total casing	20.9 ft		

Depth (BGL)		
From	To	Fill
0.0	3.0	cement
3.0	5.0	bentonite chips
5.0	9.5	backfill with cuttings, silt, sand clay
9.5	20.0	washed pea gravel

Figure 2.10.3. -- Well log for RIC-01 (22N59E16BABA01).

Table 2.10.1 -- Water quality for well RIC-01 (22N59E16BABA01).

Ground-Water Information Center **Water Quality Report**

Site Name: MDA WELL RIC-01 **Report Date:** 6/18/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id:	2005Q0277 / 214378	**Sample Date:**	10/25/2004 10:55:00 AM
Location (TRS):	22N 59E 16 BABA	**Agency/Sampler:**	MBMG / JCR
Latitude/Longitude:	47° 40' 26" N 104° 9' 20" W	**Field Number:**	214378
Datum:	NAD27	**Lab Date:**	12/1/2004
Altitude:	1892.00	**Lab/Analyst:**	MBMG / WO
County/State:	RICHLAND / MT	**Sample Method/Handling:**	PUMPED / 3120
Site Type:	WELL	**Procedure Type:**	DISSOLVED
Geology:		**Total Depth (ft):**	21.160
USGS 7.5' Quad:		**SWL-MP (ft):**	15.310
PWS Id:		**Depth Water Enters (ft):**	9.200
Project:	MDAPESTNET		

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	123.000	6.138	Bicarbonate (HCO3)	581.200	9.526
Magnesium (Mg)	49.500	4.073	Carbonate (CO3)	0.000	0.000
Sodium (Na)	88.900	3.867	Chloride (Cl)	8.350	0.236
Potassium (K)	6.610	0.169	Sulfate (SO4)	179.000	3.729
Iron (Fe)	6.410	0.344	Nitrate (as N)	<0.25	0.000
Manganese (Mn)	2.180	0.079	Fluoride (F)	<0.25	0.000
Silica (SiO2)	26.000		Orthophosphate (OPO4)	<0.25	0.000
Total Cations		14.719	**Total Anions**		13.490

Trace Element Results (µg/L)

Aluminum (Al):	<10	Cadmium (Cd):	<1	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<2	Chromium (Cr):	<2	Molybdenum (Mo):	<10	Titanium (Ti):	<1
Arsenic (As):	7.220	Cobalt (Co):	<2	Nickel (Ni):	4.770	Thallium (Tl):	<5
Barium (Ba):	59.100	Copper (Cu):	<2	Silver (Ag):	<1	Uranium (U):	2.830
Beryllium (Be):	<2	Lead (Pb):	<2	Selenium (Se):	<1	Vanadium (V):	<5
Boron (B):	232.000	Lithium (Li):	60.100	Strontium (Sr):	1,159.000	Zinc (Zn):	<2
Bromide (Br):	<250					Zirconium (Zr):	<2

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	776.260	Field Hardness as CaCO3:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	1,071.150	Hardness as CaCO3:	510.870	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	1,072.000	Field Alkalinity as CaCO3:	NR	PCP (µg/L):	NR
Lab Conductivity (µmhos):	1,090.000	Akalinity as CaCO3:	476.680	Phosphate, TD (mg/L as P):	<0.05
Field pH:	7.180	Ryznar Stability Index:	5.964	Field Nitrate (mg/L):	NR
Lab pH:	7.500	Sodium Adsorption Ratio:	1.710	Field Dissolved O2 (mg/L):	NR
Water Temp (°C):	11.200	Langlier Saturation Index:	0.768	Field Chloride (mg/L):	NR
Air Temp (°C):	NR	Nitrite (mg/L as N):	<0.25	Field Redox (mV):	NR

Notes

Sample Condition: SLIGHTLY SILTY-NEW WELL.
Field Remarks:
Lab Remarks:

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **ft** = feet; **NR** = No Reading in GWIC

Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions; ***** = Duplicate analysis not within control limits; ****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO3, CO3, SO4, Cl, SiO2, NO3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.

Table 2.10.2--Water-quality comparison for well RIC-01 (22N59E16BABA01).

Drinking water limits are based on U.S. Environmental Protection Agency primary and secondary standards for public water supplies (view their standards). Stock water and irrigation water recommendations are from U.S. Department of Agriculture Natural Resources Conservation Service water-quality guidelines. The guidelines are general and my vary depending on specific applications. Irrigation guidelines are based on continuous irrigation.

Sample Id	GWIC Id	Sample Date	Site Name	Location	Site Type
2005Q0277	214378	10/25/2004 10:55:00 AM	MDA WELL RIC-01	22N 59E 16 BABA	WELL

Constituent	This Sample	Drinking Water	Stock Water	Irrigation Water
Calcium (Ca)	123.000 mg/L	---	---	---
Magnesium (Mg)	49.500 mg/L	---	2,000 mg/L	---
Sodium (Na)	88.900 mg/L	250 mg/L [smcl]	2,000 mg/L	see SAR
Potassium (K)	6.610 mg/L	---	---	---
Iron (Fe)	6.410 mg/L	0.3 mg/L [smcl]	---	---
Manganese (Mn)	2.180 mg/L	0.05 mg/L [smcl]	---	2.0 mg/L
Silica (SiO2)	26.000 mg/L	---	---	---
Bicarbonate (HCO3)	581.200 mg/L	---	---	---
Carbonate (CO3)	0.000 mg/L	---	---	---
Chloride (Cl)	8.350 mg/L	250 mg/L [smcl]	1,500 mg/L	---
Sulfate (SO4)	179.000 mg/L	250 mg/L [smcl]	1,500 mg/L	[b]
Nitrate (NO3 as N)	<0.25 mg/L	10 mg/L [mcl]	100 mg/L	---
Fluoride (F)	<0.25 mg/L	4 mg/L [mcl]	2 mg/L	---
Ortho-Phosphate (as P)	<0.25 mg/L	---	---	---
Aluminum (Al)	<10 ug/L	50-200 ug/L [smcl]	---	1,000 ug/L
Antimony (Sb)	<2 ug/L	6 ug/L [mcl]	---	---
Arsenic (As)	7.220 ug/L	10 ug/L [mcl]	50 ug/L	100 ug/L
Barium (Ba)	59.100 ug/L	2,000 ug/L [mcl]	---	---
Boron (B)	232.000 ug/L	---	---	---
Cadmium (Cd)	<1 ug/L	5 ug/L [mcl]	10 ug/L	5 ug/L
Chromium (Cr)	<2 ug/L	100 ug/L [mcl]	1,000 ug/L	100 ug/L
Cobalt (Co)	<2 ug/L	---	1,000 ug/L	50 ug/L
Copper (Cu)	<2 ug/L	1,300 ug/L [mcl]	500 ug/L	200 ug/L
Lead (Pb)	<2 ug/L	15 ug/L [mcl]	50 ug/L	5,000 ug/L
Lithium (Li)	60.100 ug/L	---	---	2,500 ug/L
Molybdenum (Mo)	<10 ug/L	---	---	5 ug/L
Nickel (Ni)	4.770 ug/L	---	---	200 ug/L
Phosphate (P)	<0.05 ug/L	---	---	---
Selenium (Se)	<1 ug/L	50 ug/L [mcl]	50 ug/L	20 ug/L
Silver (Ag)	<1 ug/L	100 ug/L [smcl]	---	---
Strontium (Sr)	1,159.000 ug/L	---	---	---
Titanium (Ti)	<1 ug/L	---	---	---
Vanadium (V)	<5 ug/L	---	---	---
Zinc (Zn)	<2 ug/L	5,000 ug/L [smcl]	24,000 ug/L	2,000 ug/L
Zirconium (Zr)	<2 ug/L	---	---	---

Key: **NR** = No reading in GWIC; **mg/L** = milligrams per Liter; **ug/L** = micrograms per Liter; **---** = Currently no standard for this constituent; **[b]** = High concentrations of sulfate may restrict calcium uptake by crops; **[c]** = Varies with crop, generally dissolved solids should be less than 2,000 mg/L (equivalent to specific conductance of about 2,000 to 3,000 micromhos/cm); **[d]** = Dependent upon other variables such as type of clay in soil and salt content of water. (See SAR); **[mcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999; **[smcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard.

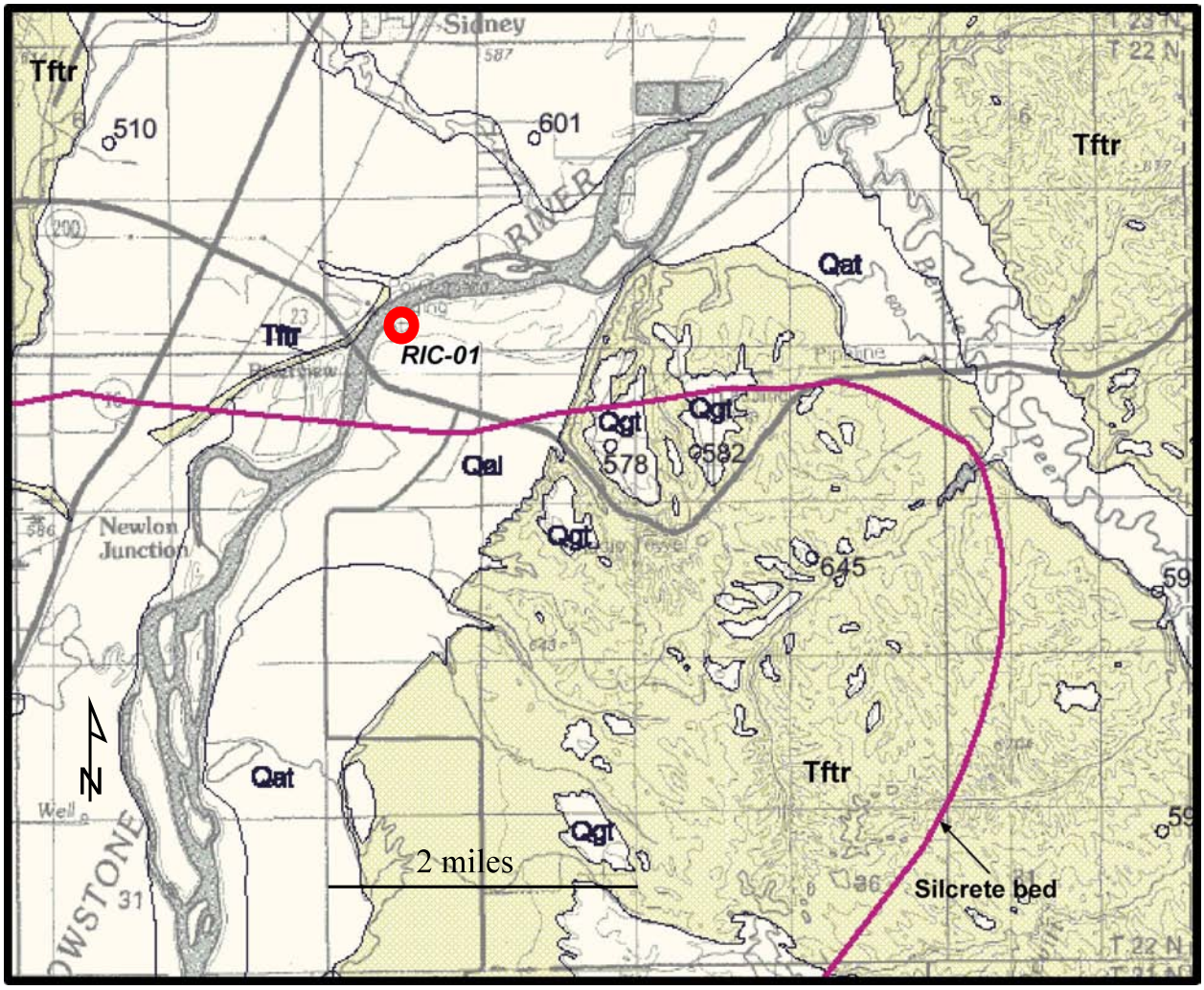


Figure 2.10.4 – Geology of part the Sidney 30’ x 60’ quadrangle consists of the Tongue River Member of the Fort Union Formation (Tftr) covered by alluvium (Qal and Qgt) in the area of well site RIC-01 taken from Vuke and others (2003).

2.11 TETON COUNTY
25N04W26BCBD01
Well TET-01

2.11.1 Site Location

A well was drilled in tracts BCBD sec. 26, T.25N., R.04W., at an altitude of 3,778 ft in Teton County (figure 2.11.1). The latitude (NAD27) is 47.8930 and the longitude is -112.0892. Access is via HWY 220 north-northeast about 5 miles north to 19th Road northwest, 3 miles east, and then north 0.7 miles. The house is on the east side of the road. The site is on the east end of the Burton Bench (figure 2.11.2).

2.11.2 Well Completion Details

- Driller: MBMG, Fred Schmidt
- Date: 06/24/2004
- Total depth: 19 ft
- Screened interval: 8.8 ft to 18.8 ft
- Yield: 1.25 gpm
- SWL: 10.94 ft BGL

A well log is attached along with copy of the water-quality data (figure 2.11.3 and tables 2.11.1 and 2.11.2). Completion details and water-quality data also can be obtained online at the Montana Bureau of Mines and Geology's Ground-Water Information Center (GWIC) website at http://mbmggwic.mtech.edu/. The GWIC identification number for this well is 213965. The results of the pesticide analyses and minimum reporting levels are included in appendix 1.

2.11.3 Land Use

As depicted in figure 2.11.1, the land use is primarily dryland wheat on the uplands with a center-pivot hay field in the river bottom.

2.11.4 Geology

There is buff tan silty sediments on the bluffs east of the site; the top two feet of the borehole was predominantly tan silt. The tan silts consist of glacial silt and clay. The well was completed in Quaternary alluvium consisting mostly of gravel with minor sand and clay from 2.0 ft to 19.0 ft.

a.

b.

Figure 2.11.1 – a) Developing the well TET-01 (25N04W26BCBD01) after drilling to remove silt and sand. b) View to the southwest towards Choteau.

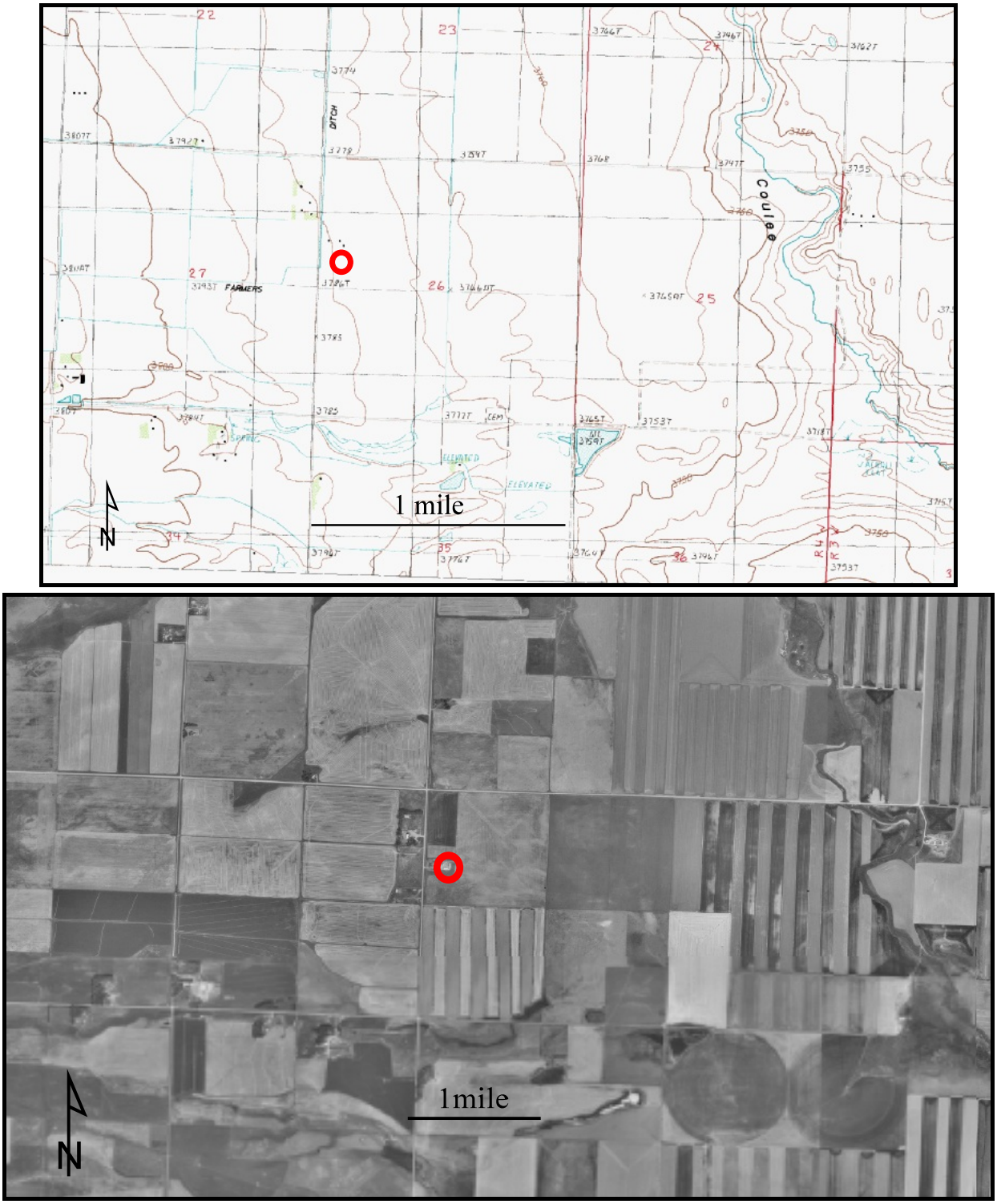


Figure 2.11.2–Well TET-01 (25N04W26BCBD01) on the Eyraud 7.5-min. quadrangle and orthophoto quadrangle is located about 7-miles northeast of Choteau. The red circle is the approximate location of the well.

MDA Well Logs

Well name:	**TET-01**	TD:	19.45 ft MP/TOC (18.25 ft below ground level)
GWIC ID:	M:213965	SWL:	12.14 ft MP/TOC (10.94 ft below ground level)
Date Drilled:	6/24/2004		
County:	Teton	MP stick up:	1.2 ft AGL
TRS location:	BCBD sec. 26, 25N 04W	MP Elevation	

Well on farm yard lot with grass near horse corral. Area is surrounded and adjacent to irrigated small grain crops. Significant ditch system and flood irrigation in area.

DD latitude:	47.893
DD longitude:	-112.0892
Elevation:	3,778.0 ft
Logged by:	J. Rose

Drilling Interval	Depth From (ft)	To (ft)	Lithology
0-5	0.0	2.0	Light-brown silt with small gravels and very little clay. Dry.
	2.0	5.0	Medium-coarse grained gravel and pebbles. Gravels are dark grey to black metasediments or igneous crystalline rocks. Very dry.
5-10	5.0	10.0	Coarse gravel and pebbles. Very dry.
10-15	10.0	12.0	Black, coarse gravel and pebbles with dark-brown silt. Dry.
	12.0	13.0	Drill augers binding, tight
	13.0	15.0	Black coarse pebbles with tan, sandy-silt. Very slightly damp.
15-20	15.0	19.0	Black, crystalline, rounded, pebbles and medium-coarse gravels with medium-brown silt with some sand and clay. 16-18 feet augers binding, tight.
	TD	**19.0**	Hard stop at 19.0 feet. Bedrock.

Completion data	Depth (BGL)		
From	To	Casing	
0	8.8	blank (10 foot total)	
8.8	18.8	screen	

Depth (BGL)		
From	To	Fill
0.0	1.5	cement
1.5	3.4	bentonite chips
3.4	7.0	backfill cuttings
7.0	9.0	bentonite chips
9.0	19.0	10/20 filter pack silica sand

Figure 2.11.3. -- Well log for TET-01 (25N04W26BCBD01).

Table 2.11.1 -- Water quality analyses for well TET-01 (25N04W26 BCBD01).

Ground-Water Information Center **Water Quality Report**

Site Name: FLOWERS, TOM * MDA WELL TET-01 **Report Date:** 5/20/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2005Q0203 / 213965
Location (TRS): 25N 04W 26 BCBD
Latitude/Longitude: 47° 53' 34" N 112° 5' 21" W
Datum: NAD27
Altitude: 3778.00
County/State: TETON / MT
Site Type: WELL
Geology:
USGS 7.5' Quad: EYRAUD LAKES
PWS Id:
Project: MDAPESTNET

Sample Date: 9/21/2004 8:35:00 AM
Agency/Sampler: MBMG / JCR
Field Number: 213965
Lab Date: 10/20/2004
Lab/Analyst: MBMG / WO
Sample Method/Handling: PUMPED / 3120
Procedure Type: DISSOLVED
Total Depth (ft): 19.000
SWL-MP (ft): 10.930
Depth Water Enters (ft): 8.800

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	48.600	2.425	Bicarbonate (HCO_3)	298.600	4.894
Magnesium (Mg)	35.800	2.946	Carbonate (CO_3)	0.000	0.000
Sodium (Na)	18.900	0.822	Chloride (Cl)	2.480	0.070
Potassium (K)	1.560	0.040	Sulfate (SO_4)	58.800	1.225
Iron (Fe)	0.013	0.001	Nitrate (as N)	1.130	0.081
Manganese (Mn)	<0.001	0.000	Fluoride (F)	0.359	0.019
Silica (SiO_2)	8.190		Orthophosphate (OPO_4)	<0.05	0.000
Total Cations		6.250	**Total Anions**		6.288

Trace Element Results (µg/L)

Aluminum (Al):	<10	Cadmium (Cd):	<1	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<2	Chromium (Cr):	<2	Molybdenum (Mo):	<10	Titanium (Ti):	<1
Arsenic (As):	<1	Cobalt (Co):	<2	Nickel (Ni):	<2	Thallium (Tl):	<5
Barium (Ba):	102.000	Copper (Cu):	<2	Silver (Ag):	<1	Uranium (U):	2.790
Beryllium (Be):	<2	Lead (Pb):	<2	Selenium (Se):	<1	Vanadium (V):	<5
Boron (B):	30.400	Lithium (Li):	22.000	Strontium (Sr):	576.000	Zinc (Zn):	<2
Bromide (Br):	<50					Zirconium (Zr):	<2

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	322.930	Field Hardness as $CaCO_3$:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	474.430	Hardness as $CaCO_3$:	268.710	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	540.000	Field Alkalinity as $CaCO_3$:	NR	PCP (µg/L):	NR
Lab Conductivity (µmhos):	606.000	Akalinity as $CaCO_3$:	244.900	Phosphate, TD (mg/L as P):	<0.05
Field pH:	7.600	Ryznar Stability Index:	7.269	Field Nitrate (mg/L):	NR
Lab pH:	7.580	Sodium Adsorption Ratio:	0.500	Field Dissolved O_2 (mg/L):	NR
Water Temp (°C):	11.100	Langlier Saturation Index:	0.156	Field Chloride (mg/L):	NR
Air Temp (°C):	NR	Nitrite (mg/L as N):	<0.05	Field Redox (mV):	NR

Notes

Sample Condition: CLEAR.
Field Remarks:
Lab Remarks:

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **ft** = feet; **NR** = No Reading in GWIC

Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions; ***** = Duplicate analysis not within control limits; ****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO_3, CO_3, SO_4, Cl, SiO_2, NO_3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.

Table 2.11.2--Water-quality comparison for well TET-01 (25NO4W26BCBD01).

Drinking water limits are based on U.S. Environmental Protection Agency primary and secondary standards for public water supplies (view their standards). Stock water and irrigation water recommendations are from U.S. Department of Agriculture Natural Resources Conservation Service water-quality guidelines. The guidelines are general and my vary depending on specific applications. Irrigation guidelines are based on continuous irrigation.

Sample Id	GWIC Id	Sample Date	Site Name	Location	Site Type
2005Q0203	213965	9/21/2004 8:35:00 AM	FLOWERS, TOM * MDA WELL TET-01	25N 04W 26 BCBD	WELL

Constituent	This Sample	Drinking Water	Stock Water	Irrigation Water
Calcium (Ca)	48.600 mg/L	---	---	---
Magnesium (Mg)	35.800 mg/L	---	2,000 mg/L	---
Sodium (Na)	18.900 mg/L	250 mg/L [smcl]	2,000 mg/L	see SAR
Potassium (K)	1.560 mg/L	---	---	---
Iron (Fe)	0.013 mg/L	0.3 mg/L [smcl]	---	---
Manganese (Mn)	<0.001 mg/L	0.05 mg/L [smcl]	---	2.0 mg/L
Silica (SiO2)	8.190 mg/L	---	---	---
Bicarbonate (HCO3)	298.600 mg/L	---	---	---
Carbonate (CO3)	0.000 mg/L	---	---	---
Chloride (Cl)	2.480 mg/L	250 mg/L [smcl]	1,500 mg/L	---
Sulfate (SO4)	58.800 mg/L	250 mg/L [smcl]	1,500 mg/L	[b]
Nitrate (NO3 as N)	1.130 mg/L	10 mg/L [mcl]	100 mg/L	---
Fluoride (F)	0.359 mg/L	4 mg/L [mcl]	2 mg/L	---
Ortho-Phosphate (as P)	<0.05 mg/L	---	---	---
Aluminum (Al)	<10 ug/L	50-200 ug/L [smcl]	---	1,000 ug/L
Antimony (Sb)	<2 ug/L	6 ug/L [mcl]	---	---
Arsenic (As)	<1 ug/L	10 ug/L [mcl]	50 ug/L	100 ug/L
Barium (Ba)	102.000 ug/L	2,000 ug/L [mcl]	---	---
Boron (B)	30.400 ug/L	---	---	---
Cadmium (Cd)	<1 ug/L	5 ug/L [mcl]	10 ug/L	5 ug/L
Chromium (Cr)	<2 ug/L	100 ug/L [mcl]	1,000 ug/L	100 ug/L
Cobalt (Co)	<2 ug/L	---	1,000 ug/L	50 ug/L
Copper (Cu)	<2 ug/L	1,300 ug/L [mcl]	500 ug/L	200 ug/L
Lead (Pb)	<2 ug/L	15 ug/L [mcl]	50 ug/L	5,000 ug/L
Lithium (Li)	22.000 ug/L	---	---	2,500 ug/L
Molybdenum (Mo)	<10 ug/L	---	---	5 ug/L
Nickel (Ni)	<2 ug/L	---	---	200 ug/L
Phosphate (P)	<0.05 ug/L	---	---	---
Selenium (Se)	<1 ug/L	50 ug/L [mcl]	50 ug/L	20 ug/L
Silver (Ag)	<1 ug/L	100 ug/L [smcl]	---	---
Strontium (Sr)	576.000 ug/L	---	---	---
Titanium (Ti)	<1 ug/L	---	---	---
Vanadium (V)	<5 ug/L	---	---	---
Zinc (Zn)	<2 ug/L	5,000 ug/L [smcl]	24,000 ug/L	2,000 ug/L
Zirconium (Zr)	<2 ug/L	---	---	---

Key: **NR** = No reading in GWIC; **mg/L** = milligrams per Liter; **ug/L** = micrograms per Liter; **---** = Currently no standard for this constituent; **[b]** = High concentrations of sulfate may restrict calcium uptake by crops; **[c]** = Varies with crop, generally dissolved solids should be less than 2,000 mg/L (equivalent to specific conductance of about 2,000 to 3,000 micromhos/cm); **[d]** = Dependent upon other variables such as type of clay in soil and salt content of water. (See SAR); **[mcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999; **[smcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard.

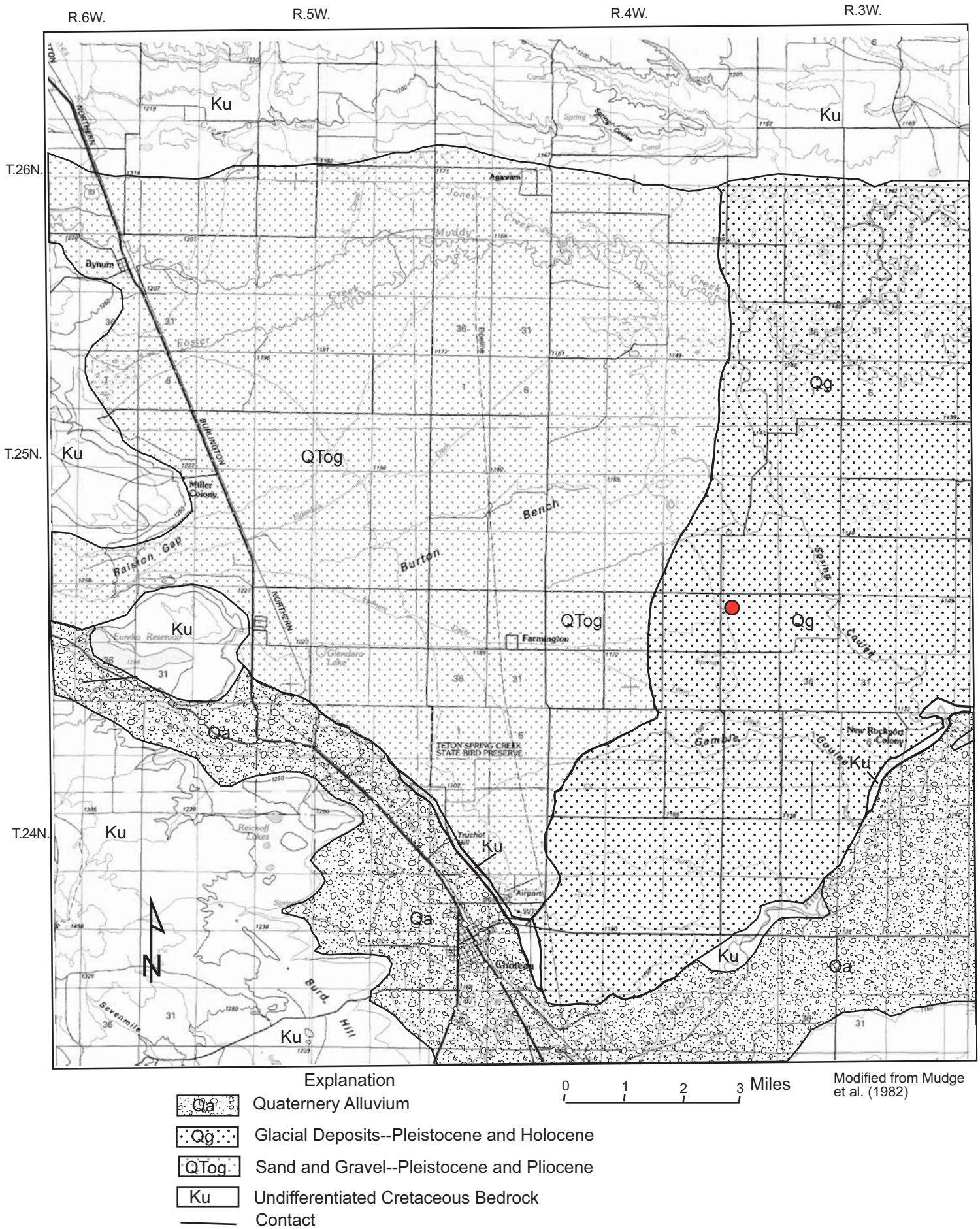


Figure 2.11.4 --Well TET-01 (25N04W26BCBD01) Generalized surficial geology map modified from Mudge and others (1982). East of Farmington, fine grain glacial material (Gg) overlies the the sand and gravel (QTog). The red circle is the approximate location of the well.

2.12 VALLEY COUNTY
29N38E36ADDD01
Well VAL-01

2.12.1 Site Location

A well was drilled in tracts ADDD sec. 36, T.29N., R.38E., at an altitude of 2,102 ft in Valley County (figure 2.12.1). The latitude is 48.2261 and longitude is -106.7158). Access is by driving west from town on 2nd Street to the railroad crossing, then left to stock tank before crossing the Milk River bottom (figure 2.12.2).

2.12.2 Well Completion Details

- Driller: MBMG; Fred Schmidt
- Date: 07/14/2004
- Total depth: 22 ft and then re-drilled to 15 ft
- Screened interval: 4.8 ft to 14.8 ft
- Yield: <1gpm
- SWL: 6.58 ft BGL

A well log is attached along with copy of the water-quality data (figure 2.11.3 and tables 2.11.1 and 2.11.2). Completion details and water-quality data also can be obtained online at the Montana Bureau of Mines and Geology's Ground-Water Information Center (GWIC) website at http://mbmggwic.mtech.edu/. The GWIC identification number for this well is 213969. The results of the pesticide analyses and minimum reporting levels are included in appendix 1.

2.12.3 Land Use

As depicted in 2.12.1, the land use is primarily thick wheatgrass and foxtail barley. A wet Spring and early Summer of the year improved soil moisture.

2.12.4 Geology

The well was completed in the Judith River Formation which was covered by Quaternary alluvium (figure 2.12.4). It encountered clays and some silt from 0 ft to 19 ft. Shale bedrock was encountered from 19 ft to 22 ft.

a.

b.

Figure 2.12.1 – The well site of VAL-01 (29N38E36ADDD01) looking upgradient. b) MBMG personnel observe as Department of Agriculture personnel purge the well during development.

Figure 2.12.2– Well VAL-1 (29N38E36ADDD01), Glasgow 7.5-min. quadrangle and orthophoto, is located about 4.2 miles northwest of Glasgow. The red circle is the approximate location of the well.

MDA Well Logs

Well name:	**VAL-01**	TD:	16.75 ft MP/TOC (14.75 ft below ground level)
GWIC ID:	M:213969	SWL:	6.58 ft MP/TOC (4.58 ft below ground level)
Date Drilled:	7/14/2004		
County:	Valley	MP Stick up:	2.0 ft AGL
TRS location:	ADDD sec. 36, 29N 38E	MP Elevation:	~2,092 ft
DD latitude:	48.2261		Near stock-water tank. Thick wheatgrass and foxtail barley in flood-irrigated field upgradient from well.
DD longitude:	-106.7158		
Elevation:	~2,090 ft		
Logged by:	J. Rose		

Drilling Interval	Depth From	Depth To	Lithology
0-5	0.0	4.5	Dark brown-black, clay Loam. Dry.
	4.5	10.0	Dark brown-black, slick, plastic clay. Damp.
5-10	10.0	11.0	Brown, soft, pliable clay with silt, sand, and very few gravels. Damp/wet with grainy texture.
	11.0	14.0	Medium-brown, very soft, silty-sandy clay. Layers of sand in clay. Wet.
10-15	14.0	15.0	Layered, stiff clay. Fragments of bedrock shale formation. Hard, tight drilling, lifting drill rig
15-20	15.0	17.0	Gray-brown, stiff clay. Damp.
	17.0	19.0	Brown, saturated intervals of hard clay and soft silty/sandy clays.
	19.0	22.0	Hard, stiff clay, lifting drill rig. Hard strings of gray, plastic clay/shale. Bedrock shale
	TD	**22 ft**	Redrill to 15 feet.

Difficult hole to drill. Very few water or seep zones.

First casing installation was a dry hole. Pulled casing, reamed out hole and reset casing. Redrilling may have smeared clays on wall of hole and reduced connectivity to water-bearing layers.

Completion data	Depth (BGL)		
From	To	Casing	
0.0	4.8	Blank (total 6.8 feet)	
4.8	14.8	Screen	
TD	**15.0**		

Depth (BGL)		
From	To	Fill
0.0	4.0	Bentonite chips, cement cap at surface
4.0	14.8	Washed pea gravel

2.12.4

Figure 2.12.3. -- Well log for VAL-01 (29N38E36ADDD01).

Table 2.12.1 -- Water quality analyses for well VAL-01 (29N38E36ADDD01).

Ground-Water Information Center **Water Quality Report**

Site Name: MDA WELL VAL-01 **Report Date:** 6/18/2005

Compare to Water Quality Standards

Location Information

Sample Id/Site Id: 2005Q0279 / 213969
Location (TRS): 29N 38E 36 ADDD
Latitude/Longitude: 48° 13' 33" N 106° 42' 56" W
Datum: NAD27
Altitude:
County/State: VALLEY / MT
Site Type: WELL
Geology:
USGS 7.5' Quad:
PWS Id:
Project: MDAPESTNET

Sample Date: 10/26/2004 11:45:00 AM
Agency/Sampler: MBMG / JCR
Field Number: 213969
Lab Date: 12/1/2004
Lab/Analyst: MBMG / WO
Sample Method/Handling: PUMPED / 3120
Procedure Type: DISSOLVED
Total Depth (ft): 16.750
SWL-MP (ft): NR
Depth Water Enters (ft): 4.800

Major Ion Results

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca)	853.000	42.565	Bicarbonate (HCO3)	766.200	12.558
Magnesium (Mg)	507.000	41.721	Carbonate (CO3)	0.000	0.000
Sodium (Na)	2,004.000	87.174	Chloride (Cl)	3,841.000	108.355
Potassium (K)	28.300	0.724	Sulfate (SO4)	2,589.000	53.929
Iron (Fe)	0.119	0.006	Nitrate (as N)	<1.25	0.000
Manganese (Mn)	0.249	0.009	Fluoride (F)	<1.25	0.000
Silica (SiO2)	16.500		Orthophosphate (OPO4)	<1.25	0.000
Total Cations		172.453	**Total Anions**		174.841

Trace Element Results (µg/L)

Aluminum (Al):	<300	Cadmium (Cd):	<10	Mercury (Hg):	NR	Tin (Sn):	NR
Antimony (Sb):	<100	Chromium (Cr):	<100	Molybdenum (Mo):	<100	Titanium (Ti):	<10
Arsenic (As):	<100	Cobalt (Co):	<20	Nickel (Ni):	<20	Thallium (Tl):	<200
Barium (Ba):	49.500	Copper (Cu):	<50	Silver (Ag):	<100	Uranium (U):	269.000
Beryllium (Be):	<20	Lead (Pb):	<100	Selenium (Se):	<150	Vanadium (V):	<100
Boron (B):	584.000	Lithium (Li):	1,193.000	Strontium (Sr):	8,759.000	Zinc (Zn):	<20
Bromide (Br):	1,870.000					Zirconium (Zr):	<20

Field Chemistry and Other Analytical Results

**Total Dissolved Solids:	10,216.610	Field Hardness as CaCO3:	NR	Ammonia (mg/L):	NR
**Sum of Diss. Constituents:	10,605.370	Hardness as CaCO3:	4,216.750	T.P. Hydrocarbons (µg/L):	NR
Field Conductivity (µmhos):	6,400.000	Field Alkalinity as CaCO3:	NR	PCP (µg/L):	NR
Lab Conductivity (µmhos):	11,700.000	Akalinity as CaCO3:	628.420	Phosphate, TD (mg/L as P):	<0.50
Field pH:	7.220	Ryznar Stability Index:	4.432	Field Nitrate (mg/L):	NR
Lab pH:	7.110	Sodium Adsorption Ratio:	13.430	Field Dissolved O2 (mg/L):	NR
Water Temp (°C):	8.800	Langlier Saturation Index:	1.339	Field Chloride (mg/L):	NR
Air Temp (°C):	NR	Nitrite (mg/L as N):	<1.25	Field Redox (mV):	NR

Notes

Sample Condition: SLIGHTLY/TURBID.
Field Remarks:
Lab Remarks:

Explanation: **mg/L** = milligrams per Liter; **µg/L** = micrograms per Liter; **ft** = feet; **NR** = No Reading in GWIC

Qualifiers: **A** = Hydride atomic absorption; **E** = Estimated due to interference; **H** = Exceeded holding time; **K** = Na+K combined; **N** = Spiked sample recovery not within control limits; **P** = Preserved sample; **S** = Method of standard additions; ***** = Duplicate analysis not within control limits; ****** = Sum of Dissolved Constituents is the sum of major cations (Na, Ca, K, Mg, Mn, Fe) and anions (HCO3, CO3, SO4, Cl, SiO2, NO3, F) in mg/L. Total Dissolved Solids is reported as equivalent weight of evaporation residue.

Table 2.12.2 -- Water quality comparison for well VAL-01 (29N38E36ADDDD01).

Drinking water limits are based on U.S. Environmental Protection Agency primary and secondary standards for public water supplies (view their standards). Stock water and irrigation water recommendations are from U.S. Department of Agriculture Natural Resources Conservation Service water-quality guidelines. The guidelines are general and my vary depending on specific applications. Irrigation guidelines are based on continuous irrigation.

Sample Id	GWIC Id	Sample Date	Site Name	Location	Site Type
2005Q0279	213969	10/26/2004 11:45:00 AM	MDA WELL VAL-01	29N 38E 36 ADDD	WELL

Constituent	This Sample	Drinking Water	Stock Water	Irrigation Water
Calcium (Ca)	853.000 mg/L	---	---	---
Magnesium (Mg)	507.000 mg/L	---	2,000 mg/L	---
Sodium (Na)	2,004.000 mg/L	250 mg/L [smcl]	2,000 mg/L	see SAR
Potassium (K)	28.300 mg/L	---	---	---
Iron (Fe)	0.119 mg/L	0.3 mg/L [smcl]	---	---
Manganese (Mn)	0.249 mg/L	0.05 mg/L [smcl]	---	2.0 mg/L
Silica (SiO2)	16.500 mg/L	---	---	---
Bicarbonate (HCO3)	766.200 mg/L	---	---	---
Carbonate (CO3)	0.000 mg/L	---	---	---
Chloride (Cl)	3,841.000 mg/L	250 mg/L [smcl]	1,500 mg/L	---
Sulfate (SO4)	2,589.000 mg/L	250 mg/L [smcl]	1,500 mg/L	[b]
Nitrate (NO3 as N)	<1.25 mg/L	10 mg/L [mcl]	100 mg/L	---
Fluoride (F)	<1.25 mg/L	4 mg/L [mcl]	2 mg/L	---
Ortho-Phosphate (as P)	<1.25 mg/L	---	---	---
Aluminum (Al)	<300 ug/L	50-200 ug/L [smcl]	---	1,000 ug/L
Antimony (Sb)	<100 ug/L	6 ug/L [mcl]	---	---
Arsenic (As)	<100 ug/L	10 ug/L [mcl]	50 ug/L	100 ug/L
Barium (Ba)	49.500 ug/L	2,000 ug/L [mcl]	---	---
Boron (B)	584.000 ug/L	---	---	---
Cadmium (Cd)	<10 ug/L	5 ug/L [mcl]	10 ug/L	5 ug/L
Chromium (Cr)	<100 ug/L	100 ug/L [mcl]	1,000 ug/L	100 ug/L
Cobalt (Co)	<20 ug/L	---	1,000 ug/L	50 ug/L
Copper (Cu)	<50 ug/L	1,300 ug/L [mcl]	500 ug/L	200 ug/L
Lead (Pb)	<100 ug/L	15 ug/L [mcl]	50 ug/L	5,000 ug/L
Lithium (Li)	1,193.000 ug/L	---	---	2,500 ug/L
Molybdenum (Mo)	<100 ug/L	---	---	5 ug/L
Nickel (Ni)	<20 ug/L	---	---	200 ug/L
Phosphate (P)	<0.50 ug/L	---	---	---
Selenium (Se)	<150 ug/L	50 ug/L [mcl]	50 ug/L	20 ug/L
Silver (Ag)	<100 ug/L	100 ug/L [smcl]	---	---
Strontium (Sr)	8,759.000 ug/L	---	---	---
Titanium (Ti)	<10 ug/L	---	---	---
Vanadium (V)	<100 ug/L	---	---	---
Zinc (Zn)	<20 ug/L	5,000 ug/L [smcl]	24,000 ug/L	2,000 ug/L
Zirconium (Zr)	<20 ug/L	---	---	---

Key: **NR** = No reading in GWIC; **mg/L** = milligrams per Liter; **ug/L** = micrograms per Liter; **---** = Currently no standard for this constituent; **[b]** = High concentrations of sulfate may restrict calcium uptake by crops; **[c]** = Varies with crop, generally dissolved solids should be less than 2,000 mg/L (equivalent to specific conductance of about 2,000 to 3,000 micromhos/cm); **[d]** = Dependent upon other variables such as type of clay in soil and salt content of water. (See SAR); **[mcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999; **[smcl]** = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard.

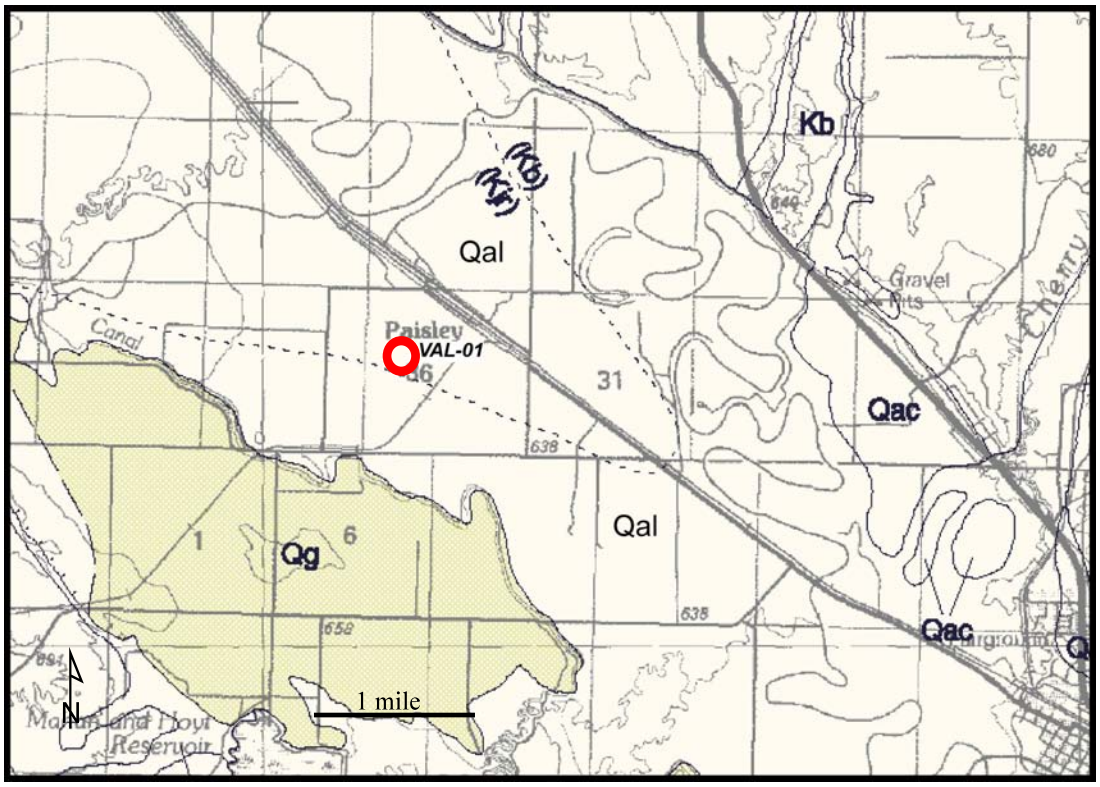


Figure 2.12.4. – Geology consists of the Judith River Formation covered by alluvium as shown on a part of the geologic map of the Glasgow 30' x 60' quadrangle in the area of well site VAL-01 taken from Bergantino (1999). Abbreviations: Qal = Quaternary alluvium; Qg= Quaternary glacial deposit; Qac = Quaternary alluvium/colluvium; Kjr = Judith River Formation.

3.0 REFERENCES

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Table A1--Pesticide minimum reporting levels.

Table A1--Pesticide minimum reporting levels.

Compound	Minimum reporting limit (µg/L)	Human Health Standard (µg/L)	Compound	Minimum reporting limit (µg/L)	Human Health Standard (µg/L)
		Tralkoxydim (Achieve) and Metabolites			
Glutaric Acid	0.05	-	Tralkoxydim	0.05	20
Imine	0.05	-	Tralkoxydim acid	0.05	-
Isoxazole	0.05	-	Trione	0.05	-
Oxazole	0.05	-			
		Imazamethabenz methyl (Assert)			
Imazamethabenz methyl acid metab	0.20	-	Imazamethabenz methyl ester	0.20	400
		Carbamates			
Aldicarb	1.00	7	Carbofuran	1.50	40
Aldicarb Sulfone	2.00	-	3-OH-carbofuran	2.00	-
Aldicarb Sulfoxide	2.00	-	Methomyl	0.50	200
Carbaryl	2.00	700			
		Phenoxy			
2,4-D	0.28	70	5-OH-Dicamba	0.25	-
2,4-DB	0.72	-	MCPA	1.00	4
2,4-DP	0.30	-	MCPP	1.00	7
Bentazon	0.63	200	PCP	0.16	1
Clopyralid	0.50	3500	Picloram	0.35	500
Dicamba	0.28	200	Triclopyr	0.25	350
		Atrazine and Metabolites			
Atrazine	0.03	3	Deisopropyl atrazine	0.03	-
Deethyl deisopropyl atrazine	0.03	-	Deisopropyl hydroxy atrazine	0.07	-
Deethyl atrazine	0.02	-	Hydroxy atrazine	0.02	-
Deethyl Hydroxy atrazine	0.04	-			
		Nitrate / Nitrite			
Nitrate as Nitrogen (x1000)	1.00	10	Nitrite as Nitrogen (x1000)	0.10	1
		Nitrogen MRM			
Acetochlor	0.50	-	Metolachlor	0.75	100
Alachlor	0.38	2	Metribuzin	0.15	200
Atrazine	0.13	3	Prometon	0.30	100
Bromacil	2.50	90	Prometryn	0.19	-
Butachlor	0.38	-	Pronamide	0.76	50
Butylate	0.15	350	Propachlor	0.50	90
Carboxin	0.60	700	Propazine	0.13	10
Cyanazine	0.40	1	Simazine	0.30	4
Cycloate	0.25	-	Tebuthiuron	1.30	500
EPTC	0.25	-	Terbacil	2.20	90
Hexazinone	0.76	400	Triallate	0.50	-
Imazalil	5.00	-			

Table A1--Pesticide minimum reporting levels.

Compound	Minimum reporting limit (µg/L)	Human Health Standard (µg/L)	Compound	Minimum reporting limit (µg/L)	Human Health Standard (µg/L)
		Phosphorous MRM			
Azinphos Methyl	1.30	-	Fenamiphos	1.00	2
Chlorfenvinphos	0.70	-	Fenthion	0.20	-
Chlorpyrifos	0.18	20	Malathion	0.40	100
Diazinon	0.25	0.60	Metalaxyl	3.50	420
Dichlorvos	2.50	-	Methidathion	0.60	-
Disulfoton	0.30	0.30	Mevinphos	5.00	-
Disulfoton Sulfone	0.50	-	Ethyl Parathion	0.50	2
Disulfoton Sulfoxide	0.38	-	Methyl Parathion	0.50	-
Ethion	0.30	-	Terbufos	0.50	0.90
Ethoprop	0.19	-			
		SU's			
Chlorsulfuron	0.01	-	Prosulfuron	0.01	-
Ethametsulfuron methyl	0.01	-	Sulfometuron methyl	0.01	-
Halosulfuron methyl	0.01	-	Thifensulfuron methyl	0.01	910
Nicosulfuron	0.01	-	Triasulfuron	0.01	70
Metsulfuron methyl	0.01	1750	Triflusulfuron methyl	0.01	-
Primisulfuron methyl	0.01	42			

Table A2--Pesticide Analyses results.

Site	Date Sampled	Tralk-oxydim	Tralk-oxydim metab-olites	Imaza-meth-abenz methyl ester	Imaz-ameth-abenz methyl acid met.	Atrazine	Atrazine metabolites	Carba-mates	Nitrate (ppm)	Nitrite (ppm)	Nitrogen MRM	Phos-phorus MRM	Phenoxy MRM	SU's
BEA-1	9/22/2004	-	-	-	-	-	-	-	2.1	-	-	-	-	-
BRO-1	9/22/2004	-	-	-	-	-	-	-	-	-	-	-	-	-
CHO-1	9/21/2004	-	-	-	-	-	-	-	-	-	-	-	-	-
DAN-1	10/25/2004	-	-	-	-	-	-	-	13	-	-	-	-	-
DAW-2	3/9/2005	-	-	-	-	-	-	-	-	-	-	-	-	-
GLA-1	10/27/2004	-	-	-	-	-	-	-	37	-	- -	-	-	-
HIL-1	10/26/2004	-	-	-	-	-	-	-	21	-	-	-	-	-
LAK-1	10/27/2004	-	-	-	-	-	-	-	7.4	-	0.45 Prometon		-	-
LAK-1*	1/24/2005	-	-	-	-	-	-	-	-	-	0.53 Prometon		-	-
LAK-2	3/10/2005	-	-	-	-	-	-	-	-	-	-	-	-	-
RIC-1	10/25/2004	-	-	-	-	-	-	-	-	-	-	-	-	-
TET-1	9/21/2004	-	-	0.36	-	-	-	-	1.1	-	-	-	-	-
VAL-1	10/26/2004	-	-	-	-	-	-	-	1.7	-	-	-	-	-

* indicates verification sampling

- = No Detection at or above the reporting limit