Statement of Interest by the Montana Bureau of Mines and Geology

National Ground Water Monitoring Network: Pilot Project

By

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October 30, 2009

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INTRODUCTION

The Ground Water Assessment Program (GWAP) at the Montana Bureau of Mines and Geology (MBMG), together with its cooperators, manages a statewide water-level and water-quality network of more than 940 sites. MBMG's goal is to gather water-quantity and water-chemistry data and create long-term time series water-level and water-quality records. Statewide network data are available over the Internet at the Montana Ground Water Information Center (GWIC) website. Time-series data are essential to planners, scientists, and others who must address how climate variability, groundwater development, land use change, or other factors may impact groundwater resources.

Although there are many groundwater monitoring networks in Montana, many efforts target environmental issues such as Superfund sites in the Upper Clark Fork River Basin. These networks may collect long-term data but are often targeted on specific water-quantity and water-quality issues; sites within these networks address limited areas from a principal aquifer point of view. MBMG's statewide long-term monitoring network is designed to collect data at "aquifer-wide" scales and includes many potential National Ground Water Monitoring Network (NGWMN) sites that are within Montana's segments of the nation's principal, major, or other important aquifers.

Montana's statewide network is authorized in statute and, although directly managed by MBMG, is a **strongly coordinated effort**. The Montana Ground Water Assessment Steering Committee includes representatives from Montana's departments of Natural Resources, Environmental Quality, Agriculture, and State Library as voting members and has responsibility to review and approve groundwater monitoring sites selected by MBMG. Federal agencies with water-related interests and industrial, agricultural, county, and developmental interests are ad hoc steering committee members.

Beyond the coordination activities of the Ground Water Assessment Steering Committee, the MBMG operates some intermontane valley segments of the statewide network through memoranda of understanding with county-based local water quality protection districts. The local districts have developed dedicated monitoring networks from which they collect time-series water-level and water-quality data. The MBMG contracts with individual districts to reimburse quarterly data-collection costs from selected network wells. Each district may collect measurements more frequent than quarterly and if so, will forward those data to MBMG for public distribution through GWIC database's web interface.

PROJECT AREA

Montana's statewide network covers most of its major aquifers and a NGWMN pilot project would allow state and federal agencies to determine which statewide monitoring sites would appropriately fit into the NGWMN. Additionally, the pilot project would identify data gaps, potential operational changes, and potential NGWMN-related costs. Montana recognizes that decisions to 'tag' any of its statewide monitoring network sites as NGWMN monitoring

points would depend on NGWMN design elements, and that not all of Montana's sites would become NGWMN sites.

Table 1 (Appendix B) identifies principal, major, or other important aquifers that could be addressed by designating monitoring points in Montana's statewide network as NGWMN sites. Important Montana aquifers not specifically described in HA370-I include extensive Upper Tertiary aggradational sand and gravel deposits in northern Montana and Upper Cretaceous sandstone aquifers within the Judith River and Eagle formations in north-central Montana outside of the area mapped in HA-370-I.

Maps for Montana's segments of principal and major aquifers are included within HA370-I and can be viewed at: http://pubs.usgs.gov/ha/ha730/ch_i/index.html. Figure 1 (Appendix A) shows the distribution of monitoring points within Montana's statewide network.

EXISTING NETWORK

The MBMG's statewide, monitoring network is designed to generate long-term records of ground-water quantity and quality. MBMG employees and cooperators travel to network wells each calendar quarter to measure water levels, service about 100 water-level recorders, and collect water-quality samples. Figure 1 (Appendix A) shows the well distribution within the statewide network.

Montana's network design is based primarily on aquifer extents and level of development. Therefore, statewide monitoring spatially reflects Montana's geology and those areas where groundwater is heavily utilized. Monitoring locations may also be keyed to local interests and a need for targeted monitoring. An example of a targeted segment within Montana's network is a cluster of monitoring points north of Scobey, Montana as shown on Figure 1 (Appendix A). In this area, coal mining in Saskatchewan, immediately north of the United States-Canada border, presents potential trans-boundary groundwater quantity and quality issues to Montana.

Montana's complex geology of intermontane basins in the west connected by thin alluvial deposits along river valleys, and regionally extensive bedrock sandstone and carbonate rock aquifers in the east required different network design approaches.

- **Western Montana:** Western Montana monitoring wells are distributed within the intermontane basin aquifers west of the northwest-southeast line on Figure 1 (Appendix A). Where available, potentiometric surface, conceptual groundwater flow models, and geology guide monitoring well location selections so that up-gradient recharge, mid-basin storage, and down-basin discharge areas are represented.
- **Eastern Montana:** Eastern Montana aquifers occur in alluvial deposits along rivers and streams and in extensive Lower Tertiary to Paleozoic bedrock formations east of the northwest-southeast line in Figure 1 (Appendix A). These aquifers are in outcrop or relatively near land surface near structural highs, but are sometimes more than 1,000

ft below land surface in structural basins. Because there are relatively few wells deep in the basins, most of the bedrock aquifers are monitored near their outcrop.

About 50 percent of the statewide network sites are dedicated monitoring wells, unused production wells, or very low-use production wells. Examples of very low-use wells are those that serve remote one-room schools in eastern Montana, or highway department maintenance shops. Most other network wells produce water for domestic and stock purposes. The distribution of dedicated, unused, and low use wells is shown in Figure 2 (Appendix A).

Monitoring program staff and cooperators visit each network well quarterly to measure water levels and service water-level recorders. MBMG staff collects inorganic water-quality samples from about 70 sites annually, concentrating on groups of wells not sampled during the previous 10-12 years. Field staff collects samples for common ion, trace metal, and selected nutrient analyses. Water-level data are entered into the GWIC database remotely or in Butte via web-based tools and appear on the database for public access usually within one week of measurement or instrumental download. Water-quality results appear on the database when released by the laboratory.

Figure 3 (Appendix A) shows the spatial distribution of water-level measurement frequencies within the Montana network. Table 2 (Appendix B) shows that about half of the network wells have between 11 and 20 years of record. The median number of measurements for all network wells is 4/yr but the range is from about once annually for a few wells not measured consistently across their periods of record, to hourly for wells that have data loggers. The frequency of measurement during a period of record varies, depending on installation of recorders, cooperative agreements, or other factors.

MONITORING GOALS

Montana's statewide monitoring network primary goal is to build long-term time-series water-level and water-quality data sets to address questions such as:

- How are water supplies being impacted by climate variability/ change?
- How are water supplies (sw+gw) being impacted by groundwater development?
- How does variability in oceanic conditions as indicated by the El Nino-Southern Oscillation Index and the Pacific Decadal Oscillation change groundwater storage?
- How do current irrigation practices and changes such as conversion from flood irrigation to sprinkler irrigation impact groundwater storage?
- Are there long-term baseline water-quality changes occurring in Montana's major aquifers?
- Are land use changes causing nutrient concentrations to change in Montana's major aquifers?

The long-term time series data in themselves delineate how the measured parameters are changing with time. The network's utility depends on what questions eventually are asked and the comparability/correlation of the network data with ancillary data sets such as streamflow or precipitation records.

Most of Montana's statewide network is generally considered to be 'ambient-unstressed' and most monitoring is not targeted at specific issues. Exceptions include:

- A few monitoring sites dedicated to observing the long-term impact of cropping practices at a saline seep research site.
- Wells in northeast Montana north of Scobey (Figure 1, Appendix A) to monitor potential impacts of a coal fired power plant in Canada
- Wells near current and reclaimed coal mining in the Powder River basin to keep core monitoring active and observe long-term mining impacts.
- Wells near other areas of active or potentially active groundwater development; these wells were added to the statewide network at the request of regulatory agencies.

The water-level records themselves will illustrate various levels of stress from potential nearby pumpage, in-well pumpage, irrigation practices, surface/groundwater interactions, etc. Pumpage impacts are noted within the time-series record by annotating measurements that are 'non-static' when collected. As used within the framework document 'baseline', 'surveillance', and 'trend ' monitoring essentially describe how often a site may be visited. Montana does not designate monitoring sites in this manner although it does store the planned measurement frequency (quarterly, monthly, etc.) for each network well. Montana could incorporate these designations within its data structures for NGWMN purposes and at many sites measurement frequency could be changed to meet NGWMN goals.

POTENTIAL MONITORING POINTS

Potential candidate monitoring points within Montana's segments of principal, major, or other important aquifers are listed in Appendix D and the preliminary number of sites assignable to each aquifer is summarized in Table 1 (Appendix B). The Northern Rocky Mountains Intermontane Basins aquifer system (S100NRMTIB) is very important in Montana and is represented in the statewide network by more than 400 monitoring sites. Individual wells and geologic units represented within the S100NRMTIB range from recent alluvial deposits along rivers and streams, to Tertiary basin-fill deposits, to Precambrian consolidated rocks along the intermontane basin edges.

Lower Tertiary (N300LTRTRY) and Upper Cretaceous aquifers (N300UPCTCS) are monitored by about 260 sites showing the importance of these aquifers in eastern Montana. The distribution of N300LTRTRY monitoring sites falls within areas mapped in the National Atlas but the most important N300UPCTCS aquifers in Montana are the Fox Hills and Hell Creek formations, the Judith River Formation, and the Eagle/Virgelle Formation. The Judith River and Eagle formations are described as being too 'shale rich' within the area mapped in

the National Atlas to be important aquifers, but in Montana - to the west and northwest of the mapped area - these formations contain substantial beds of permeable sandstone. Many thousands of Montanans rely on these aquifers for domestic and stock water supply.

How many and which monitoring sites listed in Appendix D will be suitable for the NGWMN will depend on the need for data collected in at a given location from a national point of view. If data from a location is desired for the NGWMN, the quality of information provided by a Montana statewide network site including period of record, long-term access, suitability for quantity or quality measurements, well construction detail, etc. would help determine the suitability of that site.

Known data gaps in Montana's statewide network include:

- The ability to monitor deeply buried aquifers such as parts of the Fox Hills and Hell Creek formations, Lower Cretaceous (N300LCRTS) aquifers such as the Kootenai Formation, and important Paleozoic (N500PLOZOC) aquifers such as the Madison Group is hampered by access. Because drilling depths are great throughout most of eastern Montana, these aquifers are mostly used in relatively near-surface areas near their outcrops. A significant monitoring gap exists where these formations are deeply buried because there are few to no existing wells.
- Targeted monitoring within areas being developed for coal bed methane. Opportunities exist for additional cooperation with other MBMG monitoring networks to tag wells as part of the statewide network and to include those wells in the NGWMN.
- Lack of monitoring locations on Montana's Tribal lands.
- Need for more instrumented wells and data telemetry. Current and future questions require more frequent data collection and data telemetry will decrease data collection costs.

FIELD PRACTICES

MBMG and its cooperators use a variety of standard field equipment such as steel tapes, electric water-level sounders, pressure gages for artesian flowing wells, and field water-quality instruments to collect data at statewide monitoring network sites. Standard Operating Procedures guiding field activity are included in Appendix E.

DATA MANAGEMENT AND DISSEMINATION

All data collected from Montana's statewide monitoring well sites are stored in a relational database structure within a Microsoft SQL Server 2005 environment. The relational database (GWIC) consists of about 140 tables which store 'sites', 'borehole', 'field visit', 'measuring point', 'static-water level', 'water-quality', 'ownership', and many other relevant data. GWIC uses a unique a 6-digit site-identification number as its primary relational key but contains latitude/longitude fields with which to form unique site identifiers as required by NGWMN data structures. GWIC data structures contain many of the data elements outlined

in the Framework Document's Appendix 6. An annotated comparison between current GWIC data structures and Framework Document data elements is in Appendix C.

Water-level and water-quality data collected at NGWMN sites would be stored within GWIC along with other statewide monitoring network data. Water-level data at each well would be collected using the standard operating procedures listed in Appendix E, entered into GWIC through non-public data entry websites at MBMG, or uploaded from pre-built spreadsheet files. Water quality samples and field chemistry data would be collected using standard operating procedures. The samples would be processed at the MBMG or other laboratories and the analytical results transferred to GWIC. Field chemistry data would be loaded to GWIC from field sheets completed at the time of the well visit, and relationally linked with analytical laboratory data.

Focusing on static-water levels, periodic measurement and data uploads from spreadsheets are cross checked by visually verifying data values in data entry screens against the field records, evaluating departure from water-level average fields calculated and displayed at the time of data entry, and by review of hydrographs. For example, a mis-assigned or typographically incorrect water-level data point will immediately display a large departure from average at the time the value is stored, alerting the data entry person to a potential problem. Data uploaded through spreadsheets but inadvertently assigned to incorrect well identifiers will not show up when the hydrograph is retrieved for verification or will be 'out-of-pattern'. Data reviewers have on-line tools to fix data entry errors at the time of discovery. Although internal 'data-ownership' and 'data-release' tools are available to control the release of information, most GWIC data are public and generally become viewable on the GWIC website upon storage in the SQL system.

GWIC currently contains more than 4.8 million water levels from about 13,000 wells. In addition to water levels, GWIC users can obtain well-construction, water-level, lithologic-description, and water-quality data from individual wells, or for groups of wells in areas as large as drainage basins. Figure 4 (See Appendix A) shows part of the main menu screen for the GWIC website.

Figure 5 (Appendix A) is a typical GWIC hydrograph. Links at the bottom of the hydrograph provide access to the well log report or allow the user to download data used to make the graph. If the user retrieves the well log, a well log report shown in Figure 6 (Appendix A) allows evaluation of the well's construction details.

GWIC is accessible through the Internet at http://mbmggwic.mtech.edu. The web applications running GWIC consist of more than 1,000 scripts/pages containing about 255,000 lines of HTML/ASP code. The website provides numerous 'pre-built' retrievals that allow data users to select, retrieve, and download groundwater data. Public or private retrieval options could be built to access data that may be generated from wells selected to be within the NGWMN. The database is comprehensive and serves site-location, water and borehole-log, field-visit, water-chemistry, and water-level data for more than 250,000 sites.

GWIC is actively and heavily used by many customer constituencies. Figure 7 (Appendix A) illustrates some user statistics for calendar year 2009. Since January 2009, customers have started almost 34,000 user sessions and made more than 560,000 queries.

The Internet-capable GWIC interface coupled with a Microsoft SQL Server database manager and a relatively close match between GWIC and NGWMN data elements, indicate that modifications at GWIC to either support direct access to NGWMN wells through a portal or to support ready uploading of data to federal systems should be possible.

CONTACT INFORMATION

The primary contact person for the Montana statewide monitoring network is:

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Partners with the MBMG in operation of the statewide network are described below in the ONGOING COLLABORATION Section. Partners include Montana's Departments of Agriculture, Natural Resources, and Environmental Quality; the Gallatin, Lewis and Clark, and Missoula local water quality protection districts; The Confederated Salish and Kootenai Tribes, and the U.S. Geological Survey – Cooperative Water Program.

APPROACH AND MILESTONES

Montana anticipates that the pilot project would last one year. Montana will continue to operate its statewide network to meet its purposes but would participate as necessary and work with the Pilot Project work group to:

- Modify GWIC data structures as necessary (see Appendix C) to 'tag' statewide monitoring sites as NGWMN sites and insure that MBMG data management is compatible with the NGWMN.
- Tag statewide wells as NGWMN sites and designate stressed (targeted), unstressed, surveillance, baseline, trend sub network types. However, because NGWMN sub network types determine measurement frequency, Montana will **not** be able to increase monitoring frequencies appropriate to the sub network type until such time as federal

cost share to support federal interests in data from Montana's statewide network becomes available.
- Reconcile MBMG standard operating procedures used on NGWMN sites with procedures developed by the NGWMN.
- Modify access to GWIC as necessary to allow the NGWMN portal to routinely either access data or except data linked to NGWMN tagged sites

PARTICIPATION COSTS

If selected, the MBMG Ground Water Assessment Program will support costs to participate in the NGWMN Pilot Project for the duration of the project period. If the NGWMN is implemented and Montana's participation continues beyond the pilot phase, MBMG will seek federal cost share as appropriate for operation of its NGWMN tagged sites.

EXPECTATIONS

Within reasonable limits and in conjunction with operation of its statewide monitoring network, MBMG will, if selected as a NGWMN pilot project partner, commit personnel resources towards the completion of pilot project tasks listed below.

- Attend telephone meetings and web conferences.
- Potentially modify standard operating procedures for collection of water-level data and water-quality samples to accommodate NGWMN standards.
- Potentially modify GWIC data structures to accommodate data elements necessary to allow linkage to a NGWMN central data exchange and access system (portal).
- Potentially modify GWIC website programming to allow linkage to the NGWMN portal.
- Tag potential NGWMN monitoring sites as unstressed or targeted, and whether the monitoring is baseline, surveillance, maintenance, etc.;
- Work with pilot project workgroup members to develop report outlines and finished documents; and
- Communicate with the SOGW, study partners, and the monitoring community.

The MBMG and the Montana Ground Water Assessment Program have a proven track record of working cooperatively with multi-stakeholder groups as shown by Montana statewide network cooperators listed in the ONGOING COLLABORATION section below. That MBMG has a long-standing interest in developing central data access systems for groundwater information is shown by development of its Ground Water Information Center (GWIC) database; GWIC began offering groundwater data electronically through dial-up access to cooperating government agencies in the mid 1990's and became accessible to the general public through the Internet on January 4, 1999.

ONGOING COLLABORATION

The Montana statewide monitoring network although managed and operated by MBMG through its Ground Water Assessment Program, has a strong collaborative component. Statutory management/oversight by the Ground Water Assessment Steering Committee has created an environment where many groups are aware of the network and can influence its operation. Generally, participation comes in the form of willingness to ship data to MBMG for distribution through GWIC. Agencies that actively collaborate/cooperate in the statewide network are:

- The Gallatin Valley Water Quality District: provides monthly/quarterly water-level data from 47 statewide network wells in the Gallatin Valley and monthly data from the remainder of their network wells.
- The Lewis and Clark County Water Quality Protection District: provides monthly/quarterly water-level data on 45 statewide network wells in the Helena Valley and monthly data from the remainder of their network wells.
- The Missoula Valley Water Quality District: provides quarterly water-level data on 19 statewide network wells in the Missoula Valley and quarterly data from the remainder of their network wells.
- The Confederated Salish and Kootenai Tribes: provides an annual update of quarterly water-level measurements from 28 wells on the Flathead Reservation.
- The Gros Ventre and the Assiniboine Tribes which allow operation of a water-level recorder on the Fort Belknap Reservation.
- Assiniboine and Sioux Tribes which allow operation of two water-level recorders on the Fort Peck Reservation.
- Montana Department of Natural Resources and Conservation: forwards project specific data from non-network wells to MBMG for distribution through GWIC. Occasionally requests that new targeted monitoring points be added to the network.
- U.S. Geological Survey: operation of 9 quarterly measurement sites and 10 continuous recorder sites for the statewide network through the cooperative water program.

MBMG contacted the Montana Departments of Agriculture, Environmental Quality, and Natural Resources to determine whether these agencies were contemplating submission of a SOI. These agencies indicated agreement that MBMG should take the lead in making Montana's response to the RSOI and that they would allow wells under their control to be tagged as NGWMN wells. When asked, the Gallatin, Lewis and Clark, and Missoula county water quality districts responded that they were not going to submit SOI's and agreed that wells in their county networks could be tagged as NGWMN wells. The Salish and Kootenai tribes stated that they were not going to submit a SOI and that their network wells could be used within the NGWMN.

ONGOING MONITORING

State and non-federal groundwater monitoring programs within Montana exclusive of site specific regulatory monitoring include:

- **(State)** Montana Department of Agriculture: the department samples ground water and surface water across the state to determine the presence of pesticides and fertilizers. The department has a permanent network of 44 monitoring wells from which it periodically collects samples for pesticide and fertilizer screenings.
- **(State)** MBMG: the Bureau monitors water levels and collects periodic water-quality samples from a network of 227 wells within the Powder River Basin. The data are used to observe impacts of coal mining and coal bed methane development but is not regulatory. About 15 of these wells are tagged as Montana statewide network wells. Information collected is available through GWIC.
- **(State)** MBMG: the Bureau monitors water levels and collects periodic water-quality samples from a network of about 80 wells in the Anaconda-Opportunity, Montana area. Information collected is available through GWIC.
- **(State)** MBMG: the Bureau monitors 16 wells in the closed groundwater area surrounding Yellowstone National Park for long-term water levels. Information collected is available through GWIC.
- **(State)** MBMG: the Bureau monitors 137 wells in Sheridan and Roosevelt counties to evaluate performance of a heavily developed ancestral Missouri River valley aquifer. Twenty-two of these wells are tagged as statewide monitoring wells.
- **(Federal)** The U.S. Geological Survey maintains about 180 active monitoring points within Montana Seventy-seven sites are part of the Survey's Smith River SW/GW project which began in 2006 and is scheduled to end in 2012. Seventeen periodic sites are distributed in two townships in Lincoln County. Seventeen periodic sites are in a single quarter section within Missoula County. Nineteen periodic sites are in Sheridan County. The remaining 53 sites are scattered across 16 different counties. Nineteen of these sites are operated in conjunction with the MBMG under the Cooperative Water Program and are part of Montana's statewide network. Six of the USGS sites are part of the climate monitoring network.

Appendix A -- FIGURES

Figure 1 – Montana's statewide monitoring network (yellow points) provides data from heavily used intermontane basin aquifers in the west and widely used alluvial, Lower Tertiary, Upper Cretaceous, Lower Cretaceous, and Paleozoic aquifers in the east. Red points mark the locations of more than 210,000 water wells. The northwest-southeast white line designates the general boundary between intermontane basin aquifers in the west and regionally extensive bedrock aquifers in the east

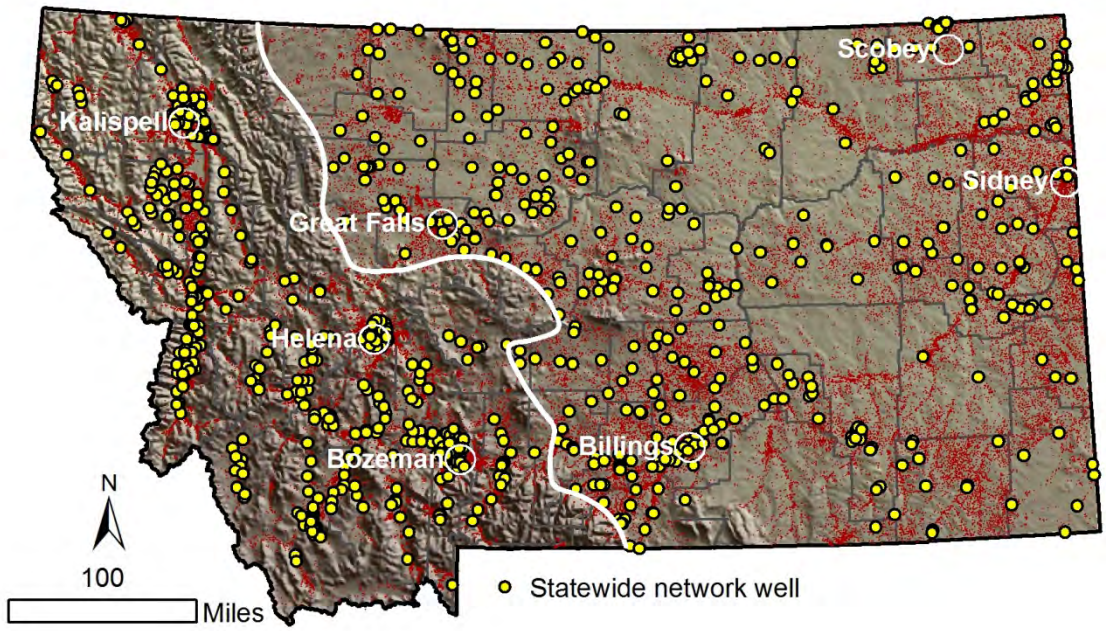


Figure 2 – The Montana network contains about 30 percent dedicated monitoring wells. Another 20 percent of wells are unused or of very low use. The remainder is mostly production wells that produce water for stock and domestic purposes.

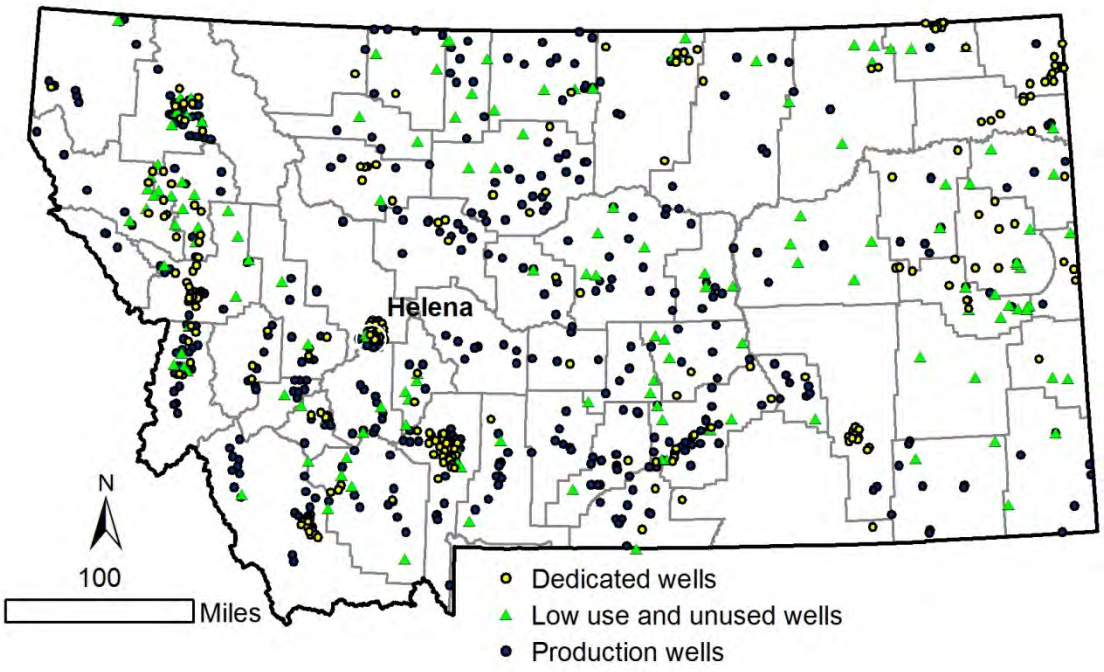


Figure 3 – Measurement frequencies in the statewide Montana network range from monthly, to quarterly, to hourly from some instrumented wells.

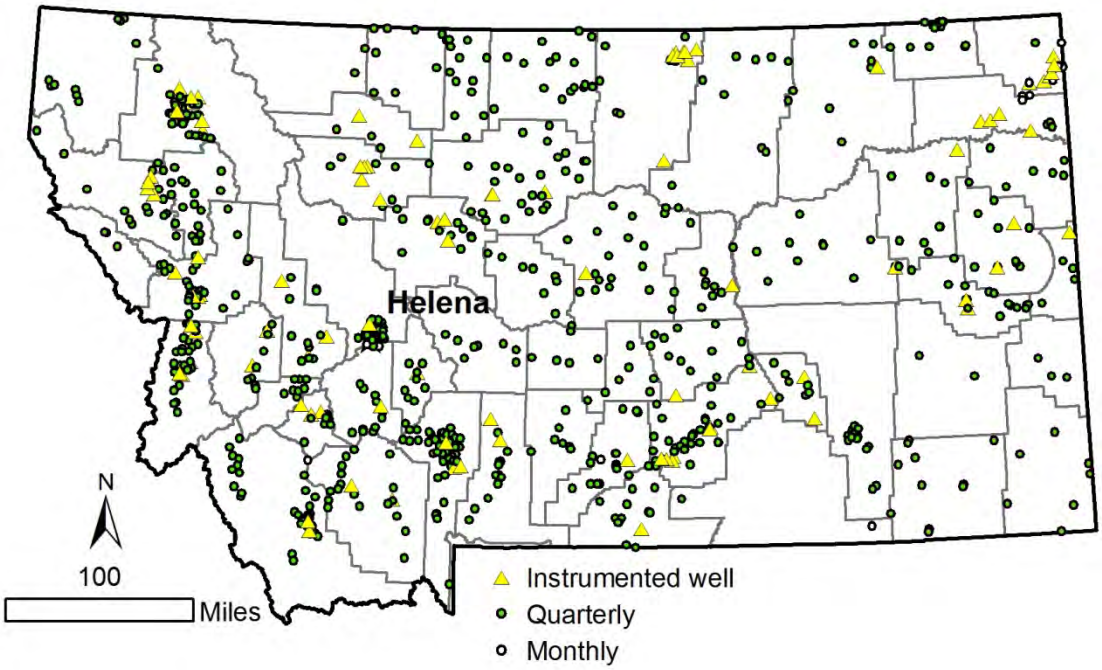


Figure 4 – Groundwater data for Montana are available through MBMG's GWIC database. Users can select from multiple search and report options to locate well construction, water quality, water level, and aquifer test data.

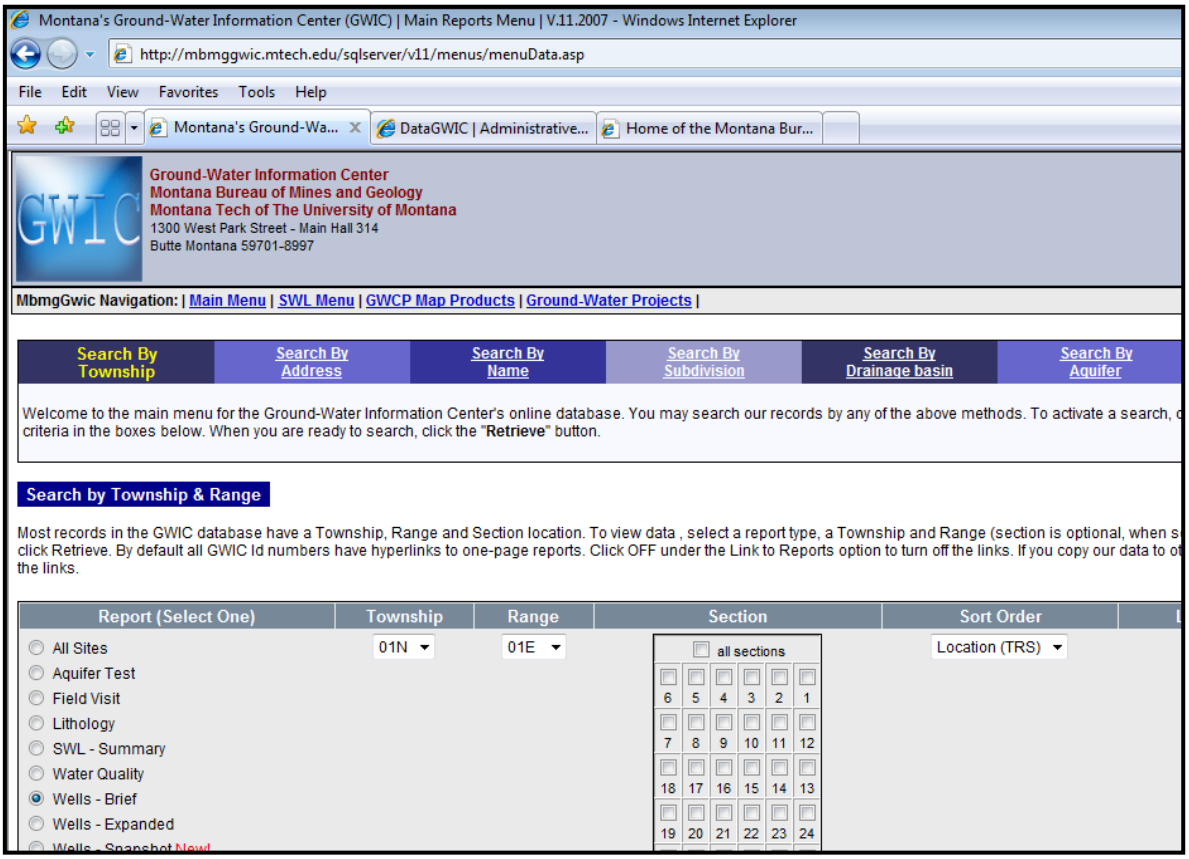


Figure 5 – This hydrograph of water levels in a long-term monitoring well in northwest Montana's Flathead Valley shows that a long-term downward trend appears to have begun in about 1973. Superimposed on this trend are influences caused by nearby pumping and response to wetter than normal climate between 1995 and 1998. A single "recovering" water level measured in 2006 is flagged as 'non-static'.

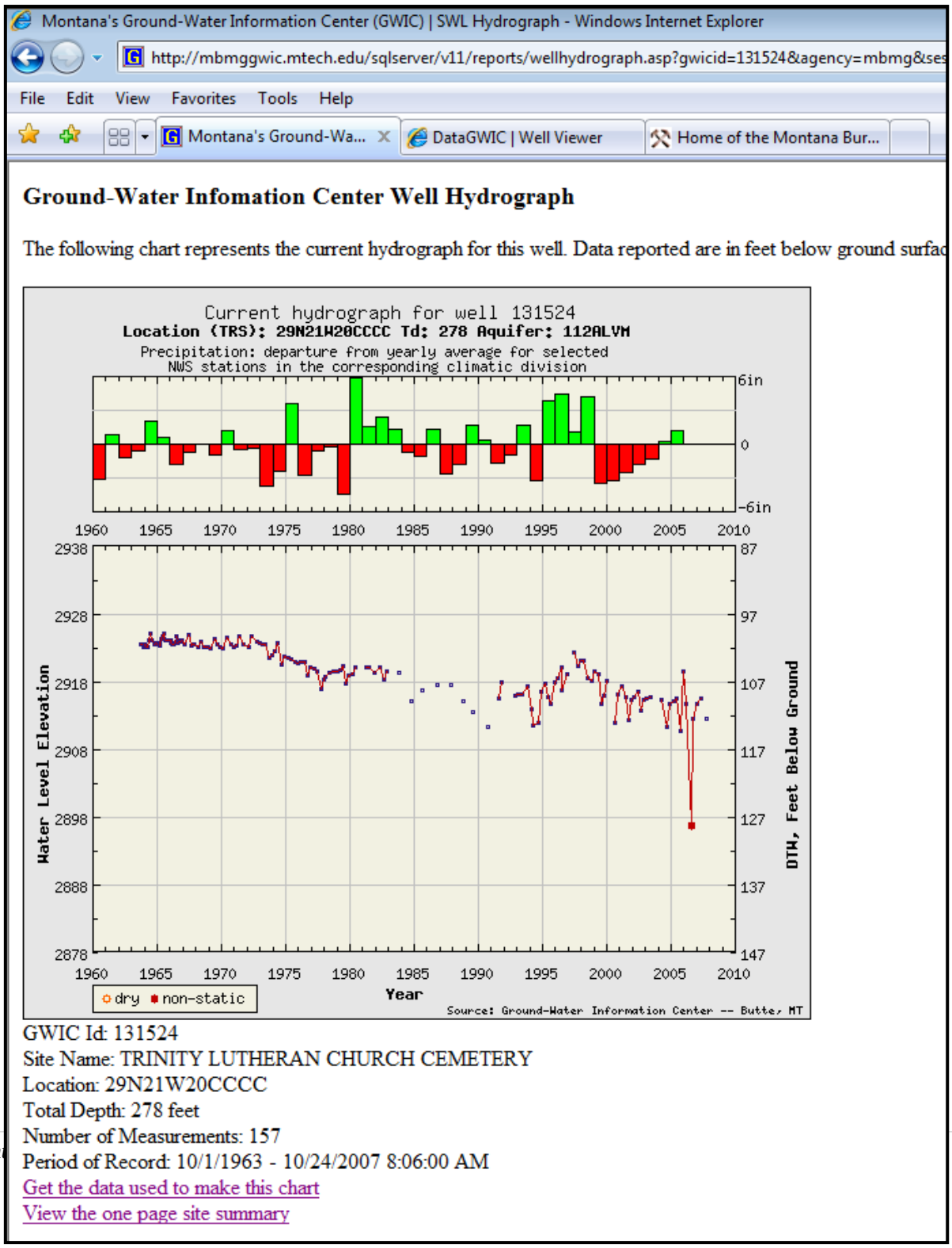
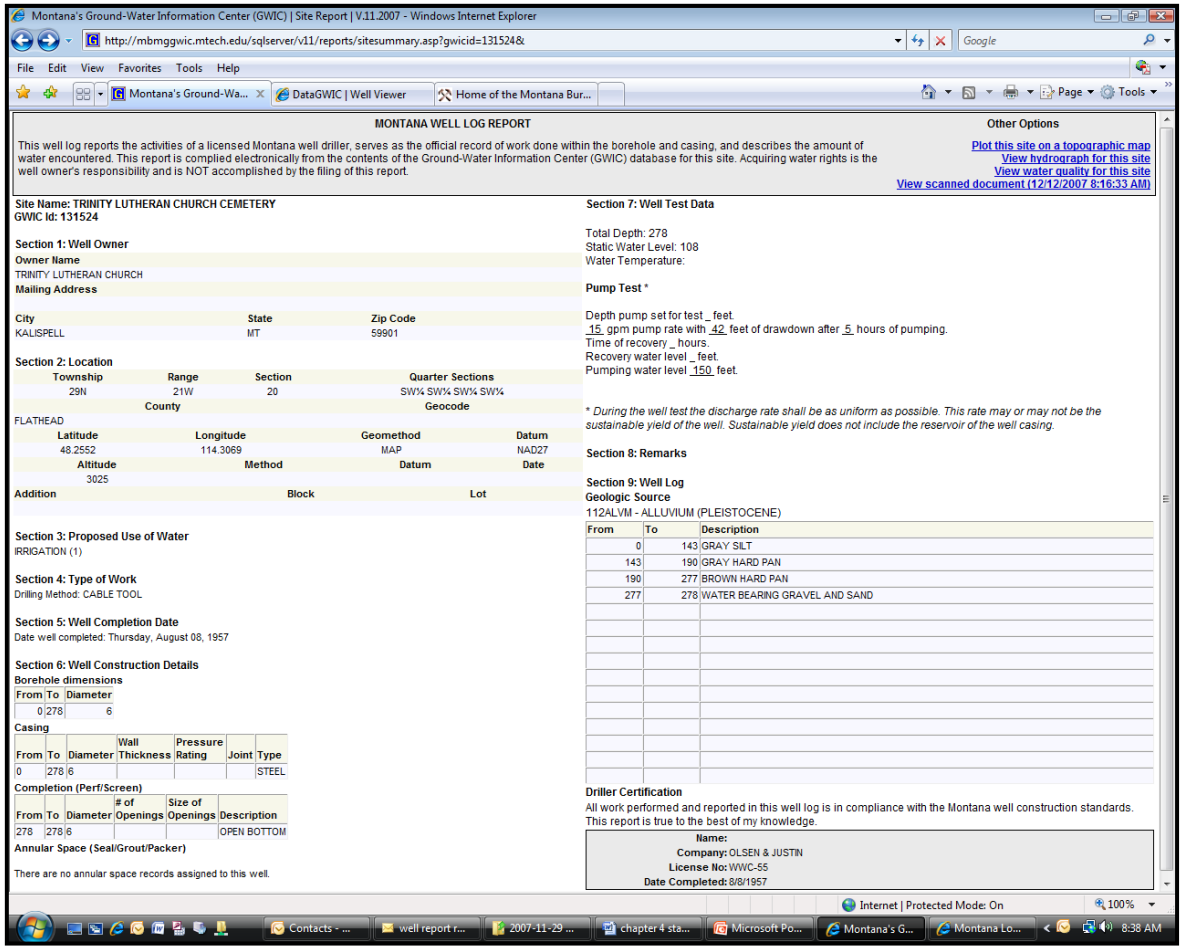


Figure 6 – The GWIC well log report provides construction details for the monitored well as well as links that allow a user to: plot the well on maps or photographs, access water-quality results, access the hydrograph or view a scanned image of the original well-log document.



Montana's Ground-Water Information Center (GWIC) | Site Report | V.11.2007 - Windows Internet Explorer

http://mbmggwic.mtech.edu/sqlserver/v11/reports/sitesummary.asp?gwicid=131524&

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is complied electronically from the contents of the Ground-Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Plot this site on a topographic map
View hydrograph for this site
View water quality for this site
View scanned document (12/12/2007 8:16:33 AM)

Site Name: TRINITY LUTHERAN CHURCH CEMETERY
GWIC Id: 131524

Section 1: Well Owner

Owner Name		
TRINITY LUTHERAN CHURCH		
Mailing Address		
City	**State**	**Zip Code**
KALISPELL	MT	59901

Section 2: Location

Township	Range	Section	Quarter Sections
29N	21W	20	SW¼ SW¼ SW¼ SW¼

County	Geocode
FLATHEAD	

Latitude	Longitude	Geomethod	Datum
48.2552	114.3069	MAP	NAD27

Altitude	Method	Datum	Date
3025			

Addition	Block	Lot

Section 3: Proposed Use of Water
IRRIGATION (1)

Section 4: Type of Work
Drilling Method: CABLE TOOL

Section 5: Well Completion Date
Date well completed: Thursday, August 08, 1957

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	278	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
0	278	6				STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
278	278	6			OPEN BOTTOM

Annular Space (Seal/Grout/Packer)

There are no annular space records assigned to this well.

Section 7: Well Test Data

Total Depth: 278
Static Water Level: 108
Water Temperature:

Pump Test *

Depth pump set for test _ feet.
_15_ gpm pump rate with _42_ feet of drawdown after _5_ hours of pumping.
Time of recovery _ hours.
Recovery water level _ feet.
Pumping water level _150_ feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log

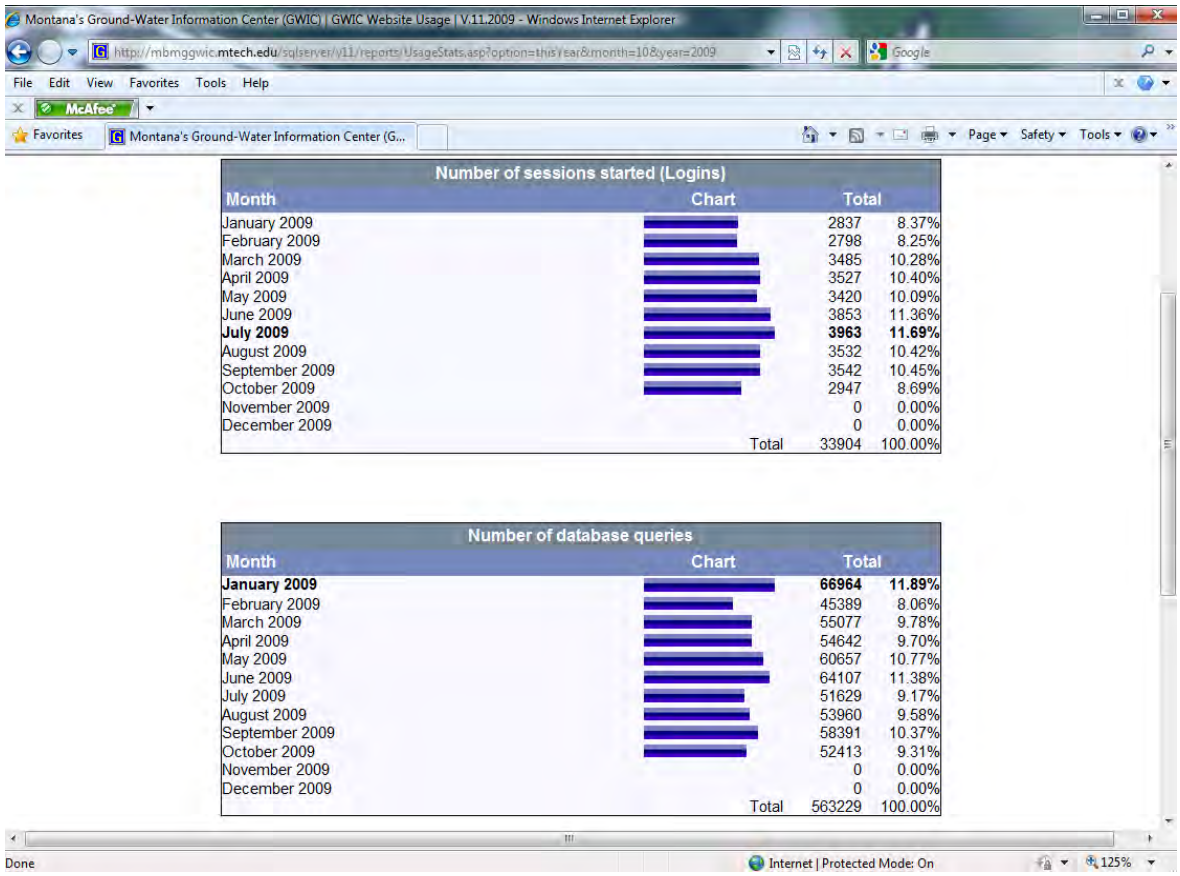
Geologic Source
112ALVM - ALLUVIUM (PLEISTOCENE)

From	To	Description
0	143	GRAY SILT
143	190	GRAY HARD PAN
190	277	BROWN HARD PAN
277	278	WATER BEARING GRAVEL AND SAND

Driller Certification
All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name:
Company: OLSEN & JUSTIN
License No: WWC-55
Date Completed: 8/8/1957

Figure 7 – Statistics reported on October 28, 2009 show that GWIC users have logged on to the database almost 34,000 times and made more than 560,000 queries since January 2009.



Number of sessions started (Logins)

Month	Chart	Total	
January 2009		2837	8.37%
February 2009		2798	8.25%
March 2009		3485	10.28%
April 2009		3527	10.40%
May 2009		3420	10.09%
June 2009		3853	11.36%
July 2009		**3963**	**11.69%**
August 2009		3532	10.42%
September 2009		3542	10.45%
October 2009		2947	8.69%
November 2009		0	0.00%
December 2009		0	0.00%
	Total	33904	100.00%

Number of database queries

Month	Chart	Total	
January 2009		**66964**	**11.89%**
February 2009		45389	8.06%
March 2009		55077	9.78%
April 2009		54642	9.70%
May 2009		60657	10.77%
June 2009		64107	11.38%
July 2009		51629	9.17%
August 2009		53960	9.58%
September 2009		58391	10.37%
October 2009		52413	9.31%
November 2009		0	0.00%
December 2009		0	0.00%
	Total	563229	100.00%

Appendix B – TABLES

Table 1 – Montana segments of principal aquifers and aquifer systems and Montana designated important aquifers that could be addressed through inclusion of Montana statewide network wells in the NGWMN.

National Aquifer/ System Name	National Aquifer Code	Montana comments	Potential Montana sites
Alluvial aquifers	N100ALLUVL	All non-glacial alluvial deposits	98
Sand and gravel aquifers (glacial regions)	N100GLCIAL	Will include sand and gravel related to glaciations in eastern Montana.	94
Upper Tertiary aquifers		Will include Miocene/ Pliocene aggradational sand and gravel aquifers important in northern Montana. Upper Tertiary deposits within intermontane basins will be included within the Northern Rocky Mountains Intermontane Basins aquifer system.	17
Northern Rocky Mountains Intermontane Basins aquifer systems	S100NRMTIB	Will include Quaternary and Tertiary basin-fill deposits and surrounding fractured bedrock aquifers associated with flow systems in individual basins.	412
Pacific Northwest volcanic rock aquifers	N100PCFNWV	Minor area in Montana near West Yellowstone.	0
Lower Tertiary aquifers	N300LTRTRY	Area mapped in HA370-I generally corresponds with Lower Tertiary aquifers important in Montana.	102
Upper Cretaceous aquifers	N300UPCTCS	Will include important Upper Cretaceous sandstone aquifers in north-central Montana from areas outside those mapped in HA370-I.	162
Lower Cretaceous aquifers	N300LCRTS	Area mapped in HA370-I generally corresponds with Lower Tertiary aquifers important in Montana.	32
Paleozoic aquifers	N500PLOZOC	Area mapped in HA370-I generally corresponds with Lower Tertiary aquifers important in Montana.	12

Table 2 – Periods of record and measurement frequencies for Montana statewide network wells. About 120 statewide monitoring wells in Montana have periods of record greater than 25 years. Most wells are measured between 3 and 12 times annually.

Period of record			Frequency of measurement		
Period (yrs)	**Wells**	**Percent**	**Measurements/yr**	**Wells**	**Percent**
0-5	57	6.1	0-1	5	0.5
6-10	123	13.1	2-3	153	16.4
11-15	296	31.5	3-4	296	31.8
16-20	219	23.3	5-12	335	35.7
21-25	77	8.2	12-24	23	2.0
>25	168	17.9	>24	125	13.5
Totals	940	100		937*	100

*Three wells have less than one year of record.

Appendix C – NGWMN and GWIC Data Elements

Data Element	Definition	Comparable USGS Data Element	MBMG table/field names	MBMG notes
1.0 POINT OF CONTACT (Metadata collected and reported one time for a well or monitoring site)			NA	Monitoring points in the Montana Statewide network would all have the Montana Bureau of Mines and Geology as their contact agency.
1.1 Source of data	Identifies the primary source or provider of data, including name, address, telephone number, email address	(1) Agency code (2) Water level reporting agency	Valid_agency.agency	GWIC code for source agency. Includes MBMG for data collected by the Montana Bureau of Mines and Geology
1.1.1 Organization Name	Legal formal name of organization that is the primary source of data	Water level reporting agency	Valid_agency.description	Name of agency contributing data to GWIC
1.1.2 Mailing Address	Exact address where mail is intended to be delivered, including street, rural route and./or PO Box	(1) Address line 1 (2) Address line 2	NA	Field(s) would be added to MBMG Valid_agency table.
1.1.2.1 City, Town, Village Name	City where organization that collected information resides	City name	NA	Field(s) would be added to MBMG Valid_agency table.
1.1.2.2 State Name	State	USPS postal abbreviation code	NA	Field(s) would be added to MBMG Valid_agency table.
1.1.2.3 Mailing Address ZIP Code/Postal Code	5-digit Zone Improvement Plan (ZIP) code and 4-digit extension code (if available)	USPS zip code	NA	Field(s) would be added to MBMG Valid_agency table.
1.1.3 Telephone number	Telephone number (including area code) of the person who is the point of contact for the organization	Address phone number	NA	Field(s) would be added to MBMG Valid_agency table.
1.1.4 Electronic Mail Address	Electronic Mail Address (email) of the contact person at the organization	NI	NA	Field(s) would be added to MBMG Valid_agency table.
2.0 SITE IDENTIFICATION/ DESCRIPTION (Metadata collected and reported one time for a well or monitoring site)				
2.1 Site Identifier	Unique site identifier consisting of latitude (DDMMSS), longitude (DDDMMSS), and sequence number (NN) (DDMMSSDDDMMSSNN)	Site identification number	Sites.latitude, sites.longitude, sites.sequence	A USGS-style site identifier can be constructed from fields existing in the GWIC sites file. GWIC itself uses a unique 6-digit number that identifies each of its sites.
3.0 GEOLOGIC/ HYDROLOGIC DESCRIPTION (Metadata collected and reported one time for a well or monitoring site)				
3.1 Hydrologic basin		(1) Hydrologic unit code	sites.drainage_basin	GWIC basin code consisting of two-letters. The valid_basin table contains a field to with the 8-digit USGS hydrologic unit code.
3.2 Geologic unit(s) containing aquifer (Aquifer lithology; the		[Geohydrologic units] Lithology code	aquifer.aquifer	MBMG/ GWIC aquifer code made up of 3 numbers for age and 4

Data Element	Definition	Comparable USGS Data Element	MBMG table/field names	MBMG notes
lithology of the primary contributing unit(s))				letters for unit.
3.3 Aquifer tapped (Principal Aquifer or other significantly used aquifer; primary unit(s)contributing water to the well)	USGS Atlas designation of aquifer	(1) Aquifer code (2) Aquifer name (3) National aquifer code (4) National aquifer name (5) Contributing unit	NA	Field would be added to MBMG/ GWIC data structures to allow grouping of sites by principal major or other significant aquifer.
3.4 Local aquifer name (if applicable)		(1) Aquifer code (2) Aquifer name (3) Contributing unit	NA	MBMG/GWIC does not currently store local aquifer codes or names.
3.5 Aquifer type	Type of aquifer	Aquifer type code	NA	MBMG/GWIC does not currently store this information
3.6 Aquifer conditions: (1) confined or (2) unconfined or leaky confined		NI	NA	MBMG/GWIC does not currently store this information
4.0 WELL LOCATION (Metadata collected and reported one time for a well or monitoring site)				
4.1 Horizontal Location				
4.1.1 Latitude	Measure of angular distance on a meridian north or south of the equator in degrees, minutes seconds, or decimal degrees	(1) Sexagesimal latitude (2) Decimal latitude	sites.latitude	Latitude value stored in decimal degrees.
4.1..2 Longitude	Measure of angular distance on a meridian east or west of the prime meridian in degrees, minutes, seconds, or decimal degrees	(1) Sexagesimal longitude (2) Decimal longitude	sites.longitude	Longitude value stored in decimal degrees.
4.1.3 Horizontal Reference Datum	The reference datum in to determine latitude and longitude coordinates.	Latitude/longitude (horizontal) coordinate datum	sites.datum_latlon	Reference datum for latitude and longitude values.
4.1.4 Location Horizontal Accuracy	The measure of accuracy (in feet) of the latitude and longitude coordinates	Latitude/longitude coordinate accuracy	sites.latacc sites.lonacc	Accuracy measurement for the latitude and longitude values.
4.1.5 Location Collection Method	Method used to determine latitude and longitude coordinates for well	Method determining horizontal datum	sites.geomethod	Method used to determine latitude and longitude values.
4.2 Vertical Location				
4.2.1 Altitude of Land Surface at Wellhead	Altitude of the ground surface for the well at which a measurement is being taken		sites.altitude	Altitude of site in feet above mean sea level.
4.2.2 Altitude measurement method	Method used to determine altitude		sites.method_altitude	Method used to determine the altitude.
4.2.3 Altitude (Land surface elevation)	The measure of elevation above or the depth below a reference	Gage or land surface datum	NA	All MBMG/GWIC altitudes are referenced to mean sea level
4.2.4 Altitude accuracy	The accuracy of altitude measurement	Altitude accuracy code	NA	
4.2.5 Vertical Reference Datum	Datum of altitude	Altitude datum code	sites.datum_altitude	Reference datum for altitude value.
4.3 Well Address				
4.3.1 Owner data	Owner Name	(1) Site owner number (2) Party identification number (3) Site owner	sites.site_name owner.owner	Name of the most current owner of the site/well.

Data Element	Definition	Comparable USGS Data Element	MBMG table/field names	MBMG notes
		type code		
4.3.2 Mailing Address	Exact address where well is located, including street, rural route, and house number	NI	owner.address, owner.addresstype	Mailing for the recorded owner of the well, or the actual well address as determined by address type.
4.3.3 City or Town	Nearest City, Town, village where well is located	NI	owner.city	City of the well location.
4.3.4 State name	State where well is located.	(1) State name (2) State FIPS code	sites.state	State of the well location.
4.3.5 Tribal Reservation/Country	Tribal Reservation/Country where well is located.	FIPS country code as defined by FIPS PUB 10-4	NA	Default value is "US" since Montana us located in the United States.
4.3.6 Mailing Address ZIP Code/Postal Code	5-digit Zone Improvement Plan (ZIP) code and 4-digit extension code (if available)		owner.postalcode	ZIP code for well location if address is located in the United States.
4.3.7 Time Zone	Standard time zone of location of well	(1) Time zone code. (2) Time zone number. (3) Time zone name. (4) Time zone description	NA	GWIC contains no field, but Montana is entirely in the Mountain time zone.
4.3.8 Daylight Savings Zone flag	Identifies whether site location undergoes daylight savings time	(1) Time zone Daylight Saving Time code (2) Time zone Daylight Saving Time name	NA	GWIC contains no indicator of this property, but Montana does participate in DST.
5.0 WELL CHARACTERISTICS (Metadata collected and reported one time for a well or monitoring site)				
5.1 Local/State Identifier	State unique identifier/state permit number	Site Identification Number	sites.gwicid	Key field for the GWIC database
5.2 Depth of well		Well depth	boreholes.total_depth	
5.3 Source of Data	The contributing source of the well depth data	(1) Reporting agency or entity (2) User name of person who created site record	NA	Source of data is the GWIC database housed at MBMG
5.6 Casing depth of well		(1) Depth to casing string bottom (2) Well thickness of this casing (3) Well depth NOT CORRECT	casing.case_to, casing.wall_thickness	Bottom of casing interval in feet below ground surface.
5.7 Top of screened or open hole (rtd) (Depth to top of each open interval)		Depth to top of open interval	completion.comp_from	Top of completion (screened/perforated) interval in feet below ground surface.
5.8 Bottom of screened or open hole (rtd) (Depth to bottom of each open interval)		Depth to open interval bottom	completion.comp_to	Bottom of completion interval in feet below ground surface.
5.9 Casing material(s), if there is a casing		Casing material	casing.description	Type of material used to case the well.

Data Element	Definition	Comparable USGS Data Element	MBMG table/field names	MBMG notes
5.10 Screen material type(s) at each open interval(s), if the well has well screen(s)		Casing material	completion.material	Type of completion installed at this interval.
5.11 Well type	Specified well type: (1) Background (2) Targeted	Type of network	NA	MBMG/ GWIC would add this field/flag.
5.12 Well Purpose	Indication of well purpose: (a) Quantity/Level (b) Quality (c) Both		NA	MBMG/GWIC would add this field/flag.
5.13 Well Log or Completion Report Available	Indication of well log or Completion Report availability: Yes/No		metadata.datasource scans.filename. All borehole, casing, completion, performance data, and lithology table fields.	GWIC datasource records where the data for the record came from. The scans table contains data as to whether the document is available online.
5.2 Measurement Location (Metadata collected and reported one time for each well)				
5.2.1 Description of Measurement/Sampling/Reference Point	Location at which the measurement/sampling was done: (a) top of well above land surface (b) top of well at land surface (c) top of well below land surface	(1) Measurement point sequence number (2) Description of measurement point	mp_table,date_mp, mp_altitidude, mp_table.description	Date of mp, altitude of mp, and description of mp describe a measuring point in GWIC. The table can contain references to all recorded mp's at a site.
5.2.2 Measurement/Sampling point height (Measuring point elevation relative to datum (rtd)	Height of measurement/sampling point from land surface elevation (altitude) in feet	(1) Height of measuring point (2) Measuring point altitude	mp_table.mp_altitude	Altitude of measuring point.
5.2.3 Measuring/Sampling Point Accuracy of Measurement	Indication of accuracy of measuring the point of measurement or sampling in feet		NA	
6.0 MEASUREMENT/SAMPLING EVENT (Metadata collected and reported for each measurement and sampling event and data for water level measurement)				
6.1 Purpose				
6.1.1 Monitoring Purpose	Specified monitoring purpose: (a) baseline (b) surveillance (c) trend (d) special studies	NI	NA	GWIC would add this field/flag.
6.2 Date and Time (Metadata collected and reported for each measurement and sampling event)				
6.2.1 Time zone code	Code for which time zone datum is used for measurement	(1) Time zone code. (2) Time zone number. (3) Time zone name. (4) Time zone description	NA	GWIC does not store the time zone, Montana is completely in the Mountain time zone.
6.2.2 Measurement/Sampling date/time			analysis.date_sampled	Date time that the water quality was sampled.

Data Element	Definition	Comparable USGS Data Element	MBMG table/field names	MBMG notes
6.2.2.1 Level Measurement date and time (Data for water level measurement collected and reported for each measurement event)				
6.2.2.2 Water-level measurement date	The calendar date when water level was measured, reported as 4-digit year, 2-digit month, and 2-digit day in YYYYMMDD format.	Water level date for ground water sites	swl_table.date_measured	GWIC stores the measurement as a datetime value.
6.2.2.3 Water-level measurement time	The measure of clock time and time zone when water level was measured, reported as a 24-hour day with 2-digit hour, 2-digit minute, and 2-digit second.	Water level time for ground water sites	Swl_table date_measured	GWIC stores time in as part of the datetime measurement value.
6.2.3 Quality Sampling date and time (Metadata for water quality sampling collected and reported for each sampling event)				
6.2.3.1 Sample Collection Date	The calendar date when collection of the analyte was started, reported as 4-digit year, 2-digit month, and 2-digit day in YYYYMMDD format.	Sample start date	analysis.date_sampled	GWIC stores the collection time as a datetime value.
6.2..3.2 Sample Collection Time Measure	The measure of clock time and time zone when collection of the analyte was begun, reported as a 24-hour day with 2-digit hour, 2-digit minute, and 2-digit second.	**?**	analysis.date_sampled	GWIC stores time in as part of the datetime measurement value
6.3 Measurement /Sampling Site Use (Metadata collected and reported each time for water level or water quality sampling event)				
6.3.1 Site use at time of measurement/sampling event	Use of area immediately around well: Commercial, industrial, agricultural cropping, undeveloped pasture/range, forest, or residential at time of measurement or sampling event	(1)Primary use of site	well_use.well_use	Recorded use of site from the well log form or from use determined at time of site visit.
6.4 Level Elevation Measurement (Data collected and reported each time for a water level measurement)				
6.4.1 Water Level	Water level, in feet, reported to accuracy of measurement to the nearest ones, tenths, or hundredths of a foot	(2) Water level measurement referenced to land surface datum (2) Water level measurement referenced to measuring point (3) Water level measurement referenced to mean sea level	swl_table.swl	GWIC records measurement in feet below measuring point. Measurements from ground reference are calculated from land surface elevation, mp elevation, and distance to water from mp.
6.4.2 Measurement method	Method of water-level measurement	Water-Level Method of Measurement	swl_table.method	Method used to determine static water level value.

Data Element	Definition	Comparable USGS Data Element	MBMG table/field names	MBMG notes
6.4..3 Water level accuracy	Accuracy of water-level measurement in feet	[Water level] Accuracy code	NA	
6.4.4 Water-level status	Status of water-level: (a) static (b) pumping	NI	swl_table.nonstatic	GWIC stores a flag to determine a "nonstatic" water level measurement.
6.5 Sampling Point Elevation Measurement (Metadata collected and reported each time for a water quality sampling event)				
6.5.1 Sampling Point Elevation	Elevation in the well water column at which the sample was drawn, in feet, reported to accuracy of measurement to the nearest ones, tenths, or hundredths of a foot	(1) Water level measurement referenced to land surface datum (2) Water level measurement referenced to measuring point (3) Water level measurement referenced to mean sea	NA	
6.5.2 Sampling Point Elevation Measurement method	Method of sampling point elevation measurement	[Water level] Method code	NA	
6.5..3 Sampling Point Elevation accuracy	Accuracy of sampling point elevation in feet	[Water level] Accuracy code	NA	
6.6 Sample Collection (Metadata collected and reported for each water quality sample)				
6.6.1 Sample Type	The type of sample being described. Permitted values include: (1) Sample (2) Duplicate sample (3) Other entries as applicable	**NI**	NA	
6.6.2 Sample Identification	The unique name, number, or code assigned to identify the sample.	Record number is the eight-digit number that identifies the water-quality sample	analysis.sampleid	
6.6.3 Sample Collection Method Code	An alphanumeric label to identify the sample collection method	NI	analysis.collection_method	
7.0 WATER QUALITY RESULTS (data from Laboratory reported for each sample and analyte tested)				GWIC stores analytical results in a 'row' format. All values in the row are 'dissolved', total recoverable, etc. and are completed with the same EPA analytical method. Current plans are to migrate GWIC water-quality data storage to a structure similar to that desired by NGWMN in the next few years.
7.1 Result Value	Reportable numerical measure of the result for the chemical or microbiological analyte, or other characteristic, being analyzed	Value of result parameter	NA	

Data Element	Definition	Comparable USGS Data Element	MBMG table/field names	MBMG notes
7.1.1 Result Value Unit of Measure	The name of the determinate quantity for a standard of measurement used for measuring dimension, capacity, or amount of something (e.g., mg/L, pCi/L, CFU/mL, etc.).	Parameter reporting units	NA	
7.1.3 Analyte Name	The name assigned to a substance or feature that describes it in terms of its molecular composition, taxonomic nomenclature or other characteristic. This field is optional if the analyte is adequately described in one of the following subelements	(1) Parameter code (2) Parameter short name (3) Fixed-value domain element value (4) Fixed-value element short name	NA	
7.1.4 Chemical Identifier/Number (Chemicals only)	Chemical Identifier/Number is the unique number assigned to all chemical substances in the Chemical Abstract Service's (CAS) Registry or, in the EPA Chemical Registry System, to chemical groupings for which CAS Registry Numbers do not exist and cannot be assigned.		NA	
7.1.5 Biological Identification Number	The unique identification number assigned by either the Integrated Taxonomic Information System, (ITIS) the International Committee on Taxonomy of Viruses, or the EPA Biological Registry System .		NA	
7.1.6 Biological Systematic Context Name	The name of the classification system used to assign a systematic name to a biological entity.		NA	
7.2 Analytical Method Number	The method number of the analytical method used, represented as a reference number: (a) EPA (Specify number) (b) ASTM (Specify number) (c) SM (Specify number) (d) Other methods as applicable	(1) USGS Central Laboratory method code (2) Method type (3) Method name (4) Method description (5) [Water quality result] Laboratory method code	NA	

Appendix D – Lists of Potential Monitoring Sites

N100ALLUVL -- Alluvial aquifers: All non-glacial alluvial deposits

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
78887	47.92505	-112.13579	31	12.4	110ALVM	AGAWAM BENCH	DEDICATED
78891	47.919167	-112.177778	68	48.7	110ALVM	AGAWAM BENCH	DEDICATED
78983	47.9208	-112.2209	52	53	110ALVM	AGAWAM BENCH	DEDICATED
3501	48.26263	-110.04416	167	167	110ALVM	ANCESTRAL MISSOURI RIVER	DEDICATED
43335	48.55553	-109.75277	122.3	111	110ALVM	ANCESTRAL MISSOURI RIVER	UNUSED
140484	48.52508	-109.80088	180		110ALVM	ANCESTRAL MISSOURI RIVER	DEDICATED
73716	47.3024	-115.1022	199	175	120SNGR	CLARK FORK - LOWER	IN USE
75108	47.4763	-114.8919	50	30	110ALVM	CLARK FORK - LOWER	IN USE
105523	45.1438	-109.006	55	46	111SNGR	CLARKS FORK ALLUVIAL	DEDICATED
126439	45.2688	-108.9145	50	47	111SNGR	CLARKS FORK ALLUVIAL	IN USE
171415	44.9997	-109.0679	57.25	57.3	111SNGR	CLARKS FORK ALLUVIAL	LOW USE
6184	47.6678	-111.8372	23	5.5	110TRRC	FAIRFIELD BENCH	DEDICATED
76659	47.6681	-111.9772	50	50	110ALVM	FAIRFIELD BENCH	UNUSED
156442	47.71828	-114.381151	200	40	111ALVM	LOWER FLATHEAD RIVER	DEDICATED
41464	48.32892	-111.14517	150			MARIAS RIVER ALLUVIAL	LOW USE
155439	47.92882	-110.51588	38		110ALVM	MARIAS RIVER ALLUVIAL	IN USE
43877	48.566	-109.54534	38	20	110ALVM	MILK RIVER ALLUVIAL	IN USE
44268	48.50917	-107.2041	43		110ALVM	MILK RIVER ALLUVIAL	IN USE
149986	48.5817	-109.62824	52.5	52.5	110ALVM	MILK RIVER ALLUVIAL	IN USE
288	45.8725	-106.6295	40	24	111ALVM	MISC - ALLUVIAL	DEDICATED
290	45.873	-106.6299	25	14	110ALVM	MISC - ALLUVIAL	DEDICATED
292	45.8719	-106.6288	40	30	110ALVM	MISC - ALLUVIAL	DEDICATED
296	45.8714	-106.6282	35	23	110ALVM	MISC - ALLUVIAL	DEDICATED
1089	45.9025	-106.631	23	18	110ALVM	MISC - ALLUVIAL	DEDICATED
1091	45.9018	-106.6321	26	20	110ALVM	MISC - ALLUVIAL	DEDICATED
4287	48.96512	-105.45334	45.8	36	110OTSH	MISC - ALLUVIAL	DEDICATED
14968	45.9962	-108.7709	67	27	111ALVM	MISC - ALLUVIAL	UNUSED
17277	46.177	-107.1246	60	45	111ALVM	MISC - ALLUVIAL	IN USE
22290	46.5259	-110.3963	50		110ALVM	MISC - ALLUVIAL	IN USE
34637	47.5795	-110.8005	30	30	110ALVM	MISC - ALLUVIAL	IN USE
34678	47.5402	-110.545	20		110ALVM	MISC - ALLUVIAL	IN USE
39487	48.1332	-111.57	20	12	110ALVM	MISC - ALLUVIAL	UNUSED
39607	48.14039	-110.06497	29	23	110ALVM	MISC - ALLUVIAL	IN USE
45348	48.6966	-111.3681	20	20	110ALVM	MISC - ALLUVIAL	UNUSED
67843	46.8808	-113.5774	65	42	111ALVM	MISC - ALLUVIAL	LOW USE
75539	47.61072	-111.9451	30	12	110TRRC	MISC - ALLUVIAL	IN USE
78825	47.9222	-111.8149	45	35	110ALVM	MISC - ALLUVIAL	IN USE
110163	44.8518	-112.7969	205	158	120SNGR	MISC - ALLUVIAL	IN USE
121804	45.7271	-109.2802	45	18	111SNGR	MISC - ALLUVIAL	IN USE
122531	45.3709	-108.5589	209	149	110ALVM	MISC - ALLUVIAL	DEDICATED

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
122532	45.3709	-108.5589	17	12	110ALVM	MISC - ALLUVIAL	DEDICATED
133047	47.095	-109.9668	20	8.8	110TRRC	MISC - ALLUVIAL	DEDICATED
134562	46.5982	-112.599	180	60	120SDMS	MISC - ALLUVIAL	IN USE
137279	46.8442	-105.3088	18	6	110ALVM	MISC - ALLUVIAL	DEDICATED
139130	48.4953	-111.8393	22		110ALVM	MISC - ALLUVIAL	DEDICATED
148530	47.6443	-109.3103	23		110ALVM	MISC - ALLUVIAL	UNUSED
149779	47.3357	-108.958	5.3		110ALVM	MISC - ALLUVIAL	UNUSED
155350	45.3709	-108.5588	198	138	110ALVM	MISC - ALLUVIAL	DEDICATED
157745	46.23188	-107.13815	32		111ALVM	MISC - ALLUVIAL	IN USE
174343	46.5948	-112.5339	54		120SDMS	MISC - ALLUVIAL	DEDICATED
182535	48.81998	-106.05545	29.7		110ALVM	MISC - ALLUVIAL	UNUSED
122839	47.8234	-110.6684	50	35	110ALVM	MISSOURI RIVER ALLUVIAL	IN USE
150965	48.12237	-104.47421	21		110ALVM	MISSOURI RIVER ALLUVIAL	DEDICATED
17911	46.2977	-109.2447	32	15	110ALVM	MUSSELSHELL ALLUVIAL	IN USE
137386	46.4297	-109.799	17.2		110ALVM	MUSSELSHELL ALLUVIAL	DEDICATED
147334	46.5822	-107.8642	19.7		110ALVM	MUSSELSHELL ALLUVIAL	UNUSED
103321	45.4008	-105.4625	22	12	110ALVM	POWDER RIVER ALLUVIUM	IN USE
183563	45.0637	-105.8709	30		111ALVM	POWDER RIVER ALLUVIUM	IN USE
101131	45.4611	-109.7593	44	33	111SNGR	STILLWATER SC ALLUVIUM	UNUSED
74518	47.4918	-112.3981	40	20	110ALVM	SUN RIVER ALLUVIAL	IN USE
78294	47.8196	-112.1953	23	19.5	110ALVM	TETON ALLUVIAL-UPPER	DEDICATED
183560	45.4387	-106.4205	20		111ALVM	TONGUE RIVER ALLUVIUM	IN USE
46420	48.75792	-107.62773	25		110ALVM	WHITEWATER CREEK	UNUSED
3110	47.87013	-104.10526	72	65	110ALVM	YELLOWSTONE ALLUVIAL	IN USE
10066	45.8359	-109.9596	25	25	110ALVM	YELLOWSTONE ALLUVIAL	IN USE
10615	45.7873	-108.5528	21	16	111ALVM	YELLOWSTONE ALLUVIAL	IN USE
13934	45.9246	-108.2422	50		111TRRC	YELLOWSTONE ALLUVIAL	IN USE
14009	45.9499	-108.1432	35		111TRRC	YELLOWSTONE ALLUVIAL	IN USE
18521	46.2604	-107.3444	18		111ALVM	YELLOWSTONE ALLUVIAL	IN USE
18534	46.3007	-107.1729	21	13	111ALVM	YELLOWSTONE ALLUVIAL	DEDICATED
24755	46.7706	-105.3015	90	70	110TRRC	YELLOWSTONE ALLUVIAL	UNUSED
29115	47.11189	-104.7304	30	27	110ALVM	YELLOWSTONE ALLUVIAL	IN USE
29312	47.1025	-104.7235	21	9	110ALVM	YELLOWSTONE ALLUVIAL	LOW USE
92383	45.7366	-110.2238	44	44	110ALVM	YELLOWSTONE ALLUVIAL	IN USE
93351	45.73769	-108.63912	30	26	111TRRC	YELLOWSTONE ALLUVIAL	IN USE
93844	45.7824	-108.5699	26	21	111TRRC	YELLOWSTONE ALLUVIAL	IN USE
93857	45.7745	-108.568	25	20	111TRRC	YELLOWSTONE ALLUVIAL	IN USE
94118	45.753	-108.5245	26	21	111TRRC	YELLOWSTONE ALLUVIAL	IN USE
96972	45.66019	-110.55337	33	22	110ALVM	YELLOWSTONE ALLUVIAL	IN USE
96983	45.6567	-110.5729	63	59	110ALVM	YELLOWSTONE ALLUVIAL	IN USE
97745	45.6295	-108.8356	25	25	111TRRC	YELLOWSTONE ALLUVIAL	IN USE
98056	45.6897	-108.7788	94	80	111ALVM	YELLOWSTONE ALLUVIAL	UNUSED
98128	45.6771	-108.7683	57	51	111TRRC	YELLOWSTONE ALLUVIAL	IN USE

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
126522	46.8908	-105.0545	60	51	110ALVM	YELLOWSTONE ALLUVIAL	IN USE
129979	45.6363	-110.5794	51.5	51.5	110ALVM	YELLOWSTONE ALLUVIAL	IN USE
134054	45.805	-109.871	60	60	110ALVM	YELLOWSTONE ALLUVIAL	IN USE
136361	46.8822	-105.0028	34.7		110ALVM	YELLOWSTONE ALLUVIAL	LOW USE
136651	47.75697	-104.12537	18.7	4.6	110ALVM	YELLOWSTONE ALLUVIAL	DEDICATED
143838	45.7804	-109.7949	31	31	110ALVM	YELLOWSTONE ALLUVIAL	IN USE
144916	45.6753	-108.6579	44.3	44.3	111TRRC	YELLOWSTONE ALLUVIAL	DEDICATED
148500	46.7786	-105.3026	39	34	110ALVM	YELLOWSTONE ALLUVIAL	DEDICATED
158212	45.9273	-108.2322	33		111TRRC	YELLOWSTONE ALLUVIAL	DEDICATED
158554	46.1404	-107.5549	18.5		111ALVM	YELLOWSTONE ALLUVIAL	DEDICATED
158587	45.9913	-108.0008	20.5		111ALVM	YELLOWSTONE ALLUVIAL	UNUSED
158589	45.70508	-108.6442	25	18	111ALVM	YELLOWSTONE ALLUVIAL	DEDICATED
158606	45.6861	-108.7261	33		111TRRC	YELLOWSTONE ALLUVIAL	UNUSED
182524	45.9762	-108.2863	38		111ALVM	YELLOWSTONE ALLUVIAL	IN USE
240631	46.40431	-105.83985	23.4		111ALVM	YELLOWSTONE ALLUVIAL	IN USE

N100GLCIAL - Sand and gravel aquifers (glacial regions)

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
78841	47.9418	-112.0407	95	65	112ALVF	AGAWAM BENCH	DEDICATED
3533	48.2158	-105.03973	30	4	112OTSH	ANCESTRAL MISSOURI RIVER	DEDICATED
3539	48.2229	-104.93134	111	95	112ALVM	ANCESTRAL MISSOURI RIVER	DEDICATED
3541	48.26554	-104.82304	68	57	112TRRC	ANCESTRAL MISSOURI RIVER	DEDICATED
3766	48.4908	-104.4541	233	201	112ALVM	ANCESTRAL MISSOURI RIVER	DEDICATED
3769	48.4978	-104.281	270	230	112ALVM	ANCESTRAL MISSOURI RIVER	DEDICATED
41865	48.35977	-107.825059	65		112ALVM	ANCESTRAL MISSOURI RIVER	UNUSED
43571	48.55715	-109.64036	169	166	112ALVM	ANCESTRAL MISSOURI RIVER	IN USE
239610	48.1718	-104.24199	177		112ALVM	ANCESTRAL MISSOURI RIVER	DEDICATED
3480	48.15747	-104.27561	180	170	112OTSH	BAINVILLE CHANNEL	IN USE
3481	48.1713	-104.2361	200	170	112OTSH	BAINVILLE CHANNEL	IN USE
207881	48.13735	-104.22191	39		112OTSH	BAINVILLE CHANNEL	UNUSED
133571	45.2488	-111.2517	31	30	112SNGR	BIG SKY AREA	IN USE
73165	47.2027	-114.9462	318	318	112ALVM	CLARK FORK - LOWER	IN USE
73642	47.2987	-115.0801	192	192	112ALVM	CLARK FORK - LOWER	IN USE
127172	47.8888	-115.638	282	281	112SNGR	CLARK FORK - LOWER	IN USE
149183	47.6225	-115.343	308	308	112SNGR	CLARK FORK - LOWER	IN USE
159523	47.3041	-115.0917	58	58	112ALVM	CLARK FORK - LOWER	IN USE
122340	45.4638	-108.8568	22.6	12.6	112SNGR	CLARKS FORK ALLUVIAL	DEDICATED
3605	48.389	-104.5415	185	167	112ALVM	CLEAR LAKE AQUIFER	DEDICATED
3606	48.3607	-104.5414	147	84.5	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
3677	48.3895	-104.4527	350	264	112ALVM	CLEAR LAKE AQUIFER	DEDICATED

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
3767	48.4908	-104.4541	118	102	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
3770	48.4977	-104.281	140	100	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
3773	48.555	-104.1816	143	126	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
3777	48.5338	-104.2056	80	55	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
3779	48.498	-104.1729	270	170	112ALVM	CLEAR LAKE AQUIFER	DEDICATED
3858	48.6138	-104.1444	130	97	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
3861	48.604	-104.1002	137	121	112OTSH	CLEAR LAKE AQUIFER	UNUSED
3862	48.5982	-104.0994	150	110	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
3866	48.6063	-104.0482	238	163	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
3868	48.5921	-104.0479	150	140	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
3871	48.5855	-104.1453	98	74	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
3947	48.6855	-104.1439	110	83	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
148578	48.6057	-104.107	6	4	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
149610	48.7802	-104.0486	92.5	90	112OTSH	CLEAR LAKE AQUIFER	DEDICATED
6112	47.59722	-111.78386	19.5	10	112SNGR	FAIRFIELD BENCH	IN USE
103466	45.4351	-104.0591	37		111ALVM	LITTLE MISSOURI ALLUVIUM	IN USE
106527	45.008	-104.415	30	24	111ALVM	LITTLE MISSOURI ALLUVIUM	IN USE
184438	45.2075	-104.2639	38		111ALVM	LITTLE MISSOURI ALLUVIUM	IN USE
6039	47.3086	-114.2866	160	110	112ALVM	LOWER FLATHEAD RIVER	DEDICATED
6215	47.6313	-114.3705	50		112ALVM	LOWER FLATHEAD RIVER	UNUSED
133880	47.4102	-114.3075	75		112OTSH	LOWER FLATHEAD RIVER	UNUSED
155732	48.43768	-107.26285	114		112SNGR	MILK RIVER ALLUVIAL	UNUSED
2560	47.5975	-110.2711	28	7	112DRFT	MISC - ALLUVIAL	DEDICATED
2787	47.72963	-110.69635	48		112DRFT	MISC - ALLUVIAL	DEDICATED
2788	47.73223	-110.69114	48		112DRFT	MISC - ALLUVIAL	DEDICATED
3802	48.60748	-108.25394	76	66	112SNGR	MISC - ALLUVIAL	DEDICATED
4086	48.8816	-109.3961	130	119	112OTSH	MISC - ALLUVIAL	DEDICATED
4231	48.9994	-105.4636	53	31	112OTSH	MISC - ALLUVIAL	DEDICATED
4340	48.9991	-105.4247	43	24	1120TSH	MISC - ALLUVIAL	DEDICATED
29502	47.2589	-111.4202	39	39	112SNGR	MISC - ALLUVIAL	
35343	47.6584	-110.35658	40	27	112DRFT	MISC - ALLUVIAL	IN USE
36052	47.72227	-110.23752	111	105	112ALVM	MISC - ALLUVIAL	IN USE
38849	48.0528	-109.8519	80	71.5	112SNGR	MISC - ALLUVIAL	IN USE
41482	48.3891	-110.6917	197	196.5	112ALVM	MISC - ALLUVIAL	UNUSED
47010	48.9089	-111.2533	132		112DRFT	MISC - ALLUVIAL	UNUSED
47125	48.91145	-110.13871	148	148	112ALVM	MISC - ALLUVIAL	IN USE
47757	48.9883	-111.6292	100	100	112OTSH	MISC - ALLUVIAL	IN USE
47808	48.9185	-111.2255	210	210	112DRFT	MISC - ALLUVIAL	UNUSED
47921	48.99883	-109.70473	170	161	112ALVM	MISC - ALLUVIAL	IN USE
63181	46.585	-112.9281	24		112SNGR	MISC - ALLUVIAL	IN USE
66693	46.77256	-113.71412	50		112ALVM	MISC - ALLUVIAL	IN USE
110156	44.89722	-112.81908	34	23	112SNGR	MISC - ALLUVIAL	IN USE
121622	47.5208	-111.7152	50	28	112SNGR	MISC - ALLUVIAL	IN USE

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
124105	48.99915	-105.40834	31.1	28.6	112OTSH	MISC - ALLUVIAL	DEDICATED
126239	48.0507	-112.1573	18	18	112TRRC	MISC - ALLUVIAL	
136738	48.8613	-111.2136	95	0	112DRFT	MISC - ALLUVIAL	IN USE
136927	47.50432	-111.08966	281	281	112GFLK	MISC - ALLUVIAL	IN USE
144835	48.99939	-105.41867	31.5	29	112OTSH	MISC - ALLUVIAL	DEDICATED
151291	46.9807	-109.6905	39	39	112TRRC	MISC - ALLUVIAL	IN USE
151292	46.9811	-109.6907	42	39	112TRRC	MISC - ALLUVIAL	DEDICATED
155438	47.94229	-110.66497	42.7	42.7	112SNGR	MISC - ALLUVIAL	UNUSED
157735	48.0723	-112.2991	25	22	112SNGR	MISC - ALLUVIAL	
170361	48.7798	-111.10275	100	95	112TILL	MISC - ALLUVIAL	IN USE
170571	45.18414	-109.26327	58	58	112SNGR	MISC - ALLUVIAL	IN USE
154360	47.3853	-111.5566	156	156	112SNGR	MISSOURI RIVER ALLUVIAL	
209225	47.2472	-111.6893	90	90	112SNGR	MISSOURI RIVER ALLUVIAL	
214464	47.4144	-111.3725	205	203	112SNGR	MISSOURI RIVER ALLUVIAL	
104763	45.1901	-109.2468	38	38	112SNGR	ROCK CK SOUTH ALLUVIUM	IN USE
161253	45.4527	-109.0996	35		112SNGR	ROCK CK SOUTH ALLUVIUM	IN USE
143942	45.6205	-109.2824	40	25	112SNGR	STILLWATER SC ALLUVIUM	IN USE
79060	47.91116	-112.56383	69	50	112SNGR	TETON ALLUVIAL-UPPER	IN USE
46392	48.78891	-107.85994	83		112SNGR	WOODY ISLAND COULEE	IN USE
47964	48.9491	-108.4563	70	50	112OTSH	WOODY ISLAND COULEE	LOW USE
11806	45.8057	-108.1508	76		112ALVM	YELLOWSTONE ALLUVIAL	IN USE
13628	45.9021	-108.3455	28	20	112ALVM	YELLOWSTONE ALLUVIAL	IN USE
32717	47.36933	-104.5558	51	24	112TRRC	YELLOWSTONE ALLUVIAL	UNUSED
132580	45.6425	-109.2813	48	39	112SNGR	YELLOWSTONE ALLUVIAL	IN USE
152674	45.63218	-108.92194	31.5		112SNGR	YELLOWSTONE ALLUVIAL	IN USE
171246	45.76682	-108.6253	35	30	112TRRC	YELLOWSTONE ALLUVIAL	DEDICATED
171264	45.6681	-108.841	31	26	112YRT3	YELLOWSTONE ALLUVIAL	DEDICATED
179890	45.7084	-109.5437	31	14	112TRRC	YELLOWSTONE ALLUVIAL	IN USE
191488	45.8732	-108.4158	14.44	7	112ALVM	YELLOWSTONE ALLUVIAL	DEDICATED

Upper Tertiary aquifers

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
4029	48.79516	-105.18041	67	46	121FLXV	FLAXVILLE-PEERLESS	DEDICATED
4261	48.97421	-105.54067	68	59	121FLXV	FLAXVILLE-PEERLESS	DEDICATED
4030	48.79508	-105.18022	70	48	121FLXV	FLAXVILLE-PEERLESS	DEDICATED
45679	48.67434	-106.21502	75	78	121FLXV	OPHEIM-PEERLESS	DEDICATED
184333	48.6667	-106.2853	76.1		121FLXV	OPHEIM-PEERLESS	DEDICATED
120897	48.77123	-108.56041	37.8	32.8	121FLXV	TURNER - HOGELAND	DEDICATED
122520	48.7705	-108.5641	39.3	31.8	121FLXV	TURNER - HOGELAND	DEDICATED

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
120894	48.76411	-108.57611	40	29.2	121FLXV	TURNER - HOGELAND	DEDICATED
140367	48.80748	-108.6013	54		121FLXV	TURNER - HOGELAND	UNUSED
46278	48.803433	-108.55659	64	50	121FLXV	TURNER - HOGELAND	UNUSED
3977	48.82909	-108.56273	79	60	121FLXV	TURNER - HOGELAND	DEDICATED
3988	48.77296	-108.42279	60	45	121FLXV	TURNER - HOGELAND	DEDICATED
133034	48.83669	-108.47732	59	44	121FLXV	TURNER - HOGELAND	DEDICATED
133035	48.85179	-108.3273	52	37	121FLXV	TURNER - HOGELAND	DEDICATED
140369	48.835	-108.456	54		121FLXV	TURNER - HOGELAND	UNUSED
46295	48.7698	-108.6324	65	55	121FLXV	TURNER - HOGELAND	IN USE
45654	48.72238	-106.2776	132	105		OPHEIM-PEERLESS	UNUSED

S100NRMTIB - Northern Rocky Mountains Intermontane Basins

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
109717	45.17758	-112.65649	41	41	111ALVM	BEAVERHEAD-BLACKTAIL	UNUSED
123858	45.2243	-112.8071	155	110	120SNGR	BEAVERHEAD-BLACKTAIL	IN USE
126663	45.1161	-112.6214	105.3	95.6	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
126664	45.0896	-112.6182	148.8	141.8	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
126669	45.0651	-112.5762	55.3	45.5	110ALVM	BEAVERHEAD-BLACKTAIL	DEDICATED
131122	45.0928	-112.6026	158.5	130	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
131129	45.0458	-112.5483	148	109.3	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
131130	45.0458	-112.5483	25	15.5	110ALVM	BEAVERHEAD-BLACKTAIL	DEDICATED
133329	45.1628	-112.6405	60.3	50.8	110ALVM	BEAVERHEAD-BLACKTAIL	DEDICATED
133332	45.1256	-112.6077	176.5	86	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
133371	45.0904	-112.6358	217	211	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
133372	45.0614	-112.6259	300	204.8	120SNGR	BEAVERHEAD-BLACKTAIL	DEDICATED
133373	45.1019	-112.6399	400	323	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
133374	45.102	-112.6399	226.7	219	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
133375	45.1207	-112.6611	300	269.6	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
133376	45.1207	-112.6611	98.2	93	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
133377	45.1422	-112.6663	400.2	390	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
133378	45.1422	-112.6663	173.8	100	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
133380	45.1839	-112.6362	540	508	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
133382	45.2081	-112.6581	220	190	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
133384	45.2148	-112.6307	400	315.5	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
133386	45.2148	-112.6308	80	74	110ALVM	BEAVERHEAD-BLACKTAIL	DEDICATED
133387	45.1911	-112.6716	160	96	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
133390	45.1913	-112.6726	17.9	17.9	110ALVM	BEAVERHEAD-BLACKTAIL	DEDICATED
133392	45.1643	-112.6854	600	475	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
133394	45.1643	-112.6855	50	43	110ALVM	BEAVERHEAD-BLACKTAIL	DEDICATED
133397	45.1336	-112.7298	50.8	43.5	110ALVM	BEAVERHEAD-BLACKTAIL	DEDICATED
133399	45.1788	-112.7168	200	65	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
135736	45.1602	-112.6602	47		110ALVM	BEAVERHEAD-BLACKTAIL	DEDICATED
145392	45.2081	-112.658	12		111ALVM	BEAVERHEAD-BLACKTAIL	DEDICATED
145396	45.2027	-112.7643	35		110ALVM	BEAVERHEAD-BLACKTAIL	IN USE
149511	45.1593	-112.7221	273		120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
149512	45.1773	-112.656	400	275	120SDMS	BEAVERHEAD-BLACKTAIL	DEDICATED
109716	45.17676	-112.65732	38	31	111ALVM	BEAVERHEAD-BLACKTAIL	IN USE
5418	46.2841	-114.0701	1110	209	120SDMS	BITTERROOT VALLEY	UNUSED
5809	46.6322	-114.0794	342	113	120SDMS	BITTERROOT VALLEY	LOW USE
50727	46.0275	-114.176	35		112TRRC	BITTERROOT VALLEY	IN USE
50808	46.0148	-114.2002	124	116	120SDMS	BITTERROOT VALLEY	IN USE
52962	46.1605	-114.147	36	26	112ALVF	BITTERROOT VALLEY	IN USE
53666	46.2973	-114.0229	220	40	120SDMS	BITTERROOT VALLEY	IN USE
53982	46.2934	-114.0813	30	22	120SNGR	BITTERROOT VALLEY	IN USE
54061	46.2823	-114.0614	80	50	120SNGR	BITTERROOT VALLEY	IN USE
55463	46.2467	-114.1809	79	74	120SNGR	BITTERROOT VALLEY	IN USE
55559	46.2545	-114.2133	126	0	120SNGR	BITTERROOT VALLEY	IN USE
56528	46.3142	-114.1138	40	40	111ALVM	BITTERROOT VALLEY	LOW USE
57128	46.3133	-114.1571	31	23	112TRRC	BITTERROOT VALLEY	IN USE
57525	46.4831	-113.979	59	51	112ALVF	BITTERROOT VALLEY	IN USE
58096	46.4181	-114.1471	39	34	112ALVF	BITTERROOT VALLEY	LOW USE
60137	46.5123	-114.0809	552	310	120SNGR	BITTERROOT VALLEY	DEDICATED
63811	46.5829	-114.0036	245	237	120SNGR	BITTERROOT VALLEY	IN USE
64077	46.6318	-114.0795	77	67	112ALVF	BITTERROOT VALLEY	LOW USE
84910	46.2925	-114.0816	240	163	120SDMS	BITTERROOT VALLEY	IN USE
123132	46.6317	-114.0122	168	160	120SDMS	BITTERROOT VALLEY	IN USE
126793	46.1188	-114.206	110	90	120SDMS	BITTERROOT VALLEY	IN USE
130860	46.4275	-114.0639	440	145	400BELT	BITTERROOT VALLEY	IN USE
132260	46.4167	-114.2071	28	23	112ALVF	BITTERROOT VALLEY	IN USE
134503	46.5257	-114.1349	200	40	112ALVF	BITTERROOT VALLEY	IN USE
136050	46.3118	-114.1856	83.9		120SDMS	BITTERROOT VALLEY	IN USE
136486	46.6319	-114.0613	52		111ALVM	BITTERROOT VALLEY	DEDICATED
136964	46.2552	-114.1536	40	30	112TRRC	BITTERROOT VALLEY	DEDICATED
136969	46.4414	-114.1466	52		112ALVF	BITTERROOT VALLEY	IN USE
136970	46.4638	-114.0288	112		120SDMS	BITTERROOT VALLEY	IN USE

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
139851	46.7127	-114.0877	144	139	112ALVM	BITTERROOT VALLEY	IN USE
140366	45.9543	-114.1499	280	55	120PLNC	BITTERROOT VALLEY	IN USE
154007	46.3234	-114.2272	300	150	211DBTL	BITTERROOT VALLEY	UNUSED
163226	46.2447	-114.127	160	130	120SNGR	BITTERROOT VALLEY	DEDICATED
168180	46.5829	-114.0044	84		120SNGR	BITTERROOT VALLEY	DEDICATED
207823	46.3464	-114.0448	263	140	120PLNC	BITTERROOT VALLEY	IN USE
207831	46.3463	-114.0433	180		120PLNC	BITTERROOT VALLEY	DEDICATED
246207	46.3464	-114.0448	440	207	120PLNC	BITTERROOT VALLEY	IN USE
706786	46.2809	-114.0745	65		120SDMS	BITTERROOT VALLEY	IN USE
4483	45.955	-112.5054	72	62	120SNGR	BUTTE VALLEY	DEDICATED
4716	45.9883	-112.4933	119	108	120SDMS	BUTTE VALLEY	DEDICATED
4719	45.9783	-112.5148	75	65	120SDMS	BUTTE VALLEY	DEDICATED
49336	45.9362	-112.4872	80	75	120SNGR	BUTTE VALLEY	IN USE
49421	45.9211	-112.4786	71	66	120SNGR	BUTTE VALLEY	IN USE
50275	45.9624	-112.5028	105		120SNGR	BUTTE VALLEY	UNUSED
120297	45.915	-112.5178	54	48	120SNGR	BUTTE VALLEY	IN USE
128728	45.9557	-112.4727	115		120SDMS	BUTTE VALLEY	IN USE
145960	45.9095	-112.4501	100	80	211BDBT	BUTTE VALLEY	IN USE
892116	46.010128	-112.561853	206.5	138	211BDBT	BUTTE VALLEY	DEDICATED
6103	47.4788	-114.6208	99	5	112ALVM	CAMAS PRAIRIE	DEDICATED
6104	47.4786	-114.6211	98	11	112ALVM	CAMAS PRAIRIE	DEDICATED
133886	47.5161	-114.645	68		400PRCD	CAMAS PRAIRIE	UNUSED
5376	46.1667	-112.8779	50		110ALVM	DEERLODGE-ANACONDA VALLEY	IN USE
5410	46.2526	-112.813	112	58	120SDMS	DEERLODGE-ANACONDA VALLEY	IN USE
5411	46.2518	-112.8689	80	75	112SNGR	DEERLODGE-ANACONDA VALLEY	IN USE
51102	46.1117	-112.8358	35	29	112SNGR	DEERLODGE-ANACONDA VALLEY	IN USE
51325	46.0603	-112.7863	200	70	120SDMS	DEERLODGE-ANACONDA VALLEY	UNUSED
51731	46.1845	-112.7592	115	109	120SDMS	DEERLODGE-ANACONDA VALLEY	IN USE
51775	46.1651	-112.8203	100	94	120SNGR	DEERLODGE-ANACONDA VALLEY	IN USE
57391	46.4137	-112.6702	29	22	112SNGR	DEERLODGE-ANACONDA VALLEY	IN USE
59272	46.5373	-112.7388	210	190	211CLRD	DEERLODGE-ANACONDA VALLEY	UNUSED
120721	46.3954	-112.8039	40	31	120SDMS	DEERLODGE-ANACONDA VALLEY	IN USE
128682	46.254	-112.7387	150		120SDMS	DEERLODGE-ANACONDA VALLEY	IN USE
128684	46.4175	-112.7141	95		120SDMS	DEERLODGE-ANACONDA VALLEY	IN USE
128741	46.1391	-112.9775	60	30	112SNGR	DEERLODGE-ANACONDA VALLEY	UNUSED
129343	46.5001	-112.7242	162	140	211CLRD	DEERLODGE-ANACONDA VALLEY	IN USE
219909	46.44414	-112.72628	96	75	120SNGR	DEERLODGE-ANACONDA VALLEY	DEDICATED
219913	46.44414	-112.72622	37	14	111ALVM	DEERLODGE-ANACONDA VALLEY	DEDICATED
52347	46.1662	-113.2989	240	200	400MCRB	DRUMMOND-FLINT CREEK	IN USE

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53637	46.2293	-113.3875	95	80	400MCRB	DRUMMOND-FLINT CREEK	IN USE
55965	46.3321	-113.3066	81.5	42	120SNGR	DRUMMOND-FLINT CREEK	IN USE
63339	46.5859	-113.1947	70		120SNGR	DRUMMOND-FLINT CREEK	IN USE
153180	46.1913	-113.3086	60	40	112SNGR	DRUMMOND-FLINT CREEK	IN USE
154583	46.6212	-113.2058	160	127	120SNGR	DRUMMOND-FLINT CREEK	DEDICATED
154584	46.6212	-113.2058	60	40	120SNGR	DRUMMOND-FLINT CREEK	DEDICATED
154593	46.2438	-113.3476	138		120SICL	DRUMMOND-FLINT CREEK	DEDICATED
154595	46.3479	-113.3477	135	115	120SDMS	DRUMMOND-FLINT CREEK	DEDICATED
161943	46.66779	-113.14595	200	140	200UDFD	DRUMMOND-FLINT CREEK	IN USE
165356	46.4574	-113.2281	125	85	330MDSN	DRUMMOND-FLINT CREEK	IN USE
9771	45.80555	-111.13108	39	39	110ALVM	GALLATIN VALLEY	IN USE
9858	45.83291	-111.00785	60	60	110ALVM	GALLATIN VALLEY	IN USE
91230	45.72269	-111.16511	32.5	32.5	110ALVM	GALLATIN VALLEY	IN USE
91244	45.714905	-111.196784	45	45	110ALVM	GALLATIN VALLEY	IN USE
91931	45.7647	-111.0152	200	200	120SDMS	GALLATIN VALLEY	IN USE
96132	45.61299	-111.06967	156	70	120SDMS	GALLATIN VALLEY	DEDICATED
96826	45.62166	-110.9928	159	142	120SDMS	GALLATIN VALLEY	UNUSED
99215	45.54603	-111.17423	50	50	110ALVM	GALLATIN VALLEY	IN USE
126354	45.76175	-111.03814	100	55	120SDMS	GALLATIN VALLEY	IN USE
129491	45.6422	-111.0986	165	90	110ALVM	GALLATIN VALLEY	DEDICATED
129952	45.66022	-111.07714	117	72	110ALVM	GALLATIN VALLEY	UNUSED
130172	45.83917	-111.06186	109		120SDMS	GALLATIN VALLEY	IN USE
133162	45.83534	-111.20149	315	300	110ALVM	GALLATIN VALLEY	DEDICATED
133165	45.82157	-111.28513	81	15	110ALVM	GALLATIN VALLEY	DEDICATED
133167	45.87889	-111.34855	61	42	110ALVM	GALLATIN VALLEY	DEDICATED
133172	45.70826	-111.30777	113	15	120SDMS	GALLATIN VALLEY	DEDICATED
133174	45.77246	-111.23809	97.5		110ALVM	GALLATIN VALLEY	DEDICATED
133176	45.75835	-111.1131	141	15	110ALVM	GALLATIN VALLEY	DEDICATED
135081	45.75464	-111.04784	285	145	120SDMS	GALLATIN VALLEY	DEDICATED
135680	45.91579	-111.1184	33.8		110ALVM	GALLATIN VALLEY	IN USE
135689	45.86335	-111.09765	13.5		110ALVM	GALLATIN VALLEY	IN USE
135720	45.65624	-111.04046	160		120SDMS	GALLATIN VALLEY	UNUSED
135722	45.76661	-111.06083	112		120SDMS	GALLATIN VALLEY	UNUSED
135734	45.72212	-111.26495	120		120SDMS	GALLATIN VALLEY	UNUSED
135735	45.80231	-111.16528	101	10	110ALVM	GALLATIN VALLEY	DEDICATED
135737	45.86312	-111.16216	NULL		120SDMS	GALLATIN VALLEY	IN USE
139989	45.66468	-111.05537	184	169	110ALVM	GALLATIN VALLEY	IN USE
148531	45.79863	-111.35775	137	60	120SDMS	GALLATIN VALLEY	DEDICATED
148789	45.672424	-111.081457	40	40	110SNGR	GALLATIN VALLEY	DEDICATED

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183082	45.83917	-111.06178	138.5	138.5	120SDMS	GALLATIN VALLEY	
216675	45.700899	-111.19341	40	8	111ALVM	GALLATIN VALLEY	DEDICATED
226761	45.71193	-111.05145	85	73	120SNGR	GALLATIN VALLEY	DEDICATED
226762	45.71193	-111.05145	37	26	111SNGR	GALLATIN VALLEY	DEDICATED
226763	45.86035	-111.32844	70	55	120SNGR	GALLATIN VALLEY	DEDICATED
226764	45.86035	-111.32844	29	18	111SNGR	GALLATIN VALLEY	DEDICATED
226766	45.87411	-111.2171	45	29	111SNGR	GALLATIN VALLEY	DEDICATED
226768	45.75836	-111.07243	90	68	120SNGR	GALLATIN VALLEY	DEDICATED
226769	45.661395	-111.173276	50	35	111ALVM	GALLATIN VALLEY	DEDICATED
226772	45.69338	-111.08826	56.5	46	111ALVM	GALLATIN VALLEY	DEDICATED
226774	45.69338	-111.08826	23	12	111SICL	GALLATIN VALLEY	DEDICATED
234907	45.6537	-111.19025	28	16	111ALVM	GALLATIN VALLEY	DEDICATED
234909	45.80254	-111.0454	86.5	66.5	120SNGR	GALLATIN VALLEY	DEDICATED
235473	45.6167	-111.099	36	26	112SNGR	GALLATIN VALLEY	DEDICATED
235474	45.87861	-111.19389	77	62	120SNGR	GALLATIN VALLEY	DEDICATED
235475	45.74848	-111.1698	73	58	112SNGR	GALLATIN VALLEY	DEDICATED
235511	45.67436	-111.12483	36	26	111SNGR	GALLATIN VALLEY	DEDICATED
235512	45.52311	-111.24959	57	47	111ALVM	GALLATIN VALLEY	DEDICATED
241692	45.71252	-111.06435	8.9		120SNGR	GALLATIN VALLEY	
242770	45.673751	-111.186858	23	23	111SNGR	GALLATIN VALLEY	
5816	46.678	-111.8988	45.4	41	110ALVM	HELENA VALLEY	DEDICATED
5846	46.7041	-111.9933	46.4	42	110ALVM	HELENA VALLEY	DEDICATED
58737	46.53	-112.0053	207	207	211BDBT	HELENA VALLEY	IN USE
58923	46.5455	-112.0738	124	84	211BDBT	HELENA VALLEY	IN USE
60803	46.6138	-111.8963	100	80	120SDMS	HELENA VALLEY	IN USE
62006	46.6052	-112.0151	100	60	400HELN	HELENA VALLEY	DEDICATED
62261	46.5822	-112.0172	140	80	400HELN	HELENA VALLEY	IN USE
62369	46.6516	-112.0775	110	80	210PLNC	HELENA VALLEY	IN USE
62523	46.635	-112.0583	50	30	110ALVM	HELENA VALLEY	IN USE
62748	46.6143	-112.0706	100	60	400BELT	HELENA VALLEY	UNUSED
64640	46.7367	-112.0198	70	70	400SPKN	HELENA VALLEY	UNUSED
64649	46.7363	-112.0191	110	70	400SPKN	HELENA VALLEY	IN USE
64737	46.7294	-112.0169	208	142	400SPKN	HELENA VALLEY	IN USE
65432	46.70291	-112.05922	120	110	400SPKN	HELENA VALLEY	DEDICATED
88213	46.646152	-111.937116	104	99	110ALVM	HELENA VALLEY	DEDICATED
88214	46.646152	-111.937116	25	20	110ALVM	HELENA VALLEY	DEDICATED
110196	46.6505	-111.8944	70	30	120SDMS	HELENA VALLEY	IN USE
123550	46.6316	-111.9394	78	73	110ALVM	HELENA VALLEY	DEDICATED
125628	46.7175	-112.0391	124	124	120SDMS	HELENA VALLEY	IN USE

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134497	46.5342	-111.9402	145	145	370HMRK	HELENA VALLEY	IN USE
140486	46.6061	-111.9355	150	80	120SDMS	HELENA VALLEY	DEDICATED
148259	46.733	-111.9544	350	300	400RVLL	HELENA VALLEY	IN USE
170202	46.7177	-111.9126	300	180	400SPKN	HELENA VALLEY	DEDICATED
191524	46.6524	-111.994	25	15	110ALVM	HELENA VALLEY	DEDICATED
191525	46.6524	-111.994	50	40	110ALVM	HELENA VALLEY	DEDICATED
191526	46.6607	-111.9712	46	36	110ALVM	HELENA VALLEY	DEDICATED
191527	46.6607	-111.9719	18	8	110ALVM	HELENA VALLEY	DEDICATED
191532	46.72833	-112.03636	100	90	111ALVM	HELENA VALLEY	DEDICATED
191533	46.6018	-111.9798	121	111	120SDMS	HELENA VALLEY	DEDICATED
191535	46.6018	-111.9798	55	45	120SDMS	HELENA VALLEY	DEDICATED
191537	46.7043	-112.0199	43	33	110ALVM	HELENA VALLEY	DEDICATED
191538	46.6159	-111.9811	80	66	110ALVM	HELENA VALLEY	DEDICATED
191539	46.624	-112.048	19	9	110ALVM	HELENA VALLEY	DEDICATED
191540	46.5905	-111.9939	61	51	120SDMS	HELENA VALLEY	DEDICATED
191548	46.5917	-111.877	136	126	120SDMS	HELENA VALLEY	DEDICATED
191549	46.6618	-111.9461	16	6	110ALVM	HELENA VALLEY	DEDICATED
191550	46.635	-111.9531	47	37	110ALVM	HELENA VALLEY	DEDICATED
191552	46.6753	-112.0418	60	47	110ALVM	HELENA VALLEY	DEDICATED
191554	46.6618	-111.9461	61	51	110ALVM	HELENA VALLEY	DEDICATED
191555	46.6753	-112.0418	29	19	110ALVM	HELENA VALLEY	DEDICATED
193574	46.623703	-112.051871	100	45	110ALVM	HELENA VALLEY	
248640	46.62446	-112.10716	70	49	120SNGR	HELENA VALLEY	
706042	46.59	-112.175	100		211BDBT	HELENA VALLEY	IN USE
892180	46.6316	-111.9394	40	37	110ALVM	HELENA VALLEY	DEDICATED
892195	46.6455	-112.0158	23	20	110ALVM	HELENA VALLEY	DEDICATED
48477	45.872	-112.0876	45	25	110ALVM	JEFFERSON RIVER BASIN	UNUSED
48667	45.8589	-112.2088	123	118	120SDMS	JEFFERSON RIVER BASIN	IN USE
49147	45.8838	-112.0905	88	40	120SDMS	JEFFERSON RIVER BASIN	IN USE
107080	45.7235	-112.1785	85	12	112ALVM	JEFFERSON RIVER BASIN	IN USE
107340	45.6741	-112.2608	89	62	120SDMS	JEFFERSON RIVER BASIN	UNUSED
107647	45.5348	-112.3094	66	66	110ALVF	JEFFERSON RIVER BASIN	LOW USE
108949	45.3244	-112.4409	38	32	110ALVF	JEFFERSON RIVER BASIN	IN USE
108962	45.2738	-112.4463	80	75	110ALVM	JEFFERSON RIVER BASIN	LOW USE
108966	45.3447	-112.5928	200	200	120SDMS	JEFFERSON RIVER BASIN	IN USE
123857	45.2781	-112.6417	120	90	120SDMS	JEFFERSON RIVER BASIN	IN USE
130176	45.4512	-112.3175	275		120SDMS	JEFFERSON RIVER BASIN	DEDICATED
130177	45.4199	-112.3388	200		120SDMS	JEFFERSON RIVER BASIN	DEDICATED
130178	45.3938	-112.4223	21		120SDMS	JEFFERSON RIVER BASIN	DEDICATED

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130179	45.5988	-112.3072	120		120SDMS	JEFFERSON RIVER BASIN	IN USE
131577	45.3938	-112.422	63		120SDMS	JEFFERSON RIVER BASIN	DEDICATED
215992	45.8741	-111.975	100	70	120SNGR	JEFFERSON RIVER BASIN	IN USE
133834	47.0566	-114.0716	112	46	112DRFT	JOCKO VALLEY	DEDICATED
133836	47.1016	-114.0422	63		112OTSH	JOCKO VALLEY	DEDICATED
156396	47.166901	-114.05483	134		112OTSH	JOCKO VALLEY	DEDICATED
703168	47.1622	-114.0258	307	198	120SDMS	JOCKO VALLEY	DEDICATED
6419	48.213056	-114.2725	23	16	111ALVM	KALISPELL VALLEY	DEDICATED
6455	48.25476	-114.25456	22	16	111ALVM	KALISPELL VALLEY	UNUSED
80389	48.08882	-114.03589	247	247	112ALVM	KALISPELL VALLEY	IN USE
80736	48.09651	-114.09926	140		400RVLL	KALISPELL VALLEY	IN USE
80745	48.0947	-114.13681	400		112ALVM	KALISPELL VALLEY	IN USE
81530	48.19758	-114.07113	171	169	112ALVM	KALISPELL VALLEY	IN USE
81636	48.2168	-114.07314	75	58	400RVLL	KALISPELL VALLEY	UNUSED
81711	48.19313	-114.07326	340	320	400RVLL	KALISPELL VALLEY	IN USE
82139	48.20409	-114.29302	297	259	112ALVM	KALISPELL VALLEY	IN USE
82381	48.18405	-114.29006	229	229	112ALVM	KALISPELL VALLEY	IN USE
82934	48.19603	-114.37479	220	175	112ALVM	KALISPELL VALLEY	IN USE
83662	48.25415	-114.115	120	80	400RVLL	KALISPELL VALLEY	IN USE
83716	48.24754	-114.18275	338	338	112ALVM	KALISPELL VALLEY	IN USE
83875	48.29854	-114.30679	260		112VFAL	KALISPELL VALLEY	IN USE
84525	48.2842	-114.4249	73	73	112OTSH	KALISPELL VALLEY	DEDICATED
84560	48.28088	-114.36813	220		112ALVM	KALISPELL VALLEY	UNUSED
84669	48.24797	-114.40579	210	207	112ALVM	KALISPELL VALLEY	IN USE
84687	48.24765	-114.42118	231	231	112ALVM	KALISPELL VALLEY	IN USE
85274	48.39235	-114.21331	360		112DRFT	KALISPELL VALLEY	UNUSED
85628	48.34287	-114.18518	149	149	112DRFT	KALISPELL VALLEY	IN USE
85689	48.34417	-114.14498	308	308	112ALVM	KALISPELL VALLEY	IN USE
85940	48.37264	-114.31694	176	171	112ALVM	KALISPELL VALLEY	UNUSED
86054	48.3739	-114.23831	144		112DRFT	KALISPELL VALLEY	IN USE
86411	48.38936	-114.34249	389	389	112ALVM	KALISPELL VALLEY	UNUSED
86565	48.34744	-114.40583	560	493	400MCRB	KALISPELL VALLEY	IN USE
87873	48.40036	-114.13696	168	91	112DRFT	KALISPELL VALLEY	DEDICATED
88197	48.40182	-114.46124	168	168	112ALVM	KALISPELL VALLEY	IN USE
120810	48.17861	-114.41822	408	380	112ALVM	KALISPELL VALLEY	LOW USE
130530	48.072	-113.95037	460		400RVLL	KALISPELL VALLEY	IN USE
131524	48.25546	-114.30819	278	278	112ALVM	KALISPELL VALLEY	IN USE
131916	48.59771	-114.61839	35	35	112OTSH	KALISPELL VALLEY	IN USE
134212	48.07394	-113.96575	108	100	112ALVM	KALISPELL VALLEY	IN USE

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141562	48.10042	-114.18033	400		112ALVM	KALISPELL VALLEY	IN USE
141665	48.25738	-114.45288	275	212	400RVLL	KALISPELL VALLEY	IN USE
148187	48.34806	-114.19693	157	151	112ALVM	KALISPELL VALLEY	DEDICATED
148188	48.34841	-114.19905	518		112ALVM	KALISPELL VALLEY	IN USE
148189	48.34691	-114.19912	342		112ALVM	KALISPELL VALLEY	IN USE
148191	48.34778	-114.2985	397.5	397.5	112VFAL	KALISPELL VALLEY	DEDICATED
148193	48.32062	-114.34792	437.5		112ALVM	KALISPELL VALLEY	IN USE
148194	48.31984	-114.39022	377.5		400MCRB	KALISPELL VALLEY	DEDICATED
150622	48.14291	-114.05627	43	43	112OTSH	KALISPELL VALLEY	DEDICATED
152883	48.09639	-114.21492	360		112ALVM	KALISPELL VALLEY	IN USE
153329	48.459185	-114.356968	341	308	400BELT	KALISPELL VALLEY	DEDICATED
154871	48.08875	-114.03553	18	18	112OTSH	KALISPELL VALLEY	IN USE
158200	48.34322	-114.12955	170	84	400SPKN	KALISPELL VALLEY	IN USE
169098	48.2263	-114.3277	544	452	112ALVM	KALISPELL VALLEY	DEDICATED
702934	48.25367	-114.12665	422		112ALVM	KALISPELL VALLEY	IN USE
6662	48.44616	-115.87704	46	45	110ALVM	KOOTENAI RIVER BASIN	IN USE
84895	48.30045	-115.51867	337	337	112SNGR	KOOTENAI RIVER BASIN	IN USE
86863	48.34349	-115.53959	240	236	112SNGR	KOOTENAI RIVER BASIN	IN USE
86974	48.38453	-115.56701	80	69	112SNGR	KOOTENAI RIVER BASIN	IN USE
88736	48.41167	-115.81468	45	41	112ALVM	KOOTENAI RIVER BASIN	IN USE
132577	48.39897	-115.84478	187		110ALVM	KOOTENAI RIVER BASIN	DEDICATED
70688	46.94451	-112.66928	47.5	47.5	110ALVM	LINCOLN - OVANDO	IN USE
71610	47.0136	-113.0658	208	208	120SNGR	LINCOLN - OVANDO	UNUSED
131018	46.95641	-112.67048	50	50	110ALVM	LINCOLN - OVANDO	IN USE
131374	46.87042	-112.96828	71	61	112SNGR	LINCOLN - OVANDO	IN USE
152543	47.0347	-112.96542	115	115	112SNGR	LINCOLN - OVANDO	IN USE
6096	47.4763	-114.4091	331	300	112LONE	LITTLE BITTERROOT	DEDICATED
6142	47.5909	-114.4611	186	140	112ALVM	LITTLE BITTERROOT	DEDICATED
6217	47.66	-114.5263	92		112DRFT	LITTLE BITTERROOT	UNUSED
6283	47.7141	-114.6477	377		112LONE	LITTLE BITTERROOT	DEDICATED
6320	47.8088	-114.6061	328	319	112ALVM	LITTLE BITTERROOT	DEDICATED
45118	47.76243	-114.62526			112LONE	LITTLE BITTERROOT	UNUSED
77168	47.62295	-114.573			112LONE	LITTLE BITTERROOT	UNUSED
77225	47.67332	-114.65326	300	300	112LONE	LITTLE BITTERROOT	UNUSED
133916	47.8619	-114.5525	170		112ALVM	LITTLE BITTERROOT	UNUSED
133957	47.4611	-114.4358	155		112DRFT	LITTLE BITTERROOT	DEDICATED
108186	45.5101	-112.71887	85	75	120SNGR	LOWER BIGHOLE BASIN	IN USE
161775	45.6308	-112.6847	32		111ALVM	LOWER BIGHOLE BASIN	LOW USE
162176	45.3925	-112.6975	270		120SNGR	LOWER BIGHOLE BASIN	IN USE

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
6024	47.2844	-114.0294	147	142	112OTSH	MISSION VALLEY	DEDICATED
6271	47.7255	-114.2213	138		112DRFT	MISSION VALLEY	IN USE
73475	47.3169	-114.1025	30		112LKML	MISSION VALLEY	IN USE
76048	47.5658	-114.1019	295	295	112LKML	MISSION VALLEY	DEDICATED
77922	47.7427	-114.2583	300	180	400RVLL	MISSION VALLEY	UNUSED
128076	47.8125	-114.4755	460		112DRFT	MISSION VALLEY	DEDICATED
133839	47.3344	-114.0102	305		112LKML	MISSION VALLEY	DEDICATED
133840	47.2869	-114.0636	160		112LKML	MISSION VALLEY	UNUSED
133842	47.3988	-114.0483	90		112LKML	MISSION VALLEY	UNUSED
133883	47.518	-114.0194	525		400RVLL	MISSION VALLEY	DEDICATED
133891	47.5361	-114.2355	420		400RVLL	MISSION VALLEY	UNUSED
133895	47.6508	-114.1136	500		112ALVM	MISSION VALLEY	UNUSED
133913	47.8361	-114.3519	NULL		112DRFT	MISSION VALLEY	IN USE
67037	46.833012	-114.051838	38	24	111ALVM	MISSOULA VALLEY	DEDICATED
67179	46.8151	-114.1016	320	189	400MSSL	MISSOULA VALLEY	IN USE
69402	46.8491	-114.0072	76.3	60.3	112ALVM	MISSOULA VALLEY	DEDICATED
150967	46.87171	-113.98135	45	25	112ALVM	MISSOULA VALLEY	DEDICATED
151061	46.8925	-114.0388	50	20	112ALVM	MISSOULA VALLEY	DEDICATED
151081	46.8794	-113.9752	24	4	111ALVM	MISSOULA VALLEY	DEDICATED
151101	46.8558	-114.0916	25	5	112ALVM	MISSOULA VALLEY	DEDICATED
151143	46.868	-114.0291	45	20	111ALVM	MISSOULA VALLEY	DEDICATED
151161	46.8513	-114.0394	53	33	111ALVM	MISSOULA VALLEY	DEDICATED
151179	46.8833	-114.0902	42	12	111ALVM	MISSOULA VALLEY	DEDICATED
151186	46.8936	-114.0602	50	20	112ALVM	MISSOULA VALLEY	DEDICATED
151188	46.8486	-114.1011	35	20	111ALVM	MISSOULA VALLEY	DEDICATED
151189	46.856389	-114.060556	50	38	112ALVM	MISSOULA VALLEY	DEDICATED
151190	46.85793	-114.00252	76.3	66.3	112ALVM	MISSOULA VALLEY	DEDICATED
151191	46.8662	-113.988899	53	31	112ALVM	MISSOULA VALLEY	DEDICATED
151204	47.0307	-114.2726	25	5	111ALVM	MISSOULA VALLEY	DEDICATED
157208	46.8578	-114.0021	113	113	112ALVM	MISSOULA VALLEY	DEDICATED
157212	46.9291	-114.108	120	95	112ALVM	MISSOULA VALLEY	DEDICATED
157213	46.9652	-114.1413	35	5	111ALVM	MISSOULA VALLEY	DEDICATED
157214	46.9002	-113.9655	100	90	112ALVM	MISSOULA VALLEY	DEDICATED
157215	46.7808	-114.0236	150	150	112ALVM	MISSOULA VALLEY	DEDICATED
164349	46.8898	-113.9276	330	55	400MSSL	MISSOULA VALLEY	IN USE
72114	47.0348	-114.3881	138	138	112ALVM	NINEMILE VALLEY	IN USE
72167	47.0786	-114.4458	61	61	111ALVM	NINEMILE VALLEY	IN USE
134890	47.0586	-114.3405	98	77	110SNGR	NINEMILE VALLEY	IN USE
150981	47.0891	-114.4031	142	87	120SNGR	NINEMILE VALLEY	UNUSED

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
49049	45.9042	-111.9536	74	69	120SDMS	NORTH BOULDER VALLEY	IN USE
50002	46.0211	-111.8733	45	38	110ALVM	NORTH BOULDER VALLEY	IN USE
50006	45.9791	-111.8811	80	80	120SDMS	NORTH BOULDER VALLEY	IN USE
50963	46.1022	-111.9493	201	160	120SDMS	NORTH BOULDER VALLEY	IN USE
51656	46.1476	-111.9673	77	77	120SDMS	NORTH BOULDER VALLEY	IN USE
51692	46.202	-112.0977	240	120	211BDBT	NORTH BOULDER VALLEY	IN USE
53392	46.2358	-112.1308	49	49	110ALVM	NORTH BOULDER VALLEY	IN USE
121965	46.0716	-111.9013	225	181	120SDMS	NORTH BOULDER VALLEY	UNUSED
21567	45.5563	-110.5749	60.5	60.5	110TRRC	PARADISE VALLEY	IN USE
99787	45.5539	-110.6085	100	55	110ALVM	PARADISE VALLEY	IN USE
99837	45.5408	-110.5402	220	150	120SDMS	PARADISE VALLEY	IN USE
101007	45.49	-110.5813	70	70	110ALVM	PARADISE VALLEY	IN USE
102486	45.3752	-110.6847	220	220	120SDMS	PARADISE VALLEY	IN USE
103644	45.2952	-110.83519	72	52	110ALVM	PARADISE VALLEY	IN USE
104586	45.2051	-110.8933	101.4	86.4	110ALVM	PARADISE VALLEY	LOW USE
15713	46.1369	-111.5938	220	128.1	120SDMS	RADERSBERG VALLEY	UNUSED
16609	46.19875	-111.63346	40	40	110ALVM	RADERSBERG VALLEY	LOW USE
130432	46.11778	-111.52978	30	13.5	110ALVM	RADERSBERG VALLEY	DEDICATED
131579	45.9884	-112.6685	445		120SDMS	ROCKER VALLEY	DEDICATED
131967	45.7692	-112.7365	55	45	110ALVM	ROCKER VALLEY	IN USE
180702	45.9534	-112.6694	95	85	120SDMS	ROCKER VALLEY	IN USE
107951	45.4521	-112.1917	225	81	120SDMS	RUBY RIVER VALLEY	UNUSED
108471	45.37865	-112.16426	41	36	110SNGR	RUBY RIVER VALLEY	IN USE
108917	45.2913	-112.098	80		120SDMS	RUBY RIVER VALLEY	IN USE
73341	47.3466	-113.58872	55	45	112ALVM	SEELEY - SWAN	LOW USE
120512	47.16939	-113.44874	103	103	112ALVM	SEELEY - SWAN	LOW USE
127166	47.83588	-113.81681	439	439	112ALVM	SEELEY - SWAN	IN USE
133044	47.68294	-113.81074	40		112DRFT	SEELEY - SWAN	IN USE
133045	47.54495	-113.72107	172	148	112ALVM	SEELEY - SWAN	UNUSED
136565	47.14924	-113.45508	140	100	400BELT	SEELEY - SWAN	IN USE
155165	47.14525	-113.46229	80	50	112OTSH	SEELEY - SWAN	IN USE
155593	47.15488	-113.44174	220	85	112TILL	SEELEY - SWAN	IN USE
32	45.81363	-111.46782	145	125	120SDMS	THREE FORKS	IN USE
775	45.88878	-111.56818	152.5	23	120SDMS	THREE FORKS	IN USE
818	45.89316	-111.48508	19	16.8	110ALVM	THREE FORKS	DEDICATED
820	45.89316	-111.48508	41	38.1	110ALVM	THREE FORKS	DEDICATED
822	45.89316	-111.48508	55.4	53	110ALVM	THREE FORKS	DEDICATED
824	45.89316	-111.48508	245	235	123CBGA	THREE FORKS	DEDICATED
9258	45.81679	-111.64288	60	60	120SDMS	THREE FORKS	IN USE

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
9271	45.80893	-111.5662	220	209	120SDMS	THREE FORKS	IN USE
136051	45.9397	-111.6155	930		330MDSN	THREE FORKS	UNUSED
136052	45.9391	-111.6161	525		330MDSN	THREE FORKS	UNUSED
163677	45.7002	-111.7855	140	120	120SNGR	THREE FORKS	IN USE
90508	48.96331	-115.05811	230	140	112SNGR	TOBACCO RIVER VALLEY	IN USE
90519	48.95541	-115.12488	45	45	112SNGR	TOBACCO RIVER VALLEY	LOW USE
90525	48.94331	-115.09853	362	320	112SNGR	TOBACCO RIVER VALLEY	IN USE
131939	48.77688	-114.89524	10		110ALVM	TOBACCO RIVER VALLEY	IN USE
16677	46.22193	-111.41086	136	0	120SDMS	TOWNSEND VALLEY	IN USE
20667	46.4031	-111.6014	240	215	120SDMS	TOWNSEND VALLEY	IN USE
120777	46.338	-111.503	105	101	120SDMS	TOWNSEND VALLEY	DEDICATED
121070	46.3377	-111.5038	226	226	120SDMS	TOWNSEND VALLEY	UNUSED
125678	46.28509	-111.50903	180	120	120SDMS	TOWNSEND VALLEY	UNUSED
134121	46.40644	-111.44676	115		120SDMS	TOWNSEND VALLEY	IN USE
9010	45.5314	-113.5163	35	32	111SNGR	UPPER BIGHOLE VALLEY	IN USE
92804	45.5302	-113.517	101	82	120SDMS	UPPER BIGHOLE VALLEY	IN USE
107681	45.5678	-113.4578	205	200	120SDMS	UPPER BIGHOLE VALLEY	IN USE
108215	45.5089	-113.4281	235	180	120SNGR	UPPER BIGHOLE VALLEY	IN USE
108595	45.4043	-113.4853	43	31	111SNGR	UPPER BIGHOLE VALLEY	IN USE
108610	45.3527	-113.4013	36	30	120SDMS	UPPER BIGHOLE VALLEY	UNUSED
129084	45.7763	-113.4532	140		120SDMS	UPPER BIGHOLE VALLEY	IN USE
129086	45.7012	-113.5605	36	30	112OTSH	UPPER BIGHOLE VALLEY	IN USE
129151	45.6183	-113.4467	125		120SDMS	UPPER BIGHOLE VALLEY	IN USE
153311	45.6383	-113.5174	203	198	120SNGR	UPPER BIGHOLE VALLEY	IN USE
165827	45.3282	-113.4058	33	27	112SNGR	UPPER BIGHOLE VALLEY	IN USE
8889	44.9019	-111.5925	99	97	110TRRC	UPPER MADISON	UNUSED
106775	44.7044	-111.1002			112ALVM	UPPER MADISON	IN USE
107744	45.4422	-111.7313	130	122	120SDMS	UPPER MADISON	IN USE
108666	45.3363	-111.7338	85	74	120SDMS	UPPER MADISON	IN USE
109142	45.2178	-111.6865	175	175	120SDMS	UPPER MADISON	IN USE
128327	45.314994	-111.785908	170	140	400MMPC	UPPER MADISON	IN USE
136049	45.1077	-111.5852	130		110ALVF	UPPER MADISON	IN USE
204606	45.3511	-111.7431	100		120SDMS	UPPER MADISON	DEDICATED
1703	46.5576	-110.83034	85	55	400PIGN	WHITE SULPHUR	IN USE
22251	46.5459	-110.8734	135	95	120SDMS	WHITE SULPHUR	IN USE
23116	46.63497	-111.2019	70	50	120SDMS	WHITE SULPHUR	IN USE
23142	46.5933	-111.0567	40	31	211PLNC	WHITE SULPHUR	IN USE
129117	46.4568	-110.9735	158	138	120SDMS	WHITE SULPHUR	IN USE

N300LTRTRY - Lower Tertiary aquifers

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
206	45.832	-106.7077	225	212	125MKCB	FORT UNION FORMATION	DEDICATED
210	45.832	-106.7077	149	121	125RBCB	FORT UNION FORMATION	DEDICATED
337	45.8458	-106.6411	248	235	125MKCB	FORT UNION FORMATION	DEDICATED
339	45.8458	-106.6411	225	197	125RBCB	FORT UNION FORMATION	DEDICATED
382	45.817	-106.6062	40	24	125SUMK	FORT UNION FORMATION	DEDICATED
1103	45.8815	-106.591	45	33.5	125MKCB	FORT UNION FORMATION	DEDICATED
1115	45.8815	-106.5911	24	16.5	125RBCB	FORT UNION FORMATION	DEDICATED
1574	46.3592	-108.4405	183	159	125MMUB	FORT UNION FORMATION	DEDICATED
1575	46.3592	-108.4405	152	142	125MMCB	FORT UNION FORMATION	DEDICATED
1845	46.84063	-105.31044	340	243	125TLCK	FORT UNION FORMATION	DEDICATED
2384	47.3838	-104.91381	220	180	125TGRV	FORT UNION FORMATION	DEDICATED
3001	47.8043	-105.659	101	91	125LEBO	FORT UNION FORMATION	IN USE
3772	48.5549	-104.1818	318	303	125FRUN	FORT UNION FORMATION	DEDICATED
3872	48.5855	-104.1454	330	290	125FRUN	FORT UNION FORMATION	DEDICATED
4211	48.9977	-105.63707	85	78	125TGRV	FORT UNION FORMATION	DEDICATED
4227	48.9994	-105.4633	83	63	125TGRV	FORT UNION FORMATION	DEDICATED
4248	48.98325	-105.51904	205	185	125FRUN	FORT UNION FORMATION	DEDICATED
4267	48.983	-105.4744	147	128	125TGRV	FORT UNION FORMATION	DEDICATED
4274	48.96503	-105.45334	208	53	125TGRV	FORT UNION FORMATION	DEDICATED
4290	48.96863	-105.4976	195	179	125FRUN	FORT UNION FORMATION	DEDICATED
4297	48.95422	-105.51967	288	263	125FRUN	FORT UNION FORMATION	DEDICATED
8107	45.12542	-106.48297	232	209	125CNCB	FORT UNION FORMATION	DEDICATED
8863	45.0807	-105.8628	410		125TGRV	FORT UNION FORMATION	IN USE
17518	46.2108	-104.4122	180		125FRUN	FORT UNION FORMATION	UNUSED
18368	46.2413	-108.2195	150	60	125TGRV	FORT UNION FORMATION	IN USE
20002	46.3084	-108.1528	197	70	125FRUN	FORT UNION FORMATION	IN USE
24162	46.6986	-104.9539	135		125FRUN	FORT UNION FORMATION	UNUSED
27457	47.0462	-106.5825	245	165	125FRUN	FORT UNION FORMATION	UNUSED
31035	47.3381	-107.2936	120	70	125FRUN	FORT UNION FORMATION	UNUSED
31087	47.3237	-106.9143	145	110	125FRUN	FORT UNION FORMATION	IN USE
31653	47.31852	-104.10024	140		125FRUN	FORT UNION FORMATION	UNUSED
35606	47.69457	-104.78982	28	20	125TGRV	FORT UNION FORMATION	IN USE
36251	47.7457	-105.2098	176		125FRUN	FORT UNION FORMATION	UNUSED
36423	47.78058	-104.24603	126		125FRUN	FORT UNION FORMATION	UNUSED
37259	47.80747	-104.47085	60	16	125TGRV	FORT UNION FORMATION	IN USE
38286	47.99137	-109.63791	141	25	125TLCK	FORT UNION FORMATION	IN USE
47501	48.84943	-106.25096	100		125FRUN	FORT UNION FORMATION	UNUSED
94661	45.7782	-106.0323	135		125TGRV	FORT UNION FORMATION	IN USE
94666	45.7524	-106.0505	190	168	125TGRV	FORT UNION FORMATION	IN USE

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
98860	45.7448	-105.0899	340	260	125TLCK	FORT UNION FORMATION	LOW USE
100472	45.5935	-106.1642	193		125KNUB	FORT UNION FORMATION	IN USE
104686	45.2274	-109.2907	150	150	125TGRV	FORT UNION FORMATION	IN USE
105007	45.2153	-106.2697	110	70	125CNOB	FORT UNION FORMATION	IN USE
120639	47.2989	-105.7649	100	80	125FRUN	FORT UNION FORMATION	IN USE
122303	46.5117	-108.2035	80	60	125FRUN	FORT UNION FORMATION	IN USE
123790	45.8173	-106.6652	177	146.5	125RBCB	FORT UNION FORMATION	DEDICATED
123791	45.8173	-106.6652	209	196.5	125MKCB	FORT UNION FORMATION	DEDICATED
129758	45.7978	-106.7045	205	200	125RBCB	FORT UNION FORMATION	DEDICATED
132732	47.1198	-106.1036	263	258	125TGRV	FORT UNION FORMATION	DEDICATED
132734	47.1196	-106.1035	103	63	125FRUN	FORT UNION FORMATION	DEDICATED
132737	47.124	-106.0638	145	115	125FRUN	FORT UNION FORMATION	DEDICATED
132738	47.124	-106.0639	145	105	125FRUN	FORT UNION FORMATION	DEDICATED
132892	45.7978	-106.7045	265	265	125MKCB	FORT UNION FORMATION	DEDICATED
132904	46.9627	-105.5152	440		125TLCK	FORT UNION FORMATION	DEDICATED
136678	46.94731	-104.08056	114	108	125FRUN	FORT UNION FORMATION	DEDICATED
136679	47.07953	-104.94905	317		125LEBO	FORT UNION FORMATION	DEDICATED
136680	47.07953	-104.94911	193		125TGRV	FORT UNION FORMATION	DEDICATED
137973	47.41423	-104.72639	105	80	125FRUN	FORT UNION FORMATION	DEDICATED
137987	47.0928	-104.1994	155		125FRUN	FORT UNION FORMATION	DEDICATED
138001	47.5002	-105.1296	180	118	125FRUN	FORT UNION FORMATION	DEDICATED
138003	47.3245	-106.0447	278		125TGRV	FORT UNION FORMATION	IN USE
138134	47.418	-105.5821	150	103.5	125FRUN	FORT UNION FORMATION	UNUSED
138223	47.09324	-105.20665	202		125FRUN	FORT UNION FORMATION	DEDICATED
138227	47.07953	-104.94921			125FRUN	FORT UNION FORMATION	
138914	45.9253	-109.9134	135	95	125FRUN	FORT UNION FORMATION	IN USE
140123	46.4417	-108.551	148	0	125FRUN	FORT UNION FORMATION	IN USE
141828	46.4509	-107.7897	235		125TLCK	FORT UNION FORMATION	IN USE
142636	47.03499	-104.09297	46.5		125TGRV	FORT UNION FORMATION	DEDICATED
143790	47.0922	-105.9167	164		125FRUN	FORT UNION FORMATION	DEDICATED
143791	46.7893	-104.8488	63		125FRUN	FORT UNION FORMATION	UNUSED
143792	46.9492	-105.3265	188		125FRUN	FORT UNION FORMATION	UNUSED
143793	46.9491	-105.3267	400	160	125FRUN	FORT UNION FORMATION	IN USE
143795	47.1662	-105.4342	380		125FRUN	FORT UNION FORMATION	DEDICATED
143805	47.595	-104.9404	68		125TGRV	FORT UNION FORMATION	DEDICATED
143947	48.004	-104.95216	26		125FRUN	FORT UNION FORMATION	LOW USE
143948	46.3545	-104.55	362		125TGRV	FORT UNION FORMATION	DEDICATED
144103	45.3557	-109.4581	110	50	125TLCK	FORT UNION FORMATION	IN USE
149510	45.6558	-109.5677	110		125FRUN	FORT UNION FORMATION	IN USE
149925	45.1921	-109.2515	150	90	125TGRV	FORT UNION FORMATION	IN USE
150349	45.4947	-109.4581	52		125FRUN	FORT UNION FORMATION	IN USE

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
152305	47.03498	-104.09284	57.8	52.8	125FRUN	FORT UNION FORMATION	DEDICATED
153815	46.0618	-109.8444	37.5		125FRUN	FORT UNION FORMATION	IN USE
157581	47.7534	-105.4914	196.4		125FRUN	FORT UNION FORMATION	UNUSED
157879	45.7393	-106.4904	86	72	125RBCB	FORT UNION FORMATION	DEDICATED
157882	45.7394	-106.4905	68	48	125RBOB	FORT UNION FORMATION	DEDICATED
157883	45.7199	-106.5126	88.5	71.5	125KNCB	FORT UNION FORMATION	DEDICATED
157884	45.72	-106.5126	46	38	125KNOB	FORT UNION FORMATION	DEDICATED
161429	45.017	-109.1716	190	110	125TGRV	FORT UNION FORMATION	IN USE
165155	47.2245	-105.7241	229		125FRUN	FORT UNION FORMATION	IN USE
182530	48.80996	-105.60116	95.45		125FRUN	FORT UNION FORMATION	IN USE
182531	48.79352	-104.35364	146		125FRUN	FORT UNION FORMATION	IN USE
182533	48.80443	-105.16965			125TGRV	FORT UNION FORMATION	UNUSED
182534	48.81035	-105.81237	133.15		125FRUN	FORT UNION FORMATION	UNUSED
183559	45.4114	-106.4549	540		125FGUB	FORT UNION FORMATION	IN USE
183561	46.2439	-105.2719	126		125TLCK	FORT UNION FORMATION	LOW USE
183564	45.6404	-105.9758	60		125TGRV	FORT UNION FORMATION	LOW USE
183565	45.4275	-105.9171	167		125PWUB	FORT UNION FORMATION	IN USE
185284	45.4914	-109.4857	300	140	125TLCK	FORT UNION FORMATION	IN USE
197444	45.3366	-109.1638	160	80	125TGRV	FORT UNION FORMATION	IN USE
199495	45.225	-109.2217	70	70	125TGRV	FORT UNION FORMATION	IN USE
705232	45.9764	-107.071	55		125TLCK	FORT UNION FORMATION	UNUSED
92295	45.7383	-110.4866	160	10	125FRUN	LIVINGSTON FORMATION	IN USE

N300UPCTCS - Upper Cretaceous aquifers

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
2010	47.1557	-110.2198	205	38	211CLRD	COLORADO GROUP	UNUSED
34619	47.58864	-110.93127	150		211CLRD	COLORADO GROUP	IN USE
34665	47.5261	-110.76629	75		211CLRD	COLORADO GROUP	IN USE
37488	47.94856	-110.97648	75	75	211CLRD	COLORADO GROUP	UNUSED
72924	47.25623	-111.71057	200	180	211KVIN	COLORADO GROUP	IN USE
151290	47.1285	-109.6156	232		211CLRD	COLORADO GROUP	UNUSED
96	45.8625	-108.4386	1050	800	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
2333	47.3945	-109.137	1430	1120	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
2609	47.582	-108.7189	1630	1524	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
2743	47.6443	-109.3103	1624	1474	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
3384	48.2063	-110.35514	612	618	211VRGL	EAGLE-VIRGELLE FORMATION	UNUSED
11126	45.8177	-108.5239	75	54	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
11531	45.795	-108.4477	115	80	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
15907	46.0715	-109.2029	97.6		211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
22393	46.5618	-108.8939	125	75	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
23991	46.7199	-108.154	680	0	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
25223	46.8512	-108.3122	120	76	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
26038	46.9407	-108.1865	101	60	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
26046	46.9651	-108.0801	135		211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
32119	47.3776	-109.8294	125	45	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
35394	47.6455	-110.06601	107	90	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
35402	47.61274	-110.1078	89		211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
36883	47.8548	-110.3864	196	182	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
37627	47.88526	-110.141	345	328	211VRGL	EAGLE-VIRGELLE FORMATION	IN USE
39503	48.16115	-111.00124	90		211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
41479	48.33444	-110.80709	247	0	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
43211	48.51298	-110.95207	398	281	211EGLE	EAGLE-VIRGELLE FORMATION	UNUSED
44535	48.5975	-111.1322	150	111	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
44548	48.6033	-110.9438	575	575	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
45363	48.66153	-111.20816	115	106.5	211VRGL	EAGLE-VIRGELLE FORMATION	IN USE
81455	48.155	-112.0988	100	80	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
85046	48.3117	-112.2544	90	90	211EGLE	EAGLE-VIRGELLE FORMATION	UNUSED
88838	48.4883	-112.0927	78	28	211VRGL	EAGLE-VIRGELLE FORMATION	IN USE
89572	48.7995	-112.0872	64	64	211VRGL	EAGLE-VIRGELLE FORMATION	UNUSED
90371	48.9922	-111.9557	118	116	211VRGL	EAGLE-VIRGELLE FORMATION	IN USE
92715	45.7447	-108.8732	159	159	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
126091	47.71938	-110.1277	100	43	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
127844	47.5064	-108.4163	2102	1757	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
138844	45.2752	-108.9237	134	74	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
151276	47.2563	-109.3581	510	367	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
155351	45.8214	-108.695	52	30	211TPCK	EAGLE-VIRGELLE FORMATION	IN USE
158207	47.99669	-108.71884	244	164	211VRGL	EAGLE-VIRGELLE FORMATION	DEDICATED
164863	47.0209	-108.261	198		211EGLE	EAGLE-VIRGELLE FORMATION	UNUSED
167178	47.0513	-108.2558	80		211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
169145	47.0101	-108.1593	180	100	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
171235	47.75644	-110.08796	180		211EGLE	EAGLE-VIRGELLE FORMATION	DEDICATED
176921	46.0474	-109.0372	70	30	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
192041	46.0551	-109.0508	115.2		211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
248651	46.85083	-108.31274	150		211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
890877	48.9618	-111.3142	523	523	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
890895	48.91282	-111.00224	673	587	211EGLE	EAGLE-VIRGELLE FORMATION	IN USE
1330	46.0907	-107.65919	445	404	211LNCE	FOXHILLS - HELL CREEK	IN USE
1388	46.1761	-108.6123	427	362	211HLCK	FOXHILLS - HELL CREEK	DEDICATED

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
1567	46.3948	-109.1329	137	77	211HLCK	FOXHILLS - HELL CREEK	IN USE
1657	46.3954	-107.7822	1175	903	211FHHC	FOXHILLS - HELL CREEK	DEDICATED
1658	46.3954	-107.7825	850	803	211LNCE	FOXHILLS - HELL CREEK	DEDICATED
1659	46.3952	-107.7818	486	430	211LNCE	FOXHILLS - HELL CREEK	DEDICATED
1811	46.7733	-104.8246	1187		211FXHL	FOXHILLS - HELL CREEK	IN USE
1846	46.8409	-105.3183	973	778	211FHHC	FOXHILLS - HELL CREEK	DEDICATED
2061	47.1195	-106.1039	1460	1138	211FHHC	FOXHILLS - HELL CREEK	DEDICATED
3002	47.8034	-105.6592	640	580	211FHHC	FOXHILLS - HELL CREEK	IN USE
4329	48.99895	-105.40946	218	212	211FXHL	FOXHILLS - HELL CREEK	DEDICATED
15078	45.9933	-108.2887	75	63	211LNCE	FOXHILLS - HELL CREEK	IN USE
15965	46.1034	-108.8278	410	220	211LNCE	FOXHILLS - HELL CREEK	IN USE
15966	46.1035	-108.8278	80	37	211LNCE	FOXHILLS - HELL CREEK	UNUSED
16581	45.5199	-104.0663	150	110	211FHHC	FOXHILLS - HELL CREEK	IN USE
17596	46.1935	-104.2397	100		211HLCK	FOXHILLS - HELL CREEK	LOW USE
21506	46.4115	-107.5075	180	100	211FHHC	FOXHILLS - HELL CREEK	IN USE
24862	46.758	-104.7476	1275		211FXHL	FOXHILLS - HELL CREEK	LOW USE
24903	46.7772	-104.4636	100	80	211FXHL	FOXHILLS - HELL CREEK	IN USE
27377	47.0395	-107.5524	90		211HLCK	FOXHILLS - HELL CREEK	IN USE
27815	47.07613	-104.69512	785	170	211HLCK	FOXHILLS - HELL CREEK	LOW USE
30997	47.2763	-107.6745	190	150	211FHHC	FOXHILLS - HELL CREEK	IN USE
31041	47.1959	-107.21	700	593	211FHHC	FOXHILLS - HELL CREEK	LOW USE
31165	47.3103	-106.9104	520	448	211FHHC	FOXHILLS - HELL CREEK	IN USE
32476	47.4181	-105.5789	1508	1298	211FHHC	FOXHILLS - HELL CREEK	IN USE
34908	47.5542	-107.17	350	306	211FHHC	FOXHILLS - HELL CREEK	UNUSED
95030	45.7814	-104.4202	360	319	211FHHC	FOXHILLS - HELL CREEK	IN USE
95031	45.7816	-104.4204	160	95	211HLCK	FOXHILLS - HELL CREEK	UNUSED
103306	45.4177	-105.4562	499		211LHUD	FOXHILLS - HELL CREEK	IN USE
103320	45.4006	-105.4627	992		211FHHC	FOXHILLS - HELL CREEK	IN USE
121589	47.11724	-104.73414	70	45	211HLCK	FOXHILLS - HELL CREEK	UNUSED
121803	45.727	-109.2855	150	31	211HLCK	FOXHILLS - HELL CREEK	IN USE
121860	45.6092	-109.2735	121	80	211HLCK	FOXHILLS - HELL CREEK	IN USE
124229	46.4767	-108.6818	240	198	211HLCK	FOXHILLS - HELL CREEK	UNUSED
124231	46.62	-108.7383	300	120	211HLCK	FOXHILLS - HELL CREEK	UNUSED
124876	45.7624	-109.7836	65	50	211HLCK	FOXHILLS - HELL CREEK	IN USE
132902	46.84063	-105.31044	565	440	211HLCK	FOXHILLS - HELL CREEK	DEDICATED
133036	46.7736	-104.6442	1449	1100	211COGT	FOXHILLS - HELL CREEK	UNUSED
136636	46.778	-104.6202	145		211COGT	FOXHILLS - HELL CREEK	UNUSED
136642	46.7485	-104.6513	1467		211COGT	FOXHILLS - HELL CREEK	UNUSED
138002	47.8251	-106.1053	300		211FHHC	FOXHILLS - HELL CREEK	DEDICATED
140122	46.3058	-108.8557	89		211HLCK	FOXHILLS - HELL CREEK	UNUSED

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
140128	46.1357	-109.594	62.5		211FXHL	FOXHILLS - HELL CREEK	UNUSED
142191	46.1516	-107.1657	210	80	211LHUD	FOXHILLS - HELL CREEK	IN USE
143862	46.1407	-107.4581	100	80	211LNCE	FOXHILLS - HELL CREEK	IN USE
145486	45.4917	-109.5631	105	45	211HLCK	FOXHILLS - HELL CREEK	IN USE
147175	47.3386	-106.3709	350	310	211FHHC	FOXHILLS - HELL CREEK	LOW USE
152675	45.6819	-109.4543	50.8		211HLCK	FOXHILLS - HELL CREEK	IN USE
157936	46.0892	-108.2205	97	37	211LNCE	FOXHILLS - HELL CREEK	IN USE
171183	46.4255	-105.8753	830	760	211FHHC	FOXHILLS - HELL CREEK	LOW USE
177421	48.86199	-106.47807	326		211FHHC	FOXHILLS - HELL CREEK	UNUSED
183429	45.6249	-104.8189	332	272	211FXHL	FOXHILLS - HELL CREEK	IN USE
195290	45.2479	-104.9868	92		211HLCK	FOXHILLS - HELL CREEK	LOW USE
221274	48.0094	-105.3317	180		211FHHC	FOXHILLS - HELL CREEK	DEDICATED
249240	47.7731	-104.8251	1100		211FXHL	FOXHILLS - HELL CREEK	IN USE
1502	46.23176	-107.14034	946	886	211JDRV	JUDITH RIVER FORMATION	IN USE
2195	47.3136	-107.9395	1003	800	211JDRV	JUDITH RIVER FORMATION	IN USE
3563	48.36624	-109.26447	453	445	211JDRV	JUDITH RIVER FORMATION	IN USE
3572	48.36987	-106.79305	195	180	211JDRV	JUDITH RIVER FORMATION	IN USE
3623	48.4677	-109.898	215	186	211JDRV	JUDITH RIVER FORMATION	IN USE
3691	48.55073	-110.11256	237.5	222	211JDRV	JUDITH RIVER FORMATION	UNUSED
10289	45.8571	-108.8656	75	25	211JDRV	JUDITH RIVER FORMATION	IN USE
16888	46.2018	-109.4035	250	250	211JDRV	JUDITH RIVER FORMATION	IN USE
16962	46.2066	-108.9045	55	30	211JDRV	JUDITH RIVER FORMATION	UNUSED
20773	46.4311	-110.3947	65	60	211JDRV	JUDITH RIVER FORMATION	IN USE
22380	46.5627	-109.1152	965	788	211JDRV	JUDITH RIVER FORMATION	IN USE
32125	47.4452	-109.4893	145	27	211JDRV	JUDITH RIVER FORMATION	UNUSED
36953	47.85531	-109.69618	144	76	211JDRV	JUDITH RIVER FORMATION	IN USE
36972	47.7987	-108.6294	600	575	211JDRV	JUDITH RIVER FORMATION	IN USE
37663	47.91597	-109.85228	128.5	75	211JDRV	JUDITH RIVER FORMATION	IN USE
38260	48.0198	-109.9413	347	165	211JDRV	JUDITH RIVER FORMATION	IN USE
38920	48.07754	-107.59045	351	95	211JDRV	JUDITH RIVER FORMATION	IN USE
38924	48.04734	-107.53962	600		211JDRV	JUDITH RIVER FORMATION	IN USE
41637	48.35488	-109.21516	80	76	211JDRV	JUDITH RIVER FORMATION	IN USE
43880	48.56457	-109.54729	208	130	211JDRV	JUDITH RIVER FORMATION	UNUSED
45563	48.73917	-107.25291	40		211JDRV	JUDITH RIVER FORMATION	IN USE
46113	48.7824	-110.77787	140	140	211JDRV	JUDITH RIVER FORMATION	UNUSED
46129	48.79239	-110.53994	125	125	211JDRV	JUDITH RIVER FORMATION	IN USE
46155	48.74073	-110.34508	205		211JDRV	JUDITH RIVER FORMATION	IN USE
46168	48.79579	-109.97569	455	216	211JDRV	JUDITH RIVER FORMATION	IN USE
46179	48.75446	-110.04324	165	157	211JDRV	JUDITH RIVER FORMATION	IN USE
46194	48.7497	-109.7558	258	240	211JDRV	JUDITH RIVER FORMATION	IN USE

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
46442	48.77869	-107.45366	246	185	211JDRV	JUDITH RIVER FORMATION	IN USE
123280	46.4588	-109.4827	115	60	211JDRV	JUDITH RIVER FORMATION	IN USE
126044	45.6793	-109.1566	70	58	211JDRV	JUDITH RIVER FORMATION	DEDICATED
127958	47.5603	-109.0851	600	600	211JDRV	JUDITH RIVER FORMATION	IN USE
128313	47.6258	-108.7036	500	307	211JDRV	JUDITH RIVER FORMATION	IN USE
128579	48.61285	-109.45808	220	178	211JDRV	JUDITH RIVER FORMATION	IN USE
129249	47.98759	-109.61327	120	80	211JDRV	JUDITH RIVER FORMATION	IN USE
131693	45.8047	-108.1449	205	160	211JDRV	JUDITH RIVER FORMATION	IN USE
132221	48.9538	-109.5529	560	530	211JDRV	JUDITH RIVER FORMATION	IN USE
137779	46.4467	-109.9446	64.3		211JDRV	JUDITH RIVER FORMATION	IN USE
137796	46.6712	-109.7904	100	100	211JDRV	JUDITH RIVER FORMATION	IN USE
142657	46.6446	-108.8413	600	500	211JDRV	JUDITH RIVER FORMATION	LOW USE
144353	45.8039	-108.3523	402	302	211JDRV	JUDITH RIVER FORMATION	IN USE
153975	48.49471	-108.01163	165	120	211JDRV	JUDITH RIVER FORMATION	IN USE
157751	46.3213	-107.3872	1080		211JDRV	JUDITH RIVER FORMATION	IN USE
157773	45.91	-108.2388	240	240	211BRPW	JUDITH RIVER FORMATION	UNUSED
157818	47.6214	-108.553			211JDRV	JUDITH RIVER FORMATION	IN USE
171103	45.5592	-109.1378	405	310	211JDRV	JUDITH RIVER FORMATION	IN USE
178197	48.1012	-106.67154	540	460	211JDRV	JUDITH RIVER FORMATION	UNUSED
184127	46.4665	-110.2266	81.4		211CLGT	JUDITH RIVER FORMATION	IN USE
9950	45.8283	-110.56	29	30	211LVGS	LIVINGSTON FORMATION	UNUSED
12953	45.8858	-110.5952	40		211LVGS	LIVINGSTON FORMATION	IN USE
125664	45.9947	-110.6719	100	40	211LVGS	LIVINGSTON FORMATION	DEDICATED
6757	48.8266	-112.211	127		211TMDC	TWO MEDICINE FORMATION	IN USE
81481	48.1988	-112.5058	90	76.5	211TMDC	TWO MEDICINE FORMATION	IN USE
122382	48.9884	-112.1189	60	30	211TMDC	TWO MEDICINE FORMATION	IN USE
135527	47.4948	-112.403	100	80	211TMDC	TWO MEDICINE FORMATION	IN USE
140541	47.9814	-112.4442	80		211TMDC	TWO MEDICINE FORMATION	IN USE
142312	48.6385	-112.3201	250		211TMDC	TWO MEDICINE FORMATION	DEDICATED

N300LCRTS - Lower Cretaceous aquifers

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
167347	45.2077	-111.2414	95	55	221MRSN	BIG SKY AREA	IN USE
185464	45.2356	-111.2595	115	90	217MDDY	BIG SKY AREA	IN USE
2031	47.11642	-109.5081	260	240	217FCCK	COLORADO GROUP	UNUSED
25943	46.9759	-108.6152	200	180	217FCCK	COLORADO GROUP	IN USE

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
136870	46.8113	-109.9595	140	80	217DKOT	COLORADO GROUP	IN USE
188746	47.0698	-109.4649	360		217FCCK	COLORADO GROUP	IN USE
196527	47.4566	-111.3795	100	65	217FLOD	COLORADO GROUP	
200298	47.4053	-111.6281	90	60	217BCKF	COLORADO GROUP	
895628	47.1269	-108.2714	2941	2941	217FCCK	COLORADO GROUP	UNUSED
25911	46.9905	-108.9003	390	294	221SWFT	ELLIS GROUP	IN USE
27093	47.0148	-109.3517	185	105	221ELLS	ELLIS GROUP	IN USE
29604	47.2709	-110.7316	120	84	221SWFT	ELLIS GROUP	IN USE
31992	47.4005	-110.928	75	70	221SWFT	ELLIS GROUP	IN USE
1862	46.9685	-110.0911	238	198	217KOTN	KOOTENAI FORMATION	IN USE
1872	46.9963	-109.5087	705	340	217KOTN	KOOTENAI FORMATION	IN USE
1929	47.0564	-109.9519	1620	1387	217KOTN	KOOTENAI FORMATION	IN USE
1959	47.0817	-109.3281	90	60	217TCCK	KOOTENAI FORMATION	IN USE
2000	47.1695	-110.3369	404	214	217KOTN	KOOTENAI FORMATION	IN USE
2042	47.1772	-108.9674	1431	1285	217SCCK	KOOTENAI FORMATION	IN USE
2283	47.3677	-111.1914	198	130	217KOTN	KOOTENAI FORMATION	DEDICATED
2395	47.51	-111.4303	130	120	217KOTN	KOOTENAI FORMATION	IN USE
2448	47.4539	-111.0199	180	140	217KOTN	KOOTENAI FORMATION	IN USE
23955	46.6939	-108.5878	1635	1535	217LKOT	KOOTENAI FORMATION	IN USE
25200	46.8388	-108.6436	400	340	217KOTN	KOOTENAI FORMATION	IN USE
27321	47.02469	-107.95726	1500		217TCCK	KOOTENAI FORMATION	UNUSED
28142	47.1575	-110.219	817	817	217SCCK	KOOTENAI FORMATION	IN USE
29631	47.2417	-110.5658	250	222	217KOTN	KOOTENAI FORMATION	IN USE
30542	47.2987	-111.045	65	30	217KOTN	KOOTENAI FORMATION	IN USE
31762	47.4348	-111.2867	65	25	217KOTN	KOOTENAI FORMATION	IN USE
59114	46.716	-109.7757	80	52	217KOTN	KOOTENAI FORMATION	IN USE
98399	45.6356	-108.466	1245	1176	217PRYR	KOOTENAI FORMATION	IN USE
252517	47.435383	-111.288008	160	150	217KOTN	KOOTENAI FORMATION	IN USE

N500PLOZOC - Paleozoic aquifers

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
120525	47.00277	-109.34285	37.3	26.8	330MDSN	MADISON FORMATION	
28054	47.1765	-110.9727	180	140	330MDSN	MADISON FORMATION	
181868	47.262	-111.4134	260	229	330MDSN	MADISON FORMATION	
120973	47.4053	-111.6276	1455	1078	330MDSN	MADISON FORMATION	
217818	47.4205	-111.4267	455	435	330MDSN	MADISON FORMATION	
216851	47.53034	-111.23009	470	440	330MDSN	MADISON FORMATION	DEDICATED
33038	47.5086	-111.3148	369	369	330MDSN	MADISON FORMATION	DEDICATED

GWICID	Latitude	Longitude	Total depth (ft)	Depth water enters (ft)	Aquifer code	Area/aquifer	Network status
2247	47.4044	-111.1548	185	185	330MDSN	MADISON FORMATION	IN USE
2315	47.38379	-110.92347	435	242	330MDSN	MADISON FORMATION	DEDICATED
2394	47.5241	-111.4122	605	518	330MDSN	MADISON FORMATION	IN USE
186362	47.0995	-110.8368	178	173	341JFRS	MISC - BEDROCK	
2526	47.53278	-111.23132	40	24		MADISON FORMATION	DEDICATED

Appendix E – Standard Operating Procedures

Standard Operating Procedure For
Water-Level Measurements in Non-Flowing Wells

SOP M -

Prepared by
John I. LaFave

Prepared For
Montana Bureau of Mines and Geology

Document File Location:

Approved by:

Effective Date:

Disclaimer: This Standard Operating Procedure has been prepared for the use by the Montana Bureau of Mines and Geology and may not be applicable to the activities of other organizations.

1.0 Title

Standard Operating Procedure for Water-Level Measurements in Non-Flowing Wells

2.0 Location

Ground-water level measurements are made in the field at the well head.

3.0 Purpose

The purpose of these guidelines is to provide technical guidance and to outline a standard procedure to ensure that accurate water-level measurements are made in the field during ground-water investigations.

4.0 Scope

Water-level data are used to indicate the direction of ground-water flow, determine areas of recharge and discharge, evaluate the effects of manmade and natural stresses on ground-water systems, define the hydraulic characteristics of aquifers, and to evaluate stream-aquifer relationships. Water-level measurements are obtained from wells and piezometers.

Wells selected for water-level measurement should be inventoried in the MBMG GWIC system. The well should be accessible and information regarding construction, use and physical condition of the well should be available.

Graduated steel tape and electrical measuring lines are the most commonly used methods for measuring water levels. Water-level measurements made with a steel tape should be accurate to within ± 0.01 foot, measurements made with an electrical line should be accurate to within ± 0.05 foot. At depths greater than 300, feet the tape or electric line may stretch due to its suspended weight, thus reducing the accuracy of the measurements.

5.0 References

Garber, M. S., and Koopman, F. C., 1968, Methods of Measuring Water Levels in Deep Wells, Techniques of Water-Resource Investigations of the U. S. Geological Survey, Book 8, Chapter A1, 23 p.

U. S. Geological Survey, 1980, National Handbook of Recommended Methods for Water-Data Acquisition - Chapter 2, Ground Water, 149 p.

6.0 Sample Handling and Preservation

NA

7.0 Apparatus and Materials

1. Steel surveyors tape, of appropriate length, graduated in 0.01 foot increments.
2. Carpenters chalk.

- or-

3. Graduated electrical line or tape (sounder), e.g. Solinst, Sinco, or equivalent.
4. Distilled water and spray bottle, paper towel or cloth rag.

8.0 Procedures

A clearly established measuring point, normally the top of the well casing, should be established at any well where water-levels are to be measured. Field notes should clearly describe the measuring point. The distance between the land surface and the measuring point should also be measured and recorded in the field notes with special emphasis on whether the measuring point is above or below land surface. Water levels that are being measured in conjunction with water-quality sampling should be measured before purging the well.

8.1 Steel Tape Measurements

1. Apply chalk to the first few feet of the tape by pulling the tape across a piece of carpenters chalk. A smooth coating of chalk on the tape should result.
2. Lower the tape into the well from the measuring or "hold" point at the top of the well until a short length of the tape is submerged.

Note: It is helpful to have the most recent water-level measurement to determine how far into the well the tape should be lowered.

3. When the tape is submerged, "hold" the tape at the measuring or "hold" point, read the value on the tape, and record the value in the field notes.
4. Retrieve the tape from the well and note the water mark, or "cut" mark, on the chalked part of the tape. Record the "cut" mark in the field notes.

Note: Under dry surface conditions it may be necessary to retrieve the tape as quickly as possible to read the tape before the "cut" mark dries.

Note: When air temperatures are below freezing the "cut" mark may be difficult to read if the chalk coating is not adequately applied.

5. Subtract the "cut" reading from the "hold" reading to determine the distance to water below the measuring point. Record the resulting distance to water value in the field notes.
6. Repeat the measurement by lowering the tape into the well a second time and "holding" at a point on the tape 1 foot greater than the initial "hold" point. Subtract the new "cut" mark and determine a second distance-to-water value for the well. If two measurements made within a few minutes do not agree within 0.01 or 0.02 foot (in wells having a depth-to-water less than 300 feet), repeat the measurements until a reason for the lack of agreement is determined, the results are shown to be reliable, or until it is determined that an accurate measurement is not possible. For depths greater than 300 feet measurements should agree to within ± 0.1 ft.

7. After completing the distance-to-water measurement, the part of the tape that was wetted should be thoroughly rinsed with distilled water and dried.

8.2 Electric Line (Sounder) Measurements

1. Test the probe by dipping it in water and observing the indicator or by activating the "test" switch.
2. Lower the probe slowly into the well until contact with the water surface is indicated.
3. Read the electric line at the measuring point while the probe is just touching the water surface, and record the distance to water.

   If the electric line is "banded" at 5 foot intervals, determine the distance between the nearest line "band" and a mark on the line made while the probe is just touching the water surface. Add or subtract, as appropriate, the distance between the mark and the "band" to determine the distance to water. Record the "band" value, the distance between the "band" and the mark while the probe is touching the water surface value, and the final result in the field notes.

Note: When taking measurements, the electrical tape or line should not be allowed to rub across the top of the casing or any other sharp edges to avoid abrading the line insulation.

4. Repeat the measurement. If two measurements of static water level made within a few minutes do not agree within 0.05 foot (in wells having a depth to water less than 300 feet), repeat the measurements until a reason for the lack of agreement is determined, the results are shown to be reliable, or until it is determined that an accurate measurement is not possible. For depths greater than 300 feet, measurements should agree to within ± 0.1 ft.

Note: Cascading water within a borehole or well may cause false readings or make it impossible to obtain accurate reading of the water level.

Note: Wells recovering from pumping will have steadily lessening distance-to-water values when repeatedly measured. Keep measuring the distance to water until the water-level recovery in the well appears to be complete, or it appears that full water-level recovery will not occur while you are at the well. If a distance-to-water measurement is accepted and recorded under these conditions, the period of time involved in measuring distances-to-water at the well should be recorded also. For example: '**Pump off 25 minutes, well still recovering**.'; might be an appropriate comment.

5. After completing the depth to water measurement, the part of the electric line that was wetted should be thoroughly rinsed with distilled water and dried.

Note: Care should be taken in placing or removing electric lines (tapes) into or from wells. The cables on these instruments tend to wrap around pipe or other objects in the well

bore causing the instrument to "hang-up". Usually, slow placement of the electric line into the well and slow, gentle removal of the line helps alleviate these problems.

9.0 Quality Control

Quality control will be maintained by collecting two consecutive measurements of the depth to water that are within acceptable agreement. If agreement is not achieved, record the lack of agreement. Also, a staff member not involved in obtaining the measurement will review the data and ensure that they are properly recorded. Because electrical lines or tapes are susceptible to permanent stretch, they should be checked against a steel tape at least once a year or after an electrical line or tape has been pulled hard in an attempt to free it from the well.

10.0 Data Analysis

After the distance-to-water measurements have been checked, they may be used to calculate the ground-water altitude by subtracting the distance-to-water measurement from the altitude of the measuring (hold) point. The distance-to-water measurement, date, time and any remarks can then be entered into the GWIC database.

11.0 Documentation

The distance to water and any raw data used to obtain the measurement should be recorded in the field notes. For example, when using a steel tape the "hold" and "cut" readings should be recorded. An accurate description of the measuring point should also be recorded in the field notes.

Standard Operating Procedure for
Pressure Measurements in Flowing Wells

SOP M -

Prepared by
Dennis P. McKenna

Prepared For
Montana Bureau of Mines and Geology

Document File Location:

Approved by:

Effective Date:

Disclaimer: This Standard Operating Procedure has been prepared for the use by the Montana Bureau of Mines and Geology and may not be applicable to the activities of other organizations.

1.0 Title Standard Operating Procedure for Pressure Measurements in Flowing Wells

2.0 Location
Pressure measurements are made in the field at the well head.

3.0 Purpose
The purpose of these guidelines is to provide technical guidance and to outline a standard procedure to ensure that accurate pressure (ground-water head) measurements are made in the field during ground-water investigations.

4.0 Scope
Pressure measurements are converted to water-level measurements. These data are used to indicate the direction of ground-water flow, determine areas of recharge and discharge, evaluate the effects of manmade and natural stresses on ground-water systems, define the hydraulic characteristics of aquifers and to evaluate stream-aquifer relations. Pressure measurements are obtained from flowing wells and piezometers.

Wells selected for pressure measurement should be inventoried in the MBMG GWIC system. The well should be accessible and information regarding construction, use and physical condition of the well should be available.

Pressure gauges are the most commonly used methods for measuring water levels in flowing wells. Measurements made with a pressure gauge should be accurate to within ± 0.01 PSI.

5.0 References

6.0 Sample Handling and Preservation
NA

7.0 Apparatus and Materials
Pressure gauge
Various pipe fittings
Teflon tape
Wire brush

8.0 Procedures

A clearly established measuring point, normally the point at which the gauge is attached, should be established at any well where pressure is measured. Field notes should clearly describe the measuring point used. Pressure measurements made in conjunction with a sampling event should be measured before purging the well.

1. Turn off the valve controlling flow from the well, after noting its position when open. **Do not force the valve.**

2. Carefully wire brush the threads on the pipe extending from the well. Put Teflon tape around the threads. If the pipe is cross-threaded or if there is any uncertainty about the integrity of the well casing and piping on a discharging well, do not attempt to measure pressure.

3. Carefully attach the necessary fittings to reduce to the diameter of the fitting on the pressure gauge. Attach the pressure gauge.

4. Open the valve controlling flow from the well as far as you can by hand. **Do not force.**

5. Read the pressure gauge reading twice several minutes apart. If two measurements of pressure level made within a few minutes do not agree within 0.05 PSI, repeat the measurements until a reason for the lack of agreement is determined or until the results are shown to be reliable or until it is determined that an accurate measurement is not possible.

6. Record both measurements on a field data sheet or in a field logbook.

9.0 Quality Control

Quality control will be maintained by collecting two consecutive measurements of the pressure that are within acceptable agreement. If agreement is not achieved this will be noted on the Field Data Sheet. Also, a staff member not involved in obtaining the measurement will review the data and ensure that they are properly recorded. The pressure gauges shall be checked against a known standard at least once a year or after being dropped or otherwise damaged.

10.0 Data Analysis

After the pressure measurements have been checked they may be used to calculate the ground-water altitude by converting the pressure measurement to head (in feet above land surface) and then adding the head measurement to the altitude of the measuring point. The ground-water head measurement, date, time and any remarks can then be entered into the GWIC database.

11.0 Documentation

The pressure measurement and any raw data used to obtain the head measurement should be recorded on the Field Data Sheet. An accurate description of the measuring point should also be recorded on the Field Data Sheet.

Standard Operating Procedure for
Collection of Ground-Water Samples for Inorganic Analyses

SOP M -

Prepared by
John I. LaFave and Dennis P. McKenna

Prepared For
Montana Bureau of Mines and Geology

Document File Location:

Approved by:

Effective Date:

Disclaimer: This Standard Operating Procedure has been prepared for the use by the Montana Bureau of Mines and Geology and may not be applicable to the activities of other organizations.

1.0 Title Standard Operating Procedure for Collection of Ground-Water Samples for Inorganic Analysis.

2.0 Location
Ground-water samples are collected at, or as close as possible to, the well head. Preference should be given to sampling wells where the sample can be collected before a pressure tank. **Do not collect a sample if sample can not be collected before a water-treatment device such as a water softener or filter.**

3.0 Purpose
This SOP provides general guidelines for the collection of ground-water samples from wells to assure that the water is representative of the particular zone being sampled.

4.0 Scope
The primary consideration is to obtain a sample that is representative of the actual ground-water quality. Standing water in a well is generally not representative of formation water. To safeguard against collecting a non-representative sample all wells will be purged prior to being sampled. The well will be purged until at least one well volume has been purged and water-quality parameters, pH, temperature and specific conductivity have stabilized, and/or at least three well volumes have been removed.

5.0 References

6.0 Apparatus and Materials

- Submersible pump & generator or bailer (if well does not have a pump)
- Tool box
- Conductivity meter and probe
- pH/temperature meter and probes
- Redox potential probe
- Dissolved oxygen probe
- Alkalinity titration equipment and supplies (see "SOP for Conducting Total Alkalinity Titration of Aqueous Solutions")
- Flow-through chamber
- Teflon tape
- Filter holder and filters (0.45 um), or
- Filter cartridges (0.45 um)
- Sample bottles (250-mL and 500-mL)
- Acid preservatives

Note: Before leaving for the field, contact the laboratory to obtain the necessary number and type of sample bottles and the required amount and type of acid preservative(s).

- Blank Water-Quality/field Data Sheets

- Site Inventory Sheets for wells to be sampled (blank if well has not been visited, completed if well has been visited)
- Kim wipes
- Extra sample-bottle labels
- 1-gallon Ziplock bags
- Waterproof pens (Sharpies)
- Ice chests
- Ice
- Water-level indicator
- Appropriate keys (for locked wells)
- Plastic buckets
- Garden hose
- Spray bottles and carboy of deionized (DI) Water
- Decontamination solution - DI water and Alconox

7.0 Procedures
At each well site, the following activities will be conducted.

1) Confirm landowner permission to sample the well.
2) Measure static water level in well and calculate volume of water in well.
3) Set up flow-through chamber and field meters.
4) Pump well until purging parameters stabilize.
5) Collect ground-water samples and QA/QC samples as necessary.
6) Conduct titration to determine total alkalinity of sample.
7) Confirm that all bottles are properly labeled and that the Water-Quality Data sheet is completely and accurately filled out. **Be sure to record the complete mailing address of the well owner so that we can send the results of the water-quality analyses.**

7.1 Equipment Setup
The following are general steps for equipment setup:

1) Rinse the faucet threads and Y-adapter coupling.

2) Attach the Y-adapter to the sampling faucet - if necessary wrap the faucet threads with Teflon tape. **Be sure the flow diverters on the Y-adapter are in the "off" position.**

3) Attach the garden hose to one end of the Y-adapter and place the other end of the garden hose at an appropriate drainage area.

4) Rinse the threaded coupling on the end of the tubing on the flow-through cell and attach the tubing to the faucet Y-adapter.

5) Use the long length of tubing to route the discharge water from the flow-through cell to an appropriate drainage area.

7.1.1 Stabilization of Purging Parameters

Wells must be purged to obtain a sample that is representative of the aquifer. At least one well volume should be pumped from the well and the purging parameters (temperature, pH and specific conductance) should stabilize before collecting the sample. The purging parameters should be recorded at regular intervals on the Field Data Sheet. Space the readings based on the total time needed to purge the well. For example, if it will take 30 minutes to purge one well volume; then record purging parameter values every 10 minutes. If temperature, pH and specific conductance do not exhibit stability after three well volumes have been removed, the well may be sampled. Record the number of well volumes pumped from the well. Temperature is considered stable when three consecutive readings are within 0.5 degrees. For example, 12.2^{o}, 12.5^{o}, 12.3^{o}. The pH is considered stable if three consecutive readings are within 0.1 units. For example, 7.2, 7.1, 7.2. The specific conductance is considered stable if three consecutive readings are within +/- 5 percent. For example, 712, 696, 724. Five percent of 712 is 36.

Note: Operation and maintenance of the pH and specific conductance meters should follow procedures outlined by the manufacturer that are appropriate for the particular make and model of meter being used

Note: For wells that are flowing when you arrive at the site, "purging" the well is not necessary, but temperature, pH and specific conductance must be measured and recorded if the well is to be sampled.

1) Completely open the diverter on the Y-adapter that controls flow to the garden hose. Turn on the faucet (pump). Note the time that pumping was initiated on the Water Quality Data Sheet.

2) Measure the flow rate through the garden hose. Time how long it takes (in seconds) to fill a five gallon bucket. Check the flow rate at least three times during the well purging procedure.

3) **CAREFULLY** open the diverter on the Y-adapter that controls flow through the tubing to the flow-through cell. Only a gentle flow is needed to keep water circulating through the flow cell. **DO NOT OVER-PRESSURIZE THE FLOW-THROUGH CELL BECAUSE DAMAGE TO THE CELL AND PROBES COULD RESULT.**

4) Turn on pH, temperature, and conductivity meters. Monitor these parameters until they have stabilized and at least one well volume has been purged. Record the readings to document stabilization.

7.1.2 Calculation of Well Volume

To calculate the well volume:

1. Determine the total depth of the well from the well listing, well log or by sounding the well.
2. Determine the radius (r) of the well in feet. For example, if the well has an inside diameter (D) of 6 inches, the radius ® =D/2) would be 3 inches or 0.25 ft (3/12).
3. Measure the static water level.
4. Calculate the linear feet of standing water (h) in the well (total depth minus the static water level).
5. Calculate the total volume in gallons of water in the well.

$V = \Pi r^2 h * 7.48$
$\Pi = 3.14$
r = radius of the well in feet.
h = height of standing water column in the well
7.48 = conversion from ft^3 to gallons

OR refer to the attached table.

To calculate how long it will take to purge a well volume divide the flow rate (gallons per minute) into the total number of gallons that need to be purged. For example, if the height of water (h) in a 6-inch diameter well is 34 feet, then the volume of water in the well would equal $V = 3.14(0.25)^2(34)*7.48 = 50$ gallons. If the well is pumped at 10 gpm, then it will take 5 minutes (50/10) to purge one well volume, and 15 minutes to pump three well volumes.
The well-volume calculation should be recorded on the Field Data Sheet.

7.2 Sample Collection

The samples for laboratory analysis may be collected after the purging parameters have stabilized and at least one well volume has been removed or after three well volumes have been removed from the well if purging parameters fail to stabilize.

In general, at each sample location a total of four sample bottles will be filled:

1) a 250-mL sample that has been filtered but not preserved (for inorganic anions and fluoride),

2) a 500-mL sample that has been filtered and preserved with nitric acid (for dissolved metals and trace metals),

3) a 250-mL filtered sample that has been preserved with sulfuric acid (for nitrate-nitrite), and

4) a 500-mL unfiltered, unpreserved sample (for laboratory alkalinity and specific conductance).

Note: If other parameters are on the target analyte list, be sure to verify the filtering, preservative and volume requirements prior to sampling.

The sampling apparatus includes a flow-through cell to facilitate the accurate measurement of the purging parameters, and two separate sampling lines---one with an in-line filter and one without. Each line is controlled to allow the sample flow to be easily routed between lines.

6) Using a waterproof pen, record on the sample-bottle label with the well M:number, the sample date, the preservative and the filtration status (i.e. filtered or unfiltered). The sampler should also record the project ID (e.g. GWCP02), number the bottle (e.g. 1 of 4, 2 of 4, etc.), and initial the bottle label. On the sample bottle (not the label) write sample number and the filtration and preservation status. For example, **RU** for unfiltered, unpreserved samples, **FU** for filtered unpreserved samples, and **FA** for filtered, acidified samples. This redundancy in identifying the sample (on the label and the bottle) will help prevent confusion in the event that the sample labels are detached from the bottles.

To Collect Samples

1) Place a new 0.45-um filter cartridge on the sample line.

2) For filtered samples, open filtered sampling line, allow sample to flush through the line for 3 to 5 minutes. For unfiltered samples open the unfiltered line and flush with sample for 3 to 5 minutes.

3) Rinse sample bottle and cap 3 times with sample water. Polyethylene or glass sample bottles with screw-on caps should be used. While collecting samples, place the bottle cap open-side down on a clean surface.

4) Collect the sample.

Note: For the samples that require preservative (metals, trace metals, nitrate-nitrite), do not completely fill the sample bottle, leave a small amount of head space to accommodate the acid preservative. For the samples that do not require preservative (fluoride, inorganic ions, lab alkalinity and specific conductance), completely fill the bottle to prevent the loss of carbon dioxide.

5) Add preservative, if required, tightly replace the cap, and gently shake the bottle to disperse the preservative. Premeasured ampules of acid should be provided from the laboratory (nitric acid preservative for the metals samples and sulfuric acid preservative

for nitrate-nitrite samples). With either preservative the resulting pH of the sample should be < 2.

6) After filling the required number of sample bottles and completing the labels, all the bottles should be placed in a Ziplock-type bag. The bag should be sealed and labeled with the sample number, date and the total number of bottles.
7) Samples should be stored in a cooler on ice until delivered to the laboratory.

8.0 Sample Handling and Preservation

Following sample collection it is necessary to take precautions to ensure that the chemistry of the sample is not altered between the time of sampling and analysis. Samples are filtered to remove any particulate or colloidal material which could adsorb metals in solution. Some samples are preserved with acid (nitric and sulfuric) to keep metals in solution and prevent precipitation. To inhibit bacterial growth the samples should be transferred to coolers packed with ice immediately after sampling to keep the sample temperature as close to 4° C as possible and to keep the sample out of the sunlight. Storing the samples in a cooler also helps protect the sample bottles from damage during transport.

9.0 Quality Control

Quality control should be maintained by thoroughly documenting the sampling effort and routinely analyzing duplicate samples and, if the sampling plan warrants, equipment and field blanks.
Thorough documentation provides a means of accountability to assure that sampling effort meets the program design.

Duplicate samples are used to assess the reproducibilty of analytical results. One duplicate sample should be collected for every 20 well-water samples (5 percent).

Equipment and field blanks are used to determine whether sample bottles, handling procedures or site conditions have had an effect on the sample chemistry.

9.1 Collection of Quality Assurance/Quality Control Samples

A complete set of sample bottles (4 bottles) will be collected for each type of quality assurance/quality control sample: duplicates, equipment blanks and field blanks.

9.1.1 Collection of Duplicate Samples

Duplicate samples should be collected simultaneously with well-water samples. One set of sample bottles should be labeled “duplicate” with the sample/well number. If blind duplicates are required, appropriate labeling and sample tracking procedures should be developed in a project specific sampling plan.

9.1.2 Collection of Field Blanks

Bottles used for field blanks will be labeled as "Field blank" and assigned to a project specific Ground-Water Information Center (GWIC) identifier (contact the GWIC administrator for

project identifier assignments). Bottles designated as field blanks will be filled in the field from a bottle of deionized water supplied by the MBMG lab. Field blanks will be collected at the same location where well-water samples are collected and at the same time as the well-water samples. (The idea is to fill the field blank bottles under the same conditions as the well-water samples.)

Pour the DI water directly from its container into the sample bottle. Leave headspace as required for preservatives.

9.1.3 Collection of Equipment Blanks

Bottles used for equipment blanks will be labeled as "Equipment blank" and assigned to a project specific GWIC identifier (contact the GWIC administrator for project identifier assignments). Bottles designated as equipment blanks will be filled in the field with deionized (DI) water that has been pumped through the sampling and filtering apparatus. Equipment blanks will be collected at the same location and immediately before the well-water samples are collected. Samples are obtained by pumping, either with a peristaltic or hand pump, DI water through both filtered and unfiltered sampling lines. Several liters should be pumped through the lines prior to collecting the samples.

10.0 Data Analysis

The results of the equipment blanks, field blanks and duplicates should be reviewed by the program manager. Any detections should be brought to the attention of the Program QA Officer and steps taken to identify and rectify the problem.

The analytical results from the samples should be checked using methods such as:

- comparing the sum of cations with the sum of anions (relative percent difference),
- comparing determined and calculated values for dissolved solids,
- comparing specific conductance with the sum of cations or anions,
- comparing specific conductance with determined and calculated values for dissolved solids,
- comparing specific conductance and values for selected major constituents with expected results from regression curves.

Data from samples that exceed the established acceptance criteria should be flagged and/or the sample reanalyzed.

11.0 Documentation

In general, the information documented on the Water-Quality Data Sheet and field data sheet (or field log book) should include what type of sample was collected, who collected sample, when the sample was collected, the location of the sampling point, why or for what program the sample was collected, condition of the sample, stabilization criteria and the purging method. In addition, the total number of bottles, the filter and preservation status, and the desired analyses should be documented. It is impossible to over document your work; if you are not sure if a bit of information is necessary, record it.

Laboratory personnel must sign and date the Water Quality Data Sheet upon receiving the samples at the laboratory.

Standard Operating Procedure for
Measurement of Specific Conductance in Ground-Water Samples.

SOP M -

Prepared by
John I. LaFave

Prepared For
Montana Bureau of Mines and Geology

Document File Location:

Approved by:

Effective Date:

Disclaimer: This Standard Operating Procedure has been prepared for the use by the Montana Bureau of Mines and Geology and may not be applicable to the activities of other organizations.

1.0 Title Standard Operating Procedure For Measurement Of Specific Conductance Of Ground-Water Samples.

2.0 Location
The measurement of specific conductance of ground-water samples should be performed in the field as the well is purged. If unable to measure in the field, filtered samples may be collected and stored at 4°C for laboratory measurement.

3.0 Purpose
The specific conductance of a water sample provides an indication of the total dissolved ions content by measuring its ability to carry an electrical current under specific conditions. The purpose of this form is to outline a standard procedure to ensure that representative and accurate measurements of specific conductance are obtained during the course of ground-water resource investigations.

4.0 Scope
The ability of a solution to conduct an electrical current is a function of the concentration and the charge of the ions in solution and the rate at which the ions can move under the influence of an electrical potential. The temperature of the solution will affect the specific conductivity. Specific conductance is measured using a portable, battery-operated specific conductivity meter that compensates for temperature and reads directly in micromhos/cm or millimhos/cm at 25°C.

Note: The units of specific conductance (micromhos/cm) may also be expressed as microsiemens (µS).

The range of measurement is dependent upon the limitations of the instrument. For the VWR Model 2052 Digital Conductivity Meter, the measurement range is from 0 to 200,000 micromhos. The effects of temperature on the specific conductivity are compensated over a range of 5 to 45° C. The measurement resolution and instrument accuracy are presented below

RANGE	FULL SCALE (µmhos)	RESOLUTION(µmhos)	ACCURACY(% Full Scale)
A	2.000	0.001	0.20%
B	20.00	0.01	0.15%
C	200.0	0.1	0.10%
D	2,000	1	0.10%
E	20,000	10	0.15%
F	200,000	100	0.30%

Note: The VWR Model 2052 Digital Conductivity Meter will display readings in micromhos (µmhos) for Ranges A through C, and millimhos (mmhos) for Ranges D through F.

5.0 References

Hem, John D., 1985, Study and Interpretation of Chemical Characteristics of Natural Water Third Edition, U. S. Geological Survey, Water Supply Paper 2254, 263 p.

Standard Methods for The Examination of Water and Wastewater, 18th Edition, 1992, American Public Health Association, Washington D.C., ___ p.

VWR Scientific, Instruction Manual Digital Conductivity Meter Model 2052, VWR Cat. No. 2318-013, 9 p.

Wood, Warren W., 1976, Guidelines For Collection And Field Analysis Of Ground-Water Samples For Selected Unstable Constituents, TWRI, U. S. Geological Survey, Chapter D2, Book 1, 24 p.

6.0 Sample Handling and Preservation

Specific conductance should be measured in the field at the time of ground-water sampling. If the specific conductance measurement can not be completed within 24 hours of sample collection, the sample should be filtered and stored at 4°C until it can be analyzed.

7.0 Apparatus and Materials

1. VWR Model 2052 Digital Conductivity Meter or equivalent direct-reading meter.
2. Specific conductivity cell (Dip Cell - 515, or Flow Cell - 517).
3. 718-Micromho standard solution in three 250 ml bottles.
4. Deionized (DI) water in a spray bottle.
5. Thermometer, 0-50 ^{o}C graduated in 0.1^{o}C.
6. Flow-through chamber or 250-ml sample bottle or beaker.

8.0 Procedures

8.1 Calibration

The meter and each cell to be used should be calibrated before extended or regular use. Calibrate according to the instructions provided by the manufacturer. For the VWR Model 2052 Meter use the following procedure:

1. Connect the conductivity cell to the meter.
2. Turn the Function switch to ATC "On" and set the Range switch to "D" (see figure 1).
3. Prepare 3 samples of the 718-Micromho standard solution at 25°C.
4. Dip the cell into the first solution for 20 seconds.

Note: Dip cell must be immersed a minimum of 2.0 inches and flow cell must be immersed a minimum of 4.0 inches for proper measurement.

5. Withdraw the cell and shake off excess solution - do not touch or wipe.
6. Dip the cell into second solution for 20 seconds, then remove cell and shake off excess solution.
7. Place the cell in the third solution for measurement.

Note: the reading will be most accurate if the measurement is made as soon as the cell is dipped into the third solution.

8. Adjust Master Calibration Control to display 0.718.

Note: If unable to get meter to read 0.718 then check the cell for foreign material. If the cell is dirty clean with cotton swab and alcohol. Thoroughly rinse cells after each use with DI water.

9. Change Function Switch to the "Self Check" position and the Range switch to "B" to read the Cell Constant (should be between 9 and 11).

10 During extended use in the field check meter daily against a standard solution. If unable to get the meter to read within ± 5 percent of standard solution then recalibrate the meter and cell. If unable to recalibrate, adjust the Calibration Control knob until the display corresponds to the standard solution concentration. Note the adjustment on the instrument log and on the field sheets where any data obtained from the meter is recorded. Recalibrate the meter and cell as soon as possible.

8.2 Measurement of Ground Water

Use the flow cell (517) to measure specific conductance in flow-through chamber, use dip cell (515) to measure specific conductance from sample bottles or vesicles.

Note: The flow cell (517) may be used as a dip cell as long as it is immersed a minimum of 4 inches.

8.2 Measurement in a Flow-Through Chamber

To measure an unknown solution with a flow-through chamber use the following procedure:

1. Connect the flow cell (517) to the meter
2. Insert flow cell into the designated port of the flow-through chamber.

3. Turn Function Switch to ATC "On", set Range switch to "D" (0 - 2,000 µmhos) initially. Adjust the Range setting as necessary to obtain a representative measurement. Be sure to record the Range setting on the Site Inventory or Field Data Sheet.
4. As the well is being purged, record conductivity readings at 5 minute intervals, usually conductivity measurements are made in conjunction with pH and temperature readings (see SOP No. ___, Ground-Water Sampling). Record what is displayed on the meter - do not attempt to make conversions from millimhos to micromhos, or vice-versa, in the field.

Note: The specific conductance is considered stable if three consecutive readings taken 5 minutes apart are within ± 5 percent.

5. Remove cell from flow-through chamber, rinse with DI water and shake off excess solution.

8.2.2 Measurement without a Flow-Through Chamber

To measure an unknown solution without the use of a flow-through chamber use the following procedure:

1. Connect the dip cell to the meter.
2. Turn Function Switch to ATC "On".
3. Rinse dip cell in sample solution.
4. Set Range switch to "D" (0 - 2,000 µmhos) initially.
5. Fill a 250-ml bottle or beaker with a water sample as soon as possible after removing from the well.
6. Insert the dip cell into the sample and record the measurement.
7. As the well is being purged, record conductivity readings on the Field Data Sheet at 5 minute intervals in conjunction with pH and temperature readings, or if the well is being bailed take readings after each well volume until readings stabilize (see SOP No. ___, Ground-Water Sampling).
8. When sampling is complete, rinse dip cell with DI water and shake off excess solution.

Note: Cells must be kept clean. Foreign residue on the plates or chipping of the plate surface may decrease the cells' linearity range.

9.0 Quality Control

Field measurements recorded on the Site Inventory or Field Data Sheets will be reviewed by a staff member not involved in the sample collection to ensure that the appropriate procedure was followed. Conductivity cells will be rinsed with DI water after each use and cleaned with cotton swabs and alcohol after extended periods of use.

10.0 Data Analysis

Standard units for reporting specific conductance are micromhos per centimeter at t ^{o}C however; the precaution of including the length in the unit is usually not essential and in practice may be omitted. The VWR Model 2052 has Automatic Temperature Compensation (ATC) to account for changes in ionic movement with changes in temperature. Readings will automatically be compensated, with a reference temperature of 25°C, for solutions between 5 and 45 ^{o}C.

11.0 Documentation

The measurement of specific conductance should be recorded with the other field parameters on the Field Data Sheet.

Standard Operating Procedure for
Total Alkalinity Titrations in Aqueous Solutions

SOP M-

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Prepared For
Montana Bureau of Mines and Geology

Document File Location:

Approved by:

Effective Date:

Disclaimer: This Standard Operating Procedure has been prepared for the use by the Montana Bureau of Mines and Geology and may not be applicable to the activities of other organizations.

1.0 Title: Standard Operating Procedure for Total Alkalinity Titrations in Aqueous Solutions.

2.0 Location Alkalinity titrations are generally performed in conjunction with ground-water sampling in the field.

3.0 Purpose The purpose of this procedure is to describe steps necessary to measure alkalinity concentrations of aqueous solutions.

4.0 Scope

Alkalinity concentrations of aqueous solutions are a function of solution pH. For chemical equilibrium calculations related to carbonate minerals, it is essential to have an accurate value for pH, carbonate and bicarbonate concentrations. Carbonate and bicarbonate determinations fo ground water must be made in the field at the time of sampling if the concentrations are to accurately represent those present in the water. These parameters are subject to change due to degassing of carbon dioxide, especially if the sample is stored in plastic bottles that are permeable to carbon dioxide. In general, the carbonate (CO_3^{-2}) and bicarbonate (HCO_3^{-}) concentrations are determined by titration of the water sample with a standard solution of strong acid. The governing reactions are:

1) $CO_3^{-2} + H^+ \rightarrow HCO_3^-$ (This reaction is complete near pH 8.3)

and

2) $HCO_3^- + H^+ \rightarrow H_2O + CO_2$ (This reaction is complete near pH 4.5)

Total alkalinity will be measured by titration using a HACH Digital Titrator and a pH meter to a pH 4.5 end point.

5.0 References

HACH Company, 1992, HACH Digital Titrator Model 16900-01 Manual, pp 34-40.

EPA Method 150.1, 1979, Methods For Chemical Analysis of Water and Waste.

Standard Methods for the Examination of Water and Wastewater, 18th edition, 1992. American Public Health Association, American Water- Works Association, and Water Environment Federation.

6.0 Sample Handling and Preservation

The alkalinity will be determined as soon after sample collection as possible, preferably in the field at the time of sampling- weather permitting. A field alkalinity analysis will be performed on an unfiltered, unpreserved sample. A 500 ml unfiltered, unpreserved sample will also be collected for laboratory analysis of alkalinity and specific conductance at each sampling location.

Careful attention should be paid to correctly sealing the sample vial in order to prevent any air bubbles in the sample. This will help prevent any dissolved CO_2 from escaping out of solution. The sample will then be transferred to a holding cooler packed with ice in order to limit bacterial growth in transit back to the MBMG laboratory.

7.0 Apparatus and Materials

The following list describes the apparatus and materials needed to measure the total alkalinity of aqueous solutions in the field:

- ♦HACH Digital Titrator Manual
- ♦HACH Digital Titrator Model
- ♦Titration cartridges (1.600 N H_2SO_4)
- ♦Titration delivery tubes
- ♦Wipe cloth
- ♦Deionized water (DI) and spray bottle
- ♦Several 250 ml polyethylene graduated beakers
- ♦100 ml graduated cylinder
- ♦pH meter
- ♦Portable Cole-Palmer magnetic stirrer and magnetic stir bars (with extra batteries)

7.1 Titrator Maintenance

The digital titrator shall be stored in its appropriate case at all times when not in use. The titrator should be periodically wiped clean with a towel that is moistened with DI water.

8.0 Procedure

Measuring the total alkalinity of an aqueous solution is a straight forward procedure. 100 ml sample is titrated to a pH 4.5 endpoint using a calibrated pH meter; the amount and concentration of sulfuric acid titrated is recorded. If the initial pH of the sample is above 8.3, the sample is titrated to pH = 8.3, then the sample is titrated to pH = 4.5. Depending on the alkalinity concentration the sample for titration may or may not be diluted.

Procedures:

1.) While waiting for well purge to complete, set up magnetic stir plate and insert vial of 1.6N sulfuric acid into digital titrator. Insert the hook dispenser and gently press the movable rod against the bottom of the vial until acid has filled the hook completely without overflowing. Check for air bubbles and eliminate if present. You can use the counter knob to advance the acid to the end of the hook. Once this is done, be sure to clear out the counter numbers before starting titration. Make sure to recheck the end of the hook prior to beginning the titration process, as the acid will sometimes migrate up the hook while unused. Rinse a 250 ml graduated beaker and 100 ml graduated cylinder with about 50 ml of sample. Repeat two times.

2.) Collect appropriate sample volume (25 to 100 ml) for titration based on expected alkalinity concentration (pH and conductivity values are a clue); if unsure start with 50 ml of sample. Use graduated cylinder to measure the sample volume, dilute with de-ionized water so the that the total volume to be titrated is equal to 100 ml. Pour sample into the beaker with magnetic stir bar. Place beaker on portable magnetic stirrer, turn it on and insert pH probe. Record the initial pH.

3.) Turn delivery knob to eject a few drops of titrant, reset the counter to zero, and wipe the tip. Begin to add acid slowly, watching the pH decrease on the pH meter display.

4.) If initial pH is above 8.3, titrate to pH 8.3 endpoint and record the number of digits, then continue the titration to a pH 4.5 endpoint. Otherwise add enough acid to drop the pH of the sample to 4.5. As alkalinity is consumed by the acid the buffering effect will result in a slow rate of pH change, however once the buffering is complete the rate of change will be much faster. When the pH is near 5.5 add drops very slowly to avoid over shooting the end point. Record the number of digits that it took to reach 4.5.

5.) Calculate:

Digits required X Digit Multiplier X Dilution factor = mg/L Total alkalinity as $CaCO_3$.

The digit multiplier for 1.6N sulfuric acid is 1.
The dilution factor is the ratio of raw sample to the total volume titrated. For example if 50ml of raw sample was diluted with 50ml of DI water for a total volume titrated of 100 ml, the dilution factor would be 2 (total sample/raw sample).

9.0 Quality Control

Field measurements are to be recorded on Site Inventory or Field Data Sheets. All field chemistry equipment should be rinsed repeatedly with DI after each alkalinity titration. Field duplicates should be done once each sampling trip.