MBMG 545

Hydrogeologic Characterization of Acid Mine Drainage (AMD) along Belt Creek near Belt, Montana

Final Technical Report

by Jon Reiten, Shawn Reddish, and Justin Brown

2006

Montana Bureau of Mines and Geology

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES (in back of report)

EXECUTIVE SUMMARY

Decades of underground coal mining have resulted in acid mine drainage (AMD) that has contaminated ground-water and surface-water resources in Belt, Montana. The AMD has lowered the pH of Belt Creek and increased trace-metals concentrations in the stream. The overall goal of work in the Belt area was to define the hydrogeologic regime in the vicinity of Belt so that recharge to old mine workings, the source of acid mine drainage, could then be delineated with a reasonable level of certainty. This project was funded by the Montana Department of Environmental Quality (MDEQ) 319 Program with supplemental funding from the MDEQ Remediation Division-Abandoned Mine Lands, Montana Water Resource Center, and the Montana Bureau of Mines and Geology (MBMG). Work is continuing under additional task orders through MDEQ Remediation Division-Abandoned Mine Lands.

This project consisted of a phased approach to define and mitigate water quality problems in Belt Creek near the town of Belt, which is 23 miles southeast of Great Falls. Phase 1 is a hydrogeologic investigation to determine contaminant sources and their relative contributions, and to identify and evaluate mitigation measures. Phase 2 will be based on a later proposal to apply specific measures to reduce recharge to the Anaconda Mine and monitor their success.

Shawn Reddish, under the supervision of Jon Reiten, conducted work documenting the hydrogeologic conditions surrounding the abandoned Anaconda Copper Mining Company Mine (Anaconda Mine) near Belt. Specific tasks included inventorying, sampling for water quality and collecting samples for age-dating water from wells, springs, adits and seeps. These tasks were conducted to determine if the recharge to the mine workings was local or regional. The inventory process included collecting Geographic Positioning System (GPS) coordinates of pertinent locations, measuring specific conductivity (SC), pH, oxidation-reduction potential (ORP), dissolved oxygen (DO); and determining the geologic source of water in wells, springs, adits and seeps. These field data were then evaluated to screen for the most useful sampling sites; all information was entered into MBMG Ground Water Information Center (GWIC) a database accessible by the public.

Water levels at 28 wells and discharges at 2 springs were monitored. Some of these wells were measured monthly for about 2 years to monitor the fluctuations of local aquifers. Several of these wells and springs have been sampled for tritium, helium-3/tritium and

chlorofluorocarbons (CFC) to determine the average residence time of the water. All sampled wells have tritium concentrations greater than background pre-nuclear testing levels. This suggests a modern (post-nuclear testing) age for ground water in the alluvial, Kootenai, Morrison, Swift, and Madison aquifers. CFC samples also indicated that all of the recharge is relatively recent. Several samples from the Madison aquifer were supersaturated with CFCs, but the cause of this supersaturation is unknown. The results of helium-3/tritium dating of two water samples also supports the relatively young age of water in aquifers near Belt.

Stream flows at nine sites were also measured monthly in the study area. Differences in flows between measuring sites were used to evaluate gaining or losing reaches of the streams. Field parameters, including SC, pH, ORP, and DO were measured at each site. The AMD discharge, including flow and field parameters, was monitored at five sites on a monthly basis for approximately 2 years. In addition to monthly measurements, an H-flume installed by another project in the area was set up with a pressure transducer to record the AMD discharge from the mine adit. Based on this work and other ongoing MBMG research, the direct loading to Belt Creek from AMD was estimated to be about 100,000 pounds of iron per year and 65,000 pounds of aluminum per year. Indirect loading to Belt Creek from other AMD sources moving through alluvial sediments was estimated to be 40,000 pounds of iron per year and 28,000 pounds of aluminum per year. The main source of AMD is the discharge from the Anaconda Mine, which averages about 132 gallons per minute (gpm) or about 213 acre feet per year. The primary purpose of this work has been to identify the source of water recharging the mine workings and recommend possible methods to reduce the recharge which would result in a decrease or possible elimination of AMD loading to Belt Creek.

Several possible sources of recharge were suggested when this project started; others developed as new information became available. Possible sources include: 1) recharge from regional aquifers such as the Madison aquifer, 2) upward seepage from deep aquifers along fault planes, 3) localized recharge from precipitation directly overlying the mines or up-gradient recharge areas, 4) water loss from Box Elder Creek, and 5) focused recharge through shallow depressions overlying the mines. Water-level data from wells completed in the Madison aquifer, below the mine workings and in areas surrounding the mine, indicate the static water-level in the Madison aquifer to be about 400 feet below the mine voids. Therefore, the Madison aquifer is not hydrologically connected to the workings, nor is it a likely source of recharge to the mines. Other regional aquifers do not appear to be likely sources either, although these have not been completely ruled out. Upward seepage along fault planes does not appear to be a likely source of recharge; based on the downward hydraulic gradients. Box Elder Creek is at a higher elevation than the mine workings and therefore has a potential for losses to the mine. Flow data along Box Elder are currently inconclusive to document stream losses. The most likely source of recharge to the mines is infiltration of precipitation on the land surface overlying the mine workings, including up-gradient areas that recharge the localized Kootenai aquifer system.

A significant source of water to the Anaconda Mine (ACM) appears to be from the overlying Kootenai Formation; which is about 260 feet thick in the Belt area. A potentiometric-surface map of the Kootenai aquifer was constructed based on well inventory and monitoring measurements. This map was contoured using measurements from 48 wells and springs near the mine. The Kootenai potentiometric-surface map combines head data from aquifers in both the Sunburst and Cutbank Members of the Kootenai Formation. As a result, the map shows only general water-level conditions in the mapped area. Additional wells at critical locations will be needed to accurately depict ground-water flow. Ground water is interpreted to flow from a divide located about 3.5 miles south of the Anaconda Mine. The ground-water divide, south of the mine, appears to be both topographically and structurally controlled. The topographically high area forming the ground-water divide is located just north of a paired, anticline-syncline structure that trends north 45 degrees east. Only precipitation falling north of this divide has the potential to move towards the mine. Once recharge infiltrates vertically to the saturated zone, ground-water flow is generally to the north, perpendicular to the potentiometric contours illustrated in the predominant recharge area to the mine. The upland area between Belt Creek and Box Elder Creek is highly dissected by tributaries of the two streams. These tributaries, plus the main stems of the two streams, are discharge areas for ground water moving out of the Kootenai Formation. The potential recharge area covers about 2,100 acres overlying and up-gradient of the mine. The highly dissected nature of the upland appears to cause much of the precipitation to 1) recharge a shallow ground-water flow system, and 2) cause discharge to the surface-water drainages as seeps and springs in the valley walls. Several of the springs coincide with the contact of the Sunburst Sandstone Member (aquifer) and the underlying unnamed fine-grained unit (aquitard).

Based on the data collected, it appears that recharge to the Anaconda Mine is locally derived. The recharge appears to be relatively constant, as recorded in the discharges from the mine. Fluctuations in precipitation cause significant changes in discharge from the overlying Sunburst aquifer springs. However, the mine discharges remain stable. Apparently the head increase, caused by precipitation-derived recharge, is rapidly dissipated through leakage at contact springs. As a result of this localized flow system, the volume of AMD discharging from the mine could be reduced or possibly eliminated by changing land- use in the recharge area. Other possible remediation options would be diverting flow from overlying aquifers to prevent filling the mine voids or flooding the mine voids to reduce pyrite oxidation. Growing alfalfa or other water consumptive crops would have the potential to significantly reduce infiltration and possibly decrease the AMD discharges.

INTRODUCTION

In the vicinity of Belt, the water quality of Belt Creek is currently degraded by acid mine drainage (AMD) from the abandoned Anaconda Mine, as well as, smaller acidic discharges from other abandoned coal mines along Belt Creek. The overall goal of all AMD work in the Belt area is to restore the water quality of Belt Creek by reducing or eliminating all sources of AMD pollution. This will improve stream habitat, restore native fish populations and improve ground-water quality of the alluvial aquifer. This project was designed to define hydrogeologic conditions in the vicinity of Belt so that recharge to old mine workings, the primary source of AMD, could be delineated with a reasonable level of certainty. Several possible sources of recharge were suggested when this project started and others developed as new information became available. The possible sources include: 1) recharge from regional aquifers such as the Madison aquifer, 2) upward seepage from deep aquifers along fault planes, 3) localized recharge from precipitation directly overlying the mines, or up-gradient recharge areas, 4) water loss from Box Elder Creek, and 5) focused recharge through shallow depressions overlying the mines. Hydrogeologic data and water-quality information were used to document the source of recharge and to estimate potential changes in recharge rates, ground-water flow rates, and acid mine drainage discharges under various scenarios including combinations of cropping, dewatering or other techniques that might have been found to be appropriate. Water samples from a variety of sources potentially associated with AMD was age-dated by testing for tritium, helium3/tritium and chlorofluorocarbons. With this combined hydrogeologic knowledge, best-management practices can be developed to reduce future generation of acidic discharges into Belt Creek.

Background

The town of Belt is located on the north flank of the Little Belt Mountains in central Montana (Figure 1). Decades of underground coal mining have resulted in acid mine drainage (AMD) that has contaminated ground-water and surface-water resources in Belt, Montana. The Anaconda Mine is the largest mine in the area and was developed in 1895 (Fischer, 1907). Coal was extracted from a 6-foot thick seam located in a stratigraphic position near the top of the Morrison Formation (Fischer, 1909). Although mining ended about 80 years ago, water with a pH of 2.94 is still flowing out of abandoned mine workings adjacent to, and near, the town of Belt. Acid mine drainage continues to add metals and lower the pH of Belt Creek. Belt Creek discharges acidic, metal-laden, water into the Missouri River. Belt Creek also can not support fish below the town of Belt. Previous mitigation efforts involved a development of a series of wetlands to remediate the AMD. These wetlands, however, were unsuccessful in reducing acidic discharges. Acid water recharging the alluvial aquifer along Belt Creek has rendered that aquifer unusable in some areas (Koerth, oral communication, 2002).

In 1978, the city of Belt drilled two public water wells. These wells were drilled through the alluvium aquifer and completed in the Madison Formation. The town of Belt is concerned that acid ground water, in the shallow alluvium along Belt Creek, might corrode the casings of the town's water wells. If corrosion to the city's well casings were to occur (including the direct damage to the city's infrastructure,) metal-laden, acidic water from the alluvium aquifer could drain down to the Madison Formation and consequently degrade that watersource.

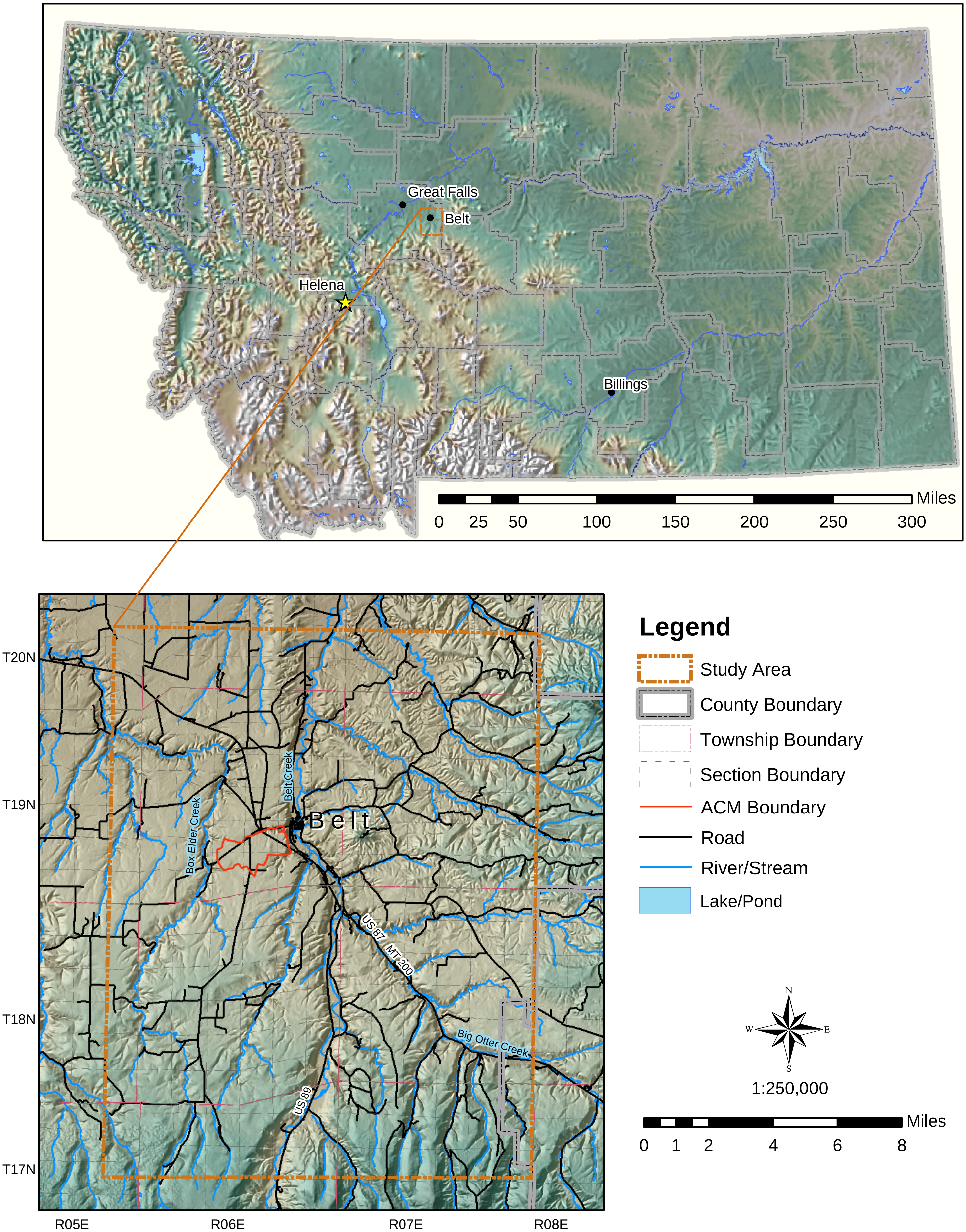


Figure 1. The town of Belt is located on the north flank of the Little Belt Mountains in central Montana.

Belt's #2 well (GWIC ID 2315) is located near Belt Creek on "Coke Oven Flats", where coal waste was stored during mining operations. This public well is located adjacent to reclaimed mine spoils and is only about 140 feet south east from monitor well #1(MW1-GWIC ID 214917). A water-quality sample extracted from this monitor well indicated very corrosive water containing high concentrations of trace metals.

In the late 1980's, the MDEQ began the reclamation of a large burning pile of coal waste located on "Coke Oven Flats" and closed several open mine portals. In 1994, the water main between the pump house and water tanks corroded and leaked. These leaks were caused by reactions of acidic ground-water and acidic soils with the metal pipe (Figure 2). The leaks were repaired when the metal water mains were replaced with plastic PVC pipe (DEQ, 2000).

Figure 2. Corroded municipal water line from the town of Belt.

Water-quality problems at Belt are caused by geochemical processes enhanced by the method of mine abandonment. Oxygen-rich meteoric waters recharging the ground-water system overlying the coal mines eventually infiltrates into mine workings that contain pyrite-rich waste coal and are often overlain by pyrite-rich sandstone immediately above the coal, thereby producing acid mine drainage (Wheaton and Brown, 1999). These acidic discharges flow into Belt Creek at an average rate of 132 gpm. These inflows, in addition to data for stream flow at Belt Creek, were collected as part of this project to help identify loading to Belt Creek. The AMD problem is continuous. Other studies show a direct relationship of AMD production with precipitation and infiltration (Wheaton and Brown, 1999; Osborne and others, 1987). Of particular concern is the increase in ground-water recharge brought about by the crop/fallow cropping system that overlies much of the recharge area to the mine.

Previous Investigations

In the 1980's, as part of a larger project covering the entire Great Falls coal field, the Montana Department of State Lands (currently MDEQ Remediation Division-Abandoned Mine Lands) identified a number of environmental problems associated with the historic coal mines and their ancillary facilities in the Belt area. As part of MDEQ's activities, the mine adit for the No.2 Anaconda Mine was closed. A pipe was installed to carry the acidic water, discharging from the mine, downhill where it combined with acidic water from another discharge. This combined AMD water forms a channel that flows adjacent to reclaimed mine spoils before discharging into Belt Creek.

MDEQ, along with the U.S. Bureau of Mines (USBM), installed a series of wetlands for passive treatment of acid-mine water originating from the French Coulee Mine, located in the next coulee south of the Anaconda Mine. This water is also very acidic. However, the flow is considerably less than that from the Anaconda Mine. A portion of this water was diverted into the wetlands for treatment and then discharged to Belt Creek. However, due to the high iron concentrations and harsh winter weather in the area, the wetlands were not able to achieve an acceptable level of treatment and were abandoned. Water from this location flows under the existing railroad beds, down a steep hill, and then discharges into the same channel that receives the Anaconda Mine drain water.

The United States Geologic Survey (Karper, 1998) conducted an intensive water-quality study of a number of sites in the Belt area as part of a study of acid mine drainage problems in the Stockett-Sand Coulee and Belt areas. They installed a flume and stilling well for continuous monitoring of the discharge from the Anaconda Mine and collected periodic water-quality samples from various sites.

When the coal-waste area below the Anaconda Mine (and adjacent to the channel receiving acid mine water discharge) was reclaimed, a series of six, shallow, monitoring wells were installed by the MDEQ for ground-water monitoring (Tetra Tech, 1995). These wells were installed for monitoring of a proposed grouting project aimed at mitigating the discharge of contaminated ground-water into Belt Creek. However, this project was postponed and no additional data was collected from these wells.

One project (Osbourne and others, 1987) characterized hydrogeologic conditions at several abandoned mines in a similar geologic setting in the Stockett-Sand Coulee area and possible recommendations for cleanup at these sites were developed. One of the approaches discussed was to change current land uses in the recharge areas of the mines from a crop-fallow system to a more water-consumptive cropping pattern. Another study done by Wheaton and Brown (1999) evaluated the hydrogeology and geochemistry of the Cottonwood Mine near Stockett-Sand Coulee. Local precipitation recharges the Cottonwood Mine workings. A previous land-use change from crop fallow to the Conservation Reserve Program (CRP) appears to have significantly reduced the recharge volume and, consequently, acidic discharges from the mine were also lowered.

A concurrent project, supervised by Ted Duaime of the MBMG and funded by the MDEQ, is focusing on the hydrogeology in the area immediately surrounding the Anaconda Mine. Work has included detailed geologic mapping, remote sensing mapping, AMD sampling, stream sampling, and surface flow monitoring of streams and other discharges. The construction of nested monitoring wells in significant aquifers in the Anaconda Mine area is nearly finished. Preliminary findings of this DEQ sponsored work has been published as a MBMG open file report (Duaime and others, 2004). This open file report also contains an excellent summary of the coal mining history in the Belt area.

Project Sponsor and Funding Sources

The city of Belt was the project sponsor. Funding sources came from MDEQ section 319 grant along with funds from the Montana Water Center, Task Orders through the MDEQ Remediation Division-Abandoned Mine Lands, and the Montana Bureau of Mines and Geology.

Methods

Data collected for this project include an inventory of ground-water and surface-water conditions, water-quality samples, stable-isotope samples, tritium samples and chlorofluorocarbon samples. All data are available on the Environmental Protection Agency (EPA) Storet data base. Ground-water, surface-water, and water-quality data are available on the Montana Bureau of Mines and the Geology Ground-Water Information Center (GWIC) at (www.mbmggwic.mtech.edu). GWIC ID numbers are attached to all wells used in this report.

During this project, 72 existing water wells, 6 AMD sites, 6 monitor wells, 2 ponds, 9 stream sites and 17 springs were inventoried in the vicinity of Belt (Figures 3 and 4). The locations of the inventory sites were determined using GPS, and surface elevations were estimated from 1:24,000 topographic maps or Digital Elevation Models (DEMs). As part of the well inventory, static-water level, pumping-water level, and well depth were measured when possible and water use was identified. At surface-water sites, stream flow and spring discharge were monitored as part of the inventory. Field water-quality parameters (pH, SC, Temperature, DO, Redox) were tested at all sites that water samples could be collected. All the inventory data are summarized in Appendix A.

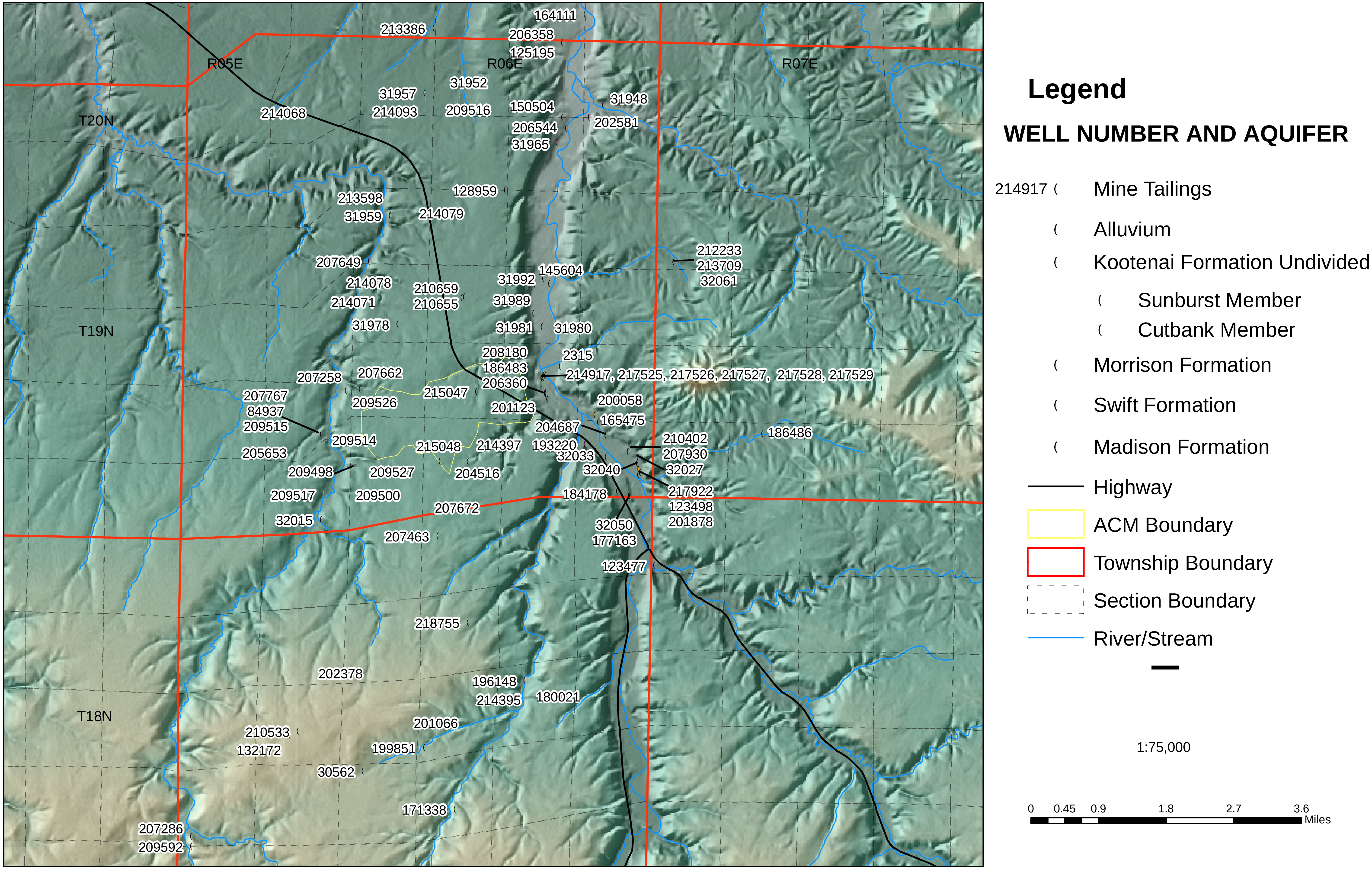


Figure 3. Map showing locations of wells and springs inventoried in the Belt area.

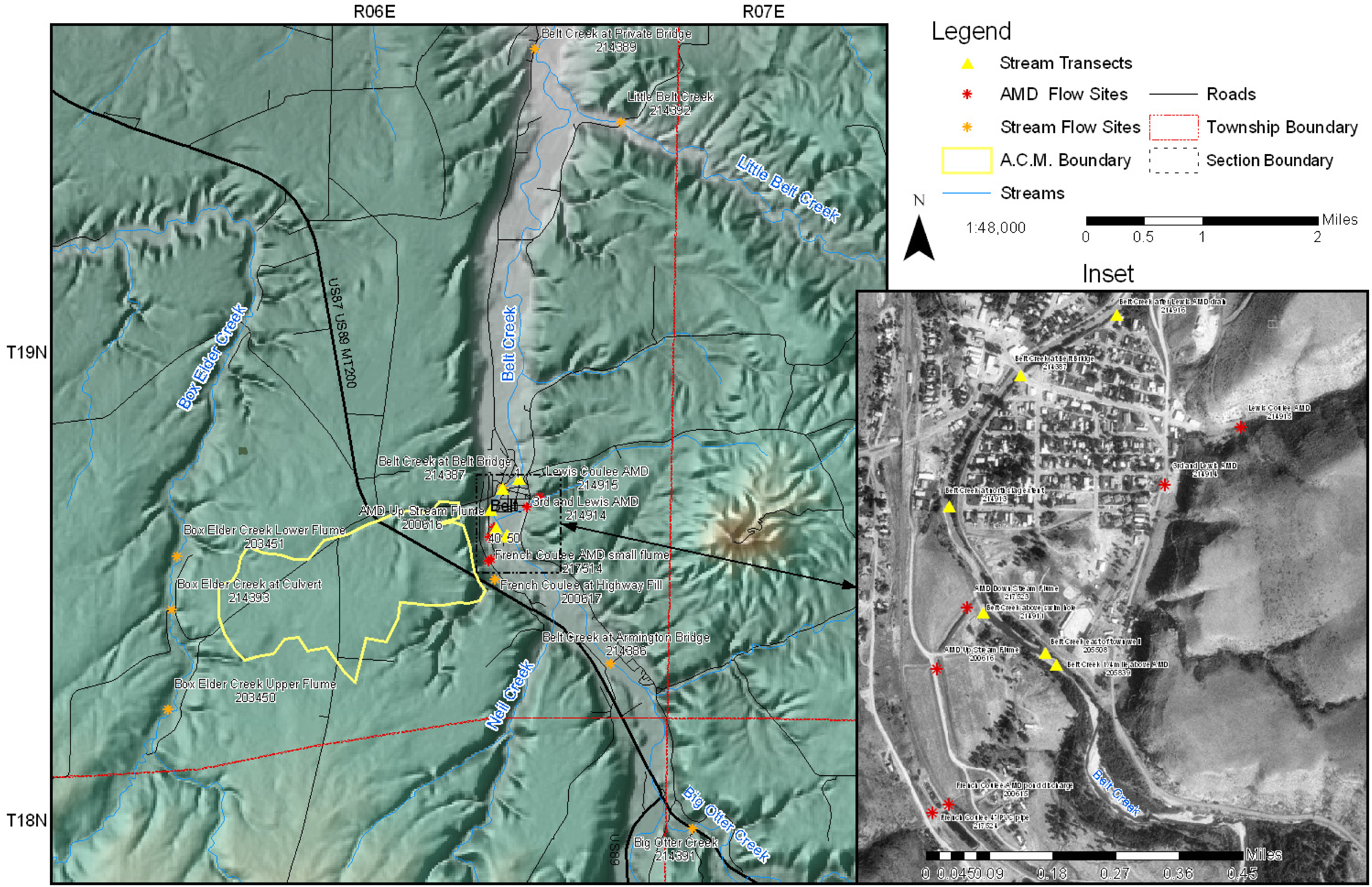


Figure 4. Map showing surface-water and AMD inventory and monitoring sites.

Between September, 2002 and October, 2004, ground-water and surface-water measurements were collected to document water-level fluctuations and changes in field water-quality parameters. Water-levels were measured monthly at 31 of the inventoried wells. Six wells, originally installed in 1995 by the MDEQ Remediation Division-Abandoned Mine Lands to monitor AMD, were included in the monitoring network. Two wells (GWIC ID #'s 2315 and 31992) were also measured quarterly by the MBMG ground-water characterization program. Ground-water level hydrographs were plotted with daily precipitation or stream flow and are compiled in Appendix B. Selected hydrographs are also shown in several figures within this report.

Stream flow, spring water flow rates and field water-quality parameters (pH, SC, Temperature, DO, Redox) were monitored monthly from 9 surface-water sites in the study area. During low-flow conditions, stream flow was calculated by measuring stream velocities while wading the creek at specific transect locations. During high-flow conditions, a bridge crane and weighted "fish" were used for transects when conditions were too dangerous to wade. Parshall flumes were used to measure flow in Box Elder Creek and at several AMD discharges. At some locations, flows were calibrated by gauge height or volumetric measurements (bucket and stop watch). Refer to Appendix C for field chemistry, flow measurement method, and flow rate chart data.

Acid mine drainage flow rates and field-water quality parameters were also measured monthly at five sites. Flow rates were obtained by either H-flume gauge height or volumetric measurements (bucket and stop watch). Refer to Appendix D for field chemistry, flow measurement method, and flow rate chart data.

Several ground-water samples were collected for tritium, stable isotopes, helium-3/tritium and chlorofluorocarbons. These ground-water samples were collected after purging three casing volumes from the well (or until field water-quality parameters stabilized). Surface-water samples were collected directly from the stream or discharge. Samples were not preserved and were shipped to the appropriate laboratory for analyses as soon as possible.

The stable-isotopes of oxygen were analyzed on 15 samples to better delineate the source(s) of ground-water recharge. The samples were analyzed by the University of Waterloo in Ontario, Canada. Isotope contents are expressed in terms of the difference between the measured ratio of isotopes (i.e., sampled $^{18}O/^{16}O$) and a standard reference ratio of the isotopes (i.e. reference $^{18}O/^{16}O$) and are expressed in a delta notation (δ) in parts per thousand (permill). The formula for this expression (using ^{18}O as an example) is as follows:

$$\delta\, ^{18}O \text{ sample} = \frac{^{18}O/^{16}O \text{ sample} - {}^{18}O/^{16}O \text{ VSMOW}}{^{18}O/^{16}O \text{ VSMOW}}$$

The standard reference ratios (Coplen and kendall, 2000) for the isotopes used in this investigation are as follows:

Hydrogen ($\delta\,^{2}H$): VSMOW (Vienna Standard Mean Ocean Water)

Oxygen ($\delta^{18}O$): VSMOW

Tritium samples were collected to determine the age of ground-water, surface-water, and AMD-water in the study area. The tritium samples were collected from ground-water wells by purging wells and filling unpreserved bottles. Surface and AMD water were collected at the source. These tritium analyses were performed by The University of Waterloo in Ontario, Canada.

Chlorofluorocarbon (CFC) samples were also collected as another estimate of the average age of ground water. Samples were collected by attaching one end of low-permeability rubber viton tubing to an outside faucet, while placing the other end inside a small glass jar. The jars were then purged with water to avoid any atmospheric contamination. The samples were collected in bottles and sealed with tape and sent to the University of Miami for analysis.

Water samples were collected from 21 wells, 14 surface-water sites, and 4 AMD sites for common-ion and trace constituent analyses. Ground-water samples were collected after purging the well approximately three casing volumes. Stream-water samples were collected at individual flow measurement sites along stream transects and combined into a composite sample. Field parameters of pH, SC, ^{0}C, DO, and ORP were also recorded at time of sample collection. The samples were collected in accordance with standard field and laboratory protocols. The analyses for the water-quality samples were conducted by the MBMG analytical laboratory in Butte, Montana. Refer to Appendix E for lab analyses.

PROJECT SETTING

Climate, Physiography and Land Use

Belt has a semiarid climate with warm summers, cold winters and moderate amounts of precipitation. Because of the location near the boundary between the Great Plains and the Rocky Mountains, the climate is influenced by characteristics of both regions. This climate summary is based on records from the closest long-term climatic station, about 25 miles northwest of Belt at the Great Falls Airport (http://www.wrcc.dri.edu). The average annual precipitation for the period of record (July, 1948-December, 2004) was 14.77 inches. The average snowfall was 60.6 inches. Much of the precipitation falls during the growing season. The average monthly maximum temperature is 56.4 degrees F. and the average monthly minimum is 33.2 degrees F. Winters are cold, but temperatures are often moderated by extended periods of mild temperatures brought on by strong, southwesterly, Chinook winds. Spring is usually cloudy and cool with frequent episodes of rain or snow. Summer characteristically has warm days and cool nights with frequent afternoon and evening thunderstorms. Fall months cycle between cool, moist and warm, dry conditions.

Climatic conditions during the study period (2002-2004) were drier than normal (Figure 5). A local climate station was established in April, 2003, located approximately three miles southwest of Belt at the Reddish Ranch (T 18N R 6E NW1/4 Section 14). Data from this site, and the long-term monthly averages at the Great Falls Airport, are compared in Figure 6. During the 21 month period from April, 2003 through December, 2004, precipitation at Belt was 6 inches less than the average at the Great Falls Airport. Much of the deficit in precipitation was during the typically wet growing season months, especially in 2003.

The reclaimed main access to the Anaconda Mine is located within the city limits of Belt with the main haulage opening on the west side of the Belt Creek valley. The Anaconda Mine underlies the drainage divide between the Belt Creek watershed and the Box Elder Creek watershed (part of the Upper Missouri-Dearborn River watershed). The land surface rises to the southwest from an elevation at Belt, about 3,500 feet above sea level, towards the Little Belt Mountains. The highest elevation in the study area is about 5,000 feet. Many springs exist in the area; especially in the Box Elder Creek drainage. These springs flow year round with pronounced seasonal fluctuations.

Several of the main streams in the area, including Belt Creek and Box Elder Creek, are intermittent. Most of the flow in Belt Creek is from snowmelt in the Little Belt Mountains. Stream flow in Belt Creek typically peaks in the late spring.

Farming and ranching are the main land uses in the Belt area (Figure 7). Small grain crops and hay meadows account for about 30,564 acres. Rangeland accounts for about 46,197 acres. Urban and commercial development account for about 303 acres. Other land uses make up the remaining 62 acres. Coal mining was historically important, but has not been a significant part of the economy for over 80 years. Recently, Belt has become a bedroom community for Great Falls and it appears that housing development rates are likely to increase.

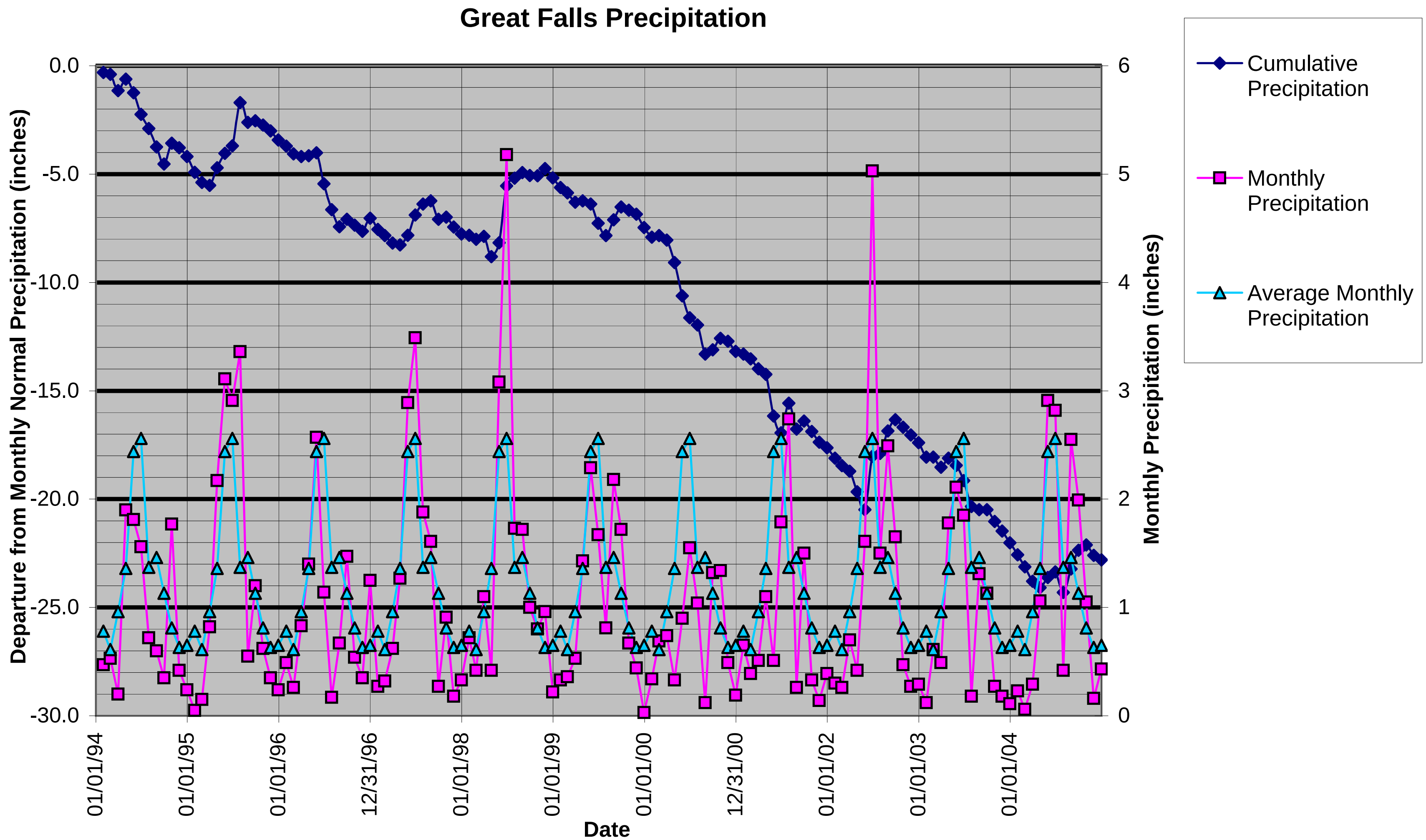


Figure 5. Comparison of Great Falls precipitation as cumulative departure from monthly normal to recorded monthly precipitation and average long-term monthly precipitation.

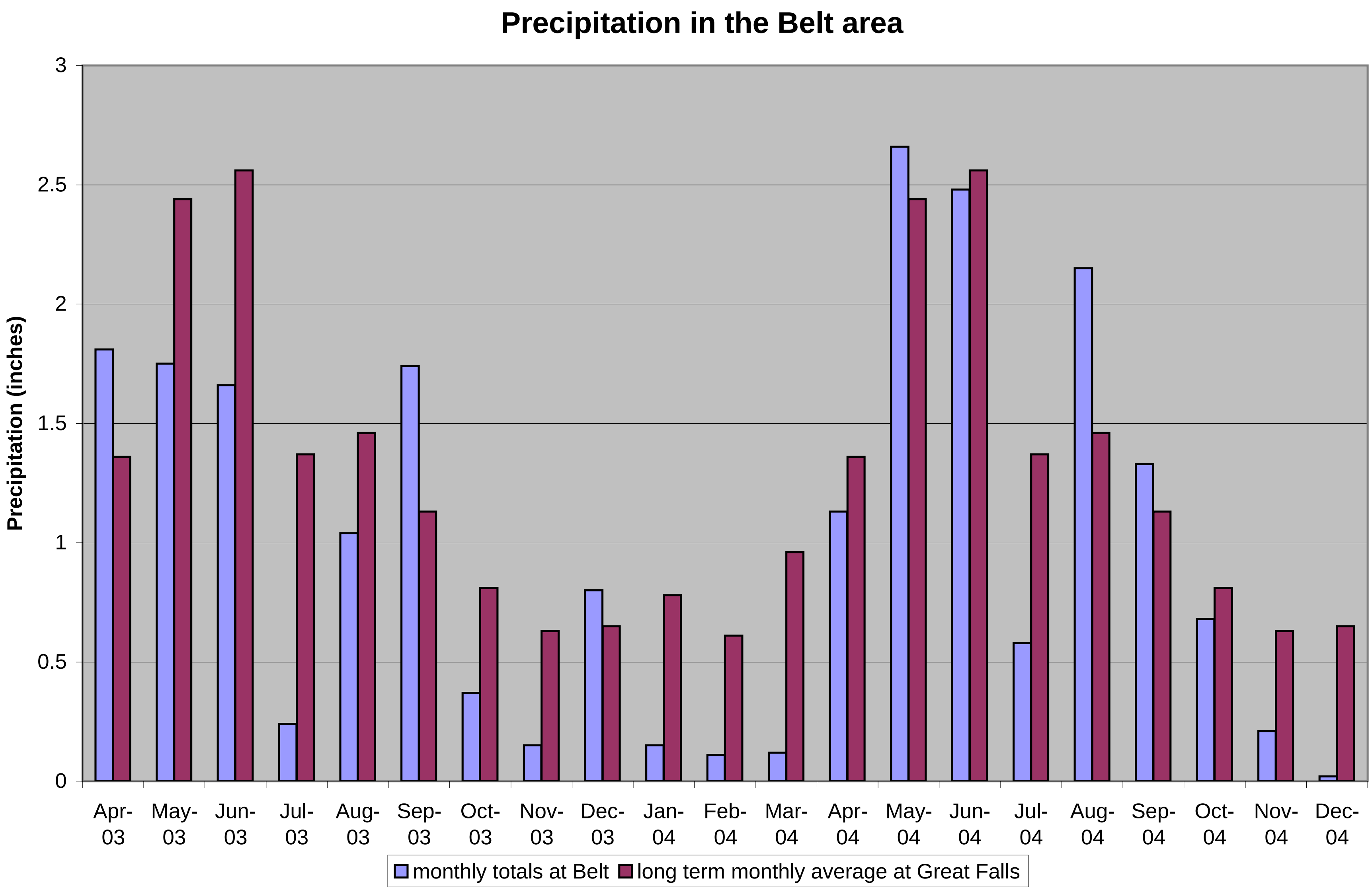


Figure 6. Comparison of precipitation from the Reddish Weather Station near Belt to long-term average precipitation at Great Falls.

Land Use	Acres	%
Other	61.60	0.07%
Urban	302.94	0.36%
Forest	6021.35	7.24%
Range/Pasture	46197.24	55.56%
Cropland	30564.46	36.76%
Total	83147.59	100.00%

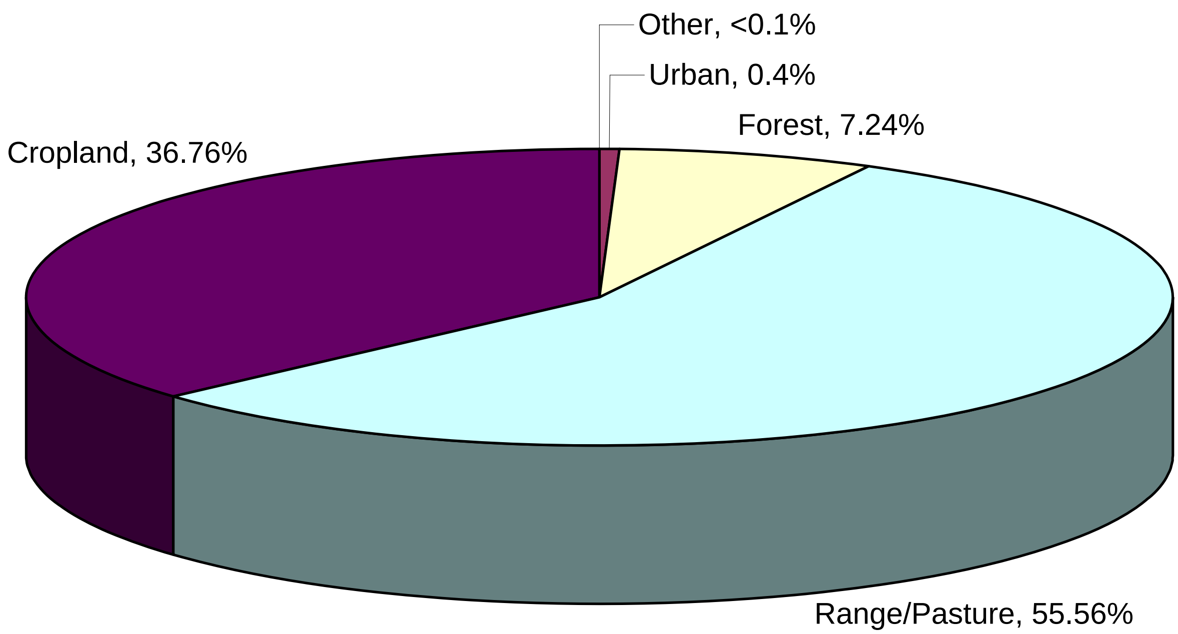


Figure 7. Land use in the Belt Study Area Shown in Figure 1 (USGS, 2000).

Geology

A geologic map of the Belt area (Vuke and others, 2002) showing the surface geology is illustrated in Figure 8. The surface geology overlying the Anaconda Mine consists of weathered mudstone and sandstone of the Kootenai Formation. Thin soils are developed on the fractured sandstone beds. These soils contain abundant cobble and boulder-sized tabular slabs of weathered sandstone. The flood plain and alluvial deposits underlying the Belt Creek valley are up to 40 feet thick. The alluvium is composed of yellowish-brown to gray gravel, sand, silt, and clay. Coal was mined from the upper part of the Morrison Formation, which is overlain by the lower Kootenai Formation. A few miles north of Belt, the upper Kootenai and overlying Blackleaf Formation are also exposed and are overlain by glacial and Tertiary terrace gravels. In the mine area, the Morrison Formation is underlain by the Swift Formation and the Madison Group. However, within a few miles south of Belt; other units of the Big Snowy Group appear between the Swift Formation and the Madison Group: the Sawtooth Formation, Otter Formation, and Kibbey Formation. Age, lithology, thickness, and depositional environments of these stratigraphic units are summarized in Table 1.

Several wells were constructed in and around the Anaconda Mine as part of an ongoing DEQ funded project. Lithologic logs of wells drilled in fall 2004 indicate that an average of about 256 feet of the Kootenai Formation overlies the Anaconda Mine (Duaime and others, 2004). The Kootenai Formation is comprised of five distinct members composed of interlayered beds of siltstone, mudstone, and sandstone; two of which are relatively clean and thick sandstone water-bearing units. The uppermost unit (Kk5) is predominantly red mudstone and sandstone, but is not present above the mine. The Fourth member (Kk4) is predominantly thin-bedded layers of sandstone at the land surface overlying the mine and averages about 80 feet thick. The Third member (Kk3) is the uppermost sandstone unit and is also referred to as the Sunburst Sandstone Member. This unit is about 45 feet thick at the mine and is composed of light-yellowish-brown, well sorted, resistant, quartzose sandstone. The Second member (Kk2) is about 115 feet thick at the mine and is predominantly red mudstone with limestone lenses. The basal unit is the Cutbank Sandstone Member (JKk1). The Cutbank Sandstone is resistant, well sorted, quartz sandstone and is up to 100 ft thick in

(Vuke and others, 2002). The Cutbank Sandstone immediately overlies the Morrison coal bed above the old mine workings.

Table 1. Stratigraphic units in the mine area (Duaime and others, 2004)

Stratigraphic Unit	Period	Lithology	Thickness	Depositional Environment
Quaternary Alluvium	Quaternary	Interbedded clay, silt, sand, and gravel	Up to 40 feet thick in the Belt Creek valley	Stream channel and floodplain
Blackleaf Formation	Cretaceous	Black shale and sandstone beds	Not present at mine; 600' thick to north	Mostly marine
Kootenai Formation	Cretaceous			
Fifth member		Red mudstone and sandstone	Not present at mine; 120' thick to north	Alluvial plain
Fourth member		Fine-grained, thin-bedded red or brown sandstone	45' thick at mine	Deltaic and fluvial
Sunburst Sandstone		Clean, porous quartz sandstone	45' thick at mine	Marginal marine
Second member		Red mudstone with limestone lenses	115' thick at mine	Alluvial plain
Cutbank Sandstone		"Salt and pepper" sandstone, may be conglomeratic	20' thick at mine	Fluvial
Morrison Formation	Cretaceous and Jurassic			Alluvial plain
ELLIS GROUP	Jurassic			Marine
Swift Formation		Orange-brown sandstone, conglomeratic, fossiliferous	50' thick at mine	
Sawtooth (Piper) Formation		Oolitic limestone, shale and siltstone	Not present at mine; 30' thick to south	
BIG SNOWY GROUP	Mississippian			Marine
Otter Formation		Green shale, limestone and gypsum	Not present at mine; 300' thick to south	
Kibbey Formation		Red mudstone, siltstone and fine-grained sandstone	Not present at mine; 100' thick to south of mine	
MADISON GROUP	Mississippian			Marine
Mission Canyon Formation		Gray, thick-bedded limestone	800' thick to south of mine	
Lodgepole Formation		Gray, thin-bedded limestone and shale	700' thick to south of mine	

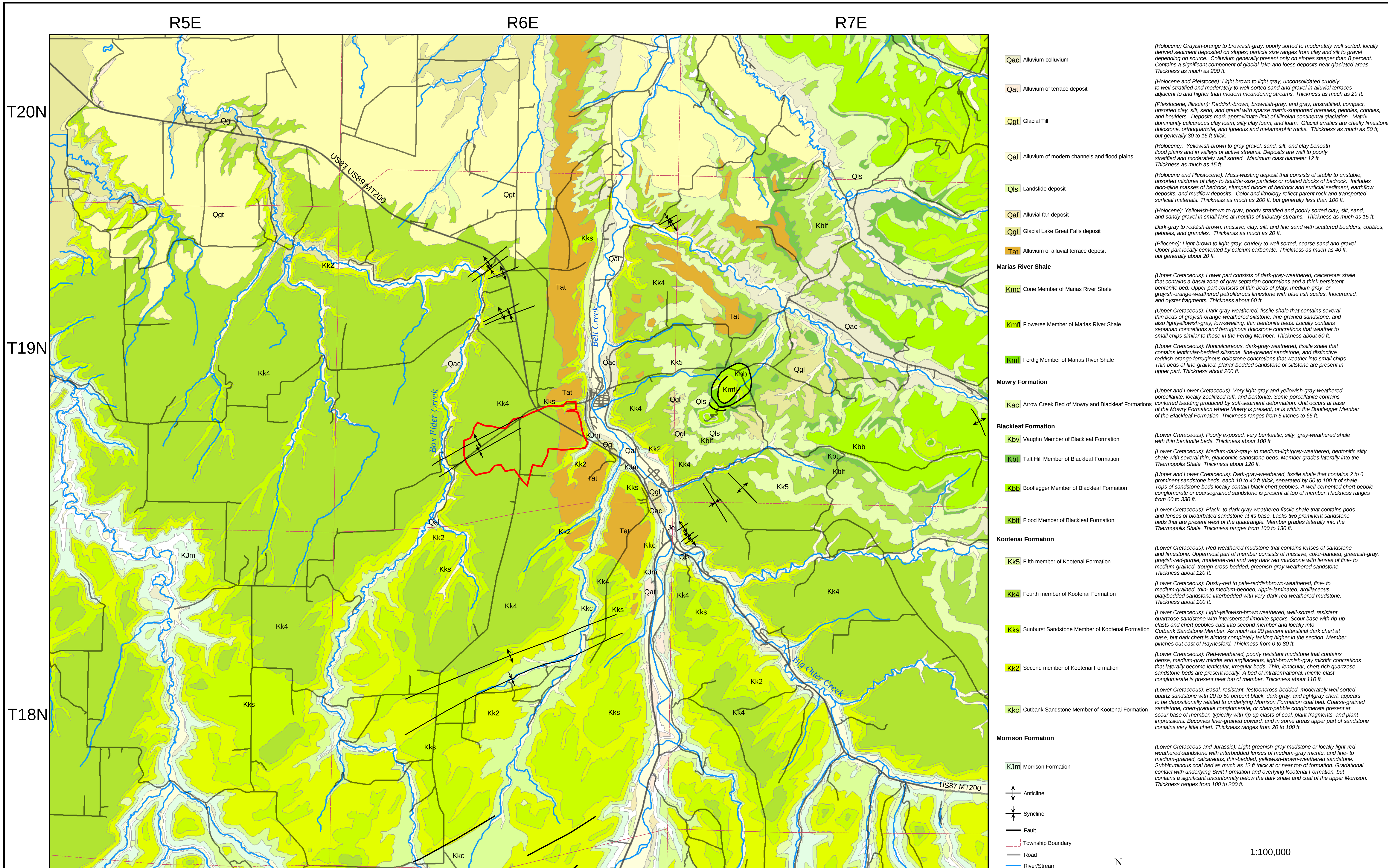


Figure 8. Geologic Map of the Belt Area, Central Montana. (Geology adapted from Vuke and others, 2002, and Vuke, 2000.)

The Jurassic Morrison Formation is about 100 feet to 300 feet thick in this area. The Morrison Formation is light-greenish- grey mudstone with lenses of yellowish-brown-weathering sandstone. A subituminous coal bed as thick as 12 feet is located at or near the top of the Morrison Formation (Vuke and others, 2002). The recent DEQ drilling project encountered voids where the coal had been mined out in this interval at several locations (Duaime, oral communication, 2004).

The Ellis Group contains the Swift Formation and is predominantly sandstone that ranges from 50-120 feet thick in the area. The Swift weathers grayish-orange and is composed of fine- to coarse-grained sandstone (Vuke and others, 2002).

Rocks of the Big Snowy Group do not appear to underlie the Anaconda Mine. These units thicken rapidly towards the Little Belt Mountains and make a significant difference in estimating depths to the Madison aquifer in the area south of Belt.

Limestone of the Mission Canyon Formation, which is up to 800 feet thick in the area, forms the upper unit of the Madison Group. The Madison Group is light-grey to dark-grey weathering, resistant, massive limestone (Vuke and others, 2002). Drill holes into the Mission Canyon Formation frequently encounter solution cavities. Sinkholes, caves, and other karst features are common in the Mission Canyon Formation.

Structure

The overall dip of surficial sedimentary rocks near the Anaconda Mine is about 4 degrees to the northeast (Vuke and others, 2002). Small faults and folds (Figure 8) strike mostly northeast in the Belt area and define the structural grain. Tectonic forces that formed faults, folds and other structures typically control development of secondary porosity such as cleat in coal beds and fractures in other rocks. This secondary porosity typically forms hydraulic connections between pore spaces and voids in the rocks to form aquifers. Several episodes of structural movement and deformation are summarized in the study done by Duaime and others (2004). Pre-Jurrassic uplift tilted the sedimentary units to the south that were subsequently eroded. Recurrent movement has been documented along the Great Falls Tectonic Zone, a northeast trending basement suture that may be responsible for much of the fracturing and folding in the Belt area (O'Neill and Lopez, 1985). The Anaconda Mine is located on the southeast flank of the Sweetgrass Arch, another recurrent basement structure that appears to have influenced the distribution of the Sunburst Sandstone and also the development of fractures and folds. Faults and folds appear to coincide with hydrologic features such as ground-water divides and may control saturated versus dry regions in the abandoned mine workings.

Underground mining commonly causes collapse of the overlying roof rocks, which can penetrate to the surface. No obvious signs of roof collapse have been observed overlying the ACM mine near Belt. However, there is a strong potential for fractures to develop over the mine workings. These fractures could provide conduits for infiltration of recharge through the overlying sediments. This has not been verified at Belt but may potentially enhance the development of AMD in the mine workings.

HYDROGEOLOGY

Aquifers/Aquitards

Several of the geologic units in the Belt area form aquifers of either regional or local extent. The Mission Canyon Formation of the Madison Group is probably the most prolific regional aquifer in the Belt area and is commonly referred to as the Madison aquifer. This aquifer supplies discharges of about 300 cubic feet per second (cfs) at Giant Springs in Great Falls (Patton, oral communication, 2004). The town of Belt has two production wells completed in the Madison aquifer. During the recent drought, many farmers and ranchers in the Belt area have either deepened their shallow wells or directly targeted the Madison aquifer. The Swift Formation of the Ellis Group forms an important local aquifer along many reaches of Belt Creek. Sandstone beds in the Morrison Formation (the coal bed located at the top of the Morrison) and the Cutbank Sandstone of the Kootenai Formation combine to form an important aquifer system of both local and regional extent in central Montana. The Sunburst Member of the Kootenai Formation is another significant aquifer and appears to be the source of numerous springs along Belt Creek and Box Elder Creek. Quaternary sand and gravel deposits along Belt Creek and Box Elder Creek are also important local aquifers. They are typically directly connected to the streams and therefore sensitive to surface flows.

Ground-Water Flow

Ground water moves through the primary porosity of sand, gravel and sandstone, secondary fractures in the sandstone, cleat in the coal, secondary fractures and solution cavities in limestone. Regional ground-water flow is both down-dip and down-slope to the north. Locally, the ground-water flow appears to be directed towards Belt Creek.

Ground-water flow in the Belt area can be characterized by individual aquifers. The primary question regarding ground-water flow for this project is: What primary source of water enters the Anaconda Mine and forms the acidic discharges? Significant differences in flow conditions are dependant on the depth and continuity of geologic units making up the aquifers. The deepest and most laterally continuous aquifer in the area is the Madison aquifer. In this area, most recharge to this aquifer is from snowmelt in the Little Belt Mountains, where the Mission Canyon Formation is at the land surface, and from infiltration of precipitation through overlying deposits down-slope from the outcrop area. The Madison aquifer continues to receive recharge from overlying units north Belt for some undetermined distance, but it discharges through springs into the Missouri River (Figure 1). The potentiometric surface of the Madison aquifer ranges from 3,275 feet (above mean sea level) where it underlies the Anaconda Mine to 3,290 feet (above mean sea level) underlying the town of Belt. The potentiometric surface in the Madison aquifer underlying the Anaconda Mine ranges from about 344 feet to 412 feet below the mined out coal horizon.

The Swift aquifer is typically only developed in stream valleys in the Belt area. Not enough data points are available to construct a ground-water flow map of this aquifer, but the potentiometric surface appears to be controlled by stream stage.

The well inventory and monitoring focused on identifying aquifers up-slope from and overlying the Anaconda Mine in areas that would potentially recharge the mines. The Kootenai aquifer system is the predominant water-bearing unit underlying this recharge area. Several layers of fine-grained mudstones, siltstones and clay beds form Aquitards that generally restrict the vertical flow of infiltrating recharge water and forming confining beds both above and underlying many of the aquifers in the Belt area. The vertical flow is restricted enough in places to allow perched aquifers to form and springs to flow at the lower contact of this aquifer. The Sunburst aquifer is perched on the Second member (Kk2) of the Kootenai Formation overlying the Anaconda Mine. Several springs issue from the base of the

Sunburst aquifer along Box Elder Creek and Belt Creek. Other springs in the Belt area appear to issue from the Cutbank sandstone which underlies the Second Member of the Kootenai Formation (Kk2). Although vertical flow is restricted, some water infiltrates through the Aquitards, recharging underlying aquifers and the mine workings. Much of this infiltration is through fractures in the sedimentary rocks. Unfortunately, only a few wells are located in this area, making it difficult to verify our hydrogeologic interpretations. Supplemental drilling by the MDEQ has greatly enhanced our understanding of the hydrogeology directly overlying the Anaconda Mine. Those data are currently being interpreted through another MBMG project.

A potentiometric-surface map of the Kootenai aquifer was constructed based on well inventory and monitoring measurements. This map was contoured using measurements from 48 wells and springs near the mine (Figure 9). The Kootenai potentiometric surface map combines head data, collected in July, 2004, from aquifers in both the Sunburst and Cutbank Members of the Kootenai Formation. As a result, this map shows only general water-level conditions in the mapped area. Additional wells at critical locations will be needed to accurately depict ground-water flow. Ground water is interpreted to flow from a divide located about 3.5 miles south of the Anaconda Mine. The ground-water divide south of the mine appears to be both topographically and structurally controlled. The topographically high area forming the ground-water divide is located just north of a paired anticline-syncline structure that trends north 45 degrees east. Only precipitation falling north of this divide has the potential to move towards the mine. Once recharge infiltrates vertically to the saturated zone, ground-water flow is generally to the north, perpendicular to the potentiometric contours depicted in Figure 9. The upland area between Belt Creek and Box Elder Creek is highly dissected by tributaries of the two streams. These tributaries, plus the main stems of the two streams, are discharge areas for ground water moving out of the Kootenai Formation. The potential recharge area covers about 2,100 acres overlying and up-gradient of the mine. The highly dissected nature of the upland appears to 1) cause much of the precipitation falling on the upland to recharge a shallow ground-water flow system, and 2) cause discharge to the surface-water drainages as seeps and springs in the valley walls. Several of the springs coincide with the contact of the Sunburst Sandstone Member aquifer and the underlying unnamed fine-grained unit (aquitard). North of the Anaconda Mine, the flow gradient in the Kootenai aquifer decreases. This may be in response to drainage into the mine voids through secondary fractures. A more detailed well network could potentially indicate the southern ground-water flow in areas just north of the mine.

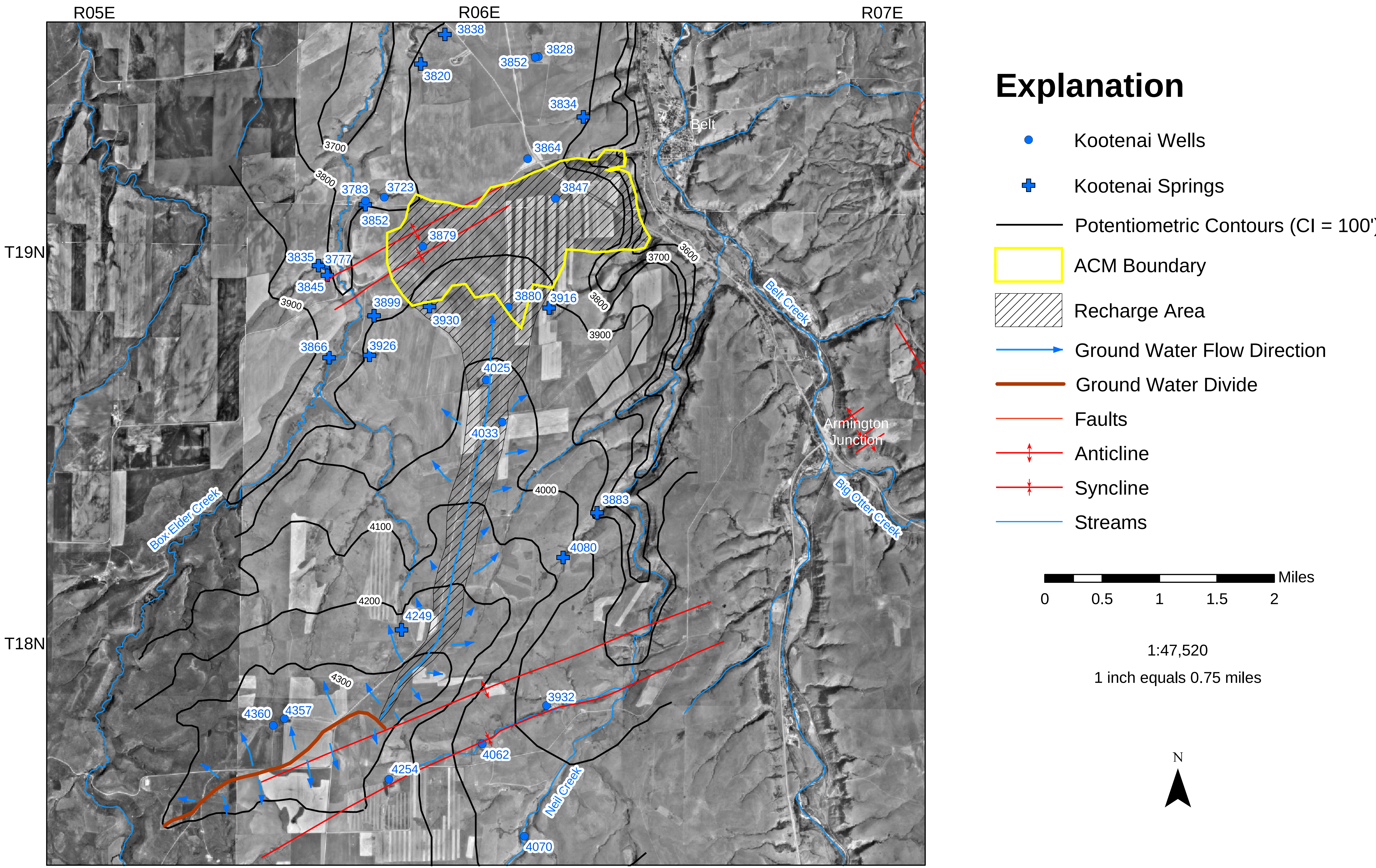


Figure 9. Potentiometric surface and ground-water divide of the Kootenai aquifer system near the ACM mine based on elevations of inventoried springs, ground-water elevations measured in July 2004, and water levels from wells drilled.

Based on these interpretations, a significant source of water to the Anaconda Mine appears to be from the overlying Kootenai Formation. The Kootenai Formation is about 260 feet thick in the Belt area. The lower sandstone unit (Cutbank Sandstone Member) forms an aquifer directly overlying the targeted coal bed. The Cutbank Sandstone Member is overlain by an unnamed fine-grained unit that forms an aquitard. The Sunburst Sandstone Member forms another aquifer overlying this aquitard. The upper unit of the Kootenai Formation is another unnamed fine-grained aquitard. The Kootenai Formation is highly fractured, causing some degree of vertical hydraulic connection from the surface down to the underlying coal bed and mine voids.

Water in the alluvial aquifer adjacent to and underlying the Belt Creek valley is hydraulically connected to the stream channel. Flow is towards the stream during low stages, while flood waters reverse the ground-water flow and recharge the aquifers during high stages.

Water-Level Fluctuations

The observed water-level fluctuations in monitoring wells responded to several variables. These include the geologic source of each well, the precipitation, and the position of each well in the landscape. Hydrographs of all wells measured are shown in Appendix B. Hydrographs of selected wells that are good examples of documenting responses to specific hydrologic events are shown in Figures 10-12.

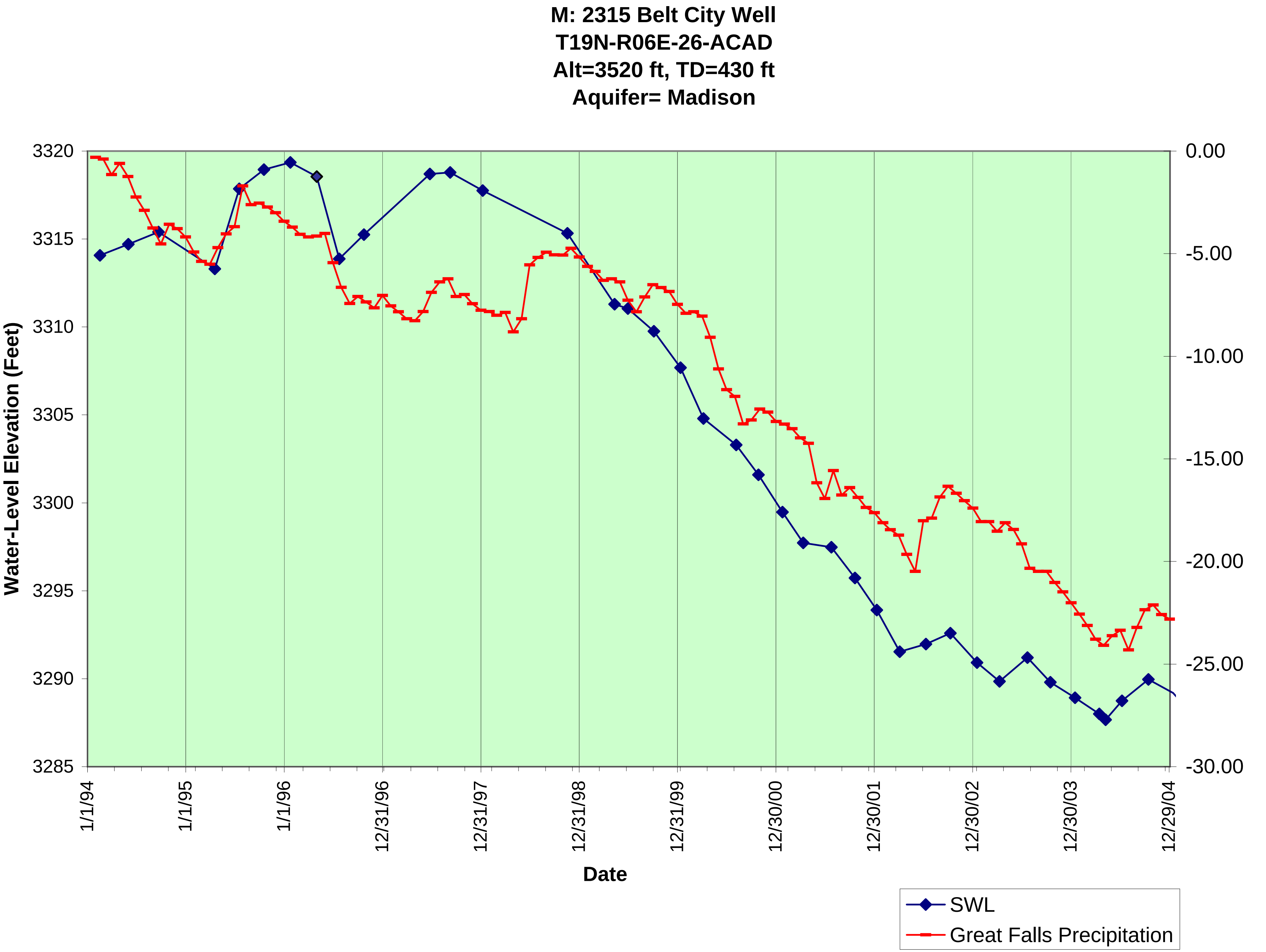


Figure 10. Hydrograph of water-level fluctuations in the Madison aquifer at Belt compared to Great Falls precipitation.

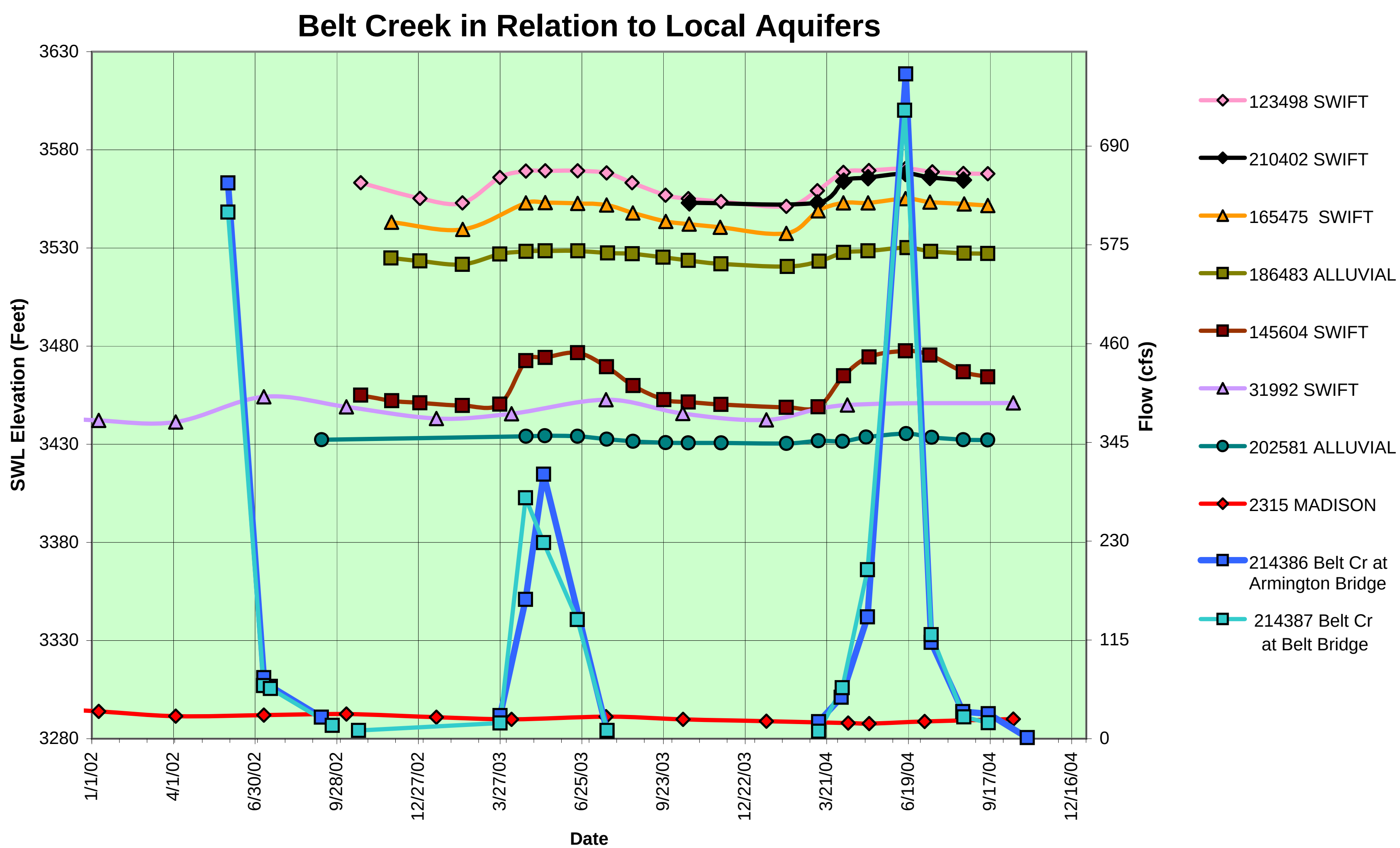
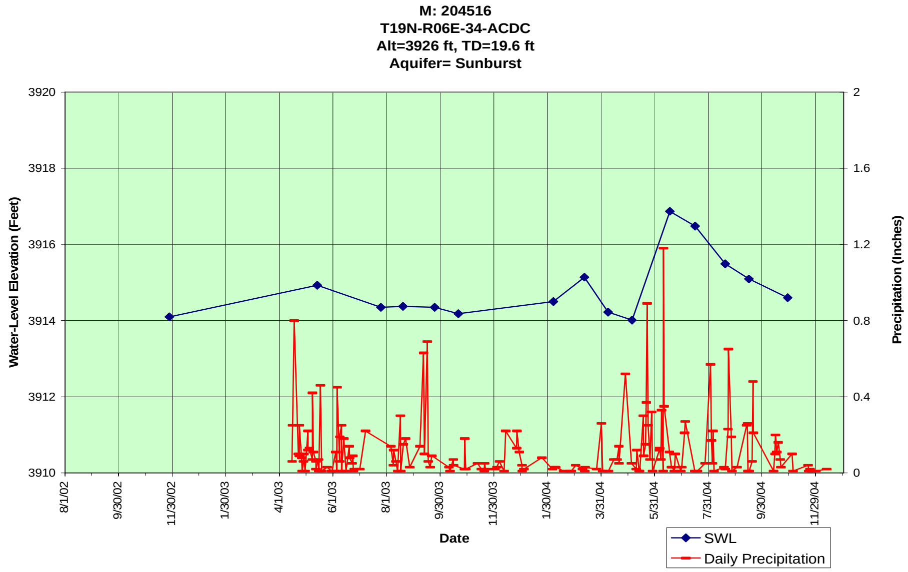
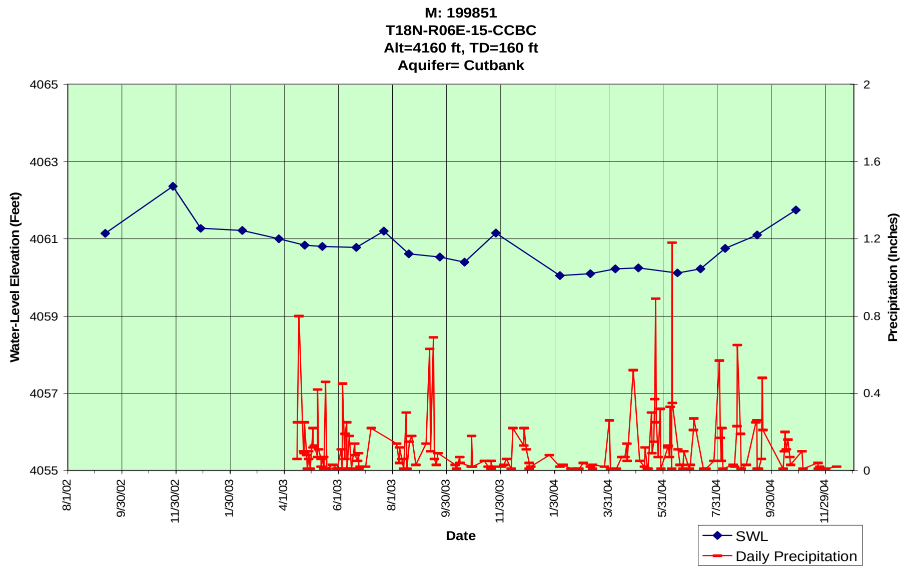
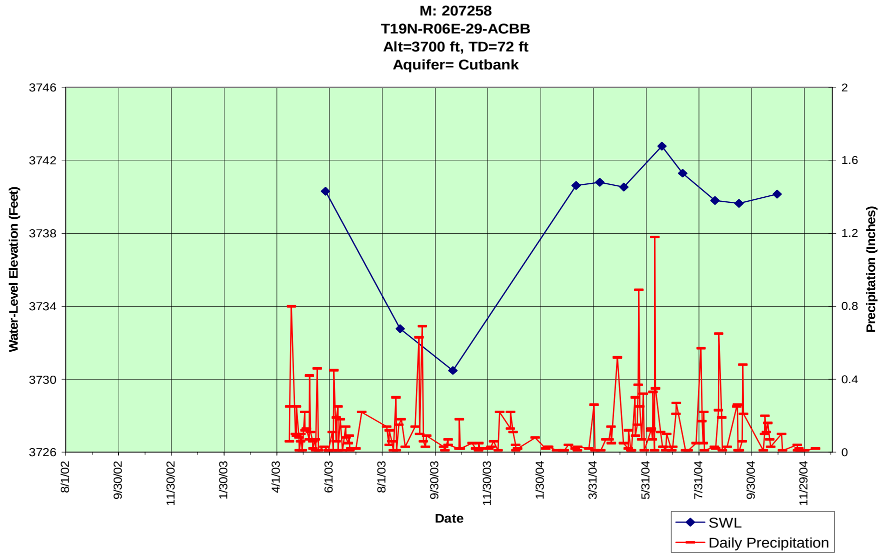


Figure 11. Hydrographs comparing water-level fluctuations in the Swift, alluvial, and Madison aquifers with Belt Creek stream flow.







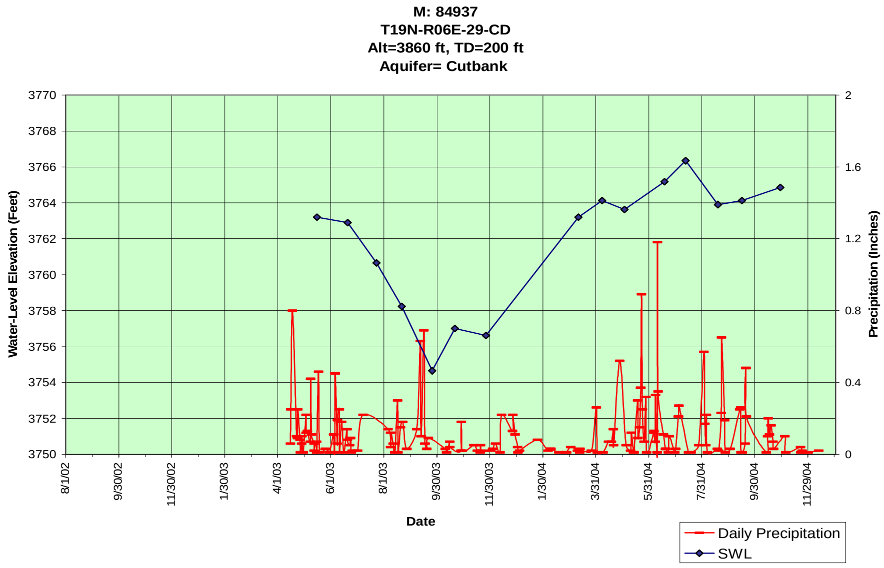


Figure 12. Hydrographs showing magnitude and pattern of water-level fluctuations in the Kootenai aquifer system close to the Anaconda Mine. The upper two charts are from wells in uplands, up-gradient of the mine and depict low-magnitude annual responses (2-3 feet). The lower two charts are from wells near slope breaks along tributaries and depict higher magnitude annual responses (11 - 13 feet).

Hydrographs from wells completed in the Madison aquifers show the response of the extended drought in the Belt area. Figure 10 is a relatively long-term hydrograph for one of the Belt city wells (GWIC ID 2315). Water levels in deeper wells completed in the Madison aquifer rise slightly in early spring, but the overall trends are declining water levels. Water levels have steadily declined since about 1998. This closely corresponds to the extended drought in this area.

Hydrographs from wells completed in the Swift aquifer show annual responses to stream stage along Belt Creek (Figure 11). Most of these wells are located very close to Belt Creek. Water levels in these wells appear to rise during periods of high stream flow and fall as snow-melt derived runoff declines.

Kootenai aquifer wells completed in the uplands, up-gradient of the mine, demonstrated minor water-level fluctuations trending flat to a slight decline responding to the recent drought (Figure 12). However water levels in the Kootenai aquifer wells completed near the break-in slope, towards small tributaries, showed a greater magnitude of water-level fluctuations in response to the recent drought. Most upland Kootenai wells have a rapid water-level increase after large precipitation events. Water-level responses in the Kootenai appear to be more dependent on the geographic setting than the specific aquifer; as can be observed in the two upper hydrographs in Figure 12. Both wells are located in an upland setting, but at different depths. The shallow well (GWIC ID 204516) is completed in the Sunburst aquifer at a depth of about 20 feet. In contrast, the deeper well (GWIC ID 199851) is completed in the Cutbank aquifer at a depth of about 160 feet.

Water levels in wells completed in the alluvial aquifer near Belt Creek tend to rise and decline with Belt Creek's seasonal variation; similar to the Swift water levels (Figure 11).

Aquifer Properties

Specific Capacity Evaluation

By assessing well drill logs in the study area, specific capacity (gpm/ft) values were calculated to estimate the aquifer properties (Table 2).

Table 2. Aquifer property analyses by specific capacity

GWIC ID	Well name	Location TRS tract	Aquifer	Type: Confined = C Unconfined = U	Well diameter (inches)	Pumping rate (gpm)	Perforated interval thickness (ft)	Static water level (ft)	Pumping water level (ft)	Drawdown (ft)	Test duration (hrs)	Specific capacity (gpm/ft)	Transmissivity (ft^2/d)	Hydraulic conductivity (ft/d)
32040	Steve Assels	T19N R06E 36 DABB	Alluvium	U	6	30	0 (open hole)	12	32	20	1	1.5	69	-
31948	Harry Nisbet	T19N R06E 01 CDBC	Alluvium	U	6	30	0 (open hole)	24	36	12	2	2.5	139	-
32015	Jim Larson ranch	T 19N R16E 32 DCCB	Alluvium	U	7	40	0 (open hole)	14	30	16	1	2.5	119	-
32027	Bob Pimperton	T19N R16E 36 ACDA	Alluvium	U	6	60	0 (open hole)	21	40	19	1	3.2	164	-
186483	Leroy Spiller	T19N R06E 26 DBCB	Alluvium	U	6	1.57	5	16.68	17	0.32	1	4.9	271	54.2
132172	Keaster \ Nelson	T18N R06E 17 CACA	Kootenai	C	4	15	20	23	160	137	2	0.1	11	0.6
186486	Dawson Ranch	T19N R07E 32 BADA	Kootenai	C	4	24.5	20	55	117	62	1	0.4	41	2.1
31957	Nathan Horst	T19N R06E 04 DACD	Kootenai	C	6	12	40	95.13	119.7	24.57	1	0.5	47	1.2
212233	Larry Murphy	T19N R07E 18 CCD	Kootenai	C	4.5	13	30	253.65	275.3	21.65	1	0.6	62	2.1
164111	Keith Hoyer	T20N R06E 35 DADA	Kootenai	C	4	60	20	1	70	69	1	0.9	96	4.8
32061	Albert Colarchik	T19N R07E 18 CCDA	Kootenai	C	4	12	3	120	132	12	1	1	125	41.7
30562	G Johnson	T18N R06E 21 BABB	Kootenai	C	6	20	15	20	35	15	1	1.3	146	9.7
171338	Mike Fellows	T18N R06E 22 CADC	Kootenai	C	6	20	10	9	24	15	1	1.3	150	15
125195	Emilio Garza	T19N R06E 02 ABDB	Kootenai	C	6	30	77	69	80	11	2	2.7	295	3.8
207286	Roger Nelson	T18N R06E 19 CCCA	Kootenai	C	5	15	30	21	24.2	3.2	2	4.7	568	18.9
32050	Ed Spragg	T19N R06E 36 DCDD	Swift	C	5	12	8	23	45	22	1	0.5	60	7.5
165475	Wallace Mcmanigle	T19N R06E 36 BABB	Swift	C	5	20	11	5	35	30	1	0.7	73	6.6
32033	Charles Fuller	T19N R06E 36 BDCD	Swift	C	6	40	9	6	40	34	1	1.2	132	14.7
31980	Caral Stevenson	T19N R06E 23 CADB	Swift	C	6	30	26	52	70	18	1	1.7	179	6.9
145604	Linda Assels	T19N R06E 23 BDBA	Swift	C	6	28	10	40	51	11	0.5	2.5	286	28.6
150504	Brenda Danks	T19N R06E 11 ABAC	Madison	C	5	12	37	178	218	40	1	0.3	29	0.8
123477	Martin Winder	T18N R07E 06 CCCB	Madison	C	4	18	80	310	350	40	3.5	0.5	47	0.6
31989	Gary Fliginger	T19N R06E 23 ABCC	Madison	C	6	6.67	151	58.85	67.45	8.6	1	0.8	69	0.5
128959	Sweeney Ranch	T19N R06E 11 CCBB	Madison	C	5	25	460	493	520	27	2	0.9	84	0.2

Using the median specific capacity, the transmissivity (ft^2d) and hydraulic conductivity (ft/d) were also estimated for each aquifer and are shown in Table 3 (Lohman, 1979).

Table 3. Aquifer properties estimated from median specific capacity values for each aquifer.

Aquifer property analyses by specific capacity			
Aquifer	**Specific capacity (gpm/ft)**	**Transmissivity (ft^2/d)**	**Hydraulic conductivity (ft/d)**
Alluvium	2.5	139	-
Kootenai	0.95	110.5	4.3
Swift	1.2	132	7.5
Madison	0.65	58	0.55

Slug Tests

Slug tests were performed in the fall of 2004 on 5 of the 6 monitoring wells (MW) located on the reclaimed slag area on Coke Oven Flats. MW-3 (GWIC ID 217526) and MW-4 (GWIC ID 217527) had sufficient casing volume for the slug test to work properly. Slug-test data from these two wells were evaluated using the Hvorslev method (Hvorslev, 1951). The results of these analyses indicated the ground-water hydraulic conductivity ranged from about 0.6 to 32.5 feet per day. MW-4 represents an alluvial well with the hydraulic conductivity between 20 and 32 feet per day. Most wells were completed at a depth where hard, cemented gravel was encountered that could not be penetrated by the auger. Unlike the other five wells drilled in this area, MW-5 (GWIC ID 217528) did not encounter cemented gravel during drilling. MW-2 (GWIC ID 217525) penetrated about 15 feet of reclaimed slag consisting of a mixture of scoria (coal clinker) and river gravel. Based on the Hvorslev model, the hydraulic conductivity of the reclaimed waste site ranged from 0.6 to 3 feet per day.

Surface Water

Surface-water monitoring locations are shown in Figure 4. AMD discharges were monitored at 5 locations. Stream flows were periodically monitored at 3 tributaries to Belt Creek, 3 locations along Belt Creek, and 3 locations on Box Elder Creek. Flow data is summarized in Appendix C.

Acid Mine Discharges

AMD were identified at 5 sites in the Belt Creek Valley (figure 4). All sites were monitored and sampled for water quality at least once for this project. Later, several flumes were added to collect more accurate flow measurements (Duaime and others, 2004).

In 1986, the Anaconda Mine's main entrance was sealed and the AMD was piped beneath the county road and Burlington Northern Sante Fe Railroad (BNSF RR) tracks to a ditch which drained into a local swimming hole at Belt Creek (Figure 13). On the east side of the railroad tracks, the area known as "Coke Oven Flats", 27 acres of waste was reclaimed in 1987. After decades of smoldering, the coal waste was extinguished and removed or buried on site (DEQ, 2000). The USGS flume recorded an average flow rate of 99 gpm from July 1994 through July 1996 (Karper, 1998). The MBMG recorded flow readings from the same flume (GWIC ID 200616) from May, 2002 to December, 2004 with an average flow rate of 132 gpm.

The French Coulee Mine Drain (GWIC ID 200615) originates from several reclaimed mines buried on the north and south side of French Coulee adjacent to the US 87 highway fill (DEQ, 2000). AMD is collected and piped under the county road to a drainage ditch (Figure 14) that was designed to mix with the Anaconda Mine discharges flowing into Belt Creek (DEQ, 2000). The AMD from the French Coulee Mine, however, seeps into the ground and does not make it directly to Belt Creek. An average flow rate of 9 gpm was measured on the east side of the railroad tracks. Flows could not be compared from USGS data due to different flow collection points.

The Lewis Coulee Mine area was reclaimed in 1985 (DEQ, 2000). The two mine openings were plugged and spoil piles were graded. A large storm drain was also constructed to carry the Lewis Coulee water and AMD (GWIC ID 214915) directly to Belt Creek (Figure 15). The average flow rate of the Lewis Coulee AMD, recorded by the MBMG during 2002-2004, was 3 gpm. Following a large precipitation event in June 2004, the runoff flow increased to 30 gpm. Stream-flow monitoring, done by the USGS in 1994 through 1996, revealed similar flow conditions of an average flow rate of 3 gpm (Karper, 1998). The USGS data also showed large precipitation events causing peak flows over 100 gpm.

Brodie, Meisted and Millard Mines were reclaimed on the east side of Belt Creek in 1986 (DEQ, 2000). The AMD discharging from these mines (GWIC ID 214914) has been referred to as “Lewis Coulee above Castner Park” in previous reports and is continued in this report (Figure 16). This AMD does not typically discharge directly into Belt Creek, but is discharged to an unlined drainage ditch where it seeps into the alluvial aquifer before entering Belt Creek (Figure 17). The MBMG estimated average flow rates to be about 2 gpm. Flow monitoring from the USGS in 1994 through 1996 averaged 5 gpm (Karper, 1998). A list of AMD sites including flow rate and field parameters are listed in Appendix D.

a.

b.

Figure 13. Anaconda Mine AMD discharges into Belt Creek at the local "swimming hole".
a. View to the south. b. View to the north.

Figure 14. The French Coulee Mine Drain collects AMD from several reclaimed mines.

Figure 15. Outlet of the Lewis Coulee Storm Drain where it enters Belt Creek.

Figure 16. Collection area for AMD from "Lewis Coulee above Castner Park".

Figure 17. AMD from "Lewis Coulee above Castner Park" seeps into an unlined ditch.

Belt Creek

Belt Creek originates near the top of the Little Belt Mountains flowing generally in a northward direction through the town of Belt and empties into the Missouri River about 15 miles north of Belt. Belt Creek is an intermittent stream with flows ranging from no-flow in late summer to nearly 800 cfs in the spring (Figure 18). The annual average flow of Belt Creek is 154 cfs, based on two years of monitoring. The main recharge to Belt creek is snow melt from the Little Belt Mountains located about 20 miles south of Belt. Belt Creek has segments that are influent (losing water to the ground) and effluent (gaining water from the ground). The Belt alluvial valley is underlain by the Swift Formation of the Ellis Group. The Swift Formation is a fine to course grained sandstone with interbeds of shale fragments is as much as 50 to 120 feet thick(Vuke and others, 2002). The Swift and alluvial aquifers located along Belt Creek are being directly recharged by the spring run off delivered by Belt Creek.

Belt Creek looses water in the reach from the Armington Bridge (GWIC ID 214386) to the bridge in downtown Belt (Figure 18). A gaining reach of Belt Creek starts just below the Belt Bridge, based on higher flows and cooler average water temperatures which suggest the influence of ground water. Gains in flow are also evident between the Belt Bridge (GWIC ID 214387) and the downstream private bridge (GWIC ID 214389). Other minor gaining and losing reaches of Belt Creek have been observed, but were less significant than those identified in the above section. During periods of low flow, AMD discharges from the Anaconda Mine provide all the water to Belt Creek.

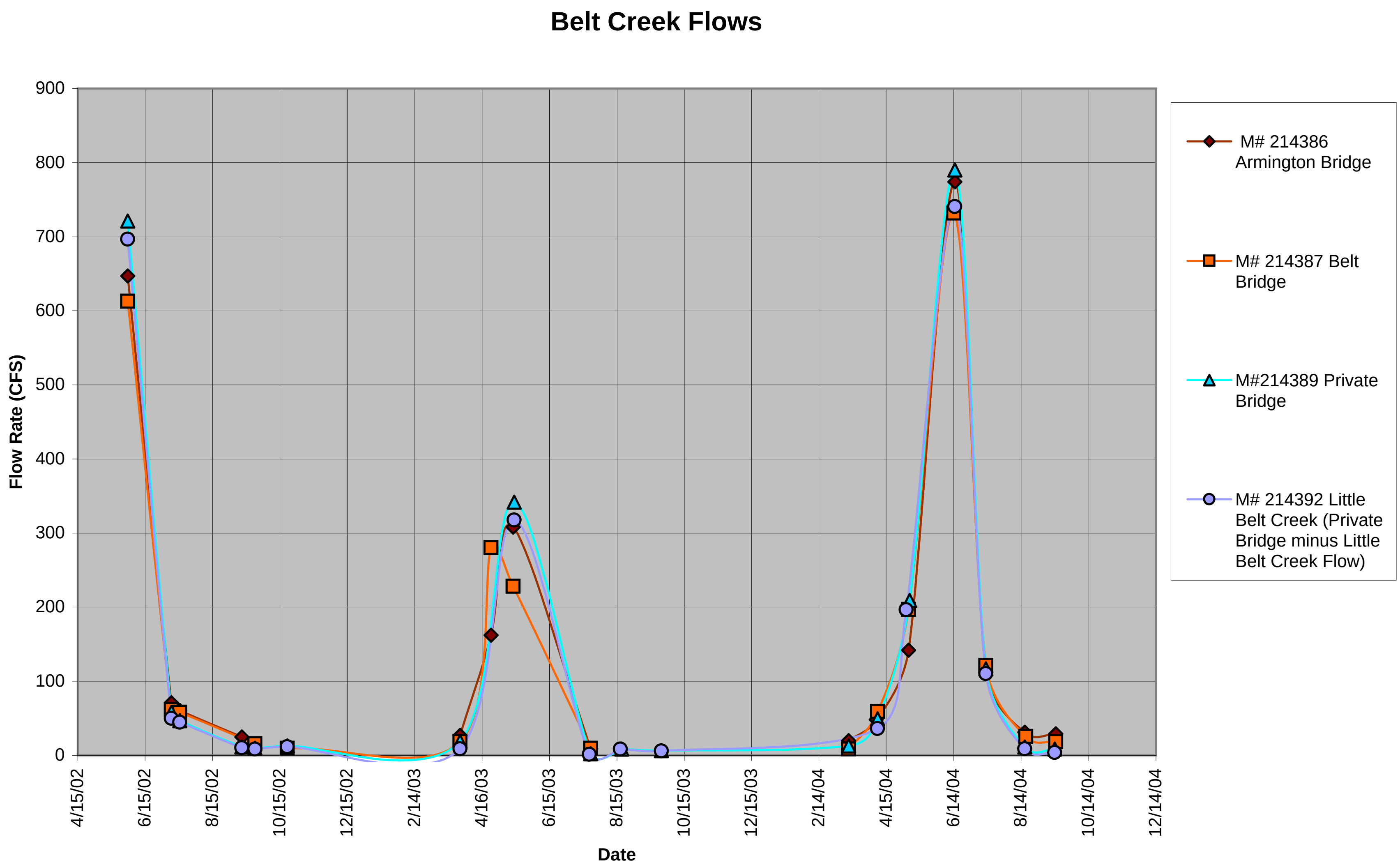


Figure 18. Stream flows along Belt Creek.

Small Streams and Springs

Within the study area, four tributary streams were monitored. Big Otter Creek, French Coulee Highway Drain and Little Belt Creek are all tributary streams that flow into Belt Creek. Box Elder Creek is a tributary of the Missouri River. Stream flow and field water-quality parameters were periodically monitored at these streams (Figure 19).

Big Otter Creek (GWIC ID 214391) is located about 3.5 miles south of the town of Belt. Big Otter Creek is an intermittent stream which occasionally goes dry in late summer. The flows range from no-flow to 28 cfs with an average of 7 cfs flowing into Belt Creek.

French Coulee Highway Drain (GWIC ID 200617) is located about one mile south of Belt, near the main Anaconda Mine adit. The creek is piped under the highway fill, draining both the French Coulee and runoff from the highway. This drain is a perennial stream with flows ranging from 1 gpm to 171 gpm with an average flow of 27 gpm emptying into Belt Creek. The stream is of good water quality, but AMD appears to be seeping out of the hillside on the north embankment. On the south embankment, there is a 2-inch PVC pipe draining water from a small seep associated with the highway fill that is referred to as the Highway Drain Seep (GWIC ID 204710).

Little Belt Creek (GWIC ID 214392) is located about 3.5 miles north of the town of Belt. Little Belt Creek is a perennial stream with flows ranging from 0.1 cfs to 49 cfs with an average of 9 cfs emptying into Belt Creek.

Box Elder Creek is located about three miles to the west of Belt. This creek was monitored in three locations. The first monitoring site was a Parshall flume installed upstream, up-gradient from any possible mine workings. The flows ranged from no-flow to 145 gpm, with a mean flow of 18 gpm. The second monitoring site (GWIC ID 214393) was located down stream, about one mile where the stream is piped under the county road. The flows at this location ranged from no-flow to 709 gpm, with a mean flow of 81 gpm. The third monitoring site was a Parshall flume located about a half mile further downstream. The flows ranged from no-flow to 908 gpm, with a mean flow rate of 75 gpm. It has been speculated that water losses from Box Elder Creek may provide recharge to the Anaconda Mine. The hydraulic head is about 130 to 140 feet higher in Box Elder Creek than the elevation of the mine voids. This provides a potential head difference for flow from Box Elder Creek to the mine. Fractures in the Kootenai Formation could produce conduits allowing flow from Box Elder Creek to the mine. Numerous springs enter into Box Elder Creek between the upper and lower flume, making it difficult to assess gaining or losing conditions through this reach.

Several springs (GWIC ID's 213598, 205653, 207767, and 204516) were initially inventoried in our study area, but only a few were monitored on a regular basis. Most of the springs identified were contact springs discharging from the base of the Sunburst Formation. These springs flow all season with increased discharges corresponding to large precipitation events. Refer to Appendix C for flow rates and water-quality parameters on springs in this area.

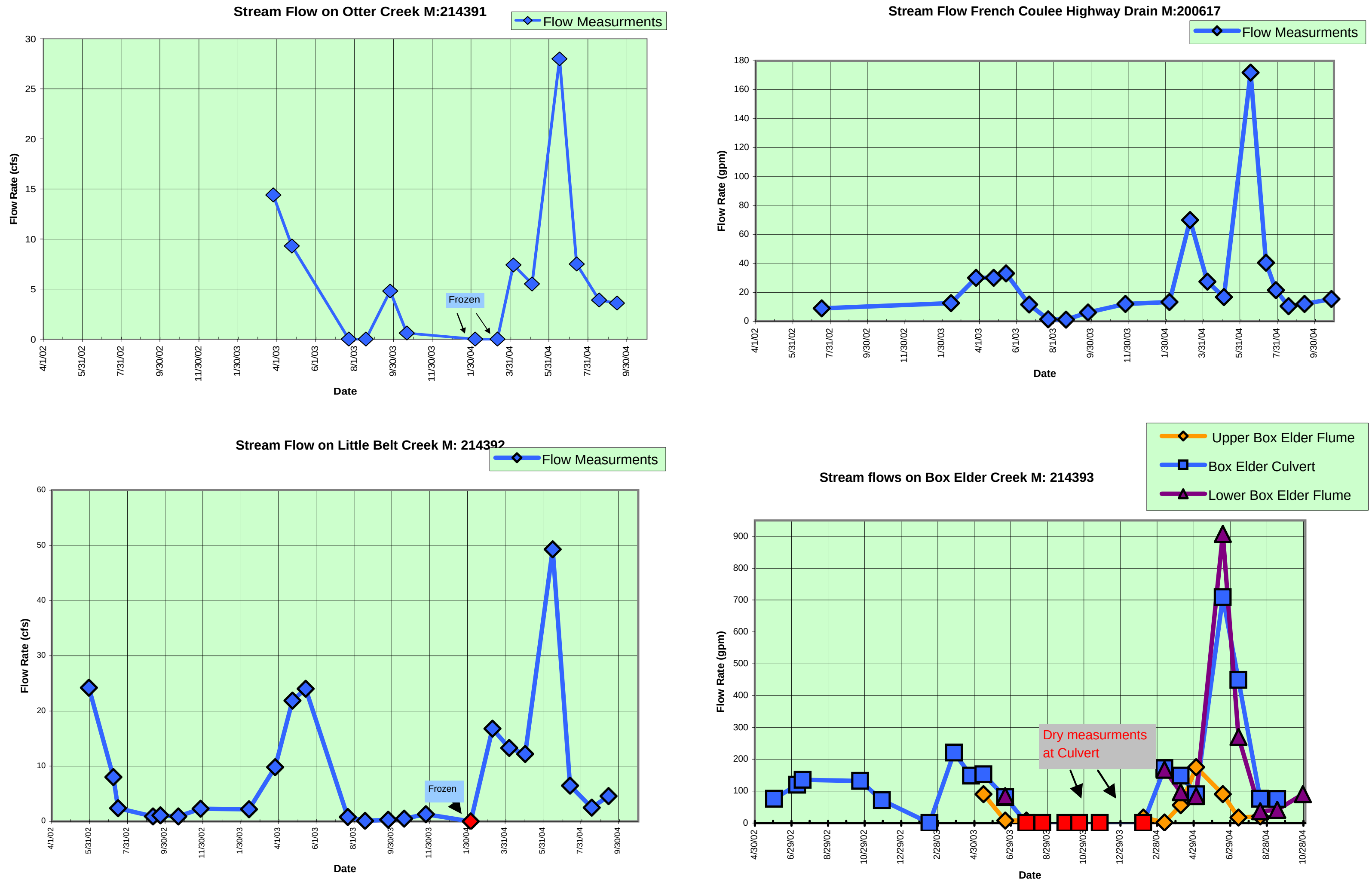


Figure 19. Hydrographs of small streams in the Belt area.

WATER-QUALITY ASSESSMENT

Field water-quality parameters measured as part of the well inventory and water-quality monitoring are shown in Appendix E. The range of dissolved minerals concentrations, oxidizing–reducing conditions, dissolved oxygen concentrations, temperature and pH of each water source were determined by evaluating these data. Variability of these parameters was also used to help determine seasonal fluctuations and the best time to collect representative samples.

Water-quality samples collected as part of this project are summarized in Appendix E. Source information and concentration data used for constructing the modified Schoeller plots are listed in Table 4. Modified Schoeller diagrams of major cations and anions were constructed to compare and contrast water quality of several water sources in the Belt area by plotting the dominant ions (Figure 20). The results of water analyses were grouped by water source (plotting lines using the same color) and were distinguished from similar sources (using solid and dashed lines).

The standard Schoeller plots were modified by adding iron (Fe) and aluminum (Al) to the list of dominant ions. Average concentrations for each constituent were calculated and converted from milligrams per liter (mg/L) to milliequivilants per liter (meq/L). When concentrations of a particular ion were below detection limits, a concentration value on half of the listed detection limit was used. In acidic waters, a low concentration value (0.0001) for the bicarbonate ion was used to allow construction of logarithmic plots.

Table 4. The average concentrations of major cations and anions (meq/L) from each source and the type of water based on dominant ions.

Source	Ca	Mg	Na	Fe	Al	HCO_3	SO_4	Cl	TYPE
AMD	10.674	8.283	0.571	28.863	31.488	0.000	86.880	0.381	Al-Fe-SO_4
Sunburst springs	3.813	4.270	0.435	0.020	0.010	5.426	2.532	0.150	Mg-Ca-HCO_3
All Creeks	3.724	2.620	0.383	0.414	0.006	4.532	1.703	0.141	Ca-HCO_3
Madison wells	4.232	2.353	0.205	0.001	0.002	3.850	2.955	0.048	Ca-HCO_3-SO_4
Alluvial wells	3.797	2.674	0.466	0.001	0.002	5.455	1.477	0.120	Ca-HCO_3
Till well	1.282	5.374	1.583	0.001	0.002	6.231	1.230	0.231	Mg-HCO_3
Mine tailings well	23.603	52.912	1.157	0.172	41.481	0.000	119.424	0.353	Mg-Al-SO_4
Sunburst wells	3.395	4.573	1.534	0.006	0.002	7.124	1.981	0.210	Mg-Ca-HCO_3
Cutbank wells	3.480	2.540	0.360	0.026	0.002	4.848	1.418	0.086	Ca-Mg-HCO_3
Coal well	4.990	3.925	0.966	0.005	0.002	6.826	2.394	0.080	Ca-Mg-HCO_3
Swift well	4.291	2.000	0.347	0.001	0.002	3.663	2.519	0.169	Ca-HCO_3-SO_4

Water Quality of wells, streams and springs in the Belt area

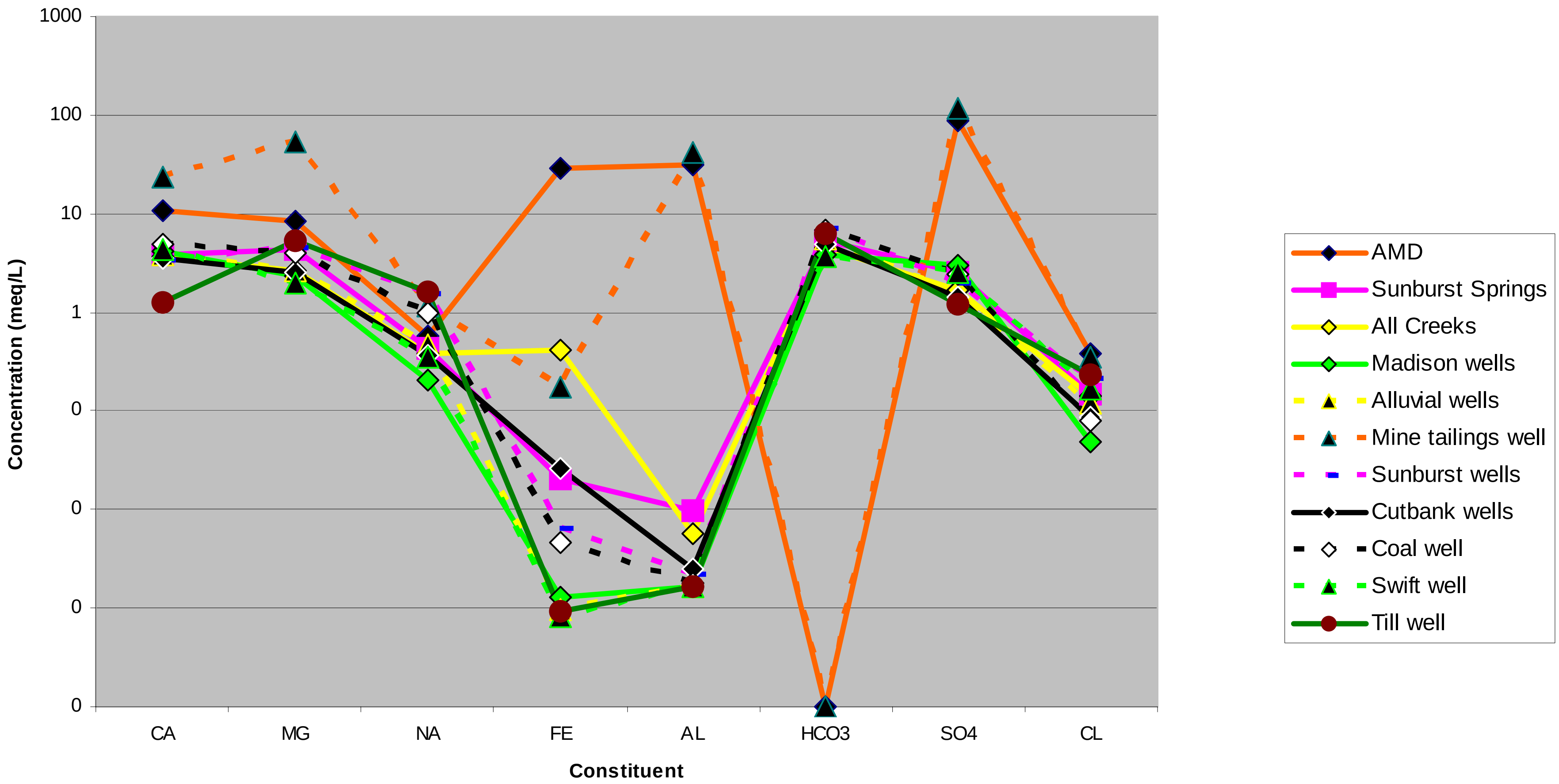


Figure 20. Schoeller diagram depicting average major-ion concentrations from water sources in the Belt area.

Acid Mine Drainage (AMD) Water

Distinct characteristics of AMD discharges are visually, physically and chemically obvious. High iron concentrations form reddish-orange precipitates of iron-oxide minerals when exposed to oxygen in the atmosphere. These iron-oxide minerals frequently cement alluvial sand and gravel along streams impacted by AMD discharges. White to light gray colloidal discharges are common where high concentrations of aluminum hydroxide in ground water discharge into relatively fresh surface water, similar to what is found at the Belt "city swimming hole"(Figure 21). Field parameters of AMD discharges include pH values ranging from 1.75 to 3.99 and an average SC of 3,585 µmhos/cm. Sources of the iron, sulfate, and acidity are pyrite deposits commonly associated with coal deposits. Previous work in the Sand Coulee area identified high concentrations of acid-producing material in the Cutbank sandstone roof rock immediately above the coal (Wheaton and Brown, 1999). Since the same coal bed was mined in the Anaconda Mine at Belt, the source of acid is likely to be similar. No cores were collected in the Belt area, but pyrite deposits overlying or within the coal appear to be primary source of AMD.

AMD samples near Belt were collected from the Anaconda Mine (GWIC ID 200616 average discharge 132 gpm), French Coulee Mine (GWIC ID 200615 average discharge 9 gpm), and Lewis Coulee area mines (GWIC ID 214914 and GWIC ID 214915~average discharge 5 gpm). Samples of AMD discharges are dominated by ions of aluminum (Al), iron (Fe) and sulfate (SO_4), (Al-Fe-SO_4 type water). The pH of the AMD ranged from 2.4 to 4.1. The average calculated dissolved solids (CDS) of the AMD discharges were 5,378 mg/L, average dissolved iron concentrations 537 mg/L, average dissolved aluminum concentrations 283 mg/L and average dissolved manganese (Mn) concentrations 0.682 mg/L. Piper plots (Figure 22) of AMD show a mixed dominance of calcium (Ca) and magnesium (Mg) cations and a strong dominance of sulfate (SO_4) anions. These plots are misleading however, since Al and Fe are the dominant cations, but neither is included in the construction of the Piper plots. The Schoeller diagram (Figure 20) more accurately depicts the dominant ions. The quality of AMD water is not uniform from the different sources. The Anaconda Mine had the freshest water with calculated dissolved solids (CDS) averaging 2,346 mg/L, average dissolved iron concentrations 152 mg/L, average dissolved aluminum concentrations 104 mg/L and average dissolved manganese concentrations 0.417 mg/L. AMD water from the Lewis Coulee Mine and "Lewis Coulee above Castner Park" were similar, having intermediate values of dissolved constituents with an average CDS of 5,800 mg/L, average dissolved iron concentrations 615 mg/L, average dissolved aluminum concentrations 336 mg/L and average dissolved manganese concentrations 1.15 mg/L. The French Coulee Mine drainage had the most concentrated water with calculated dissolved solids (CDS) averaging 8,566 mg/L, average dissolved iron concentrations 939 mg/L, average dissolved aluminum concentrations 468 mg/L and average dissolved manganese concentrations 0.900 mg/L.

A water sample extracted from a well completed in mine tailings near the Coke Oven Flats also shows impacts of AMD. Water from this well is dominated by ions of magnesium (Mg), aluminum (Al), and sulfate (SO_4), (Mg-Al-SO_4 type water). The mine tailings water was similar to AMD on the Schoeller diagram. In the mine tailings water, there were lower concentrations of dissolved iron and higher concentrations of dissolved magnesium. The pH and the CDS of the water in the mine tailings are 4.48 and 7,286 mg/L respectively. The concentrations of other significant constituents were the average dissolved iron concentrations 3.21 mg/L, average dissolved aluminum concentrations 373 mg/L, and average dissolved manganese concentrations 5.98 mg/L. Iron concentrations are significantly lower and manganese concentrations significantly higher than measured in any of the AMD discharges. These chemical differences suggest that dissolved iron may be depleted in the mine tailings, while dissolved magnesium and manganese are enriched. Water discharging into Belt Creek from the mine tailings appears related to the aluminum hydroxide discharges visible at the Belt "city swimming hole".

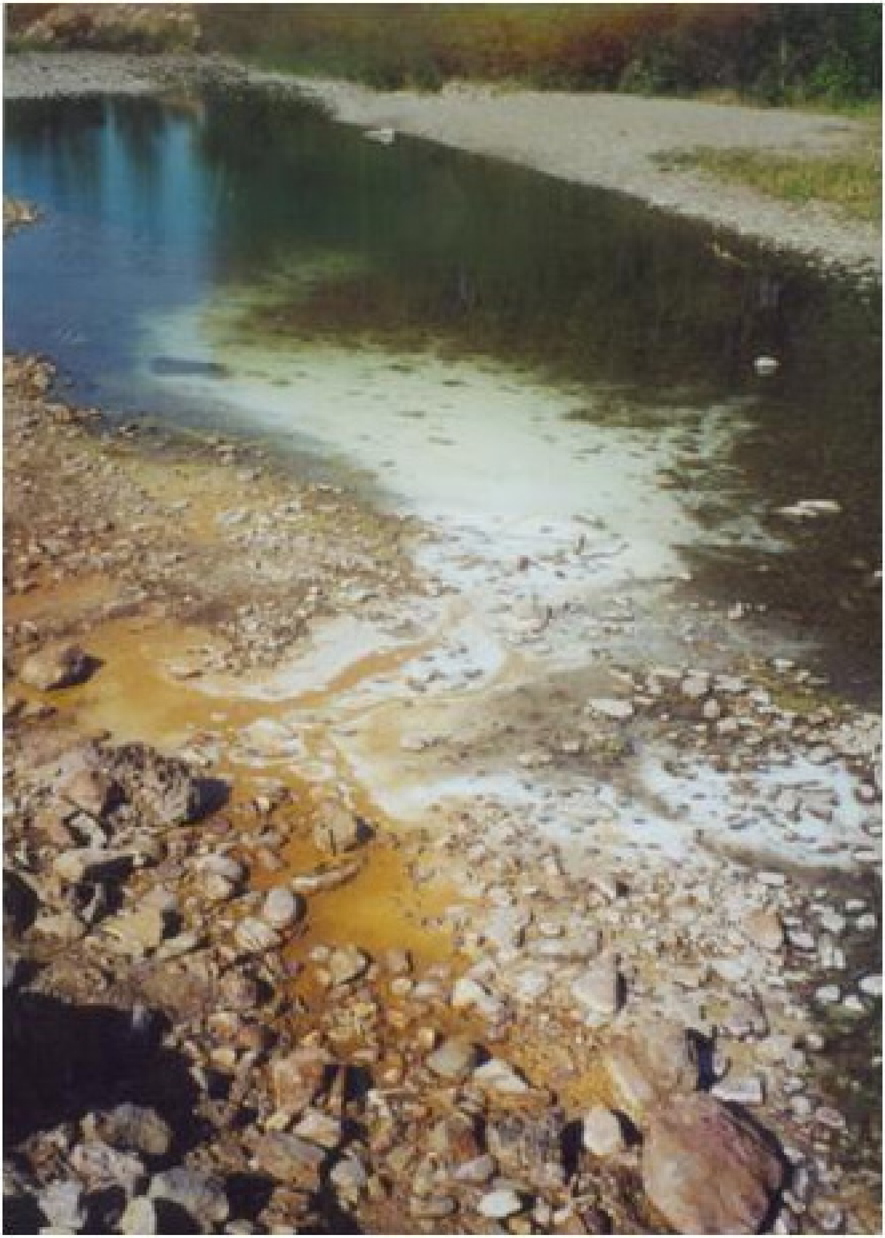


Figure 21. Aluminum hydroxide precipitate discharging into Belt Creek at the Belt "city swimming hole".

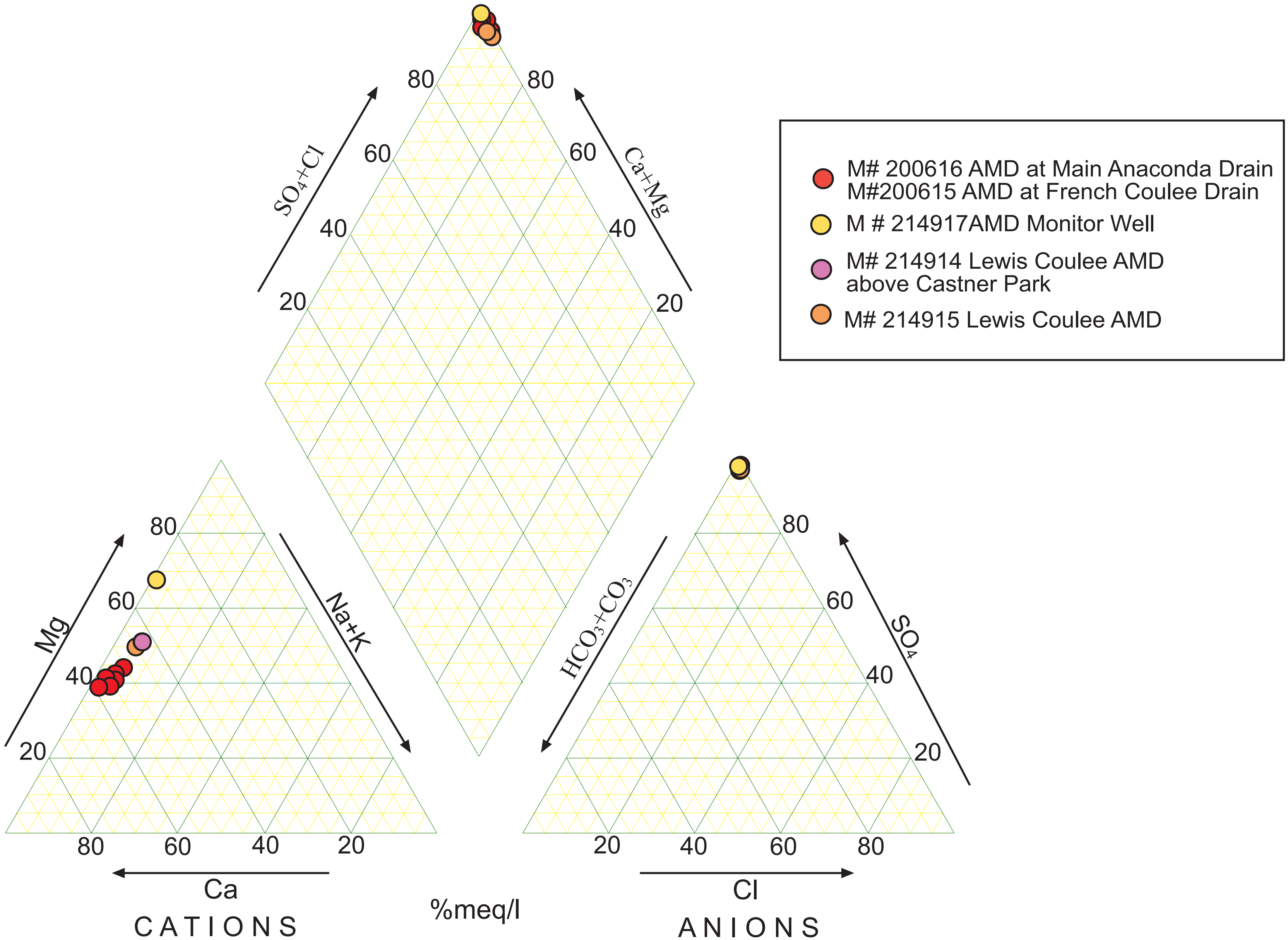


Figure 22. Piper plot of Acid Mine Drainage water in the Belt area.

Surface Water

Belt Creek and Box Elder Creek

The two main streams (Belt Creek and Box Elder Creek) in the vicinity of the Anaconda Mine contain relatively good quality water, where not impacted by AMD. A Piper plot (Figure 23) of Belt and Box Elder Creek samples shows that ions of calcium (CA) and bicarbonate (HCO_3), (CA- HCO_3 type water) dominate. The laboratory pH of all samples from these Creeks ranged from 5.83 to 8.12 and the average CDS was 353 mg/L. Schoeller diagrams of major ions from Box Elder and Belt Creeks were very similar to the diagrams constructed using average concentrations in samples from alluvial wells (figure 20). This demonstrates the close hydrologic relationship between these sources. The two plots are virtually identical with the exception of elevated concentrations of dissolved iron and aluminum ions in the stream samples. The anomalies in the average concentrations of these ions were caused by elevated concentrations in Belt Creek that are clearly associated with AMD.

Water samples from Belt Creek were collected at several locations, including the following locations: Armington Bridge (GWIC ID 214386); Belt (GWIC ID 205836); Belt (GWIC ID 205838); Belt (GWIC ID 205839); near city well (GWIC ID 205508); below Lewis Coulee discharges (GWIC ID 214916); above swimming hole (GWIC ID 214911); and at the north extent of mine tailings (GWIC ID 214913). The pH of Belt Creek ranged from 5.83 to 7.83. The average calculated dissolved solids concentrations (CDS) of Belt Creek were 326 mg/L, average dissolved iron concentrations 1.03 mg/L, average dissolved aluminum concentrations 73 micrograms/L (µg/L), and average dissolved manganese concentrations 0.08 mg/L. The quality of water along Belt Creek showed impacts of AMD with elevated concentrations of metals associated with areas of surface and ground water acidic discharges. Metals loading to Belt Creek will be discussed in a later section of this report.

Water samples from Box Elder Creek were collected at the upper flume (GWIC ID 203450) and the lower flume (GWIC ID 203451). The pH of Box Elder Creek ranged from 6.44 to 8.26. The average calculated dissolved solids concentrations (CDS) of Box Elder Creek were 371 mg/L. The average dissolved iron concentrations were 0.03 mg/L. Average dissolved aluminum concentrations 84.4 µg/L and average dissolved manganese concentrations 0.08 mg/L. The quality of water along Box Elder Creek does not appear to be impacted by AMD and no known AMD discharges have been identified along this creek.

Other small streams, including Little Belt Creek and Otter Creek, were not sampled. Based on field values, these streams are relatively fresh and have not been impacted by AMD.

Sunburst springs

Several springs discharging from the Sunburst aquifer were sampled. These include the French Coulee Highway Drain (GWIC ID 200617), a small seep referred to as the Highway Drain seep (GWIC ID 204710), and four relatively fresh springs along upper French Coulee and Box Elder Creek (GWIC ID's 213598, 205653, 207767, and 204516). Sunburst aquifer spring samples are dominated by ions of magnesium (Mg), calcium (Ca) and bicarbonate (HCO_3), (Mg-Ca- HCO_3 type water) as shown in the Piper Plot (Figure 24) and the Schoeller diagram (Figure 20). The laboratory pH of all samples from these sources ranged from 7.08 to 8.36 and the average CDS was 830 mg/L. Nitrate concentrations of the Sunburst springs range from less than 0.05 to 25.6 mg/L and nearly all of the samples had concentrations greater than 1 mg/L. The elevated nitrate concentrations may be associated with fertilizer applications on the small grain cropland that makes up most of the recharge areas to these springs.

The four fresh Sunburst springs had an average CDS concentration of 298 mg/L. These springs had very low average sulfate concentrations (29 mg/L) and chloride concentrations (3 mg/L). Nitrate concentrations were variable, but typically relatively high. The CDS of spring discharges in the French Coulee Highway Drain averaged 516 mg/L. This drain had intermediate average sulfate concentrations (164 mg/L) and low to intermediate chloride concentrations (6 mg/L). Nitrate concentrations were variable, but typically relatively high. The small seep in the Highway Drain has significantly different water quality than the other Sunburst springs. The average CDS of this water is 3,255 mg/L, nearly 3 times as concentrated as the fresh Sunburst springs. The average sulfate concentration is 2,109 mg/L, which is more than one order-of-magnitude greater than the Highway Drain and nearly two orders-of-magnitude greater than the fresh Sunburst springs. Water from this seep contains anomalously high concentrations of chloride ions.

Water qualities of the French Coulee Highway Drain and the small seep associated with the drain have relatively neutral pH and appear to have been degraded by a source other than AMD. The water appears to be associated with construction of the highway grade that these springs drain. The fill material may contain higher concentrations of salts than the typical Sunburst aquifer. In addition, pulses of calcium chloride appear to be cyclical and may relate to wintertime applications of road salt.

The water quality of samples from Sunburst springs is very similar to samples from Sunburst aquifer wells (Figure 20). The average dissolved concentration of most ions from the spring samples are higher than those from well samples. Salts may be more available for leaching in the highway fill. In addition, elevated concentrations of dissolved iron and aluminum ions may indicate an additional source of AMD.

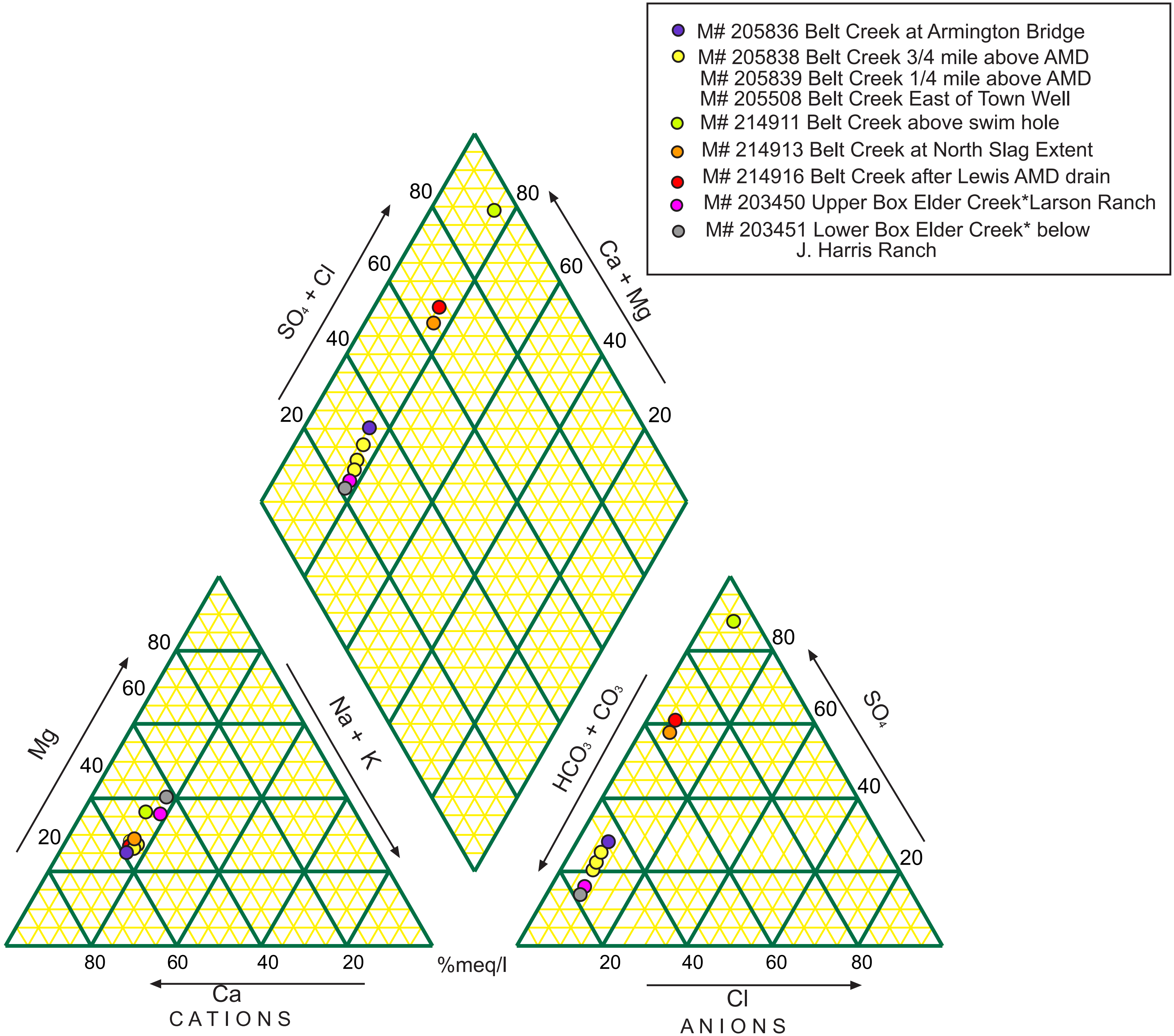


Figure 23. Piper plot of water samples from Belt Creek and Box Elder Creek. Table lists wells from upstream to downstream.

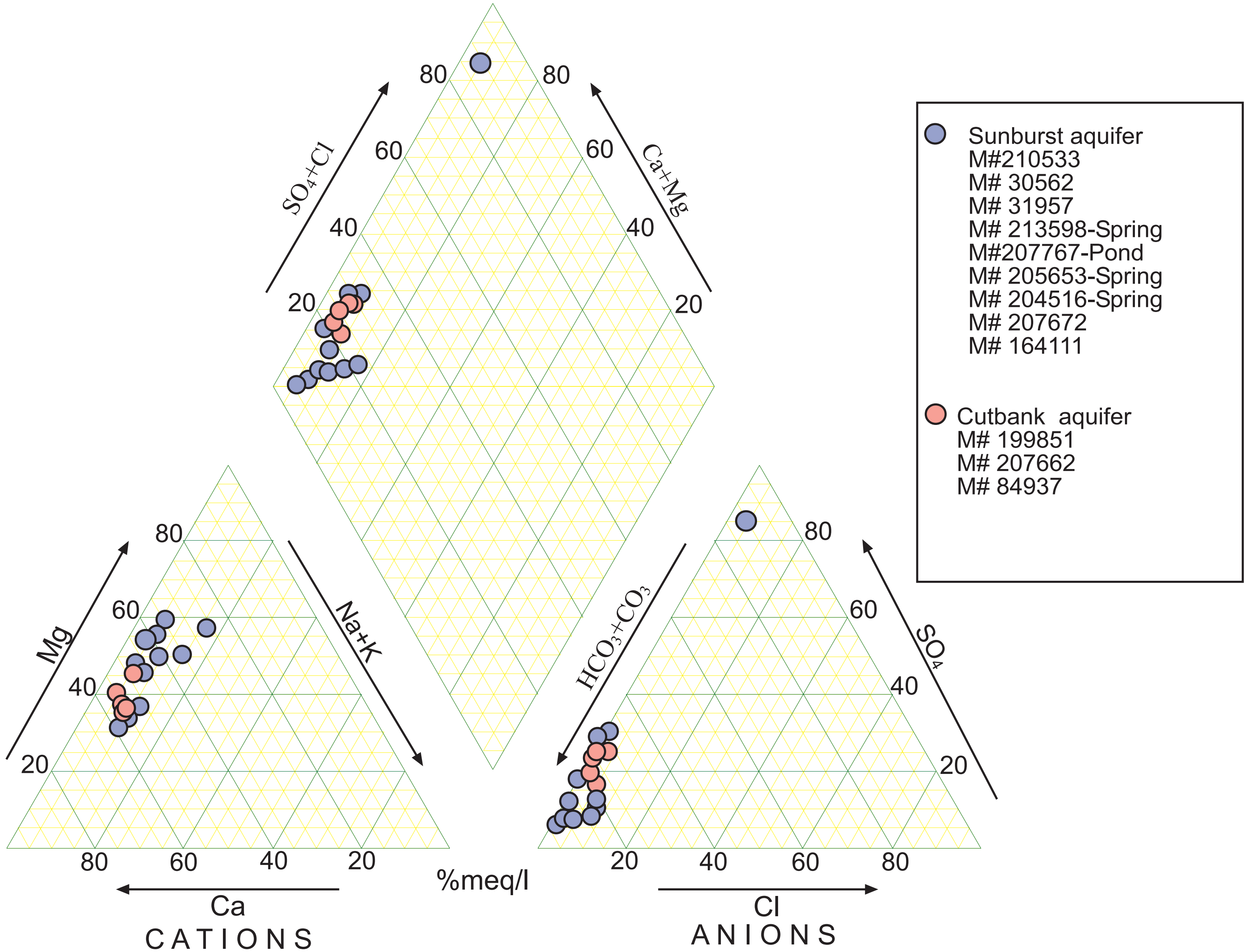


Figure 24. Piper plots of water samples from wells and springs in the Sunburst aquifer and wells in the Cutbank aquifer. Both aquifers are developed in sandstone of the Kootenai Formation.

Ground Water

Several aquifers were sampled and water-quality data compiled from the Belt area. These include the alluvial aquifer along Belt Creek and Box Elder Creek, the Kootenai aquifer system (including the Sunburst aquifer and the Cutbank aquifer), the Morrison aquifer (represented by one well into the coal bed), the Swift aquifer, and the Madison aquifer.

Alluvial aquifer

Three samples collected from two wells completed in the alluvial aquifer were analyzed for dissolved constituents. A well along Box Elder Creek (GWIC ID 32015) was sampled twice and a well along Belt Creek (GWIC ID 186483) was sampled once. The alluvial aquifer samples are very similar to each other and are dominated by ions of dissolved calcium (Ca) and bicarbonate (HCO_3), (Ca- HCO_3 type water) as shown in the Piper Plot (Figure 25) and the Schoeller diagram (Figure 20). The laboratory pH of all samples from these wells ranged from 7.66 to 7.68 and the average CDS was 372 mg/L. The dissolved nitrate concentration from the alluvial well along Belt creek was 0.66mg/L and concentrations from the well along Box Elder Creek averaged 1.04 mg/L. The slightly elevated nitrate concentrations in the Box Elder Creek alluvium are associated with discharge of Sunburst springs that appear to be impacted by fertilizer applications. The average concentration of dissolved iron was 0.018 mg/L and ranged from 0.012 to 0.023. Neither of these wells appears to be impacted by AMD. As previously discussed, the water quality of alluvial aquifer water samples is very similar to the stream samples.

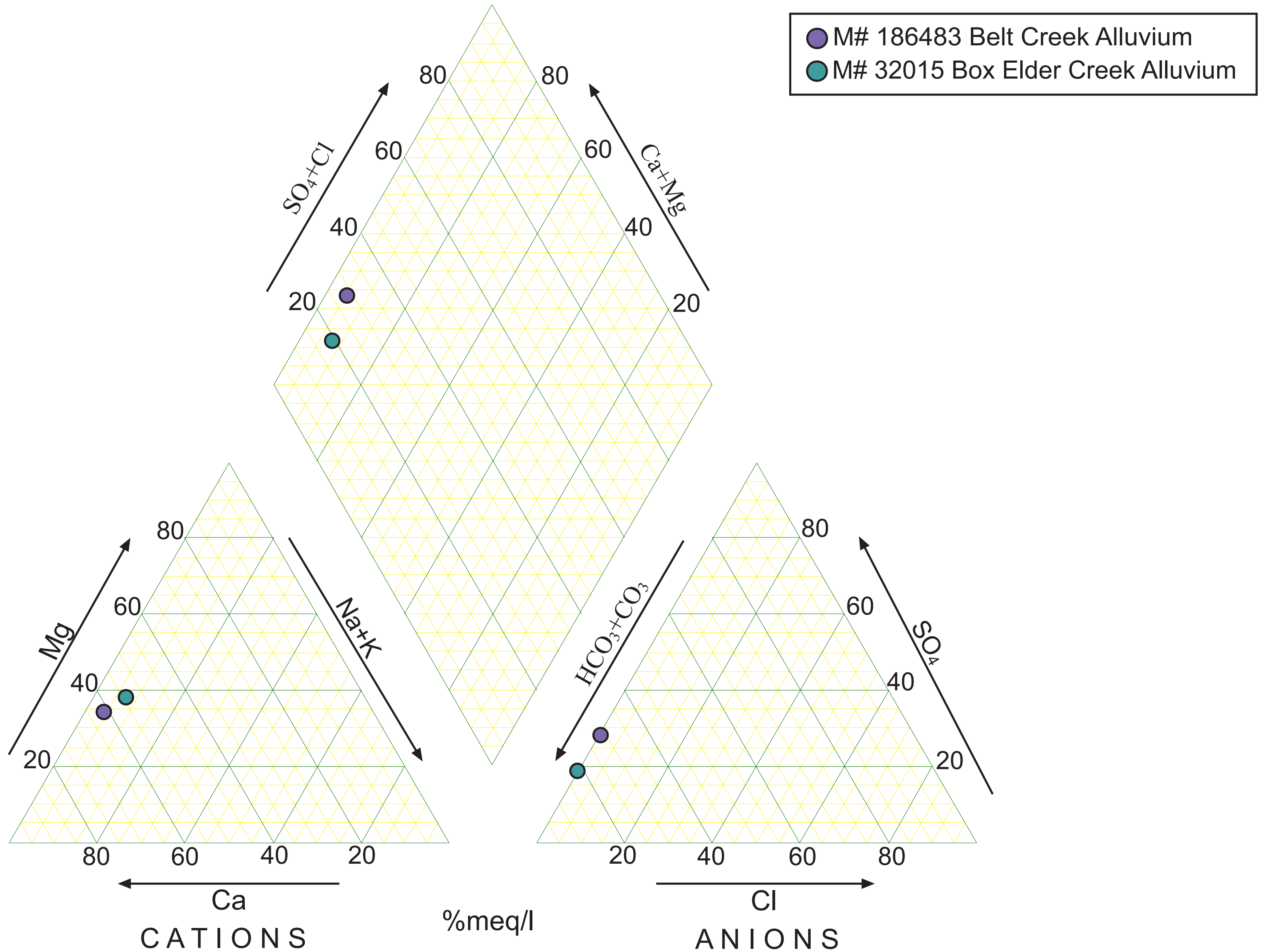


Figure 25. Piper plot of water samples from well completed in alluvium of Belt Creek (GWIC ID 186483) and Box Elder Creek Alluvium (GWIC ID 32015).

Sunburst aquifer

Nine wells completed in the Sunburst aquifer were sampled (GWIC ID's 210533, 30562, 31957, 213598, 207767, 205653, 204516, 207672, and 164111). Sunburst aquifer samples are dominated by ions of magnesium (Mg), calcium (Cg) and bicarbonate (HCO_3), (Mg-Ca- HCO_3 type water) as shown in the Piper Plot (Figure 24) and the Schoeller diagram (Figure 20). The laboratory pH of all samples from these sources ranged from 7.26 to 8.00 and the average CDS was 491 mg/L. Nitrate concentrations of the Sunburst aquifer ranged from less than 0.05 to 11.8 mg/L. Nearly all of the samples had nitrate concentrations greater than 1 mg/L. The elevated nitrate concentrations appear to be associated with fertilizer applications on the small grain cropland that makes up most of the recharge areas to these wells. Orthophosphate (OPO_4) concentrations ranging from 0.1 to 0.2 mg/L were identified in samples from two recently drilled wells located above or adjacent to the Anaconda Mine. No other Sunburst aquifer samples had detectable concentrations of this constituent and it is plausible that these observations are the result of fertilizer impacts with infiltration enhanced by fractures developed over the abandoned mine workings. As previously discussed, the water quality of Sunburst aquifer water samples is very similar to the Sunburst spring samples. The Sunburst wells have an overall lower CDS than the Sunburst springs. This observation is a result of the springs being impacted by AMD, whereas water quality of the wells is not impacted.

Cutbank aquifer

Three wells completed in the Cutbank aquifer were sampled (GWIC ID's 199851, 84937 and 207662). Typically the Cutbank aquifer samples are dominated by ions of calcium (Ca) magnesium (Mg), and bicarbonate (HCO_3), (Ca-Mg-HCO_3 type water) as shown in the Piper Plot (Figure 24) and the Schoeller diagram (Figure 20). The laboratory pH of all samples from these sources ranged from 7.26 to 7.58 and the average CDS was 339 mg/L. Nitrate concentrations of the Cutbank aquifer ranged from less than 0.05 to 2.17 mg/L. An orthophosphate concentration of 0.054 mg/L was identified in one Cutbank aquifer well that is located adjacent to the Anaconda Mine. It is plausible that this observation is the result of fertilizer impacts with infiltration enhanced by fractures developed over the abandoned mine workings. Schoeller diagrams of major ions from the Cutbank aquifer were very similar to the diagrams constructed using average concentrations in samples from a well completed in the coal bed at the top of the Morrison Formation (GWIC ID 215048). This demonstrates the close hydrologic relationship between these sources and supports well-log data indicating these units are part of a single aquifer.

Madison aquifer

Six wells completed in the Madison aquifer were sampled (GWIC ID's 196148, 150504, 31978, 2315, 215047 and 177163). Madison aquifer samples are dominated by ions of calcium (Ca), bicarbonate (HCO_3), and sulfate (SO_4) (Ca-Mg-HCO_3-SO_4 type water) as shown in the Piper Plot (Figure 26) and the Schoeller diagram (Figure 20). The laboratory pH of all samples from these sources ranged from 7.46 to 8.05 and the average CDS was 390 mg/L. Nitrate concentrations of the Madison aquifer were very low. AMD impacts were not evident in any of these samples. Sulfate ions are the second dominant anion in Madison water samples. Since no other metals have elevated concentrations, it appears that the Madison aquifer in the Belt area has relatively high concentrations of sulfate anions in comparison to other aquifers. Schoeller diagrams of major ions from the Madison aquifer were very similar to the diagrams constructed using average concentrations in samples from a well completed in the Swift aquifer (GWIC ID 145604). These aquifers are hydrologically connected in some areas and are likely to have similar water quality.

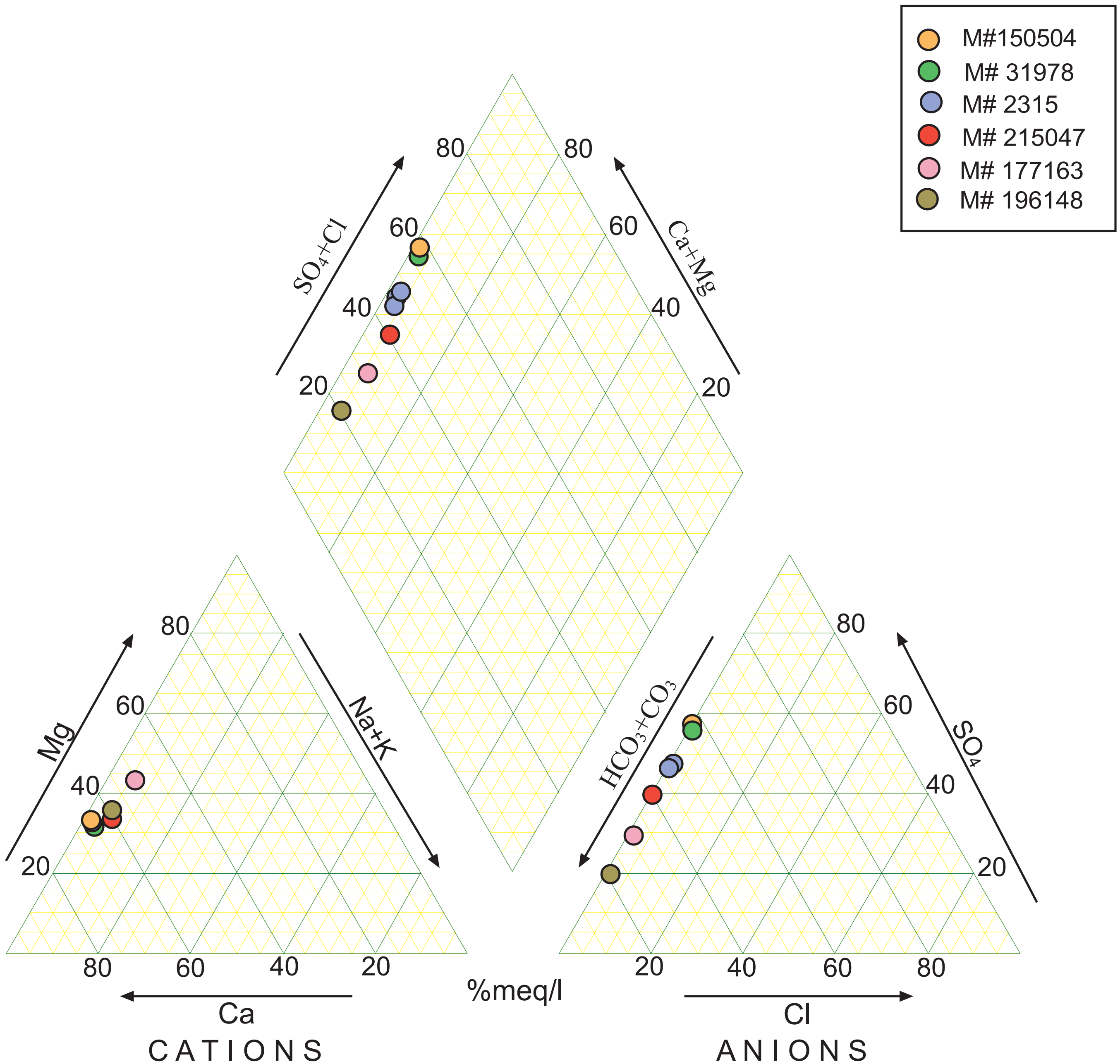


Figure 26. Piper plots of water samples from the Madison aquifer in the Belt area.

Other aquifers

Piper plots of water-quality data from other aquifers are shown in Figure 27 and the Schoeller diagram in Figure 20. These aquifers include a well completed in a glacial till aquifer (GWIC ID 231952), a well completed in the Morrison Coal (GWIC ID 215048), and a well completed in the Swift aquifer (GWIC ID 145604). All of these wells, except for the glacial till aquifer, have been covered in previous discussions. The glacial till well is located several miles north of the Anaconda Mine. The main interest in discussing the water quality from this well is to show the variability of water quality in the Belt area. Water in the till aquifer is dominated by ions of magnesium (Mg) and bicarbonate ($HC0_3$) (Mg-$HC0_3$ type water). The pH of the till well was 7.97 and CDS was 413 mg/L. Nitrate concentrations were 10.77 mg/L; which is above the drinking water standard. Water in this well appears to be impacted by an agricultural source; possibly fertilizer or animal waste. AMD impacts have not affected water in this well.

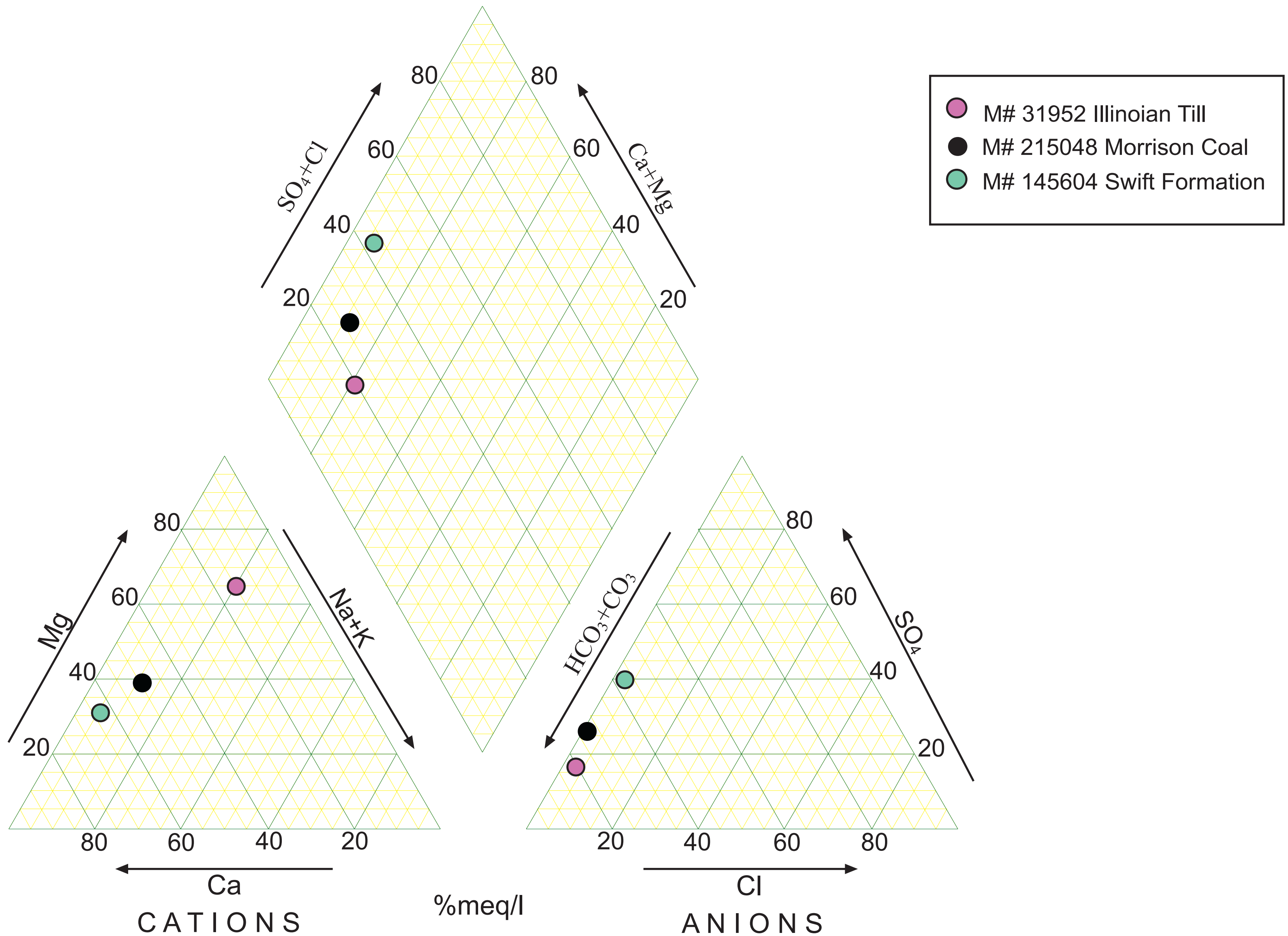


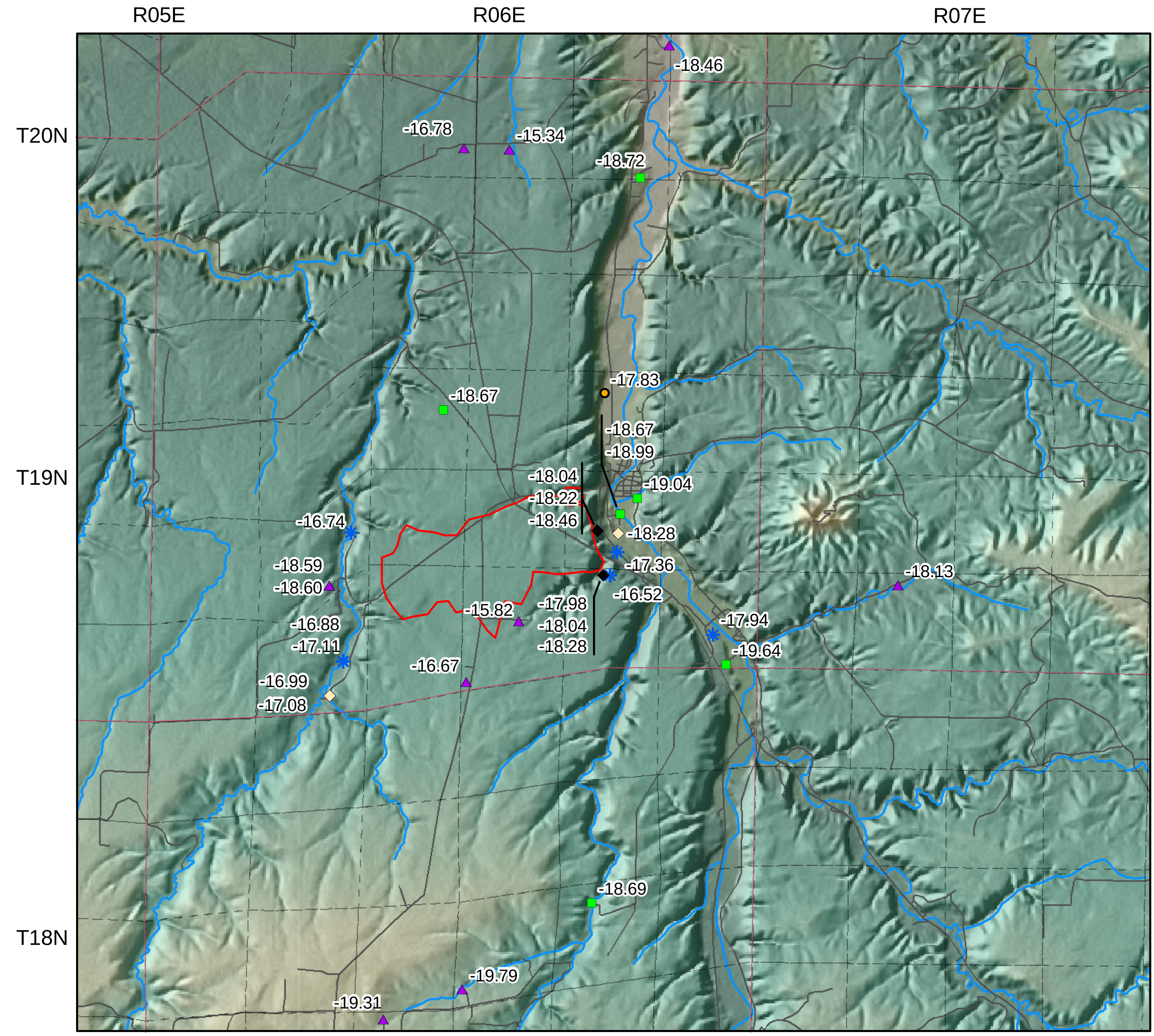
Figure 27. Piper plot of water samples from other aquifers in the Belt area.

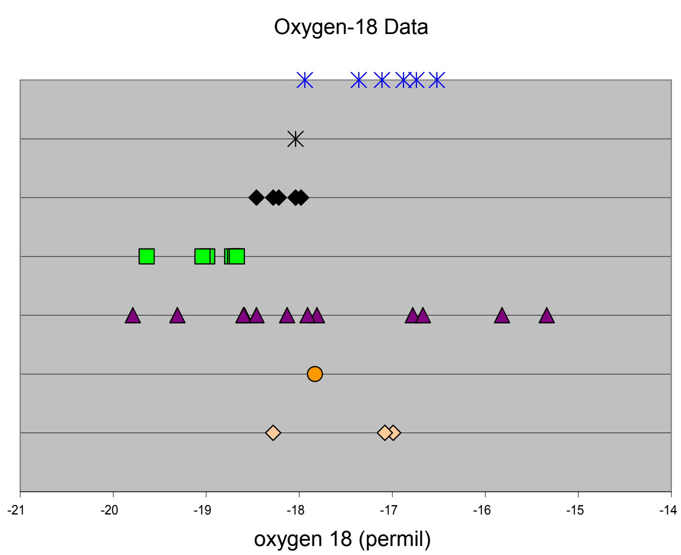
ISOTOPE ASSESSMENT

Stable Isotopes

The stable isotope of oxygen-18 (^{18}O) was analyzed in ground-water to determine recharge sources. The value of $\delta\ ^{18}O$ in precipitation is influenced by meteorological processes and particularly by the temperature, elevation, and latitude of the rain or snowfall event (Clark and Fritz, 1997). Precipitation occurring over warmer climates, low elevations, and low latitudes has higher (less depleted) $\delta\ ^{18}O$ values than precipitation occurring over colder climates, higher elevations, and higher latitudes (Kharaka and others, 2002).

Values of $\delta\ ^{18}O$ from 35 samples range from -19.79 to -15.34 per mil (Figure 28). Samples from the Madison aquifer have relativity low values ranging from -19.64 to -18.67 per mil. They also have a narrow value range, suggesting the recharge is likely from snowfall. The Kootenai aquifer has a wide value range from -19.79 to -15.34 per mil, implying the recharge is by snowfall mixing with rain events. AMD water plots near the midpoint of the range of Kootenai aquifer waters possibly suggesting this aquifer is the source of the AMD. Surface water, Swift Formation water, and alluvial water samples have a similar range; indicating a mixture of snowmelt and rainfall and possible mixing between these sources. A sample taken from the Missouri River, at Toston in May, 1986, indicated snow melt was the dominant recharge source, later mixing with rain fall (Coplan and Kendall, 2000). The map view of $\delta\ ^{18}O$ values shows no obvious trend over the study area.





SOURCE

- Missouri River at Toston
- Surface
- Alluvium
- Kootenai Formation
- Swift Formation
- Madison Formation
- AMD

N

- Township Boundary
- Section Boundary
- Road
- River/Stream
- ACM Boundary

1:100,000

Miles
0 0.5 1 2 3 4

Figure 28. Map and chart showing Oxygen 18 isotopes by water source.

Average Residence Time of Ground Water

Tritium (^3H) is a radioactive isotope of hydrogen that decays with a half-life of 12.43 years and is contained at ambient levels in precipitation as it falls to the earth. Tritium is produced naturally in the atmosphere by interaction of cosmic rays with nitrogen and oxygen; but nuclear bombs, tested between 1952 and 1969, released large quantities of tritium into the atmosphere. Therefore, precipitation during times of nuclear testing contained very high concentrations of tritium. According to the decay equation (Clark and Fritz, 1997), as the precipitation infiltrates into the ground, recharging the aquifers, the radioactive tritium decays to helium-3 (^3He). The age of the water sample is determined by the ratio of the parent (^3H) to the daughter (^3He). The relative age can be estimated using the tritium concentration alone. Table 5 lists tritium concentration and age of water based upon a linear interpretation of data (Hendry and Schwartz, 1990).

Table 5. Age date of ground water estimated from tritium concentration.

Tritium Concentration (Tu)	Age Interpretation (modified from Hendry, 1988)
>38	Average ground-water likely recharged during peak of thermo-nuclear testing between 1960-1965
4-38	Average ground-water less than 50 years old
1-4	Average ground-water less than 35 years old
<1,>0.1	Average ground-water older than 45 years old
< 0.1	Average ground-water older than 65 years old

Most of the samples collected in Belt had tritium concentrations ranging from 4-38 Tritium Units (TU). This implies the average residence time of ground water is less than 50 years old. Some samples ranged between 1-4 TU. This implies the recharge is less than 35 years old. Figure 29 displays how tritium concentrations vary across each aquifer. There was no obvious trend of tritium concentrations or ages either within specific hydrogeologic sources or by map locations of the sample sites. A few general similarities within and between groups were noted. A similar range of tritium concentrations are shown in the surface-water samples, AMD water samples, the Swift Formation water samples, and alluvial water samples. Tritium concentrations from Madison aquifer wells demonstrated the tightest grouping with TU values ranging from 11-14 for all but one sample. The Kootenai Formation water samples displayed the widest spread with TU values ranging from about 1 to greater than 20. The range of tritium concentrations in the AMD water samples tended to concentrate near the midpoint of Kootenai aquifer water samples. One possible explanation of the large range in the Kootenai samples is that many parts of the aquifer have poor hydraulic connections.

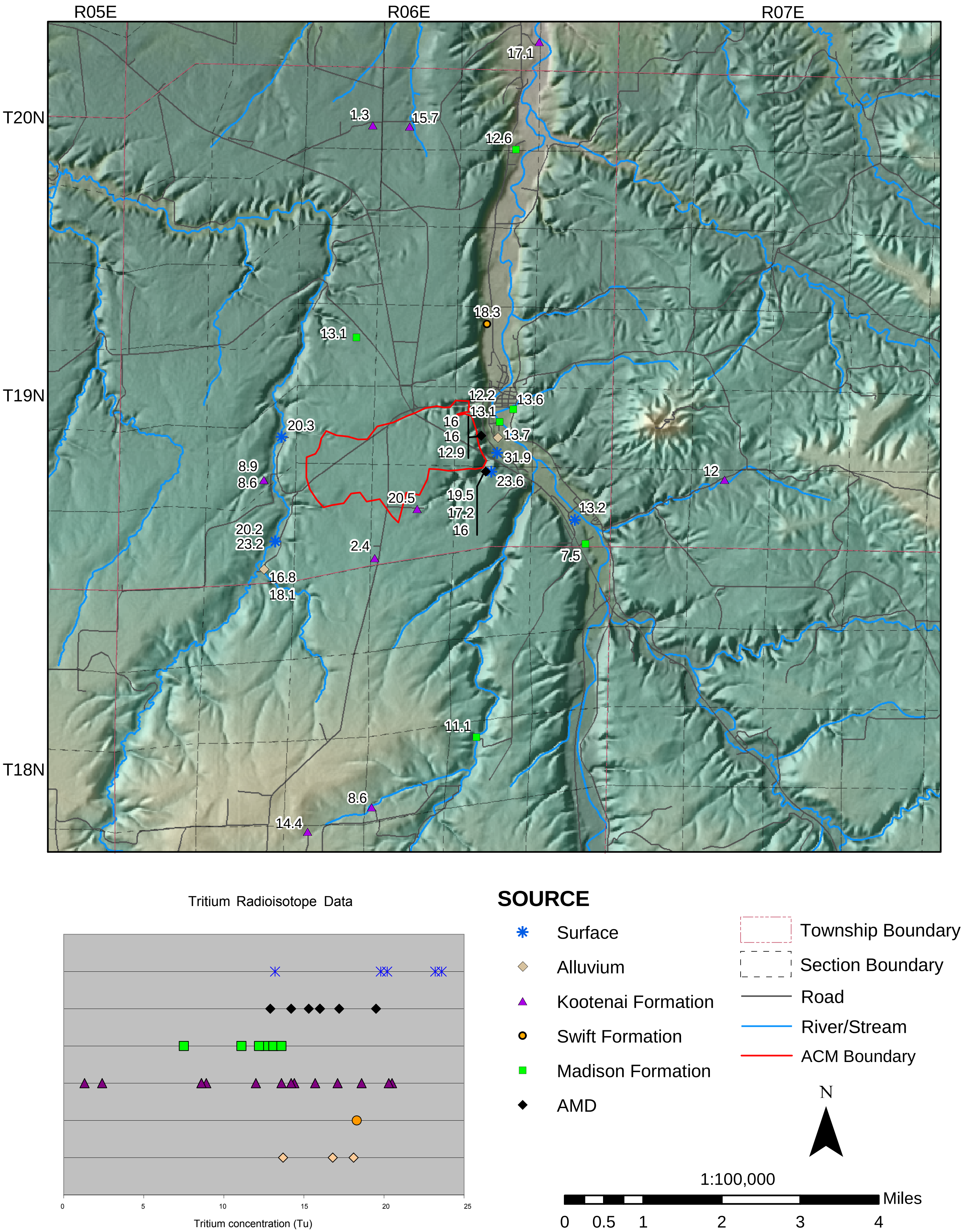


Figure 29. Map and chart showing tritium concentration by water source.

The more specific apparent ages of ground water can be estimated using the helium-3/tritium method and the chlorofluorocarbon method. Helium-3/tritium ages were estimated from two samples. A Madison aquifer sample (GWIC ID 177163) was dated at 8 years and a Kootenai aquifer sample (GWIC ID 193220) was dated at 22 years (Figure 30).

Chlorofluorocarbons (CFC) are anthropogenic components of the atmosphere that have increased in concentrations from the 1940's to the 1990's. Chlorofluorocarbon samples were also collected as another method of age-dating ground-water from the Belt area. Concentrations of three different CFC compounds (CFC-11, CFC-12, and CFC-13) can be used to estimate the average residence time of ground water (Warner and Weiss, 1985; Bu and Warner, 1995; and Prinn and others, 2000). The best recharge age estimates are typically determined by measuring CFC-12 compounds because the concentration levels are still rising and they appear to exhibit the most conservative behavior (Cook and others, 1995). Both CFC-11 and CFC-13 have leveled off since the 1990's, making two recharge ages possible on either side of the curve (younger or older). If the CFC concentrations results are supersaturated, it indicates the atmosphere is not the sole source of CFCs to the aquifer. The sample could be contaminated by industrial or urban CFC sources. Other complications involve determining the temperature of the water as it recharged the aquifer, and the elevation of the recharge area. Varying these factors can significantly change the estimated average residence time of ground water. CFC age estimates ranged from very recent to as old as 42 years (Table 6).

The CFC age estimates and the helium-3/tritium age estimates confirmed the modern ages of water indicated by the tritium concentrations. All valid samples confirmed that the age of water in these aquifers is less than 50 years old. The cause of the high rate of supersaturated CFC results is unknown.

Both CFC and helium-3/tritium age estimates were determined at two sample sites. At well (GWIC ID 193220), the relatively close agreement between the CFC age (17 years) and the helium-3/tritium age (22 years) suggest that the Kootenai aquifer water is about 20 years old. The water in the Madison aquifer at well (GWIC ID 177163) is about 8 years old based on the helium-3/tritium method, but cannot be determined based on the CFC method.

The relatively young age of the stratigraphically deeper Madison water suggests a higher rate of ground-water flux through the Madison aquifer than through the Kootenai aquifer.

It is difficult to have a great deal of confidence in apparent age dates from the various methods described above. The most significant observation from this assessment is that the water tested from all significant aquifers contained modern recharge.

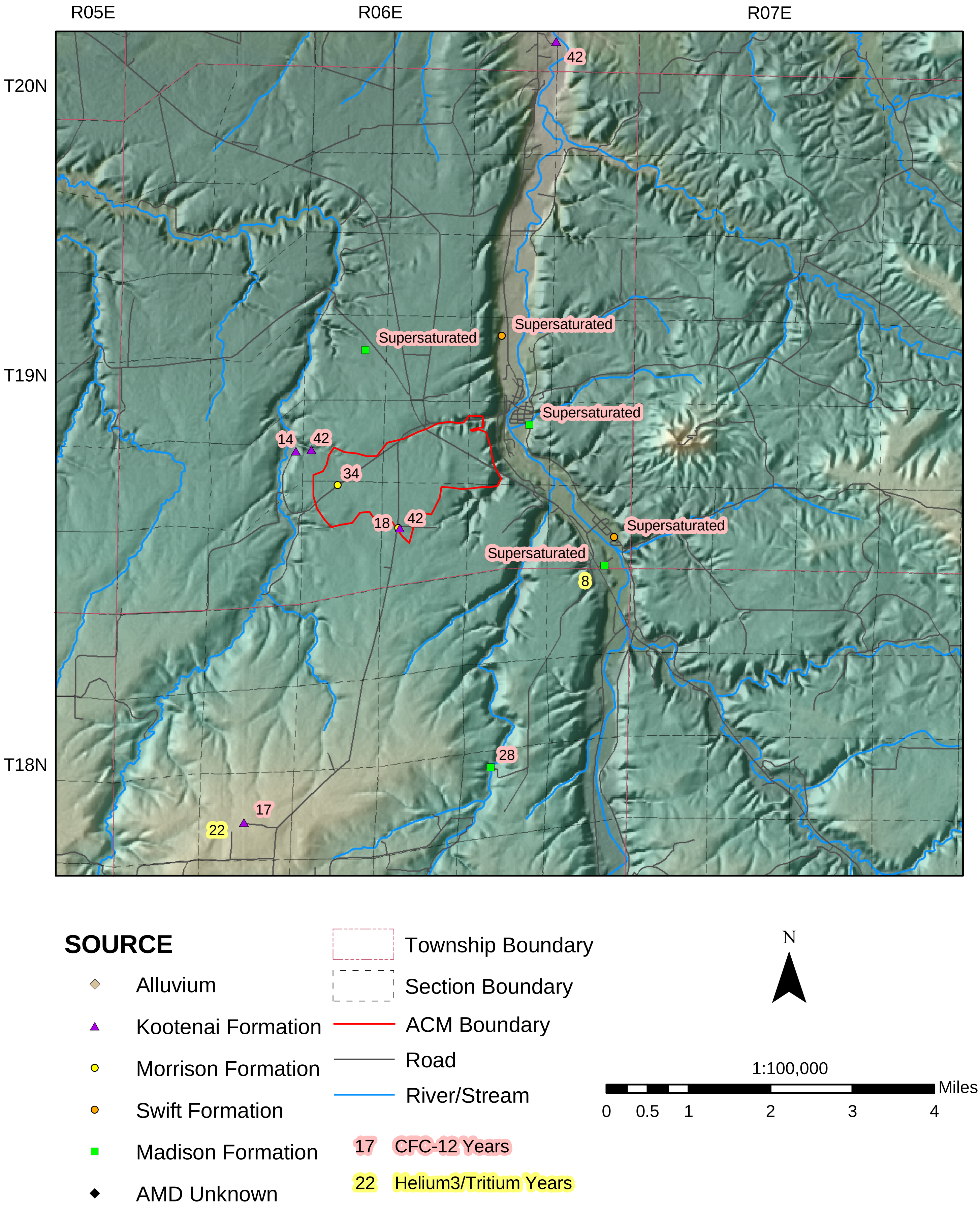


Figure 30. Map showing average residence time of ground water.

Table 6. Summary of CFC results.

					CFC12	error	CFC11	error
ID	Date	Elev. (m)	Temp ^{o}C		years	years	years	years
207258	5/5/2004	1152	10.66	Kootenai	14	2	26	2
207258	5/5/2004	1152	10.66	Kootenai	13	2	26	2
207258	5/5/2004	1152	10.66	Kootenai 75	13	2	26	2
164111	5/6/2004	1039	10.37	Kootenai	Obscured by H_2S		47	2
164111	5/6/2004	1039	10.37	Kootenai	42	2	47	2
164111	5/7/2004	1039	10.37	Kootenai	42	2	47	2
207662	5/7/2004	1177	10.02	Kootenai	41	2	39	2
207662	5/7/2004	1177	10.02	Kootenai	42	2	39	2
207662	5/6/2004	1177	10.02	Kootenai	43	2	39	2
210533	5/6/2004	1338	8.17	Kootenai	18	2	21	2
210533	5/6/2004	1338	8.17	Kootenai	17	2	21	2
210533	5/6/2004	1338	8.17	Kootenai	17	2	21	2
217056	10/28/2004	1213	8.88	Kootenai	Obscured by H_2S	2	41	2
217056	10/28/2004	1213	8.88	Kootenai	40	2	39	2
217056	10/28/2004	1213	8.88	Kootenai	40	2	38	2
215048	10/27/2004	1213	8.83	Morrison	17	2	29	2
215048	10/27/2004	1213	8.83	Morrison	Obscured by H_2S	2	31	2
215048	10/27/2004	1213	8.83	Morrison	19	2	30	2
217052	12/30/2004	1201	8.82	Morrison	34	2	38	2
217052	12/31/2004	1201	8.82	Morrison	35	2	39	2
217052	1/1/2005	1201	8.82	Morrison	34	2	37	2
145604	5/6/2004	1067	9.11	Swift	1Supersaturated		1Supersaturated	
145604	5/6/2004	1067	9.11	Swift	1Supersaturated		1Supersaturated	
145604	5/6/2004	1067	9.11	Swift	1Supersaturated		1Supersaturated	
217922	7/14/2004	1085	9.5	Swift	1Supersaturated		1Supersaturated	
217922	7/14/2004	1085	9.5	Swift	1Supersaturated		1Supersaturated	
217922	7/14/2004	1085	9.5	Swift	1Supersaturated		1Supersaturated	
196148	5/3/2004	1676	10	Madison	28	2	30	2
196148	5/3/2004	1676	10	Madison	27	2	29	2
196148	5/3/2004	1676	10	Madison	28	2	29	2
2315	5/6/2004	1676	11.1	Madison	1Supersaturated		22	2
2315	5/6/2004	1676	11.1	Madison	1Supersaturated		22	2
2315	5/6/2004	1676	11.1	Madison	1Supersaturated		23	2
177163	7/29/2004	1676	9.63	Madison	1Supersaturated		1Supersaturated	
177163	7/29/2004	1676	9.63	Madison	1Supersaturated		1Supersaturated	
177163	7/29/2004	1676	9.63	Madison	1Supersaturated		1Supersaturated	
31978	7/29/2004	1676	11.39	Madison	1Supersaturated		1Supersaturated	
31978	7/29/2004	1676	11.39	Madison	1Supersaturated		1Supersaturated	
31978	7/29/2004	1676	11.39	Madison	1Supersaturated		1Supersaturated	

ACID MINE DRAINAGE IMPACTS

Loading From AMD Discharge

Five sources of AMD discharges were identified in the Belt area. Two are direct discharges to Belt Creek: the main Anaconda Mine Drain and the Lewis Coulee Mine Drain. In addition, indirect discharges were identified from the French Coulee Main Drain and the Lewis Coulee Drain above Castner Park. Another source of indirect AMD discharge is not from a mine drain, but from seepage from Coke Oven Flats; a 27 acre area of reclaimed coal waste located near the Anaconda Mine Drain (DEQ, 2000).

Based on this work and other ongoing MBMG research, the direct loading to Belt Creek from AMD is estimated to be 103,000 pounds of iron per year and 65,000 pounds of aluminum per year (Figure 31). Indirect loading to Belt Creek, from other AMD drains moving through alluvial sediments, is estimated to be 40,000 pounds of iron per year and 28,000 pounds of aluminum per year. This indicates indirect loading from Coke Oven Flats estimated at about 80 pounds of iron per year and 8,800 pounds of aluminum per year (Table 7). The main direct source of AMD is the discharge from the Anaconda Mine; which averages about 132 gpm, or about 213 acre feet per year. The Lewis Coulee Mine Drain discharges an average of 3 gpm, or about 4.8 acre feet per year. The indirect sources discharge about 9 gpm, or 14.5 acre feet per year from the French Coulee Main Drain, and about 2 gpm, or 3.2 acre feet per year from the Lewis Coulee Drain above Castner Park. At both of these indirect sources, the AMD discharges seep into alluvial deposits prior to discharging into the creek. Indirect discharges from the Coke Oven Flats reclamation is through seeps along Belt Creek. The discharge volumes at this site were estimated based on a range of 1 to 3 percent of the year's annual precipitation recharging the 27 acre area of reclaimed waste coal that flows into Belt Creek. Using the high estimate (3 percent of precipitation), about 1 acre foot of this water discharges into Belt Creek annually. The metal loading from all known sources of AMD discharging into Belt Creek near Belt is estimated to be 143,000 pounds of iron per year and 93,000 pounds of aluminum per year.

Mnumber	Site Name	Average Flow Rate (gpm)	Iron (Fe) lbs/year	Aluminum (Al) lbs/year	Loading to Belt Creek
200616	Main Anaconda Mine Drain	132	94,000	60,000	Direct
214915	Lewis Coulee Mine Drain	3	9,000	6,000	Direct
Subtotal from Direct Loading			**103,000**	**65,000**	
200615	French Coulee Mine Drain	9	35,000	17,000	Indirect
214914	Lewis Coulee above Castner Park	2	5,000	2,000	Indirect
214917	Coke Oven Flats	0.62	80	9,000	Indirect
Subtotal from Indirect Loading			**40,000**	**28,000**	
Total AMD Loading			**143,000**	**93,000**	

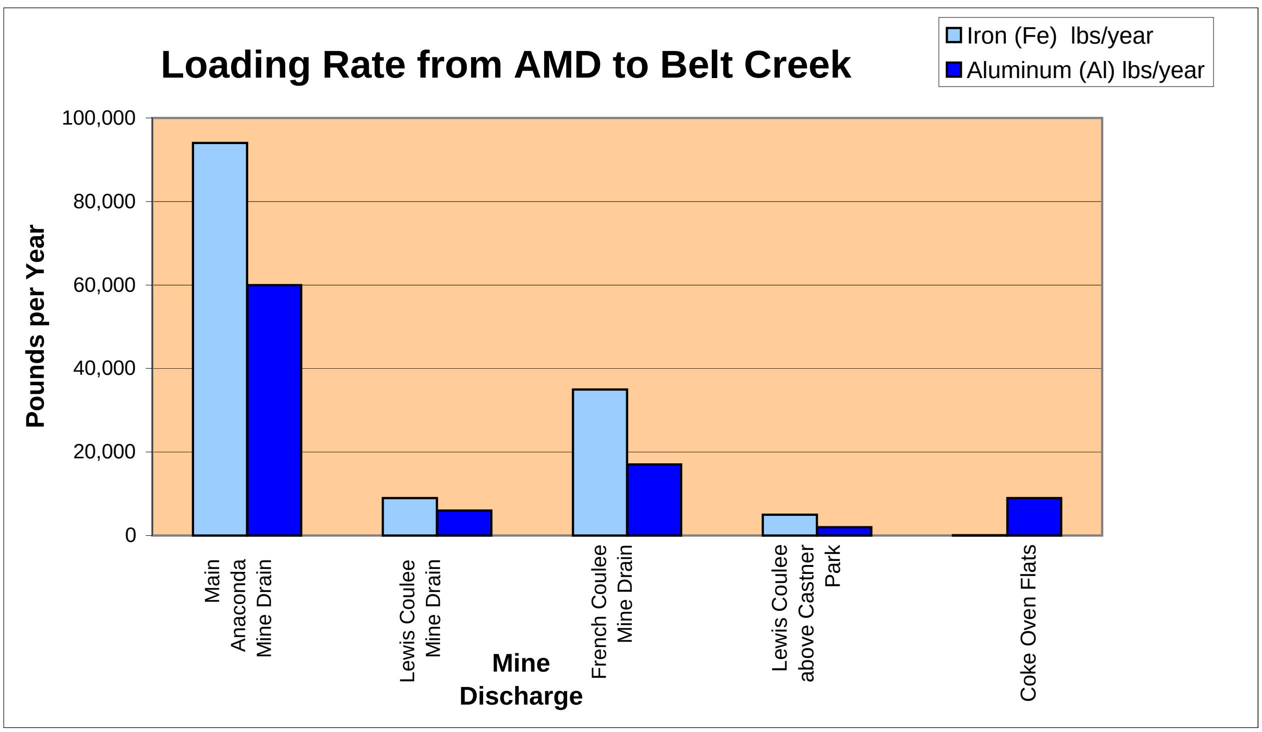


Figure 31. Annual loading to Belt Creek calculated from water quality samples taken from 1-2003 to 10-2004.

Table 7. Data used for loading calculations.

Mnumber	Site Name	Percent of Precipitation Infiltrated on 27 Acres	Flow Rate on Belt Creek at Time of Sample	Iron (Fe) mg/L	Fe Pounds/Year	Aluminum (Al) mg/L	Al Pounds/Year
214917	MW1, A Well Located Within 27 Acres of Reclaimed Coal waste on "Coke Oven Flats"	1%	*	3.210	30	373.061	2,930
		2%	*	3.210	50	373.061	5,850
		3%	*	3.210	80	373.061	8,780
214911	Belt Creek Al Above Swim Hole	*	900	0.169	700	0.568	2,230
214913	Belt Creek at North Extent of Spoil Piles	*	848	6.010	22,200	0.017	100
200616	Anaconda Mine Drain	*	132	171.000	94,500	102.846	59,280

Loading from Ground Water

Transects Across Belt Creek

The impacts of AMD discharges on Belt Creek are shown on Figure 32. This figure is based on data from eight stream transects that were conducted on October 24, 2004 along Belt Creek; from immediately above the first obvious source of AMD discharges to a point about ½ mile downstream. Field parameters pH, temperature, and specific conductance were collected as a composite sample at each transect. In addition, stream flow was measured at three of the transects. The overall flow decreased from about 2 cfs to about 1.3 cfs along this ½ mile reach of Belt Creek. Background conditions are assumed at mile point 0 (Belt Creek behind the city well). At this point, the specific conductance was less than 500 µmhos/cm, pH was about 7.8 S.U., and the water temperature was about 10.5 ^{0}C. For at least ½ mile downstream, AMD discharges were clearly evident by distinctive field parameter measurements from Belt Creek water; with lower pH and higher specific conductance values. The water temperature increased slightly from about mile point 0 to mile point 0.17. Near mile point 0.47, the water temperature had dropped by about 3 ^{0}C. This drop in temperature probably relates to a change from a losing to a gaining reach between mile points 0.17 and 0.47. The AMD impacts to Belt Creek are likely to extend further downstream and consequences on aquatic life are more of a problem during periods of low flow.

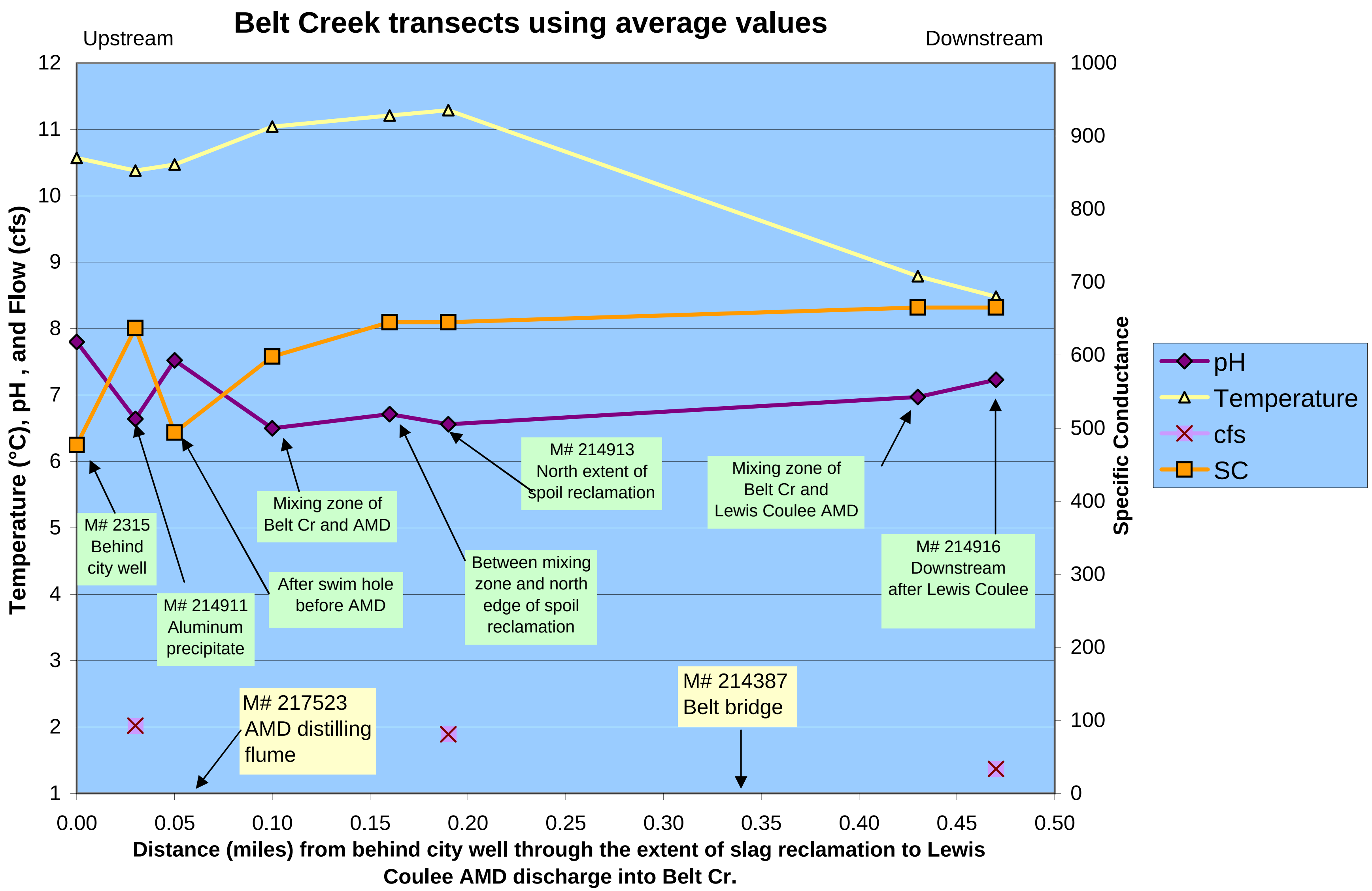


Figure 32. Field measurements collected at 8 transects along Belt Creek show AMD impacts.

Public Well

The Belt Public water supply well #2 (GWIC ID 2315) is located on "Coke Oven Flats", adjacent to Belt Creek. It produces water from the Madison aquifer from a depth of 430 feet. In 1994, the water main line between the pump house and water tanks corroded and leaked. This public well is located only about 140 feet southeast from monitor well #1(MW1) on the reclaimed spoil area. A water-quality sample was extracted from MW1 (GWIC ID 214917). This water appears to be AMD that is very corrosive and high in trace elements. The corrosion in the main line appears to be directly caused due to action of contaminated shallow ground-water and acidic soils. To mitigate the problem, the main line was replaced with plastic pipe (DEQ, 2000). MBMG attempted to inspect the public water supply well for corrosion but we could not access the well casing with the down-hole camera. According to Ground-Water Information Center (GWIC), city well #2 is completed with an 8 inch steel casing. Public water supply rules require that the well be properly grouted. It is likely that cement grout is protecting the well casing from the corrosive shallow ground water. Our recommendation would be to periodically inspect the city well for corrosion, be aware of the corrosion potential, and to develop a plan to repair the casing in case of a leak.

REMEDIATION

Based on the data collected, it appears that recharge to the Anaconda Mine is locally derived. The key to reducing AMD discharges is to slow down, or stop, the infiltration of moisture into the abandoned mine. This recharge appears to be relatively constant as recorded in the discharges from the mine. Fluctuations in precipitation cause significant changes in discharge from the overlying Sunburst aquifer springs. However, the mine discharges remain stable. Apparently the head increase, caused by precipitation-derived recharge, is rapidly dissipated through leakage at contact springs. As a result of this localized flow system, the volume of AMD discharging from the mine could be reduced, or possibly eliminated, by changing land use in the recharge area. Figure 33 is a pie chart of land use in the recharge area towards the Anaconda Mine. Crop-fallow farming covers about 73 percent of the recharge area to the mine. This type of cropping allows significant amounts of water to move below the root zone, recharging underlying ground-water systems. By changing the land use to permanent vegetation, more water consumption would be possible; preventing excess water from recharging the mine voids.

Land Use	Acres	%
Transportation	14.13	0.70%
Range/Pasture	486.10	24.00%
Forest	37.72	1.86%
Cropland	1,487.09	73.43%
Total	2,025.04	100.00%

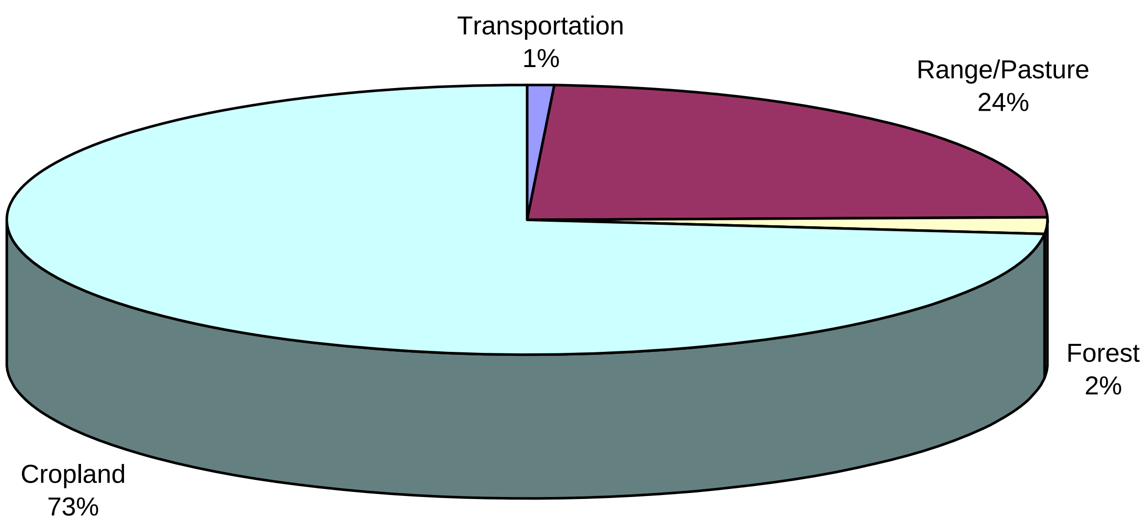


Figure 33. Land use in ground water recharge area.

It is recommended to initially focus cropping changes to areas directly over the mine voids. The region over the mine workings are likely to be highly fractured as a result of collapse or settling of overlying rocks into the mine void. Reducing recharge in this area is likely to have a good potential to limit the movement of water into the mine voids. Land-use changes in other parts of the recharge area could be developed in the future. Long-term monitoring of the AMD discharges, and selected wells in and near the mine workings, should be conducted to document any change in the hydrogeologic system. Other possible remediation options include diverting flow from overlying aquifers to prevent water from filling the mine voids. This could be accomplished by constructing horizontal wells to drain overlying aquifers laterally, or by designing vertical wells to bypass the mine workings and recharge lower aquifer zones. Flooding the mine voids to reduce pyrite oxidation could conceivably reduce AMD, but may result in other unwanted discharges. It appears likely that the least engineered solution has the best potential for mitigating the AMD problem at Belt. Growing alfalfa or other water consumptive crops would have the potential to significantly reduce infiltration and possibly decrease or eliminate the AMD discharges.

REFERENCES

Bu, X., and Warner, M.J., 1995, Solubility of chlorofluorocarbon 13 in water and seawater, Deep-Sea Res. I, 42, 1151-1161p.

Clark, Ian D., and Fritz, P., 1997, Environmental isotopes in hydrology; Lewis Publishers, New York, Boca Raton, 328p.

Cook, P. G., Solomon, D.K., Plummer, L.N., Busenberg, E. and Schiff, S.L., 1995, Chlorofluorocarbons as tracers of groundwater transport processes in a shallow, silty sand aquifer. Water Resources Research, 31: 425-434.

Coplen, Tyler B., and Kendall, Carol, 2000, Stable hydrogen and oxygen isotope ratios for selected sites of the U.S. Geological Survey's NASQAN and Benchmark Surface-Water Networks, U.S. Geological Survey Open File Report 00-160, 409p.

Department of Environmental Quality Mine Waste Cleanup Bureau, 2000, Summary of abandoned mine reclamation work in areas adjacent to Belt Creek and its tributaries.

Duaime, T.E., Sandau K.L., Vuke, S.M., Hanson, Jay, Reddish, Shawn, Reiten, J.C., 2004, Reevaluation of the hydrologic system in the vicinity of the Anaconda Mine at Belt, Cascade County, Montana.

Fischer, C.A., 1907, Great Falls Coal Field, U.S. Geological Survey Bulletin 316.

Fischer, C.A., 1909, Geology of the Great Falls Coal Field, Montana, U.S. Geological Survey Bulletin 356.

Hendry, M.J., Schwartz, F.W., 1990, The chemical evolution of ground water in the Milk River aquifer, Canada. Water Resources Research, 24: 1747-1763.

Hvorslev, M.J. 1951, Time lag and sol permeability in ground-water observations. U.S Army Corps Engineers. Waterways exp. Sta. Bull. 36, Vicksburg, Miss.

Lohman, S. W., 1979, Ground-water hydraulics, U.S. Geological Survey Professional Paper 708.

Montana Bureau of Mines and Geology well information: http://mbmggwic.mtech.edu/

Karper, P.L., 1998, Water-quality data (July 1994 through September 1996) and statistical summaries of data for surface-water in the Sand Coulee Coal Area, Montana: U.S. Geological Society Open-File Report 94-98.

Kharaka, Y.K., Thordsen, J.J., and White, L.D., Isotope and chemical Compositions of Meteoric and Thermal Waters and Snow from the Greater Yellowstone National Park Region: U.S. Geological Survey Open-File Report 02-194.

O'Neill, J.M., and Lopez, D.A., 1985, Character and regional significance of the Great Falls Tectonic Zone, east-central Idaho and west-central Montana: Bulletin of the American Association of Petroleum Geologists, v.69, 349-437p.

Osborne, T.J., M. Zaluski, B.J. Harrison, and J.L. Sonderegger. 1987, Acid-mine drainage control in the Sand Coulee Creek and Belt Creek watershed, Montana, 1983-1987. V.1., Montana Bureau of Mines and Geology Open File Report 109. 54p.

Prinn, R.G., and others, 2000, A history of chemically and raidiatively important gases in air deduced from ALE/GAGW/AGAGE, J. Geophys. Res., 105 (D14), 17751-1779 2p.

Tetra Tech, Inc., 1995, Belt, Montana reclaimed coal burn monitoring well installation, Final Report. Montana Department of Environmental Quality, AMRB Contract # 94-012 T.O. #5.

U.S. Geological Survey: 2000, National Landcover Dataset, Montana: http://nris.state.mt.us/nsdi/nris/nlcd/nlcdgrid.html

Warner, M. J. and Weiss, R.F., 1985. Solubilities of chlorofluorocarbons 11 and 12 in water and seawater. Deep Sea Research, 32: 485-497.

Western Regional Climate Center: http://www.wrcc.dri.edu/summary/.html

Wheaton, John, and Brown, Terry, 1999. Acid mine drainage at the Number 6 mine near Stockett, Montana, Unpublished Final Report to the Department of Natural Resource and Conservation (DNRC) Resource Development Grant Program (RDGP).

Vuke, Susan M., Berg, Richard B., Colton, Roger, B., and O'Brien, Hugh E., 2002. Geologic Map of the Belt 30 X 60 quadrangle, central Montana. Montana Bureau of Mines and Geology Geologic Map, MBMG 450, full color, Scale 1:1000,000.

APPENDIX A

Inventory Data

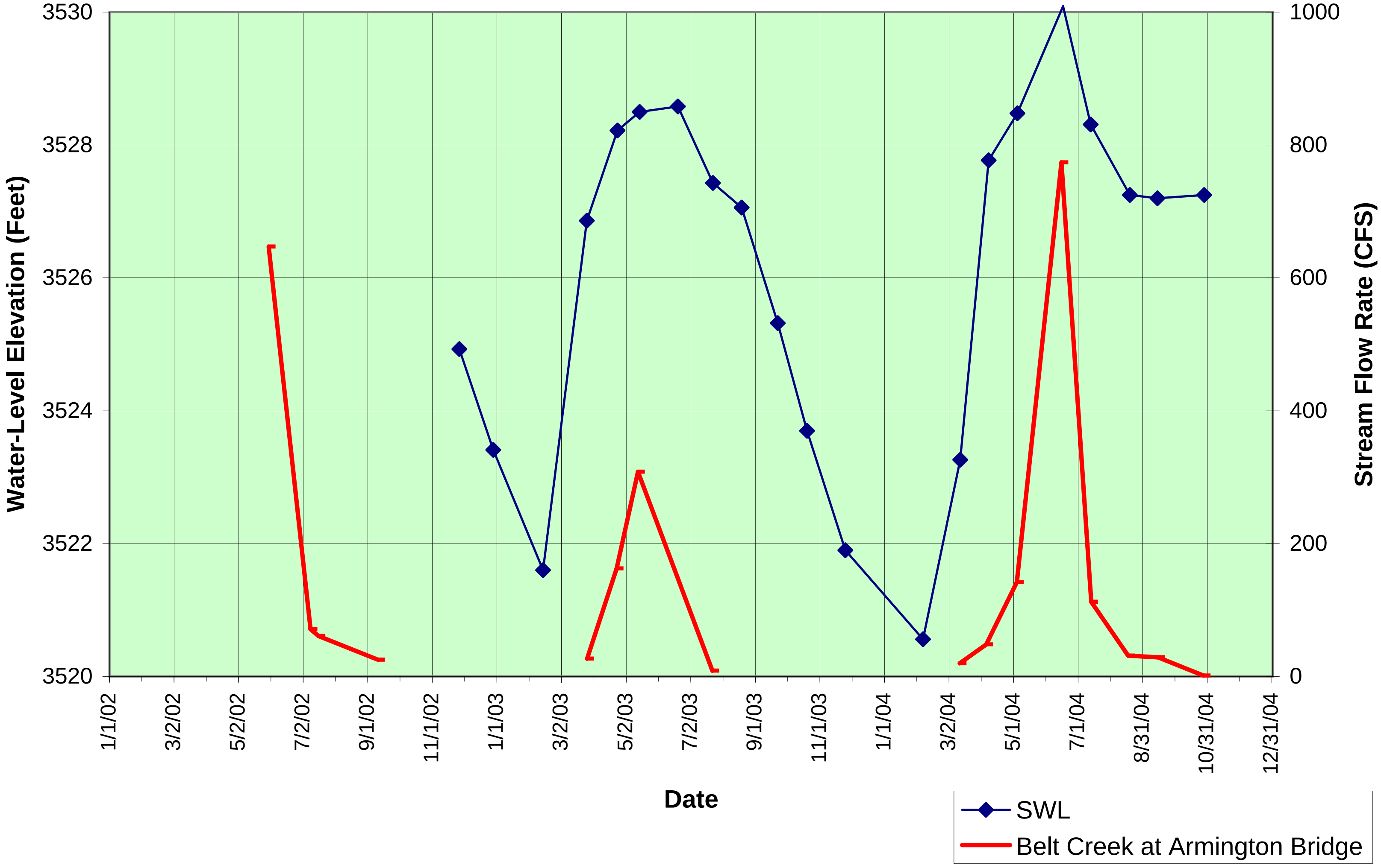
	Site Name	Latitude	Longitude	Township	Range	Section	Tract	Ground Elevation (ft)	Total depth (ft)	Date (mm/dd/yy)	Static water level from mp (ft)	Pumping water level (ft)	Water temperature (°C)	Field SC (umhos/cm)	Field pH	ORP (mV)	Field test nitrate (mg/L N)	Dissolved Oxygen (mg/L)
2315	TOWN OF BELT WELL 2	47.3838	-110.9228	19N	06E	26	ACAD	3520	430	6/5/03			12.2	600	7.06	258		5.8
30562	JOHNSON GERALD	47.3052	-110.9765	18N	06E	21	BABB	4280	35	9/12/02	19.18	19.34	8.9	512	7.42	276	5	
30562	JOHNSON GERALD	47.3052	-110.9765	18N	06E	21	BABB	4280	35	9/23/03	20.15	20.43	9.26	682	6.89	209	10	7.86
31948	NISBET HARRY	47.4342	-110.9119	19N	06E	1	CDBC	3450	56	7/25/03	23.92	28.8	10	672	7.28	-108	0	
31952	GOO EDWARD	47.4305	-110.9547	19N	06E	3	CDBA	3700	12	5/30/03	1.2		12.11	763	7.78	102.3		9.1
31957	HORST NATHAN	47.4298	-110.9655	19N	06E	4	DACD	3715	140	5/29/03	96		15	1123	7.07	14.6		
31957	HORST NATHAN	47.4298	-110.9655	19N	06E	4	DACD	3715	140	9/23/03	95.13	119.7	9.87					
31959	RIMROCK VALLY RANCH INC *BUMGARNER J. EVERETT	47.4122	-110.9718	19N	06E	9	DCC	3730	660	5/29/03			14.8					
31965	BELT COMMUNITY CHURCH	47.4269	-110.9249	19N	06E	11	ABDB	3510	250	7/25/03	216.91		12.2	634	6.94	315	0	
31978	DAWSON JIM AND DELORES	47.3913	-110.9691	19N	06E	21	ACDB	3855	670	5/28/03	427.5		13.3	737	7.32	139.5		5.7
31978	DAWSON JIM AND DELORES	47.3913	-110.9691	19N	06E	21	ACDB	3855	670	11/25/03			9.71					
31980	STEVENSON CARAL AND TERRY	47.3939	-110.9306	19N	06E	23	CADB	3500	74	9/11/02	58.76	60.5	11.3	983	7.36	195	2	
31981	BELT SCHOOL	47.3913	-110.9282	19N	06E	23	CDAD	3500	300	5/3/04	214.81							
31989	FLIGINGER GARY AND MICHELE	47.3996	-110.9263	19N	06E	23	ABCC	3490	200	10/22/03	58.85	67.45	11.4	552	7.04	213	2	9.13
32015	JIM LARSON RANCH	47.3534	-110.9897	19N	06E	32	DCCB	3865	32	6/5/03			10.2	645	7.27	222		5.81
32015	JIM LARSON RANCH	47.3534	-110.9897	19N	06E	32	DCCB	3865	32	10/23/03			10.5	630	7.34	68		5.59
32027	PIMPERTON BOB	47.3666	-110.9003	19N	06E	36	ACDA	3580	44	10/22/03	30.5			460	7	148	2	6.7
32033	FULLER CHARLES H	47.3665	-110.9093	19N	06E	36	BDCD	3570	45	10/24/02	16.85		10.4	641	7.25	-53.2	0	0.24
32040	ASSELS STEVE D.	47.3654	-110.9005	19N	06E	36	DABB	3570	41	10/24/02	18.65		9.7	475	7.49	225	0	6.87
32050	SPRAGG ED	47.3592	-110.9026	19N	06E	36	DCDD	3620	47	9/10/02	45.42							
32061	COLARCHIK ALBERT AND PATRICIA	47.4041	-110.8903	19N	07E	18	CCDA	3765	135	8/19/04	124		9.74	3152	7.03	-4		5.29
84937	HARRIS JOHN JR.	47.3699	-110.9902	19N	06E	29	DD	3860	200	5/16/03	77.8		9.1	815	7.21	180.1	0	5.6
84937	HARRIS JOHN JR.	47.3699	-110.9902	19N	06E	29	DD	3860	200	8/19/03			9.9	740	6.86	186		4.24
84937	HARRIS JOHN JR.	47.3699	-110.9902	19N	06E	29	DD	3860	200	10/23/03			9	730	7.1	36		3.3
123477	WINDER MARTIN AND BARBARA	47.3458	-110.8951	18N	07E	6	CCCB	3600	403	11/26/02	158		10.3	929	7.51	131.4	0	8.7
123498	ARNDT DENNIS	47.3632	-110.9001	19N	06E	36	DACC	3575	53	10/24/02	13.5	21	11.5	458	7.53	15.6	0	5.3
125195	GARZA EMILIO H. AND GERALDINE	47.446	-110.9238	19N	06E	2	ABDB	3480	100	7/24/03	71.9	74.1	13.8	907	6.27	244	0	
128959	SWEENEY RANCH INC.	47.4175	-110.9393	19N	06E	11	CCBB	3805	990	5/29/03	522.5		14.7	625	7.61	48		2.6
132172	KEASTER BRUCE AND NELSON ROGER	47.3118	-110.9975	18N	06E	17	CACA	4380	200	4/9/04	22.03		7.98	736	7.43	128	10	10.7
145604	ASSELS STEVEN D. AND LINDA L.	47.3994	-110.9304	19N	06E	23	BDBA	3500	66	10/24/02	47.3	50.54	12.4	652	7.27	288	0	7.91
145604	ASSELS STEVEN D. AND LINDA L.	47.3994	-110.9304	19N	06E	23	BDBA	3500	66	9/23/03		52.8	11.69	637	7.29			
150504	DANKS BRENDA	47.4317	-110.9234	19N	06E	11	ABAC	3510	300	9/11/02	211.1		12.6	656	7.66	80	0.5	
150504	DANKS BRENDA	47.4317	-110.9234	19N	06E	11	ABAC	3510	300	11/25/03	213.22		11.27	657	7.17	224		6.09
164111	HOYER KEITH AND HEATHER	47.4516	-110.9176	20N	06E	35	DADA	3410	90	8/21/03	3.7	8.48	11.3	617	7.06	8	0	0.32
164111	HOYER KEITH AND HEATHER	47.4516	-110.9176	20N	06E	35	DADA	3410	90	9/23/03	3.71	8.9	11.57	597	7.38			
165475	MCMANIGLE WALLACE	47.3732	-110.9117	19N	06E	36	BABB	3560	50	11/27/02	17.75	26.1	9.6	683	7.44	68.2	0	3.9
171338	FELLOWS MIKE	47.2982	-110.9503	18N	06E	22	CADC	4050	40	4/8/04	10.85	16.2	9.15	442	7.46	-28	2	0.87
177163	SPRAGG ED	47.3592	-110.9026	19N	06E	36	DCDD	3620	490	9/10/02	146.03		10	463	7.46	176.9	0	
177163	SPRAGG ED	47.3592	-110.9026	19N	06E	36	DCDD	3620	490	8/22/03	339.8	339.8	10.4	542	7.53	151	0	10.8
177163	SPRAGG ED	47.3592	-110.9026	19N	06E	36	DCDD	3620	490	11/26/03	340.85		9.08	608	7.36			
180021	REDDISH GARY	47.3232	-110.9302	18N	06E	14	BDBA	3890	200	11/25/00	97.65		9.8	356	7		1	
184178	HEILIG BILL	47.36	-110.906	19N	06E	36	CDAD	3640	262	11/26/03	241.1	250	9.74	813	7.25	194	0	6.22
186483	SPILLER LEROY AND FAYE	47.3785	-110.9269	19N	06E	26	DBCB	3540	24	11/26/02	17.07	17.15	10.6	639	7.32	267.4	0	7.65
186483	SPILLER LEROY AND FAYE	47.3785	-110.9269	19N	06E	26	DBCB	3540	24	9/22/03		16.69	11.19	619	7.19	245.8		6.82
186486	DAWSON RANCH	47.3715	-110.8651	19N	07E	32	BADA	3790	200	9/10/02	57.2	78.2	9.7	1585	7.23	81.8	0	
186486	DAWSON RANCH	47.3715	-110.8651	19N	07E	32	BADA	3790	200	9/23/03	57.55	94.6	9.15	2086	7	179.4		0.36
186802	BELT CR *ABOVE BELT	47.3797	-110.9285	19N	06E	26	BDDA			8/20/03			23.2	1250	3.73	477		5.74
193220	EVANS DAN AND MARY	47.3689	-110.9154	19N	06E	36	BCBD	3560	500	5/13/03	261							
196148	REDDISH GARY	47.3232	-110.9312	18N	06E	14	BDBA	3890	800	9/10/02			10	367	7.79	84	0	
196148	REDDISH GARY	47.3232	-110.9312	18N	06E	14	BDBA	3890	800	9/23/03			10.09	530	7.32	126.9		4.35
199851	ERIC JOHNSON	47.3099	-110.9593	18N	06E	15	CCBC	4160	160	9/12/02	100.06		10.2	485	7.53	55.5	0	
199851	ERIC JOHNSON	47.3099	-110.9593	18N	06E	15	CCBC	4160	160	9/23/03		100.87	10.22	482	6.84	174.5		0.34
200058	IKE HAGGESON	47.3746	-110.9127	19N	06E	25	CCDA	3560	100	11/26/02	36.65	40.47	10.5	879	7.25		0	3.65
200615	FRENCH COULEE MINE	47.3722	-110.93	19N	06E	26	CDDB	3550		1/29/03			7	5620	2.7	628		4.73
200615	FRENCH COULEE MINE	47.3722	-110.93	19N	06E	26	CDDB	3550		3/15/03			7.2	5030	2.68	650		3.75
200615	FRENCH COULEE MINE	47.3722	-110.93	19N	06E	26	CDDB	3550		4/22/03			9.7	4660	2.68	659		3.12
200615	FRENCH COULEE MINE	47.3722	-110.93	19N	06E	26	CDDB	3550		5/28/03			12.2	4410	2.62	655		3.54
200615	FRENCH COULEE MINE	47.3722	-110.93	19N	06E	26	CDDB	3550		6/18/03			12.2	2820	2.63	653		4.42
200615	FRENCH COULEE MINE	47.3722	-110.93	19N	06E	26	CDDB	3550		7/17/03								
200615	FRENCH COULEE MINE	47.3722	-110.93	19N	06E	26	CDDB	3550		8/19/03			14.3	5180	2.36	639		3.15
200615	FRENCH COULEE MINE	47.3722	-110.93	19N	06E	26	CDDB	3550		9/18/03			11.3	5690	2.41	636		5.97
200615	FRENCH COULEE MINE	47.3722	-110.93	19N	06E	26	CDDB	3550		10/23/03			10.3	5800	2.73	288		3.72
200615	FRENCH COULEE MINE	47.3722	-110.93	19N	06E	26	CDDB	3550		4/24/04			10.2	4080	2.57	573		6.63
200615	FRENCH COULEE MINE	47.3722	-110.93	19N	06E	26	CDDB	3550		6/24/04			12.23	4090	1.75	546		
200615	FRENCH COULEE MINE	47.3722	-110.93	19N	06E	26	CDDB	3550		8/12/04			12.2	6230	3.99	626		8.8
200616	ANACONDA MINE DRAIN AT CULVERT	47.3788	-110.9314	19N	06E	26	BDCD	3540		1/30/03			9.8	2290	2.99	627		2.91
200616	ANACONDA MINE DRAIN AT CULVERT	47.3788	-110.9314	19N	06E	26	BDCD	3540		3/15/03			10.7	2220	3.01	626		2.75
200616	ANACONDA MINE DRAIN AT CULVERT	47.3788	-110.9314	19N	06E	26	BDCD	3540		4/22/03			7.5	2260	2.89	639		2.6
200616	ANACONDA MINE DRAIN AT CULVERT	47.3788	-110.9314	19N	06E	26	BDCD	3540		5/28/03			11.3	2350	2.84	623		1.8
200616	ANACONDA MINE DRAIN AT CULVERT	47.3788	-110.9314	19N	06E	26	BDCD	3540		6/18/03			9.9	1425	2.51	631		2.51
200616	ANACONDA MINE DRAIN AT CULVERT	47.3788	-110.9314	19N	06E	26	BDCD	3540		7/17/03								
200616	ANACONDA MINE DRAIN AT CULVERT	47.3788	-110.9314	19N	06E	26	BDCD	3540		8/19/03			9.9	2355	2.58	607		2.1
200616	ANACONDA MINE DRAIN AT CULVERT	47.3788	-110.9314	19N	06E	26	BDCD	3540		9/18/03			9.94	2390	2.7	623		1.54
200616	ANACONDA MINE DRAIN AT CULVERT	47.3788	-110.9314	19N	06E	26	BDCD	3540		10/23/03			9.91	2300	2.99	264		1.83
200616	ANACONDA MINE DRAIN AT CULVERT	47.3788	-110.9314	19N	06E	26	BDCD	3540		4/24/04			9.8	2275	2.8	460		3.78
200616	ANACONDA MINE DRAIN AT CULVERT	47.3788	-110.9314	19N	06E	26	BDCD	3540		6/24/04			11.91	2120	2.75	495		
200616	ANACONDA MINE DRAIN AT CULVERT	47.3788	-110.9314	19N	06E	26	BDCD	3540		8/12/04			9.9	2465	2.68	630		1.61
200617	FRENCH COULEE * HIGHWAY DRAIN	47.3722	-110.9285	19N	06E	26	CDDA	3560		1/30/03			3.5	610	7.79	82		11.09
200617	FRENCH COULEE * HIGHWAY DRAIN	47.3722	-110.9285	19N	06E	26	CDDA	3560		3/15/03			4.1	440	8.17	144		10.9

	Site Name	Latitude	Longitude	Township	Range	Section	Tract	Ground Elevation (ft)	Total depth (ft)	Date (mm/dd/yy)	Static water level from mp (ft)	Pumping water level (ft)	Water temperature (°C)	Field SC (umhos/cm)	Field pH	ORP (mV)	Field test nitrate (mg/L N)	Dissolved Oxygen (mg/L)
200617	FRENCH COULEE * HIGHWAY DRAIN	47.3722	-110.9285	19N	06E	26	CDDA	3560		4/22/03			8.6	605	7.78	114		10.8
200617	FRENCH COULEE * HIGHWAY DRAIN	47.3722	-110.9285	19N	06E	26	CDDA	3560		5/28/03			13.6	740	8.13	50		9.05
200617	FRENCH COULEE * HIGHWAY DRAIN	47.3722	-110.9285	19N	06E	26	CDDA	3560		6/17/03			15.1	460	8.07	42		11.05
200617	FRENCH COULEE * HIGHWAY DRAIN	47.3722	-110.9285	19N	06E	26	CDDA	3560		7/17/03								
200617	FRENCH COULEE * HIGHWAY DRAIN	47.3722	-110.9285	19N	06E	26	CDDA	3560		8/19/03			10.6	790	7.66	304		9.6
200617	FRENCH COULEE * HIGHWAY DRAIN	47.3722	-110.9285	19N	06E	26	CDDA	3560		9/19/03			9.34	860	7.74	116		9.57
200617	FRENCH COULEE * HIGHWAY DRAIN	47.3722	-110.9285	19N	06E	26	CDDA	3560		4/24/04			8.3	620	8.16	322		12.1
200617	FRENCH COULEE * HIGHWAY DRAIN	47.3722	-110.9285	19N	06E	26	CDDA	3560		6/24/04			12.18	586	7.3	372		
200617	FRENCH COULEE * HIGHWAY DRAIN	47.3722	-110.9285	19N	06E	26	CDDA	3560		8/12/04			12	765	9.72			10.4
201066	RAY OGLE	47.3149	-110.9475	18N	06E	15	DBAC	4060		9/12/02	131.92		13.2	553	7.32	171	0	
201069	DAVE FETTER	47.2573	-110.916	17N	06E	1	CCCC	3830	11	9/12/02	9.18	10.61	14.6	417	7.81	147	0	
201123	GLEN MCCLELAND	47.3774	-110.9262	19N	06E	26	DCBA	3540		9/10/02	20.6	22.15	9.8	634	7.41	-143.9	0	
201878	PONDEROSA CAMPGROUND	47.3636	-110.8996	19N	06E	36	DACC	3580	505	8/19/03	206.55							
202378	DANNY HARDINGER	47.3241	-110.9747	18N	06E	9	CDCA	4240	0	5/16/03	3.4		7.6	601	6.86	300.9	2	6.49
202581	GENE ERBETTA	47.4318	-110.9159	19N	06E	12	BBBB	3440	35	9/11/02	9.28		13.4	446	7.69	163.9	0	
203450	UPPER BOX ELDER CREEK * LARSON RANCH	47.3586	-110.9868	19N	06E	32		3840		5/28/03			19	675	8.1	240		7.32
203450	UPPER BOX ELDER CREEK * LARSON RANCH	47.3586	-110.9868	19N	06E	32		3840		6/17/03			18.2	400	7.89	299		7.81
203450	UPPER BOX ELDER CREEK * LARSON RANCH	47.3586	-110.9868	19N	06E	32		3840		7/17/03								
203450	UPPER BOX ELDER CREEK * LARSON RANCH	47.3586	-110.9868	19N	06E	32		3840		8/19/03			15.6	620	7.85	253		7.93
203450	UPPER BOX ELDER CREEK * LARSON RANCH	47.3586	-110.9868	19N	06E	32		3840		9/18/03			8.7	620	7.58	245		9.13
203450	UPPER BOX ELDER CREEK * LARSON RANCH	47.3586	-110.9868	19N	06E	32		3840		10/23/03			9.3	660	7.71	66		6.95
203450	UPPER BOX ELDER CREEK * LARSON RANCH	47.3586	-110.9868	19N	06E	32		3840		4/25/04			13	635	8.48	296		12.8
203451	LOWER BOX ELDER CREEK * BELOW J HARRIS RANCH	47.3779	-110.9856	19N	06E	29		3745		5/28/03			24.5	680	8.2	236		5.73
203451	LOWER BOX ELDER CREEK * BELOW J HARRIS RANCH	47.3779	-110.9856	19N	06E	29		3745		6/17/03			23.3	395	8.15	286		7.88
203451	LOWER BOX ELDER CREEK * BELOW J HARRIS RANCH	47.3779	-110.9856	19N	06E	29		3745		4/25/04			17	570	8.67	288		14.3
204516	JIM LARSON	47.3651	-110.9484	19N	06E	34	ACDC	3926	19.6	11/27/02	12.9		8.1					
204516	JIM LARSON	47.3651	-110.9484	19N	06E	34	ACDC	3926	19.6	9/24/03	12.65		11.31	526	7.46	233.6		8.57
204687	OSTERMAN DARIN AND NOEL	47.3706	-110.9095	19N	06E	36	BACD	3570	381	11/26/02	278.85	279.53	10					
204710	SEEP ON LEFT SIDE OF HIGHWAY DRAIN * BELT MT	47.3757	-110.927	19N	06E	26		3600		7/17/03								
204710	SEEP ON LEFT SIDE OF HIGHWAY DRAIN * BELT MT	47.3757	-110.927	19N	06E	26		3600		8/19/03								
204710	SEEP ON LEFT SIDE OF HIGHWAY DRAIN * BELT MT	47.3757	-110.927	19N	06E	26		3600		9/19/03			10.4	3510	7.4	210		9.11
205508	BELT CREEK * E OF TOWN WELL #2	47.3812	-110.9257	19N	06E	26		3520		8/20/03			20.9	460	7.48	253		8.28
205653	JOHN HARRIS RANCH * SPRING	47.3663	-110.9974	19N	06E	29		3920		8/19/03			10	560	7.02	234		4.29
205653	JOHN HARRIS RANCH * SPRING	47.3663	-110.9974	19N	06E	29		3920		10/23/03			9.5	560	7.42	62		3.9
205836	BELT CREEK	47.3636	-110.9056	18N	06E	12	ABDA			8/27/03			17.9	297	7.79	510		
205838	BELT CREEK	47.3753	-110.9183	18N	06E	26	DDDA			8/27/03			18.4	371	7.22	512		
205839	BELT CREEK	47.3808	-110.9253	18N	06E	26	DBBA			8/27/03			19.2	372	7.48	513		
206358	BONNIE ZANTO	47.4478	-110.924	20N	06E	35	DCDB	3490	202	8/20/03	97.2		13.1	789	6.82	190	0	14.6
206360	FRANK BALITOR	47.3788	-110.9268	19N	06E	26	DBCB	3530		11/27/02								
206544	HOYER JERRY T.	47.4296	-110.9223	19N	06E	11	ABDD		265	8/22/03	175.55							
207258	PLEASENT VALLEY COLONY	47.3784	-110.9834	19N	06E	29	ACBB	3770	72	5/27/03	30.59		10		7.21	85.8		
207258	PLEASENT VALLEY COLONY	47.3784	-110.9834	19N	06E	29	ACBB	3770	72	8/21/03	38.13	38.3	10.7	137	7.55	137	1.5	8.03
207286	NELSON ROGER	47.292	-111.0247	18N	06E	19	CCCA	4150	60	4/9/04	14.72		7.99	487	7.99	-18	0	0.52
207463	IRVINE	47.3507	-110.9566	18N	06E	3	BCAD	4060	56.3	9/24/03	25.69							
207649	BRUCE KEASTER	47.4033	-110.9775	19N	06E	16	CCB	3635	30	5/28/03	4.11		19.8	892	7.02	75.5		3.9
207662	BURGE EXPLORATION ACM WELL	47.3787	-110.9794	19N	06E	29	DAAA	3860	186	8/20/03	125.4							
207662	BURGE EXPLORATION ACM WELL	47.3787	-110.9794	19N	06E	29	DAAA	3860	186	4/25/04	118.58		11.1	220	7.21	310		4.9
207662	BURGE EXPLORATION ACM WELL	47.3787	-110.9794	19N	06E	29	DAAA	3860	186	5/7/04	118.3		10.02	606	6.92	76		2.82
207672	IRVINE	47.3559	-110.9597	19N	06E	34	CCCC	4022		9/24/03			10.51	558	7.18	178	0	10.91
207767	HARRIS JOHN * POND	47.37	-110.9918	19N	06E	29		3760		9/19/03			9.9	500	7.34	192		7.73
207930	GARY CROWDER	47.3676	-110.9031	19N	06E	36	ACAA	3560	40	10/21/03	28	29.9	10.3	476	7.27	237	0	7.92
209498	JIM LARSON SPRING 3	47.3637	-110.9809	19N	06E	32	AAD	3860		5/27/03			20.7		8.19	74.6		5.4
209500	JIM LARSON SPRING 2	47.3587	-110.9816	19N	06E	32	DAA	4020		5/27/03			18.8	800	8.22	105.5		6.9
209514	JOHN HARRIS S-9	47.369	-110.9886	19N	06E	29	C	3840		5/29/03			14.4	835	7.9	76		8.3
209515	JOHN HARRIS S-8	47.3699	-110.9914	19N	06E	29	C	3820		5/29/03			14.6	775	8.01	103		9
209516	EDWARD GOO POND	47.4348	-110.9527	19N	06E	3	CDCB	3700		5/30/03			18.7	512	7.91	40.3		
209517	JIM LARSON S-1	47.3583	-110.9891	19N	06E	32	DBB	3840		5/27/03			21.5	799	8.22	82.3		7.5
209526	PLEASANT VALLEY COLONY SPRING	47.3777	-110.9829	19N	06E	29	DCAA	3800		5/27/03			16	878	7.65	106		
209527	PLEASANT VALLEY COLLONY S-4	47.365	-110.9706	19N	06E	33	BD	3910		5/27/03			18.1	574	8.58	141		6
209592	ROGER NELSON	47.2901	-111.0247	18N	06E	19	CCCD	4160		4/9/04			8.63	484	7.02	224	0	2.22
210402	BRUCE KEASTER	47.3683	-110.9024	19N	06E	36	ACAD	3580	27.5	10/21/03								
210533	MARRY EVANS	47.3126	-110.9951	18N	06E	17	CAAD	4390	90	5/6/04	29.57	32.4	8.17	1019	7.51	90.8	10	9.03
210533	MARRY EVANS	47.3126	-110.9951	18N	06E	17	CAAD	4390	90	7/29/04	25.77		8.61	886	7.26	107		8.14
210655	JIM SNIDER	47.3966	-110.951	19N	06E	22	BDDB	3860	76	5/7/04	34.65		9.83	801	7.43	173	5	6.1
212233	MURPHY, LARRY	47.4043	-110.8911	19N	07E	18	CCD	3765	380	8/19/04	253.65	275.3	10.9	1689	6.66	64		0.42
213386	JIM SNIDER	47.4484	-110.9604	20N	06E	33	DDDB	3635	29	5/7/04	12.5		8.93	1085	7.73	234	20	7.8
213598	PLEASANT VALLEY SPRING * OLD HARRIS HOMESTEAD	47.4131	-110.9716	19N	06E	16		3670		8/12/04			12.8	650	9.71	381		9.36
214068	RICK BECKER	47.4318	-110.9939	19N	06E	5	C	3730		5/30/04			10.8					
214071	JIM DAWSON	47.3956	-110.9731	19N	06E	21	BDC	3800		5/28/03			10.2	745	7.9	37.5		10.6
214078	JIM DAWSON	47.3994	-110.9687	19N	06E	21	BAD	3790		5/28/03			20.5	810	7.82	109		14.9
214079	RICK BECKER	47.413	-110.9486	19N	06E	5	C	3730		5/30/03	4.28		11.7	819	7.58	98		9.1
214093	DOUG ZIMMERMAN	47.4345	-110.9623	19N	06E	4	CADC	3720		5/29/03	94.19		12.9	1398	6.87	14.6		1.6
214395	GARY REDDISH LOWER SPRING	47.3196	-110.9298	18N	06E	14	CABA	3940		9/26/03			12.9	500	7.85	230		8.65

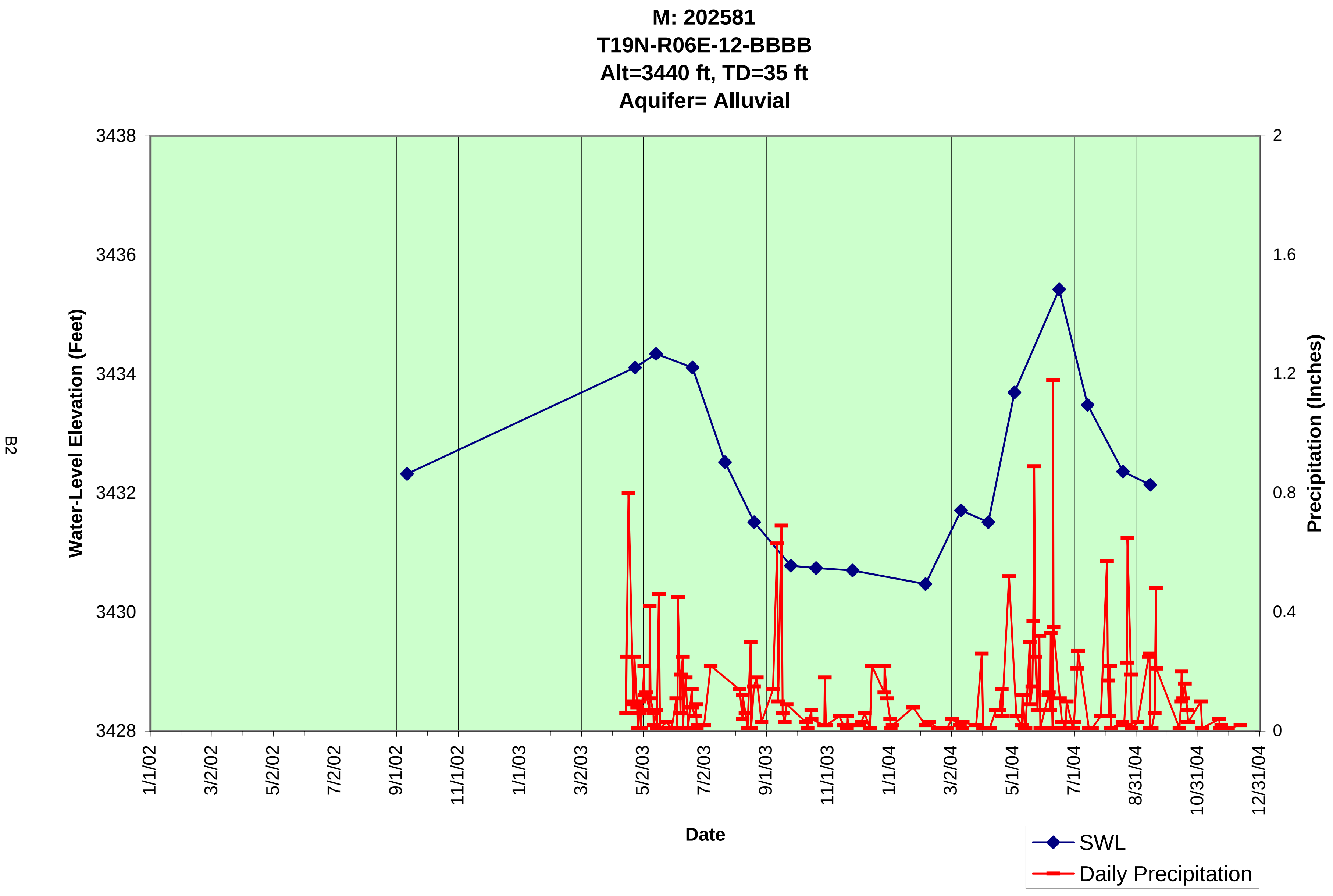
Appendix B

Ground-Water Hydrographs

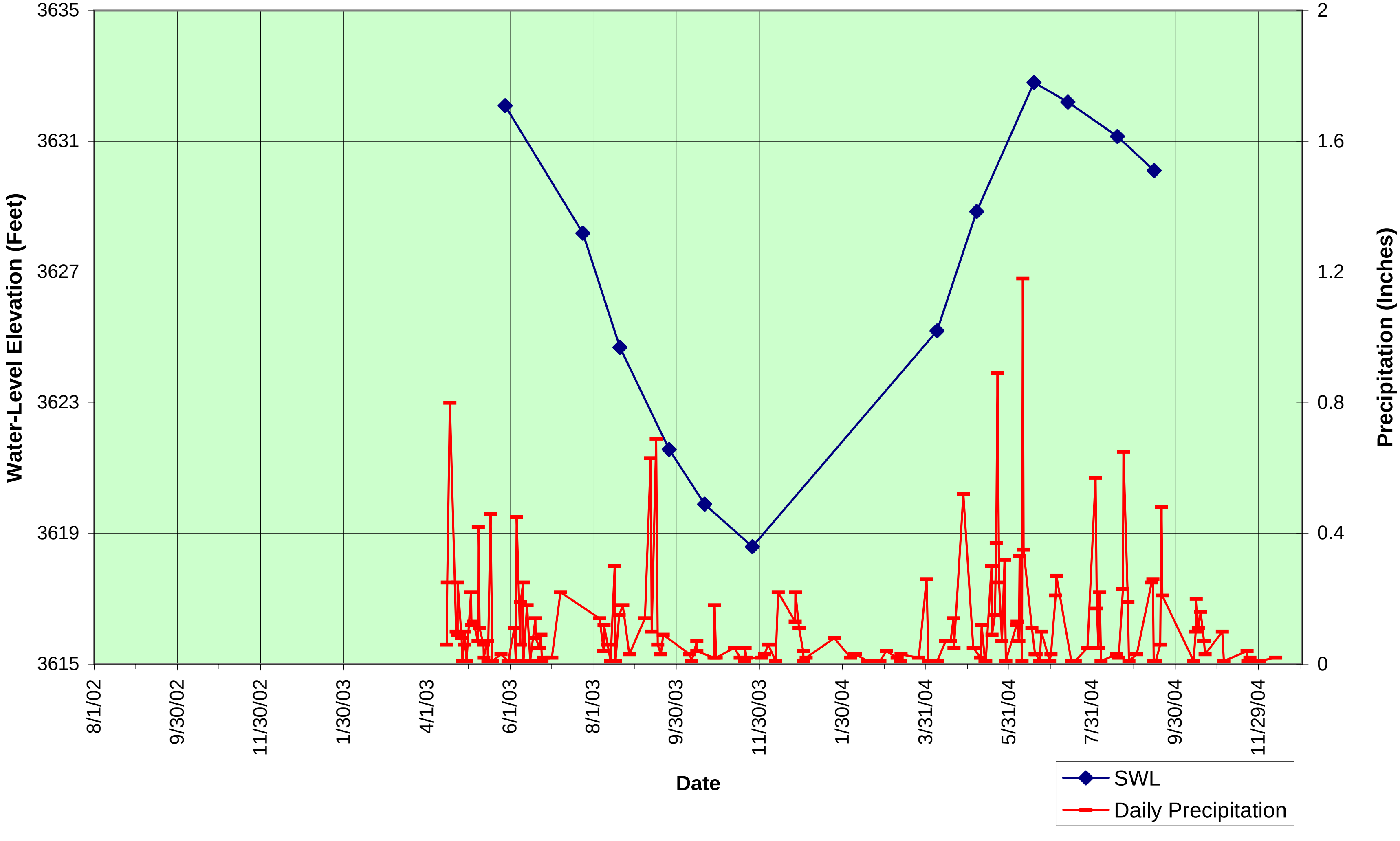
M: 186483
T19N-R06E-26-DBCB
Alt=3540 ft, TD=24 ft
Aquifer= Alluvial



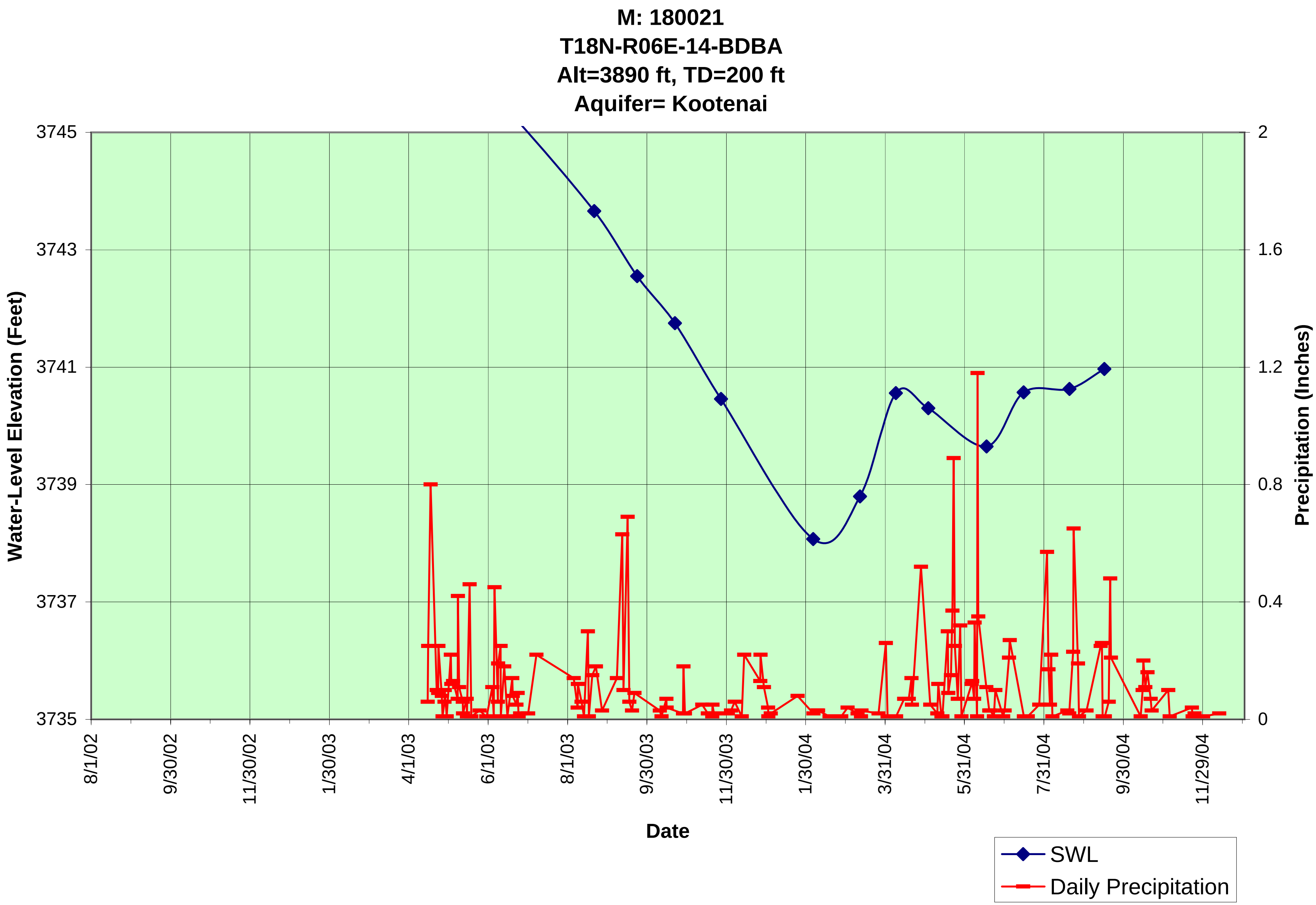
B1


M: 202581
T19N-R06E-12-BBBB
Alt=3440 ft, TD=35 ft
Aquifer= Alluvial
Water-Level Elevation (Feet)
Precipitation (Inches)
Date
3438
3436
3434
3432
3430
3428
2
1.6
1.2
0.8
0.4
0
1/1/02
3/2/02
5/2/02
7/2/02
9/1/02
11/1/02
1/1/03
3/2/03
5/2/03
7/2/03
9/1/03
11/1/03
1/1/04
3/2/04
5/1/04
7/1/04
8/31/04
10/31/04
12/31/04
SWL
Daily Precipitation
B2

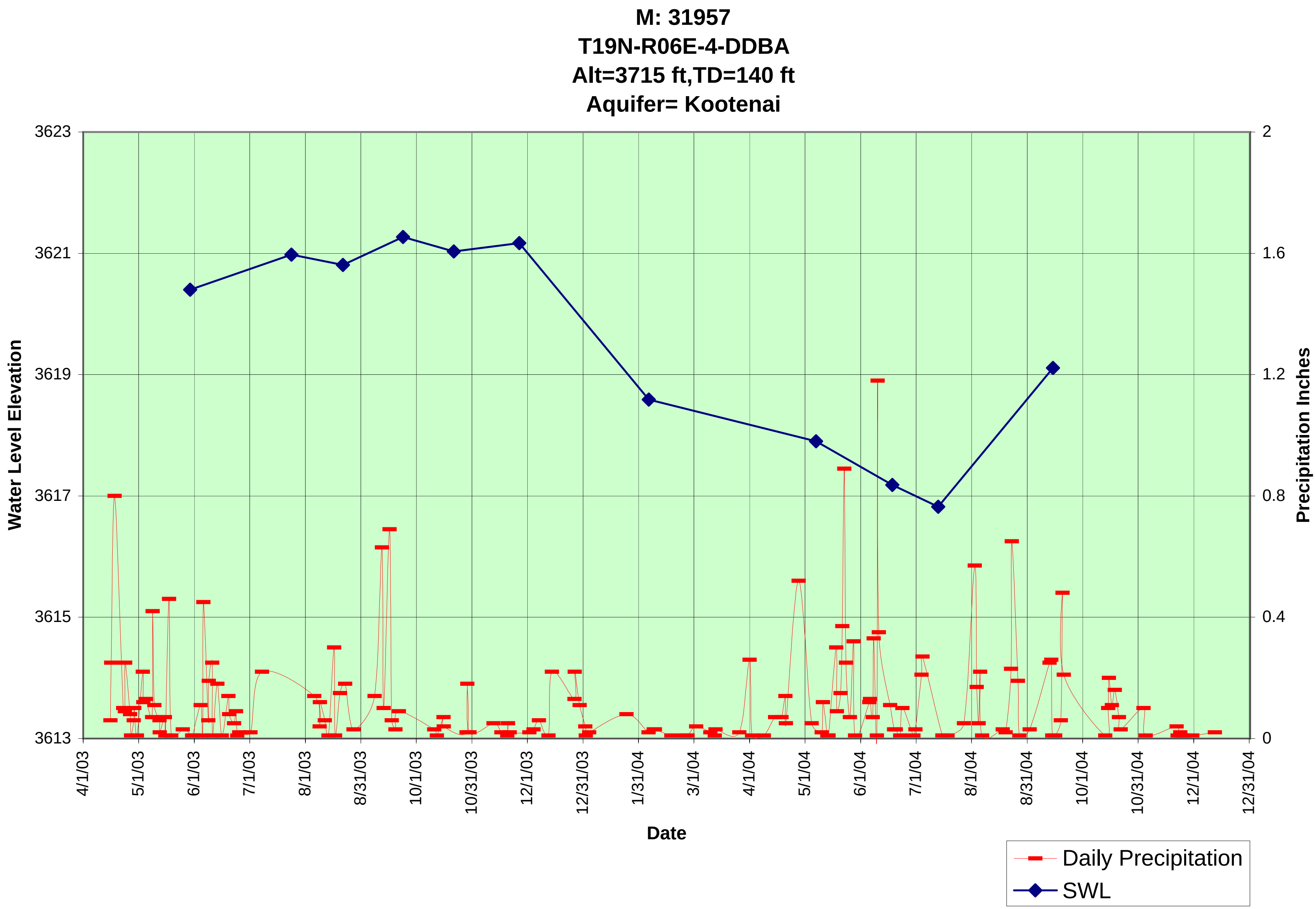
M: 207649
T19N-R06E-16-CCB
Alt=3635 ft, TD=30 ft
Aquifer= Alluvial



B3

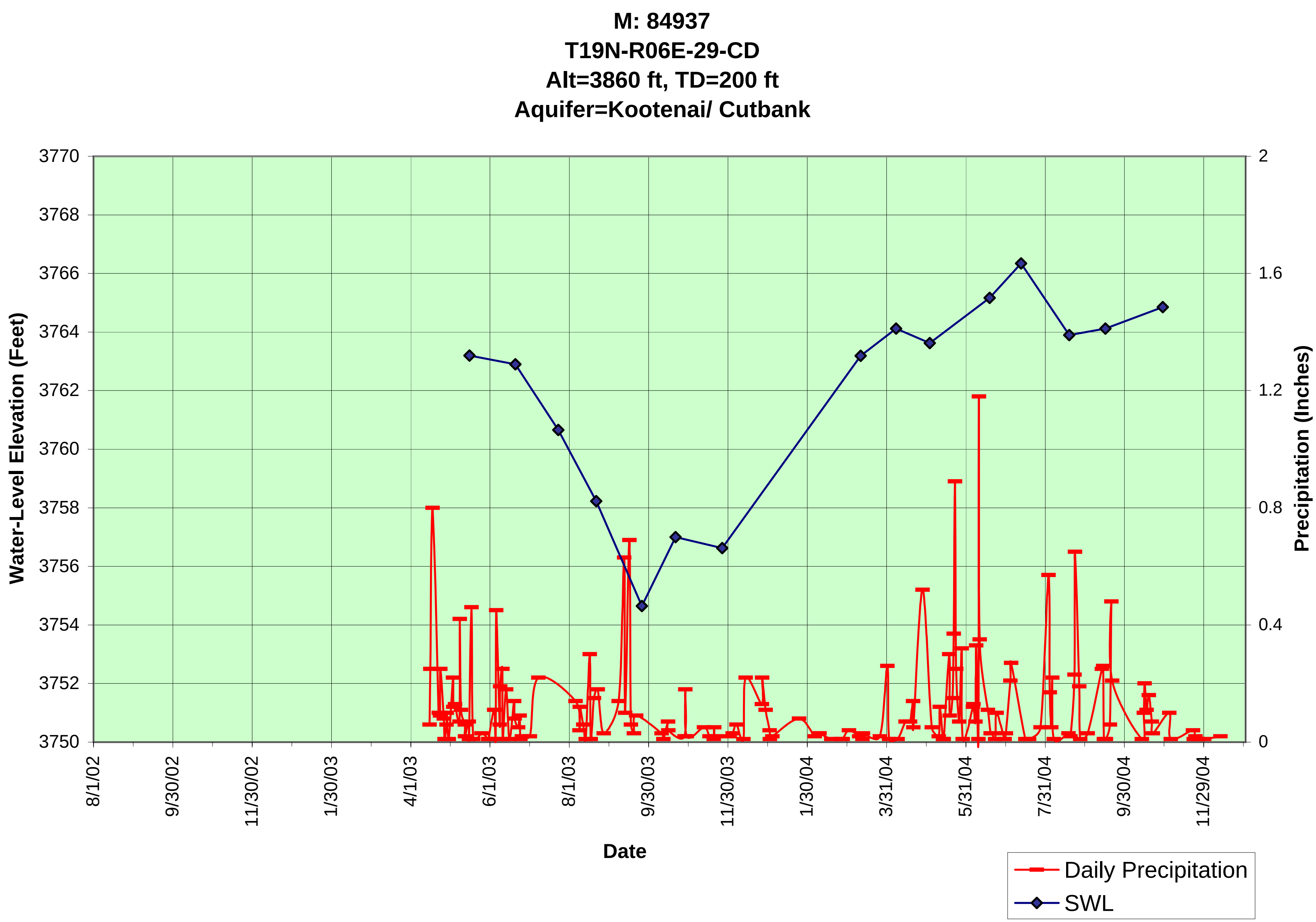

M: 180021
T18N-R06E-14-BDBA
Alt=3890 ft, TD=200 ft
Aquifer= Kootenai
Water-Level Elevation (Feet)
3745
3743
3741
3739
3737
3735
Precipitation (Inches)
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
Date
SWL
Daily Precipitation

B4

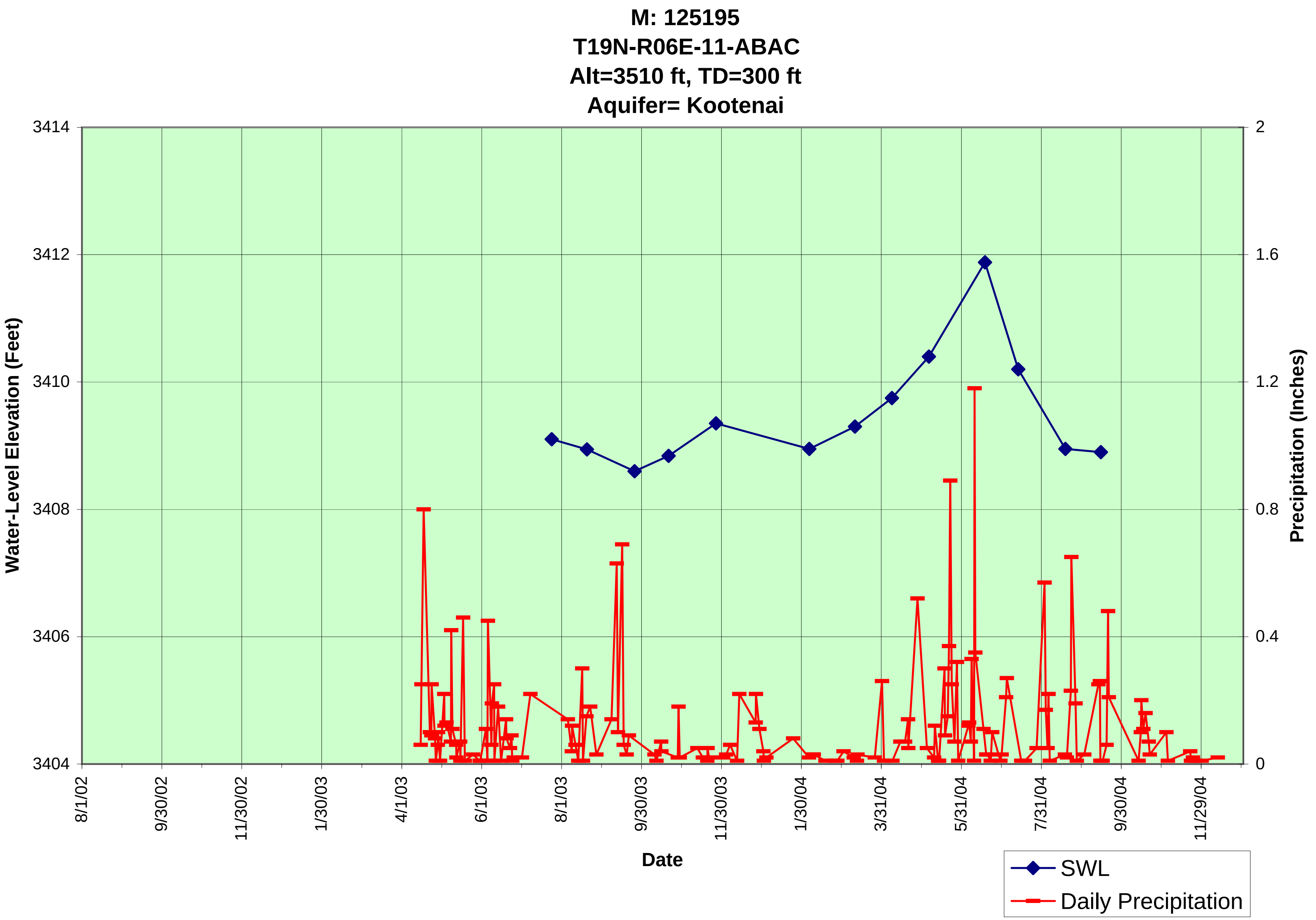


M: 31957
T19N-R06E-4-DDBA
Alt=3715 ft,TD=140 ft
Aquifer= Kootenai
Water Level Elevation
Precipitation Inches
Date
3623
3621
3619
3617
3615
3613
2
1.6
1.2
0.8
0.4
0
4/1/03
5/1/03
6/1/03
7/1/03
8/1/03
8/31/03
10/1/03
10/31/03
12/1/03
12/31/03
1/31/04
3/1/04
4/1/04
5/1/04
6/1/04
7/1/04
8/1/04
8/31/04
10/1/04
10/31/04
12/1/04
12/31/04
Daily Precipitation
SWL

B5

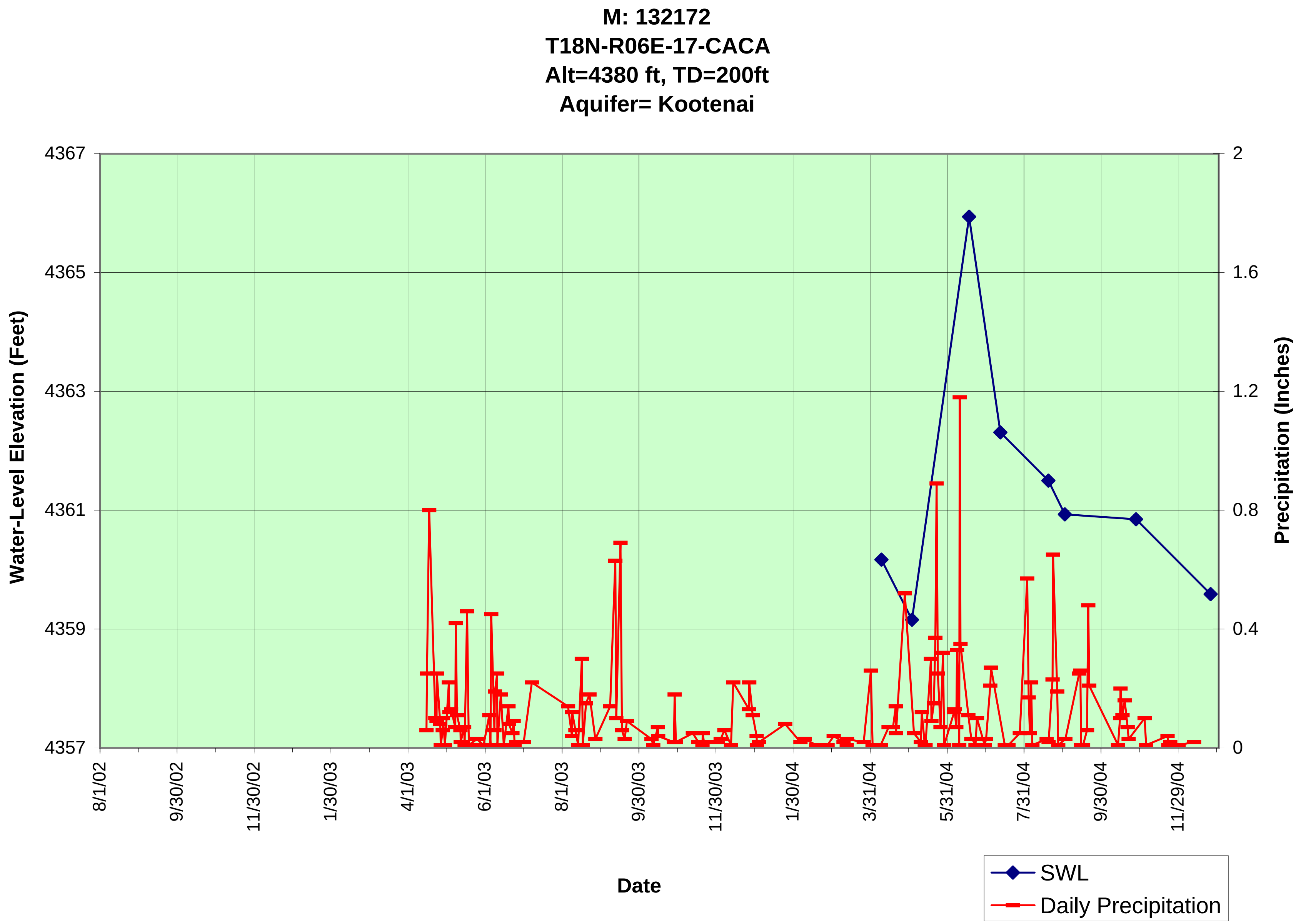

M: 84937
T19N-R06E-29-CD
Alt=3860 ft, TD=200 ft
Aquifer=Kootenai/ Cutbank
Water-Level Elevation (Feet)
Precipitation (Inches)
3770
3768
3766
3764
3762
3760
3758
3756
3754
3752
3750
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
Date
Daily Precipitation
SWL

B6

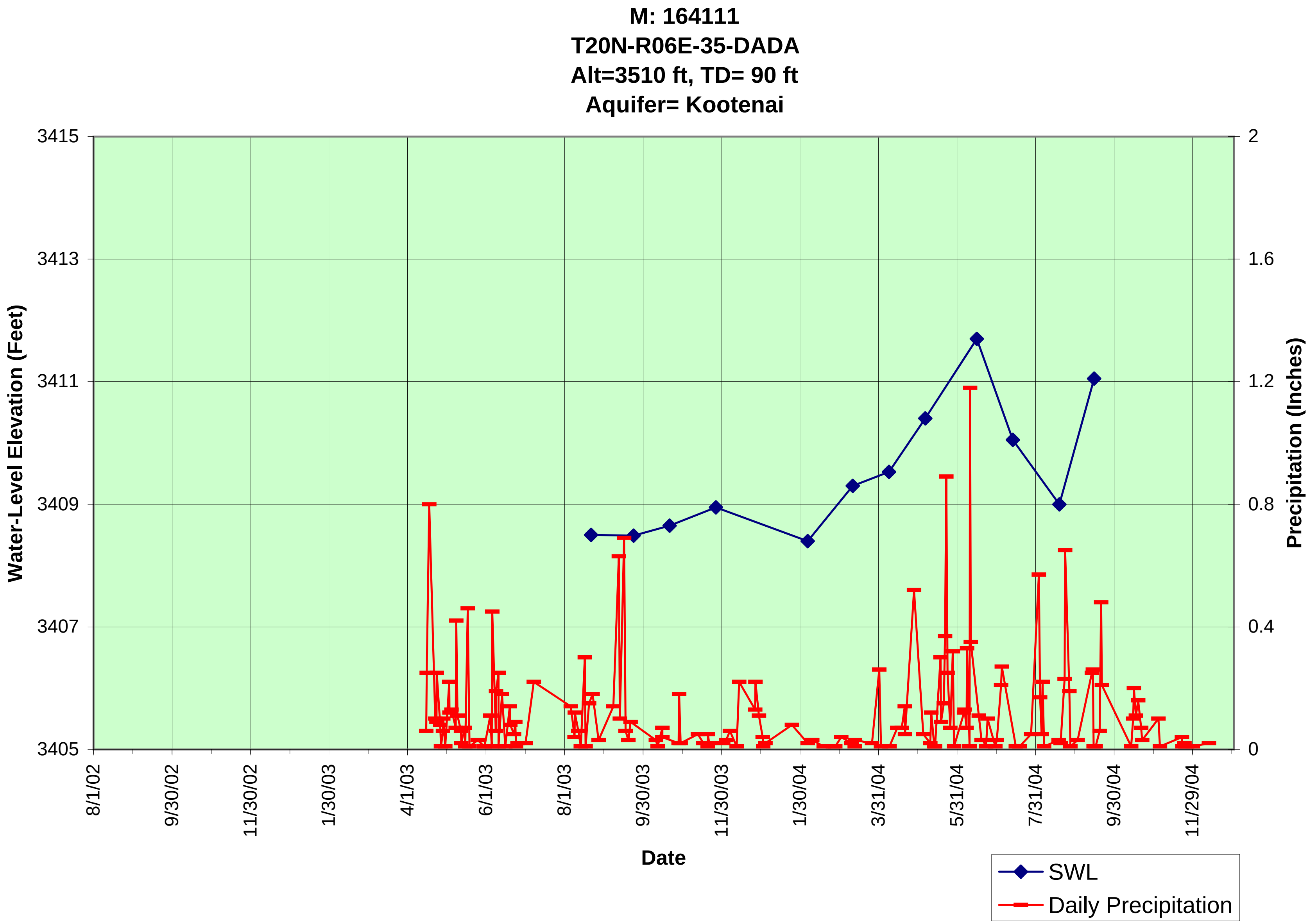


M: 125195
T19N-R06E-11-ABAC
Alt=3510 ft, TD=300 ft
Aquifer= Kootenai
Water-Level Elevation (Feet)
Precipitation (Inches)
3414
3412
3410
3408
3406
3404
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
Date
SWL
Daily Precipitation

B7

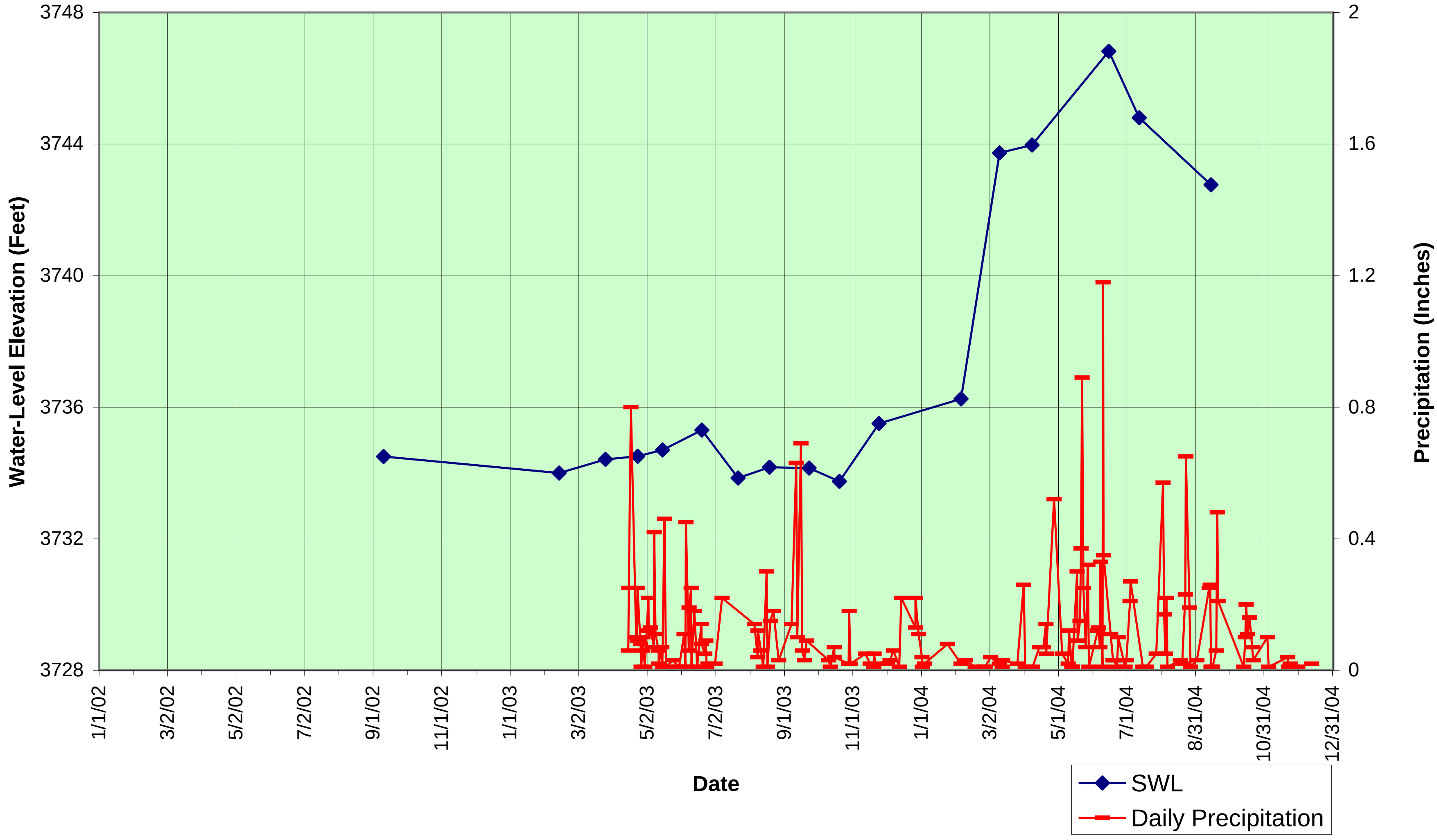

M: 132172
T18N-R06E-17-CACA
Alt=4380 ft, TD=200ft
Aquifer= Kootenai
Water-Level Elevation (Feet)
Precipitation (Inches)
4367
4365
4363
4361
4359
4357
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
Date
SWL
Daily Precipitation

B8

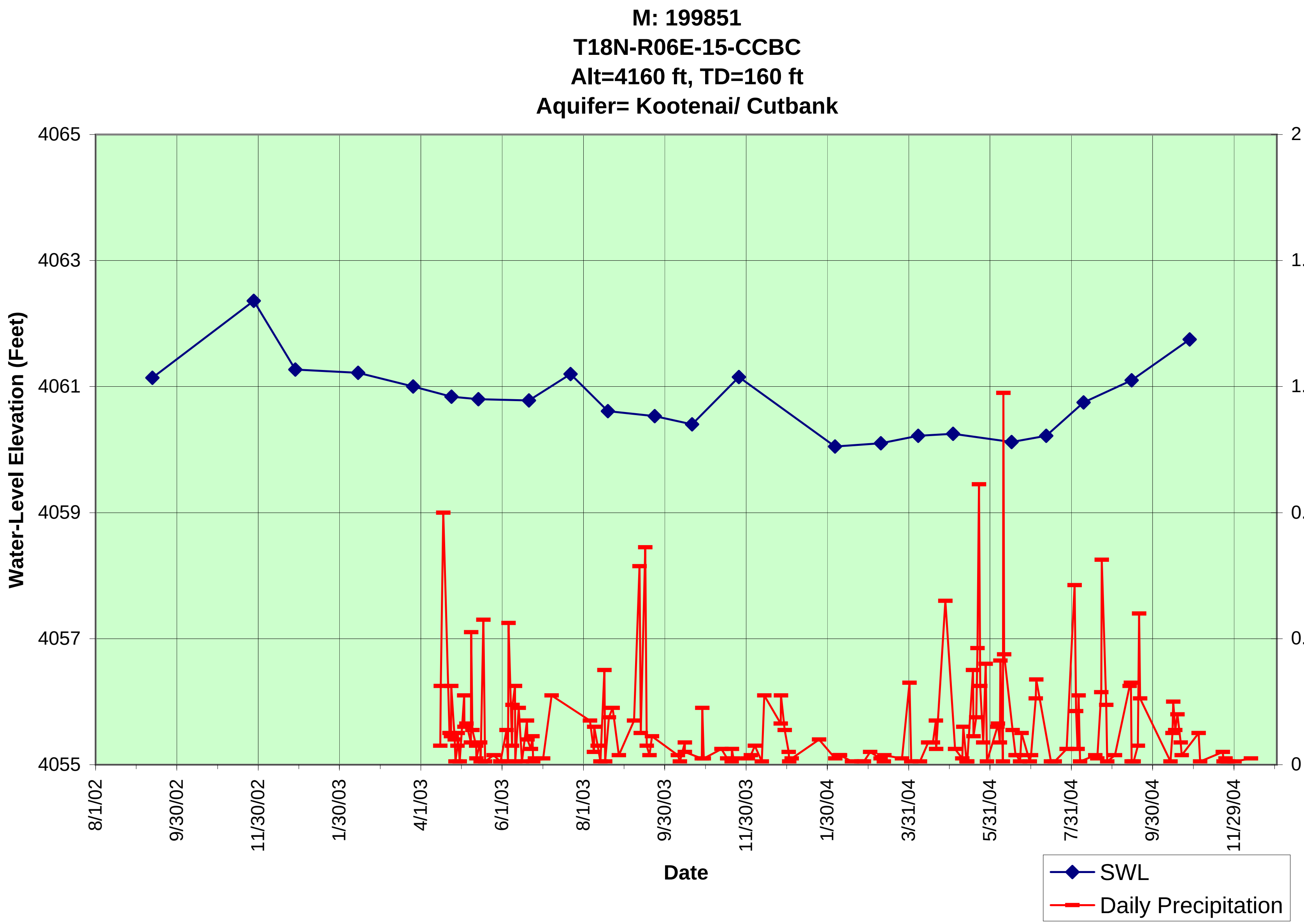

M: 164111
T20N-R06E-35-DADA
Alt=3510 ft, TD= 90 ft
Aquifer= Kootenai
Water-Level Elevation (Feet)
Precipitation (Inches)
3415
3413
3411
3409
3407
3405
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
Date
SWL
Daily Precipitation

B9

M: 186486
T19N-R07E-32-BADA
Alt=3790 ft, TD=200 ft
Aquifer= Kootenai



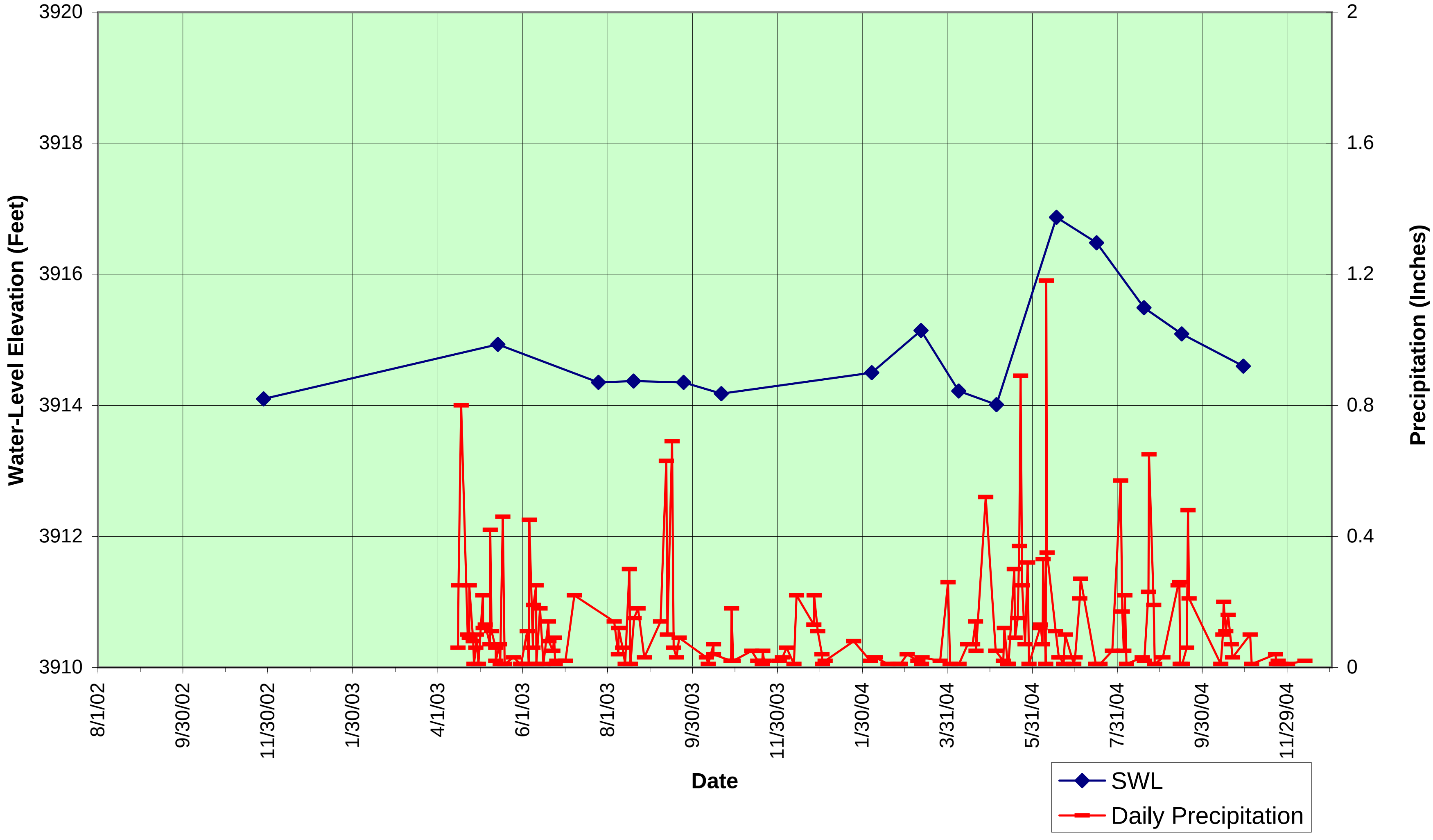
B10

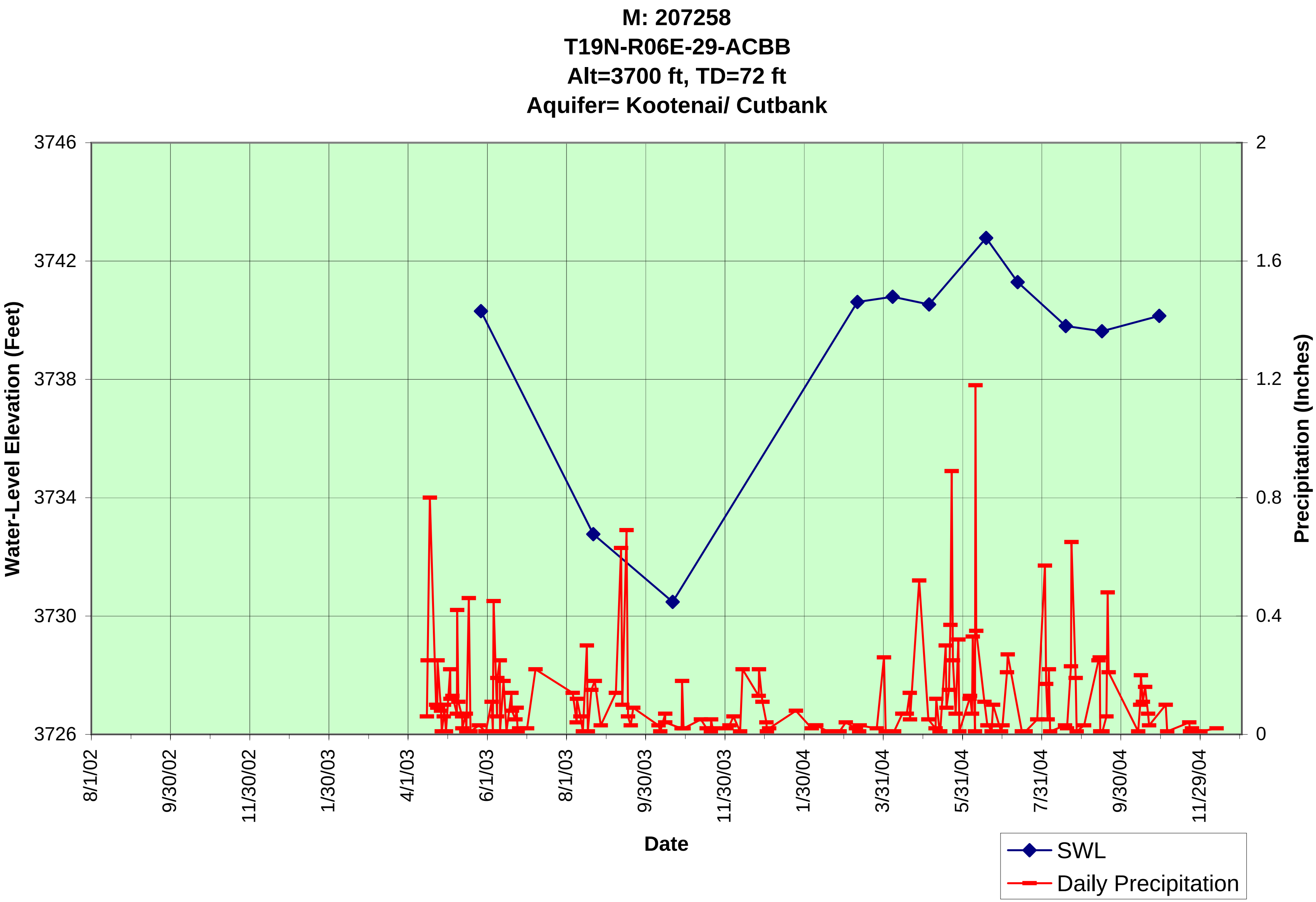

M: 199851
T18N-R06E-15-CCBC
Alt=4160 ft, TD=160 ft
Aquifer= Kootenai/ Cutbank
Water-Level Elevation (Feet)
Precipitation (Inches)
4065
4063
4061
4059
4057
4055
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
Date
SWL
Daily Precipitation

B11

M: 204516
T19N-R06E-34-ACDC
Alt=3926 ft, TD=19.6 ft
Aquifer= Kootenai/ Sunburst

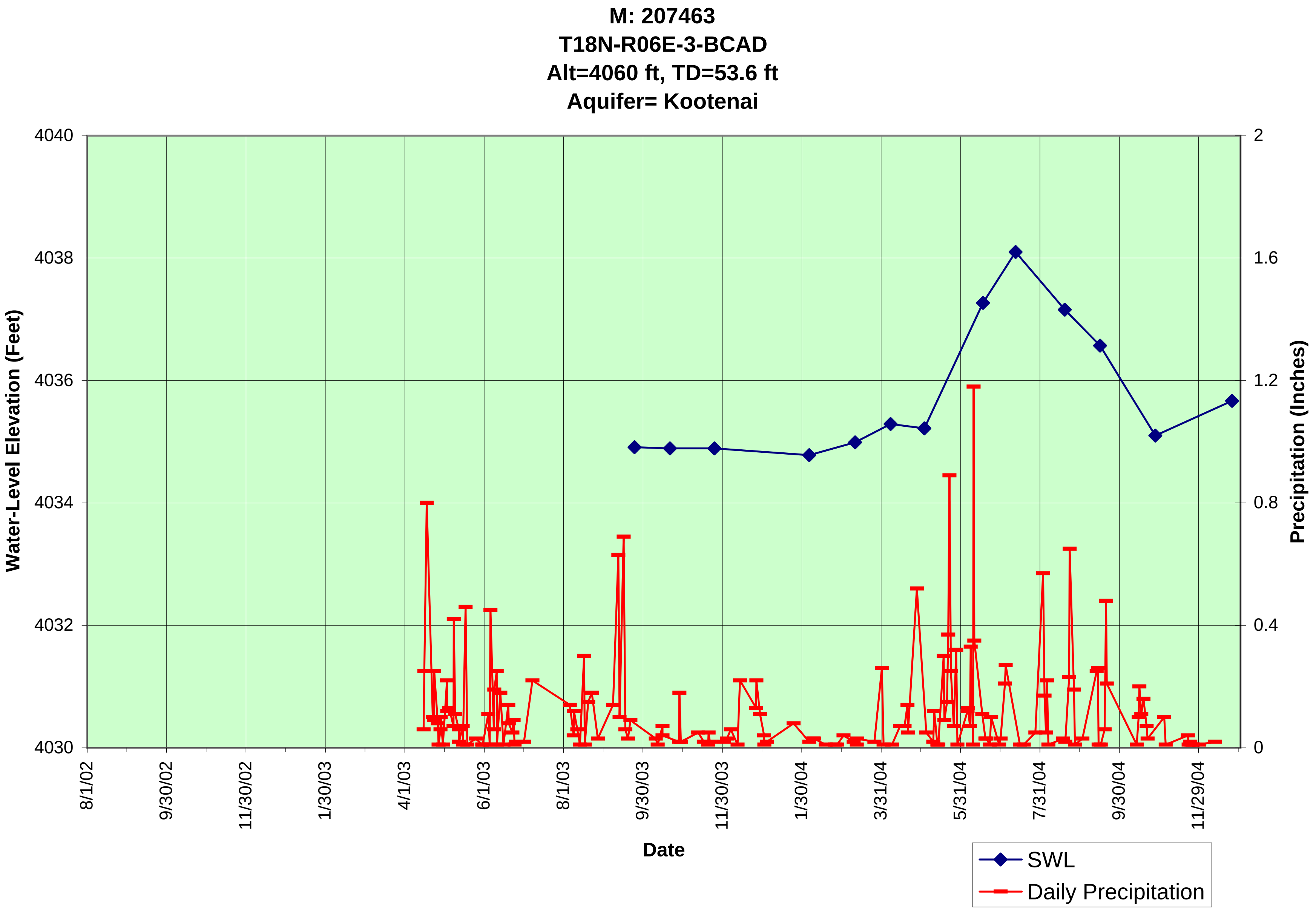
B12



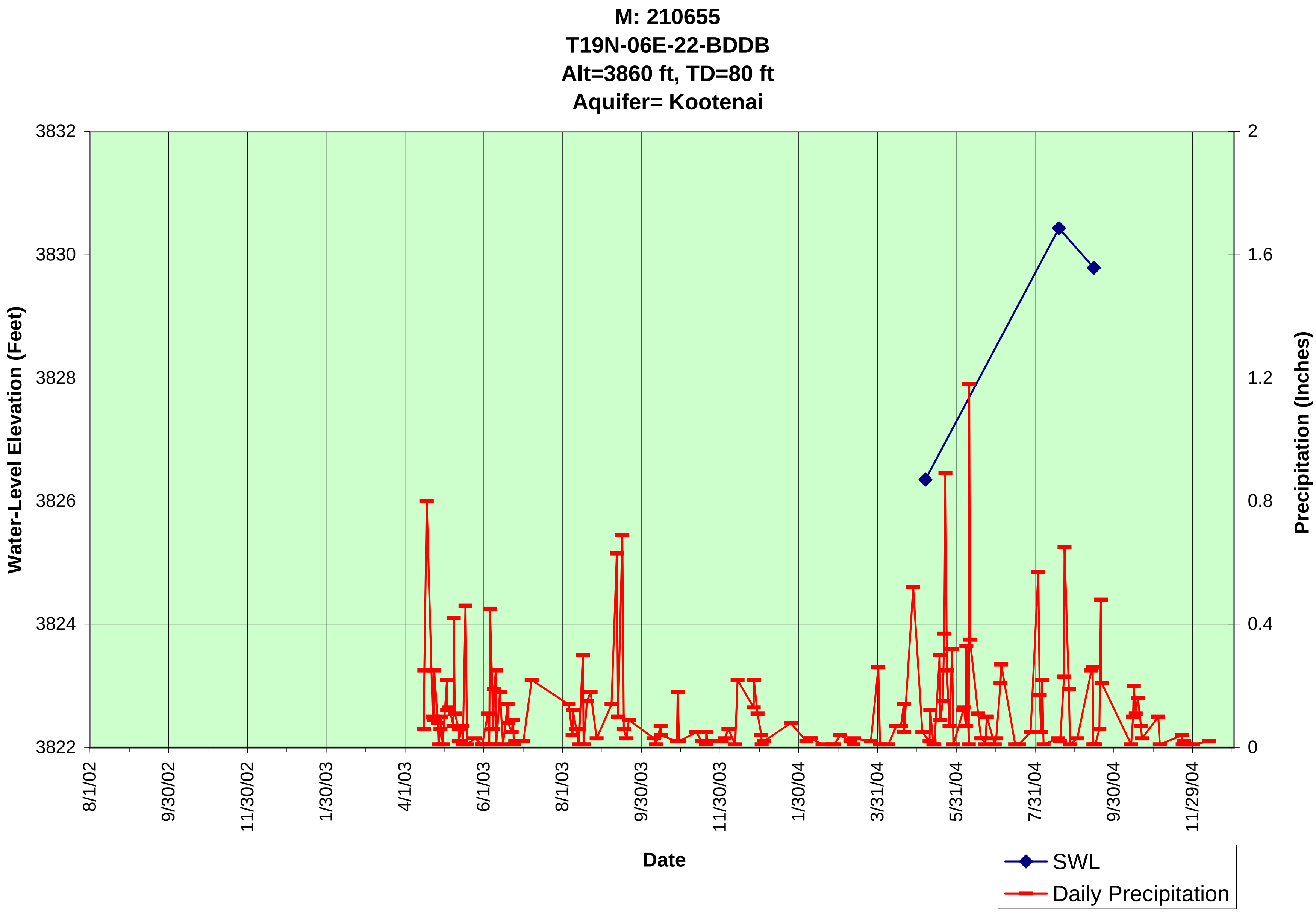


M: 207258
T19N-R06E-29-ACBB
Alt=3700 ft, TD=72 ft
Aquifer= Kootenai/ Cutbank
Water-Level Elevation (Feet)
Precipitation (Inches)
3746
3742
3738
3734
3730
3726
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
Date
SWL
Daily Precipitation

B13

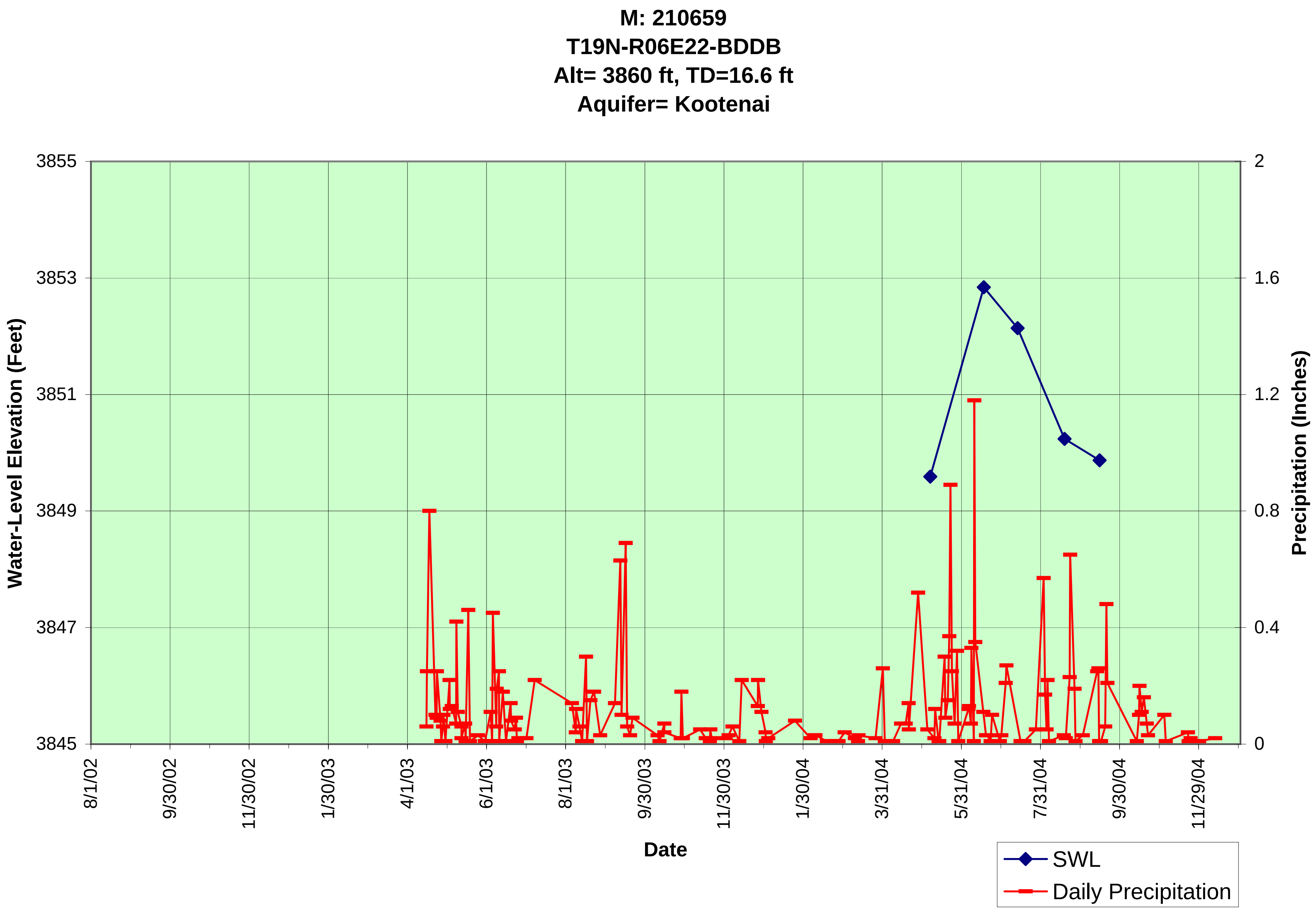

M: 207463
T18N-R06E-3-BCAD
Alt=4060 ft, TD=53.6 ft
Aquifer= Kootenai
Water-Level Elevation (Feet)
Precipitation (Inches)
4040
4038
4036
4034
4032
4030
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
Date
SWL
Daily Precipitation

B14



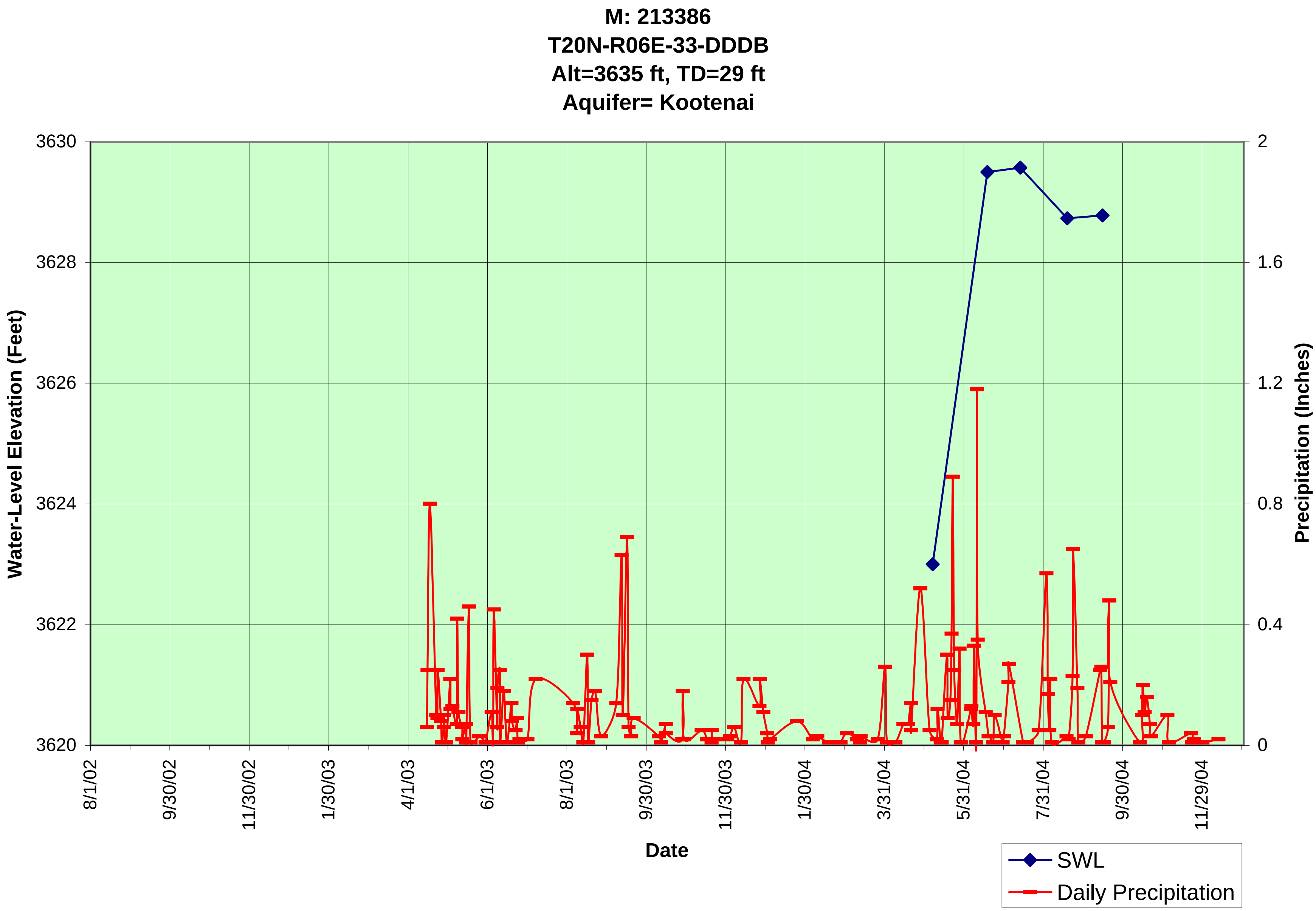
M: 210655
T19N-06E-22-BDDB
Alt=3860 ft, TD=80 ft
Aquifer= Kootenai
Water-Level Elevation (Feet)
Precipitation (Inches)
3832
3830
3828
3826
3824
3822
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
Date
SWL
Daily Precipitation

B15



M: 210659
T19N-R06E22-BDDB
Alt= 3860 ft, TD=16.6 ft
Aquifer= Kootenai
Water-Level Elevation (Feet)
Precipitation (Inches)
3855
3853
3851
3849
3847
3845
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
Date
SWL
Daily Precipitation

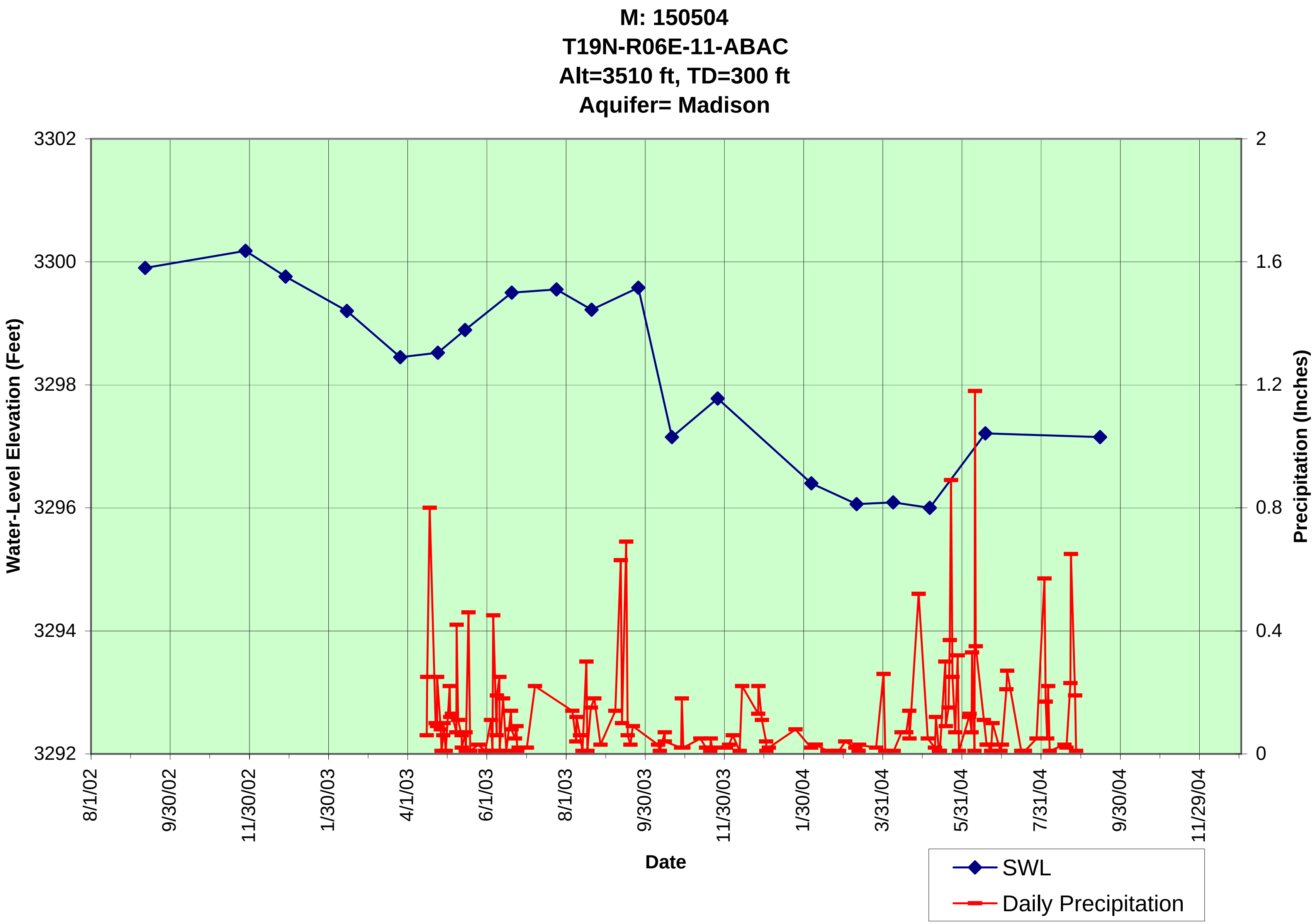
B16



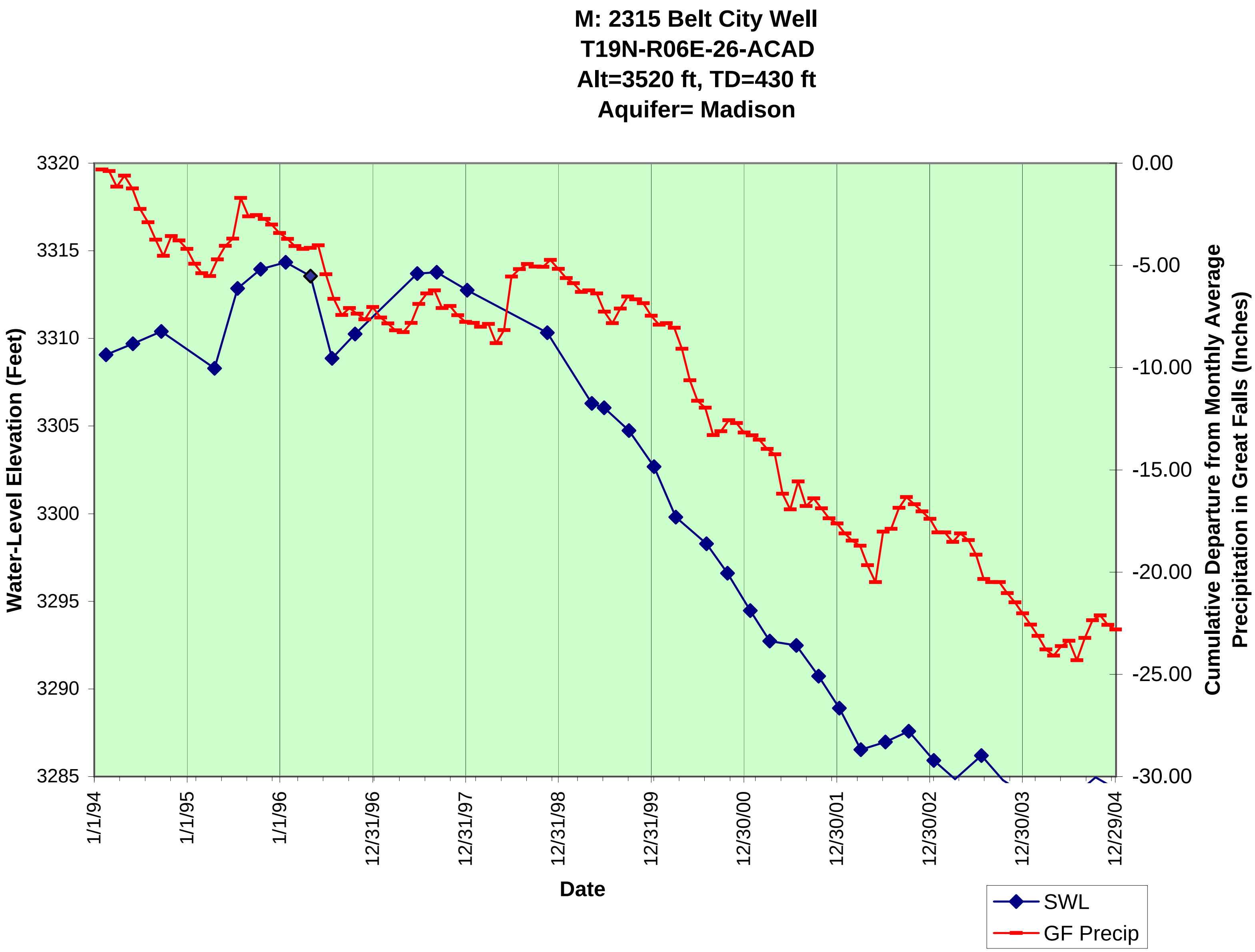
M: 213386
T20N-R06E-33-DDDB
Alt=3635 ft, TD=29 ft
Aquifer= Kootenai
Water-Level Elevation (Feet)
Precipitation (Inches)
3630
3628
3626
3624
3622
3620
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
Date
SWL
Daily Precipitation

B17

B18

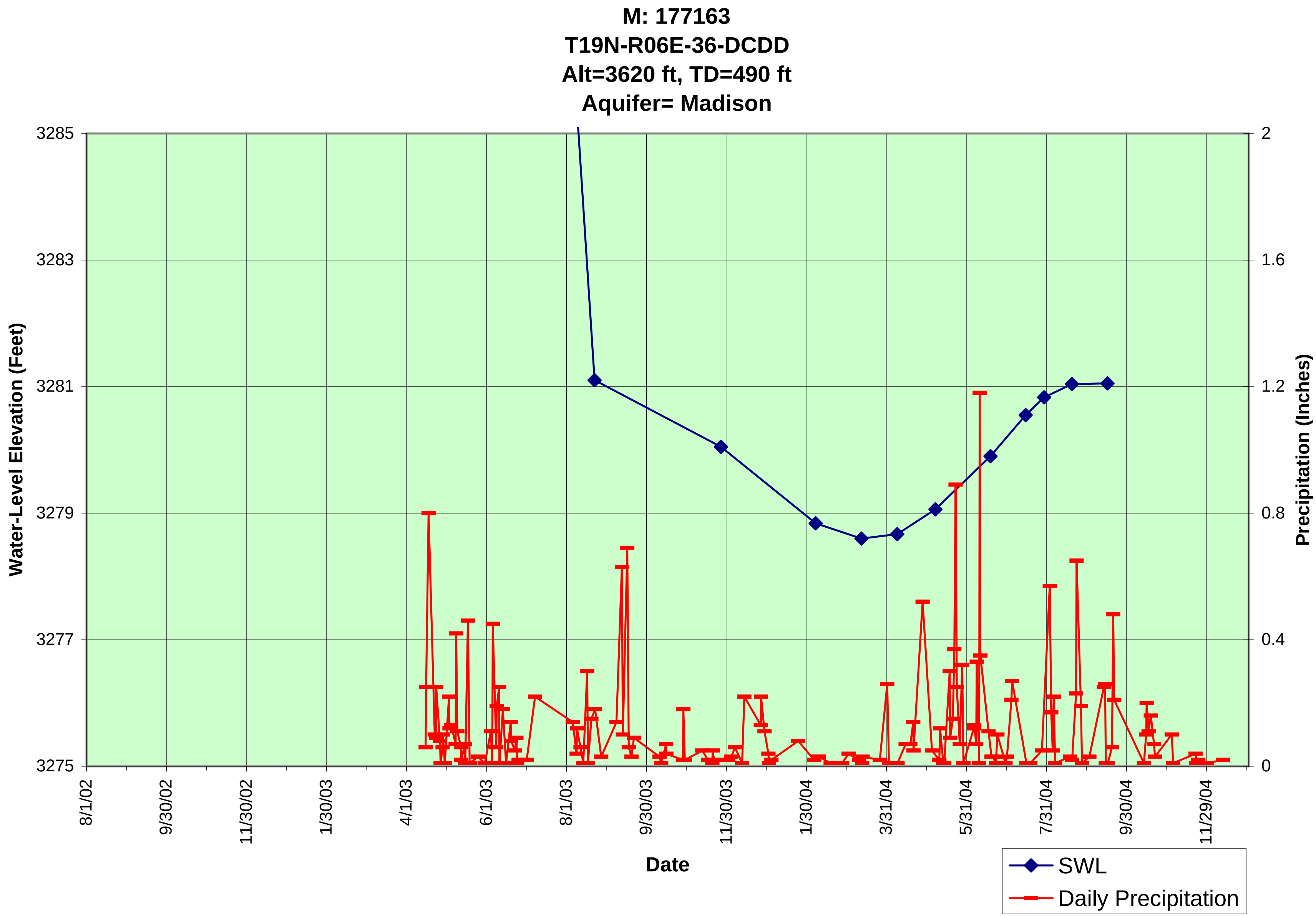


M: 150504
T19N-R06E-11-ABAC
Alt=3510 ft, TD=300 ft
Aquifer= Madison
Water-Level Elevation (Feet)
Precipitation (Inches)
Date
3302
3300
3298
3296
3294
3292
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
SWL
Daily Precipitation



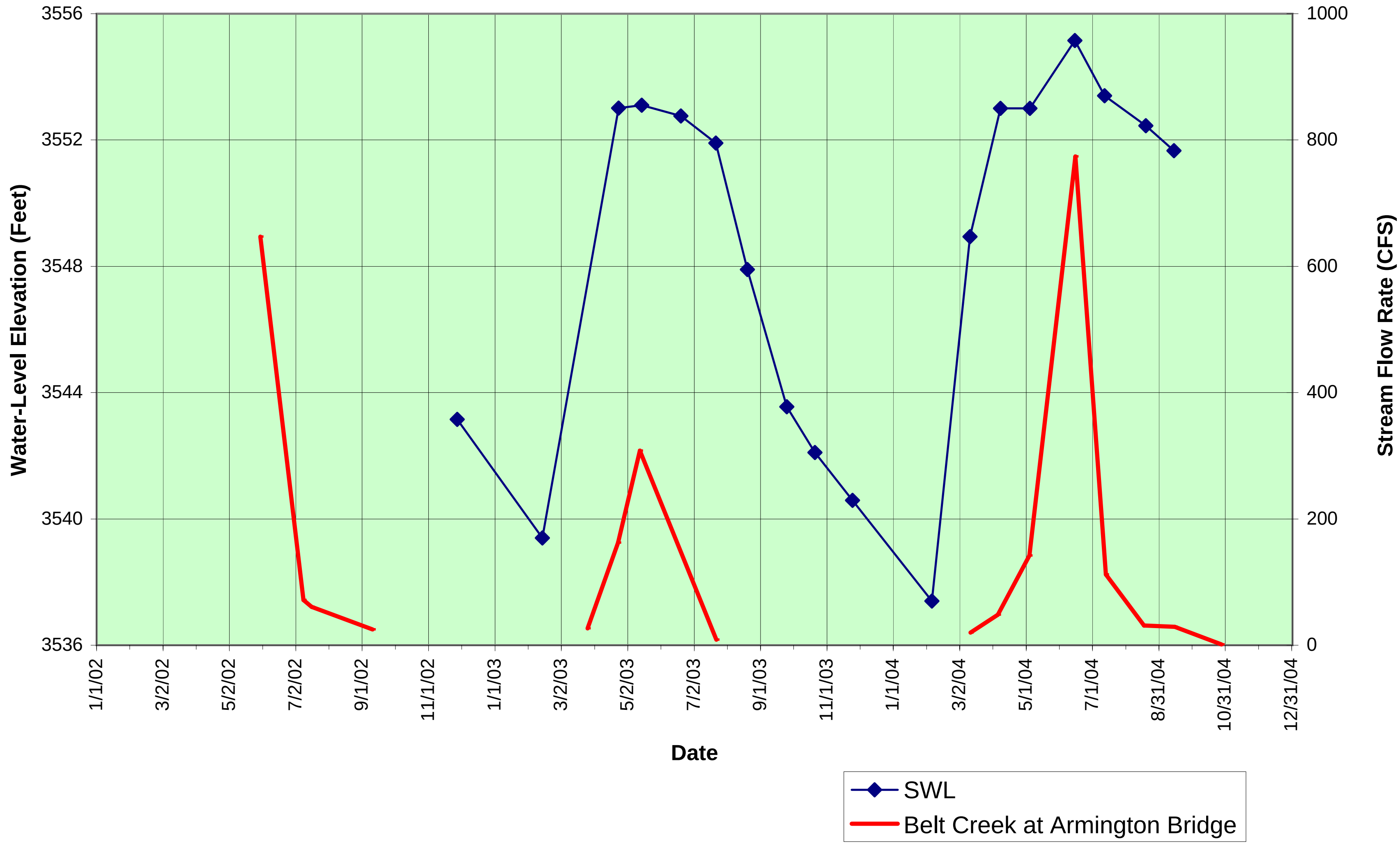
M: 2315 Belt City Well
T19N-R06E-26-ACAD
Alt=3520 ft, TD=430 ft
Aquifer= Madison
Water-Level Elevation (Feet)
3320
3315
3310
3305
3300
3295
3290
3285
Cumulative Departure from Monthly Average Precipitation in Great Falls (Inches)
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
1/1/94
1/1/95
1/1/96
12/31/96
12/31/97
12/31/98
12/31/99
12/30/00
12/30/01
12/30/02
12/30/03
12/29/04
Date
SWL
GF Precip

B19

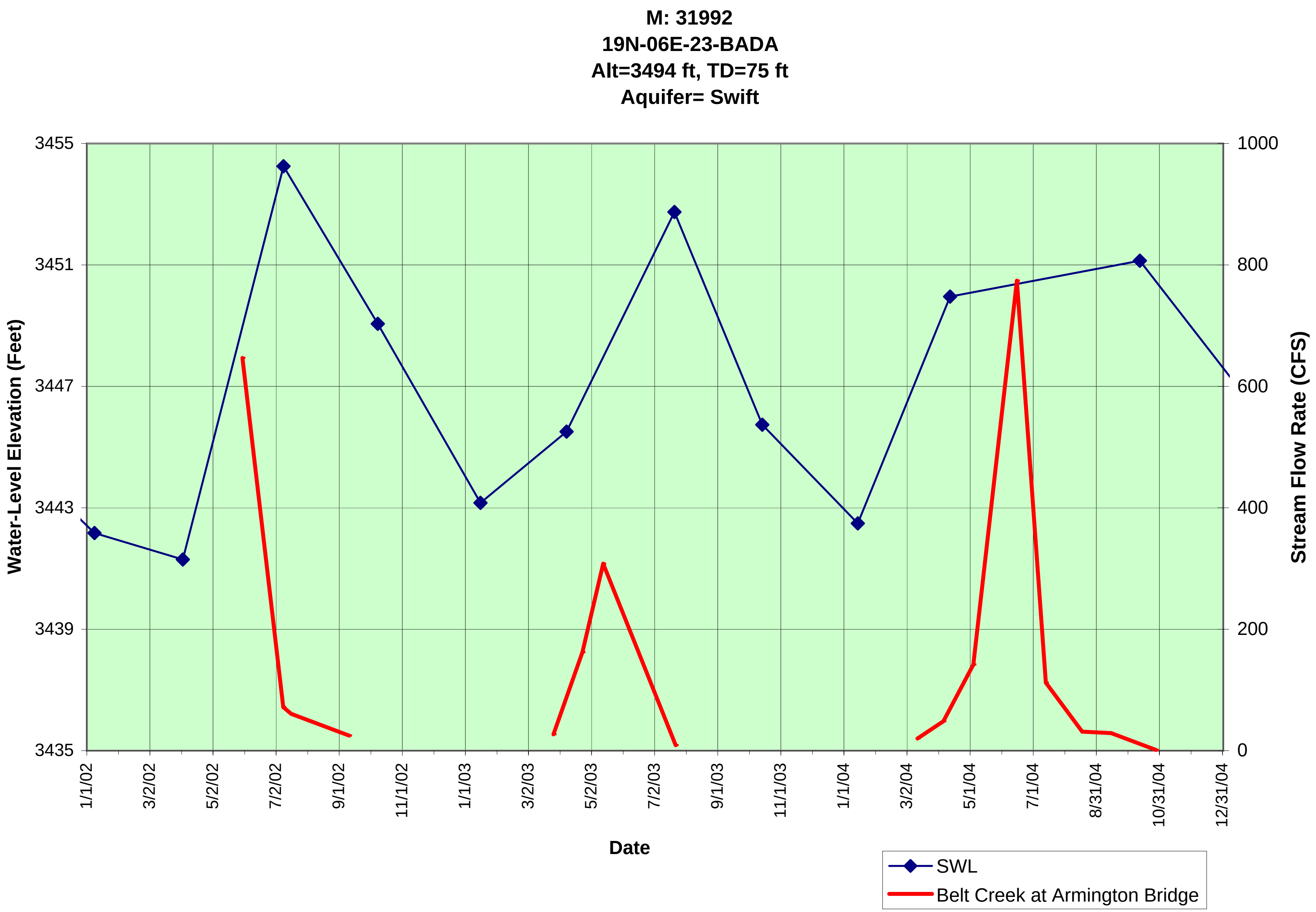

M: 177163
T19N-R06E-36-DCDD
Alt=3620 ft, TD=490 ft
Aquifer= Madison
Water-Level Elevation (Feet)
Precipitation (Inches)
Date
3285
3283
3281
3279
3277
3275
2
1.6
1.2
0.8
0.4
0
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
SWL
Daily Precipitation

B20

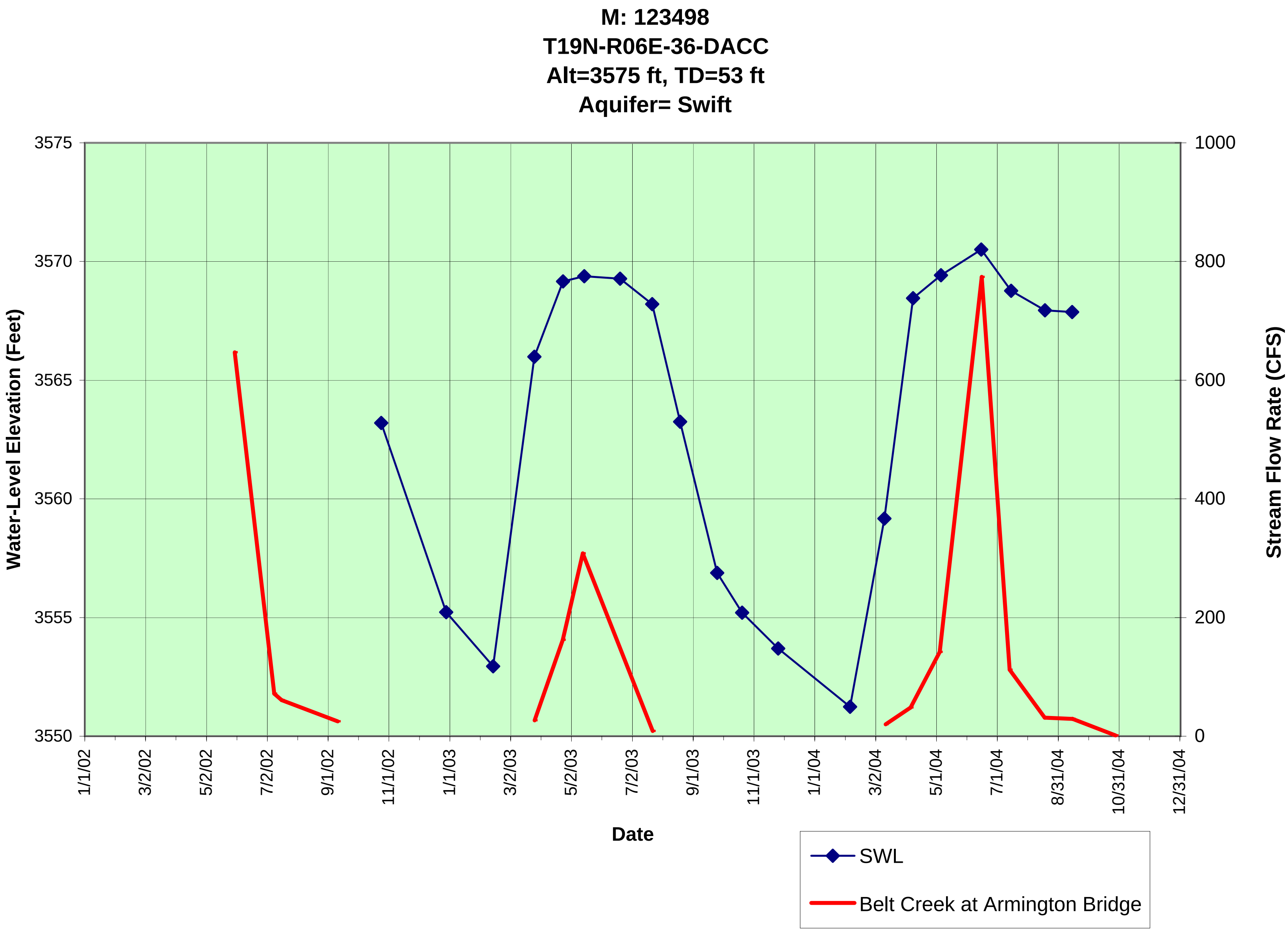
M: 165475
T19N-R06E-36-BABB
Alt=3560 ft, TD=50 ft
Aquifer: Swift



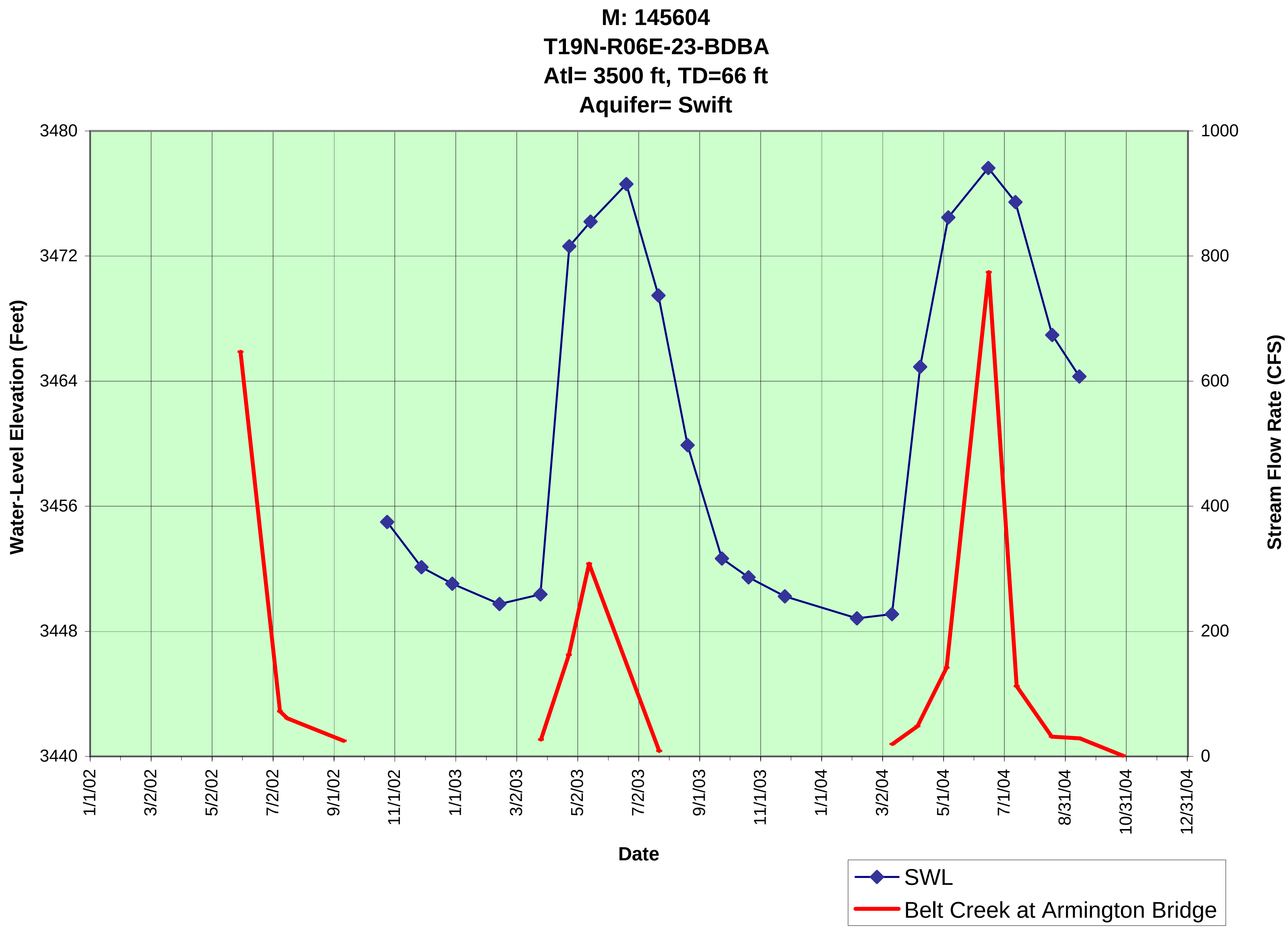
B21


M: 31992
19N-06E-23-BADA
Alt=3494 ft, TD=75 ft
Aquifer= Swift
Water-Level Elevation (Feet)
3455
3451
3447
3443
3439
3435
Stream Flow Rate (CFS)
1000
800
600
400
200
0
1/1/02
3/2/02
5/2/02
7/2/02
9/1/02
11/1/02
1/1/03
3/2/03
5/2/03
7/2/03
9/1/03
11/1/03
1/1/04
3/2/04
5/1/04
7/1/04
8/31/04
10/31/04
12/31/04
Date
SWL
Belt Creek at Armington Bridge

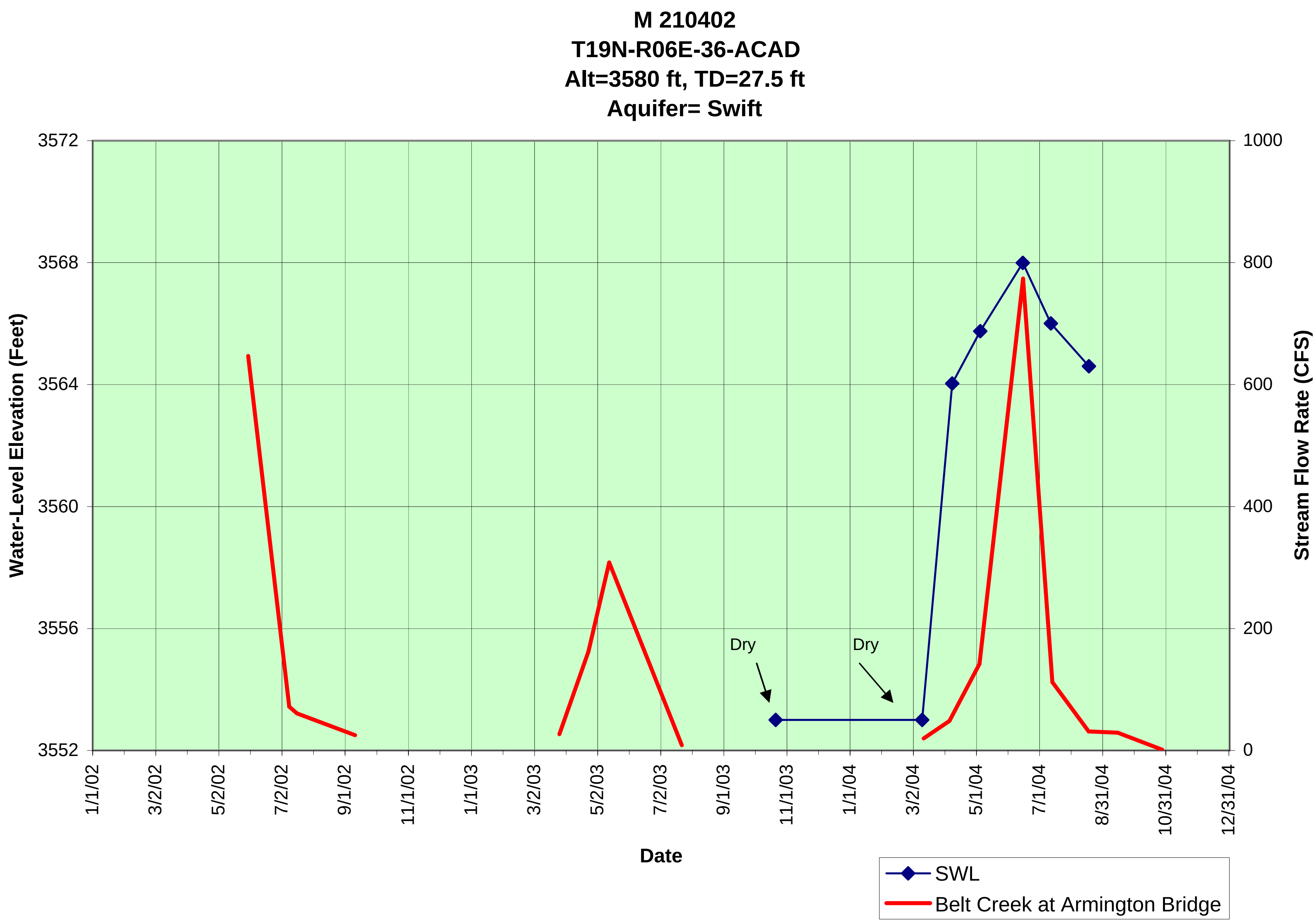
B22


M: 123498
T19N-R06E-36-DACC
Alt=3575 ft, TD=53 ft
Aquifer= Swift
Water-Level Elevation (Feet)
Stream Flow Rate (CFS)
Date
3575
3570
3565
3560
3555
3550
1000
800
600
400
200
0
1/1/02
3/2/02
5/2/02
7/2/02
9/1/02
11/1/02
1/1/03
3/2/03
5/2/03
7/2/03
9/1/03
11/1/03
1/1/04
3/2/04
5/1/04
7/1/04
8/31/04
10/31/04
12/31/04
SWL
Belt Creek at Armington Bridge

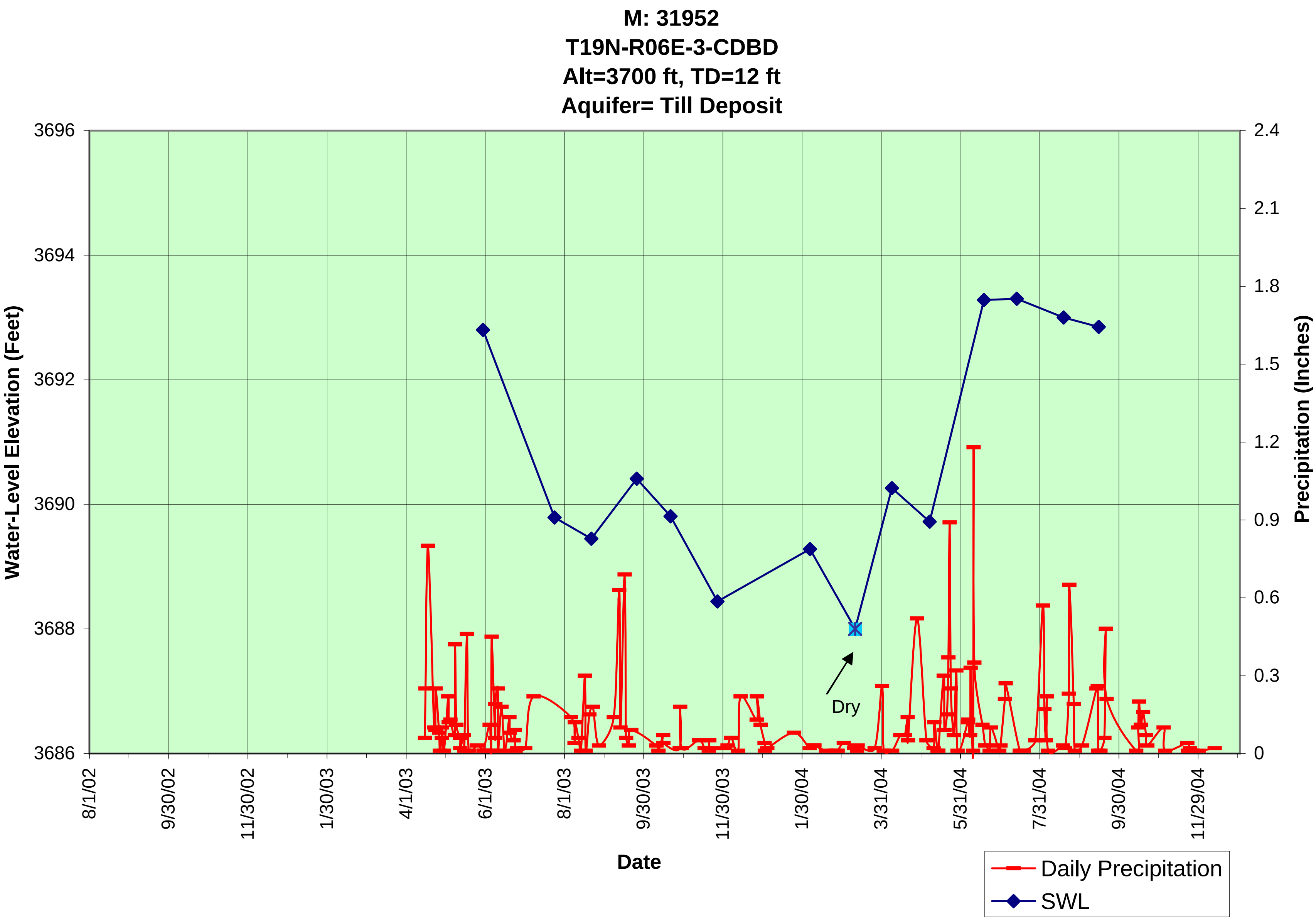
B23



M: 145604
T19N-R06E-23-BDBA
Atl= 3500 ft, TD=66 ft
Aquifer= Swift
Water-Level Elevation (Feet)
3480
3472
3464
3456
3448
3440
Stream Flow Rate (CFS)
1000
800
600
400
200
0
1/1/02
3/2/02
5/2/02
7/2/02
9/1/02
11/1/02
1/1/03
3/2/03
5/2/03
7/2/03
9/1/03
11/1/03
1/1/04
3/2/04
5/1/04
7/1/04
8/31/04
10/31/04
12/31/04
Date
SWL
Belt Creek at Armington Bridge


M 210402
T19N-R06E-36-ACAD
Alt=3580 ft, TD=27.5 ft
Aquifer= Swift
Water-Level Elevation (Feet)
Stream Flow Rate (CFS)
3572
3568
3564
3560
3556
3552
1000
800
600
400
200
0
Dry
Dry
1/1/02
3/2/02
5/2/02
7/2/02
9/1/02
11/1/02
1/1/03
3/2/03
5/2/03
7/2/03
9/1/03
11/1/03
1/1/04
3/2/04
5/1/04
7/1/04
8/31/04
10/31/04
12/31/04
Date
SWL
Belt Creek at Armington Bridge

B25



M: 31952
T19N-R06E-3-CDBD
Alt=3700 ft, TD=12 ft
Aquifer= Till Deposit
Water-Level Elevation (Feet)
3696
3694
3692
3690
3688
3686
Precipitation (Inches)
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0
Dry
8/1/02
9/30/02
11/30/02
1/30/03
4/1/03
6/1/03
8/1/03
9/30/03
11/30/03
1/30/04
3/31/04
5/31/04
7/31/04
9/30/04
11/29/04
Date
Daily Precipitation
SWL

B26

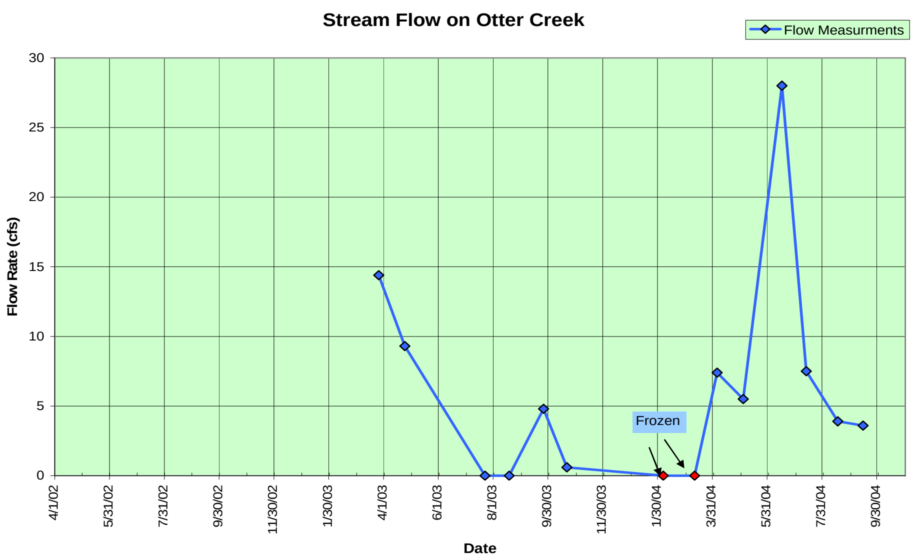
Appendix C

Surface and Spring Field Parameters and Flow Charts

C1

Mnumber	Stream	Station	Location (TRSt)	Latitude	Longitude	Elevation (feet)	Date	Depth to Water (feet)	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (cfs)	Flow Mesurment Method	Stream Conditions
214391	Otter Creek	Bridge Discharging into Belt Creek	T18N R07E 06 CCCB	47.346	-110.8957	3600	3/27/03	16.1	9.52	653	3.3	13	138.7	14.4	Staff and Wade	
							4/25/03	15.5	8.2	813	13.5		250	9.3	Staff and Wade	
							7/23/03							0		Dry
							8/19/03							0		Dry
							9/26/03	16.5						(4.8)	E	
							10/22/03	16.8	8.32	1053	13.8	13.1	239	0.6	Staff and Wade	
							2/6/04							0		Frozen
							3/12/04		7.1	634	7.02	11.27	272	0		Frozen
							4/6/04	16.6	8.15	848	14.55	13.56	283	7.4	Staff and Wade	
							5/5/04	15.6	8.16	947	14.41	12.12	123	5.5	Staff and Wade	
							6/17/04	14.8	8.37	663	12.57	10.14	224	28	Staff and Wade	
							7/14/04	16.6	8.21	892	19.23	9.26	144	7.5	Staff and Wade	
							8/18/04	16.7	7.98	1015	17.72	8.07	124	(3.9)	E	
							9/15/04	16.6	7.22	1021	11.46	12.4	107	(3.6)	E	

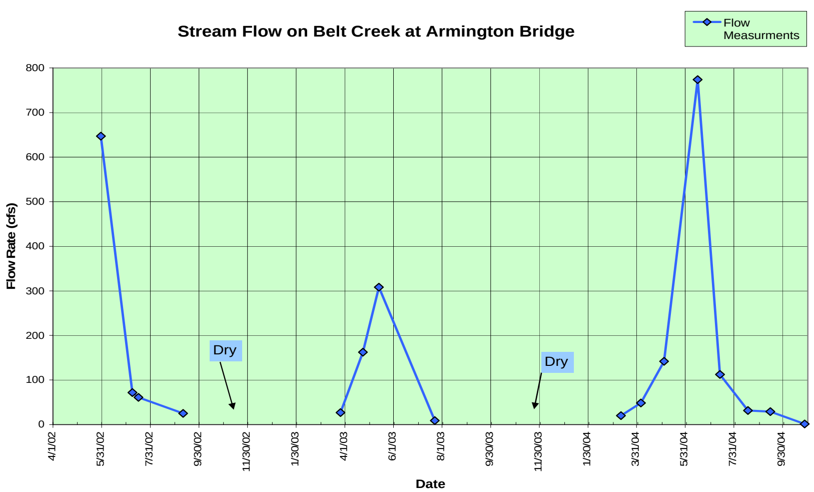
Flow measurements denoting E were calculated by using a Depth to Water method.



C2

Mnumber	Stream	Station	Location (TRSt)	Latitude	Longitude	Elevation (feet)	Date	Depth to Water (feet)	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mgl)	ORP (mv)	Flow (cfs)	Flow Mesurment Method	Stream Conditions
214386	Belt Creek	Armington Bridge	T19N R06E 36 DBBB	47.3654	-110.9066	3560	5/31/02	12.32	8.04	153	12.3		130.8	647	Fish and Crane	
							7/9/02	15.6	8.57	250	16			(71.7)	E	
							7/17/02	16.1	8.38	270	24	96.2	72.5	60.7	Staff and Wade	
							9/11/02	16.89						(25.)	E	
							9/17/02									Dry
							9/23/02									Dry
							10/22/02									Dry
							11/27/02									Dry
							3/27/03	16.8						(26.8)	E	Water From Otter Cr
							4/24/03	14.65						(162.3)	E	
							5/14/03	14.9	8.06	216	14.3	11	219	308.1	Fish and Crane	
							7/23/03	16.6	8.3	not working	25			8.77	Staff and Wade	
							8/19/03									Dry
							9/26/03									Dry
							10/21/03									Dry
							11/25/03									Dry
							2/6/04									Dry
							3/12/04	16.5	7.17	623	8.43	22.5	271	19.9	Staff and Wade	
							4/6/04	16.25	8.48	336	14.21	10.94	234	48.3		
							5/5/04	14.8	8.33	153	10.69	12.56	133	(141.9)	E	To Fast To Wade
							6/16/04	13.7	8.67	172	9.64	11.15	141	773.9	Fish and Crane	
							7/14/04	15.9	6.01	259	21.8	8.65	162	112.1	Staff and Wade	
							8/18/04	16.6	8.37	323	17.57	7.74	253	(31.4)	E	
							9/15/04	16.7	6.7	370	11.85	11.05	101	(29.)	E	
							10/28/04	17.5	7.27	487	3.68	9.67	186	1.27	Staff and Wade	

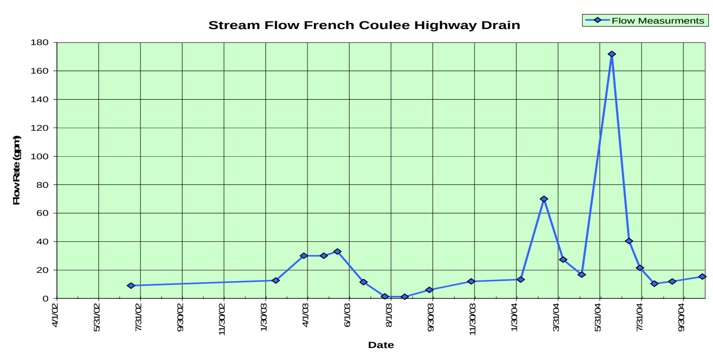
Flow measurements denoting E were calculated by using a Depth to Water method.



C3

Mnumber	Stream	Station	Location (TRSt)	Latitude	Longitude	Elevation (feet)	Date	Depth to Water (feet)	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (gpm)	Flow Mesurment Method	Nitrate	Flume size is .5 " H flume	Stream Conditions
200617	French Coulee Highway Drain	East side of Fill	T19N R06E 26 CDDA	47.3754	-110.9286	3560	7/18/02	6.26	8.41	540	15.2	9.45	22.4	9	Staff and Wade			
							2/14/03	6.3	7.8	570	2.3	12.27	109	12.6	Staff and Wade			
							3/27/03	6.3	8.45	507	4.6	13.1	199.9	30	Bucket Stop Watch			
							4/25/03		8.45	616	9.1		-15	30	Bucket Stop Watch			
							5/15/03		8.29	627	12	11.7	56.3	33	Bucket Stop Watch			
							6/22/03		8.26	745	11.9	11.14	101.3	11.5	Bucket Stop Watch			
							7/23/03		7.48	1548	15.1		22	1.40	Bucket Stop Watch			
							8/21/03		5.62	880	14.5	16.65	54	1.2	Bucket Stop Watch			
							9/26/03		7.3	971	10.93	11.16	143	6	Bucket Stop Watch			
							11/26/03		8.16	843	3.57	13.91	-113.9	12	Bucket Stop Watch			
							2/6/04		5.7	683	1.48	13.71	0.3	13.3	Bucket Stop Watch			
							3/11/04		8.18	601	5.46	19.7	65	70	Bucket Stop Watch			
							4/8/04		7.02	649	6.21	11.97	-39	27.3	Bucket Stop Watch			
							5/5/04		6.84	645	8.8	11.3	-92	16.7	Bucket Stop Watch			was .4 now .5 inch h flume
							6/18/04		6.26	667	8.95	10.3	137	171.9	Staff and Wade			Overflowing
							7/13/04		6.7	661	11.8	10.14	50	40.4	Staff and Wade	10		Overflowing
							7/29/04							21.5	Flume Guage		0.21	
							8/19/04		6.54	763	12.56	7.66	69	10.4	Flume Guage		0.15	
							9/14/04		6.82	712	10.6	10.16	8.2	11.93	Flume Guage		0.16	
							10/28/04							15.38	Flume Guage		0.18	

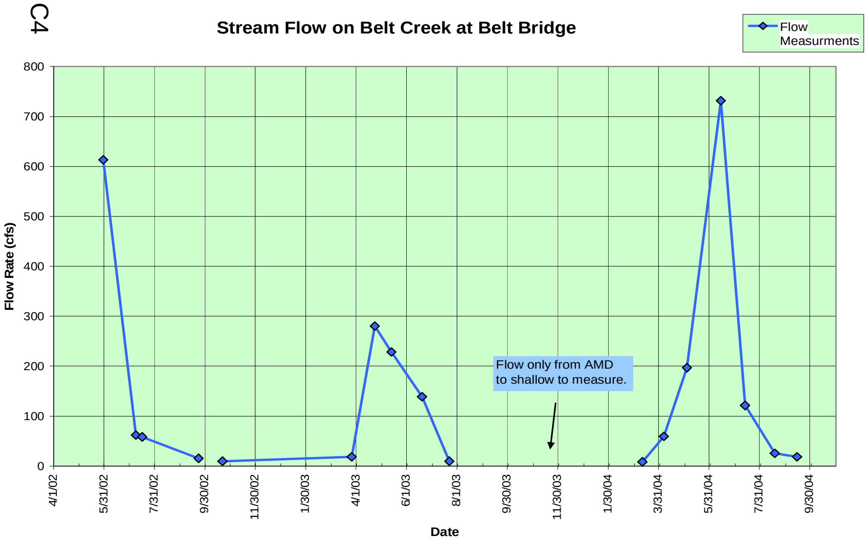
Flow measurements denoting E were calculated by using a Depth to Water method.



Mnumber	Stream	Station	Location (TRSt)	Latitude	Longitude	Elevation (feet)	Date	Depth to Water (feet)	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (cfs)	Flow Mesurment Method	Stream Conditions
214387	Belt Creek	Belt Bridge	T19N R06E 26 ABBC	47.387	-110.9269	3510	5/31/02	18.57	8.04	144	13.2		170	613	Fish and Crane	
							7/9/02	19.77	8.24	270	14.2			(61.8)	E	
							7/17/02	20.1	8.14	300	24.4	7.96	60.1	58.3	Staff and Wade	
							9/23/02	20.6		615	11			(15.5)	E	
							10/7/02		7.21	768	15					
							10/22/02	20.9	6.4	979	4.6	12	181	(9.6)	E	Creek is to spread out to get proper flow.
							3/27/03	20.5						(18.3)	E	
							4/24/03	18.9	8.08	174	11.3		202	(280.4)	E	
							5/14/03	19.32	7.67	213	14.2	10.74	220	228.3	Fish and Crane	
							6/20/03	19.3	8.28	231	14.3	10.55	168.5	(138.7)	E	
							7/23/03	20.4	7.9		25		220	9.6	Staff and Wade	
							8/19/03									Creek is to spread out to get proper flow.
							9/23/03									Dry except for AMD Discharge
							10/21/03									Dry except for AMD Discharge
							11/25/03									Dry except for AMD Discharge
							3/12/04	20.5	6.28	587	4.52	13.24	148	8.5	Staff and Wade	
							4/7/04	20	7.4	348	6.47	13.4	18.6	59.4	Fish and Crane	
							5/5/04	19.1	7.76	163	11.08	11.22	185	(196.9)	E	Leaves keep stopping meter.
							6/15/04	18	8.33	176	8.09	10.4	168	731.7	Fish and Crane	
							7/14/04	19.8	7.41	278	21.87	8.32	244	121.2	Staff and Wade	
							8/19/04	20.3	8.05	439	18.88	7.64	196	(25.4)	E	
							9/15/04	20.5	7.95	572	11.57	8.93	-115	(18.5)	E	

Flow measurements denoting E were calculated by using a Depth to Water method.

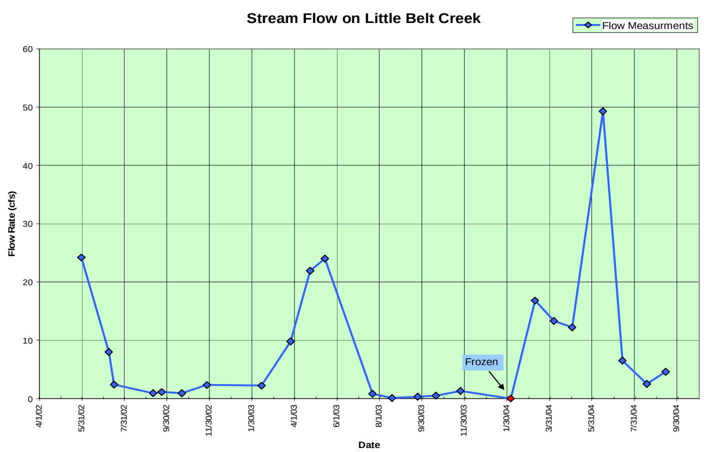
C4



C5

Mnumber	Stream	Station	Location (TRSt)	Latitude	Longitude	Elevation (feet)	Date	Depth to Water (feet)	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (cfs)	Flow Mesurment Method	Stream Conditions
214392	Little Belt Creek	First Bridge	T19N R06E 1 CDDD	47.433	-110.9065	3450	5/31/02	11.75	8.36	247	20	214.8		24.2	Staff and Wade	
							7/9/02	11.92	8.77	330	15.7			(8.)	E	
							7/17/02	12.13	9.13	370	26	34.7	7.92	2.4	Staff and Wade	
							9/11/02	12.26						(.9)	E	
							9/23/02	12.23		401	11			(1.1)	E	
							10/22/02	12.26						(.9)		
							11/27/02	12.1	8.12	377	5.8	257.1	12.23	2.3	Staff and Wade	
							2/13/03	12.12						(2.2)	E	
							3/27/03	11.9	8.5	265	3.3	211.8	14.14	9.8	Staff and Wade	
							4/24/03	11.8	8.01	268	16.5	300		21.9	Staff and Wade	
							5/15/03	11.75						(24.)	E	
							7/22/03	12.4	8.66	380	25	25		0.8	Staff and Wade	
							8/19/03	12.37	8.4	380	27	180	157	0.1	Staff and Wade	
							9/25/03	12.45						(.3)	E	
							10/21/03	12.27	8.53	384	14.65	129.8	10.93	0.5	Staff and Wade	
							11/25/03	12.2	6.9	355	2.15	210	14.9	(1.3)	E	
							2/5/04							0		Frozen
							3/11/04	11.85	8.4	349	7.82	144	14	16.8	Staff and Wade	
							4/7/04	11.9	8.42	281	7.29	186	15.35	13.3	Staff and Wade	
							5/3/04	12	7.13	296	12.2	170	10.8	12.2	Staff and Wade	
							6/16/04	11.5	8.28	253	14.86	159.5	9.15	49.3	Staff and Wade	
							7/14/04	11.9	8.06	247	24.7	220	8.37	6.5	Staff and Wade	
							8/18/04	12.1	8.66	370	18.57	196	8.49	(2.5)	E	
							9/14/04	12	8.77	365	14.45	11.07	7.5	(4.6)	E	

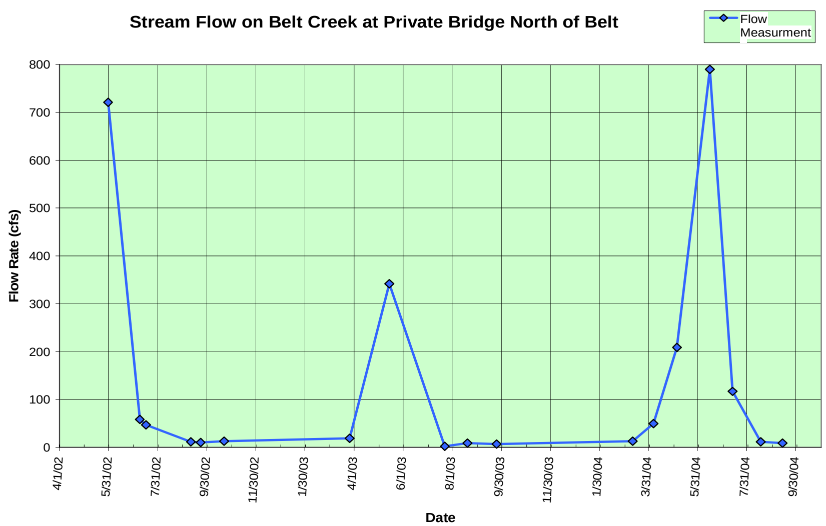
Flow measurements denoting E were calculated by using a Depth to Water method.



C6

Mnumber	Stream	Station	Location (TRSt)	Latitude	Longitude	Elevation (feet)	Date	Depth to Water (feet)	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (cfs)	Flow Mesurment Method	Stream Conditions
214389	Belt Creek	Private Bridge	T19N R06E 2 ACAD	47.4414	-110.9225	3440	5/31/02	12.32	8.04	153	12.3		130.8	721	Fish and Crane	
							7/9/02	13.69	8.44	290	15.9			(58.1)	E	
							7/17/02	14.14	8.51	350	25.7	8.17	73.6	47	Staff and Wade	
							9/11/02	14.8						(11.3)	E	
							9/23/02	14.91		484	14.4			(9.7)	E	
							10/22/02	14.72						(12.7)	E	
							3/27/03	14.45						(18.7)	E	
							5/15/03	12.8	8.21	214	11	11.24	247.9	341.6	Fish and Crane	
							7/23/03	14.8	8.34	430	22.7		220	2.1	Staff and Wade	
							8/20/03	15						(8.5)	E	
							9/25/03	15.2						(6.5)	E	
							3/12/04	14.7	7.86	354	4.19	14.19	134	12.9	Staff and Wade	
							4/7/04	14.2	8.38	367	9.76	13	237	49.4	Staff and Wade	
							5/6/04	12.7						(208.9)	E	
							6/16/04	11.6	8.42	188	11.15	10.47	150	789.9	Fish and Crane	
							7/14/04	13.8	8.51	264	23.2	8.6	184	116.7	Staff and Wade	
							8/18/04	14.8						(11.3)	E	
							9/14/04	15	8.22	442	15.38	9	162	(8.5)	E	

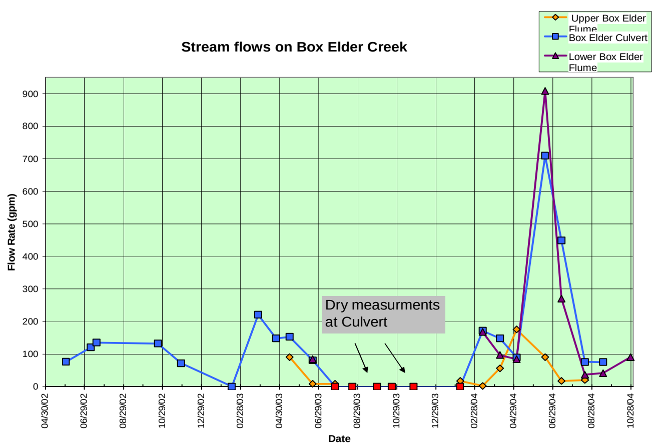
Flow measurements denoting E were calculated by using a Depth to Water method.



C7

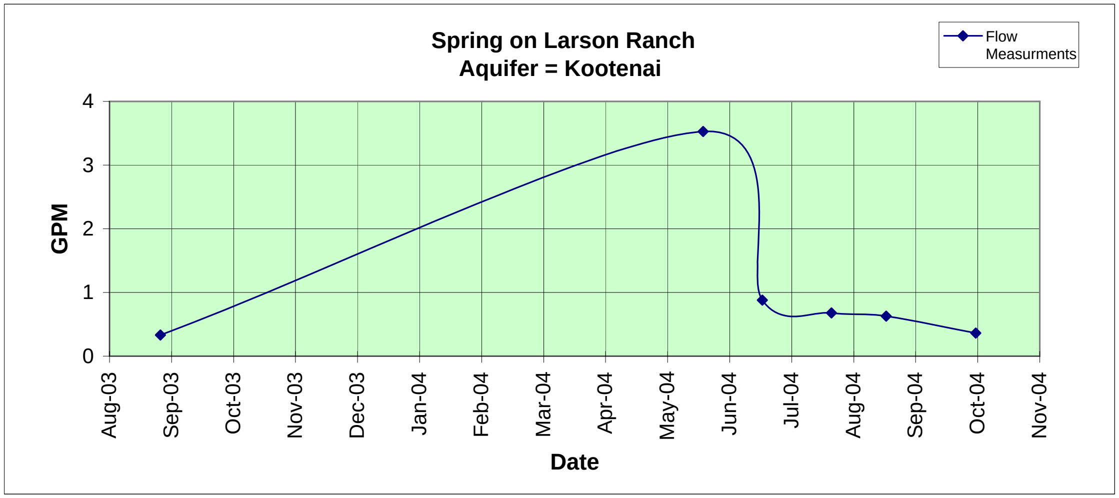
Mnumber	Stream	Station	Location (TRSt)	Latitude	Longitude	Elevation (feet)	Date	Depth to Water (feet)	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (gpm)	Flow Mesurment Method	Other conditions	Nitrate	Upper Flume 6-inch Parshall Flumes	Upper Flume Flow (gpm)	Lower Flume 6-inch Parshall Flume	Lower Flume Flow (gpm)
214393	Box Elder Creek	Road Culvert	T19N R06E 29 DCBB	47.371	-110.9875	3790	5/31/02	7	7.02	657	20.5		-71	76.33	Staff and Wade						
							7/9/02	6.9	8.27	750	8.27			(120.1)	E						
							7/18/02	6.85						(135.2)	E	Not enough flow to measure.					
							10/22/02	6.86	7.02	720	1.5	13.38	222	(132.)	E	Not enough flow to measure.					
							11/27/02	6.81	8.05	650	0.08	14.33	276	71.84	Staff and Wade						
							2/14/03							0	E	Frozen					
							3/27/03	6.85	8.54	586	2.9	16.14	188	221	Staff and Wade						
							4/24/03	6.8	7.18	694	16		268	148.2	Staff and Wade						
							5/15/03	6.75	8.29	693	18.2	10.08	205	152.7	Staff and Wade						
							6/20/03	6.8	7.51	632	16.6	7.98	135	80.8	Staff and Wade			0.23	90.51	0.22	84.37
							7/25/03							0		Dry		0.05	8.12	0	
							8/21/03							0		Dry		0.05	8.12	0	
							9/29/03							0		Dry		0		0	
							10/21/03							0		Dry		0		0	
							11/25/03							0		Dry		0		0	
							2/5/04							0		Frozen		0		0	
							3/11/04	6.75	8.09	600	7.35	18.97	108	(171.5)	E			0.08	17.06	0.34	167.83
							4/7/04	6.8	8.21	685	14.67	7.6	255	148.2	Staff and Wade			0.02	1.91	0.24	96.8
							5/3/04	7.1	8.54	658	17.76	8.02	214	89.8	Staff and Wade			0.17	56.14	0.22	84.37
							6/16/04	6.2	8.25	706	14.79	9.26	155	709.4			10	0.35	175.7	1.11	908
							7/12/04	6.8	8.3	678	19.64	6.71	190	449	Staff and Wade			0.23	90.51	0.46	270.58
							8/18/04	7.1	7.84	698	16.06	7.03	250	(75.6)	E	Water is flowing under culvert.		0.08	17.06	0.13	36.74
							9/15/04	7.1						(75.2)	E			0.095	20.55	0.14	41.31
							10/28/04											0.13	36.74	0.23	90.51

Flow measurements denoting E were calculated by using a Depth to Water method.



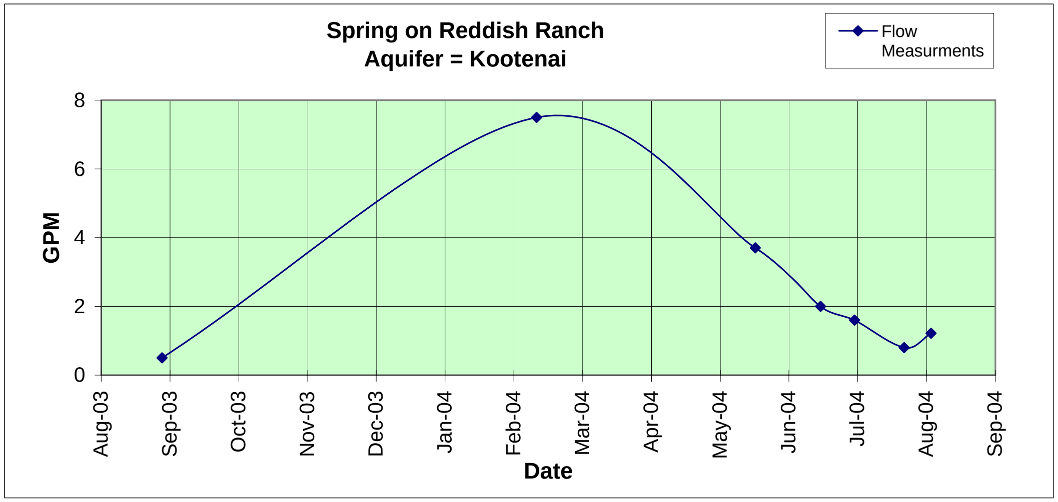
C8

Mnumber	Spring	Station	Location (TRSt)	Latitude	Longitude	Aquifer	Elevation (feet)	Date	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (gpm)	Flow Mesurment Method	Nitrate	Spring Conditions
214397	Larson Spring	Overflow Pipe	T19N R06E 34 ACDB	47.3658	-110.9463	217SNRS	3880	9/24/03	7.46	526	11.31	8.57	234	0.33	Bucket Stop Watch		
								6/17/04	5.3	583	8.73	7.1	281	3.53	Bucket Stop Watch	20	Overflow running everywhere
								7/16/04	6.02	512	10.22	6.56	255	0.88	Bucket Stop Watch	10 to 20	
								8/19/04	7.9	514	10.73	7.47	261	0.68	Bucket Stop Watch		
								9/15/04						0.63	Bucket Stop Watch		
								10/29/04						0.36	Bucket Stop Watch		



Mnumber	Stream	Station	Location (TRSt)	Latitude	Longitude	Aquifer	Elevation (feet)	Date	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (gpm)	Flow Mesurment Method	Nitrate	Stream Conditions
214395	Reddish Spring	Lower	18N R06E 14 CABA	47.3196	-110.9298	217CBNK	3940	9/26/03	7.85	500	12.93	8.65	230	0.5	Bucket Stop Watch		
								3/10/04	6.18	396	6.2	14.65	302.1	7.5	Bucket Stop Watch		
								6/15/04	6.79	440	10.11	9.29	305	3.7	Bucket Stop Watch		
								7/14/04						2	Bucket Stop Watch		
								7/29/04						1.6	Bucket Stop Watch		
								8/20/04						0.8	Bucket Stop Watch	2	
								9/1/04						1.22	Bucket Stop Watch		

C9

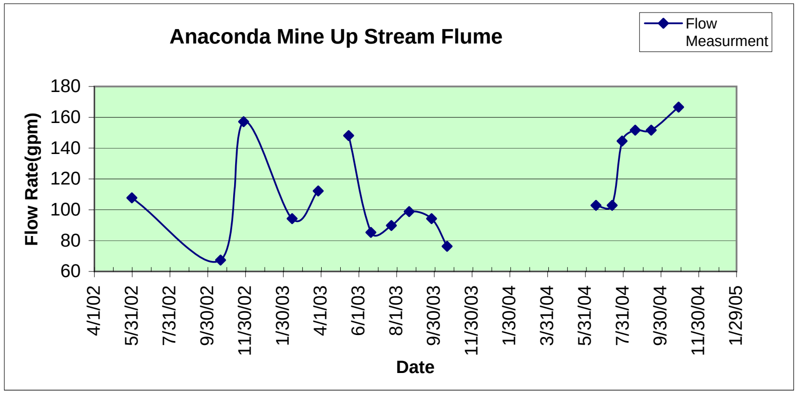


Appendix D

AMD Hydrographs & Field Measurements

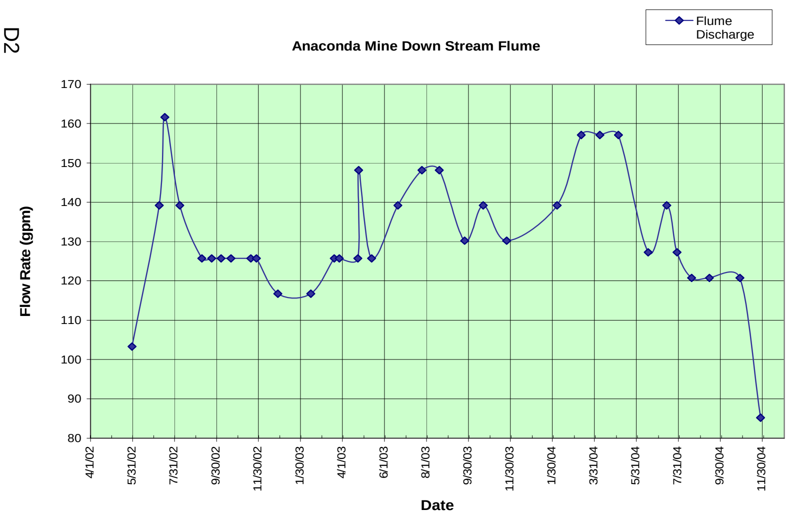
D1

Mnumber	AMD	Station	Location (TRSt)	Latitude	Longitude	Elevation (feet)	Date	Depth to Water (feet)	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (gpm)	was .5 now .75 H flume	Flow Mesurment Method	Other Conditions
200616	Anaconda Mine Drain At Culvert	AMD Up Stream Flume	T19N R06E 26 CAAA	47.381	-110.9292	3540	5/31/02	0.9	2.55	2000	11.5			107.76		Staff and Wade	
							10/21/02	0.86	2.76	2440	11	2.39	406	67.35		Staff and Wade	
							11/27/02	0.9	2.65	2260	10	1.6	407	157.15		Staff and Wade	
							2/13/03	0.82	2.87	2400	10.4	1.91	415	94.29		Staff and Wade	
							3/27/03	0.8	2.63	2220	10.3	1.6	409	112.25		Staff and Wade	
							4/24/03		2.97	2119	10.5		415			Staff and Wade	
							5/15/03	0.82	2.95	2260	10.9	1.7	415	148.17		Staff and Wade	
							6/20/03	0.9	3.24	2360	10.5	1.87	411	85.31		Staff and Wade	
							7/23/03	0.86	2.7		10.02		413	89.8		Staff and Wade	
							8/21/03	0.9	2.7	2070	10.9	2.09	408	98.78		Staff and Wade	
							9/26/03	0.9	2.85	2485	10	1.79	438.2	94.29		Staff and Wade	
							10/21/03	0.87	3.01	2471	9.99	1.75	432	76.33		Staff and Wade	
							11/25/03	0.85	2.86	2436	9.85	1	440				Did not measure
							2/6/04	0.81	2.95	2348	9.91	3.3	439				Did not measure
							3/12/04		2.6	2407	9.78	0.94	438				Did not measure
							4/8/04		2.79	2364	9.81	0.99	443				Did not measure
							5/5/04		2.86	2442	9.86	1.07	434				Did not measure
							6/17/04		2.91	2343	9.74	0.9	432	102.86	0.42	Flume	
							7/13/04		2.73	2369	9.85	1	433	102.86	0.42	Flume	
							7/29/04		2.98	2378	9.88	1.08	428	144.6	0.47	Flume	
							8/19/04		2.74	2413	9.94	2.49	426	151.7	0.48	Flume	
							9/14/04		2.98	2455	9.97	1.73	440	151.7	0.48	Flume	
							10/28/04		2.83	2470	9.94	1.44	415	166.6	0.5	Flume	Sampled



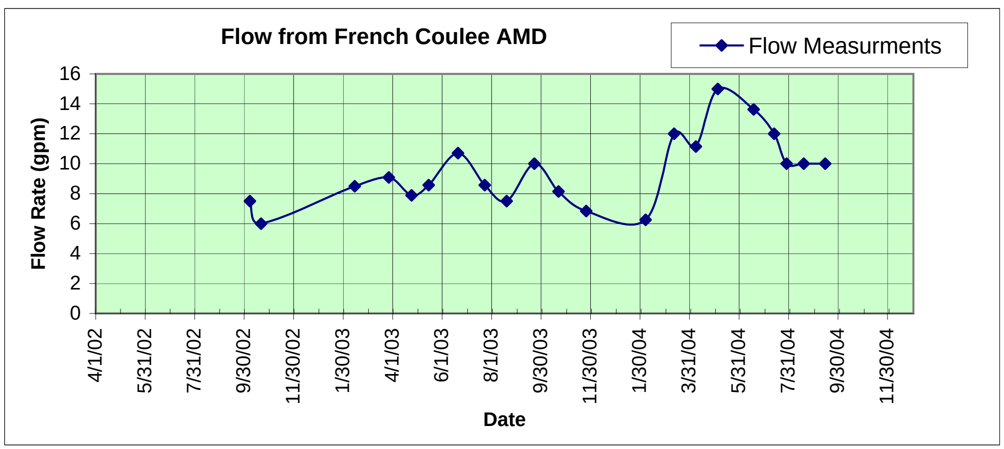
Mnumber	AMD	Station	Location (TRSt)	Latitude	Longitude	Elevation (feet)	Date	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (gpm)	Staff Guage Readings	Flow Mesurment Method	Other Conditions
217523	Anaconda Mine Drain at Down Stream Flume	AMD Down Stream Flume	T19N R06E 26 BDDD	47.3823	-110.9281	3530	5/31/02	2.58	2000	18.7		452	103.27		Staff and Wade	
							7/9/02	2.61	2680	14.7			139.19	0.42	Guage	
							7/17/02	2.55	2000	15.9	10.62	472	161.64	0.45	Guage	
							8/8/02						139.19	0.42	Guage	
							9/9/02						125.72	0.4	Guage	
							9/23/02		2340	16.7			125.72	0.4	Guage	
							10/7/02	2.64	1655	12.8			125.72	0.4	Guage	
							10/21/02	2.71	2430	12.2	2.5	442	125.72	0.4	Guage	
							11/19/02						125.72	0.4	Guage	
							11/27/02	2.73	2270	9.4	9.57	444	125.72	0.4	Guage	
							12/28/02						116.74	0.38	Guage	
							2/14/03						116.74	0.38	Guage	culver is plugged, not all water is flowing to flume
							3/20/03						125.72	0.4	Guage	
							3/27/03						125.72	0.4	Guage	
							4/23/03						125.72	0.4	Guage	
							4/24/03						148.17	0.43	Guage	Just rained hard
							5/13/03	2.98	2060	17.9	9.79	452	125.72	0.4	Guage	
							6/20/03	3.04	2290	13	9.48	441	139.19	0.42	Guage	
							7/25/03						148.17	0.43	Guage	
							8/19/03						148.17	0.43	Guage	AM Install of data logger
							9/25/03						130.21	0.41	Guage	
							10/22/03	3.02	2365	11.92	10.48	470	139.19	0.42	Guage	
							11/25/03	2.85	2382	6.04	10.94	466	130.21	0.41	Guage	logger frozen
							2/6/04	2.94	2391	10.73	10.24	464	139.19	0.42	Guage	
							3/12/04	2.77	2347	11.31	10.41	464	157.09	0.44	Guage	
							4/8/04	2.83	2294	11.08	11.17	468	157.09	0.44	Guage	
							5/5/04	2.91	2389	11.78	10.74	453	157.09	0.44	Guage	
							6/17/04	2.84	2288	13.28	9.6	458	127.28	0.4	Guage	
							7/14/04	2.85	2285	17.45	10.65	452	139.19	0.42	Guage	
							7/29/04						127.28	0.4	Guage	
							8/19/04	2.76	2331	19.23	6.46	464	120.75	0.39	Guage	Rocks jammed staff was 0.53
							9/14/04	3.28	2467	12.74	10.31	465	120.75	0.4	Guage	
							10/28/04	2.89	2312	11.71	8.65	458	120.75	0.4	Guage	
							11/27/04						85.21	0.36	Guage	

D2



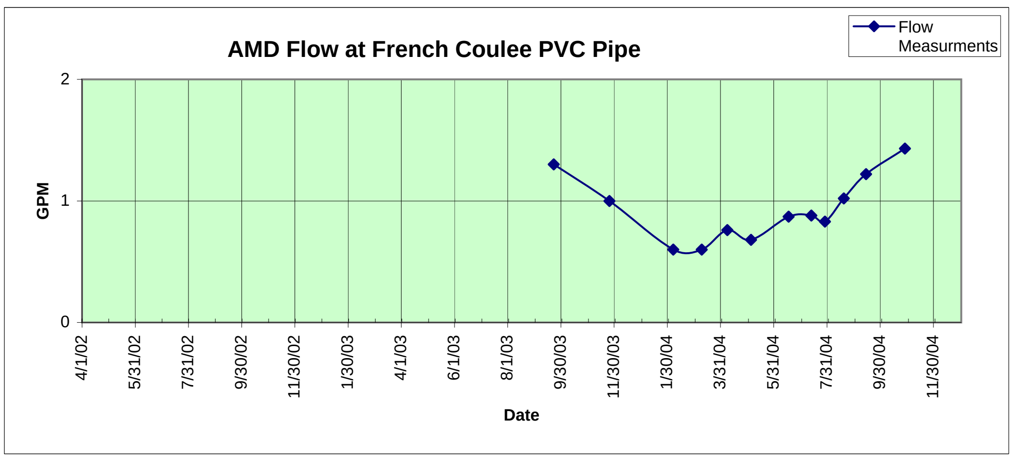
Mnumber	AMD	Station	Location (TRSt)	Latitude	Longitude	Elevation (feet)	Date	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (gpm)	Flow Mesurment Method
200615	French Coulee Discharge	Below Pond East side of RR tracks	T19N R16E 26 CADD	47.3782	-110.9278	3550	10/7/02	2.39	4400	12.8				Bucket Stop Watch
							10/21/02	2.53	4180	10.5	3.93	442	7.5	Bucket Stop Watch
							2/13/03	2.43	4400	7.2	3.5	426	6	Bucket Stop Watch
							3/27/03	2.67	4320	7.9	4.2	426	8.5	Bucket Stop Watch
							4/24/03	3.12	3520	10.5		415	9.09	Bucket Stop Watch
							5/15/03	2.68	4150	11.3	4.99	443	7.89	Bucket Stop Watch
							6/20/03	2.69	3160	12.1	4.54	438	8.57	Bucket Stop Watch
							7/23/03	2.64		14		444	10.71	Bucket Stop Watch
							8/19/03	2.91	4600	15.2		442	8.57	Bucket Stop Watch
							9/22/03	2.58	5764	12.31	4.7	457.4	7.5	Bucket Stop Watch
							10/22/03	2.76	4197	10.59	3.46	455	10	Bucket Stop Watch
							11/25/03	2.43	5875	7.28	4.52	472	8.14	Bucket Stop Watch
							2/6/04	2.68	6000	6.77	4.84	440	6.84	Bucket Stop Watch
							3/12/04	2.6	5365	7.42	3.52	445	6.25	Bucket Stop Watch
							4/8/04	2.57	4148	9.12	3.91	469	12	Bucket Stop Watch
							5/5/04	2.7	4813	9.78	4.12	465	11.15	Bucket Stop Watch
							6/18/04	2.59	3645	10.71	3.94	480	15	Bucket Stop Watch
							7/13/04	2.54	5071	12.09	2.61	451	13.63	Bucket Stop Watch
							7/29/04	2.96	5138	12.69	2.4	444	12	Bucket Stop Watch
							8/19/04	2.6	5818	13.09	1.99	441	10	Bucket Stop Watch
							9/14/04	2.67	5898	11.98	2.67	461	10	Bucket Stop Watch
							10/28/04	3.21	5935	9.69	3.06	434	10	Bucket Stop Watch

D3



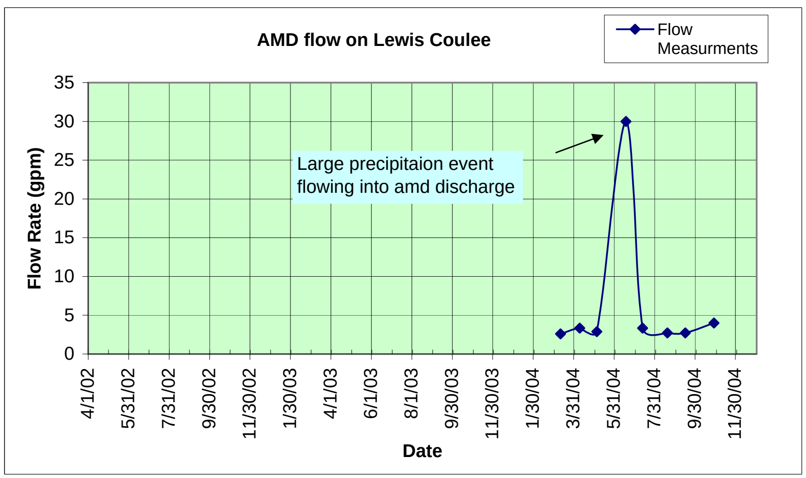
D4

Mnumber	AMD	Station	Location (TRSt)	Elevation (feet)	Date	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (gpm)	Flow Mesurment Method	Other Conditions	Nitrate	Nitrite
217524	French Coulee Discharge	French coulee 4" pvc pipe AMD	T19N R16E 26 CADC	3560	9/22/03	2.11	7322	12.05	7.31	507.8	1.3	Bucket Stop Watch			
					11/25/03	2.28	7438	8.47	7	494	1	Bucket Stop Watch			
					2/6/04	1.88	7397	7.51	9.2	509	0.6	Bucket Stop Watch			
					3/10/04	2.12	7215	8.3	8.85	499	0.6	Bucket Stop Watch			
					4/8/04	2.4	7203	9.45	8.5	491	0.76	Bucket Stop Watch			
					5/5/04	2.32	7216	10.22	7.73	486	0.68	Bucket Stop Watch			
					6/17/04	2.59	6941	10.81	9.5	479	0.87	Bucket Stop Watch		2	1.5 to 3.0
					7/13/04	2.41	6888	11.93	6.3	475	0.88	Bucket Stop Watch		1.5-3.0	
					7/29/04	2.43	6838	12.54	6.56	475	0.83	Bucket Stop Watch			
					8/19/04	2.24	7087	12.18	5.59	473	1.02	Bucket Stop Watch			
					9/14/04	2.61	7085	11.39	7.22	477	1.22	Bucket Stop Watch			
					10/28/04	2.2	7066	10.22	8.79	463	1.43	Bucket Stop Watch			



D5

Mnumber	AMD	Station	Location (TRSt)	Latitude	Longitude	Elevation (feet)	Date	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (gpm)	Nitrate	Flow Mesurment Method	Other Conditions
214915	Lewis Coulee	Lewis Coulee at first AMD flow	T19N R06E 26 AACD	47.386	-110.9193	3540	3/11/04	3.6	3806	9.54	9.06	334	2.6		Bucket Stop Watch	
							4/9/04	3.54	3735	12.5	6.08	304	3.33		Bucket Stop Watch	
							5/5/04	3.8	3575	9.85	5.2	284	2.89		Bucket Stop Watch	
							6/18/04	7.03	1132	9.41	10.09	-46	30	5	Bucket Stop Watch	30 gpm runnoff water feeding into mine
							7/13/04	3.62	3201	14.47	4.9	325	3.33		Bucket Stop Watch	
							8/19/04	3.05	3741	17.44	5.25	396	2.72		Bucket Stop Watch	
							9/15/04	3.85	3423	11.62	7.64	380	2.72		Bucket Stop Watch	
							10/28/04	3.78	3791	9.25	5.22	367	4		Bucket Stop Watch	Sampled



D6

Mnumber	AMD	Station	Location (TRSt)	Latitude	Longitude	Elevation (feet)	Date	pH	Conductivity (umhos/cm)	Temp (C°)	DO (mg/l)	ORP (mv)	Flow (gpm)	Other Conditions
214914	AMD at Lewis Coulee above Castner Park	AMD at 3rd and Lewis street in Belt	T19N R06E 26 ACAA	47.3848	-110.9223	3520	10/28/04	2.77	5319	9.04	2.67	427.7	2 estimate	sampled

Appendix E

Water-Quality Data

	Gwic Id	Site Name	Water Source	Latitude	Longitude	Geomethod	Datum	Location (TRS)	County	State	Site Type	Depth (ft)	Agency	Sample Date	Water Temp	Field pH	Lab pH	Field SC	Lab SC	CDS (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Fe (mg/l)	Mn (mg/l)	SiO2 (mg/l)	HCO3 (mg/l)	CO3 (mg/l)	SO4 (mg/l)
2005Q0283	214915	AMD AT LEWIS COULEE	AMD	47.386	-110.92	NAV-GPS	NAD83	19N06E26AACD	CASCADE	MT	MINE DRAINAGE		MBMG	10/28/2004 16:00	9.25	3.78	3.01	3,791.00	4300	6,728	226	152	27.6	0.523	672	1.07	105	0	0	5100
2005Q0287	214914	AMD 3RD AND LEWIS STREET IN BELT	AMD	47.3848	-110.922	UNKNOWN	NAD83	19N06E26ACAA	CASCADE	MT	MINE DRAINAGE		MBMG	10/28/2004 17:30	9.04	2.77	3.1	5319	3660	4873	203	147	25.1	6.97	558	1.23	69.9	0	0	3618
2003Q0848	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	1/30/2003 11:30	9.8	2.99	3.01	2290	2285	2471	148	68.6	10.3	3.24	166	0.403	52.6	0	0	1920
2003Q0866	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	3/15/2003 11:15	10.7	3.01	2.97	2220	2279	2521	164	70.4	10.5	3.3	173	0.5	52.5	0	0	1934
2003Q1018	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	4/22/2003 15:45	7.5	2.89	2.95	2260	2265	2430	153	69.7	10.9	2.83	150	0.363	49.9	0	0	1900
2003Q1079	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	5/28/2003 18:30	11.3	2.84	3.03	2350	2120	2043	140	67.5	10.8	2.8	143	0.375	52.5	0	0	1523
2003Q1163	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	6/18/2003 11:50	9.9	2.51	2.88	1425	2080	2184	156	72.5	10.7	2.92	168	0.426	53.2	0	0	1606
2004Q0029	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	7/17/2003 17:45			2.79		2090	2180	162	73.3	10.5	2.98	155	0.426	53	0	0	1610
2004Q0103	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	8/19/2003 16:30	9.9	2.58	2.8	2355	2290	2434	150	72	10.5	3.15	169	0.435	53.8	0	0	1851
2004Q0147	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	9/18/2003 18:45	9.94	2.7	2.93	2390	2350	2496	155	69.3	10.2	3.16	174	0.412	57.3	0	0	1905
2004Q0241	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	10/23/2003 16:20	9.91	2.99	3.01	2300	2290	2620	168	71.2	9.9	3.14	173	0.411	58.5	0	0	2025
2004Q0470	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	4/24/2004 15:20	9.8	2.8	3.19	2275	2280	2475	163	73.5	11	2.93	120	0.406	54.9	0	0	1916
2004Q0574	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	6/24/2004 16:50	11.91	2.75	3.34	2120	2230	2003	154	72.3	10.5	2.85	83.1	0.406	56.3	0	0	1510
2005Q0075	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	8/12/2004 14:30	9.9	2.68	2.8	2465	2280	2094	163	72.3	11	3.28	103	0.428	58.5	0	0	1580
2005Q0288	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	10/28/2004 11:30	9.94	2.83	3.09	2470	2390	2264	177	72.9	10.8	3.21	171	0.433	59.1	0	0	1663
2005Q0358	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	2/3/2005 16:25			3.13		2340	2514	167	72.6	10.8	3.08	174	0.44	56.9	0	0	1921
2005Q0419	200616	ANACONDA MINE DRAIN AT CULVERT	AMD	47.3788	-110.931	TRS-TWN	NAD27	19N06E26BDCD	CASCADE	MT	MINE DRAINAGE		MBMG	4/8/2005 12:45			3.16		2220	2456	150	68.3	10.1	2.88	156	0.395	54	0	0	2099
2003Q0846	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	1/29/2003 14:00	7	2.7	2.75	5620	5625	10057	271	117	11.7	5.4	1050	0.963	101	0	0	7990
2003Q0865	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	3/15/2003 10:45	7.2	2.68	2.71	5030	5150	8960	284	122	12.2	5.37	989	0.988	97.6	0	0	6975
2003Q1020	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	4/22/2003 14:55	9.7	2.68	2.7	4660	4800	7877	246	111	13.5	4.2	808	0.703	90	0	0	6198
2003Q1081	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	5/28/2003 18:00	12.2	2.62	2.78	4410	3960	5814	208	103	17.6	3.38	665	0.531	85.2	0	0	4400
2003Q1164	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	6/18/2003			2.66		4030	6824	241	114	16.6	3.34	761	0.65	89.8	0	0	5226
2004Q0031	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	7/17/2003 17:10			2.4		4400	7523	275	126	14.4	2.82	821	0.833	103	0	0	5750
2004Q0095	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	8/19/2003 16:00	14.3	2.36	2.54	5180	4810	8770	277	122	13.8	4.15	843	0.888	106	0	0	6891
2004Q0149	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	9/18/2003 19:05	11.3	2.41	2.76	5690	5080	9072	279	126	13.2	<5.0	929	0.902	105.4	0	0	7133
2004Q0235	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	10/23/2003 15:50	10.3	2.73	2.71	5800	5600	10491	293	127	10.8	3.65	1185	1.03	109	0	0	8152
2004Q0472	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	4/24/2004 15:45	10.2	2.57	2.95	4080	4070	6190	198	108	19.3	3.28	673	0.528	83.2	0	0	4799
2004Q0572	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	6/24/2004 16:00	12.23	1.75	3.14	4090	5510	9697	436	177	12.9	<0.50	950	1.52	160	0	0	7350
2005Q0077	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	8/12/2004 15:15	12.2	3.99	4.1	6230	5180	8373	262	129	14.7	3.75	1078	0.959	108	0	0	6244
2005Q0356	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	2/3/2005 16:45			2.9		5760	10198	292	138	12.5	4.47	1169	1.08	117	0	0	7878
2005Q0417	200615	FRENCH COULEE MINE	AMD	47.3722	-110.93	TRS-TWN	NAD27	19N06E26CDDB	CASCADE	MT	MINE DRAINAGE		MBMG	4/8/2005 15:15			2.84		5400	10082	270	135	12.6	5.59	1227	1.02	105	0	0	8694
2005Q0081	213598	PLEASANT VALLEY SPRING * OLD HARRI	217SBRS	47.4131	-110.972	NAV-GPS	NAD27	19N06E16	CASCADE	MT	SPRING		MBMG	8/12/2004 18:40	12.8	9.71	8.36	650	668	311	48.1	49.6	8.37	1.56	0.008	<0.001	8.09	285.48	0.867	20
2005Q0352	213598	PLEASANT VALLEY SPRING * OLD HARRI	217SBRS	47.4131	-110.972	NAV-GPS	NAD27	19N06E16	CASCADE	MT	SPRING		MBMG	2/4/2005 13:10			8.36		637	301	44.3	49.6	9.34	1.94	0.011	0.002	7.62	309.6	6	26.3
2004Q0025	204710	SEEP ON LEFT SIDE OF HIGHWAY DRAIN	217SBRS	47.3757	-110.927	NAV-GPS	NAD27	19N06E26	CASCADE	MT	OTHER		MBMG	7/17/2003 14:15			7.05		3340	3236	445	364	41.7	11	0.889	0.035	10.9	334.3	0	2116
2004Q0090	204710	SEEP ON LEFT SIDE OF HIGHWAY DRAIN	217SBRS	47.3757	-110.927	NAV-GPS	NAD27	19N06E26	CASCADE	MT	OTHER		MBMG	8/19/2003 18:10			7.62		3350	3271	428	352	43.9	11.5	0.534	0.033	10.7	494.1	0	2105
2004Q0153	204710	SEEP ON LEFT SIDE OF HIGHWAY DRAIN	217SBRS	47.3757	-110.927	NAV-GPS	NAD27	19N06E26	CASCADE	MT	OTHER		MBMG	9/19/2003 10:30	10.4	7.4	7.68	3510	3520	3258	443	354	43.2	11.2	0.44	0.042	10	407.5	0	2105
2003Q0850	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	1/30/2003 14:10	3.5	7.79	7.93	610	659	376	65.3	39.8	9.65	1.72	0.384	0.068	9	344.7	0	72.7
2003Q0863	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	3/15/2003 13:15	4.1	7.88	7.88	440	494	276	53.8	29	7.17	2.74	0.646	0.042	8.6	258.9	0	39.5
2003Q1024	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	4/22/2003 14:00	8.6	7.78	7.82	605	607	349	61.7	37.1	9.1	1.76	0.156	0.066	8.21	322.5	0	64.9
2003Q1083	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	5/28/2003 17:25	13.6	8.13	7.71	740	784	431	74.1	46.4	11	2.39	0.047	0.083	9.56	356.2	0	105
2003Q1165	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	6/17/2003 17:45	15.1	7.78	7.78	460	699	459	78.8	53.2	11	2.96	0.039	0.093	10.6	379.4	0	108.4
2004Q0027	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	7/17/2003 14:50			7.8		1412	967	152	103	16.5	4.59	0.698	0.147	13.3	411.5	0	457
2004Q0099	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	8/19/2003 17:45	10.6	7.66	7.69	790	1508	12634	181	134	20.1	5.82	2.12	0.196	12.4	351.4	0	706
2004Q0151	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	9/19/2003 10:05	9.34	7.74	8.13	860	1022	586	92.5	64.8	13.6	2.32	0.035	0.108	12.4	393.3	0	198
2004Q0474	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	4/24/2004 18:00	8.3	8.16	8.05	620	618	417	72	51	12	2.33	0.026	0.067	9.8	348.6	0	91.1
2004Q0570	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	6/24/2004 15:00	12.18	7.3	8.2	586	619	387	76.1	46.2	7.87	2.58	0.024	0.034	10.7	317.2	0	68.1
2005Q0079	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	8/12/2004 16:00	12	9.7	7.78	765	916	439	84.6	50	9.38	2.36	0.007	0.041	12.8	351.36	0	86
2005Q0354	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	2/4/2005 9:55			8.06		653	402	76.1	44.2	9.25	2.16	2.59	0.066	12.1	338.3	0	81.2
2005Q0415	200617	FRENCH COULEE * HIGHWAY DRAIN	217SBRS	47.3722	-110.929	TRS-TWN	NAD27	19N06E26CDDA	CASCADE	MT	OTHER		MBMG	4/8/2005 15:40			8.27		639	361	65.9	41.1	8.86	1.8	0.178	0.027	8.98	341.9	0	59.2
2004Q0101	205653	JOHN HARRIS RANCH * SPRING	217SBRS	47.3663	-110.997	NAV-GPS	NAD27	19N06E29	CASCADE	MT	SPRING		MBMG	8/19/2003 14:10	1	7.02	7.54	560	576	315	56.7	40.4	7.96	2.31	0.019	<0.001	8.35	314.8	0	36.2
2004Q0157	207767	HARRIS JOHN * POND	217SBRS	47.37	-110.992	NAV-GPS	NAD27	19N06E29	CASCADE	MT	POND		MBMG	9/19/2003 12:15	9.9	7.34	7.97	500	523	294	51.9	38.5	7.66	2.36	0.056	0.01	11.7	278.5	0	39
2004Q0233	205653	JOHN HARRIS RANCH * SPRING	217SBRS	47.3663	-110.997	NAV-GPS	NAD27	19N06E29	CASCADE	MT	SPRING		MBMG	10/23/2003 13:50	9.5	7.4	7.74	560	607	318	59.4	42.7	6.4	1.56	0.021	0.001	7.6	316.5	0	37.1
2004Q0159	204516	JIM LARSON	217SBRS	47.3651	-110.948	NAV-GPS	NAD27	19N06E34ACDC	CASCADE	MT	SPRING	19.6	MBMG	9/24/2003 15:00	11.31	7.46	7.8	526	506	248	57.5	25.3	4.69	0.84	0.011	<0.001	10.7	270.1	0	14.7
2004Q0110	205836	BELT CREEK	BELT CREEK	47.3636	-110.906	NAV-GPS	NAD27	18N06E12ABDA	CASCADE	MT	STREAM		MBMG	8/27/2003 10:50	17.9	7.79	7.83	297	428	213	51.8	14.6	4.4	1.61	0.027	0.095	7.07	157.4	0	54.7
2004Q0114	205839	BELT CREEK	BELT CREEK	47.3808	-110.925	NAV-GPS	NAD27	18N06E26DBBA	CASCADE	MT	STREAM		MBMG	8/27/2003 15:15	19.2	7.48	7.82	372	403	248	60.5	15.1	4.97	1.67	0.028	0.006	9.52	212.6	0	49.9
2004Q0112	205838	BELT CREEK	BELT CREEK	47.3753	-110.918	NAV-GPS	NAD27	18N06E26DDDA	CASCADE	MT	STREAM		MBMG	8/27/2003	18.4	7.22	7.67	371	415	242	56.3	15	5.27	1.85	0.04	0.003	8.39	217.9	0	46.5
2004Q0091	205508	BELT CREEK * E OF TOWN WELL #2	BELT CRK @CITY WELL	47.3812	-110.926	NAV-GPS	NAD27	19N06E26	CASCADE	MT	STREAM		MBMG	8/20/2003 12:30	20.9	7.48	7.83	460	552	281	69.1	17.1	5.15	1.79	0.036	0.005	9.27	227.2	0	64.8
2005Q0285	214916	BELT CREEK AFTER LEWIS AMD DRAIN	BELT CRK @LEWIS	47.3884	-110.924	NAV-GPS	NAD83	19N06E26ABAB	CASCADE	MT	STREAM		MBMG	10/29/2004 13:45	8.47	7.23	7.28	665	674	415	97	27.2	6.77	2.45	1.93	0.075	9.49	134.8	0	201
2005Q0284	214911	BELT CREEK AL ABOVE SWIM HOLE	BELT CRK @SWIM	47.382	-110.928	NAV-GPS	NAD83	19N06E26ACCC	CASCADE	MT	STREAM		MBMG	10/28/2004 14:00	10.38	6.64	5.83	637	737	506	90.4	35.8	6.04	1.78	0.169	0.375	8.35	32.9	0	344
2005Q0282	214913	BELT CREEK AT NORTH SLAG EXTENT	BELT CRK @NSLAG	47.3843	-110.929	NAV-GPS	NAD83	19N06E26BDAC	CASCADE	MT	STREAM		MBMG	10/28/2004 16:00	11.29	6.55	7.31	645	639	413	92.5	25.8	6.47	1.88	6.01	0.074	11.9	148.7	0	193
2003Q1087	203451	LOWER BOX ELDER CREEK * BELOW J H	LOWER BOXELDER	47.3779	-110.986	NAV-GPS	NAD27	19N06E29	CASCADE	MT	STREAM		MBMG	5/28/2003 16:45	24.5	8.2	8.02	680	645	371	74.8	37.6	10.4	2.7	0.061	0.065	12.8	355.4	0	49.3
2003Q1162	203451	LOWER BOX ELDER CREEK * BELOW J H	LOWER BOXELDER	47.3779	-110.986	NAV-GPS	NAD27	19N06E29	CASCADE	MT	STREAM		MBMG	6/17/2003 16:05	23.3	8.15	8.21	395	592	375	75.7	40.9	10.1	2.29	0.042	0.035	16.7	358.7	0	45.6
2004Q0478	203451	LOWER BOX ELDER CREEK * BELOW J H	LOWER BOXELDER	47.3779	-110.986	NAV-GPS	NAD27	19N06E29	CASCADE	MT	STREAM		MBMG	4/25/2004 14:10	17	8.67	8.26	570	562	344	66.7	39	10.7	3.08	0.035	0.008	3.14	315.1	0	56.6
2005Q0411	203451	LOWER BOX ELDER CREEK * BELOW J H	LOWER BOXELDER	47.3779	-110.986	NAV-GPS	NAD27	19N06E29	CASCADE	MT	STREAM		MBMG	4/8/2005 11:15	8.3	6.78	8.14	655	669	377	76.6	40.1	9.88	2.4	0.013	0.022	8.48	370.4	0	44.2
2003Q1085	203450	UPPER BOX ELDER CREEK * LARSON RA	UPPER BOXELDER	47.3586	-110.987	NAV-GPS	NAD27	19N06E32	CASCADE	MT	STREAM		MBMG	5/28/2003 15:50	19	8.1	8.13	675	678	379	78.2	34.2	11.2	2.93	0.039	0.052	9.17	351	0	59.2
2003Q1166	203450	UPPER BOX ELDER CREEK * LARSON RA	UPPER BOXELDER	47.3586	-110.987	NAV-GPS	NAD27	19N06E32	CASCADE	MT	STREAM		MBMG	6/17/2003 17:15	18.2	7.89		400			84.4	38.1	11.3	2.62	0.046	0.032	12.8			
2004Q0033	203450	UPPER BOX ELDER CREEK * LARSON RA	UPPER BOXELDER	47.3586	-110.987	NAV-GPS	NAD27	19N06E32	CASCADE	MT	STREAM		MBMG	7/17/2003 12:20			6.44		834	340	68.2	36.8	11.9	2.37	0.032	0.024	11.8	287.3	0	53.5
2004Q0097	203450	UPPER BOX ELDER CREEK * LARSON RA	UPPER BOXELDER	47.3586	-110.987	NAV-GPS	NAD27	19N06E32	CASCADE	MT	STREAM		MBMG	8/19/2003 11:20	15.6	7.85	8.09	620	625	344	68.6	36.6	9.91	2.18	0.037	0.023	12.1	330.01	0	40.6
2004Q0155	203450	UPPER BOX ELDER CREEK * LARSON RA	UPPER BOXELDER	47.3586	-110.987	NAV-GPS	NAD27	19N06E32	CASCADE	MT	STREAM		MBMG	9/18/2003 18:05	8.7	7.58	7.88	620	697	342	69.9	37.2	9.68	2.47	0.028	0.046	11.7	328.6	0	40.4
2004Q0237	203450	UPPER BOX ELDER CREEK * LARSON RA	UPPER BOXELDER	47.3586	-110.987	NAV-GPS	NAD27	19N06E32	CASCADE	MT	STREAM		MBMG	10/23/2003 11:15	9.3	7.71	7.89	660	732	387	78.4	38.9	10.3	2.3	0.033	0.042	11.8	357.5	0	51.2
2004Q0476	203450	UPPER BOX ELDER CREEK * LARSON RA	UPPER BOXELDER	47.3586	-110.987	NAV-GPS	NAD27	19N06E32	CASCADE	MT	STREAM		MBMG	4/25/2004 14:40	13	8.48	8.19	635	639	430	85.9	47.3	14.6	4.06	0.021	0.019	6.13	389.6	0	66.7
2005Q0350	203450	UPPER BOX ELDER CREEK * LARSON RA	UPPER BOXELDER	47.3586	-110.987	NAV-GPS	NAD27	19N06E32	CASCADE	MT	STREAM		MBMG	2/4/2005 13:35			8.15		683	404	77.8	38.7	11.5	2.86	0.032	0.023	11.8	401.1	0	50.1
2005Q0413	203450	UPPER BOX ELDER CREEK * LARSON RA	UPPER BOXELDER	47.3586	-110.987	NAV-GPS	NAD27	19N06E32	CASCADE	MT	STREAM		MBMG	4/8/2005 11:50			8.13		662	355	68.5	34.8	10	2.21	0.015	0.027	10	335.5	0	49.8
2005Q0286	214386	BELT CREEK AT ARMINGTON BRIDGE IN	BELT CRK @ARMING	47.3654	-110.907	NAV-GPS	NAD83	19N06E36DBBB	CASCADE	MT	STREAM		MBMG	10/28/2004 10:00	3.68	7.27	8.12	487	497	292	75.8	17.9	4.5	1.39	0.012	0.004	8.96	219.1	0	74.6
2004Q0166	196148	REDDISH GARY	330MDSN	47.3232	-110.931	NAV-GPS	NAD27	18N06E14BDBA	CASCADE	MT	WELL	800	MBMG	9/23/2003 9:00	10.09	7.32	7.68	530	542	299	65.9	23.5	5.32	1.79	0.043	0.004	8.46	277.6	0	53.1

	Gwic Id	Site Name	Water Source	Latitude	Longitude	Geomethod	Datum	Location (TRS)	County	State	Site Type	Depth (ft)	Agency	Sample Date	Water Temp	Field pH	Lab pH	Field SC	Lab SC	CDS (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Fe (mg/l)	Mn (mg/l)	SiO2 (mg/l)	HCO3 (mg/l)	CO3 (mg/l)	SO4 (mg/l)
2004Q0330	150504	DANKS BRENDA	330MDSN	47.4317	-110.923	NAV-GPS	NAD27	19N06E11ABAC	CASCADE	MT	WELL	300	MBMG	11/25/2003 14:15	11.27	7.17	7.46	657	655	425	93.4	28.6	2.4	0.916	0.013	<0.001	7.1	187.9	0	198
2004Q0329	31978	DAWSON JIM AND DELORES	330MDSN	47.3913	-110.969	NAV-GPS	NAD27	19N06E21ACDB	CASCADE	MT	WELL	670	MBMG	11/25/2003 15:35	9.71		7.54		676	445	96.5	29.3	3.49	1.13	0.024	0.004	7.8	203.1	0	205
1982Q0356	2315	TOWN OF BELT WELL 2	330MDSN	47.3838	-110.923	NAV-GPS	NAD27	19N06E26ACAD	CASCADE	MT	WELL	430	MBMG	1/6/1982 19:11	9.8	7.49	7.58	529	535.1	345	78.3	23	2.4	0.7	0.015	0.001	9	190.8	0	135
2001Q0358	2315	TOWN OF BELT WELL 2	330MDSN	47.3838	-110.923	NAV-GPS	NAD27	19N06E26ACAD	CASCADE	MT	WELL	430	MBMG	8/4/2000 11:18	10.2	7.77	8.05	574	565	346	80.4	23.4	2.5	1.1	0.006	<.001	7.85	197.2	0	132
2003Q1129	2315	TOWN OF BELT WELL 2	330MDSN	47.3838	-110.923	NAV-GPS	NAD27	19N06E26ACAD	CASCADE	MT	WELL	430	MBMG	6/5/2003 15:15	12.2	7.06	7.78	600	583	377	86.6	24.7	3.78	1.35	0.014	<0.001	7.92	208.3	0	150
2005Q0195	215047	BELT WELL 2A * MADISON WELL * LARSE	330MDSN	47.3786	-110.946	NAV-GPS	NAD27	19N06E27	CASCADE	MT	WELL	734	MBMG	9/22/2004 12:50	12.8	7.99	7.73	950	823	509	97.5	50.3	11.8	3.13	0.06	0.177	16	317.5	0	163
2004Q0328	177163	SPRAGG ED	330MDSN	47.3592	-110.903	NAV-GPS	NAD27	19N06E36DCDD	CASCADE	MT	WELL	490	MBMG	11/26/2003 14:30	9.08	7.36	7.46	608	599	373	79.9	26	5.96	5.26	0.013	0.005	7	296.7	0	99.3
2004Q0160	186483	SPILLER LEROY AND FAYE	110ALVM	47.3785	-110.927	NAV-GPS	NAD27	19N06E26DBCB	CASCADE	MT	WELL	24	MBMG	9/22/2003 16:45	11.19	7.19	7.66	619	604	360	79.1	27.5	7.64	2.75	0.018	<0.001	9.38	282.1	0	89.2
2003Q1131	32015	JIM LARSON RANCH	110ALVM	47.3534	-110.99	NAV-GPS	NAD27	19N06E32DCCB	CASCADE	MT	WELL	32	MBMG	6/5/2003 13:40	10.2	7.27	7.67	645	622	377	74.3	35.4	12.6	2.45	0.023	<0.001	9.71	349.5	0	64.6
2004Q0239	32015	JIM LARSON RANCH	110ALVM	47.3534	-110.99	NAV-GPS	NAD27	19N06E32DCCB	CASCADE	MT	WELL	32	MBMG	10/23/2003 12:20	10.5	7.34	7.68	630	655	380	74.9	34.6	11.9	2.47	0.012	<0.001	11	366.9	0	59
2004Q0163	31952	GOO EDWARD	112TILL	47.4357	-110.953	NAV-GPS	NAD27	19N06E03CDBA	CASCADE	MT	WELL	12	MBMG	9/25/2003 14:15		6.62	7.97	752	758	413	25.7	65.3	36.4	3.67	0.017	<0.001	15.3	380.2	0	59.1
2005Q0289	214917	DEQ RECLAIMED SITE MONITOR WELL 1	111MTLG	47.3815	-110.928	NAV-GPS	NAD83	19N06E26BDDD	CASCADE	MT	WELL	13.3	MBMG	10/29/2004 15:15	10.58	4.48	4.45	5462	5230	7286	473	643	26.6	9.53	3.21	5.98	4.22	0	0	5736
2005Q0043	210533	MARRY EVANS	217SBRS	47.3126	-110.995	NAV-GPS	NAD27	18N06E17CAAD	CASCADE	MT	WELL	90	MBMG	7/29/2004 15:30	8.61	7.26	8	886	896	473	71.3	63	31	1.77	0.041	<0.001	9.1	454.5	0	46.6
2004Q0168	30562	JOHNSON GERALD	217SBRS	47.3052	-110.977	NAV-GPS	NAD27	18N06E21BABB	CASCADE	MT	WELL	35	MBMG	9/23/2003 11:00	9.26	6.89	7.48	682	666	357	77.6	28.9	14.1	5.01	0.012	<0.001	10.2	316.8	0	26.9
2004Q0169	31957	HORST NATHAN	217SBRS	47.4359	-110.963	NAV-GPS	NAD27	19N06E04DACD	CASCADE	MT	WELL	140	MBMG	9/23/2003 16:35		6.92	7.29	1077	1056	642	69.8	93.7	46.1	5.72	0.12	0.05	6.37	588.8	0	121
2005Q0348	217048	BELT WELL 1C	217SBRS	47.3839	-110.953	NAV-GPS	NAD83	19N06E27BACC	CASCADE	MT	WELL	90	MBMG	2/3/2005 15:40			7.91		913	517	86.4	75.3	11.1	4.03	0.178	0.097	6.82	566.1	0	51.1
2005Q0425	217048	BELT WELL 1C	217SBRS	47.3839	-110.953	NAV-GPS	NAD83	19N06E27BACC	CASCADE	MT	WELL	90	MBMG	4/8/2005 14:30			7.31		904	510	85	75.7	11.5	3.95	0.199	0.065	6.77	553.1	0	51.5
2005Q0346	217050	BELT WELL 2C	217SBRS	47.3789	-110.947	NAV-GPS	NAD83	19N06E27CBBC	CASCADE	MT	WELL	80	MBMG	2/3/2005 17:30			7.67		615	304	37.5	46.2	6.58	1.67	0.008	0.015	7.25	357.2	0	20.1
2005Q0423	217050	BELT WELL 2C	217SBRS	47.3789	-110.947	NAV-GPS	NAD83	19N06E27CBBC	CASCADE	MT	WELL	80	MBMG	4/8/2005 18:40			7.43		654	329	43.5	55.6	8.62	2.09	0.009	0.019	7.77	348	0	25.9
2005Q0344	217053	BELT WELL 3C	217SBRS	47.3726	-110.972	NAV-GPS	NAD83	19N06E28CDC	CASCADE	MT	WELL	159	MBMG	2/4/2005 10:40			7.56		628	353	50.6	44.7	16	4.94	0.217	0.104	6.33	411.4	0	23.6
2005Q0421	217053	BELT WELL 3C	217SBRS	47.3726	-110.972	NAV-GPS	NAD83	19N06E28CDC	CASCADE	MT	WELL	159	MBMG	4/8/2005 16:50			7.51		679	367	53.5	47.4	16.9	4.86	0.283	0.097	6.24	416	0	28.9
2004Q0161	207672	IRVINE	217SBRS	47.3559	-110.96	NAV-GPS	NAD27	19N06E34CCCC	CASCADE	MT	WELL		MBMG	9/24/2003			7.74		576	318	50.3	44.9	7.42	1.78	0.03	0.002	6.9	346.2	0	24.3
2004Q0165	186486	DAWSON RANCH	217SBRS	47.3715	-110.865	NAV-GPS	NAD27	19N07E32BADA	CASCADE	MT	WELL	200	MBMG	9/23/2003 13:30	9.15	7	7.58	2086	1990	1418	119	69.4	260	6.45	0.027	0.14	7.85	512.4	0	684
2004Q0162	164111	HOYER, KEITH AND HEATHER	217SBRS	47.4516	-110.918	NAV-GPS	NAD27	20N06E35DADA	CASCADE	MT	WELL	90	MBMG	9/23/2003 15:35	11.57	7.38	7.79	597	602	359	74.9	26.4	9.16	2.56	0.102	0.213	10	274.5	0	97
2005Q0342	217056	BELT WELL 4C	217SBRS	47.3651	-110.956	NAV-GPS	NAD83		CASCADE	MT	WELL		MBMG	2/3/2005 13:50	9.6	6.83	7.37	735	761	438	65.1	51.2	20.1	6.1	0.324	0.051	6.02	505.5	0	35.9
2004Q0167	199851	ERIC JOHNSON	217CBNK	47.3099	-110.959	NAV-GPS	NAD27	18N06E15CCBC	CASCADE	MT	WELL	160	MBMG	9/23/2003 10:25	10.22	6.84	7.26	482	484	265	51.2	28.3	5.45	2.35	0.017	0.004	7.05	272.4	0	31.6
2004Q0093	84937	HARRIS JOHN JR.	217CBNK	47.3699	-110.99	NAV-GPS	NAD27	19N06E29CD	CASCADE	MT	WELL	200	MBMG	8/19/2003 13:20	9.9	6.86	7.28	740	730	444	94.5	41.3	11.9	4.06	1.31	0.09	6.35	350.4	0	107
2004Q0231	84937	HARRIS JOHN JR.	217CBNK	47.3699	-110.99	NAV-GPS	NAD27	19N06E29CD	CASCADE	MT	WELL	200	MBMG	10/23/2003 13:20	9	7.1	7.54	730	736	467	97	38.9	11.9	4.08	1.16	0.081	6.24	411.5	0	101
2004Q0468	207662	BURGE EXPLORATION ACM WELL	217CBNK	47.3787	-110.979	NAV-GPS	NAD27	19N06E29DAAA	CASCADE	MT	WELL	186	MBMG	4/25/2004 13:00	11.1	7.21	7.28	220	295	133	24	10.7	3.86	3.19	0.23	0.184	6.57	109.6	0	15.7
2004Q0513	207662	BURGE EXPLORATION ACM WELL	217CBNK	47.3787	-110.979	NAV-GPS	NAD27	19N06E29DAAA	CASCADE	MT	WELL	186	MBMG	5/7/2004 11:00			7.58		577	354	75.2	34.1	7.84	2.89	0.034	0.015	6.3	303.8	0	73.8
2005Q0340	207662	BURGE EXPLORATION ACM WELL	217CBNK	47.3787	-110.979	NAV-GPS	NAD27	19N06E29DAAA	CASCADE	MT	WELL	186	MBMG	2/4/2005 12:40			7.32		612	371	76.5	31.9	8.71	2.69	0.13	0.021	6.14	327	0	79.6
2005Q0290	215048	BELT WELL 4B COAL	221MRSN	47.3625	-110.95	TRS-TWN	NAD27	19N06E34	CASCADE	MT	WELL		MBMG	10/29/2004 10:00	8.83	6.59	7.37	877	921	507	100	47.7	22.2	5.88	0.087	0.376	7.48	416.5	0	115
2004Q0164	145604	ASSELS STEVEN D. AND LINDA L.	221SWFT	47.3994	-110.93	NAV-GPS	NAD27	19N06E23BDBA	CASCADE	MT	WELL	66	MBMG	9/23/2003 15:00	11.69	7.29	7.67	637	623	367	86	24.3	7.98	2	0.015	0.008	8.29	223.5	0	121

	Gwic Id	Cl (mg/l)	NO3 (mg/l)	F (mg/l)	OPO4 (mg/l)	Ag (ug/l)	Al (ug/l)	As (ug/l)	B (ug/l)	Ba (ug/l)	Be (ug/l)	Br (ug/l)	Cd (ug/l)	Co (ug/l)	Cr (ug/l)	Cu (ug/l)	Li (ug/l)	Mo (ug/l)	Ni (ug/l)	Pb (ug/l)	Sb (ug/l)	Se (ug/l)	Sr (ug/l)	Ti (ug/l)	Tl (ug/l)	U (ug/l)	V (ug/l)	Zn (ug/l)	Zr (ug/l)
2005Q0283	214915	<12.5	<2.50 P	<1.25	<2.50	<5	436295	<5	<150	<10	16	<1250	77.4	661	143	98.6	701	<50	2975	<10	<10	<5	2227	<10	<25	127	<25	7823	<10
2005Q0287	214914	<25.0	<2 50 P	2.91	<2.50	<10	236600	<10	<300	<20	<20	<2500	<10	517	33.8	48.1	495	<100	1377	<20	<20	<10	1888	<10	<50	24.2	<50	4376	<20
2003Q0848	200616	<10	<1.0	<1.0	<1.0	<5	99000	<5	<150	<10	16.6	<1000	6.59	265	28.3	<50	208	<10	618	<10	<10	<5	1630	1.84	<25	2.79	<25	3280	<2
2003Q0866	200616	5.8	<0.5	1.83	<0.5	<10	102000	<10	111	<20	18.8	<500	<10	292	31.5	15.7	219	<10	777	<20	<20	<10	1780	<5	<50		<50	2800	2.4
2003Q1018	200616	<10.0	<1.0	<1.0	<1.0	<5	90700	<5	118	<10	16.3	<1000	3.96	222	23.3	<10	192	<50	398	<10	<10	<5	1510	<1	<25	<2.5	<25	2790	4.49
2003Q1079	200616	7.51	<0.50	1.87	<0.50	<5	90850	<5	95	<10	11	<500	3.52	245	27	11.4	190	<50	416	<10	<10	<5	1598	<1	<25	2.94	17.3	2817	2.82
2003Q1163	200616	4.65	<0.25	0.549	<0.25	<5	106252	<2	102	2.86	20.3	<250	26	250	27.7	10.9	206	<10	450	<10	<10	<5	1930	<1	<25	3.01	<25	3121	2.66
2004Q0029	200616	<12.5	<1.25	2.18	<1.25	<5	107767	<5	96.6	<2	19	<1250	4.13	255	27.7	<10	210	<10	438	<10	<10	<5	1700	<1	<25	2.73	22.7	3171	3.01
2004Q0103	200616	8.6	<0.5	3.71	<0.5	<5	108575	<5	105	2.27	19.7	<500	4.68	264	30	<10	212	<10	485	<10	<10	<5	1876	<1	<25	2.74	26.6	3249	3.39
2004Q0147	200616	<5.0	<0.5	2.15	<0.5	<5	116063	<5	109	3.01	15.2	<500	5.33	260	38.4	<10	217	<10	454	<10	<10	<5	1806	<1	<20	2.9	18.6	3283	3.1
2004Q0241	200616	<5.0	<0.5	1.78	<0.5	<5	105949	<5	<150	2.2	14.9	<500	4.39	265	29.5	<10	217	<10	430	<10	<10	<5	1873	<1	<25	2.64	16.3	3229	3.32
2004Q0470	200616	<10.0	<1.0	4.23	<1.0	<10	126252	<5	82.5	<2	15.4	<1000	5.57	254	24.1	<10	198	<10	456	<10	<10	<5	1864	<1	<25	2.67	<25	3100	<10
2004Q0574	200616	6.7	<2.5 P	1.92	<0.50	<5	101577	<5	102	<2	18.9	<500	3.97	247	22.3	10.9	210	<10	452	<10	<10	<5	1773	<1	<20	3.13	<25	3261	<10
2005Q0075	200616	<5.0	<0.25	<0.25	<0.25	<5	98934	<5	116	2.45	12.7	<250	5.05	253	27.8	<10	218	<10	487	<10	<10	<5	1743	1.5	<20	3.46	<10	3339	4.11
2005Q0288	200616	<5.0	<1 25 P	<0.50	<0.50	<5	102846	<5	<150	4.27	19.5	<500	5.26	250	26.6	<10	216	<10	760	<10	<10	<5	1969	<1	<25	<3	21.2	3299	<2
2005Q0358	200616	<50.0	<5.0	<5.0	<5.0	<5	105027	<5	<150	<10	15.1	<5000	6.25	239	26.3	<10	212	<10	445	<10	<10	<5	1832	2.08	<20	<3.0	<25	3333	3.16
2005Q0419	200616	<10.0	<1.0	<1.0	<1.0	<5	95278	<5	109	4.59	<10	<1000	5.8	240	18.2	<10	207	<10	473	<10	<10	<5	1633	<1	<20	<3	16.5	2715	<2
2003Q0846	200615	<50	<5.0	<5.0	<5.0	<10	505000	65.6	<300	<20	45	<5000	16.8	368	131	<200	684	<100	974	<20	<20	<10	2720	<10	<50	16	<50	5120	<20
2003Q0865	200615	<50.0	<5.0	<5.0	<5.0	<10	470000	51.8	178	<20	56.5	<5000	10.7	363	130	97.5	659	<50	1080	<20	<20	<10	2880	<25	<50		<50	4090	<10
2003Q1020	200615	<125.0	<12.5	<12.5	<12.5	<10	402000	29.5	<<300	<20	<20	<12500	<10	287	95.4	93.9	547	<100	819	<20	<20	<10	2520	<10	<50	12.2	<50	3820	<20
2003Q1081	200615	16.3	<1.0	5.84	<1.0	<10	305844	24.1	<300	<20	20.7	<1000	<10	240	80.3	42.9	415	<100	356	<20	<20	<10	2119	<10	<50	14	<50	2845	21.8
2003Q1164	200615	<50.0	<5.0	<5.0	<5.0	<5	368398	27.5	<150	<10	25.9	<5000	33.7	227	80.7	31.3	488	<50	778	<10	<10	<5	2592	<5	<25	15.5	<25	3446	10.5
2004Q0031	200615	<25.0	<2.50	3.46	<2.50	<10	422685	28.3	<300	<20	34.2	<250	<10	240	92	31	589	<100	344	<20	<20	<10	2974	<10	<50	16.3	<100	4245	28.3
2004Q0095	200615	29.6	<2.5 P	9.91	<2.5	<10	467327	31.7	<300	<20	42.5	<2500	54.5	330	123	41.6	640	<100	1074	<20	<20	<10	3035	<10	<50	15.9	<50	4819	<20
2004Q0149	200615	<25.0	<2.5	6.79	<2.5	<10	473245	27.7	<300	<20	45.8	<2500	55	339	125	41.2	667	<100	539	<20	<20	<10	3154	<100	<50	16.4	<50	5082	<20
2004Q0235	200615	<25.0	<2.5	7.94	<2.5	<10	595625	45.1	<300	<20	40.8	<2500	<10	406	152	26.7	714	<100	556	<20	<20	<10	3410	<10	<50	19.5	<50	5787	<20
2004Q0472	200615	<63.0	<6.3	<6.3	<6.3	<10	304001	<10	<300	<20	28.6	<6300	<10	239	47.7	38.8	436	<100	399	<20	<20	<10	1962	<10	<50	16	<100	1835	<20
2004Q0572	200615	<25.0	<2.5	<2.5	<2.5	<10	600602	<10	<300	<20	51.4	<2500	<100	401	182	85.3	967	<100	781	<20	<20	<10	5420	<10	<50	26.6	<50	8401	<20
2005Q0077	200615	17.3	<1.25	2.57	<1.25	<10	506913	35.9	<300	<20	38.1	<1250	<10	337	128	38.8	692	<100	589	<20	<20	<10	2926	<10	<50	21.1	<50	5275	<20
2005Q0356	200615	<12.5	<12.5	13.3	<12.5	<10	566482	46.1	<300	<20	43.9	<12500	11.8	339	132	35.4	796	<100	588	<20	<20	<10	3600	<10	<50	15.6	<50	5982	<20
2005Q0417	200615	<25.0	<2.5	<2.5	<2.5	<10	560947	48.5	<300	<20	44.7	<2500	10	362	118	24.6	751	<100	600	<20	<20	<20		3058	<10	<50	13.8	4568	<20
2005Q0081	213598	7.25	25.6	1.25	<0.05	<1	51.7	<1	84.2	216	<2	<50	<1	<2	2.24	<2	24.8	<10	5.81	<2	<2	2.31	581	<1	<5	4.77	<5	<2	<2
2005Q0352	213598	2.94	<0.05	0.573	<0.05	<1	<30	<1	47.1	197	<2	<50	<1	<2	<2	<2	28.3	<10	3.77	<2	<2	2.54	577	<1	<55	3.64	<5	<2	<2
2004Q0025	204710	79.2	1.91	<0.25	<0.25	<5	<150	<5	<150	11.1	<10	<250	<5	<10	<10	<10	69.3	<50	<10	<10	<10	<5	2224	<5	<25	22	<25	254	<10
2004Q0090	204710	74.8					322	<50	<150	10.3	<10		<5	<10	<50	<25	80.4	<50	<10	<50	<50	<75	2174	<5	<100		<50	337	12.1
2004Q0153	204710	83.8	1.95	4.63	<0.5	<10	<300	<10	<300	<20	<20	<500	<10	<20	<20	<20	73.1	<100	<20	<20	<20	<10	2355	<10	<50	23.3	<50	161	<20
2003Q0850	200617	2.47	4.09	0.52	<0.05	<1	68.3	<1	31.5	173	<2	<50	1.17	<2	<2	<2	20.9	<10	3.73	<2	<2	2.43	442	<1	<5	4.57	<2	3.66	<2
2003Q0863	200617	2.6	3.78	0.56	<0.05	<1	136	<1	<30	158	<2	<50	<1	<2	<2	<2	18.2	<10	2.77	<2	<2	2.02	342	<5	<5		<5	5.27	<2
2003Q1024	200617	2.53	3.7	0.669	<0.05	<1	86.8	<1	<30	168	<2	<50	<1	<2	<2	<2	19.2	<10	2.28	<2	<2	1.82	436	<1	<5	4.06	<5	2.29	2.1
2003Q1083	200617	3.97	2.41	0.628	<0.05	<1	113	<1	<30	203	<2	<50	<1	<2	2.03	<2	24.5	<10	3.22	<2	<2	1.25	547	<1	<5	4.81	<5	3.89	<2
2003Q1165	200617	4.8	1.882	0.612	<0.05	<1	137	<1	45.3	207	<2	<50	<1	<2	<2	<2	26.6	<10	3.35	<2	<2	1.35	586	<1	<5	4.86	<5	3.45	<2
2004Q0027	200617	14.8	1.22	0.517	<0.25	<5	<30	<5	33.4	192	<2	<250	<1	<2	<10	<5	39.8	<10	4.12	<10	<10	<5	852	<1	<25	6.21	<10	33.7	2.42
2004Q0099	200617	26.1	1.04	1.87	<0.5	<1	<30	<1	59.5	113	<2	<500	<1	3.15	<2	<2	47.4	<10	10.42	<2	<2	3.8	1041	<1	<5	8.4	<5	65.7	<2
2004Q0151	200617	7.13	1.16	0.445	<0.10	<1	45.8	<1	51.7	208	<2	<100	<1	<2	<2	<2	29.9	<10	4.72	<2	<2	2.1	621	<1	<5	5.45	<5	4.83	<2
2004Q0474	200617	3.28	2.94	0.579	<0.10	<1	101	<1	51	258	<2	<100	<1	<2	<2	<2	27.9	<10	3.4	<2	<2	1.93	522	2.06	<5	6.31	<5	<2	<2
2004Q0570	200617	4.61	14.1	0.533	<0.05	<1	11.1	<1	52.8	243	<2	<50	<1	4.08	5.35	3.29	28.1	<10	4.43	<2	<2	1.28	638	<1	<5	5.67	<5	19.9	<2
2005Q0079	200617	4.36	15.6	0.49	<0.05	<1	51.6	<1	60.5	227	<2	<50	<1	<2	3.05	<2	26.6	<10	9.64	<2	<2	1.84	572	1.1	<5	7.06	<5	<2	<2
2005Q0354	200617	3.08	3.64	0.422	<0.05	<1	631	<1	<30	185	<2	<50	<1	<2	<2	<2	25.9	<10	7.94	<2	<2	2.69	599	<1	<5	4.8	<5	11.7	<2
2005Q0415	200617	2.68	3.74	0.46	<0.05	<1	127	<1	<30	186	<2	<50	<1	<2	<2	<2	20.1	<10	3.05	<2	<2	2.33	470	<1	<5	4.64	<5	2.32	<2
2004Q0101	205653	3.52	3.72	0.618	<0.05	<1	<30	<1	45.1	122	<2	127	<1	<2	<2	<2	19.1	<10	<2	<2	<2	1.89	446	<1	<5	2.4	<5	<2	<2
2004Q0157	207767	2.28	2.92	0.495	<0.05	<1	<30	1.92	39.7	150	<2	<50	<1	<2	<2	<2	19.5	<10	<2	<2	<2	1.28	385	<1	<5	<1	<5	<2	<2
2004Q0233	205653	1.8	4.4	0.672	<0.05	<1	<30	<1	40.1	133	<2	<50	<1	<2	<2	<2	18.3	<10	3.74	<2	<2	1.77	443	<1	<5	2.71	<5	4.35	<2
2004Q0159	204516	0.85	<0.5 P	0.392	<0.05	<1	<30	<1	<30	471	<2	<50	<1	<2	<2	<2	15.8	<10	<2	<2	<2	1.35	425	<1	<5	2.81	<5	3.83	<2
2004Q0110	205836	0.823	0.092	0.077	<0.05	<1	40.7	<1	<30	74.1	<2	<50	1.45	<2	<2	6.26	8.14	17.4	<2	<2	<2	<1	639	<1	<5	3.05	<5	29	<2
2004Q0114	205839	1.46	0.075	0.07	<0.05	<1	71.2	<1	<30	77.5	<2	<50	<1	<2	<2	<2	10.4	<10	<2	<2	<2	<1	673	<1	<5	1.07	<5	10.4	<2
2004Q0112	205838	1.45	<0.05	0.159	<0.05	<1	36.5	<1	<30	66.1	<2	<50	<1	<2	<2	<2	10.7	<10	<2	<2	<2	<1	644	<1	<5	1.13	<5	10.3	<2
2004Q0091	205508	1.85	0.112 P	0.161	<0.05	<1	<30	<1	<30	77.7	<2	<50	<1	<2	<2	<2	11	<10	<2	<2	<2	<1	714	<1	<5	1.17	<5	7.75	<2
2005Q0285	214916	2.11	<0.25 P	0.242	<0.05	<1	16.1	<1	31.4	59.9	<2	<50	<1	25.1	<2	<2	35	<10	61.5	<2	<2	<1	799	<1	<5	<1	<5	104	<2
2005Q0284	214911	1.75	0.532	0.14	<0.05	<1	568	<1	47.4	71.3	<2	<50	1.36	45.1	<2	<2	85.2	<10	74.5	<2	<2	<1	734	<1	<5	<1	<5	145	<2
2005Q0282	214913	1.69	<0.25 P	0.195	<0.05	<1	16.5	<1	<30	63.6	<2	<50	<1	28.2	<2	<2	34.9	<10	77.1	<2	<2	<1	814	<1	<5	<1	<5	212	<2
2003Q1087	203451	6.07	1.22	0.464	<0.05	<1	40	1.86	<30	244	<2	<50	<1	<2	3.24	3.343	16.7	<10	2.05	<2	<2	<1	436	<1	<5	2.56	<5	12	<2
2003Q1162	203451	5.5	0.991	0.461	<0.05	<1	39.1	2.07	37.7	294	<2	<50	<1	<2	<2	<2	17.7	<10	2.01	<2	<2	<1	444	<1	<5	2.74	<5	2.14	<2
2004Q0478	203451	6.8	1.81	0.434	<0.10	<1	<30	<1	40.7	213	<2	<100	1.41	<2	<2	<2	25.3	<10	3.39	<2	<2	1.04	555	<1	<5	3.67	<5	7.79	<2
2005Q0411	203451	5.81	6.95	0.348	<0.05	<1	<30	<1	<30	220	<2	<50	<1	<2	<2	<2	17.2	<10	2.79	<2	<2	<1	430	<1	<5	3.06	<5	<2	<2
2003Q1085	203450	7.91	2.51	0.401	<0.05	<1	<30	1.04	<30	213	<2	<50	<1	<2	2.82	<2	15	<10	2.08	<2	<2	<1	394	<1	<5	2.19	<5	<2	<2
2003Q1166	203450					<1	32	1.08	<30	235	<2		<1	<2	<2	<2	15.8	<10	<2	<2	<2	<1	453	<1	<5	2.29	<5	<2	<2
2004Q0033	203450	8.76	4.59	0.371	<0.05	<1	<30	<1	<30	253	<2	<50	<1	<2	<2	<2	16.9	<10	<2	<2	<2	<1	438	<1	<5	2.62	<5	<2	<2
2004Q0097	203450	7.09	3.41	0.512	<0.05	<1	<30	<1	39.8	286	<2	<50	<1	<2	<2	<2	18.1	<10	<2	<2	<2	1.14	442	<1	<5	2.71	<5	2.58	<2
2004Q0155	203450	6.96	1.33	0.43	<0.05	<1	<30	<1	35.7	338	<2	<50	<1	<2	<2	<2	17.9	<10	2.49	<2	<2	1.4	450	<1	<5	3.01	<5	<2	<2
2004Q0237	203450	7.11	9.98	0.584	<0.05	<1	35.4	<1	<30	303	<2	<50	<1	<2	<2	<2	19.7	<10	4.67	<2	<2	<1	470	<1	<5	3.84	<5	10.6	<2
2004Q0476	203450	9.85	3.48	0.39	<0.10	<1	<30	<1	42	265	<2	<100	<1	<2	<2	<2	22.2	<10	3.65	<2	<2	1.01	533	<1	<5	5.48	<5	<2	<2
2005Q0350	203450	8.2	4.75	0.264	<0.05	<1	<30	<1	<30	232	<2	<50	<1	<2	<2	<2	18	<10	6.62	<2	<2	1.08	432	1.57	<5	3.02	<5	<2	<2
2005Q0413	203450	8.04	5.81	0.328	<0.05	<1	32.4	<1	<30	203	<2	<50	<1	<2	<2	<2	15.1	<10	2.45	<2	<2	<1	354	<1	<5	2.53	<5	<2	<2
2005Q0286	214386	0.938	<0.25 P	0.061	<0.05	<1	<10	<1	<30	77.5	<2	<50	<1	<2	<2	<2	8.4	<10	2.84	<2	<2	<1	950	<1	<5	1.26	<5	17	<2
2004Q0166	196148	2.28	1.25	0.277	<0.05	<1	<30	<1	<30	69.4	<2	<50	<1	<2	<2	<2	8.42	<10	2.65	<2	<2	<1	441	<1	<5	1.28	<5	292	<2

	Gwic Id	Cl (mg/l)	NO3 (mg/l)	F (mg/l)	OPO4 (mg/l)	Ag (ug/l)	Al (ug/l)	As (ug/l)	B (ug/l)	Ba (ug/l)	Be (ug/l)	Br (ug/l)	Cd (ug/l)	Co (ug/l)	Cr (ug/l)	Cu (ug/l)	Li (ug/l)	Mo (ug/l)	Ni (ug/l)	Pb (ug/l)	Sb (ug/l)	Se (ug/l)	Sr (ug/l)	Ti (ug/l)	Tl (ug/l)	U (ug/l)	V (ug/l)	Zn (ug/l)	Zr (ug/l)
2004Q0330	150504	1.09	<0.5 P	0.802	<0.05	<1	<30	<1	<30	18.3	<2	<50	<1	<2	<2	3.8	6.35	12.9	3.46	<2	<2	1.88	995	<1	<5	2.95	<5	19.6	2.06
2004Q0329	31978	0.98	<0.5 P	0.462	<0.05	<1	<30	<1	<30	20	<2		1.52	<2	<2	<2	7.49	<10	2.61	<2	<2	<1	1738	<1	<5	2.69	<5	503	<2
1982Q0356	2315	1.6	0.34	0.43		<2.	<30.		140				<2.		<2.	9	2	30	<10.	70			1090	31			2	120	8
2001Q0358	2315	0.751	<.5 P	0.41	<.05	<1	<30	<1	<30	35.1	<2	<50	<2	<2	<2	<2	6.11	<10	2.17	<2	<2	<1	1190	<1	<5		<5	<2	<2
2003Q1129	2315	<5.0	<0.5	<0.5	<0.5	<1	<30	<1	<30	39.5	<2		<1	<2	<2	2.31	8.35	<10	<2	<2	<2	<1	1465	<1	<5	1.71	<5	4.78	<2
2005Q0195	215047	1.78	7.94	0.912	<0.10	<1	12.3	1.25	60.6	45.1	<2	<100	<1	<2	5.6	<2	38.7	18.1	11.5	<2	<2	5.08	1109	<1	<5	4.89	<5	<2	<2
2004Q0328	177163	2.6	<0.5 P	0.579	<0.05	<1	<30	<1	93.1	29.2	<2	<50	<1	<2	<2	2.89	27.8	<10	2.16	<2	<2	<1	1593	<1	<5	0.5	<5	4	2.98
2004Q0160	186483	4.26	0.664	0.37	<0.05	<1	<30	<1	32.5	51.9	<2	<50	<1	<2	<2	<2	15.7	<10	2.35	<2	<2	1.52	423	<1	<5	1.65	<5	8.5	<2
2003Q1131	32015	4.38	1.05	0.379	<0.05	<1	<30	<1	<30	241	<2		<1	<2	<2	<2	15.7	<10	<2	<2	<2	<1	356	<1	<5	<2	2.37	<5	50
2004Q0239	32015	4.14	1.04	0.36	<0.05	<1	<30	<1	36.2	254	<2	<50	<1	<2	<2	3.98	16	<10	<2	<2	<2	<1	351	<1	<5	2.72	<5	128	<2
2004Q0163	31952	8.2	10.77 P	1.18	<0.05	<1	<30	<1	132	88.2	<2	<50	<1	<2	<2	<2	50.8	<10	<2	<2	<2	3.03	544	<1	<5	9.12	<5	11.4	<2
2005Q0289	214917	<25.0	7.84 P	2.62	<2.50	<10	373061	<10	628	24.2	21	<2500	<10	309	<20	<20	946	<100	753	<20	<20	<10	1621	<10	<50	39.6	<50	1196	<20
2005Q0043	210533	25.5	<0.25 P	0.9	<0.05	<1	<10	<1	59.2	115	<2	<50	1.99	<2	<2	<2	27.9	<10	5.6	<2	<2	<1	558	<1	<5	10.7	<5	2.69	<2
2004Q0168	30562	23.9	14.35	0.107	<0.05	<1	<30	<1	<30	916	<2	<50	<1	<2	<2	<2	8.3	<10	2.96	<2	<2	<1	346	<1	<5	4.92	<5	2.36	<2
2004Q0169	31957	7.79	<0.5	0.966	<0.1	<1	<30	<1	118	23	<2	<100	<1	<2	<2	<2	105	<10	<2	<2	<2	<1	1233	<1	<5	1.36	<5	4.08	2.3
2005Q0348	217048	2.98	<0.05	0.233	0.098	<1	<30	<1	48.6	74.9	<2	<50	<1	<2	2.28	<2	36.5	<10	7.38	<2	<2	<1	640	1.54	<5	6.99	<5	<2	<2
2005Q0425	217048	2.74	<0.05	0.359	0.167	<1	42.3	<1	45.7	75.4	<2	<50	<1	<2	3.83	<2	35.4	<10	4.13	<2	<2	<1	629	<1	<5	6.76	<5	<2	<2
2005Q0346	217050	1.46	5.95	0.906	<0.05	<1	34.7	<1	48.4	108	<2	<50	<1	<2	<2	<2	28.9	<10	3.86	<2	<2	4.06	467	<1	<5	3.59	<5	5.92	<2
2005Q0423	217050	1.37	11.8	0.842	<0.05	<1	<10	<1	42.2	124	<2	<50	<1	<2	<2	<2	35.7	<10	2.23	<2	<2	3.58	545	<1	<5	3.53	<5	4.73	<2
2005Q0344	217053	2.11	0.06	1.55	0.125	<1	<30	5.41	115	94.1	<2	<50	<1	5.07	2.03	<2	65.5	<10	23.3	<2	<2	<1	915	<1	<5	<1	<5	<2	<2
2005Q0421	217053	1.92	<0.05	1.34	0.108	<1	47.2	5.3	104	95.6	<2	<50	<1	3.74	<2	<2	61.6	<10	20.5	<2	<2	<1	909	<1	<5	<1	<5	<2	<2
2004Q0161	207672	3.53	7.96	0.778	<0.05	<1	<30	<1	34.7	88.1	<2	<50	<1	<2	<2	2.7	31.2	<10	<2	<2	<2	4.17	418	<1	<5	2.64	<5	40.6	<2
2004Q0165	186486	17.9	1.2	<1.0	<1.0	<5	<30	<5	162	15.7	<2	<1000	<1	3.57	<10	<5	195.8	<10	7.87	<10	<10	<5	1876	<1	<25	7.92	<10	40.7	<2
2004Q0162	164111	3.26	<0.5 P	0.221	<0.05	<1	<30	<1	<30	58.6	<2	<50	<1	<2	<2	<2	15.2	<10	3.34	<2	<2	<1	760	<1	<5	1.77	<5	32.7	<2
2005Q0342	217056	2.51	<0.05	1.35	<0.05	<1	<30	1.14	175	59.7	<2	<50	<1	<2	2.1	<2	106	<10	4.7	<2	<2	<1	1211	<1	<5	<1	<5	<2	<2
2004Q0167	199851	2.57	1.12	1.07	<0.05	<1	<30	<1	57.3	93	<2	100	<1	<2	<2	2.39	21.9	<10	3.45	<2	<2	2.33	371	<1	<5	3.04	<5	21.3	<2
2004Q0093	84937	3.08	<0.05	1.41	<0.05	<1	<30	<1	114	21	<2	76	<1	<2	<2	<2	52.4	<10	4.32	<2	<2	<1	889	<1	<5	1.13	<5	19.3	<2
2004Q0231	84937	2.75	<0.05	1.49	<0.05	<1	<30	<1	107	22.5	<2	62	<1	<2	2.58	<2	54.3	<10	7.71	<2	<2	<1	914	<1	<5	1.41	<5	19.7	<2
2004Q0468	207662	3.89	2.17	0.255	<0.05	<1	58.4	<1	<30	71.9	<2	<50	1.85	4.42	<2	92.8	8.89	<10	7.09	<2	<2	<1	215	<1	<5	0.592	<5	8249	2
2004Q0513	207662	2.9	<0.5	0.702	<0.05	<1	<30	<1	55.7	67.6	<2	<50	<1	<2	8.83	<2	25.1	23.1	7.99	<2	<2	<1	536	1.26	<5	0.509	<5	57.3	<2
2005Q0340	207662	3.07	0.195	0.721	0.054	<1	<30	<1	39.8	64.3	<2	109	<1	<2	<2	<2	27.1	17.5	15.7	<2	<2	<1	609	<1	<5	0.908	<5	312	<2
2005Q0290	215048	2.83	<0.25	0.609	<0.10	<1	16	1.26	89	64.1	<2	128	<1	3.38	<2	<2	61.5	<10	12	<2	<2	<1	1037	<1	<5	3.05	<5	13	<2
2004Q0164	145604	6	0.79 P	0.133	<0.05	<1	<30	<1	<30	73.9	<2	<50	<1	<2	<2	<2	14.6	<10	3.22	<2	<2	<1	761	<1	<5	1.72	<5	28.9	<2

Appendix F

Isotope Data

Isotope Data						
mnumber	Sample Name	Date	Lab #	Tritium TU E3H	Oxygen 18O	Previously collected data
200616	Anaconda Mine Drain	1/30/03	57350	14.2		X
200616	Anaconda Mine Drain	5/28/03	67115	16	-18.04	X
200616	Anaconda Mine Drain	7/17/03	67123	16	-18.22	X
200616	Anaconda Mine Drain	10/23/03	72794	12.9	-18.46	X
205838	Belt Creek#2 above AMD	7/17/03	67122	13.2	-17.94	X
*	Box Elder Creek, Harris Ranch	1/29/03	57353	18.6		X
150504	Brenda Danks	11/25/03	73725	12.6	-18.72	
31978	Jim Dawson	11/24/03	73724	13.1	-18.67	
177163	Ed Spragg	11/26/03	73726	7.5	-19.64	
199851	Eric Johnson	9/23/03	73716	8.6	-19.79	
200615	French Coulee Drain	1/29/03	57351	15.3		X
200615	French Coulee Drain	5/28/03	67116	19.5	-17.98	X
200615	French Coulee Drain	7/17/03	67124	17.2	-18.04	X
200615	French Coulee Drain	10/23/03	72793	16	-18.28	X
186483	Fye Spiller	9/22/03	73713	13.7	-18.28	
196148	Gary Reddish	9/23/03	73719	11.1	-18.69	
31952	Edward Goo	9/25/03	73723	15.7	-15.34	
200617	Highway Drain	1/30/03	57352	26		X
200617	Highway Drain	5/28/03	67117	23.6	-16.52	X
204710	HWD-Seep	7/17/03	67125	31.9	-17.36	X
207672	Irvine	9/24/03	73721	2.4	-16.67	
186486	Jeff Dawson	9/23/03	73718	12	-18.13	
30562	Jerry Johnson	9/23/03	73714	14.4	-19.31	
32015	Jim Larson Well	6/5/03	67120	18.1	-16.99	X
32015	Jim Larson Well	10/23/03	72791	16.8	-17.08	X
84937	John Harris	8/19/03	68103	8.9	-18.59	X
84937	John Harris	10/23/03	72789	8.6	-18.6	X
205653	John Harris Spring	8/19/03	68104	14.2	-17.81	X
205653	John Harris Spring	10/23/03	72790	13.6	-17.91	X
164111	Keath Hoyer	9/23/03	73720	17.1	-18.46	
204516	Larson Well (Windmill)	9/24/03	73722	20.5	-15.82	
145604	Linda Assels	9/23/03	73715	18.3	-17.83	
203451	Lower Box Elder Creek	5/28/03	67118	20.3	-16.74	X
31957	Nathanial Horst	9/23/03	73717	1.3	-16.78	
2316	Town of Belt Well #1 Creek Well	6/5/03	67121	13.1	-18.67	X
2316	Town of Belt Well #1 Creek Well	11/23/03	72795	12.2	-18.99	X
2315	Town of Belt Well #2 Park Well	11/23/03	72796	13.6	-19.04	X
203450	Upper Box Elder Creek, Larson Ranch	5/28/03	67119	20.2	-17.11	X
203450	Upper Box Elder Creek	7/17/03	67126	19.8		X
203450	Upper Box Elder Creek	10/23/03	72792	23.2	-16.88	X
	X = Open File Report No. 504					