

**Town of Circle
Public Water System**

PWS ID # MT0000176

**Source Water Delineation
and Assessment Report**

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Table of Contents

INTRODUCTION.....	1
Purpose.....	1
Limitations.....	1
BACKGROUND.....	2
The Community.....	2
Geographic Setting.....	2
Climate.....	1
General Description of the Source Water.....	1
The Public Water Supply.....	1
Water Quality.....	1
DELINEATION.....	4
Geologic and Hydrogeologic Setting.....	4
PWS Well Information.....	5
Conceptual Model and Assumptions.....	6
Delineation.....	6
Limiting Factors.....	6
INVENTORY.....	1
Inventory Method.....	1
Inventory Results - Control Zone.....	2
Inventory Results - Inventory Region.....	2
Inventory Results - Recharge Region.....	1
Inventory Update.....	1
Inventory Limitations.....	1
SUSCEPTIBILITY ASSESSMENT.....	2
General Discussion.....	2
Hazard Determination.....	2
Discussion of Susceptibility.....	2
Management Recommendation.....	1
MONITORING WAIVERS.....	3
Waiver Recommendation.....	3
Monitoring Waiver Requirements.....	3
REFERENCES.....	6
GLOSSARY.....	7

Tables

Table 1. Period of Record Monthly Climate Summary Town of Circle.....	1
Table 2. Background Water Quality Results.....	3
Table 3. Summary of Well Information for Circle PWS Production Wells.....	5
Table 4. Summary of Potential Contaminant Sources in the Inventory Region.....	4
Table 5. Susceptibility Based on Hazard and Barriers.....	2
Table 6. Susceptibility Assessment of Significant Potential Contaminant Sources.....	1
Table 7. Susceptibility Assessment as it Relates to Waiver Eligibility for Significant Potential Contaminant Sources in the Inventory Region.....	3

Figures

- [Figure 1 – Vicinity Map](#)
- [Figure 2 – Geology of the Area](#)
- [Figure 3 – Drinking Water Protection Area](#)
- [Figure 4 – Land Use in the Inventory](#)
- [Figure 5 – Potential Contaminant Sources in the Inventory](#)

Appendices

APPENDIX A – PWS Sanitary Survey and Well Logs

APPENDIX B – PWS-6 Report

APPENDIX C – Concurrence Letter

EXECUTIVE SUMMARY

This Source Water Delineation and Assessment Report was prepared under the requirements and guidance of the Federal Safe Drinking Water Act and the US Environmental Protection Agency, as well as a detailed Source Water Assessment Plan developed by a statewide Montana citizens' advisory committee. The Department of Environmental Quality (DEQ) completes assessments of all public water systems in Montana. The purpose of an assessment is to provide information to the public water system staff/operator, consumers, and community citizens that enables development of strategies for protecting community drinking water sources. The information that is provided includes identification of the areas most critical to maintaining safe drinking water: the Control, Inventory, and Recharge Regions, an inventory of potential sources of contamination within these areas, and an assessment of the relative threats that these potential sources pose to the water system.

The Town of Circle Public Water System (PWS) drinking water is provided by two wells. Well No.1 (WL002) is located at the eastern edge of town and Well No. 3 (WL004) is located at the southeast end of town, near the fairground. A former supply well, Well No. 2 (WL003) has been decommissioned and disconnected from the water supply system. The primary source of Circle's drinking water is sandstone of the Fox Hills Formation. The Fox Hills Formation is overlain by siltstones and minor sandstones of the Hell Creek and Fort Union Formations. The source aquifer is considered to be a confined aquifer, due to these overlying low-permeability strata.

As the Fox Hills aquifer is confined, the overall source water sensitivity of the Circle PWS to contamination is classified as low, in accordance with Montana Source Water Protection Program aquifer sensitivity criteria (MT DEQ, 1999). Sensitivity is defined as the relative ease that contaminants can migrate to source water through the natural materials.

Three types of source water protection management regions for the Town of Circle public water system were mapped as part of this assessment. They are the control zone, inventory region, and the recharge region. Potential sources of contamination were identified within each of these three regions and the results are as follows:

- No potential sources of contamination were identified within the control zone. The control zone is delineated as a 100-foot radius around the wells and all sources of potential contaminants should be excluded in this region. The goal of management in the control zone is to avoid introducing contaminants directly into the water supply's well or immediate surrounding areas.
- Private septic tanks, underground storage tanks, and transportation routes were the only significant potential contaminant source identified within the inventory region. The inventory region is a 1,000-foot radius around the wells. The inventory region should be managed to prevent contaminants from reaching the well before natural processes reduce their concentrations.
- Significant potential contaminant sources identified within the recharge region include: underground storage tanks, treatment lagoons, and agricultural land. The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased usage. Recharge to the wells is primarily from infiltration at surface outcrops and downward leakage from the For Union Formation.

Susceptibility is the potential for a public water supply to draw water contaminated by inventoried sources at concentrations that would cause concern. Susceptibility is determined by considering the hazard rating for each potential contaminant source and the existence of barriers that decrease the likelihood that contaminated water will flow to the public water supply intake. Contaminant hazard ratings vary include high hazard sources (municipal sewer system and private septic systems), moderate hazard sources (leaking underground storage tanks) and low hazard sources (transportation corridors).

Due to the depth of the aquifer, the natural barrier of impermeable layers (siltstone) and the reverse osmosis water treatment facility, the susceptibility of Circle's public water supply to all potential contaminant sources is moderate to very low. Potential sources located outside the Inventory Region, but within the Recharge Region may still pose a threat over time, but are not discussed in detail in this assessment. This provides a quick look at the existing potential sources of contamination that could, if improperly managed or released, impact the source water for Town of Circle. The susceptibility analysis provides the community and the public water system with information on where the greatest risk occurs and where to focus resources for protection of this valuable drinking water resource.

The costs associated with contaminated drinking water are high, and prevention is the best treatment. In this report, the Source Water Protection Program provides a summary description of the supply wells' setting, such as the local geology and well construction. The area most critical to preserving drinking water quality (the Inventory Region) has been identified, in addition to potential sources of contamination within that area. Furthermore, recommendations (i.e. Best Management Practices) are provided regarding the proper use and practices associated with some common potential contamination sources. Public awareness is a powerful tool for protecting drinking water. The information in this report will help increase public awareness about the relationship between land use activities and drinking water quality.

INTRODUCTION

This Source Water Delineation and Assessment Report (SWDAR) was prepared for the Town of Circle Public Water Supply, PWS ID No. MT0000176. Circle is located in McCone County. It was completed by Joe Meek of the Source Water Protection Program at the Department of Environmental Quality with assistance from intern Bethany Haines.

PURPOSE

This report is intended to meet the technical requirements for the completion of the delineation and assessment report for the Town of Circle Public Water System (PWS) as required by the Montana Source Water Protection Program (DEQ, 1999) and the federal Safe Drinking Water Act (SDWA) Amendments of 1996 (Public Law 104-182). The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to protect public drinking water supplies from contamination. A major component of the Montana Source Water Protection Program is “delineation and assessment.” Delineation is a process whereby areas that contribute water to aquifers or surface water bodies that are used to supply drinking water are identified on a map. These areas are called source water protection areas. Assessment involves identifying locations in the delineated areas where contaminants may be generated, stored, or transported, and then determining the relative potential for contamination of drinking water by these sources. The primary purpose of this source water delineation and assessment report is to provide information that helps Town of Circle protect its drinking water sources.

LIMITATIONS

This report was prepared to assess threats to the Town of Circle public water supply, and is based on published information and information obtained from local residents familiar with the community. The terms “drinking water supply” or “drinking water source” refer specifically to the source of the Town of Circle public water supply and not to any other public or private water supply. Also, not all potential or existing sources of groundwater or surface water contamination in the area of the Town of Circle public water supply are identified. Only potential sources of contamination in areas that contribute water to its drinking water source are considered.

The term “contaminant” is used in this report to refer to constituents for which maximum concentration levels (MCLs) have been specified under the national primary drinking water standards, and to certain constituents that do not have MCLs but are considered to potentially represent health threats.

CHAPTER 1

BACKGROUND

THE COMMUNITY

Circle is located in central McCone County, approximately 48 miles northwest of Glendive, on State Highway 200S ([Figure 1](#)). The U.S. Census Bureau estimates the 2000 population of McCone County at 1,977 people, with approximately 644 of these people residing in the Town of Circle (<http://factfinder.census.gov>). Circle supports the surrounding agricultural community.

Circle's municipal water supply comes from two wells, both of which are located in the town of Circle ([Figure 1](#)). The Circle municipal sewer district services most of the areas within the town limits. A municipal wastewater treatment system utilizes sewage ponds located east of town. Treated wastewater effluent is discharged to the Redwater River annually, in compliance with a State wastewater discharge permit. Residents in areas outside of the town limits utilize individual on-site septic systems for waste disposal.

GEOGRAPHIC SETTING

Circle is located in the Eastern Montana Plains in the non-glaciated central region of the state (Heath, 1984). The area has a rolling topography with hills of low relief that are result of windblown silt deposits, termed loess (Cunnane, 2003). Circle's elevation is approximately 2,400 feet above sea level. Circle is located in the Redwater River watershed, which is located within the Lower Missouri River Watershed Management Region for Montana.

Figure 1 – Vicinity Map

CLIMATE

Information on climate in the vicinity of Circle is based on the National Oceanic and Atmospheric Administration's (NOAA) Circle climate station located at an elevation of 2,400 feet above mean sea level. Average temperatures and total precipitation for the Circle station for the period of 1971 to 2000 are shown in the graph. Average annual precipitation is 13.35 inches and monthly average precipitation ranges from 0.40 inches in February to 2.49 inches in June. The annual mean snowfall in Circle is 28.1 inches with 1 to 5-inches of measurable snow accumulation during the winter months. Air temperature can be hot during the summer and frigid during winter. Precipitation is semi-arid, and occurs primarily through the spring and summer months. Precipitation occurring during spring is the result of larger frontal systems, whereas thunderstorm activity is more common from July through August. Snow is common but not particularly abundant. The area will also often be subject to windy weather at all times of the year (Cunnane, 2003).

Table 1. Period of Record Monthly Climate Summary Town of Circle

Station (241758) Period of Record: 1971-2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	25.7	33.5	44.3	57.5	69.0	78.7	85.5	85.0	72.9	58.9	40.1	29.2	56.9
Average Min. Temperature (F)	4.0	11.4	20.8	31.4	42.0	50.6	54.9	53.7	42.8	31.7	18.3	7.6	30.9
Average Total Precipitation (in.)	0.41	0.40	0.60	1.18	1.92	2.49	1.87	1.30	1.39	0.93	0.44	0.43	13.35

Unofficial values based on averages/sums of smoothed daily data. Information is computed from available daily data during the 1971-2000 period. Smoothing, missing data and observation-time changes may cause these 1971-2000 values to differ from official NCDC values.

GENERAL DESCRIPTION OF THE SOURCE WATER

The Town of Circle obtains their drinking water from two wells. Well No.1 (WL002) is located east of town, and Well No. 3 (WL004) is on the southeastern edge of town ([Figure 1](#)). The water from the wells is pumped to a reverse osmosis plant and then to a storage reservoir. From there the water is delivered by a gravity-driven distribution system.

The nearest outcrop of the aquifer units is approximately 26 miles west-northwest of Circle. Groundwater flow is easterly and likely toward the northeast. The Fox Hills-Lower Hell Creek aquifer ultimately will discharge into the Missouri River system, which includes the Missouri main stem to the north and northeast, and also the Yellowstone River located southeast and east from Circle (Cunnane, 2003). Additional detail on the geology and hydrogeology of the area is provided in Chapter 2.

Figure 2 – Geology of the Area

THE PUBLIC WATER SUPPLY

The Town of Circle a community public water system (PWS) and serves 644 people through 365 connections. The PWS is designated a community water system since it serves at least 25 of the same residents every day. Information on the Town of Circle water system was obtained from correspondence in the DEQ Public Water Supply Section files including sanitary surveys completed in October 2001 (included as Appendix A). Another source is a PWS-6 completed by Western Groundwater Services LLC of Bozeman in February 2003 (included as Appendix B).

The town of Circle operates two wells in their water system. These wells penetrate several hundred feet to the Fox Hills- Lower Hells Creek aquifer, which is a confined aquifer that is prolific in eastern Montana. The aquifer is porous sandstone and is confined by several hundred feet of low permeability siltstone within the Hell Creek and Fort Union Formations. Water from the wells is pumped directly to the Town's reverse osmosis treatment plant. The treatment plant has a capacity of approximately 330 gallons per minute (gpm), provided by duplicate membrane units that each can process about 130 gpm and also use 35 gpm raw water as a re-blend prior to distribution. The distribution system services approximately 365 connections. Two elevated water storage tanks provide daily equalization water supply, emergency water supply for the fire suppression, and temporary water supply when wells or plant are out of service. A centralized sewer collection system extends throughout the Town. Gravity sewer flow delivers wastewater to the Town's wastewater treatment plant via one lift station. The plant consists of two lagoon cells and treated water is stored throughout the year. The Town discharges treated effluent by permit into the Redwater River on an annual basis, typically in November. This discharge event is overseen by the County Sanitarian (Cunnane, 2003).

WATER QUALITY

PWS Water Quality Monitoring Results

Every PWS is required to perform monitoring for contamination to their water supply. The monitoring constituents include coliform and other signs of pathogenic organisms, nitrates, metals and multiple organic chemicals. The monitoring schedule depends on many factors such as the size and source water for a PWS, the number of sources (e.g. wells), and the population served. Each PWS has a monitoring schedule that satisfies the general protocols defined by DEQ, but is tailored to meet the individual needs of a specific system. A summary of Town of Circle's monitoring data from DEQ's PWS database for the past five years was reviewed for this document.

The treated water quality for the Town of Circle is generally very good. Circle has experienced no confirmed coliform detections within the past five years. The maximum concentration level (MCL) of fluoride was exceeded in June 2003 at 4.72 mg/L (milligrams per liter, or parts per million). Testing in August 2003 showed fluoride below MCL at 0.98 mg/L. The U.S. Environmental protection Agency (EPA) has established a MCL for fluoride of 4 mg/L. Common sources of contamination for fluoride are: erosion of natural deposits; water additive for strong teeth; and discharge from fertilizer and aluminum factories. The MCL was not exceeded for any other monitored constituents but low levels of gross alpha particles (3 pCi/L or pico-Curies per liter), nitrate + nitrite (less than .0005 to less than .05 mg/L) were noted.

Background Water Quality

Well No. 1 and Well No. 2 were sampled for general water quality parameters in 1983. As stated above, Well No. 2 has since been decommissioned and replaced by Well No. 3. Analytical parameters included major dissolved ions (calcium, magnesium, sodium, potassium, iron, manganese, silica, bicarbonate, carbonate, chloride, sulfate, nitrate, fluoride and orthophosphate) and trace elements and metals. The analytical results for the most recent background sampling event (1983) from the GWIC database and a comparison of the results to maximum contaminant levels are summarized in Table 2. The MCL of 4

mg/L for fluoride was exceeded at both wells. The high fluoride content in the aquifer caused the Town of Circle to construct the reverse osmosis treatment plant described above. No other MCLs were exceeded in this sampling event, although the SMCL (secondary maximum contaminant level) for sodium was exceeded. SMCLs are indicators of aesthetic quality, and these are not regulatory levels; rather they suggest that taste, odor, color or other characteristic may be undesirable. The untreated water has been described as soft, and this is reflected in the high sodium levels (412 mg/L at Well No. 1, compared to the SMCL of 250 mg/L). $\mu\text{g/L}$

Table 2. Background Water Quality Results

Constituent	Town of Circle-WL003 (GWIC ID 136076)	Town of Circle – WL002 (GWIC ID 32476)	Drinking Water Standard
Sample Date	5/8/2000	7/25/1995	
Total Dissolved Solids	1,002.020	1,109.190	
Hardness as CaCO3	11.310	5.530	
Alkalinity	792.500	857.510	
Calcium (Ca)	3.740 mg/L	1.6 mg/L	---
Magnesium (Mg)	.0480 mg/L	0.374 mg/L	---
Sodium (Na)	412.0 mg/L	472.200 mg/L	250 mg/L [SMCL]
Potassium (K)	1.350 mg/L	1.40 mg/L	---
Iron (Fe)	0.043 mg/L	0.017 mg/L	0.3 mg/L [SMCL]
Manganese (Mn)	<.01 mg/L	<. 002 mg/L	0.05 mg/L [SMCL]
Silica (SiO2)	11.7 mg/L	13.60mg/L	---
Bicarbonate (HCO3)	907.700 mg/L	886.90 mg/L	---
Carbonate (CO3)	28.800 mg/L	78.00 mg/L	---
Chloride (Cl)	91.200 mg/L	100.00 mg/L	250 mg/L [SMCL]
Sulfate (SO4)	<25.0 mg/L	< 2.5 mg/L	250 mg/L [SMCL]
Nitrate (NO3 as N)	< .5 mg/L	< 0.25 mg/L	10 mg/L [MCL]
Fluoride (F)	4.310 mg/L	5.100 mg/L	4 mg/L [MCL]
Ortho-Phosphate (as P)	1.150 mg/L	< 0.1mg/L	500 mg/L [SMCL]
Aluminum (Al)	73.300 µg /L	<30. µg /L	50-200 µg /L [SMCL]
Antimony (Sb)	<2 µg /L	< 2. µg /L	6 µg /L [MCL]
Arsenic (As)	1.620 µg /L	1.200 µg /L	10 µg /L [MCL]
Barium (Ba)	30.700 µg /L	68.200 µg /L	2,000 µg /L [MCL]
Boron (B)	1,240.00 µg /L	1,333 µg /L	---
Cadmium (Cd)	<2 µg /L	<2 µg /L	5 µg /L [MCL]
Chromium (Cr)	<2 µg /L	<2.0 µg /L	100 µg /L [MCL]
Cobalt (Co)	<2 µg /L	< 2 µg /L	---
Copper (Cu)	13.700 µg /L	5.200 µg /L	1,300 µg /L [MCL]
Lead (Pb)	<2 µg /L	<2. µg /L	15 µg /L [MCL]
Lithium (Li)	56.00 µg /L	52.0 µg /L	---
Molybdenum (Mo)	< 10 µg /L	<10 µg /L	---
Nickel (Ni)	<2 µg /L	<10 µg /L	---
Phosphate (P)	1.550 mg/L	NR µg /L	---
Selenium (Se)	4.230 µg /L	5.700 µg /L	50 µg /L [MCL]
Silver (Ag)	< 1 µg /L	<1.0 µg /L	100 µg /L [SMCL]
Strontium (Sr)	60.90 µg /L	63.0 µg /L	---
Titanium (Ti)	<100 µg /L	<10.0 µg /L	---
Vanadium (V)	< 5 µg /L	< 5.0 µg /L	---
Zinc (Zn)	13.00 µg /L	<2.0 µg /L	5,000 µg /L [SMCL]
Zirconium (Zr)	< 50 µg /L	<20.0 µg /L	---

Key:

NR = No reading in GWIC

mg/L = milligrams per liter

µg /L = micrograms per liter

--- = Currently no standard for this constituent

[MCL] = U.S. Environmental Protection Agency maximum contaminant level or action level: revised October 13, 1999

[SMCL] = U.S. Environmental Protection Agency secondary maximum contaminant level or action level: revised October 13, 1999. This standard is based on aesthetic quality of water (i.e. odor, color, etc.) and is not a health standard

CHAPTER 2 DELINEATION

The source water protection area, the land area that contributes water to the Town of Circle PWS is identified in this chapter. Three management areas: the control zone, inventory region, and recharge region are identified within the source water protection area. A 100-foot radius around each wellhead defines the control zones, also known as the exclusion zones. The management goal of the control zone is to protect against the direct introduction of contaminants into the well or into the immediate area surrounding the well. The inventory region represents the zone of contribution of the PWS well intakes. Due to the depth to the (confined) source aquifer, the inventory zones are delineated by a 1,000-foot radius around each wellhead. The management goal of the inventory region is to focus on pollution prevention activities at potential contaminant sources where it is likely that contaminated water could flow to the wells within a relatively short time frame. The recharge region represents the area where the source aquifer is replenished. Management in the recharge region should focus on maintaining and improving the quality of groundwater that recharges to the wells over longer timeframes.

GEOLOGIC AND HYDROGEOLOGIC SETTING

This section provides an overview of the geology and hydrology of the vicinity of Circle. The geology of the area can be used to determine the locations, boundaries, and hydraulic properties of local aquifers. An understanding of hydrogeologic conditions also provides an explanation for the sensitivity of local aquifers to potential contaminant sources. The PWS-6 report prepared by Western Groundwater Services LLC of Bozeman, Montana in February 2003 also includes a summary of the regional geology (Appendix B).

The surface geology at Circle consists of the Fort Union Formation and recent alluvium. Alluvium has been deposited in by the Redwater River and tributaries, and forms a thin (<50 ft) deposit of clay, silt, sand and gravel. The exposed bedrock is Fort Union Formation, deposited 50 to 65 million years ago, at the beginning of the Tertiary Period. This formation is a mixture of river plain and river channel deposits, consisting primarily of silt and fine-grained sandstone. The sandstone is normally discontinuous, owing to the nature of river channel deposits. Coal deposits in the Fort Union are mined extensively in southeastern Montana and northeastern Wyoming. These deposits are representative of expansive marsh environments, and occur to a limited extent in the Fort Union at Circle (Cunnane, 2003).

The Fort Union Formation overlies the Hell Creek Formation, which in turn overlies the Fox Hills Formation. The contact between the Fort Union and Hell Creek occurs about 980 feet below ground surface, and is well defined, corresponding to the Cretaceous–Tertiary unconformity. The contact separating the Hell Creek and Fox Hills is transitional and cannot be identified as clearly. The base of the lowest shale occurring in the Fox Hills–Lower Hell Creek aquifer has been identified as the contact, which has been used by other geologist in eastern Montana. The Fox Hills Formation overlies the Pierre Shale, which is also named the Bearpaw Shale in some parts of eastern Montana. The Fox Hills–Lower Hell Creek aquifer is a low permeability bedrock formation with an average transmissivity of 117ft²/d (Miller 1979) (for comparison, a productive sand and gravel aquifer may have a transmissivity of 20,000 ft²/d). The pumping test data reported on the well log for Circle Well No. 1 indicates 540 feet of drawdown after 60hours of pumping at a rate of 164 gpm. These data may be used to estimate a transmissivity of 82ft²/d, however, the value does not account for head loss occurring at the borehole

wall. Using the average transmissivity of 117ft²/d and an aquifer thickness of 199ft, the hydraulic conductivity is estimated as 0.59 ft²/d (Cunnane, 2003).

PWS WELL INFORMATION

As described above, the town of Circle’s drinking water is supplied by two well: Well No.1 (WL002) is located east of town and Well No. 3 (WL004) is located at the southeaster end of town ([Figure 1](#)). The wells are all below 1400 feet deep. The static water levels measured at the time of drilling ranged from 159 to 283 feet below surface. The drinking water source material is interpreted to be sandstone. The aquifer is confined and the groundwater flow direction in the vicinity of the wells is towards the northeast. Recharge to the wells is likely to occur by vertical leakage, either from below or above the aquifer zone. The majority of recharge to the Fox Hills—Lower Hell Creek aquifer occurs by direct infiltration at the surface and outcrops and by downward leakage from the Fort Union Formation. Copies of the well logs showing stratigraphic and well construction information are included in Appendix A and are summarized in Table 3.

Table 3. Summary of Well Information for Circle PWS Production Wells

Supply Well	Well No. 1	Well No. 3
PWS Source Code	WL002	WL004
Well Location	SE¼, NW¼, SW¼, Sec.10, T19N, R48E	NW¼, NE¼, SW¼, Sec.15, T19N, R18E
Wellhead Elevation	N/A	N/A
Date Completed	6/17/1972	5/22/2003
Total Depth (bgs)	1,508 feet	1,480 feet
Well Completion: Casing	12-inch (steel)	10-inch steel from 1.5 feet above surface to 1230 feet bgs and 16-inch steel from 1 foot above surface to 98 feet bgs
Well Completion: Screen	210 feet of 20-slot SS screen. Depth of screen 1298 to 1508 feet bgs in “sand and gray clay” based on test hole geology and total well depth.	1168 to 1210 feet bgs slotted pipe and 5-inch stainless slotted screen from 1210 to 1470 feet bgs in “gravel and coal”
Well Completion: Annular Seal	Cement and 1298 feet bgs	Cement 1230 feet bgs and 16-36 silica sand 1168 to 1480 feet bgs.
Static Water Level (at time of drilling)	159 feet bgs	283 feet bgs
Well Pump Test Data	531 feet of drawdown after 6 hours of pumping at 467 gpm.	327 feet of drawdown after 2.5 hours of pumping at 270 gpm

Notes: bgs – below ground surface; gpm – gallons per minute

CONCEPTUAL MODEL AND ASSUMPTIONS

The Town of Circle's public water supply is located in the Redwater watershed (USGS Hydrologic Unit Code 10060002), which is located within the Lower Missouri River Watershed Management Region for Montana. The primary source of Circle's drinking water is the confined Fox Hills-Lower Hell Creek aquifer.

As the aquifer is confined, it is considered to have Low Source Water Sensitivity to contamination. This determination is according to the DEQ Source Water Protection Program criteria for ranking aquifer sensitivity (MT DEQ, 1999). Sensitivity is defined as the relative ease that contaminants can migrate to source water through the natural materials.

DELINEATION

Methods and criteria for delineating source water protection areas are specified in the Montana Source Water Protection Program (DEQ, 1999). Source water protection areas delineated for Town of Circle PWS include a controls zone around the wells, an inventory region and a recharge region. [Figure 3](#) illustrates the inventory region and control zone relative to the Town of Circle.

Control Zone – Control zones of 100-foot radii are delineated for the Town of Circle's wellheads. All sources of potential contaminants should be excluded in these regions.

Inventory Region – The inventory regions are circular area swith a radii of 1,000 feet, centered on the wellheads. All sources of potential contaminants are inventoried in these regions.

Recharge Region – This region includes the entire area contributing to the wells water supply. The recharge region may coincide with a topographic boundary, but not necessarily. The inventory for the recharge region focuses on general land uses and large industrial facilities. The goal of management in the recharge region is to maintain and improve the long-term quality of groundwater in the aquifer. Efforts to maintain and improve water quality within these land areas will benefit the Circle PWS.

LIMITING FACTORS

The inventory region represents an approximation of the distance required for upgradient contaminants to reach wells in a period of months to years. Numerous assumptions are associated with the Source Water Protection Program criteria for inventory region delineations. Contaminant transport rates and concentrations will vary depending on the physical and chemical characteristics of groundwater and the potential contaminants.

Figure 3 – Drinking Water Protection Area

CHAPTER 3

INVENTORY

INVENTORY METHOD

An inventory of significant potential contaminant sources was conducted to assess the susceptibility of Town of Circle's source water to contamination and to provide a foundation for source water protection planning. The inventory for the Circle PWS focuses on facilities that generate, use, or store potential contaminants and certain land uses in the inventory region delineated in the previous section. Sources of all primary drinking water contaminants and pathogens are identified, although only potential sources of contaminants that are the greatest threat to human health were selected for detailed inventory.

It is important to remember that the sites and areas identified in this section are only potential sources of contamination to the drinking water. Contamination of the drinking water is not likely to occur when potential contaminants are properly used and managed. Not all of these inventoried activities pose actual high risks to your public water supply. The day-to-day operating practices and contamination awareness varies considerably from one facility or land use activity to another.

The inventory for the Town of Circle PWS focuses on all activities in the control zone for the wells; certain types of municipal and private facilities or land uses in the inventory region; and general land uses and large facilities in the recharge region. Databases were searched to identify businesses and land uses that are potential sources of regulated contaminants. The process for completing the inventory included several steps, which are summarized as follows:

Step 1: Urban and agricultural land uses were identified from the U.S. Geological Survey's Geographic Information Retrieval and Analysis System (<http://nris.state.mt.us/gis/datalist.html>). Sewered and unsewered residential land uses were identified from boundaries of sewer coverage obtained from municipal wastewater utilities.

Step 2: EPA's Envirofacts System (<http://www.epa.gov/enviro/>) was queried to identify EPA regulated facilities located in the inventory region. This system accesses facilities listed in the following databases: Resource Conservation and Recovery Information System (RCRIS), Biennial Reporting System (BRS), Toxic Release Inventory (TRI), and Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) and the Permit Compliance System (PCS - for Concentrated Animal Feeding Operations with MPDES permits). The available reports were browsed for facility information including the Handler/Facility Classification to be used in assessing whether a facility should be classified as a significant potential contaminant source.

Step 3: Databases were queried to identify the following in the inventory region:

- Underground Storage Tanks (UST) (<http://www.deq.state.mt.us/Rem/tsb/iss/USTDownloads.asp>),
- Hazardous waste contaminated sites (DEQ hazardous waste site cleanup bureau),
- Landfills (<http://nris.state.mt.us/gis/datalist.html>), and
- Abandoned and active mines including gravel pits (<http://nris.state.mt.us/gis/datalist.html>)

Any information on past releases and present compliance status was noted.

Step 4: A business phone directory was queried to identify businesses that generate, use, or store chemicals in the inventory region. Equipment manufacturing and/or repair facilities, printing or photographic shops, dry cleaners, farm chemical suppliers, and wholesale fuel suppliers were targeted by Standard Industrial Classification (SIC) code.

Step 5: Major road and rail transportation routes were identified throughout the inventory region (<http://nris.state.mt.us/gis/datalist.html>).

Step 6: Public water system officials, or someone they designated as knowledgeable of the area, were interviewed to identify potential sources that are not listed in databases or on maps elsewhere (such as animal feeding operations that are not required to obtain a permit) and to assist in locating potential sources listed in the state and federal databases.

Step 7. Significant potential contaminant sources were identified in the control zone and inventory region and land uses and facilities that generate, store, or use large quantities of hazardous materials were identified within the recharge region

Potential contaminant sources are designated as significant if they fall into one of the following categories:

- Large quantity hazardous waste generators.
- Landfills.
- Underground storage tanks.
- Known groundwater contamination (including open or closed hazardous waste sites, state or federal superfund sites, and UST leak sites).
- Underground injection wells.
- Major roads or rail transportation routes.
- Cultivated cropland greater than 20 % of the inventory region.
- Animal feeding operations.
- Wastewater treatment facilities, sludge handling sites, or land application areas.
- Septic systems.
- Sewer mains.
- Storm sewer outflows.
- Abandoned or active mines

INVENTORY RESULTS - CONTROL ZONE

The control zone for the wells includes the well houses and the surrounding land. No potential sources of contamination were identified within the control zone.

INVENTORY RESULTS - INVENTORY REGION

The inventory region results are summarized in Table 5. Land use in the inventory region is reported in the National Land Cover dataset to be low intensity residential (44%), grasslands (30%), transportation routes (19%) and agricultural land (7%) ([Figure 4](#)). The agricultural land is considered a potential source of contamination.

The low intensity residential area is sewerred. As sewerred areas pose a potential risk of ongoing or catastrophic leakage of sewage into groundwater, it is considered a potential contaminant source.

There are several septic drainfields in the inventory region. These are considered potential contaminant sources, due to risk of leakage from septic pipes and vaults, and discharge from the drain field.

Well No. 3's inventory region has an inactive underground storage tank (UST) with active leaks (LUST). Petroleum bulk storage is considered a potential contaminant source.

The Highway route 200 and Montana Rail Link are potential contaminant sources. The transportation routes pose risks from spills, routine spraying, storm water runoff, and infiltration into groundwater. However, the highway does not have a high traffic and the railroad is used exclusively for grain transport, although there is no restricted use of the railroad.

Table 4. Summary of Potential Contaminant Sources in the Inventory Region

Source Type	Potential Hazard	Potential Contaminants	Description/Concern
<i>Land Use Cover (Step 1)</i>			
Residential Development with Sewer Lines	High	Pathogens and nitrates	If not properly designed, installed and maintained, sewer lines can be a point source of residential and commercial effluent in ground water.
Individual Septic Systems (Low Density)	Moderate	Nitrate, pathogens	If not properly sited, designed, installed, and maintained, septic systems can impact drinking water. Cumulative effects of multiple systems in an area may impact drinking water supply.
EPA Envirofacts Sites (Step 2)			
No sites identified			
DEQ Databases (Step 3)			
Inactive LUSTs	Moderate	VOCs, petroleum hydrocarbons	If not abandoned properly historic spills or leaks may impact the drinking water supply
Business – SIC Code Sites (Step 4)			
No Sites Identified			
Miscellaneous Others (including Step 5 and 6)			
Transportation Routes (Highway and Railroad)	Low	Nitrates, pesticides and herbicides, various others	Vehicle usage increases the risks for leaks or spills of fuels and other hazardous materials that may impact drinking water. Over-application or improper handling of pesticides or fertilizers may impact drinking water supply.

Notes: Individual sites identified are evaluated in Chapter 4.
 VOCs - Volatile organic compounds such as solvents
 UST - underground storage tank

Figure 4 – Land Use in the Inventory Region

Figure 5 – Potential Contaminant Sources in the Inventory Region

INVENTORY RESULTS - RECHARGE REGION

Land use in the recharge region is reported in the National Land Cover dataset approximately to be grasslands (60%) and agricultural land (40%). Grasslands are not generally considered a potential contaminant sources unless there is significant grazing. The percentage of agricultural land in the recharge region is interpreted to represent a moderate hazard. The concern is the potential for mismanagement or over-application of fertilizers and /or pesticides on the agricultural lands that could result in SOCs entering surface water and groundwater. Private well and septic system density within the recharge region is low and does not likely pose a risk to the water supply.

In addition to the above general land uses, several other potential contaminant sources are located within the recharge region. Several underground tank sites are located just outside of the inventory region within the town of Circle; some of these tanks sites have leak histories. Underground storage tanks present the danger of leaks of fuels or other VOCs into the groundwater supply. Two wastewater discharge sites, a RV dumpsite the municipal sewage lagoons, pose a high hazard to the water supply due to the potential for spills and leaks. The City of Circle Well No. 2 is inactive, and could pose a potential threat to water supply by acting as a conduit for contaminants if not properly abandoned. Other potential contaminant sources were not identified within the Recharge Region.

INVENTORY UPDATE

To make this SWDAR a useful document for the years to come, the certified water system operator should update the inventory for his records every year. Changes in land uses or potential contaminant sources should be noted and additions made as needed. The complete inventory should be submitted to DEQ every five years to ensure the source water delineation and assessment remains current.

INVENTORY LIMITATIONS

The potential contaminant sources described above are identified from readily available information. Consequently, unregulated activities or unreported contaminant releases may have been overlooked. The use of multiple sources of information, however, should ensure that the major threats to the source water for Town of Circle public water supply have been identified. In-depth analysis or research was not completed to assess each specific facility's compliance status with local, state and/or federal programs or laws. Further, the inventory process did not include an attempt to identify unique contamination risks at individual sites such as facilities (permitted or not) that do not safely store potentially hazardous materials.

The lack of identification of a potential contaminant source in the inventory or susceptibility assessment of this report does not mean that the potential for contamination does not exist or there is not a threat. It is highly recommended that the PWS and community "enhance" or refine the identification of the potential contamination sources through further research and local input.

CHAPTER 4

SUSCEPTIBILITY ASSESSMENT

GENERAL DISCUSSION

Susceptibility is the potential for a public water supply to draw water contaminated by inventoried sources at concentrations that would pose concern. Susceptibility is assessed in order to prioritize potential pollutant sources for management actions by local entities, in this case the Town of Circle PWS managers and operators. The goal of Source Water Management is to protect the source water by 1) controlling activities in the Control Zone, 2) managing significant potential contaminant sources in the Inventory Region, and 3) ensuring that major land use activities or other significant activities in the Recharge Region pose minimal threat to the source water. Management priorities in the Inventory Region are determined by ranking the significant potential contaminant sources identified in the previous chapter according to susceptibility. Alternative management approaches that could be pursued by the PWS managers and operators to reduce susceptibility are recommended in this chapter.

Because a contaminant source has not been identified in the inventory or susceptibility assessment of this report, it doesn't mean that the potential for contamination does not exist or is not a threat. It is highly recommended that the PWS and community "enhance" or refine the identification of the potential contamination sources through further research and local input.

HAZARD DETERMINATION

The proximity of a potential contaminant source to a well intake, potential contaminant migration pathways, or the density of potential non-point contaminant sources determines the threat of contamination, referred to here as hazard. The criteria for determining hazards within the inventory regions are established in Montana Source Water Protection Program Table 6: Hazard of Potential Contaminant Sources (MT DEQ, 1999).

Due to the facts that the source aquifer is confined and the supply well is cased and sealed through the confining layer, the hazards posed by identified contaminant sources are low.

DISCUSSION OF SUSCEPTIBILITY

Susceptibility is determined by considering the hazard rating for each potential contaminant source and the existence of barriers that decrease the likelihood that contaminated water will flow to the Circle PWS spring intake. Susceptibility ratings are determined individually for each significant potential contaminant source and/or contaminant based on Table 6.

Table 5. Susceptibility Based on Hazard and Barriers

Presence Of Barriers	Hazard		
	High	Moderate	Low
No Barriers	Very High Susceptibility	High Susceptibility	Moderate Susceptibility
One Barrier	High Susceptibility	Moderate Susceptibility	Low Susceptibility
Multiple Barriers	Moderate Susceptibility	Low Susceptibility	Very Low Susceptibility

Barriers to contamination can be anything that decreases the likelihood that contaminants will reach a spring or well. Barriers can be engineered structures, management actions, or natural conditions. Examples of engineered barriers are spill catchment structures for industrial facilities and leak detection for underground storage tanks. Emergency planning and best management practices (BMPs) are considered management barriers. Thick clay-rich soils, a deep water table or a thick saturated zone above the well intake can be natural barriers.

The Town of Circle PWS is credited with three barriers. These include the depth of the aquifer, the reverse osmosis treatment plant, and the low permeability confining layers over the source aquifer.

A summary of the susceptibility assessment for Town of Circle PWS wells are located in Table 7. These susceptibility ratings are the evaluation of the vulnerability of the spring to the more significant potential contaminant sources. Low risk potential sources such as the closed LUST site in the inventory region were not included. It is highly recommended that the PWS operator and community members familiar with the nature of businesses and land use in the area enhance the inventory through further research and local input.

Table 6. Susceptibility Assessment of Significant Potential Contaminant Sources

Potential Contaminant Source	Potential Contaminants	Hazard	Hazard Rating	Barriers	Susceptibility	Management Recommendation
Control and Inventory Zone						
Sewer Mains	Nitrates, Pathogens	Ongoing or catastrophic leakage of sewage into groundwater	High	- Aquifer depth >100 feet below ground surface (bgs) - Thick clay layers overlie the aquifer -Treatment of water before distribution	<i>Moderate</i>	Support maintenance, rehabilitation, or replacement of existing sewer mains; use of sewer main liners; and rapid response planning for leaks or ruptures.
Transportation Routes Highways and Railroad	Pesticides, fertilizers, VOCs, SOCs, other	Spills, routine spraying, storm water runoff, infiltration into groundwater	Low	- Aquifer depth >100 feet below ground surface (bgs) - Thick clay layers overlie the aquifer -Treatment of water before distribution	<i>Very Low</i>	Encourage and support emergency planning, training of local emergency response personnel, use of levees and engineered storm drainage to carry any spills away and prevent infiltration into ground, cooperation with railroad managers or MDOT to reduce herbicide use.
Inactive LUSTs	VOCs, petroleum hydrocarbons	Historic spills or leaks may impact the drinking water supply.	Moderate	- Aquifer depth >100 feet below ground surface (bgs) - Thick clay layers overlie the aquifer -Treatment of water before distribution	<i>Low</i>	Properly abandon and remove tanks if out-of-service. Encourage soil testing to evaluate potential impact from historic spills or leaks.
Septic System (Park bathroom septic system and residential septic systems)	Nitrates, Pathogens	Ongoing or catastrophic leakage of sewage into groundwater	Moderate	- Aquifer depth >100 feet below ground surface (bgs) - Thick clay layers overlie the aquifer -Treatment of water before distribution	<i>Low</i>	Encourage and support town and county efforts to extend sewer or to promote installation of community or advanced treatment septic systems and regular maintenance of septic tanks and distribution lines.
Potential Sources located in Recharge Areas						
Agricultural Land (40%)	SOCs, Nitrates, Pathogens	Contaminants leaching into groundwater	Low	- Aquifer depth >100 feet below ground surface (bgs) - Thick clay layers	<i>Not Rated – outside the inventory region</i>	Encourage and support efforts to provide educational information, materials, and resources to land owners on the proper application and storage of pesticides and fertilizers and implementing agricultural best management

				overlie the aquifer -Treatment of water before distribution		practices (BMPs).
Wastewater treatment facilities (lagoons), sludge handling sites, or land application areas	VOCs, SOCs, metals, pathogens, nitrates, others	Ongoing or catastrophic leakage of sewage into groundwater	Low	- Aquifer depth >100 feet below ground surface (bgs) - Thick clay layers overlie the aquifer -Treatment of water before distribution	<i>Not Rated – outside the inventory region</i>	Review permit status (contact DEQ Permitting and Compliance Water Protection Bureau – 406-444-3080 for more information) and ensure proper operation and maintenance, emergency planning, training of local emergency response personnel, groundwater monitoring, spill prevention and BMPs.
Inactive or Abandoned Wells	Pesticides, fertilizers, VOCs, SOCs, other	Improperly installed or maintained wells may provide a direct conduit for surface contamination into groundwater.	Low	- Aquifer depth >100 feet below ground surface (bgs) - Thick clay layers overlie the aquifer -Treatment of water before distribution	<i>Not Rated – outside the inventory region</i>	Encourage use of best management practices (BMPs) such as having positive drainage away from the well and ensuring hazardous materials are not stored or used around the well.
Active USTs	VOCs, petroleum hydrocarbons	Contaminants leaching into groundwater				Review permit status and ensure proper operation and maintenance, emergency planning, training of local emergency response personnel, groundwater monitoring, spill prevention, and BMPs.
Active Leaking UST sites	VOCs, petroleum hydrocarbons	Existing contamination may impact the drinking water supply.				Contact DEQ's Waste and Underground Tank Management Bureau (406-444-5300) to review status and any permits or monitoring network to verify existing contamination is being properly removed or remediated.

Notes: VOCs - Volatile organic compounds (i.e. solvents, fuel components)
UST - Underground Storage Tank
BMPs - Best Management Practices
RR – Recharge Region

SOCs - Synthetic Organic Compounds (i.e. pesticides, herbicides, plasticizers)
LUST - Leaking Underground Storage Tank
DEQ- Montana Department of Environmental Quality
SIC - Standard Industrial Code

The susceptibility assessment results for each significant potential contaminant source identified within the Inventory Region are described below. Sources located outside the inventory region but within the Recharge Region may still pose a threat over time, but are not discussed in detail.

Municipal Sewer System – Municipal sewer mains are present throughout the inventory region. The potential hazard imposed by pathogens and nitrate originating from the municipal sewer system is high. With the barriers identified (depth of the aquifer, thick clay layers, and treatment system), the susceptibility is rated as moderate.

Transportation Routes – The potential hazard imposed by spills and routine spraying from the highway is low. The barriers identified (depth of the aquifer, thick clay layers, and treatment system), the susceptibility is rated as very low.

Inactive Leaking Underground Storage Tank (LUST)— The potential hazard imposed by petroleum hydrocarbons originating from listed active and closed LUST is moderate. These LUST poses a moderate hazard because it is down gradient from the wells. The susceptibility of the PWS wells to petroleum hydrocarbons originating from these sources is low, due to the barriers identified (depth of the aquifer, thick clay layers, and treatment system).

Septic System – Hazard is ranked high because the sewage disposal system is located within the inventory region. The barriers identified (depth of the aquifer, thick clay layers, and treatment system), the susceptibility is rated as moderate.

MANAGEMENT RECOMMENDATION

It should be noted that even small releases of some chemicals in close proximity to a public water supply well can have significant negative impact on water quality, and therefore are a significant threat to the public water supply. Steps can be taken to reduce the likelihood of releases in the source water for the PWS or in the vicinity of the sources. Some of these management recommendations are detailed in the susceptibility table for the PWS (Table 8). If these, and other, management recommendations are implemented; they may be considered additional barriers that will reduce the susceptibility of the intake to specific sources and contaminants.

Sewer/Wastewater Treatment System Maintenance and Leak Detection – Early warning of leaks and scheduled replacement of aging sewer lines and wastewater treatment systems may reduce the susceptibility of the PWS to contamination from septic wastes.

Inactive USTs/LUSTs - It is recommended that the PWS operator or community members contact DEQ's Waste and Underground Tank Management Bureau (406-444-5300) to obtain further information on the cleanup status and any permits or monitoring networks to verify existing contamination is being properly assessed and remediated. The PWS can work with DEQ to encourage proper abandonment for out-of-service tanks and soil testing to evaluate potential impact from historic spills or leaks.

Emergency Response Plan – Several counties have compiled Emergency Response Plans that were then adopted by the local communities. The usefulness and effectiveness of a response plan are maximized if it contains a clear listing of all emergency contacts, emergency numbers, and resources available within the county to respond to an emergency situation, such as a hazardous material spill. Emergency plans are not difficult to develop or distribute, but have a significant benefit to the citizens and municipalities within the county.

Education - Educational workshops provided to the general public by the city, county, or state promote safe handling and proper storage, transport, use, and disposal of hazardous materials. Ongoing training provided to designated emergency personnel would promote the efficiency and effectiveness of emergency responses to hazardous material spills. Likewise, educational workshops provided to rural homeowners and agricultural landowners will promote best management practices for groundwater protection including proper maintenance and replacement of residential septic systems and proper management of small acreages. The EPA and the State of Montana can provide educational materials on these topics.

In addition, the Circle PWS and community should consider potential risks to the source water protection area if land uses in the inventory or recharge regions change.

CHAPTER 5

MONITORING WAIVERS

WAIVER RECOMMENDATION

The Circle PWS has a waiver for Phase 2 inorganics (which includes barium, cadmium, chromium, fluoride, mercury and selenium). The waiver allows the PWS to collect one sample round for these constituents on a nine-year cycle rather than every three years. In addition, the PWS was grandfathered under the radionuclide rule and is only required to sample once every nine years. Based on past monitoring results and the susceptibility assessment, the Circle PWS may be eligible for other waivers, including Phase 5 inorganics and volatile organic compounds. Information on susceptibility and use waivers is provided in this section to give the PWS operators an opportunity to consider if waivers may be feasible.

Before a susceptibility or use waiver is requested, the PWS Operators are encouraged to carefully review the following section on Monitoring Waiver Requirements for confined and unconfined aquifers. If after reviewing this section it is determined that an additional waivers are feasible, the Town of Circle PWS should submit a letter to DEQ requesting the specific monitoring waivers. If requested by DEQ, the PWS may also need to provide additional information regarding chemical use in the area within the Inventory Region. Table 6 shows how identified potential contaminant sources affect the eligibility for monitoring waivers.

Table 7. Susceptibility Assessment as it Relates to Waiver Eligibility for Significant Potential Contaminant Sources in the Inventory Region.

Source	Contaminant	Susceptibility	Waiver Eligibility
Transportation Corridors	VOCs, SOCs, petroleum products and other chemicals	Low	Chemical use in right-of-way may preclude waivers for some chemicals. PWS should confirm chemical use history along the right-of-way. Waivers might be rescinded if a spill occurred.
Sewer System/ Wastewater Treatment	Nitrates, pathogens	High-moderate	Waivers are not available for pathogens and nitrate. Sewer system integrity may preclude waivers. The PWS should provide information of sewer assessment and maintenance.
Agricultural/Grazing Land Use	Pesticides, fertilizers, nitrates, pathogens	Very Low	Chemical use in the area may preclude waivers for some chemicals. Circle PWS should confirm chemical use history by land parcel.

MONITORING WAIVER REQUIREMENTS

The 1986 Amendments to the Safe Drinking Water Act require that community and non-community PWSs sample drinking water sources for the presence of volatile organic chemicals (VOCs) and synthetic organic chemicals (SOCs). The US EPA has authorized states to issue monitoring waivers for

the organic chemicals to systems that have completed an approved waiver application and review process. All PWSs in the State of Montana are eligible for consideration of monitoring waivers for several organic chemicals. The chemicals diquat, endothall, glyphosate, dioxins, ethylene dibromide (EDB), dibromochloropropane (DBCP), and polychlorinated biphenyls are excluded from monitoring requirements by statewide waivers.

Use Waivers

A Use Waiver can be allowed if through a vulnerability assessment, it is determined that specific organic chemicals were not used, manufactured, or stored in the area of a water source (or source area). If certain organic chemicals have been used, or if the use is unknown, the system would be determined to be vulnerable to organic chemical contamination and ineligible for a Use Waiver for those particular contaminants.

Susceptibility Waivers

If a Use Waiver is not granted, a system may still be eligible for a Susceptibility Waiver, if through a vulnerability assessment it is demonstrated that the water source would not be susceptible to contamination. Susceptibility is based on prior analytical or vulnerability assessment results, environmental persistence, and transport of the contaminants, natural protection of the source, wellhead protection program efforts, and the level of susceptibility indicators (such as nitrate and coliform bacteria). The vulnerability assessment of a surface water source must consider the watershed area above the source, or a minimum fixed radius of 1.5 miles upgradient of the surface water intake. PWSs developed in unconfined aquifers should use a minimum fixed radius of 1.0 mile as an area of investigation for the use of organic chemicals. Vulnerability assessment of spring water sources should use a minimum fixed radius of 1.0 mile as an area of investigation for the use of organic chemicals. Shallow groundwater sources under the direct influence of surface water (GWUDISW) should use the same area of investigation as surface water systems; that is, the watershed area above the source, or a minimum fixed radius of 1.5 miles upgradient of the point of diversion. The purpose of the vulnerability assessment procedures outlined in this section is to determine which of the organic chemical contaminants are in the area of investigation.

Given the wide range of landforms, land uses, and the diversity of groundwater and surface water sources across the state, additional information is often required during the review of a waiver application. Additional information may include well logs, pump test data, or water quality monitoring data from surrounding public water systems; delineation of zones of influence and contribution to a well; time-of-travel or attenuation studies; vulnerability mapping; and the use of computerized groundwater flow and transport models. DEQ's PWS Section and DEQ's Source Water Protection Program will conduct review of an organic chemical monitoring waiver application. Other state agencies may be asked for assistance.

Susceptibility Waiver for Confined Aquifers

Confined groundwater is isolated from overlying material by relatively impermeable geologic formations. A confined aquifer is subject to pressures higher than atmospheric pressure that would exist at the top of the aquifer if the aquifer were not geologically confined. A well that is drilled through the impervious layer into a confined aquifer will enable the water to rise in the borehole to a level that is proportional to the water pressure (hydrostatic head) that exists at the top of a confined aquifer.

The susceptibility of a confined aquifer relates to the probability of an introduced contaminant to travel from the source of contamination to the aquifer. Susceptibility of an aquifer to contamination will be

influenced by the hydrogeologic characteristics of the soil, vadose zone (the unsaturated geologic materials between the ground surface and the aquifer), and confining layers. Important hydrogeologic controls include the thickness of the soil, the depth of the aquifer, the permeability of the soil and vadose zones, the thickness and uniformity of low permeability and confining layers between the surface and the aquifer, and hydrostatic head of the aquifer. These factors will control how readily a contaminant will infiltrate and percolate toward the groundwater.

The Susceptibility waiver has the objective of assessing the potential of contaminants reaching the groundwater used by the PWS. A groundwater source that appears to be confined from surface infiltration in the immediate area of the wellhead may eventually be affected by contaminated groundwater flow from elsewhere in the recharge area. Contaminants could also enter the confined aquifer through improper well construction or abandonment where the well provides a hydraulic connection from the surface to the confined aquifer. The extent of confinement of an aquifer is critical to limiting susceptibility to organic chemical contamination. Regional conditions that define the confinement of a groundwater source must be demonstrated by the PWS in order to be considered for a confined aquifer susceptibility waiver. Confinement of an aquifer can be demonstrated by pump test data (storage coefficient), geologic mapping, and well logs. Site-specific information is required to sufficiently represent the recharge area of the aquifer and the zone of contribution to the PWS well. The following information should be provided:

- Abandoned wells in the region (zone of contribution to the well),
- Other wells in the region (zone of contribution to the well),
- Nitrate/Coliform bacteria analytical history of the PWS well,
- Organic chemical analytical history of the PWS well,

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GLOSSARY

Acute Health Effect. A negative health effect in which symptoms develop rapidly.

Alkalinity. The capacity of water to neutralize acids.

Aquifer. A water-bearing layer of rock or sediment that will yield water in usable quantity to a well or spring.

Barrier. A physical feature or management plan that reduces the likelihood of contamination of a water source from a potential contaminant source

Best Management Practices (BMPs). Methods for various activities that have been determined to be the most effective, practical means of preventing or reducing non-point source pollution.

Biennial Reporting System (BRS). An EPA database that contains information on hazardous waste sites. The data can be accessed through the EPA Envirofacts website.

Chronic Health Effect. A negative health effect in which symptoms develop over an extended period of time.

Class V Injection Well. Any pit or conduit into the subsurface for disposal of waste waters. The receiving unit for an injection well typically represents the aquifer, or water-bearing interval.

Coliform Bacteria. A general type of bacteria found in the intestinal tracts of animals and humans, and also in soils, vegetation and water. Their presence in water is used as an indicator of pollution and possible contamination by pathogens.

Comprehensive Environmental Cleanup and Responsibility Act (CECRA). Passed in 1989 by the Montana State Legislature, CECRA provides the mechanism and responsibility to clean up hazardous waste sites in Montana.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Enacted in 1980. CERCLA provides a Federal "Superfund" to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. Through the Act, EPA was given power to seek out those parties responsible for any release and assure their cooperation in the cleanup.

Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS). A database that provides information about specific sites through the EPA Envirofacts website.

Confined Animal Feeding Operation (CAFO). Any agricultural operation that feeds animals within specific areas, not on rangeland. Certain CAFOs require permits for operation.

Confined Aquifer. A fully saturated aquifer overlain by a confining unit such as a clay layer. The static water level in a well in a confined aquifer is at an elevation that is equal to or higher than the base of the overlying confining unit.

Confining Unit. A geologic formation present above a confined aquifer that inhibits the flow of water and maintains the pressure of the groundwater in the aquifer. The physical properties of a confining unit may range from a five-foot thick clay layer to shale that is hundreds of feet thick.

Delineation. The process of determining and mapping source water protection areas.

Glacial. Of or relating to the presence and activities of ice or glaciers. Also, pertaining to distinctive features and materials produced by or derived from glaciers.

Geographic Information Systems (GIS). A computerized database management and mapping system that allows for analysis and presentation of geographic data.

Hardness. Characteristic of water caused by presence of various calcium and magnesium salts. Hard water may interfere with some industrial processes and prevent soap from lathering.

Hazard. A relative measure of the potential of a contaminant from a facility or associated with a land use to reach the water source for a public water supply. The location, quantity and toxicity of significant potential contaminant sources determine hazard.

Hydraulic Conductivity. A constant number or coefficient of proportionality that describes the rate water can move through an aquifer material.

Hydrology. The study of water and how it flows in the ground and on the surface.

Hydrogeology. The study of geologic formations and how they effect groundwater flow systems.

Inventory Region. A source water management area for groundwater systems that encompasses the area expected to contribute water to a public water supply within a fixed distance or a specified three year groundwater travel time.

Lacustrine. Pertaining to, produced by, or formed in a lake or lakes.

Large Capacity Septic System. Defined by Underground Injection Control regulations as an on-site septic system serving 20 or more persons.

Leaking Underground Storage Tank (LUST). A release from a UST and/or associated piping into the subsurface.

Maximum Contaminant Level (MCL). Maximum concentration of a substance in water that is permitted to be delivered to the users of a public water supply. Set by EPA under authority of the Safe Drinking Water Act to establish concentrations of contaminants in drinking water that are protective of human health.

Montana Bureau of Mines and Geology – Groundwater Information Center (MBMG/GWIC). The database of information on all wells drilled in Montana, including stratigraphic data and well construction data, when available.

Montana Pollutant Discharge Elimination System (MPDES). A permitting system that utilizes a database to track entities that discharge wastewater of any type into waters of the State of Montana.

National Pollutant Discharge Elimination System (NPDES). A national permitting system that utilizes a database to track entities that discharge wastewater into waters of the United States.

Nitrate. An important plant nutrient and type of inorganic fertilizer that can be a potential contaminant in water at high concentrations. In water the major sources of nitrates are wastewater treatment effluent, septic tanks, feed lots and fertilizers.

Nonpoint-Source Pollution. Pollution sources that are diffuse and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. Examples of nonpoint- source pollution include agriculture, forestry, and run-off from city streets. Nonpoint sources of pollution, such as the use of herbicides, can concentrate low levels of these chemicals into surface and/or groundwaters at increased levels that may exceed MCLs.

Pathogens. A microorganism typically found in the intestinal tracts of mammals, capable of producing disease.

Phase II (and IIB) Rules. EPA updated or created legal limits on 38 contaminants. The rules became effective July 30, 1992 and January 1, 1993. Some of these contaminants are frequently-applied agricultural chemicals such as nitrate and others are industrial solvents.

Phase V Rule. EPA set standards for 23 contaminants in addition to those addressed by the Phase II Rules. The Phase V Rule became effective January 17, 1994. Some of these contaminants include inorganic chemicals such as cyanide and other Phase V contaminants are pesticides that enter water supplies through run-off from fields where farmers have applied them or by leaching through the soil into groundwater. Six are probable cancer-causing agents. Others can cause liver and kidney damage, or problems of the nervous system and brain.

Point Source. A stationary location or a fixed facility from which pollutants are discharged. This includes any single identifiable source of pollution, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fracture, container, rolling stock (tanker truck), or vessel or other floating craft, from which pollutants are or may be discharged.

Pollutant. Generally, any substance introduced into the environment that adversely affects the usefulness of a resource (e.g. groundwater used for drinking water).

Permit Compliance System (PCS). An EPA database that provides information on the status of required permits for specific activities for specific facilities. The data can be accessed through the EPA Envirofacts website.

Public Water System (PWS). A system that provides water for human consumption through at least 15 service connections or regularly serves 25 individuals.

Pumping Water Level. Water level elevation in a well when the pump is operating.

Recharge Region. An area in which water is absorbed that eventually reaches the zone of saturation in one or more aquifers. As a source water management region, the term generally describes the entire area that could contribute water to an aquifer used by a public water supply. Includes areas that could contribute water over long time periods or under different water usage patterns.

Resource Conservation and Recovery Act (RCRA). Enacted by Congress in 1976. RCRA's primary goals are to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner.

Resource Conservation and Recovery Information System (RCRIS). Is a database that provides information about specific sites through the EPA Envirofacts website.

Secondary Maximum Contaminant Levels (SMCL). The maximum concentration of a substance in water that is recommended to be delivered to users of a public water supply based on aesthetic qualities. SMCLs are non-enforceable guidelines for public water supplies, set by EPA under authority of the Safe Drinking Water Act. Compounds with SMCLs may occur naturally in certain areas, limiting the ability of the public water supply to treat for them.

Section Seven Tracking System (SSTS). SSTS is an automated system EPA uses to track pesticide producing establishments and the amount of pesticides they produce.

Source Water. Any surface water, spring, or groundwater source that provides water to a public water supply.

Source Water Delineation and Assessment Report (SWDAR). A report for a public water supply that delineates source water protection areas, provides an inventory of potential contaminant sources within the delineated areas, and evaluates the relative susceptibility of the source water to contamination from the potential contaminant sources under "worst-case" conditions.

Source Water Protection Areas. For surface water sources, the land and surface drainage network that contributes water to a stream or reservoir used by a public water supply. For groundwater sources, the area within a fixed radius or three-year travel time from a well, and the land area where the aquifer is recharged.

Spill Response Region. A source water management area for surface water systems that encompasses the area expected to contribute water to a public water supply within a fixed distance or a specified four-hour water travel time in a stream or river.

Standard Industrial Classification (SIC) Code. A method of grouping industries with similar products or services and assigning codes to these groups.

Static Water Level (SWL). Water level elevation in a well when the pump is not operating.

Susceptibility (of a PWS). The relative potential for a PWS to draw water contaminated at concentrations that would pose concern. Susceptibility is evaluated at the point immediately preceding treatment or, if no treatment is provided, at the entry point to the distribution system.

Synthetic Organic Compounds (SOC). Man made organic chemical compounds (e.g. herbicides and pesticides).

Total Dissolved Solids (TDS). The dissolved solids collected after a sample of a known volume of water is passed through a very fine mesh filter.

Total Maximum Daily Load (TMDL). The total pollutant load to a surface water body from point, nonpoint, and natural sources. The TMDL program was established by section 303(d) of the Clean Water Act to help states implement water quality standards.

Toxicity. The quality or degree of being poisonous or harmful to plants, animals, or humans.

Toxicity Characteristic Leachate Procedure. A test designed to determine whether a waste is hazardous or requires treatment to become less hazardous.

Toxic Release Inventory (TRI). An EPA database that compiles information about permitted industrial releases of chemicals to air and water. Information about specific sites can be obtained through the EPA Envirofacts website.

Transmissivity. A number that describes the ability of an aquifer to transmit water. The transmissivity is determined by multiplying the hydraulic conductivity time the aquifer thickness.

Turbidity. The cloudy appearance of water caused by the presence of suspended matter.

Unconfined Aquifer. An aquifer containing water that is not under pressure. The water table is the top surface of an unconfined aquifer.

Underground Storage Tanks (UST). A tank located at least partially underground and designed to hold gasoline or other petroleum products or chemicals, and the associated plumbing system.

Volatile Organic Compounds (VOC). Chemicals such as petroleum hydrocarbons and solvents or other organic chemicals that evaporate readily to the atmosphere.

Watershed. The region drained by, or contributing water to, a stream, lake, or other water body of water.

* With the exception of the definitions for Lacustrine, Phase II and Phase V Rules, and Standard Industrial Classification Code, definitions were adapted from EPA's Term References System (formerly known as Glossary of Selected Terms and Abbreviations) which can be found at: <http://www.epa.gov/trs/index.htm> . The definitions of glacial and lacustrine were taken from the Glossary of Geology by Robert L. Bates and Julia A. Jackson.

The definitions for Phase II and Phase V Rules were adapted from:

<http://www.epa.gov/OGWDW/source/therule.html#PhaseII>

<http://www.epa.gov/OGWDW/source/therule.html#PhaseV>

The definition for Standard Industrial Classification Code was adapted from:

EPA/Office of Enforcement and Compliance Assurance: Guide to Environmental Issues: Glossary of Terms & Acronyms *Term Detail*

APPENDIX A

Circle PWS Sanitary Survey and Well Logs

Montana Bureau of Mines and Geology
 Ground-Water Information Center Site Report
 TOWN OF CIRCLE WL004

[Plot this site on a topographic map](#)

Location Information

GWIC Id: 203115
 Location (TRS): 19N 18E 15 BACB
 County (MT): MCCONE
 DNRC Water Right:
 PWS Id:
 Block:
 Lot:
 Addition:

Source of Data: LOG
 Latitude (dd): 47.4187
 Longitude (dd): -109.4183
 Geomethod: TRS-TWN
 Datum: NAD27
 Altitude (feet):
 Certificate of Survey:
 Type of Site: WELL

Well Construction and Performance Data

Total Depth (ft): 1480.00
 Static Water Level (ft): 283.00
 Pumping Water Level (ft): 610.00
 Yield (gpm): 270.00
 Test Type: PUMP
 Test Duration: 2.50
 Drill Stem Setting (ft):
 Recovery Water Level (ft): 350.00
 Recovery Time (hrs): 0.50
 Well Notes:

How Drilled: ROTARY
 Driller's Name: BOYCE
 Driller License: WWC247
 Completion Date (m/d/y): 5/22/2003
 Special Conditions:
 Is Well Flowing?:
 Shut-In Pressure:
 Geology/Aquifer: Not Reported
 Well/Water Use: PUBLIC WATER SUPPLY

Hole Diameter Information

From	To	Diameter
0.0	98.0	20.0
98.0	1230.0	13.0
1230.0	1490.0	10.0

Annular Seal Information

Casing Information¹

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	1230.0	10.0	0.375			STEEL
-1.0	98.0	16.0	0.375			STEEL

Completion Information¹

From	To	Description
0.0	1230.0	CEMENT
1168.0	1480.0	16-30 SILICA SAND

From	To	Dia	# of Openings	Size of Openings	Description
1168.0	1210.0	5.0			SLOTTED PIPE
1210.0	1470.0	5.0			.020 STAINLESS SCREEN

Lithology Information

From	To	Description
0.0	28.0	BROWN SAND AND CLAY
28.0	35.0	GRAVEL
35.0	46.0	CLAY
46.0	65.0	GRAVEL
65.0	75.0	CLAY
75.0	94.0	GRAVEL
94.0	119.0	GRAY CLAY SET OF 98 FT OF 16 IN STEEL SURFACE CASING
119.0	125.0	SANDSTONE
125.0	135.0	GRAY CLAY
135.0	148.0	SAND
148.0	205.0	GRAY CLAY
205.0	209.0	COAL
209.0	259.0	GRAY CLAY
259.0	271.0	COAL
271.0	292.0	GRAY CLAY
292.0	302.0	COAL LOST CIRCULATION
302.0	348.0	GRAY CLAY
348.0	352.0	COAL
352.0	354.0	SANDSTONE
354.0	434.0	GRAY CLAY
434.0	437.0	COAL
437.0	445.0	GRAY CLAY
445.0	447.0	SANDSTONE
447.0	483.0	GRAY CLAY
483.0	489.0	COAL
489.0	500.0	GRAY CLAY
500.0	545.0	GRAY CLAY WITH LAYERS OF COAL LOST CIRCULATION AGAIN
545.0	551.0	SANDSTONE
551.0	645.0	GRAY CLAY WITH LAYERS OF COAL
645.0	651.0	COAL
651.0	700.0	GRAY CLAY
700.0	740.0	SANDY
740.0	751.0	GRAY CLAY
751.0	753.0	SANDSTONE
753.0	840.0	GRAY CLAY WITH LAYERS OF COAL
840.0	842.0	SANDSTONE
842.0	881.0	GRAY CLAY WITH LAYERS OF COAL
881.0	930.0	SANDY CLAY
930.0	967.0	SAND
967.0	969.0	SANDSTONE
969.0	973.0	SAND
973.0	1040.0	GRAY CLAY
1040.0	1041.0	SANDSTONE

1041.0	1185.0	GRAY CLAY
1185.0	1230.0	BROWN CLAY
1230.0	1257.0	SAND
1257.0	1290.0	GRAY CLAY
1290.0	1325.0	SAND
1325.0	1355.0	GRAY CLAY
1355.0	1470.0	SAND
1470.0	1530.0	GRAY CLAY WITH LAYERS OF SANDSTONE

¹ - All diameters reported are inside diameter of the casing.

These data represent the contents of the GWIC databases at the Montana Bureau of Mines and Geology at the time and date of the retrieval. The information is considered unpublished and is subject to correction and review on a daily basis. The Bureau warrants the accurate transmission of the data to the original end user. Retransmission of the data to other users is discouraged and the Bureau claims no responsibility if the material is retransmitted. Note: non-reported casing, completion, and lithologic records may exist in paper files at GWIC.

Location Information

GWIC Id: 32476	Source of Data: COMBO
Location (TRS): 19N 48E 10 DACA	Latitude (dd): 47.4181
County (MT): MCCONE	Longitude (dd): -105.5789
DNRC Water Right: W002472-00	Geomethod: NAV-GPS
PWS Id: 00176002	Datum: NAD27
Block:	Altitude (feet): 2433.10
Lot:	Certificate of Survey:
Addition:	Type of Site: WELL

Well Construction and Performance Data

Total Depth (ft): 1508.00	How Drilled: ROTARY
Static Water Level (ft): 159.00	Driller's Name: FREDERICKSON
Pumping Water Level (ft): 690.00	Driller License: WWC124
Yield (gpm): 164.00	Completion Date (m/d/y): 6/17/1972
Test Type: AIR	Special Conditions:
Test Duration: 6.00	Is Well Flowing?:
Drill Stem Setting (ft):	Shut-In Pressure:
Recovery Water Level (ft):	Geology/Aquifer: 211FHHC
Recovery Time (hrs):	Well/Water Use: PUBLIC WATER SUPPLY

Well Notes: This well is referred to as deep well number 1 by the city It is located southeast of the hospital on the east edge of town. Contact Joe Paine at city hall for access to this well.

Hole Diameter Information

From	To	Diameter
0.0	1508.0	18.0

Casing Information¹

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
0.0	1298.0	12.0				STEEL
1298.0	1508.0	5.0				SS SCREEN

Annular Seal Information

From	To	Description
0.0	1298.0	CEMENT

Completion Information¹

From	To	Dia	# of Openings	Size of Openings	Description
1298.0	1508.0	6.0			20 SLOT S.S. SCREEN

Lithology Information

No Lithology Records currently in GWIC.

¹ - All diameters reported are inside diameter of the casing.

These data represent the contents of the GWIC databases at the Montana Bureau of Mines and Geology at the time and date of the retrieval. The information is considered unpublished and is subject to correction and review on a daily basis. The Bureau warrants the accurate transmission of the data to the original end user. Retransmission of the data to other users is discouraged and the Bureau claims no responsibility if the material is retransmitted. Note: non-reported casing, completion, and lithologic records may exist in paper files at GWIC.

APPENDIX B
PWS-6 Report

APPENDIX C
Concurrence Letter