Town of Browning
Public Water System

PWS ID # MT0000169

<u>Source Water Delineation and Assessment Report</u>

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EXECUTIVE SUMMARY

The drinking water for the Town of Browning is supplied by six wells in two production well fields located four to five miles west of town. 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 citizen's advisory committee here in Montana. The Department of Environmental Quality (DEQ) is conducting these assessments for all public water systems in Montana. The purpose is to provide information so that the public water system staff/operator, consumers, and community citizens can begin developing strategies to protect your source of drinking water. The information that is provided includes the identification of the area most critical to maintaining safe drinking water, i.e., the Inventory Region, an inventory of potential sources of contamination within this area, and an assessment of the relative threat that these potential sources pose to the water system.

Based on the sanitary surveys, well logs, and regional geology, the sand and gravel deposits along buried channels in the surficial glacial till is providing water to the PWS's wells. In accordance with the Montana Source Water Protection Program criteria (1999), the aquifer (source water) is considered to have a moderate sensitivity to potential contaminant sources since it because the aquifer is semi-confined to unconfined and is an unconsolidated alluvial/glaciofluvial aquifer. 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 Browning public water system were mapped as part of this assessment. They are the control zone, inventory region/surface water buffer region, and the recharge region. Potential sources of contamination were identified within each of these three regions and the results are as follows:

- The goal of management in the control zone is to avoid introducing contaminants directly into the water supply's well or immediate surrounding areas. 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. Potential contaminant sources identified within the control zones include: potential chemical use at one home and grazing cattle.
- The inventory region should be managed to prevent contaminants from reaching the well before natural processes reduce their concentrations. The inventory region includes the area of land overlying the aquifer upgradient (southwest) of the well that is expected to supply groundwater recharge to the well over the next three years. Significant potential contaminant sources identified within the inventory region include: grasslands with grazing, occasional septic systems and Highway 89.
- Since it is conservatively assumed that the wells are in hydraulic connection with the creek, a surface water buffer around Flatiron and Willow Creeks approximately 10-miles upstream of the wells is delineated. Potential sources of nitrate and bacteria identified in the surface water buffer region included the grasslands with grazing.
- The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased usage. The topographic divide that represents the watershed boundary (based on the 11-digit USGS hydrologic unit for Cut Bank Creek Watershed is used as the recharge region for the PWS well. Significant potential contaminant sources identified within the recharge region include: grasslands with grazing and the transportation corridors (highways and railroad).

Susceptibility is the potential for a public water supply to draw water contaminated by inventoried sources at concentrations that would pose 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 well intakes. The Browning public water supply has a high to very high susceptibility to the following potential contaminant sources: grasslands with grazing, occasional septic systems and Highway

89. 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 Browning. 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. Developing and approach to protect that resource will reduce the risks of a contamination event occurring. In this report, we have summarized the local geology and well construction issued as they pertain to the quality of your drinking water source. We have identified the area we believe to be most critical to preserving your water quality (the Inventory Region) and have identified potential sources of contamination within that area. In addition, we provide you with recommendations, i.e., Best Management Practices, regarding the proper use and practices associated with some common potential contamination sources. We believe public awareness is a powerful tool for protecting drinking water. The information in this report will help you 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 Browning Public Water Supply, PWS ID# MT0000169, located in Glacier County. It was completed by Julie Harvey with the Source Water Protection Program at the Department of Environmental Quality.

PURPOSE

This report is intended to meet the technical requirements for the completion of the delineation and assessment report for the Town of Browning 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 Browning protect its drinking water sources.

LIMITATIONS

This report was prepared to assess threats to the Town of Browning 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 Browning 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 Browning 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

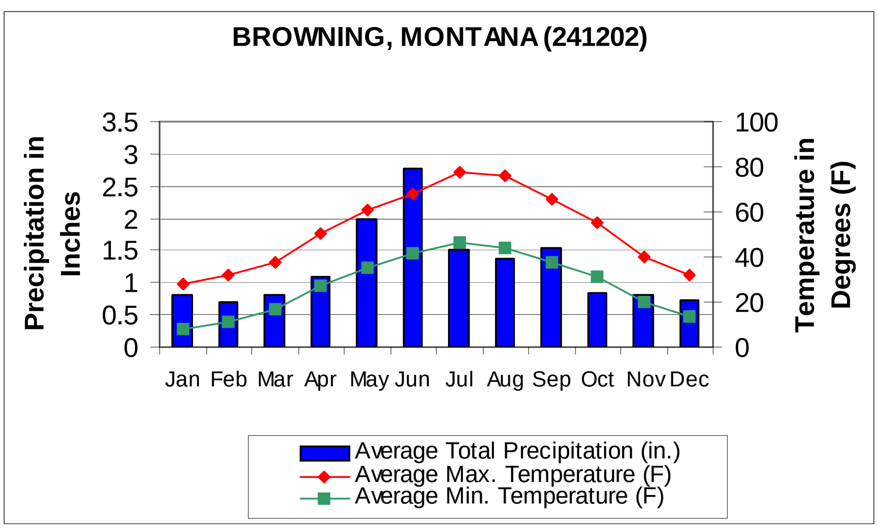
THE COMMUNITY

Browning is located in the south central portion of Glacier County on the Blackfeet Indian Nation approximately 15 miles east of Glacier Park and 30 miles west of Cut Bank (Figure 1). The U.S. Census Bureau estimates the 2000 population of Glacier County at 13,247 people with approximately half of these people residing in Browning (http://factfinder.census.gov). The Town of Browning provides municipal sewer system for waste disposal utilizing a sewage treatment lagoon located east of town. On the north side of town, Blackfeet Utilities provides sewer service and utilizing the Meineke lagoon system also located east of Browning. Individual properties outside of the sewer system limits are served by individual or large-capacity on-site septic systems.

Browning's drinking water is currently supplied by six wells in two production well fields located four to five miles west of town (Figure 1). The Willow Creek well field (Figure 1) and City Hall well have been classified by the Town as no longer useable and have been disconnected from the water system. Browning's public water system (PWS) is classified as a community PWS and serves a total population of 5, 029 people through 1,616 connections. The total water production from the well fields does not provide adequate water for peak demand periods, fire protection or growth within the community. A new water utility company, the Blackfoot Utilities, is constructing a surface water supply intake and treatment plant that will supply public water to East Glacier and Browning starting in 2004 or 2005. Once connected to the surface water supply, Browning's groundwater well fields will remain active as a backup/supplemental water supply for the town (personal communication with Browning PWS operator, 2/10/04).

GEOGRAPHIC SETTING

Browning is located just east of the Rocky Mountain Front Range and Glacier National Park. The town elevation is approximately 4,360 to 4,390 feet. Browning is situated about four miles south of Cut Bank Creek and Flatiron, Willow, and Depot Creeks drain the general area. These small streams flow easterly until they merge and flow into Cut Bank Creek. Browning is located in the Cut Bank Creek watershed, U.S. Geological Survey (USGS) hydrologic unit code (HUC) Number 10030202, which is located within the Lower Missouri River Watershed Management Region for Montana. The Cut Bank Creek hydrologic unit covers 77.7 square miles in primarily Glacier County. It includes Cut Bank Creek and its tributaries from their origination along the Rocky Mountain Front to Cut Bank Creek's confluence with the Marias River south of Cut Bank.



CLIMATE

Information on climate in the Browning area is based on the National Oceanic and Atmospheric Administration's (NOAA) Browning climate station located at an elevation of 4,360 feet above mean sea

level (Western Regional Climate Station). Average temperatures and total precipitation for the period of 1894 to 1989 are shown in the graph. Average annual precipitation is 15 inches. Monthly average precipitation ranges from 0.70 inches in February to 2.77 inches in June. The annual mean snowfall in Browning is 59.5 inches
with 1 to 3-inches of measurable snow accumulation during the winter months.

General Description of the Source Water

Browning's drinking water is currently supplied by six wells in two production well fields located four to five miles west of town (Figure 1). The Flatiron Well Field is located approximately five miles west of town and consists of four wells (Wells #1, #2, #3, and #4, DEQ Source numbers WL002 through WL005). The Flatiron wells were drilled in 1998 and replaced the previous Flatiron Springs Wells and infiltration gallery which were abandoned. The Chlorinator well field located at the Parsons Ranch approximately four miles west of town has two wells, Well #1 and Well #2 (DEQ Source Numbers WL006 and WL007).

All of the currently used wells are completed at relatively shallow depths (screened intervals from 38 to 68 feet deep) and static water levels seasonally range from 10 to 50 feet below ground surface. The source is interpreted to be the sand and gravel deposits along buried channels in the surficial glacial till (Cannon, 1997). The aquifer is semi-confined to unconfined and is may be in hydraulic connection with the creek. Groundwater flow direction in the vicinity of each well field is likely towards the northeast parallel to the creek (Flatiron Creek for the Flatiron well field and Willow Creek for the Parsons well field). Recharge to the wells is likely from infiltration of precipitation and local surface water through the overlying till. Additional detail on the geology and hydrogeology of the area is provided in Chapter 2.

As mentioned above, Browning's Willow Creek well field (Figure 1) and City Hall well have been classified by the Town as no longer useable and have been disconnected from the water system. Browning will have an additional water source from the Blackfoot Utilities surface water supply intake starting in 2004 or 2005. At that time, Browning's groundwater well fields will remain active as a backup/supplemental water supply for the town (personal communication with Browning PWS operator, 2/10/04).

THE PUBLIC WATER SUPPLY

The town of Browning is classified as a community public water system (PWS) and serves 5,029 people through 1,616 connections. The PWS is classified as a community water system since it serves at least 25 of the same people every day. Information on the water system was obtained from correspondence in the DEQ Public Water Supply Section files including an Operations and Maintenance Technical Assistance (O&M TA) Visit Memorandum from the Midwest Assistance Program (dated July 25, 2002), a sanitary survey completed on August 24, 1999, communications on the new surface water supply, and personal communication with the PWS operator. The sanitary survey and O&M TA Visit Memo are provided for reference in Appendix A.

Water from the four wells at the Flatiron well field is piped to the Parsons/Chlorinator site where it is combined with water from the two Parsons wells in a central well house. The drinking water is disinfected with chlorine gas, pumped to the million-gallon storage tank, and into the distribution system. A general facility configuration map is provided in Appendix A. The 2002 O&M TA Visit Memo indicated that water system is generally well maintained and efficiently operated and no deficiencies were noted. Sanitary survey deficiencies noted in 1999 were not observed in 2002 indicating that they had likely been corrected.

POTENTIAL FOR SURFACE WATER INFLUENCE (GWUDISW)

For the purpose of this Source Water Assessment, we have conservatively assumed that the groundwater in both well fields is in hydraulic connection with surface water sources; however, it is important to note that a formal determination of groundwater sources under the direct influence of surface water (GWUDISW) has not been made. A preliminary GWUDISW assessment for Town of Browning indicated that the groundwater might be influenced by surface water. Direct surface water influence is that influence that may cause the risk of pathogenic organism (giardia, cryptosporidium) transfer from a surface source to a groundwater source (DEQ Circular PWS 5).

Groundwater can be in hydraulic connection with surface water and receive recharge from surface water without being classified as "under the direct influence" if pathogens are not likely to influence the source water. If the well source is determined to be GWUDISW, then it is subject to the requirements of the Surface Water Treatment Rule which may include full-time disinfection or filtration.

Additional sampling (microparticulate analysis, MPA) was conducted in 1997 for the aquifer at the Flatiron well field using groundwater samples from wells that are no longer in use. The MPA analysis indicates that the Flatiron well field water will likely be classified as groundwater; however, DEQ has not made a formal determination at this time. A formal determination of GWUDISW will be based on the MPA analysis, and an evaluation of well construction and site layout (i.e. quality of the well bore annular seal, potential for flooding, and other potential routes for surface water to influence the groundwater quality.) Further analysis (i.e. MPA) has not been completed for the Parsons/Chlorinator well field.

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 specific monitoring program tailored to their system that follows the general protocols for operation of a PWS defined by DEQ. The Browning PWS monitoring data from DEQ's PWS database for the past five years was reviewed and is summarized in this section.

Total coliform was detected in February and April of 2001. These detections were not confirmed and there have been no detections since April 2001. There is no correspondence in the PWS file regarding the source of the coliform and whether it was attributed to the distribution system or the source water; however, since it was not detected in subsequent monitoring rounds, it is not likely attributed to the source water.

Other compounds detected in Town of Browning's source water or distribution system monitoring over the past 5 years include low levels of nitrate + nitrite (0.04 to 0.15 mg/L), fluoride (0.14 to 0.20 mg/L), sodium (16.3 mg/L), barium (0.051 mg/L), dis(2ethylhexyl)phthalate (0.001 mg/L), bromodichloromehtane (0.00123 mg/L), dichloromethane (0.00096 mg/L), and chloroform (0.00083 mg/L). The latter four compounds are likely associated with the distribution system and are probably not in the source water. These detections are all below EPA primary maximum contaminant levels (MCLs) where established.

The 1999 Sanitary Survey indicates that test results for the Flatiron Wells completed in 1998 showed manganese levels ranging from 0.44 to 0.59 mg/L and iron levels from 5.46 to 29.7 mg/L. These levels exceed EPA's secondary drinking water standards (SMCLs) of 0.05 mg/L for manganese and 0.3 mg/L for iron. National SMCLs are non-enforceable guidelines regarding contaminants that are generally not a health risk but may cause cosmetic effects (such as taste, odor, or color). Other groundwater sampling data collected to characterize background groundwater quality was not identified.

CHAPTER 2
DELINEATION

The source water protection area, the land area that contributes water to the Town of Browning PWS is identified in this chapter. Three management areas are identified within the source water protection area. These three regions, the control zone, inventory region, and recharge region, are delineated for the wells. The control zone, also known as the exclusion zone, is an area at least 100-foot radius around each well. The inventory region represents the zone of contribution of the well, which typically approximates a three-year groundwater time-of-travel. Analytical equations describing groundwater flow using estimates of pumping and aquifer characteristics and simple hydrogeologic mapping are used to calculate groundwater time-of-travel distance. The recharge region represents the area where the source aquifer for the Town of Browning water system wells is replenished.

GENERAL GEOLOGIC AND HYDROGEOLOGIC SETTING

This section provides an overview of the geology and hydrology of the vicinity of the Browning well fields and is primarily based on a report regarding the Water Resources of the Browning Starr School Area, Blackfeet Indian Reservation (Cannon, 1997), well logs for the Browning PWS wells, and regional well logs available from the Montana Bureau of Mines and Geology (MBMG) Ground-Water Information Center (GWIC). A regional geologic map is provided in Figure 2. 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 Browning area is underlain by gravelly to clayey till, a heterogeneous mixture of clay, silt, sand, gravel, and boulders, deposited by the Piedmont glaciers. The till includes buried channels and melt water channels consisting of sand and gravel deposits. The till is typically 5 to 45 feet thick. The till is generally a poor aquifer because of its low permeability (the ability to transmit water); however, the sand and gravel in buried channels and lenses between till units transmits water and are important aquifers.

The till is underlain by mudstone, soft shale, and fine-grained sandstones of the Two Medicine and Virgelle Sandstone/Telegraph Creek Formations of Cretaceous age. This bedrock in the Browning area has undergone intense faulting and deformation. As a result of thrust faulting, the bedrock units dip steeply (20 to 70 degrees) to the southwest producing the segmented geology shown on Figure 2. In general, the mudstone and shale layers do not yield water wells but some of the sandstone beds may yield small quantities (usually less than 15 gallons per minute) of water to stock or domestic wells.

PWS WELL INFORMATION

Browning's drinking water is currently supplied by six wells in two production well fields located four to five miles west of town (Figure 1). Copies of the well logs showing stratigraphy and well construction information are included in Appendix B and the well information is summarized in Table 1. The Flatiron Well Field is located approximately five miles west of town and consists of four wells (Wells #1, #2, #3, and #4, DEQ Source numbers WL002 through WL005). The Flatiron wells were drilled in 1998 and replaced the previous Flatiron Springs Wells and infiltration gallery which were abandoned. The Chlorinator well field located at the Parsons Ranch approximately four miles west of town has two wells, Well #1 and Well #2 (DEQ Source Numbers WL006 and WL007).

All of the currently used wells are completed at relatively shallow depths (screened intervals from 38 to 68 feet deep) and static water levels seasonally range from 10 to 50 feet below ground surface. The source of the water is interpreted to be the sand and gravel deposits along buried channels in the surficial glacial till (Cannon, 1997). The aquifer is semi-confined to unconfined and for the purpose of this Source Water Assessment, we have conservatively assumed that the groundwater in both well fields is in hydraulic connection with surface water sources. Groundwater flow direction in the vicinity of each well field is likely towards the northeast parallel to Flatiron Creek for the Flatiron well field and Willow Creek for the Parsons well field. Recharge to the wells is from infiltration of precipitation and local surface water through the overlying till.

Table 1. Summary of Well Log Information for PWS Production Wells

	Chlorinator/ Parsons Well Field		Flatiron Well Field			
	Well #1	**Well #2**	**Well #1**	**Well #2**	**Well #3**	**Well #4**
PWS Source Code	WL006	WL007	WL002	WL003	WL004	WL005
Well Location	NE¼ , NE¼, Sec.12, T32N, R12W		SW¼ , NE¼, Sec.11, T32N, R12W			
Well Elevation	Approx. 4540 feet		Approx. 4660 feet			
Date Completed	4/22/1994	4/5/1994	9/15/1998	9/2/1998	9/14/1998	9/3/1998
Total Depth (bgs)	58 feet	75 feet	80 feet	80 feet	80 feet	64 feet
Well Completion: Casing	8-inch steel from –2 to 58 feet bgs	8-inch steel from –2 to 75 feet bgs	8-inch steel from –3 to 47.5 feet bgs	8-inch steel from –3 to 38 feet bgs	8-inch steel from –3 to 46.5 feet bgs	8-inch steel from –2 to 49 feet bgs
Well Completion: Screen	Slotted 45 to 55 feet bgs	Slotted 55 to 65 feet bgs	0.80 Slot SS screen 47.5 to 68 feet bgs	0.80 Slot SS screen 38 to 48 feet bgs	0.80 Slot SS screen 46.5 to 67 feet bgs	0.80 Slot SS screen 49 to 63 feet bgs
Well Completion: Annular Seal	Bentonite grout to 20 feet bgs	Bentonite grout to 190 feet bgs	Bentonite grout to 25 feet bgs	Bentonite grout to 32 feet bgs	Bentonite grout to 25 feet bgs	Bentonite grout to 32 feet bgs
Static Water Level (at time of drilling)	11.5 feet bgs	22 feet bgs	4.95 feet bgs (11/4/1998)	4.75 feet bgs (11/4/1998)	5.75 feet bgs (11/4/1998)	10.72 feet bgs (11/10/1998)
Well Pump Test Data	125 gpm for 24 hrs	125 gpm for 24 hrs	400 gpm for 3-days	55 gpm for 3-days	215 gpm for 3-days	80 gpm for 24 hrs

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

CONCEPTUAL MODEL AND ASSUMPTIONS

The Town of Browning's production wells are located in the Cut Bank Creek watershed (USGS Hydrologic Unit Code 10030202) which is located within the Lower Missouri River Watershed Management Region for Montana. The source of Town of Browning's drinking water is the buried sand and gravel deposits along channels in the surficial glacial till.). The aquifer is semi-confined to unconfined and for the purpose of this Source Water Assessment, we have conservatively assumed that the groundwater in both well fields is in hydraulic connection with surface water sources. Recharge to the wells is from infiltration of precipitation and local surface water through the overlying till. Till overlying and surrounding the sand and gravel deposits limits the rate of recharge to the aquifer and long-term pumping of wells significantly lowers the water level near the wells (Cannon 1997). flow direction in the vicinity of each well field is likely towards the northeast parallel to Flatiron Creek for the Flatiron well field and Willow Creek for the Parsons well field.

Using DEQ Source Water Protection Program criteria for ranking aquifer sensitivity (Table 2), the Town of Browning source water is considered as having **Moderate Source Water Sensitivity** to contamination because the aquifer is semi-confined to unconfined and is an unconsolidated alluvial/glaciofluvial aquifer. Sensitivity is defined as the relative ease that contaminants can migrate to source water.

Table 2. Source Water (Aquifer) Sensitivity Criteria

based on DEQ Source Water Protection Program Criteria (DEQ, 1999)

High Source Water Sensitivity	Moderate Source Water Sensitivity	Low Source Water Sensitivity
• Surface water and GWUDISW • Unconsolidated Alluvium (unconfined) • Fluvial-Glacial Gravel • Terrace and Pediment Gravel • Shallow Fractured or Carbonate Bedrock	• Semi-consolidated Valley Fill sediments (semi-confined) • Unconsolidated Alluvium (semi-confined)	• Consolidated Sandstone Bedrock • Deep Fractured or Carbonate Bedrock • Semi-consolidated • Confined Aquifers

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 the Browning PWS include controls zones for each well, an inventory region, a surface water buffer region and a recharge region. The delineated management zones for the wells are shown on Figure 3 and Figure 4.

Control Zones - 100-foot radius control zones are delineated for Town of Browning's wells. All sources of potential contaminants should be excluded in this region.

Inventory Regions - For the Browning wells, the DEQ's Source Water Protection Program criteria for an unconfined aquifer system was followed. The inventory zone was delineated based on a ground water time-of-travel (TOT) distance of one and three years. This distance was determined using a simple ground water flow model using the uniform flow equation (EPA, 1991). Conservative estimates for aquifer properties were made using available data from published reports and pump test data for the wells provided by the PWS. For the Parsons Well Field, the results of the calculations indicate an estimated distance of approximately 3,000 feet (0.57 miles) for a one-year TOT and a distance of 7,600 feet (1.44 miles) for a three-year TOT. For the Flatiron Well Field, the results of the calculations indicate an estimated distance of approximately 3,200 feet (0.61 miles) for a one-year TOT and a distance of 8,000 feet (1.48 miles) for a three-

year TOT. A summary of the time of travel calculations is included in Appendix C. The inventory zones for the wells were broadened to reflect potential changes in the flow system during seasonal periods of high and/or low flow and to encompass the buried sand and gravel channel mapped by Cannon (1997). The delineated inventory regions for the well fields are shown on Figure 3. All sources of potential contaminants are inventoried in this region.
Surface Water Buffer Region - Since it is conservatively assumed that the wells are in hydraulic connection with the creek, a surface water buffer ½-mile around Flatiron and Willow Creeks between the PWS wells and approximately 10-miles upstream of the wells is delineated (Figure 4). Potential sources of nitrate and bacteria are inventoried in the surface water buffer region.

Recharge Region – The recharge region for the Town of Browning wells includes the entire Cut Bank Creek watershed where surface water would drain into the valley upstream from the PWS wells as shown on Figure 4. The watershed bounded by the ridge-tops of the surrounding hills and mountains and closely approximates the ½-mile surface water buffer on the north and south sides. 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.

LIMITING FACTORS

Delineation of the source water protection areas for the Town of Browning PWS wells is based on published reports, lithology indicated on the well logs, and pump test data provided by the PWS. The interaction of surface water with the shallow buried channel deposits is not completely understood and the changes in the flow regime under seasonal conditions are not known. The delineation was completed using conservative assumptions to help ensure that the inventory zone reflects the actual area where contamination to the system may occur.

CHAPTER 3
INVENTORY

INVENTORY METHOD

An inventory of significant potential contaminant sources was conducted to assess the susceptibility of Town of Browning's wells to contamination and to provide a foundation for source water protection planning. The inventory for Town of Browning 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 Browning PWS focuses on all activities in the control zones for the wells; certain types of municipal and private facilities or land uses in the inventory region; potential source3s of nitrates and pathogens in the surface water buffer; 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:

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

CONTROL ZONE INVENTORY RESULTS

The 100-foot control zone for the wells includes the fencing around the wells and open grassland. There is one home within the 100-foot control zone for one of the wells in the Flatiron well field; however, the drainfield for the septic system for this home is located outside of the control zone (personal communication with the PWS operator, February 10, 2004). If not properly sited, designed, installed, and maintained, septic systems can impact drinking water, especially in close proximity to the wellhead. There are no homes in the Parsons Well field vicinity.

Grazing cattle are present in the vicinity of all of the wells but there is fencing around each of the wellheads with the exception of the Parsons Well #2 which is scheduled to be fenced this spring. Improper storage and management of animal wastes may impact drinking water supply especially if the animals have access to the control zone. No other potential sources of contamination were identified within the control zone.

INVENTORY REGION RESULTS

The inventory results for Town of Browning's source water are summarized in Table 3 and are shown on Figure 5 and Figure 6. Land cover in the inventory region for the Town of Browning PWS is reported in the 1992 National Land Cover dataset (Figure 5) to be primarily grassland (89%). Grasslands are not considered potential sources of contamination unless there are significant grazing operations in the area. Based on the permeable aquifer materials and potential hydraulic connection with surface water, the cattle grazing in the inventory region presents a high potential hazard to the Town of Browning water supply.

The low densities of septic systems present in the inventory region and surface water buffer a low hazard to the PWS source water; however, individual septic systems in close proximity to the wells (within the one-year time-of-travel zone) can present a high potential hazard.

State Highway 89 passes through the inventory region for the Flatiron Well Field (Figure 6). There is a potential for spills along the transportation routes and for spraying of pesticides and herbicides. The hazard posed by the highway is considered as high.

A gravel quarry site was identified as a potential source of contamination located near the three-year time-of-travel distance for the Flatiron Well Field. Gravel pits are generally not considered a risk to the water supply unless there is heavy equipment being used for mining operations or if an inactive location is used for illegal dumping. This gravel pit is considered a low risk to the water supply since it is mainly used for stockpiling materials and is monitored to restrict dumping (correspondence with the PWS operator, 3/17/04).

Several local businesses/facilities with a "Browning" address were identified in the regulatory databases used and in the business directory by SIC code. None of these businesses are located within the inventory, surface water buffer, or recharge regions.

Table 3. Summary of Potential Contaminant Sources in the Inventory Region and Surface Water Buffer Zone

Source Type	***Potential Contaminants***	***Description/Concern***
Land Use Cover (Step 1)		
Grasslands with Grazing (~90%)	Pathogens and nitrates	Improper storage and management of animal wastes may impact drinking water supply.
EPA Envirofacts Sites (Step 2)		
None identified		
DEQ Databases (Step 3)		
None identified		
Business – SIC Code Sites (Step 4)		
None identified		
Miscellaneous Others, including Step5 and 6		
Occasional septic systems in close proximity to wells	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.
Highway 89	Various chemicals	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 the drinking water supply.
Potential mining activities – gravel pit	Metals and petroleum products or VOCs from equipment	Spills, leaks, or improper handling of chemicals and wastes generated in mining operations or from heavy equipment may impact the drinking water supply. Illegal dumping in inactive or abandoned locations may impact the drinking water supply.

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

SURFACE WATER BUFFER INVENTORY RESULTS

The purpose of the surface water buffer zone is to help identify potential sources of nitrate and pathogens that could contribute contaminants to the surface water which could in turn transport the contaminants into the source water used by a public water supply. Therefore, only potential sources of nitrates and pathogens are identified in the surface water buffer zone.

Land use in the surface water buffer region is primarily grasslands (Figure 5) which are considered a high potential hazard since there is significant grazing in this area. Septic system density within the surface water buffer region is low and is not considered a risk to the PWS drinking water. Other potential sources of nitrates or pathogens were not identified within the surface water buffer region.

WATERSHED/RECHARGE REGION INVENTORY RESULTS

Land use in the watershed/ recharge region is 82 percent grasslands with the remaining 18 percent being forest, wetlands, shrub land, and open water (Figure 5). Based on the grazing that occurs in the area, the grasslands are considered a high hazard potential contaminant source. Septic system density within the watershed/recharge region is low and is not considered a risk to the PWS drinking water.

In addition to the above general land uses, several other potential contaminant sources are located within the recharge region as shown on Figure 6.

- Transportation corridors (Highway 2, Highway 89, and the railroad) pose a high potential hazard to the water supply due to the potential for spills along the transportation routes and for spraying of pesticides and herbicides.
- Two oil/gas test wells were identified within the recharge region. One of the wells is listed as a test hole and the other is a development well where "oil but no gas" was encountered. Due to the distance from the PWS well fields and the low number of oil production wells, these likely do not pose hazard to the drinking water supply.
- A potential mining site labeled as a "iron-titanium mineral location" was identified within the recharge region. It appears that active mining is not occurring at this location and it does not pose a hazard to the drinking water supply. If this becomes an active mineral extraction site, spills, leaks, or improper handling of chemicals and wastes generated in mining operations or from heavy equipment may impact the drinking water supply.

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 Browning's public water supply have been identified. 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 a concern. Susceptibility is assessed in order to prioritize potential pollutant sources for management actions by local entities, in this case the Town of Browning 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 Watershed/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.

HAZARD DETERMINATION

The proximity of a potential contaminant source to a spring or 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 (Table 4). Hazard and the existence of barriers to contamination determine susceptibility, which is described in Table 5. Table 4 below describes the criteria to determine hazard within the inventory region as it was delineated in this SWDAR. Note that this table is specific to PWSs that draw their water from unconfined aquifers. The determination of hazard is somewhat different for other types of water sources.

Table 4. Hazard of Potential Contaminant Sources for Wells Drawing Water from Unconfined Aquifers

Type of Potential Contaminant Source	High Hazard	Moderate Hazard	Low Hazard
Septic System Density (# per square mile)	More than 300 septic systems per sq. mile	Between 50 and 300 septic systems per sq. mile	Less than 50 septic systems per sq. mile
Municipal or Community Sanitary Sewer (% land use)	More than 50 percent of the inventory region	Between 20 and 50 percent of the inventory region	Less than 20 percent of the inventory region
Cropland (% land use)	More than 50 percent of the inventory region	Between 20 and 50 percent of the inventory region	Less than 20 percent of the inventory region
Point sources of all contaminants	Within 1-year TOT	1-3 years TOT	Over 3-year TOT or within Surface Water Buffer as determined by hydrogeologic mapping

Note: Highlighted areas are those relevant to the Town of Browning inventory region

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 Town of Browning PWS well intakes (Table 5).

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 are considered management barriers. Thick clay-rich soils, a deep water table or a thick unsaturated zone above the well intake can be natural barriers.

No natural barriers were identified for the Town of Browning PWS wells for the Inventory Region. The density and low permeability of the till surrounding the buried groundwater channels acts as a barrier to groundwater flow in the areas surrounding the buried channels which includes most of the recharge region.

A summary of the susceptibility assessment for Town of Browning PWS production wells is located in Table 6. 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. Table 6 only includes the potential contaminant sources identified in Chapter 3 that were determined to present a significant potential risk to the drinking water supply. Low risk potential sources such as the non-active “mineral occurrence” location, the gravel pit or the oil and gas test holes 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 Recommendations
Inventory Region and Surface Water Buffer (note, only potential sources of nitrates and pathogens are identified in the Surface Water Buffer)						
Grasslands with Grazing (~90% of inventory region)	Pathogens and nitrates	Contaminants leaching into groundwater or impacting surface water	***High***	- None	***Very High Susceptibility***	Maintain fencing around the wells to prevent cattle access. Encourage use of agricultural best management practices (BMPs) in the watershed to keep cattle away from the wells and stream especially directly upstream of the well locations.
Occasional septic systems in close proximity to wells (within one-year time-of-travel)	Nitrate and pathogens	Contaminants leaching into groundwater	***High***	- None	***Very High Susceptibility***	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.
Transportation Corridor - Highway 89	Pesticides, fertilizers, VOCs, SOCs, others	Spills, routine spraying, storm water runoff, infiltration into groundwater	***High***	- County Emergency Response Plan, training and preparation of local response personnel	***High Susceptibility***	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.
Recharge Region						
Grasslands with Grazing (~82% of inventory region)	Pathogens and nitrates	Contaminants leaching into groundwater	***High***	- Low permeability till impedes groundwater movement outside of buried channels	***Not Rated –*** *outside the inventory region*	Encourage use of best management practices (BMPs)
Transportation Corridors (Highway 89, Highway 2 and Burlington Northern Santa Fe Railroad)	Pesticides, fertilizers, VOCs, SOCs, others	Spills, routine spraying, storm water runoff, infiltration into groundwater	***High***	- Low permeability till impedes groundwater movement outside of buried channels - County Emergency Response Plan, training and preparation of local response personnel	***Not Rated –*** *outside the inventory region*	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.

Notes: VOCs - Volatile organic compounds (i.e. solvents, fuel components)
UST - underground storage tank
SOCs - Synthetic Organic Compounds (i.e. pesticides, herbicides, plasticizers)
LUST - leaking underground storage tank

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 Watershed/Recharge Region may still pose a threat over time, but are not discussed in detail.

Grazing areas – Grazing occurs throughout the watershed and the hazard to the shallow groundwater and surface water is high. No barriers were identified and the susceptibility is rated as very high.

Individual Septic Systems – The overall density of septic systems within the inventory region and surface water buffer is low; however, there are a couple of homes that have septic systems located in close proximity to the well fields. Septic systems located within the one-year time-of-travel zone pose a high potential hazard. With no barriers identified, susceptibility is assigned a very high rating.

Highway 89 – The highway passes through the inventory region for both well fields and comes relatively close to the Parsons wells. The potential for accidents and spills is assigned a high hazard for the well fields. Local and county emergency response is recognized as barrier and results in a high susceptibility rating.

MANAGEMENT RECOMMENDATIONS

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 steps (considered management recommendations) are listed below.

Some of these management recommendations are detailed in the susceptibility table for the Town of Browning PWS (Table 6). 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.

Agricultural Best Management Practices (BMPs) – The water system should encourage local land users to utilize BMPs to keep the concentration of cattle low in the inventory region and to keep livestock away from the creeks especially immediately upgradient from the wells.

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 will promote the proper maintenance and replacement of residential septic systems. The EPA and the State of Montana can provide educational materials on these topics.

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.

CHAPTER 5
MONITORING WAIVERS

WAIVER RECOMMENDATION

The Town of Browning PWS does not appear to have any monitoring waivers. Based on past monitoring results and the susceptibility assessment of the Town of Browning PWS, the PWS wells both have a high to very high susceptibility to a wide range of contaminants. It is unlikely that Use or Susceptibility Waivers could be granted to the PWS. 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.

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 will 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 Unconfined Aquifers

Unconfined aquifers are the most common source of usable groundwater. Unconfined aquifers differ from confined aquifers in that the groundwater is not regionally contained within relatively impervious geologic strata. As a result, the upper groundwater surface or water table in an unconfined aquifer is not under pressure that produces hydrostatic head common to confined aquifers.

Unconfined aquifers are usually locally recharged from surface water or precipitation. In general, groundwater flow gradients in unconfined aquifers reflect surface topography, and the residence time of water in the aquifer is comparatively shorter than for water in confined aquifers. Similar water chemistry often exists between unconfined groundwater and area surface water, and physical parameters and dissolved constituents can be an indicator of the hydraulic connection between groundwater and surface water. Consequently, unconfined aquifers can be susceptible to contamination by organic chemicals migrating from the ground surface to groundwater.

The objective of the susceptibility waiver application is to assess the potential of organic chemical migration from the surface to the unconfined aquifer. The general procedures make use of a combination of site-specific information pertaining to the location and construction of the source development, monitoring history of the source, geologic characteristics of the unsaturated soil and vadose zones, and chemical characteristics of the organic chemicals pertaining to their mobility and persistence in the environment. The zone of contribution of the unconfined groundwater source must be defined and plotted. This should describe the groundwater flow directions, gradients, and a 3-year time-of-travel. All surface bodies within 1,000 feet of the PWS well(s) must be plotted. Analytical monitoring history of the PWS well and those nearby should be provided as 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

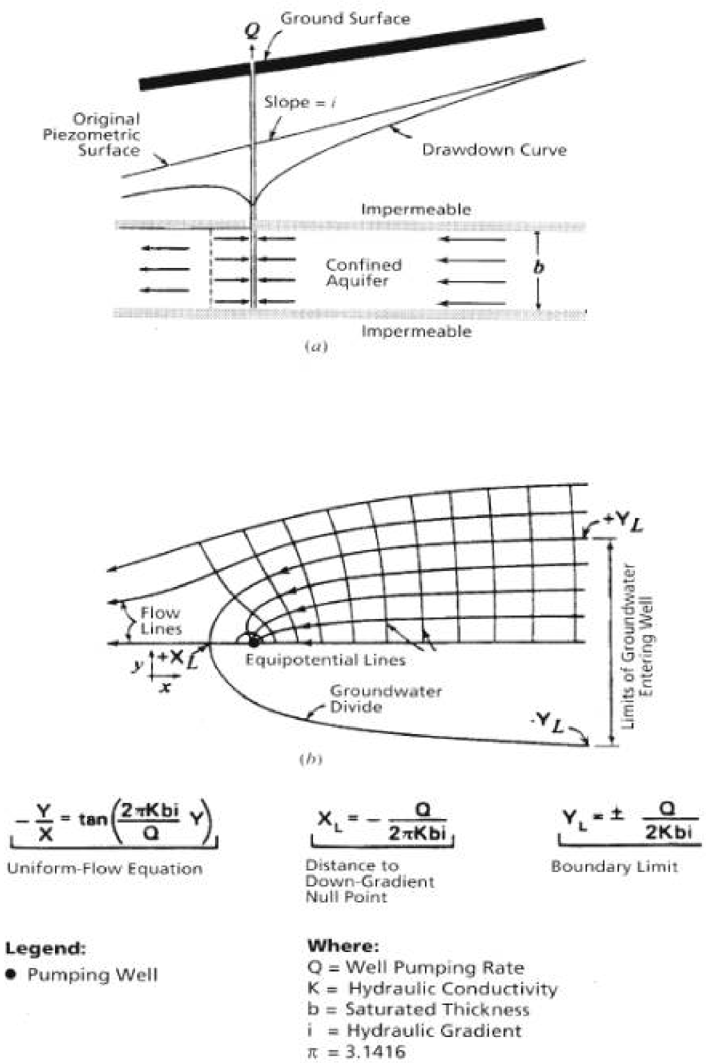
The definition for Standard Industrial Classification Code was adapted from:
EPA/Office of Enforcement and Compliance Assurance: Guide to Environmental Issues: Glossary of Terms & Acronyms *Term Detail*

Appendix A
PWS Sanitary Survey

Appendix B
PWS Well Logs

Appendix C
Groundwater Time-of-Travel Calculations

Model Input



The values selected for the calculation of time of travel represent conservative assumptions made to identify areas that may potentially impact the Town of Browning PWS. The criteria for selection of each value used for this delineation are as follows:

- ***Transmissivity***: The transmissivity value is estimated at 7,160 gpd/ft to 68,200 gpd/ft based on the pump test for Well #4 in the Flatiron Well Field (See Appendix B). This corresponds to 957 ft^2/day.
- ***Thickness***: The value for the thickness of the aquifer is estimated at 25 feet for the Flatiron Well Field and 13 feet for the Parsons Well Field, based on the estimated thickness of the aquifer from the well logs and the screened interval.
- ***Hydraulic Conductivity***: A value for hydraulic conductivity is estimated using the basic relationship T = Kb, where T = transmissivity and b = aquifer thickness. The estimated value for the hydraulic conductivity (K) is 42 ft/day.
- ***Hydraulic Gradient***: The hydraulic gradient was estimated based on local topography. The estimated gradient is 0.03 feet/feet.
- ***Flow Direction***: The flow direction is considered northeast, parallel to the creeks.
- ***Porosity***: The value for effective porosity is estimated from (Todd, 1980) at 23% which is an average of silty sand (0.20) to gravelly sand/outwash (0.26).
- ***Pumping Rate***: The pumping rate for the Flatiron Well Field wells was estimated at 750 gpm. The pumping rate for the Parsons Well Field was estimated at 250 gpm. These are based on volumes used during the pump tests.

DELINEATION RESULTS

The results of the calculations are shown below.

Input Values for Q, K, b, I, n, and XL							Calculated Values					
Well_Num	Pumping Rate ft3/day	Hydraulic Conductivity ft/day	Saturated Thickness ft	Hydraulic Gradient ft/ft	Effective Porosity %	Distance ground water travels in Tx	Time of Travel Limit days	Stagnation Point ft	Lateral Flow Limit ft	TOT Distance Threshold ft	Average Velocity ft/day	TOT Distance Threshold miles
	Q	K	b	I	n	XL	Tx	-X	YL	XL (feet)	V	XL (miles)
Flatiron-3yr	144385	42	25	0.03	0.23	7792	1,095	-730	2,292	7,792	7.12	1.48
	144385	42	25	0.01	0.23	4417	1,095	-2,189	6,875	4,417	4.03	0.84
Flatiron-1yr	144385	42	25	0.03	0.23	3234	365	-730	2,292	3,234	8.86	0.61
	144385	42	25	0.01	0.23	2178	365	-2,189	6,875	2,178	5.97	0.41
Parsons-3yr	48128	42	13	0.03	0.23	7314	1,095	-468	1,469	7,314	6.68	1.39
	48128	42	13	0.01	0.22	3976	1,095	-1,403	4,407	3,976	3.63	0.75
Parsons-1yr	48128	42	13	0.03	0.22	3032	365	-468	1,469	3,032	8.31	0.57
	48128	42	13	0.01	0.22	1897	365	-1,403	4,407	1,897	5.20	0.36

Time-of-travel Calculation Method: The Time of Travel for water to move along a line parallel to the hydraulic gradient form a point to a pumping well (EPA, 1991) is Tx where:

Notes on Variables

Tx = travel time from point x to a pumping well (days)

K = hydraulic conductivity (ft/day)

b = aquifer thickness (ft)

I = hydraulic gradient (ft/ft)

Q = average production rate (ft3/day)

n = effective porosity (%)

X = distance from pumping well over which groundwater travels in Tx (ft)

Null Point = distance to downgradient null point (ft)

Boundary Limit = maximum distance from the center line to the boundary of the capture zone (ft) (i.e. half the maximum width of the capture zone

Appendix D
Concurrence Letter