# Town of Bainville
# Public Water System
**PWSID # MT0000020**

# *SOURCE WATER DELINEATION AND ASSESSMENT REPORT*

**Date of Report: 11/20/02**

**Town of Bainville**

**Mayor Vernon Warren**

**Contact Person:**

**Vernon Warren**
**Certified Operator**
**P.O. Box 92**
**Bainville, MT 59212**
**(406) 769-2621**

# Table of Contents

**FIGURES:**



**TABLES:**

# INTRODUCTION

This Delineation and Assessment Report was prepared by Perri Phillips, Hydrogeologist in the Source Water Protection Program of the Montana Department of Environmental Quality (DEQ). The Bainville PWS is located in Roosevelt County, Montana, in the south-central area of the Fort Peck Indian Reservation. The DEQ PWS identification number, operator name, and operator number for the Bainville PWS evaluated in this report appear on the title page of this report.

## Purpose

This report is intended to meet the technical requirements for the completion of the source water delineation and assessment report for the town of Bainville PWS as required by the Montana Source Water Protection Program (DEQ, 1999) and the federal Safe Drinking Water Act (SDWA) Amendments of 1996 (P.L. 104-182). The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to the protection of public drinking water supplies from contamination. The primary purpose of this source water delineation and assessment report is to provide information to assist the Bainville PWS operator in the identification of potential contaminant sources near the Town of Bainville wells and the need for a source water protection plan to protect the Town of Bainville drinking water source.

Delineation and assessment constitute major components of the Montana Source Water Protection Program. Delineation entails mapping the boundaries of source water protection areas, which encompass ground water and/or surface waters contributing to public water supply sources. Assessment involves identifying locations or regions within source water protection areas where contaminants may be generated, stored, transported, or disposed, and determining the relative susceptibility of drinking water to contamination from these sources.

## Limitations

This report was prepared to assess threats to the Town of Bainville public water supply, and is based on published data and information obtained from local residents familiar with the community. The terms “drinking water supply” and “drinking water source” refer specifically to the sources of the public water supplies, and not 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 Bainville are identified. Only potential sources of contamination in areas that contribute water to the identified drinking water sources 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 carcinogenic or toxic constituents that do not have MCLs but are considered to be significant health threats.

# CHAPTER 1
# BACKGROUND

## The Community

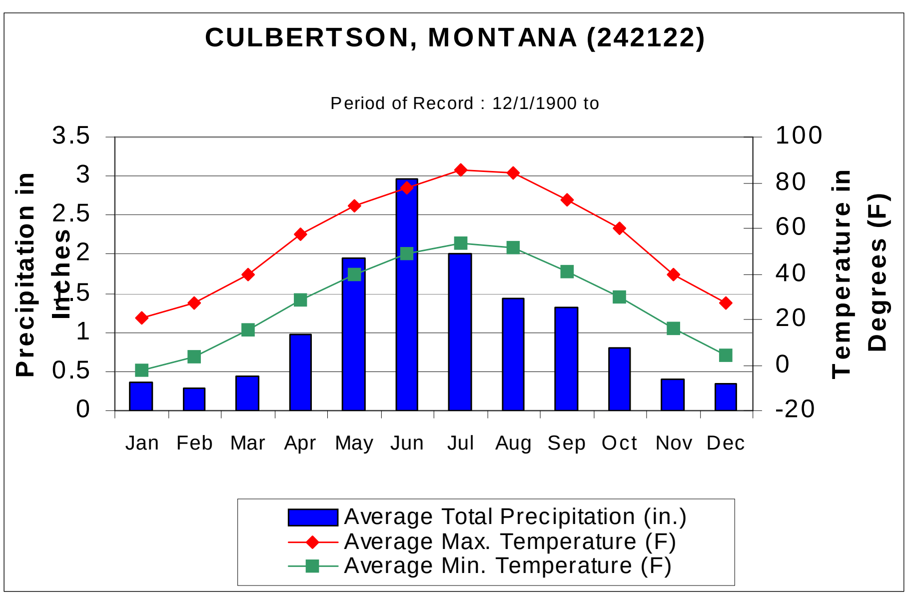
The town of Bainville is located on the Fort Peck Indian Reservation in the south-central area of Roosevelt County (Figure 1). The town is situated on the north bank of the Missouri River downstream of Fort Peck Reservoir and the Poplar River confluence. The U.S. Census Bureau estimates the 2000 population of Roosevelt County at 10,620 people, 245 of whom reside in Bainville. The Bainville population has decreased from 368 in 1990. The main line of the Burlington Northern Railroad runs east-west through the city. U.S. Highway 2 connects Bainville with Culbertson to the East, and Poplar to the west.

Agriculture contributes significantly to the economy of Bainville. The principal agricultural products for the adjacent Culbertson area are wheat, sugar beets, alfalfa, beef cattle, and food oils (Great Northern Development Corporation, http://www.gndc.org/culbert.htm). The largest revenue-generating industries in Roosevelt County in 1999 were services, 24.9 percent of earnings; state and local government, 20.3 percent; and farm, 17.1 percent (www.bea.doc.gov/bea/regional/bearfacts).

Within Bainville city limits, residents obtain their drinking water from the municipal PWS. No additional community, transient, or non-community, non-transient PWSs are located in the vicinity of Bainville. The Bainville municipal sewer district services all residents within city limits. Municipal wastewater is discharged to two infiltration lagoons located east of town. Treated wastewater effluent is then discharged to the Missouri River east of Bainville. Residents in areas outlying the city limits utilize on-site septic systems for waste disposal.

## Climate

**Figure 2. Culbertson Average Temperature and Presipitation**




The climate in the vicinity of Bainville is semi-arid. Based on Western Regional Climatic Center data for the December 1, 1900 to December 31, 2000 period of record at the nearby Culbertson station, annual precipitation averages 13.26 inches. Monthly average precipitation ranges from 0.28 inches in February to 2.97 inches in June. Intense, localized thunderstorms commonly occur from May through July (Donovan, 1988). The annual mean snowfall in Culbertson is 21.5 inches. Periodic drought cycles (as defined by moving annual precipitation averages less than 10 inches) occur in the region at approximately 10 to 20 year intervals. Evaporation rates are high, averaging 25 to 35 inches per year.

## Geographic Setting

Bainville is located in the Great Plains physiographic province of North America (Rocky Mountain Association of Geologists, 1972), and the glaciated central ground-water region of the United States (Heath, 1984). In the vicinity of Bainville, the Missouri River has incised through the underlying bedrock, forming terraces north and south of the river's broad floodplain. Quaternary glacial deposits, slope wash, and colluvium mantle these bedrock terraces, which slope gently towards the Missouri River floodplain. Bainville is situated in the Shotgun Creek drainage north of the Missouri River. Shotgun Creek is a tributary to Little Muddy Creek, which flows into the Missouri River approximately five miles south of Bainville.

The Shotgun Creek valley is approximately 1.5 miles wide in the vicinity of Bainville. The topography in the vicinity of the town exhibits relatively low relief, typically less than 100 feet over several miles. The elevation of Bainville is approximately 2000 feet above mean sea level. The glaciated Lustre – Volt and Flaxville Bredette plateaus located north of Bainville both gently slope to the southeast (Donovan, 1988). North of the Missouri River, at elevations below 2500 feet, a series of alluvial terrace remnants capped by glacial deposits form a poorly defined bench, which is dissected by several tributaries, including Shotgun and Little Muddy creeks.

Bainville is located in the Charlie - Little Muddy watershed. The U.S. Geological Survey hydrologic unit code for this watershed is 10060005. The Shotgun Creek drainage is oriented northwest - southeast near Bainville, with a flow direction to the southeast towards Little Muddy Creek.

## Geology

This section provides an overview of the geology and hydrology of the area in the vicinity of Bainville. The geology of the Bainville 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 contamination sources.

Northeast Montana lies on the western flank of the Williston Basin. The formation of the basin occurred from the Ordovician Period through the Cenozoic Era (Donovan, 1988). The Upper Cretaceous Hell Creek formation and the overlying Tertiary Fort Union formation in the vicinity of Bainville underwent structural deformation during basin formation. Colton and Bateman (1956) illustrate a localized east southeast dip for the top of the Greenhorn limestone equivalent as a result of basin formation in the vicinity of Bainville.

Colton (1963) describes the Hell Creek formation near Culbertson as a gray to tan shale, siltstone, sandstone, and carbonaceous shale sequence approximately 280 feet thick. He describes the Fort Union formation in the vicinity of Culbertson as an interbedded gray clay, buff silt, lignite, buff calcareous sandstone, brown carbonaceous clay, olive gray sand, and bentonitic gray clay sequence approximately 600 feet thick.

The town of Bainville is built on Quaternary Shotgun Creek alluvium (Figure 3a; Montana Bureau of Mines and Geology, 1998). To the south of Bainville, Quaternary alluvium blankets the Missouri River valley. Quaternary alluvial fan and colluvium deposits commonly apron the base of terraces and slopes on the margins of the Missouri River valley. Tertiary Fort Union formation underlies the Quaternary alluvium, colluvium, and glacial deposits outcrop in incised Missouri River tributary drainages, and discontinuously along the Missouri River valley margins (Colton, 1963).

Four major glacial advances occurred in Montana during the Pleistocene Epoch (10,000 – two million years ago) (Alden, 1932; Simon et al., 1999). Ice covered the northern third of the state during the maximum extent of the glacial advance. Prior to glaciation, the ancestral Missouri River flowed north around the Bearpaw Mountains and occupied the course of the present Milk River. From there, it followed the existing channel of the Missouri to what is now the town of Bainville, then northeastward through the Big Muddy Creek valley and eastern Roosevelt County (Donovan, 1988). Approximately 50,000 to 70,000 years ago, advancing ice blocked the river near the present town of Big Sandy, diverting the flow to the south into its current channel.

The Missouri River has exhibited varied and complex channel dynamics since the early Pleistocene (Simon et al., 1999). At numerous locations, ice diverted the flow for both long and short durations, and sometimes re-routed the channel. During glacial recessions, the addition of glacial meltwater to runoff volumes and glacial reworking of till and fluvial deposits resulted in the increased transport and deposition of coarser-grained sediments and a higher rate of deposition than has occurred since. As a result, the older alluvium in the lower portion of the post-glacial Missouri River deposits is coarser-grained.

Alden (1932) describes an abandoned valley of the Missouri River extending from Culbertson east to Bainville, and along the Shotgun Creek drainage to the confluence with the presently occupied course of the river. If Alden's interpretation is accurate, the Missouri River occupied this channel during the Pre-Wisconsin Illinoian or Iowan stage of glaciation during the advance of the Keewatin ice sheet. As a result, ancestral Quaternary Missouri River alluvial deposits likely occupy the Shotgun Creek valley with a greater thickness and extent than the modern alluvial deposits associated with Shotgun Creek. Beekly (1912) noted that the Fort Union formation was draped with a thin film to 25-foot thick deposits of glacial drift in the uplands surrounding Bainville. Alden (1932) reports considerably thick glacial drift northeast of Bainville, expressed as undulating topography in the lowlands between the bluffs. Alden interprets this geomorphology as evidence of the occupation of this area by ice subsequent to the occupation of the ancestral Missouri River channel. As a result, the ancestral Missouri River alluvium is likely overlain and/or interfingers with glacial deposits in the vicinity of the Bainville PWS well field near the northern edge of the ancestral channel floodplain.

The modern Missouri River valley comprises interbeds of alluvium, lacustrine, and glaciofluvial silt, sand, clay, and gravel sediments (Donovan, 1988). Preglacial and glacial deposits are unconsolidated and extremely hetereogeneous, varying in thickness from 30 to 100 feet (Hopkins and Tilstra, 1966). Silts and clays are exposed at ground level in most areas, and depths to water-bearing lenses of sands, sandy clay, or gravelly sand are not consistent (Hopkins and Tilstra, 1966). The Missouri River alluvium in the vicinity of Bainville contains significant vertical and horizontal variations in bedding (Simon et al, 1999). Individual stratigraphic horizons range in thickness from one inch to four feet, and all are lenticular in shape. Generally, the upper horizons of the alluvial deposits are finer-grained than the lower horizons.

**General Description of the Source Water**

The Bainville wells are drilled through Quaternary alluvium and finished in underlying glacial outwash deposits. (See well logs in Appendix B.) Donovan (1988) describes Pleistocene to Holocene alluvial and glacial aquifers in the present Missouri River valley as unconfined to semi-confined, 0 to 150 feet in thickness, and wells finished in these units yield 5 to 25 gallons per minute (gpm). The water occupying porespaces within the alluvial and glacial aquifers constitutes the Bainville aquifer.

Ground-water flow in the region is generally directed from the higher elevation benches to the modern river valleys (Donovan, 1988). Regional ground-water flow occurs within bedrock aquifers generally below 200 feet (Donovan, 1988). The general direction of regional ground-water flow in the vicinity of Bainville is from west to east, following the structural trend of the Williston basin. Recharge to the bedrock aquifers is derived in part from downward infiltration from Lustre-Volt plateau gravel aquifers (Flaxville Formation) to the west and north of Bainville.

Fort Union and Hell Creek formation ground-water likely flows parallel to the dip of the formations in the vicinity of Bainville. Assuming that these formations dip parallel to the dip of the underlying Greenhorn limestone equivalent, the dip direction on both the Fort Union and the underlying Hell Creek formations is east southeast in the vicinity of Bainville. Local deviations from this ground-water flow direction are likely, and affected by the configuration and interconnectedness of fractures within the formation, as well as large-scale structural features. Ground water in the overlying glacial deposits and the adjacent Missouri River alluvium likely flow to the southeast near Bainville, based on topographic slope and the southeastern gradient of Shotgun Creek.

### The Public Water Supply

The Bainville PWS is classified as a community system under the Federal Safe Drinking Water Act, because the system serves at least 25 year-round residents through at least 15 service connections. The PWS services approximately165 residents via 78 active service connections.

Three wells (#3, 4, and 5) are utilized as primary water supply sources. Well information for all Bainville PWS sources is summarized in Table 3. See Appendix B for lithologic logs and construction specifications available for each well. The three source wells are located approximately two miles north of Bainville (Figure 4). Water from all three wells undergoes treatment prior to delivery to the distribution system. A new Filtronics iron and manganese removal treatment facility was completed in Bainville in 1999 (HDR Engineering, 2001). Ground water is pumped from the three primary wells into a pump house where the water piping joins into a single header (HDR Engineering, 2001). The water is chlorinated and subsequently pumped into a one minute reaction vessel. Then sulfur dioxide is added to the water, and it flows into another one minute reaction vessel. The water is subsequently run through a pressure filter and chlorinated before it is pumped to a buried concrete 108,000-gallon storage tank and out to the distribution system (See map of distribution system in Appendix A.)

The Town's Well No. 3 (Source 002) is located in Township 28 North, Range 58 East, Section 22 in tract BDD, inside the well house (Figure 4; See map in Appendix C ). The latitude of the well location is 48.1647°, and the longitude is –104.2169°. The well was drilled on September 15, 1976 to a total depth of 46 feet below ground surface (bgs). The well has an 10-inch diameter casing extending from ground level to 46 feet bgs. A No. 20, 10-inch diameter perforated screen extends from 32 to 39 ft bgs. A No. 15, 10-inch diameter perforated screen extends from 39 to 44 ft bgs. The annular space is sealed with cement from the ground surface to 25 ft bgs. The well is finished in glacial outwash +/- alluvial gravels and sands. The well yield is 40 gpm (gallons per minute). A specific capacity could not be estimated for this well due to the absence of pump test data.

The Town's New Well No. 4 (Source 003) is located in Township 28 North, Range 58 East, Section 22 in tract BDD, east of Well #1 and east of the pumphouse. (See map in Appendix C.) The latitude of the well location is 48.166°, and the longitude is -104.215° (see Appendix B for the well log). The well was drilled on November 10, 1977 to a total depth of 45 feet bgs. The well has a 4-inch diameter casing extending from ground level to 45 feet bgs. A 20 slot, 4-inch diameter perforated screen extends from 33 to 45 ft bgs. The annular space is sealed with cement from 8 to 22 ft bgs. The well yield is 28 gpm. The specific capacity of the well, based on a three-hour pump test, is 4 gpm/ft.

The Town of Bainville Well No. 5 (Source 004) is located in Township 28 North, Range 58 East, Section 22 in tract BDDD, southeast of the pumphouse and Well #1 (Figure 4; See map in Appendix C). The latitude of the well location is 48.1624°, and the longitude is -104.2153° (see Appendix B for the well log). The well was drilled to a total depth of 50 feet bgs. No completion date is available for the well. The well has an 7-inch diameter casing extending to an unknown depth. The well yield is approximately 37 gpm. No annular seal, lithologic, completion, or pump test information is available for this well.

All three Bainville wells are finished in an unconsolidated, semi-confined glacial aquifer. As a result, these sources should be classified as highly sensitive to contamination, in accordance with Montana Source Water Protection Program aquifer sensitivity criteria (1999); see Table 2.

## Water Quality

Public water systems must conduct routine monitoring for contaminants in accordance with Federal Safe Drinking Water Act requirements. Parameters such as coliform bacteria, lead, copper, nitrate, nitrite, volatile organic chemicals (including hydrocarbons and chlorinated solvents), inorganic chemicals (including metals), synthetic organic chemicals (including pesticides), and radiological contaminants must be sampled in community PWSs and non-community, non-transient PWSs in accordance with schedules specified in the Administrative Rules of Montana. Transient, non-community PWSs are required to conduct routine monitoring for pathogens (including coliform bacteria), nitrate, and nitrite. All contaminant concentrations detected in required samples must comply with numeric maximum contaminant levels (MCLs) specified in the Federal Safe Drinking Water Act.

Background Bainville Water Quality

The Montana Bureau of Mines and Geology collected samples from two wells finished in glacial deposits in the vicinity of Bainville. Both wells are located approximately four miles northwest of Bainville. The first well (GWIC No. 3477) was sampled on May 1, 1985, and the second well (GWIC No. 3478) was sampled on May 26, 1985.

**Table 1**. Dissolved constituent concentrations in shallow Bainville glacial aquifer

| GWIC No. | Date | Reference | Depth (ft) | $SO_4$ (mg/l) | $NO_3$ (as N) (mg/l) | Hard-ness (as $CaCO_3$) (mg/l) | Ca (mg/l) | Na (mg/l) | Fe (mg/l) | Cu (ug/l) | T.D.S. (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3477 | 5/1/85 | MBMG GWIC | 49 | 640 | 0.03 | 434.77 | 30 | 260 | 0.17 | 2.0 | 1445.27 |
| 3478 | 5/26/85 | MBMG GWIC | 50 | 535 | 0.09 | 478.37 | 34 | 331 | 0.55 | 7.0 | 1214.44 |
| MCL (mg/l) | | | | NA | **10** | NA | NA | NA | NA | NA | NA |
| Treatment Technique level (mg/l) | | | | NA | NA | NA | NA | NA | NA | **Action Level = 1.3** | NA |
| MCLG (mg/l) | | | | NA | NA | NA | NA | NA | NA | **1.3** | NA |
| Secondary MCL (mg/l) | | | | **250** | NA | NA | NA | NA | **0.3** | NA | NA |

*NA = not applicable

Based on these sampling results, shallow ground water in the vicinity of Bainville falls under the Class II Montana ground-water classification. Class II ground waters are at least marginally suitable for public and private water supplies, culinary and food processing purposes, irrigation and some agricultural crops, drinking water for livestock and wildlife, and most commercial and industrial purposes.

The State of Montana classifies the segment of the Missouri River from the Poplar River confluence to the North Dakota border as a B-3 surface water. These waters are suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming, and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supplies. This stretch of the Missouri River appears on the Montana 2000 303(d) list as partially supporting aquatic life and a warm water fishery. DEQ has identified flow alteration and thermal modifications as probable causes of impairment on this segment. Hydromodification, upstream impoundment, and flow regulation/modification have been identified as probable sources of these impairments. No other streams in the vicinity of Bainville have been identified as water quality impaired by DEQ.

Town of Bainville PWS Water Quality

Bainville has experienced several fecal coliform violations within the past five years. Bainville incurred two coliform MCL violations between 2000 and 2002. HDR Engineering, Inc. (2001) reported several well house and storage tank maintenance problems that may constitute coliform contamination sources or conduits for coliform contamination at the time of a April 13, 2001 sanitary survey inspection. During the same inspection, it was also noted that the chlorine residual monitoring for the system was inadequate (HDR Engineering, Inc., 2001). No MCL exceedances were noted for any other monitored constituents.

# CHAPTER 2
# DELINEATION

The source water protection area, the land area that contributes water to the Town of Bainville public water supply wells, is identified in this chapter. Four management regions are identified within the source water protection area. These four regions are the control zone, inventory region, surface water buffer, and recharge region. The control zone, also known as the exclusion zone, is a circular area with a 100-foot radius around the well. The inventory region represents the zone of contribution of the well, which is approximated by a modified 1-mile radius circle around the well. Fixed distances and hydrogeologic mapping were used to estimate the inventory region area. The surface water buffer encompasses a shallow lake located upgradient from the Bainville well field and within the boundaries of the inventory region. A surface water buffer was delineated for the Bainville wells due to suspected hydraulic connections between the Quaternary glacial deposit aquifer penetrated by the wells and the small lake located in the inventory region. The recharge region represents the entire area of the Shotgun Creek watershed that contributes water to the Town of Bainville's water system.

## Hydrogeologic Conditions

The infiltration of precipitation, streamflow loss, applied irrigation water, and lateral inflow from adjacent bedrock aquifers recharge the shallow Quaternary glacial and alluvial aquifers in the vicinity of Bainville. These shallow aquifers lose water to streamflow, evapotranspiration, and water withdrawals. The deeper aquifer in the Tertiary Fort Union formation receives recharge principally through the infiltration of precipitation. These fractured bedrock aquifers lose water to streamflow, discharge to overlying or adjacent glacial or alluvial aquifers, and water withdrawals.

The Tertiary Fort Union formation underlies the Quaternary glacial aquifers in the vicinity of Bainville, comprising the lower boundary for this shallow aquifer (Figure 3a). Depth to shallow ground water varies from 5 to 60 feet bgs near the Bainville PWS wells, based on a review of well logs for wells completed in the shallow aquifer within a one-mile radius of the Bainville PWS wells.

The Town of Bainville source water will be treated as a semi-confined aquifer for the purpose of this report. The variation in thickness and limited lateral extent of confining tills provide adequate rationale for using a more conservative delineation approach. The aquifer is also assumed to be in hydraulic connection with the shallow lake located in the inventory region.

Using DEQ Source Water Protection Program criteria for ranking aquifer sensitivity (Table 2), Bainville source water is considered highly sensitive to contamination. The sensitivity ranking is based on the unconsolidated lithology of the surficial glacial deposits, and the assumed communication between the shallow glacial aquifer and the shallow lake located in the inventory region.

A shallow, intermittent lake is located north of the Bainville PWS well field in the inventory region. This lake appears on an August 3, 1997 aerial photograph of the inventory region. As part of the 1989 National Wetland Inventory, the U.S. Fish and Wildlife Service also mapped this lake as an intermittent lacustrine feature based on an April, 1982 aerial photograph. The lake is fed by an irrigation canal system within which water is diverted out of Shotgun Creek, into Shotgun Reservoir, out of Shotgun Reservoir to the shallow, intermittent lake, and out of the lake back to Shotgun Creek. The lake typically dries out by the end of the summer during most water years, and flows again in response to water diverted in to the irrigation canal system in the spring. Water is typically diverted out of Shotgun Creek during the spring when the stream is flowing. Following spring runoff, flows in Shotgun Creek typically diminish to near zero cubic feet per second, leaving isolated standing pools of water in the channel. For this reason, diversions out of

Shotgun Creek are limited to the spring runoff period. During some water years, flows are not adequate in Shotgun Creek to supply water to the canal system.

**Table 2**. Source water sensitivity criteria (DEQ, 1999).

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

### Conceptual Model and Assumptions

A hydrogeologic conceptual model is a simplified representation of a flow system. Conceptual models help us to visualize how ground water flows in the Bainville area. The model also demonstrates the general relationship between shallow and deeper aquifers, and the nature of existing hydraulic connections between ground water and surface waters. The shallow glacial aquifer appears to be semi-confined in the immediate vicinity of the Town of Bainville PWS wells. One of the assumptions used in the model is the southeast to southwest flow direction, which may vary seasonally and spatially, due to seasonal changes in precipitation, irrigation practices, and lake stage, as well as lithologic heterogeneities in the glacial deposits. The model also assumes some hydrologic recharge from the series of shallow lakes northwest of the Bainville well field. The recharge from these lakes to the shallow glacial aquifer may be seasonal in nature, and may vary depending on annual precipitation patterns and accumulations, local irrigation practices, evapotranspiration rates, and the types of sediments underlying the lake and overlying the aquifer. The glacial aquifer boundaries occur along the basal contact with the Tertiary Fort Union formation bedrock, and the aquifer extends south to the contact with the Shotgun Creek alluvium. Well log information may not indicate the full range in variability of aquifer characteristics on a local or regional scale.

### Well Information

See Appendix B for the Town of Bainville PWS well lithologic and construction logs.

**Table 3.** Source well information for the Town of Bainville PWS.

| Information | Well #3 | Well #4 | Well #5 |
|---|---|---|---|
| **PWS Source Code** | 002 | 003 | 004 |
| **Well Location (lat./ long.)** | 48.1647°N<br>-104.2169W° | 48.166°N<br>-104.215°W | 48.1642°N<br>-104.2153°W |

**Table 3.** Source well information for the Town of Bainville PWS (cont'd).

| Information | Well #3 | Well #4 | Well #5 |
|---|---|---|---|
| **MBMG GWIC#** | 40305 | 40306 | 3482 |
| **DNRC Water Right #** | C026590 | C026591 | C059497 |
| **Date Well was Completed** | September 15, 1976 | November 10, 1977 | 1983 |
| **Total Depth** | 46 ft | 45 ft | 50 ft |
| **Perforated Interval** | 32 to 44 ft bgs | 33 to 45 ft bgs | Unknown |
| **Surface/Sanitary Seal** | cement from 0 to 75 feet bgs | cement from 8 to 22 feet bgs | Unknown |
| **Static Water Level** | 23 ft bgs | 26 ft bgs | Unknown |
| **Pumping Water Level** | Unknown | 33 ft bgs | Unknown |
| **Drawdown** | Unknown | 7 ft | Unknown |
| **Test Pumping Rate/ Yield (Q)** | 40 gpm | 28 gpm | 37 gpm |
| **Specific Capacity (Q/drawdown)** | Unknown | 4 gpm/ft | Unknown |

## Delineation Results

Town of Bainville PWS Control Zones

The control zones for the Town of Bainville PWS wells are circular areas encompassing each well with a uniform radius of 100 feet, in accordance with the criteria specified in the Source Water Protection Program Document (1999) (Figure 4).

Town of Bainville PWS Inventory Regions

The inventory regions for the three Town of Bainville PWS wells were combined due to the close proximity of the wells, and to facilitate management of the inventory area by creating a uniform boundary around the well field (Figure 5). The one-mile fixed radius circle delineation method was utilized for the inventory region due to the absence of data available on the hydraulic properties of the fractured bedrock aquifer or the shallow alluvial, colluvial, and glacial aquifers near Bainville. The area of the inventory region was reduced to encompass only those areas assumed to be upgradient. The inventory region encompasses potential components of shallow ground-water flow oriented parallel to the long axis of the Shotgun Creek drainage and perpendicular to topographic slope. The inventory region area also accounts for uncertainties associated with estimated hydraulic properties of the shallow glacial aquifer.

Town of Bainville PWS Surface Water Buffer Zone

The surface water buffer zone for the Town of Bainville PWS wells was delineated using hydrogeologic mapping (Figure 6). The surface water buffer extends .0.5 miles in all directions from the series of shallow lakes located in the inventory region to the northwest of the Bainville PWS well field in accordance with SWPP criteria (DEQ, 1999). A surface water buffer for the shallow lakes is included in the inventory region delineation for the Town of Bainville PWS wells due to the assumed hydraulic connection between surface water in the shallow lakes and the underlying shallow glacial aquifer. The drainage flowing into and out of the lakes was not included in the surface water buffer because the stream is mapped as ephemeral, and no significant potential contaminant sources were identified along this water body.

Town of Bainville PWS Recharge Region

The recharge region for the wells was also delineated using hydrogeologic mapping (Figure 7). The Shotgun Creek watershed divides were designated as recharge region boundaries upstream of the Town of Bainville wells. The recharge region encompasses areas of surface water and ground-water contributions to the shallow glacial aquifer in the Shotgun Creek drainage.

**Limiting Factors**

The inventory region delineation for the Town of Bainville PWS wells represents an approximation of the distance required for upgradient ground water to reach the wells within days to a few years. Due to the extremely limited data available on the PWS wells and the hydraulic properties of the aquifer, large uncertainties are associated with estimates of the ground water flow directions. Additionally, many assumptions made regarding the aquifer properties were based on the conceptual model, which is a simplification of the existing flow system. The presumed existence of a dynamic hydraulic connection between the shallow lakes in the inventory region and the shallow glacial aquifer, the unknown extent and degree of hydraulic interaction between the shallow glacial aquifer and deeper bedrock aquifers, as well as the documented occurrence of heterogeneities in the lithology of the glacial deposits in the vicinity of Bainville suggest a far more complex flow regime.

# CHAPTER 3
# INVENTORY

An inventory of potential sources of contamination was conducted to assess the susceptibility of the Bainville PWS to contamination, and to identify priorities for source water protection planning. These inventories were conducted within the inventory region assigned to the PWS. The inventory for the Town of Bainville PWS focuses on facilities that generate, use, store, transport, or dispose potential contaminants, and on land types on which potential contaminants are generated, used, stored, transported, or disposed. Additionally, the inventory identifies potential sources of all primary drinking water contaminants and Cryptosporidium. Only significant potential contaminant sources were selected for detailed inventory. The contaminants posing significant potential threats to the Town of Bainville PWS include nitrate, pathogens, pesticides, petroleum hydrocarbons, total dissolved solids, and VOCs. The inventory for the Bainville PWS also focuses on all activities in the control zone, certain sites or land use activities in the inventory region, and general land uses and large potential contaminant sources in the recharge region and surface water buffer.

## Inventory Method

Available databases were initially searched to identify businesses and land uses that are potential sources of regulated contaminants in the inventory region. The following steps were followed:

Step 1: Land cover is identified from the National Land Cover Dataset compiled by the U.S. Geological Survey and U.S. Environmental Protection Agency (U.S.G.S., 2000). Land cover types in this dataset were mapped from satellite imagery at 30-meter resolution using a variety of supporting information.

Step 2: EPA's Envirofacts System was queried to identify EPA regulated facilities. This system accesses the following databases: Resource Conservation and Recovery Information System (RCRIS), Biennial Reporting System (BRS), Toxic Release Inventory (TRI), Permit Compliance System (PCS), and Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS). The available reports were browsed for facility information including the Handler/Facility Classification to be used in assessing whether a facility is a significant potential contaminant source.

Step 3: DEQ databases were queried to identify Underground Storage Tanks (UST), hazardous waste contaminated sites, landfills, and abandoned mines.

Step 4: A business phone directory was consulted 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 Codes.

Step 5: Major road and rail transportation routes were identified.

Step 6. All significant potential contaminant sources were identified in the inventory region and land uses and facilities that generate, store, transport, or dispose 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) Hazardous waste contaminated sites
4) Underground storage tanks
5) Major roads or rail transportation routes
6) Cultivated cropland
7) Animal feeding operations
8) Wastewater lagoons or spray irrigation
9) Septic systems
10) Sewered residential areas
11) Storm sewer outfalls
12) Floor drains, sumps, or dry wells
13) Abandoned or active mines

**Inventory Results/Control Zone**

The Town of Bainville PWS wells are located on privately owned property. This property is used as fallow ground and for grazing. A county road is located within the control zone for well #5. No on-site septic systems are located within the 100-ft radius control zones for any of the wells.

**Inventory Results/Inventory Region**

Land covers within the inventory region for the Town of Bainville PWS include open water, deciduous forest, shrubland, grasslands/herbaceous, small grains/pasture/hay, and fallow ground (Figure 8). Cultivated cropland occupies 35 percent of the inventory region. Mismanagement or over application of fertilizers and/or pesticides poses a potential threat to the Town of Bainville PWS, due to the size of the inventory region area over which fertilizers and/or pesticides may be applied. The principal land covers in the inventory region are grasslands/herbaceous, fallow ground, and shrubland.

A natural gas pipeline is located north of Wells #3 and #5 and south of Well #4 in the inventory region. This pipeline may represent a potential contaminant source in the event of a rupture or leak (Figure 5).

Septic densities are low throughout the entire inventory region. No concentrated animal feeding operations are located in the inventory region, but grazing is a land use.

The intermittent lake located in the inventory region represents a potential contaminant source of nitrate and pathogens (Figure 5). Feces from cattle, birds, and wildlife may be washed into the lake from the surrounding area, or may be directly deposited in the lake or the dry lakebed. When the lake is filled with water, it may recharge the underlying shallow glacial aquifer and contaminants could potentially migrate through the aquifer to reach the Bainville PWS well intakes.

**Table 4.** Significant potential contaminant sources in the control zones for the Town of Bainville PWS wells.

| Source | Address Or Map ID Number | Potential Contaminants | Hazard |
|---|---|---|---|
| County road | 1 | Petroleum hydrocarbons, Pesticides | Spills, surface runoff, infiltration into ground water |

**Table 5.** Potential contaminant sources in the inventory region for the Town of Bainville PWS.

| Source | Address Or Map ID Number | Potential Contaminants | Hazard |
|---|---|---|---|
| Gas pipeline | 2 | VOCs | Pipe rupture, leaking connections |
| Intermittent lake | 3 | Pesticides, fertilizers, VOCs | storm water runoff, infiltration into underlying ground water |
| Cultivated cropland (including grazing) | See Figure 8 | Fertilizers, pesticides, pathogens, nitrate | Spills, over application, surface runoff |

**Table 6.** Significant potential contaminant sources in the inventory region for the Town of Bainville PWS.

| Source | Address Or Map ID Number | Potential Contaminants | Hazard |
|---|---|---|---|
| Gas pipeline | 2 | VOCs | Pipe rupture, leaking connections |
| Intermittent lake | 3 | Pesticides, fertilizers, pathogens, nitrate | Storm water runoff, infiltration into ground water |
| Cultivated cropland (including grazing) | See Figure 8 | Fertilizers, pesticides, pathogens, nitrate | Spills, over application, surface runoff |

## Inventory Results/Surface Water Buffer

Land covers occurring in the surface water buffer for the Town of Bainville PWS wells include grasslands/herbaceous, fallow ground, small grains, and shrubland (Figure 9). Cultivated cropland occupies 36 percent of the surface water buffer area for the Town of Bainville PWS. The intermittent lake and Shotgun Reservoir also constitute potential nitrate and pathogen sources within the surface water buffer (Figure 6). The gas pipeline may represent a potential contaminant source in the event of a rupture or leak. Septic densities are low within the entire surface water buffer area. There are no known concentrated animal feeding operations in the surface water buffer zone, but grazing is one of the land uses within the buffer area.

**Table 7.** Significant potential contaminant sources in the surface water buffer for the Town of Bainville PWS.

| Source | Address Or Map ID Number | Potential Contaminants | Hazard |
|---|---|---|---|
| Gas pipeline | 2 | VOCs | Pipe rupture, leaking connections |
| Intermittent lake | 3 | Pesticides, fertilizers, pathogens, nitrate | Storm water runoff, infiltration into ground water |
| Cultivated cropland (including grazing) | See Figure 9 | Fertilizers, pesticides, pathogens, nitrate | Spills, over application, surface runoff |

## Inventory Results/Recharge Region

The recharge region for the Bainville PWS is assumed to be the portion of the Shotgun Creek watershed upgradient and upstream from the PWS wells. Predominant land covers in the recharge region include fallow ground (39%), grasslands/herbaceous (30%), small grains (18%), and shrubland (10%) (Figure 10). Herbicides and fertilizers utilized on cultivated cropland in the recharge region constitute significant potential contaminant sources, as cropland occupies 60 percent of the recharge region area. No permitted confined animal feeding operations are located in the recharge region, but a portion of the land is used for grazing.

Numerous oil and gas wells are located in the recharge region (Figure 7). The majority of these wells are development wells, and some of them have produced oil or gas. A number of the oil and gas wells appear to be located upgradient or upstream from the Bainville PWS wells. As a result, the oil and gas wells appear to constitute a significant potential contaminant source in the recharge region.

The natural gas pipeline previously described in the inventory region also extends across the recharge region. A spur line of the Burlington Northern Santa Fe Railway extends across the recharge region west of the PWS wells. The railroad constitutes a significant potential contaminant source in the event of a derailment or spill, due to the upgradient location of the tracks, assuming a southwestern flow direction in the shallow glacial aquifer.

**Table 8.** Significant potential contaminant sources in the recharge region for the Town of Bainville PWS.

| Source | Address Or Map ID Number | Potential Contaminants | Hazard |
|---|---|---|---|
| Gas pipeline | 2 | VOCs | Pipe rupture, leaking connections |
| Oil and Gas Wells | 4 | Total dissolved solids, petroleum hydrocarbons | Migration of byproduct brines into surface water or ground water |
| Cultivated cropland (including grazing) | See Figure 10 | Fertilizers, pesticides, pathogens, nitrate | Spills, over application, surface runoff |
| Burlington Northern Santa Fe Railway | 5 | Fertilizers, pesticides, pathogens, nitrate | Spills, Derailments |

## Inventory Update

The certified operators of the Bainville PWS should update the inventory 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 re-certification of the source water delineation and assessment report.

## Inventory Limitations

The extent of the potential contaminant source inventory is limited in several respects. The inventory is based on data readily available through state documents, published reports, and GIS data. Documentation may not be readily available on some potential sources. As a result, all potential contaminant sources may not have been identified. In some instances, inadequate location information precluded the inclusion of potential sources in the inventory.

# CHAPTER 4
# SUSCEPTIBILITY ASSESSMENT

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 Bainville and Roosevelt County.

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 land use activities in the recharge region pose minimal threats 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 Bainville PWS owners and operators to reduce susceptibility are recommended.

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 PWS well(s) (Table 9). For point sources, hazard is rated by the proximity of a potential contaminant source to the well(s). A high hazard rating is assigned to point sources located within the 1-year time-of-travel distance to a well. A moderate hazard rating is assigned to point sources located between the 1-year time-of-travel distance and the 3-year time-of-travel distance to a well. A low hazard rating is assigned to point sources located farther than the 3-year time-of-travel distance to a well. Hazard ratings for nonpoint sources are assigned based on the following criteria in Table 9:

**Table 9.** Hazard of potential contaminant sources for the Bainville public water system wells.

| | **High Hazard** | **Moderate Hazard** | **Low Hazard** |
|---|---|---|---|
| **Point Sources of All Contaminants** | Within 1-year TOT | 1- to 3-year TOT | Over 3-year TOT |
| **Septic Systems** | More than 300 per sq. mi. | 50 – 300 per sq. mi. | Less than 50 per sq. mi. |
| **Municipal Sanitary Sewer** (% land use) | More than 50 % of region | 20 to 50 % of region | Less than 20 % of region |
| **Cropped Agricultural Land** (% land use) | More than 50 % of region | 20 to 50 % of region | Less than 20 % of region |

**Table 10.** Susceptibility to potential contaminant sources based on hazard and the presence of barriers.

| | **High Hazard** | **Moderate Hazard** | **Low Hazard** |
|---|---|---|---|
| **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 |

Susceptibility ratings are presented individually for each significant potential contaminant source and each associated contaminant (Table 11). The susceptibility of each well to each potential contaminant source is assessed separately.

**Susceptibility Assessment Results**

The Town of Bainville source water is highly susceptible to contamination from the adjacent county road and intermittent lake. The city wells are moderately susceptible to contamination from the natural gas pipeline, oil and gas wells, and agricultural lands (Table 11).

Table 11 displays the susceptibility assessment results for the Town of Bainville PWS wells. The susceptibility of the three Town wells was evaluated collectively, due to the close proximity of the three well locations (Figure 4). The Town wells are susceptible to a number of different contaminants, including pathogens, nitrates, fertilizers, pesticides, petroleum hydrocarbons, volatile organic chemicals (VOCs), and total dissolved solids. Tables 5, 7, 8, and 9 list all potential contaminant sources identified in the control zone, inventory zone, and surface water buffer for the three Town wells.

The construction specifications for Well No. 3 is unknown. As a result, well construction was not considered a protective barrier for any of the wells.

The susceptibility results for each significant potential contaminant source identified source follow:

***County road –*** The potential hazard imposed by pesticides and petroleum hydrocarbons originating from the county road located adjacent to the Bainville well field is high. The highway poses a high hazard because it is located proximal to the wells. The highway is also located upgradient from the wells, assuming a south to southwest flow direction in the glacial drift and alluvial/colluvial aquifers. The susceptibility of the wells to this source is very high due to the absence of natural, engineered or management barriers between the road and the well field.

***Intermittent lake –*** The potential hazard imposed by pathogens and nitrate originating from the intermittent lake located north of the well field is high. The lake presents a high hazard because it is located very close to and upgradient of the wells. The susceptibility of the wells to contaminants originating from this source is also high, as the only barrier identified is the riparian vegetation on the perimeter of the lake, which enables the filtration and degradation of contaminated surface water runoff.

***Natural gas pipeline –***In the event of a pipe rupture or leaking connections, the gas pipeline in the inventory zone may threaten the Bainville wells with VOC contamination. The hazard presented by the pipeline is high, due to its proximal location to the wells. The presence of pipeline emergency shut-off valves and the Roosevelt County Hazardous Material Response Plan provide multiple management barriers to the contamination hazard posed by the pipeline. The resultant susceptibility of the well to the pipeline is moderate.

***Cultivated croplands –*** The potential hazard imposed by pathogens and nitrate originating from agricultural lands is moderate. Cropped agricultural lands constitute 35% of the inventory zone, 36% of the surface water buffer, and 60% of the recharge region, falling between 20% and 50% of the area on average. The susceptibility of the wells to these agricultural sources of nitrate and pathogens is also moderate due to the denitrification and degradation of pesticides and fertilizers occurring through natural attenuation between distal cropland and the PWS wells.

***Burlington Northern Sante Fe railway –*** The potential hazard imposed by pesticides, fertilizers, VOCs and SOCs originating from the Burlington Northern Sante Fe railway is low. The railway poses a low hazard because it is located distal from and downgradient of the wells. The susceptibility of the wells to pesticides, fertilizers, VOCs and SOCs originating from this source is also low. The only barrier identified for this source is the Roosevelt County Hazardous Material Response Plan, part of the Disaster and Emergency Response Plan.

**Table 11.** Susceptibility assessment for significant potential contaminant sources in the control zone, inventory region, surface water buffer, and recharge region for the Town of Bainville PWS wells.

| Source | Contaminant | Map ID Number | Hazard | Hazard Rating | Barriers | Susceptibility | Management Recommendations |
|---|---|---|---|---|---|---|---|
| County road | Petroleum hydrocarbons, Pesticides | 1 | Spills, surface runoff, infiltration into ground water | High | None | Very High | Implementation of stormwater BMPs; proper application of pesticides |
| Intermittent lake | Pesticides, fertilizers, pathogens, nitrate | 3 | Storm water runoff, infiltration into ground water | High | Filtration and degradation | High | Educate land owners on proper application and storage of pesticides and fertilizers, as well as other agricultural and grazing BMPs |
| Gas pipeline | VOCs | 2 | Pipe rupture, leaking connections | High | Emergency shut-off valves, Disaster & Emergency Response Plan | Moderate | Proper maintenance of pipeline; Maintain preparedness of local emergency personnel through active training |
| Oil and Gas Wells | Total dissolved solids, petroleum hydrocarbons | 4 | Migration of byproduct brines into surface water or ground water | Moderate | Natural attenuation | Moderate | Proper disposal of brine wastewater |
| Cultivated cropland (including grazing) | Fertilizers, pesticides, pathogens, nitrate | See Figures 8,9, and 10 | Spills, over application, surface runoff | Moderate | Natural attenuation | Moderate | Educate land owners on proper application and storage of pesticides and fertilizers, as well as other agricultural and grazing BMPs |
| Burlington Northern Sante Fe Railway | Pesticides, fertilizers, VOCs, SOCs | 5 | Spills, storm water runoff, infiltration into ground water | Low | Disaster & Emergency Response Plan | Low | Maintain preparedness of local emergency personnel through active training |

## Management Recommendations

Management recommendations are included in the susceptibility table for the Bainville PWS (Table 11). If these management recommendations are implemented, they may be considered additional barriers that will reduce the susceptibility of Bainville's wells to specific sources and contaminants.

Management recommendations fall into the following categories:

- Agricultural best management practices
- Stormwater management
- Education
- Emergency Response Plan
- Proper disposal of oil and gas well production wastewater

***Agricultural best management practices (BMPs)* –** BMPs that address application and mixing of fertilizer and pesticides are a viable alternative to prohibition of their use. Grazing BMPs may be utilized to minimize range, riparian vegetation, and water quality impacts. BMPs are generally voluntary but their implementation can be encouraged through education and technical assistance.

***Stormwater management* –** Stormwater planning should address source and drainage control. Source control can be accomplished through educational programs focusing on residential and commercial chemical use, disposal, and recycling. Drainage control and pollutant removal can be accomplished through the use of vegetated detention basins at outfall locations.

***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 will 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* -** Roosevelt County has compiled an Emergency Response Plan that has been adopted by the cities and towns in the county (personal communication, Wolf Point Disaster & Emergency Services Coordinator, August, 2001). The effectiveness of this response plan will be maximized if it is updated on an annual basis to reflect changes in emergency contacts, emergency numbers, and resources available within the county to respond to an emergency situation, such as a hazardous material spill.

***Proper disposal of oil and gas production wastewater* -** The saline wastewater co-produced with oil and gas development should be properly disposed. Deep well reinjection is the preferred method of wastewater disposal to minimize impacts to surface water and shallow ground water used for drinking and agricultural purposes. Total dissolved solids and petroleum hydrocarbon impacts to ground water and surface waters in the vicinity of well fields should be monitored.

These management recommendations should be considered by the Town of Bainville PWS operator, the Town administration, and the Roosevelt County administration. Should contamination reach the Town wells, the Town and County will likely need to work cooperatively to address remediation or relocation of the Bainville PWS sources. Editorial contributions from the Bainville PWS operator and the Town of Bainville administration have been solicited and incorporated into this report.

## Monitoring Waivers

### 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 miles 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 miles 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. Review of an organic chemical monitoring waiver application will be conducted by DEQ’s PWS Section and DEQ’s Source Water Protection Program. 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,

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 an 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 a 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.

Waiver Recommendation

Based on past monitoring results and the susceptibility assessment of the Bainville PWS wells, the Bainville PWS appears to be eligible for additional monitoring waivers. See Table 9 for the affect of identified potential contaminant sources on monitoring waiver eligibility for the Bainville PWS. Currently, Bainville has no monitoring waivers. Bainville may be eligible for a Phase II inorganic chemicals (barium, cadmium, chromium, flouride, mercury, and selenium) and Phase V inorganic chemicals monitoring waiver (antimony, thallium, beryllium, and nickel), as well as volatile organics and semivolatile organics waivers. For further monitoring waiver consideration, the Bainville PWS should submit a letter to DEQ requesting additional monitoring waivers. The PWS also needs to provide additional information to DEQ regarding chemical use within the inventory region.

**Table 12.** Susceptibility and waiver eligibility associated with significant potential contaminant sources in the inventory region for the Town of Bainville PWS wells.

| Source | Contaminant | Map ID Number | Susceptibility | Waiver Eligibility |
|---|---|---|---|---|
| County road | Pesticides, Petroleum hydrocarbons | 1 | Very High | May affect eligibility for VOC waiver |
| Intermittent lake | Pesticides, fertilizers, pathogens, nitrate | 3 | High | May affect eligibility for SOC waivers |
| Gas pipeline | VOCs | 2 | Moderate | May affect eligibility for VOC waiver |
| Oil and Gas Wells | Total dissolved solids, petroleum hydrocarbons | 4 | Moderate | May affect eligibility for VOC waiver |
| Cultivated cropland (including grazing) | Fertilizers, pesticides, pathogens, nitrate | See Figures 8, 9, and 10 | Moderate | May affect eligibility for SOC waivers |
| Burlington Northern Sante Fe Railway | Pesticides, fertilizers, VOCs, SOCs | 5 | Low | May affect eligibility for SOC and VOC waivers |

# REFERENCES


Alden, W.C., 1932. Physiography and Glacial Geology of Eastern Montana and Adjacent Areas, U.S. Geological Survey Professional Paper 174, 133p.

Beekly, A.L., 1912. The Culbertson Lignite Field, Valley County, Montana, U. S. Geological Survey Bulletin 471.

Collier, Arthur J., 1918. Geology of Northeastern Montana, U.S. Geological Survey Professional Paper 120-B, 39p.

Colton, Roger B., 1963. Geologic Map of the Bainville Quadrangle, Roosevelt, Richland, and McCone Counties, Montana, U.S. Geological Survey, Miscellaneous Geologic Investigations, Map I-367. Scale 1:62,500.

Donovan, Joseph J., 1988. Ground-water Geology and High-yield Aquifers of Northeastern Montana, Montana Bureau of Mines and Geology Open-File Report 209,116p.

Freeze, Allan R. and Cherry, John A., 1979. Groundwater, Prentice-Hall, Inc., Englewood Cliffs, N.J., 604p.

Heath, Ralph C., 1984. Ground-water Regions of the United States, U.S. Geological Survey, Water Supply Paper 2242, Washington D.C., 78p.

Hopkins, W.B. and Tilstra, J.R., 1966. Availability of Ground Water from the Alluvium Along the Missouri River in Northeastern Montana, U.S. Geological Survey Hydrologic Investigations Atlas HA-224. Scale 1:96,000.

Montana Department of Environmental Quality, 1999. Montana Source Water Protection Program Document.

Perry, Eugene S., 1934. Geology and Artesian Water Resources Along Missouri and Milk Rivers in Northeastern Montana, Montana Bureau of Mines and Geology, Memoir No. 11, 34p.

Rocky Mountain Association of Geologists, 1972. Geologic Atlas of the Rocky Mountain Region, United States of America, Denver, Colorado, 331p.

Simon, A. et al., 1999, Channel Erosion on the Missouri River, Montana between Fort Peck Dam and the North Dakota Border, U.S. Department of Agriculture, Agricultural research Service, National Sedimentation Laboratory, Oxford, Mississippi, 393p.

U.S. Geological Survey, 2000. National Landcover Dataset, Montana.

# APPENDICES

APPENDIX A

## PWS SITE PLAN

APPENDIX B

# WELL LOG(s)

APPENDIX C

## SANITARY SURVEY

APPENDIX D

## CONCURRENCE LETTER