

**Phillips County / Zortman
Water and Sewer District
Public Water System
PWSID # MT0001623**

*SOURCE WATER DELINEATION AND
ASSESSMENT REPORT*

11/99

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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 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.

Community. A town, neighborhood or area where people live and prosper.

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 does not allow the flow of water, maintaining the pressure of the ground water in the aquifer. The physical properties of a confining unit may range from a five-foot thick clay layer to a shale that is hundreds of feet thick.

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

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

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 ground water flow systems.

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

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 – Ground Water 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). Database system to track entities that discharge wastewater of any type into waters of the State of Montana.

National Pollutant Discharge Elimination System (NPDES). A national database system to track entities that discharge wastewater.

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. Nonpoint sources of pollution, such as the use of herbicides, can concentrate low levels of chemicals into surface and/or ground waters at increased levels that may exceed MCLs.

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

Point-Source. A stationary location or fixed facility from which pollutants are discharged.

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. 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. A source water management region that is generally 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. The Resource Conservation and Recovery Information System (RCRIS) 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 ground water source that provides water to a public water supply.

Source Water Assessment Report. A report for a public water supply that delineates source water protection areas, performs 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 ground water 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.

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.

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.

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 which evaporates readily to the atmosphere.

* Definitions adapted from EPA's Glossary of Selected Terms and Abbreviations
(<http://www.epa.gov/ceisweb1/ceishome/ceisdocs/glossary/glossary.html>)

INTRODUCTION

This Source Water Delineation and Assessment Report was assembled by James Swierc with the DEQ Source Water Protection Program, based partly on a Wellhead Protection Plan previously prepared for the system by Bill O'Connell, Ground Water Technician for Montana Rural Water Systems. Assistance for both of these efforts was provided by John Boland and Rory Schmidt, Operators for the Phillips County/Zortman Water and Sewer District (ID# 1623). Zortman is located in Phillips County, in the southeastern part of the Little Rocky Mountains.

This report is intended to meet the technical requirements for the completion of the delineation and assessment report for the Zortman PWS as required by the Montana Source Water Protection Program and the federal Safe Drinking Water Act (SDWA).

The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to protecting public drinking water supplies from contamination. A major component of the Montana Source Water Protection Program is termed "delineation and assessment". The emphasis of this delineation and assessment report is identifying significant potential contaminant threats to public drinking water sources and providing the information needed to develop a source water protection plan for Zortman.

Delineation is a process whereby areas that contribute water to aquifers or surface waters used for drinking water, called source water protection areas, are identified on a map. Geologic and hydrologic conditions are evaluated to delineate source water protection areas. Assessment involves identifying locations or regions in source water protection areas where contaminants may be generated, stored, or transported, and then determining the potential for contamination of drinking water by these sources.

Delineation and assessment is the foundation of source water protection plans, the mechanism Zortman can use to protect their drinking water source. Although voluntary, source water protection plans are the ultimate focus of source water delineation and assessment. This delineation and assessment report is written to encourage and facilitate the Zortman operator and the local community to complete a source water protection plan that meets their specific needs.

Limitations

This report was prepared to assess threats to the Zortman 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 Zortman public water supply 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 Zortman 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 be significant health threats.

CHAPTER 1

BACKGROUND

The Community

The unincorporated community of Zortman is located in the southeastern part of the Little Rocky Mountains, near the southern boundary of the Fort Belknap Indian Reservation ([Figure 1](#)). The Zortman PWS serves an estimated 74 people through 36 active service connections. The residents are predominantly retired workers (and their families) from the Zortman-Landusky mines which operated in the area until approximately 1996. No major US or Montana State highways run through Zortman; although there is one road through town, with two access roads connecting to US Highway 191 southeast of Zortman ([Figure 1](#)).

Wastewater from homes in the community is treated by individual septic systems.

Geographic setting

Zortman is located in the southeastern part of the Little Rocky Mountains as depicted in [Figure 1](#). The elevation of the town is approximately 4,000 feet above sea level. One of the highest points in the Little Rocky Mountains, Old Scraggy Peak at an elevation of 5,708 feet above sea level, is located approximately 7,000 feet north of the Zortman town area. The major drainage through town is Ruby Gulch, which is a mining impacted stream that drains a portion of the former Zortman mine. Ruby Gulch is an ephemeral stream that flows in a general southeastern direction through town. Alder Gulch, which drains the southern part of the mine complex, is an ephemeral stream that flows in a general eastward direction south of town, where it joins with the Ruby Gulch drainage ([Figure 1](#)).

The climate in the area reflects the orographic effects of the Little Rocky Mountains on the arid plains of north central Montana. Zortman gets an average of 18.61 inches of precipitation annually, with the wettest months in May and June averaging 3.09 and 3.74 inches monthly. The driest months are November and February, with respective averages of 0.44 and 0.52 inches per month. The temperature ranges from an average high of 79.1° F in August (minimum August average of 49.9° F) to an average of 30.8° F in January (minimum January average of 8.1° F).

General description of the Source Water

The Zortman PWS obtains water from two wells installed in a confined bedrock aquifer in the Mission Canyon Member of the Madison Limestone. The wells are located adjacent to each other approximately one mile east of the town. The wells draw water from about 700 feet below the ground surface. An additional well proposed for use with the PWS is located east of town, and also installed into the Madison. The well proposed for the PWS was originally installed as a monitoring well. The well was part of a monitoring well network designed to evaluate the impacts of mining activities on water in the Madison aquifer in the Zortman area south of the mine complex. The ground water flow direction in the Mission Canyon Member of the Madison Limestone in this area is not well understood since the aquifer has been tectonically deformed in the area and comprises a karst fracture flow system in limestone.

The Public Water Supply

The Zortman PWS currently serves an estimated population of 74 with 36 active service connections. Both wells are located in the same area east of town, as shown in [Figure 1](#). The wells were installed outside of the Ruby Gulch drainage as a protective measure against the potential impacts to local ground water quality from the Zortman mine complex. Ground water quality in the immediate vicinity of the mine has been impacted by various mining activities, including the effects of acid-rock drainage on exposed sulfide ore materials.

The primary well (Source 002) for the Zortman PWS is an 8-inch well installed in 1983. The backup well (Source 003) is a 6-inch well installed in 1978. Both wells were installed to an approximate depth of 740 feet, with steel casing to 394 feet. The primary well pumps at approximately 65 gpm, while the backup well has a pump capable of delivering approximately 20 gpm. There is currently no treatment to the water. From the sources, the water is pumped into two storage tanks located southwest of Zortman, a 20,000 gallon fiberglass storage tank and a 17,000 gallon steel tank. Water from the tanks is fed by gravity to the users through a distribution system constructed primarily of PVC pipe. During recent years, the system has experienced a significant loss of water due to leakage from the distribution system. A general plan showing the layout of this system is included with the most recent sanitary survey presented in Appendix A.

The Zortman PWS wells also supply water to the Camp Creek Water Users Association, with a 30,000 gallon storage reservoir located east of the wells, and to the BLM Camp Creek Campground and Picnic Area. BLM has indicated a plan to install a new well at the campground; however, the status of this has not been determined at this time.

Water Quality

Every PWS is required to perform monitoring for contamination of the water supply. The monitoring constituents include coliforms and other signs of pathogenic organism, nitrates, metals, and multiple 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. A review of the DEQ PWS database indicates that monitoring results for the Zortman PWS show no violations or exceedences of any drinking water quality standards.

The ground water in the Madison Limestone in the Zortman area has been extensively characterized from the studies associated with the Zortman mining activities (WMI, 1998a; WMI, 1998b). Copies of the data results from several sampling events are included in Appendix B, with selected data listed in Table 1. The Madison ground water in the Zortman area is a calcium bicarbonate type, with generally low concentrations of dissolved constituents. This water is generally acceptable for all uses, including use as a drinking water supply source. The data listed in Table 1 is considered representative of background water quality conditions for the Madison Limestone in the Zortman area.

Table 1 – Averaged 1997 Water Quality in the Madison Limestone in the Zortman Area*

Sample		Cond	pH	Temp	TDS	Hardness	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	F	NO ₃
Location	Description					As CaCO ₃										
		μ S/cm	SU	° C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Mg/L
Z-8A	Zortman Main PWS Well	407	7.6	10.6	267	231	67	16	4	2	221	0	44	< 1.0	0.56	0.27
ZL-312	Located North of Zortman Town	580	7.4	8.4	375	239	66	18	26	5	256	0	105	2	1.49	< 0.01
ZL-323	Proposed New PWS Well	393	7.7	7.4	264	201	62	11	8	1	166	0	69	1	1.01	0.30

* The results represent the average results from multiple sampling events in 1997

CHAPTER 2

DELINEATION

The source water protection area, the land area that contributes water to the Zortman PWS, is identified in this chapter. Three management areas are identified within the source water protection area. These three regions are the control zone, inventory region, and recharge region. The control zone, also known as the exclusion zone, is an area at least 100-foot radius around the well. The inventory region for the confined aquifer represents an area of a 1,000 foot radius around each wellhead. The recharge region represents the area where the aquifer is replenished.

Hydrogeologic Conditions

Geologic and hydrogeologic studies of the Little Rocky Mountains and the Zortman area are listed in Table 2. The hydrogeologic system in the Zortman mine area, including the Zortman townsite, has been evaluated in detail as part of the proposed mine expansion (WMI, 1998a), and more recently, for the reclamation process for mine closure. The following description of the local hydrogeology is adapted from the sources listed in Table 2.

A Tertiary igneous intrusive body that forms the core of the mountains defines the geology of the Little Rocky Mountains (Alverson, 1965; Feltis, 1983). Sedimentary formations were folded over the intrusion, and are present in outcrops of decreasing age with increasing distance away from the mountains. The central part of the mountains comprises the Tertiary intrusive body. A geologic map that depicts the different rock types in the area is presented in [Figure 2](#). A geologic cross section depicting the general relationship of the sedimentary formations to the intrusive body is shown in [Figure 3](#). The drainage system from the mountains has incised valleys with deposits of coarse-grained alluvium, which can potentially be developed as local water sources. Glacial activity which covered portions of Montana during recent geologic times only effected the northern part of the mountains, and did not include the Zortman area (Alden, 1932).

The ground water system in the mountains is characterized as a fracture flow system through the Tertiary intrusive bedrock (WMI, 1998a), with streams gaining flow with decreasing elevation as they flow away from the core of the mountains. The streams lose water when they flow from bedrock onto alluvial surfaces where the stream water recharges the shallow alluvial systems. Recharge to the system occurs from precipitation and infiltration in the upper elevations of the mountains.

The Madison Limestone is a regional aquifer that is developed at various locations across central Montana. The nature of the Madison as a regional aquifer is evaluated in detail in Feltis (1983), and the following discussion is adapted from this source. The area near the Little Rocky Mountains represents a regional discharge point for the Madison, with several warm springs from Madison sources located south and east of the mountains (Big Warm Springs, Little Warm Springs, and The Plunge). Regionally, the water in the Madison reflects thermal heating and contains elevated levels of dissolved solids, and would not be a good source for drinking water. In the Little Rocky Mountains, the Madison is recharged locally from the bedrock source that feeds the shallow ground water system in the central part of the

mountains. The nature of mixing of water in the Madison from the local and regional systems is not well understood; however, the water quality in the Madison near Zortman (Table 1) reflects local recharge, and not water quality in the regional system.

The ground water flow direction in the Madison aquifer near Zortman is considered to flow away from the mining areas in a general south to northeastern direction. The dynamics of the interaction of the regional Madison aquifer systems with the locally recharged system are not well understood. However, water quality from the wells in the Madison in the Zortman area reflect local recharge, suggesting that flow is away from the higher elevation areas where the majority of recharge occurs in the central parts of the mountains (see Appendix B). The area immediately north of PWS wells and the Zortman Town near Old Scraggy Peak was not included with the mine complex, and may represent the primary recharge area for the local system.

In the Zortman area including the location of the PWS wells, the Madison is considered a confined aquifer; although it is a shallow, fractured carbonate aquifer. This classification is based on the presence of approximately 250 feet of shale overlying the Madison at the location of the PWS wells (see well log in Appendix C). However, system could be considered unconfined or semi-confined at locations near the Zortman area, based on varying levels of the potentiometric surface. Based on this hydrogeologic setting, the aquifer is classified as having a high source water sensitivity to contamination.

Table 2. List of geologic or hydrogeologic investigations near Zortman and the Little Rocky Mountains.

Title of Project	Reference Information	Area Covered	Maps	Project Purpose
Physiography and Glacial Geology of Eastern Montana and adjacent areas	Alden, W.C., 1932 U.S. Geological Survey Professional Paper 174	Eastern Montana	Various maps of glacier positions and deposits	Document the regional glacial history and related deposits.
Geology and Hydrology of the Fort Belknap Indian Reservation, MT	Alverson, D.C., 1965 U.S. Geological Survey Water Supply Paper 1576-F	Fort Belknap Reservation and Little Rocky Mountains	Detailed Geologic Map of Little Rocky Mountains	Characterize water resources of Fort Belknap Reservation
Ground-Water Resources of the Fort Belknap Indian Reservation	Feltis, R.D., 1983 Montana Bureau of Mines and Geology Memoir 53	Fort Belknap Reservation and Little Rocky Mountains	Regional Potentiometric Surface of Madison Limestone and others	Characterize water resources of Fort Belknap Reservation
1997 Annual Groundwater Monitoring Report*	Water Management Consultants (WMI), 1998	Zortman and Landusky Mines and Adjacent Areas	Various	Summarize results of ground water monitoring
Zortman/Landusky Project, Draft Summary Report for the Groundwater Investigation*	Water Management Consultants (WMI), 1998	Zortman and Landusky Mines and Adjacent Areas; and the Southern Part of the Fort Belknap Reservation	Potentiometric surface within bedrock core of Little Rocky Mountains Geologic Map of mining areas, and others	Evaluate the impacts of mining activities to regional ground water resources, including the Fort Belknap Reservation

** Reports by Water Management Consultants are present in DEQ files, and not publicly available*

Conceptual Model and Assumptions

A conceptual hydrogeologic model is a simplified representation of the hydrogeologic system. For the Zortman area, the ground water occurs in the Madison Limestone several hundred feet below the surface. Recharge to the Madison Limestone in this area is believed to occur from infiltration of precipitation and other forms of surface water in the Little Rocky Mountains near the PWS well locations. The flow direction would generally be radially outward from the central part of the mountains; however the development of karst secondary porosity as the primary porosity in the limestone suggests that the major component of flow would follow the trend of the formation to the northeast. A schematic cross section depicting the general relationship of the Madison Limestone to the Little Rocky Mountains, and the effects on the ground water flow system within the Madison, is included in [Figure 3](#).

Well Information

The two source wells for the Zortman PWS are located east of town as depicted in [Figure 1](#). The additional well proposed for the PWS is located west of town. Copies of the well logs are included in Appendix C, with a summary of well information listed in Table 3. Both existing source wells are cased to the same depth and are completed as an open hole to the total depth of the well. The proposed new well (ZL-323) was originally constructed as a monitoring well for the Zortman mine located north of town.

Table 3. Source well information for Zortman PWS.

Information	Well 1 "South Big Well"	Well 2 "North Small Well"	Proposed Well ZL-323
PWS Source Code	002	003	--
Well Location (T, R, Sec or lat, long)	T25N, R25E, Section 16 DDCC	T25N, R25E, Section 16 DDCC	T25N, R25E, Section 17 DCD
MBMG #	37718	--	163885
Water Right #	GO53271	GO31281	--
Date Well Completed	August 1983	1978	7/13/97
Total Depth	740 feet	740 feet	560.7
Perforated Interval	Open hole below 394'	Open hole below 394'	520.1 – 560.7 feet
Static Water Level	547 feet	--	474.4 to 491.8 feet*
Pumping Water Level	584 feet	--	--
Drawdown	37 feet	--	--
Test Pumping Rate	106 gpm	--	--
Specific Capacity	3.0 gpm/foot	--	--

* variance reflects multiple measurements during 1997

Methods and Criteria

The methods and criteria used to delineate the source water protection zones for the Zortman water system are specified in the Montana Department of Environmental Quality Source Water Protection Program (DEQ, 1999). For the Zortman system, the criteria for confined systems were followed for the wells. This incorporates using a fixed radius to identify the control and inventory zones around each well. The inventory zones for the Zortman wells defined by these criteria, a 100-foot radius for the control zone and a 1,000-foot radius for the inventory zone, are depicted in [Figure 4](#). The recharge area is identified using available geologic maps ([Figure 3](#)).

Madison Aquifer Property Tests

As part of the investigation of the ground water system for the Zortman Mine, aquifer tests were conducted on existing monitoring wells. This data is included here to demonstrate the variability of the aquifer properties in the area. The tests were performed by adding a known volume of water to the wells, and measuring the rate the water flowed into the aquifer. The results from two tests on ZL-312, located north of Zortman, indicated hydraulic conductivity values of 0.02 ft/day and 0.11 ft/day, with associated transmissivities of 3.05 ft²/day and 15.1 ft²/day, respectively. The results of a single test on ZL-323 indicated a hydraulic conductivity of 0.032 ft/day and a transmissivity of 21.8 ft²/day. For the Little Rocky Mountains, data from 16 test on the Madison are reported. The determined hydraulic conductivities range from 0.0001 ft/day to 1,750 ft/day. This variability is typical for a limestone aquifer with fracture and karst porosity.

Ground Water Flow Rates and Time of Travel

Time of travel calculations were not completed for the Madison Limestone aquifer source for the Zortman PWS. The complex geology associated with the aquifer setting, and the nature of ground water flow in limestone aquifers in general make assumptions regarding flow rates difficult to assess without data collected from a program designed specifically for this purpose. While there has been extensive work regarding ground water flow in the area, the work has focused on the impacted mining areas and not specifically on the Madison Limestone aquifer in the Zortman area.

Recharge Area

The recharge area is considered to be the central part of the Little Rocky Mountains north of Zortman. This includes the area in the town, and other areas where the igneous bedrock is exposed (see geologic map in [Figure 3](#)). The Camp Creek watershed immediately north of the PWS wells is shown on [Figure 4](#); however, the significance of this area relating to recharge of the Madison aquifer is not known.

Limiting Factors

The use of a fixed-radius approach to delineate the inventory zones around the confined aquifer helps ensure that uncertainties in ground water flow directions are accounted for in completing the inventory of potential contaminant sources. However, the long-term nature of the dynamics of the hydrologic

system suggest that complex flow paths may increase the susceptibility of the aquifer to contamination from potential contaminant sources identified outside the delineated inventory zones.

CHAPTER 3

INVENTORY

Potential sources of contamination were inventoried for the Zortman PWS within the control and inventory regions. Potential sources of all primary drinking water contaminants and Cryptosporidium were identified, however, only significant potential contaminant sources were selected for detailed inventory. The significant potential contaminants in the Zortman PWS inventory region are nitrates and pathogens from a limited number of septic systems and agriculture; and herbicides and pesticides used in the area.

The inventory for the Zortman PWS focuses on all activities in the control zone, certain sites or land use activities in the inventory region, and general land uses and large facilities in the recharge region.

Inventory Method

The primary inventory method represents a "windshield survey" of the Zortman Town and surrounding area. The search was conducted to identify any businesses that can represent potential contaminant sources under "worst-case" conditions. No sources were identified within the inventory zone. The following sites were identified as potential sources.

- ▶ Buckhorn Store, with one above ground tanks for petroleum products.
- ▶ The Zortman Garage, which may have oils, waste oils, cleaning solvents, and a UST.
- ▶ The Camp Creek Campground, with septic systems for wastewater treatment.
- ▶ The Bureau of Land Management facility recently constructed east of Zortman. The BLM office has a septic system and drain field for wastewater treatment/disposal; and a well to supply water to the facility.

Urban and agricultural land uses were identified from the University of Montana GAP landuse analysis project (Redmond et. al., 1998). This information is depicted in [Figure 5](#).

Septic system density was evaluated using census block population data, reflecting a septic system density of 2.6 persons per septic system.

EPA's Envirofacts System 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), Permit Compliance System (PCS) and Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS). No facilities were identified using this database.

DEQ Databases were queried to identify the following in the inventory region: Underground Storage Tanks (UST), hazardous waste contaminated sites (DEQ hazardous waste site cleanup bureau), landfills, abandoned mines, and active mines including gravel pits. Any information on past releases and present compliance status was noted.

- ▶ No active UST sites were identified in the Zortman area; although the windshield survey has indicated that USTs are present at the Zortman Garage.
- ▶ The Zortman solid waste transfer station (collection site) was identified south of the Zortman town site.
- ▶ The following Leaking UST (LUST) Sites were identified. None of the sites are located within the inventory zones for the wells.

Zortman Area Leaking Underground Storage Tank (LUST) Sites

<i>Name</i>	<i>Address</i>	<i>Facility ID</i>	<i>Leak #</i>	<i>Confirmed Release Date</i>	<i>Cleanup Completion Date</i>	<i>Ground Water Impacts / Comments</i>
Zortman Mine	<i>3 1/2 mile north of mine access road</i>	36-02281	881	9/9/91	4/26/95	Release of unknown amount of gasoline
BLM – Zortman Work Center	<i>West of Zortman</i>	36-13322	2410	10/25/94	--	Small release of pentachlorophenol

- ▶ The Zortman gold mine and associated facilities were identified. The mine is located northwest of the townsite, away from the identified Inventory Zone

The major road through the town was identified, and is indicated on [Figure 6](#), with the other identified potential contaminant sources.

All wells located within the inventory region were identified and well logs were obtained when available. Based on the well summary, no wells are present within the inventory zones installed into the source aquifer for the Zortman PWS.

The following summarizes the results of the inventory for the Zortman area. There are no potential contaminant sources identified within the control zone for the Zortman PWS wells, including the well proposed for PWS use. The potential contaminants are listed in Table 4, with a description of the potential release mechanism for the site. Inventory sheets for these properties are included in Appendix E. In all cases, releases may occur due to unavoidable conditions such as flooding, lightning or fire. The sites where a disaster represents the primary potential release mechanism are identified as such. For sites

where other release mechanisms may be more common, the potential for a release from a disaster is assumed.

Table 4. Summary of Inventory Results for Zortman PWS Inventory Zone.

<i>ID#</i>	<i>Source</i>	<i>Potential Contaminants</i>	<i>Description/Concern</i>
1	Septic Systems	Pathogens and Nitrates	Non-point source pollution, loading of ground water system with effluent
2	Agricultural Land Use	Pathogens and Nitrates; Pesticides and Herbicides	Non-point source pollution, concentration of fertilizers/chemicals in surface/ground water
3	Zortman Garage (USTs)	Petroleum Hydrocarbons	Leakage/infiltration into water source
4	LUST Sites	Petroleum Hydrocarbons	Leakage/infiltration into water source
5	Mining Areas	Metals, Cyanide, Nitrates	Migration of impacted water into source aquifer
6	Above Ground Petroleum Tanks	Petroleum Hydrocarbons	Natural Disaster or accident – spill/release of chemicals from tanks
7	Zortman Solid Waste Transfer Station	Various Chemicals	Leakage from material collected for landfill disposal
8	BLM Facility	Pathogens and Nitrates; various chemicals	Septic System as a contaminant source; a spill/release of chemicals stored at facility
9	Main Access Highway	Spills of various chemicals	Natural Disaster or accident – spill/release of chemicals transported on highway

Inventory Results, Recharge Area

The recharge area where the source aquifer is replenished has the greatest potential contaminant sources present. This represents the areas impacted by mining at the closed Zortman mine, and the potential

effects of acid-rock drainage to the ground water system. Impacts to ground water quality from mining operations in the area have been documented, however the long-term fate of these waters is not understood at this time. Monitoring of ground water quality will continue as part of the ongoing reclamation process for the mine. Additional potential sources include septic systems in the area, agricultural land use, LUST sites and the above ground petroleum tanks in Zortman.

Inventory Update

The certified operator for the Zortman PWS will update the inventory every year. Changes in land use or potential contaminant sources will be noted and additions made as needed. The complete inventory will be submitted to DEQ every five years to ensure re-certification of the source water delineation and assessment report.

Inventory Limitations

The inventory is limited by the accuracy of information in databases used for the assessment. The windshield survey provides a level of quality assurance that the information presented reflects current conditions at the time of preparation of this report.

Considerations for New Well from Zortman Mining

The new well that may be included in the system, ZL-323, does not have any potential contaminant sources located within the delineated management zones for the well. However, the location west of Zortman is closer to the impacted mining areas and may be recharged from different areas than the existing PWS wells.

CHAPTER 4

SUSCEPTIBILITY ASSESSMENT

Susceptibility is the potential for a public water supply to draw water contaminated 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 Zortman PWS.

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 no more than 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. Management approaches that could be pursued by the Zortman PWS 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 Zortman PWS wells (Table 5). Hazard for confined aquifers is low if all wells in the inventory region are constructed to current state standards. Hazard is high if the PWS well is not sealed into the confining layer and moderate if only other wells are not properly constructed. Susceptibility ratings are presented individually for each significant potential contaminant source and each associated contaminant (Table 6). The susceptibility of each well to each potential contaminant source is assessed separately. 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 Zortman PWS wells (Table 6).

Table 5. Relative susceptibility to specific contaminant sources as determined by hazard and the presence of 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

A query of the MBMG-GWIC database indicated no wells installed to depths similar to the Zortman PWS wells potentially present in the inventory zone. For purposes of the susceptibility assessment, the construction protocols of the PWS wells for the Zortman system need to be evaluated. The most recent sanitary survey (see Appendix A) suggests that the two active PWS wells are not properly constructed with adequate seals to prevent surface water intrusion. Based on this assumption, the relative hazard assigned for all point sources of potential contamination in the inventory zone is **high**. All point sources of potential contamination located outside of the inventory zone are assigned a relative hazard of **moderate**.

The Zortman PWS is currently scheduled for an update of the water system for sometime in the Fall of 2000. At this time, an inspection of the wells may indicate that the seals are adequate, and the relative hazards for the identified potentially contaminant sources may be adjusted as follows. When completed, a copy of the most recent sanitary survey will be appended to this report.

The seal around the proposed new PWS well, ZL-323, is assumed to be properly constructed. Should any point sources of potential contamination be present within the inventory zone for this well, the relative hazard would be considered **low**, and any other sources outside the inventory zone would have a **very low** relative hazard.

The relative hazard for non-point potential contaminant sources are based on criteria for septic systems in the DEQ Source Water Protection Program (DEQ, 1999). For septic systems, the low population density results in a **low** relative hazard. Agricultural land use in the area is classified as a **low** relative hazard.

Should a release of a contaminant occur, a primary barrier for all of the potential contaminant sources is the clay-rich soils in the area, and the depth to ground water in the Madison Aquifer in the Zortman area. These soils can inhibit migration of any released potential contaminants into the subsurface. The depth to the aquifer decreases quickly north of town, and no barriers are present for the impacted waters of the mined areas. This classification reflects the dynamics of the flow system, and the documented impacts to water in the area.

The results of the susceptibility assessment indicate that the Zortman PWS wells are potentially susceptible to a spill or leak from the surface in the area near the wellheads. This greatest hazard is classified as spill from the highway access route into town, over which petroleum hydrocarbons are transported into the Zortman area.

The potential impacts of mining to the system represent a long-term threat, where impacts may not be seen for many years. Continued monitoring of water quality associated with reclamation activities at the Zortman mine may help reduce the potential for contamination of the water supplied to residents.

Table 6. Susceptibility assessment for significant potential contaminant sources in the Control Zone and Inventory Region.

Source	Contaminant	Hazard	Hazard Rating	Barriers	Susceptibility	Management
Septic Systems	Pathogens and Nitrates	Leak	Low	Clay-rich soils, depth to water	Very Low	Properly maintain septic systems
Agricultural Land Use	Pesticides and herbicides; Nitrates	Non-point source, concentration	Low	Clay-rich soils, depth to water	Very Low	Educate community on BMPs for agriculture
USTs (Zortman Garage)	Petroleum Hydrocarbons	Infiltration to ground water	Moderate	Clay-rich soils, depth to water	Low	Close USTs and monitor closure
LUST Sites	Petroleum Hydrocarbons	Infiltration to ground water	Moderate	Clay-rich soils, depth to water	Low	Closed Sites
Mining Areas	Metals, Cyanide and Nitrates	Migration of impacted waters to source aquifer	Moderate	None	High	Review progress of mine reclamation, and ground water monitoring results
Above Ground Petroleum Tanks	Petroleum Hydrocarbons	Spill or release	Moderate	Clay-rich soils, depth to water	Low	BMPs when transferring chemicals
Zortman Solid Waste Transfer Station	Various	Infiltration to ground water	Moderate	Clay-rich soils, depth to water	Low	Monitor waste placed into landfill
Bureau of Land Management Offices/Facility	Various	Infiltration to ground water	Low	Clay-rich soils, depth to water	Very Low	Coordinate with BLM managers on BMPs for facility
Main Highway Access Route	Various	Spill	High	Clay-rich soils	High	Develop emergency response protocols

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