

SOURCE WATER DELINEATION AND ASSESSMENT REPORT

11/99

Cardwell School
Public Water System
Jefferson County

PWSID # MT0001398

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INTRODUCTION

This report is intended to meet the technical requirements for the completion of the Source Water Delineation and Assessment for the Cardwell School Public Water Supply System (PWSID# 01398) as required by the Montana Source Water Protection Program and the federal Safe Drinking Water Act (SDWA). The Source Water Delineation and Assessment Report (SWDAR) for the Cardwell School was completed by Karen LaClair and Chad Walby, MSU undergraduate students, and Dr. Steve Custer Associate Professor of Geology, MSU - Bozeman. Information on the well and public water supply comes from published sources, individuals familiar with the public water supply, and a sanitary survey completed in January of 2001 by The Cadmus Group, Inc of Helena Montana (available from DEQ upon request).

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 to identify significant potential contaminant threats to public drinking water sources and provide the information needed to develop a source water protection plan for Cardwell School.

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 in order 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 Cardwell School 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 Cardwell School water operator and the community to complete a source water protection plan that meets their specific needs.

CHAPTER 1

BACKGROUND

The Community

Cardwell School is considered a non-transient non-community public water supply system because it regularly serves at least 25 of the same persons for more than six but less than twelve months per year. The school is located in Cardwell, Montana. Cardwell is an unincorporated town in Jefferson County located 1 mile south of Interstate 90 on Montana Highway 359 approximately 10 miles Southeast of Whitehall and 19 miles Northwest of Willow Creek (Appendix A, [Figure 1](#)). The legal location of the school is SW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ section 10, Township 1 North, Range 3 West (Appendix A, [Figure 2](#)).

The population of Jefferson County was estimated at 10,405 in 2001. Approximately 40 residents live in Cardwell (2000 Census). Wholesale and Retail trade form the economic base in Jefferson County. Health care and social assistance and accommodation and foodservices sectors are also important according to the 1997 Economic Census. Mining and agriculture contribute significantly as well.

Cardwell is not served by a sanitary sewer system. Each structure in Cardwell is served by an on-site septic system. [Figure 3](#), Appendix A, depicts the location of the septic tanks and leach fields relative to the school well.

Geographic Setting

Cardwell is located in the Jefferson River Valley a north-northeast-trending intermontane basin in southwestern Montana. The basin is bounded by the Highland Mountains on the west, the Continental Divide on the northwest, Bull Mountain on the north, the London Hills on the northeast, and the Tobacco Root Mountains on the east. The Jefferson River Valley ranges in altitude from approximately 4,300 to 5,800 feet (Kendy & Tresch, 1996). Cardwell lies in the eastern basin margin where the Jefferson River bends to the east at an elevation of 4,280 feet. The Jefferson Slough flows immediately to the north of Cardwell and the Main Stem of the Jefferson River immediately to the south (Appendix A, [Figure 2](#)). Cardwell is in the Jefferson River Watershed. The designated hydrologic unit code for this watershed is 10020005.

The average high and low temperatures in the Cardwell vicinity are 30° F and 8° F for January and 81° F and 45° F for July. The climate in the Cardwell vicinity is semi-arid with precipitation averaging 10 - 12 inches annually concentrated in the months of May and June. Snowfall averages 51 - 60 inches annually (Caprio & Neilson, 1992).

Soil underlying the Cardwell School is classified as Meadowcreek Silty Clay Loam, 0% to 2 % slope. Meadowcreek Silty Clay Loam is found on floodplains, drainage ways, and terraces. It is moderately susceptible to erosion. This type of soil is subirrigated and considered prime farmland if irrigated. Recent alluvium underlies the Meadowcreek Silty Clay Loam (USDA NRCS, 2001).

General Source Water Description

The Cardwell School PWS is supplied by groundwater. The aquifer is the Jefferson River Quaternary alluvium. The Jefferson alluvium is characterized by sediment derived from materials in upland and upstream areas from which it was formed. Area well logs indicate sands, coarse sands, gravels, and various clay layers (MBMG GWIC, 2002). Groundwater of the alluvium flows east parallel to the flow of the Jefferson River (Kendy & Tresch, 1996). Recharge to the aquifer is expected to be mainly from loss of river water to the alluvium. Small amounts of recharge may come from the underlying Tertiary Sedimentary aquifer, but the magnitude of transmission relative to that within the alluvium is expected to be quite small.

Aquifer characteristics are used to assess the overall sensitivity of the aquifer to potential contamination. According to the Montana Source Water Protection criteria, an aquifer consisting of unconsolidated alluvium that is unconfined is rated as highly sensitive to potential sources of contamination. Semi-consolidated and consolidated bedrock aquifers are considered to have a low sensitivity to potential contamination (Montana DEQ, 2000, Table 2). The Jefferson alluvium is unconsolidated and unconfined and therefore has a high sensitivity to potential contamination.

Public Water Supply

The Cardwell School PWS is supplied by one well (source 002). The well serves approximately 45 individuals in winter through one active service connection and is occasionally used during the summer (Appendix D). Total daily water demand in the winter is approximately 1125 gallon. This number was arrived at by multiplying the number served by 25 gallons per day per person, the average daily demand estimated by the EPA for a day school with cafeteria, gymnasium, and showers (1991).

According to the most recent sanitary survey on file at the DEQ water is pumped from the six-inch steel cased well located near the front steps of the school (see Appendix B for site plan diagrams). The well log on file at the Montana Bureau of Mines and Geology Ground Water Information Center does not provide well construction information (see Appendix C for well log). A shallow well centrifugal suction pump forces water through a Chem-Tech model 100/024 chlorinator and delivers it to a 300-gallon vertical hydropneumatic pressure tank located in the basement and then to service throughout the school. A complete copy of the sanitary survey is in Appendix D.

Water Quality

The Cardwell School PWS is routinely monitored for compliance with drinking water standards. Bacteriological monitoring occurs monthly. Compliance with other drinking water standards is based on additional sampling on a variety of schedules depending on system classification and population served. Nitrate can come from human or animal wastes but also occurs naturally. The highest level of nitrate-nitrogen detected in the Cardwell School well in the last five years was 0.14 mg/l. The U.S. Environmental Protection Agency standard for maximum allowable nitrates is 10 mg/l. The Cardwell School PWS has tested free of bacteria for the last five years (DEQ, BAC-T, 2001).

The Jefferson River water is a calcium bicarbonate type with an average dissolved-solids concentration of 213 mg/L. Water quality was determined on the basis of 253 samples taken near Twin Bridges. A reconnaissance survey of arsenic in the upper Missouri River basin reports values below the maximum contaminant level of 50 µg/L for samples taken from the Jefferson River near Three Forks and from Big Pipestone Creek at Whitehall

(Kendy & Tresch, 1996).

Water from flood-plain alluvium is a calcium bicarbonate type in general with a dissolved-solids concentration of less than 250 mg/L (Kendy & Tresch, 1996). There is no water quality data available for the Jefferson River alluvium in the Cardwell vicinity. Characterization of other aquifers in the Cardwell area are available from Kendy & Tresch (1996).

CHAPTER 2 DELINEATION

All source water protection areas for the Cardwell School well were delineated as required for non-transient, non-community public water supplies under the Montana Source Water Protection Program (DEQ, 1999). A 100-foot radius control zone was delineated for the Cardwell School (Appendix A, [Figure 3](#)). The control zone is the most critical area within which direct introduction of contaminants into the well or immediate area can occur. An inventory region using a 1-mile fixed radius was delineated for the school well (Appendix A, [Figure 4](#)). The Inventory Region encompasses the area from which water or contaminants can flow to the well over a period of months to years. The recharge region (Appendix A, [Figure 6](#)) was delineated using hydrogeologic mapping. This region encompasses the area contributing recharge water to groundwater that may flow to a drinking water supply over long time periods or under a higher pumping rate. The area contributing recharge includes the Jefferson River alluvium for 10 miles upstream of Cardwell and the Boulder River alluvium also for 10 miles upstream of Cardwell.

Hydrogeologic Conditions

Land surface elevation decreases towards the Jefferson River from the north and the south. Groundwater flow direction in the Cardwell vicinity is generally eastward along the river (Kendy & Tresch, 1996).

There are three aquifers in the Cardwell area. Wells closer to the Jefferson River appear to be completed in an unconsolidated Quaternary alluvial aquifer. This shallow unconfined aquifer is composed of silt, sand, and gravel deposits. Wells installed farther away from the river to the north-west, west, and south appear to be completed in the undifferentiated Tertiary sedimentary aquifer. This is a deeper aquifer found in discontinuous river sized channels of mostly poorly consolidated gravels and sands located throughout the formation. The Tertiary sediments belong to the dominantly fine-grained Renova Formation and the overlying coarse-grained Sixmile Creek Formation of the Bozeman Group (Kendy & Tresch, 1996). The Tertiary sediments are composed of clastic deposits and include mostly poorly consolidated gravels, sands, silts, and clays and local lenses of lignite and bentonite. To the south-west and east wells are completed in the North Boulder Group of the Belt Series. This group includes greenish-grey conglomerate at base, with arkose conglomerate, and sandy and silty strata above, and locally includes strata resembling the Greyson and Spokane shales (Ross, et. al., 1955). The Cardwell area geology can be summarized as Tertiary-Quaternary valley fill overlying Precambrian to Tertiary sediment, Tertiary volcanic bedrock, and Cretaceous intrusive rocks.

Cardwell is located in the southern corner of the Southwest Montana Transverse Fault Zone. It is a geologically complex area. The attitude of bedding under Cardwell is not directly known. North of Cardwell the strike is generally 190 degrees and dip is between 32 and 75 degrees to the west. See Appendix A, [Figure 7](#) and [Figure 8](#) for geologic maps of the Cardwell area. Kendy & Tresch (1996) further describes the geology of the Jefferson River Valley.

Reports from projects in the Cardwell area may provide additional information on hydrogeologic conditions. A list of projects is provided in Table 1. Geologic and Hydrogeologic maps available for the area are listed in Table 2.

Table 1. Geologic or hydrogeologic investigations near the Cardwell area.

Title of Project	Period of Project	Area Covered	Project Purpose
Environmental Assessment and Characterization of the Boulder River Watershed	1997-2001	Boulder River basin, Montana	Design and implement a reliable strategy that will supply the scientific information needed to develop effective and cost-efficient remediation of abandoned mine lands.

Table 2. Geologic or hydrogeologic maps available for the Cardwell area.

Title or Description	Date	Area Covered	Reference
Bozeman Quadrangle Geologic Field Map	1996	Bozeman 30x60 Quadrangle	Vuke, S.M., et al., 1996
Geologic Map of Montana	1955	Entire state	Ross, C. P., et. al., 1955

Conceptual Model and Assumptions

There are three aquifers in the Cardwell area. The shallow unconfined Quaternary alluvial aquifer is composed of silt, sand, and gravel deposits. A deeper Tertiary sedimentary aquifer is found in discontinuous river sized channels of mostly poorly consolidated gravels and sands located throughout the formation. A review of well logs reveals that much of the top 100 feet contains many clay and claystone layers some of which appear to be continuous, specifically a soft brown clay layer between 5 and 11 feet and a medium hard brown claystone layer between 50 and 87 feet. The aquifer of the North Boulder Group of the Belt Series is found in sandy and silty strata. Strata resembling the Greyson and Spokane shales is the local composition of the North Boulder Group (Ross, et.al., 1955). A review of well logs in the vicinity reveals layers mostly of sand, gravel, and mixes and variants of these (MBMG GWIC, 2002).

Recharge to the Jefferson River alluvium most likely comes from river water loss to the aquifer. Well level fluctuations and basement flooding at the school coincident with the rise and fall of river water indicates a surface water-groundwater interaction between the river and the aquifer. Additional recharge may come from the Tertiary sedimentary aquifer, but the small magnitude of transmission relative to that within the alluvium suggests a small contribution. Additionally, clay layers within the alluvium indicated in well logs likely isolate the Tertiary sediments from the overlying alluvium.

Well Information

Groundwater is supplied to the Cardwell school by one well (Appendix B). The well is located on the Cardwell School property near the front entrance of the school building. The completion date of the well is in question. The sanitary survey reports it was completed in 1911. According the well log it was completed in 1918. The operator could not corroborate either date, but said the school was built in approximately 1914. The well depth is 35 feet below ground surface. It has a 4-inch diameter casing. There is no other information available about the well construction. The well is completed in a recent alluvial aquifer. See Table 3 for additional well information. Based on this information, the Cardwell School well is interpreted to be completed in a shallow

unconfined alluvial aquifer. The aquifer is considered to be highly sensitive to potential sources of contamination in accordance with the Montana Source Water Protection Guidelines (DEQ, 1999).

Table 3. Source well information for Cardwell School

Information	Well #1	Source of Information
PWS Source Code	002	Sanitary Survey
MBMG #	48402	GWIC
Water Right #	Not reported	Well Log
Legal Location (T, R, Sec.)	01N 03W 10 AADC	Well Log
Latitude/Longitude	45.8569/111.9519	Well Log
Date Completed	1918	Well Log
Well Depth	35	Sanitary Survey
Perforated Interval	unknown	
Static Water Level Depth	unknown	
Pumping Water Level Depth	unknown	
Drawdown	unknown	
Test Pumping Rate	20gpm	Sanitary survey
Specific Capacity	unknown	
Source Type	Alluvium	Well log

Limiting Factors

The well log for the Cardwell School well does not provide lithologic information. Hydrogeologic data were obtained by reviewing well logs in the vicinity (MBMG GWIC) and from an unpublished open-file geologic field map of the Bozeman 30x60 quadrangle (USGS, 1996). Groundwater flow direction is based on a generalized 1:750,000 scale potentiometric surface map (Kendy and Tresch, 1996).

CHAPTER 3

INVENTORY

Inventory of potential sources of contamination was conducted for Cardwell School within the control and inventory regions. Potential sources of known 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 Cardwell School inventory region are nitrate, pathogens, fuels, solvents, and agricultural chemicals.

The inventory for Cardwell School 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

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

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

Step 3: The Permit Compliance System (PCS) was queried using Envirofacts (<http://www.epa.gov/enviro/>) to identify Concentrated Animal Feeding Operations with MPDES permits. The water system operator or other local official familiar with the area included in the inventory region identified animal feeding operations that are not required to obtain a permit.

Step 4: Databases were queried to identify the following in the inventory region: Underground Storage Tanks (UST) (<http://webdev.deq.state.mt.us/UST/>), hazardous waste contaminated sites (DEQ hazardous waste site cleanup bureau), landfills (<http://nris.state.mt.us/gis/datalist.html>), abandoned mines (<http://nris.state.mt.us/gis/datalist.html>) and active mines including gravel pits. Any information on past releases and present compliance status was noted.

Step 5: A business phone directory was queried to identify businesses that generate, use, or store chemicals in the inventory region. Equipment manufacturing and/or repair facilities, printing or photographic shops, dry cleaners, farm chemical suppliers, and wholesale fuel suppliers were targeted by SIC code.

Step 6: Major road and rail transportation routes were identified throughout the inventory region (<http://nris.state.mt.us/gis/datalist.html>).

Step 7. All land uses and facilities that generate, store, or use large quantities of hazardous materials were identified within the recharge region and identified on the base map.

Step 8: All wells located within the inventory region were identified and well logs were obtained when available.

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

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

Inventory Results/Control Zone

The 100-foot control zone lies mostly on the school property. This was determined by viewing a digital orthogonal photograph of the area. There is what appears to be a county road running directly in front of the school and through the control zone. The school is in a rural area with no other buildings in the control zone. There is a structure of unknown type immediately to the north of the school building. The area within the control zone is designated as grassland/herbaceous according to the USGS National Land Cover dataset (Appendix A, [Figure 9](#)). Currently, there is no information to indicate that there are significant potential contaminants used within the control zone. However, there is the possibility of contaminants being transported through it. The school should consider restricting the intensive use of fertilizers, pesticides, herbicides, and other chemicals and the practice of washing fertilizer and pesticide application equipment near the well. The school's two septic tanks and drainfields appear to be just outside the control zone ([Figure 1](#)).

Inventory Results/Inventory Region

Land cover information for the Cardwell School inventory region (Appendix A, [Figure 9](#)) was summarized from the National Landcover Dataset, Montana (USGS, 2000). Land cover within the 1-mile Cardwell Inventory Zone includes 67% grassland/herbaceous, 22% pasture/hay, 3% small grains, 2% evergreen forest and open water, 1.5% shrubland, 1% commercial/industrial/transportation and row crops, and less than 1% fallow, woody wetlands, and deciduous forest (Appendix A, [Figure 10](#)). Agricultural land is considered a significant potential contaminant source and at 26.5% is given a moderate hazard rating.

The most significant potential sources of contamination in the inventory region are two underground storage tanks (Appendix A, [Figure 5](#)). The Fells Store tank, which is approximately 1/3 of a mile north of the school, is leaking. Other significant potential contaminant sources are summarized in Table 4. See Appendix E,

worksheet 2a for facility names. It should be noted that while there are a range of septic tank densities in the inventory zone the majority of the inventory zone is rated low and the near vicinity of the school well, within a quarter mile radius, is low.

Table 4. Significant potential contaminant sources for Cardwell School.

Source	Contaminants	Description
LUST/UST	VOC's, SOC's, inorganics	Contaminants leaching to groundwater
Highways	All	Contaminants leaching to groundwater
Railways	All	Contaminants leaching to groundwater
Cultivated cropland	Pathogens, nitrates, agchemicals	Contaminants leaching to groundwater
RV dump	Nitrates, biohazards	Contaminants leaching to groundwater
Septic Systems	Pathogens and Nitrates	Contaminants leaching to groundwater

Inventory Results/Recharge Region

Land cover within the Cardwell School recharge region (Appendix A, [Figure 11](#)) includes 55% Grassland, 24% Forests, 11% Shrubland, 7% Agricultural land, and less than 1% each wetlands, barren land, and residential land (Appendix A, [Figure 12](#)).

A Montana Department of Transportation maintenance facility is within the recharge region (Appendix A, [Figure 6](#)). The facility uses a Class V injection well to dispose of melt-water from snowplows that collects on shop floors. The town of Whitehall is in the northwest corner of the recharge region. Although the town is within the recharge region and has potential contaminant sources associated with it, it is approximately 10 miles from Cardwell and the threat from those sources is low to insignificant. The Golden Sunlight Mine is an extensive gold and silver surface mine on Bull Mountain (Appendix A, [Figure 4](#) and [Figure 6](#)). The mine is west-northwest of Cardwell and close to, but outside the boundary of the recharge region. The mine may contribute nitrate, metals, and VOCs. However, because of its distance from the PWS and the low transmissivity of Tertiary-Cretaceous aquifers compared with that of the Jefferson River alluvium the contaminants probably do not constitute a significant threat. Several underground storage tanks exist in the Cardwell area at unmapped locations. These are listed in tables 5 and 6.

Table 5. Leaking underground storage tanks of unknown locations in the Cardwell area

City	Site Name	Location	AltEvent ID	Date	Confirmed Release Date	Project Officer	Active
Cardwell	CARDWELL SCHOOL DIST # 16 & 31	RR 1 BOX 2506	2207112*2029	14-Dec-93	13-Dec-93		No
Cardwell	FELLS STORE	HWY 359 RR 1 BOX 2666	2202630*1104	25-Feb-92	25-Feb-92	Joe Radonich	Yes
Cardwell	MULLIGAN, JOHN HOWARD	NE CORNER OF INTERS OF HWY 2 E & ?	2213314*2218	03-Jun-94	02-Jun-94		No

Table 6. Underground storage tanks of unknown locations in the Cardwell area

AltFacilityID	Facility Name	Street Address	City	County	Active	Nonactive
---------------	---------------	----------------	------	--------	--------	-----------

					Tanks	Tanks
22-07112	Cardwell School Dist # 16 & 31	Rr 1 Box 2506	Cardwell	Jefferson		1
22-13424	Cardwell Store Inc	770 Hwy 2 E	Cardwell	Jefferson	4	
22-10490	Edwards, John And Diane	126 Cottonwood Road	Cardwell	Jefferson		1
22-02630	Fells Store	Hwy 359 Rr 1 Box 2666	Cardwell	Jefferson		2
22-13314	Mulligan, John Howard	NE Corner Of Inters Of Hwy 2 E &	Cardwell	Jefferson		5
22-01146	Powell, John N	900 Boulder Cut Off Rd	Cardwell	Jefferson		1

Inventory Update

The certified operator will update the inventory for his or her records every year. Changes in land uses 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 potential sources of contamination for the Cardwell High School have been identified using readily available data and reports. Unregulated activities or unreported contaminant releases may have been missed. The use of multiple sources of data, however, should ensure that the major potential contaminant threats to the Cardwell School are known.

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 Cardwell School.

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 threat to the source water. Management priorities in the Inventory Region are determined by ranking the significant potential contaminant sources identified in the previous chapter according to susceptibility. Alternative management approaches that could be pursued by the Cardwell School to reduce susceptibility are recommended.

Susceptibility is determined by considering the hazard rating for each potential contaminant source and the existence of barriers (Table 7) that decrease the likelihood that contaminated water will flow to Cardwell School well(s). 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.

Table 7. 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

Susceptibility ratings are presented in Table 8 for each significant potential contaminant source and each associated contaminant. The overall susceptibility of the Cardwell School well is high because the Jefferson River alluvium is classified as an unconsolidated aquifer. Additionally, there are no annular seal records reported in the school's well log and the sanitary survey states that the well casing is not properly sealed. Other wells in the vicinity lack annular seal records also (MBMG GWIC, 2002).

Table 8. Susceptibility assessment for significant potential contaminant sources in the Inventory Region.

Source	Contaminant	Hazard	Hazard Rating	Barriers	Susceptibility	Management
Highways	All	Spill threat	High	None	Very High	Develop an emergency response plan
Railways	All	Spill threat	High	None	Very high	Develop an emergency response plan
Cultivated cropland	Nitrates, pathogens, agchemicals	Nitrates, pathogens, & agchemicals leaching to groundwater from spills, over application, and run-off	Moderate	None	High	Use best management practices & apply agchemicals according to labels
LUST/UST	VOC's, SOC's, inorganics	Contaminants leaching to groundwater from spills or leaks	High	Parallel gradient to Cardwell PWS, dilution and mixing As of Dec 1999, USTs had to be replaced with ones that met new standards. If replaced the new tank and monitoring can be used as a barrier	Moderate	Monitor groundwater for contaminants
Class V Injection Well	VOCs, SOCs	Contaminants not diluting adequately and contaminating groundwater	Low	None	Moderate	Monitor groundwater
RV Dump	Nitrates, Biological	Nitrates & pathogens leaching to groundwater	Low	None	Moderate	Monitor groundwater
Active & Abandoned Septic Systems	Nitrates and Biological	Nitrates and bacteriological agents leaching to groundwater from leaking tanks or inadequate drainage fields	Low	None	Moderate	Monitor groundwater to ensure abandoned septic systems not causing impacts

Barriers

There is no data regarding whether the UST/LUSTs in question have leak detection systems in place. There is a possibility that dilution and mixing occurs in the Jefferson alluvium. GWIC wells within the Jefferson Island 1:100,000 quadrangle completed in the Jefferson River alluvium were surveyed. A majority of these did not contain enough information to calculate specific capacities. Of the small minority that were calculable, six wells within four miles upstream of the Cardwell School well showed specific capacities of greater than 15 gpm/ft and one well showed no drawdown with a yield of 30 gpm (Appendix A, [Figure 13](#)). Dilution and mixing were used as a barrier in the case of the underground storage tanks due to the high specific capacities.

REFERENCES

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GLOSSARY*

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

Alkalinity. The capacity of water to neutralize acids.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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.

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

Hydrologic Unit Codes (HUC). Uniform, nationally consistent map codes for river basins.

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

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). A permitting system that utilizes a database to track entities that discharge wastewater of any type into waters of the State of Montana.

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

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

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

exceed MCLs.

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

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

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

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

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

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

Public Water System. 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.

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

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

Section Seven Tracking System (SSTS). SSTS is an automated system EPA uses to track pesticide producing

establishments and the amount of pesticides they produce.

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

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

Source Water Protection Areas. For surface water sources, the land and surface drainage network that contributes water to a stream or reservoir used by a public water supply. For 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.

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

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

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

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

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

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

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

Underground Storage Tanks (UST). A tank located at least partially underground and designed to hold

gasoline or other petroleum products or chemicals, and the associated plumbing system.

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

Watershed. The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common delivery point.

* With the exception of the definitions for Phase II and Phase V Rules, definitions were adapted from EPA's Glossary of Selected Terms and Abbreviations which can be found at:
<http://www.epa.gov/ceisweb1/ceishome/ceisdocs/glossary/glossary.html>

The definitions for Phase II and Phase V Rules were adapted from:
<http://www.epa.gov/OGWDW/source/therule.html#PhaseII>
<http://www.epa.gov/OGWDW/source/therule.html#PhaseV>

APPENDICES

APPENDIX A

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APPENDIX C

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CHECKLIST

APPENDIX A

Figures

- [Figure 1.](#) Cardwell vicinity map
- [Figure 2.](#) Private and public wells and septic density in the Cardwell vicinity
- [Figure 3.](#) Cardwell School well and septic locations
- [Figure 4.](#) Potential contaminant sources in the Cardwell vicinity
- [Figure 5.](#) Cardwell School PWS inventory and control zones with potential contaminant sources
- [Figure 6.](#) Cardwell School PWS recharge region with potential contaminant sources
- [Figure 7.](#) General geology of the Cardwell vicinity



Figure 8a. Detailed geology of the Cardwell vicinity (Vuke, et.al., 1996)

Quaternary	Qal-alluvium Qg-alluvial terrace deposit
Tertiary	Tr-Renova (Bozeman Group) TKi-Intrusive Undivided
Cretaceous Volcanics	Kev-Elkhorn Mountain Kk-Kootenai
Jurassic	Jm-Morrison
Permian	Pp-Phosporia
Pennsylvanian	Pq-Quadrant
Mississippian	MPa-Amsden Mmm-Mission Canyon Mml-Lodgepole MDt-Three Forks
Devonian	Dj-Jefferson
Cambrian	€pi-Pilgrim

Figure 8b. Correlation of Geologic Map Units

(For lithologic descriptions, see Dixon, S.A., Custer, S.G., 1999)

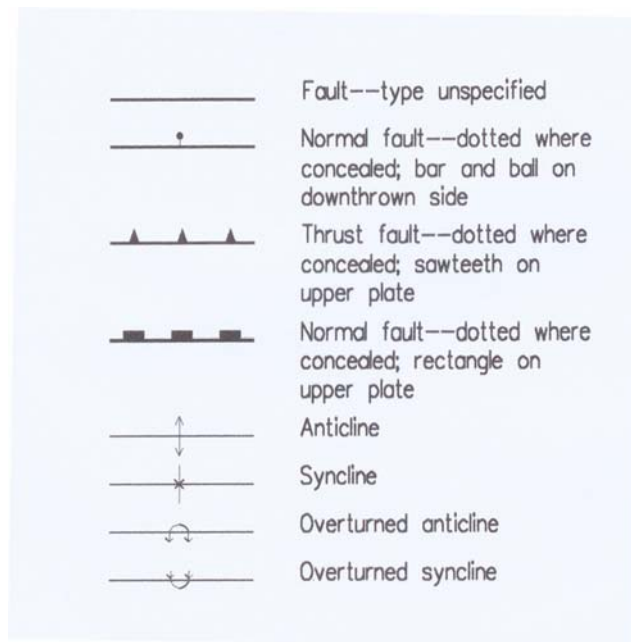
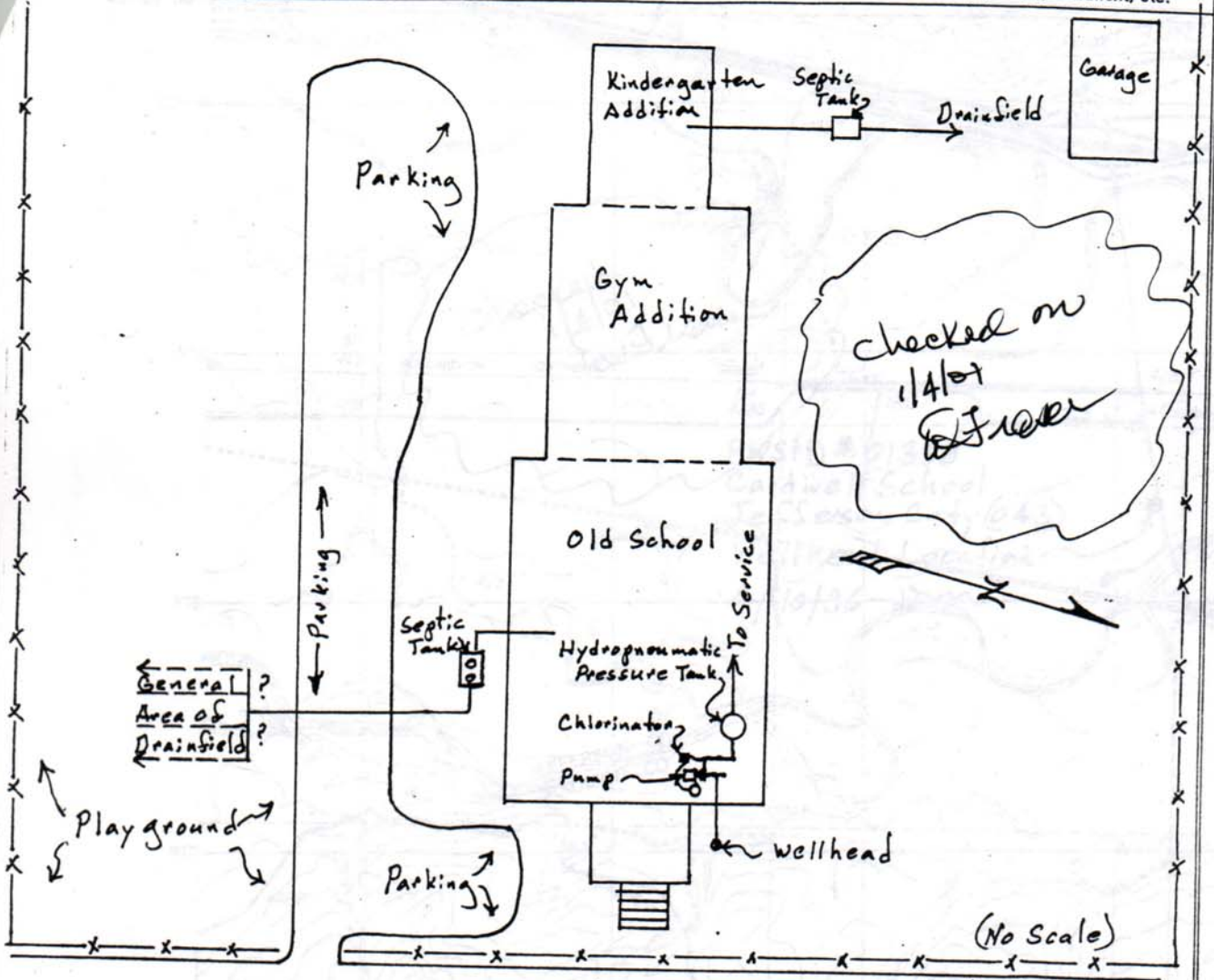


Figure 8c. Map Key for Detailed Geologic Map

- [Figure 9](#). Land cover for the Cardwell School PWS inventory and control zones
- [Figure 10](#). Percent land cover chart for the Cardwell School inventory zone
- [Figure 11](#). Land cover for the Cardwell School PWS recharge region
- [Figure 12](#). Percent land cover chart for the Cardwell School recharge region
- [Figure 13](#). Wells with high specific capacities relative to the Cardwell School PWS

APPENDIX B
SITE PLAN

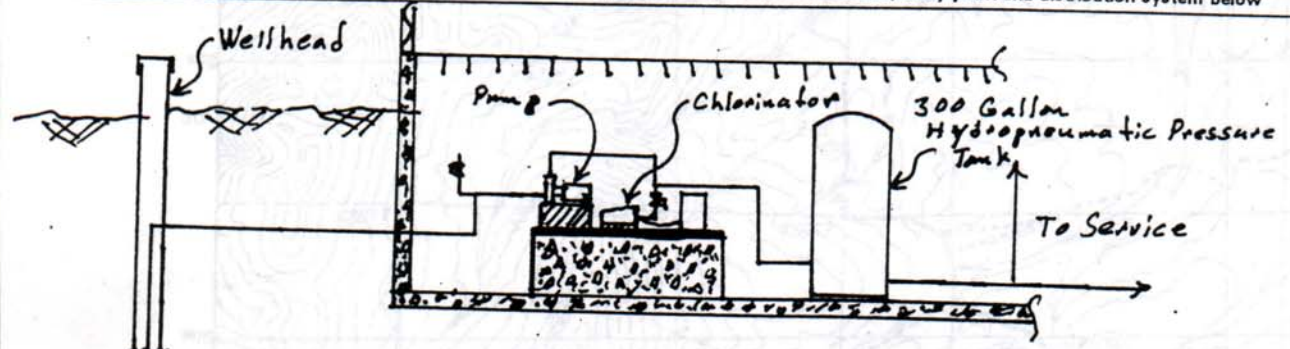
Draw brief site plan showing location of well(s), springs(s), water storage, distribution system, pumphouse(s), entry point(s), treatment, etc.



(No Scale)

Cardwell & I-90 →

Draw Brief schematic of placement of filters and disinfection equipment in relation to the source, entry point and distribution system below



(No Scale)

APPENDIX C
WELL LOG(S)

**Montana Bureau of Mines and Geology
Ground-water Information Center Site Report
CARDWELL SCHOOL DISTRICT 16 AND 31**

[Plot this site on a topographic map](#)
[View Water Quality for this Site](#)

Location Information

GWIC Id:	48402	Source of Data:	GW4
Location (TRS):	01N 03W 10 AADC	Latitude (dd):	45.8569
County (MT):	JEFFERSON	Longitude (dd):	-111.9519
DNRC Water Right:	Not Reported	Geomethod:	MAP
PWS Id:	01398002	Datum:	1927
Block:		Addition:	
Lot:		Type of Site:	WELL
Certificate of Survey:			

Well Construction and Performance Data (measurements are reported below land surface)

Total Depth (ft):		How Drilled:	Not Reported
Static Water Level (ft):		Driller's Name:	Not Reported
Pumping Water Level (ft):		Driller License:	Not Reported
Yield (gpm):	10.00	Completion Date:	Jan 01, 1918
Test Type:	Not Reported	Special Conditions:	None Reported
Test Duration:		Is Well Flowing?:	No
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	110ALVM
Recovery Time (hrs):		Well/Water Use:	PUBLIC WATER SUPPLY

Hole Diameter Information

No hole diameter records were found.

Casing Information

From (ft)	To (ft)	Dia (in)	Description
0.0	0.0	6.0	

Annular Seal Information

No annular seal records were found.

Completion Information

No completion records were found.

Lithology Information

No lithology records were found.

Site Notes

TRACT LOCATION BASED ON LATLONG FROM DEQ.

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

APPENDIX D
SANITARY SURVEY

APPENDIX E
Hazard and Barrier Worksheets

Candwell
 PWSID 01398
 Well ID 002

Hazard Determination - Significant Potential Contaminant Sources for Wells

Hazard Time-of-Travel (years):	High <1	Moderate 1-3	Low >3
A. Animal Feeding Operations			
A1. _____	_____	_____	_____
A2. _____	_____	_____	_____
B. Wastewater Treatment, Spray Irrigation, Lagoons			
B1. _____	_____	_____	_____
B2. _____	_____	_____	_____
C. Spill Threat: Highway, Railway, or Pipeline			
C1. <u>MT 2 / I-90 / Route 359 / other local paved</u>	<u>X</u>	_____	_____
C2. <u>Northern Pacific / Chicago / Milwaukee / St. Paul</u>	<u>X</u>	_____	_____
D. Underground Storage Tanks			
D1. <u>Fells Store (Leaking)</u>	<u>X</u>	_____	_____
D2. <u>Candwell Store Inc.</u>	<u>X</u>	_____	_____
D3. _____	_____	_____	_____
E. Known Groundwater Contamination Sites			
E1. _____	_____	_____	_____
E2. _____	_____	_____	_____
E3. _____	_____	_____	_____
E4. _____	_____	_____	_____
E5. _____	_____	_____	_____
F. Other Significant Point Contaminant Sources			
F1. <u>Hackberry Seasonal RV Campground w/public sewer</u>	_____	_____	<u>X</u>
F2. _____	_____	_____	_____
F3. _____	_____	_____	_____
F4. _____	_____	_____	_____
F5. _____	_____	_____	_____
G. Injection Wells			
_____	_____	_____	<u>X</u>
H. Sanitary Sewer Mains			
_____	_____	_____	_____
I. Storm Sewer Outflows			
_____	_____	_____	_____
Number / Sq. Mile:	>300	50 - 300	<50
J. Septic Systems (unsewered residential)	_____	_____	<u>X</u>
Percent:	>50	20-50	<20
K. Cropped Agricultural Land	_____	<u>X</u>	_____

Cardwell

Natural Barriers – Significant Potential Contaminant Sources

PWSID 01398
Source 002

ID#	Facility Name	Barrier Type	Description
Wells	A – Continuous Clay Layer; B – Depth to Water > 100 ft.; C – Upward Gradient; D – Dilution; E – Natural Attenuation		
Surface Water	A - Dilution; B – Forested Riparian Zone > 50 ft.		
Significant Point Sources Including Underground Storage Tanks			
<u>1</u>	<u>Fells Store LUST</u>	<u>D, C</u>	<u>Parallel Gradient</u> <u>High specific capacities</u>
<u>2</u>	<u>Cardwell Store UST</u>	<u>D, C</u>	<u>"</u>
<u>3</u>	<u>Hunkaba Seasonal RV campground</u>	<u>none</u>	
Ground Water Remediation Sites			
Animal Feeding Operations			
Wastewater Treatment, Spray Irrigation, Lagoons			
Spill Threat: Highway, Pipeline, or Railway			
<u>4</u>	<u>MT 2 / I-90 / Route 359</u>	<u>none</u>	
<u>5</u>	<u>Northern Pacific / Chicago, Milwaukee, St Paul</u>	<u>none</u>	
MPDES Wastewater Discharges			
Injection Wells			
<u>6</u>	<u>MT DOT Maintenance Facility</u>	<u>none</u>	
Sanitary Sewer Main			
Storm Sewer Outfall			
Septic Systems			
<u>7</u>	<u>Low</u>	<u>none</u>	
Cropped Agricultural Land			
<u>8</u>	<u>Medium 26.5%</u>	<u>none</u>	

