Sanders County Water District

Public Water Supply – PWS ID # MT0000385

SOURCE WATER DELINEATION AND ASSESSMENT REPORT

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EXECUTIVE SUMMARY

This Source Water Delineation and Assessment Report was prepared under the Federal Safe Drinking Water Act and the Montana Source Water Assessment Plan. The Department of Environmental Quality (DEQ) is conducting these assessments for all public water systems (PWSs) in Montana. The purpose is to provide information so that the public water system staff/operators, consumers, and community citizens can begin developing strategies to protect your source of drinking water. The information that is provided includes the identification of the area most critical to maintaining safe drinking water, i.e., the Inventory Region, an inventory of potential sources of contamination within this area, and an assessment of the relative threat that these potential sources pose to the water system.

The drinking water for the Sanders County Water District is supplied by two (2) wells located between town and the Clark Fork River (Figure 2 & Figure 3). Based on the sanitary survey, well logs, and the depth of the wells, it appears that the shallow unconfined aquifer underlying this portion of the Clark Fork River valley is providing water to the PWS wells. In accordance with the Montana Source Water Protection Program criteria (1999), the aquifer (source water) is considered to have a high sensitivity to potential contaminant sources since the aquifer is shallow, in alluvium, and unconfined. Sensitivity is defined as the relative ease that contaminants can migrate to source water through the natural materials.

Four (4) types of source water protection management regions for the Sanders County Water District public water system were mapped as part of this assessment. They are the control zone, inventory region, surface water buffer, and the recharge region. Potential sources of contamination were identified within each of these three regions and the results are as follows:

- The control zone is delineated as a 100-foot radius around each of the wells and all sources of potential contaminants should be excluded in this region. The goal of management in the control zone is to avoid introducing contaminants directly into the water supply's well or immediate surrounding areas. No potential contaminant sources were identified within the control zones.
- The inventory region for the wells was based on a heavily modified 1-mile radius circle around the wells (see Figure 5 and Figure 6). The inventory region was modified to account for the lateral limits of the river valley margins and the presence of potential contaminant sources mostly in the proximity of town. The inventory region was designed to help identify potential contaminant sources in close proximity to the wells. The inventory region should be managed to help prevent contaminants from reaching the wells before natural processes reduce their concentrations. The most significant potential contaminant sources identified within the inventory region are private onsite septic systems associated with the housing in town. The wells are considered to be vulnerable to contamination form this significant potential contaminant source. Historic water quality data from the wells confirms that these septic systems do have an ongoing impact on water quality in the production wells. The highway and the railroad are probably the next greatest threat to the wells. The wells are considered to somewhat vulnerable to spills or releases associated with accidents along these transportation corridors. The shallow unconfined aquifer beneath the Sanders County Water District production wells is probably recharged along the mountain range fronts on either side of the river valley and from the Clark Fork River itself. The recharge comes mostly from precipitation, discharge from local streams before they enter the main valley, and from the Clark Fork River. Within the unconfined aquifer

groundwater generally flows from the edges of the basin toward the Clark Fork River and northwest, which is parallel and sub-parallel to the river. Groundwater flow beneath the Sanders County Water District wells is probably mostly from the southeast to the northwest.

- Because the Clark Fork River runs right through the inventory region and the river probably does interact with the aquifer that the wells draw upon for water, a surface water buffer was delineated as seen on Figure 7. The surface water buffer is an area encompassing 0.5 miles on each side of the larger streams and approximately 10 miles upstream. This area was inventoried for large sources of nitrate and pathogens. None were found during the inventory.
- The recharge region was delineated based upon topographic mapping of watersheds above the public water supply (see Figure 8). The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased usage. The potential contaminant sources identified within the recharge region were mostly the highway and railroad, and a number of abandoned mine sites. It didn't appear that there were extensive mine tailings impacted streams within the recharge region. These assorted potential contaminant sources are not considered immediate threats to water quality at the Sanders County Water District PWS, but may influence long-term water quality.

Susceptibility is the potential for a public water supply to draw water contaminated by inventoried contaminant sources at concentrations that would pose concern. Susceptibility is determined by considering the hazard rating for each potential contaminant source and the existence of barriers that decrease the likelihood that contaminated water will flow to the public water supply well intakes. The susceptibility analysis provides the community and the public water system with information on where the greatest risk occurs and where to focus resources for protection of this valuable drinking water resource. The Sanders County Water District public water supply has a very high susceptibility to contamination associated with private onsite septic systems with drainfields that are located within town. Other significant potential contaminant sources were identified, but the wells appear to have a moderate to low susceptibility to contamination from these sources.

The costs associated with contaminated drinking water are high. Developing an approach to protect that drinking water resource will reduce the risks of a contamination event occurring. In this report, we have summarized the local geology and well construction issues as they pertain to the quality of your drinking water source. We have identified the area we believe to be most critical to preserving your water quality (the Inventory Region) and have identified potential sources of contamination within that area. In addition, we provide you with recommendations, i.e., Best Management Practices, regarding the proper use and practices associated with some common potential contamination sources (see Table 9). We believe public awareness is a powerful tool for protecting drinking water. The information in this report will help you increase public awareness about the relationship between land use activities and drinking water quality. Refer to the figures within the document to better understand the spatial relationship of the area. The susceptibility of the PWS to the significant potential contaminant sources is discussed on Table 9. Overall, there appear to be few threats to the Sanders County Water District production wells other than the septic systems associated with town. The presence of the private onsite septic systems upgradient from the wells is and will continue to be a major threat to water quality. To protect water quality of this PWS, the author recommends that the town seriously consider the feasibility of developing a community sewer system and wastewater treatment plant to remove and treat sewage. Alternately, the development of alternate (and more secure) water sources should be explored.

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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 Sanders County Water District public water supply (PWS) # MT0000385. This report is completed as required by the Montana Source Water Protection Program and the federal Safe Drinking Water Act. Jeffrey Frank Herrick, a hydrogeologist with the Source Water Protection Program, Montana Department of Environmental Quality (DEQ) completed this Delineation and Assessment Report (SWDAR). This SWDAR was completed on behalf of the Sanders County Water District PWS located in Paradise, Montana.

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 source water protection planning.

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 for the Sanders County Water District groundwater 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 Sanders County Water District PWS managers and operators and the surrounding community to be involved in source water protection planning and the possible development of a Source Water Protection Plan that is tailored to meet their specific needs.

This report has been written based on readily available public information and is as complete and accurate as possible within time and resource constraints. Unfortunately, accurate and reliable information may not be available on the hydrogeology beneath certain areas or on the nature or location of some potential contaminant sources in the area. The author has asked for comments and/or corrections from the managers and operators of this PWS prior to finalization of this report.

CHAPTER 1
BACKGROUND

The Community

The Sanders County Water District is located adjacent to the City of Thompson Falls, which is in Sanders County of northwestern Montana (Figure 1). It is situated within the northwest trending Clark Fork River Valley and along the east shore of the Clark Fork River (Figure 2 & Figure 3). The public water supply (PWS) addressed in this SWDAR is the Sanders County Water District PWS, MT0000385, which is classified by DEQ as a Community Non-Transient PWS serving approximately 183 residents through 100 service connections. It should be noted that the most recent Sanitary Survey (1999) that the author has seen indicated that the PWS served 300 persons through 111 service connections. The address and name of the contact(s) for this PWS are listed on the cover of this document and in the next chapter. According to the 2000 US Census, the population of the unincorporated community of Paradise consists of approximately 184 people and Sanders County has a population of approximately 10,227 people. The population of the county has increased approximately 18% since the 1990 Census. The City of Thompson Falls is the Sanders County seat and the largest community in the area. The economic base of the Clark Fork River Valley and Sanders County is not very diverse. The county's leading industries are wood products manufacturing, some manufacturing, the railroad, tourism, and service industries in support of federal government facilities. Residents and businesses located in or around the community of Paradise must use onsite septic systems and drainfields to treat and dispose of septic effluent (Figure 3).

Geographic Setting

The unincorporated community of Paradise and the Sanders County Water District PWS are located just east of the Clark Fork River along the Clark Fork River canyon. The Clark Fork River canyon/valley is a northwest trending intermountain valley on the western side of the continental divide in northwestern Montana. The Coeur d'Alene Mountains flank the valley on the southwest and the Cabinet Mountains border the valley on the northeast. The Clark Fork River currently flows along the southwest side of the valley in the river reach at Paradise. A broad flood plain typically occupies the valley between the river on the one side and the range front on the other. The river meanders and occupies alternating sides of the valley along its journey to the northwest. The elevation of Paradise is approximately 2,480 feet above sea level near. There are alluvial aquifers distributed intermittently throughout the length of the Clark Fork River valley and present in the area of Paradise. These aquifers are usually highly transmissive sand and gravel water table (unconfined) aquifers and deeper confined aquifers in the broader and deeper valleys. The Sanders County Water District PWS wells are within a 330 yards of the Clark Fork River and they appear to draw water from what the author believes is an unconfined aquifer.

The climate of the Clark Fork River Valley is consistent with that of other middle elevation basins in the northern Rocky Mountains, west of the Continental Divide. The elevation at the nearest permanent weather station in Thompson Falls is around 2,240-2,250 feet above mean sea level. The ranges of average temperatures at the weather station in Trout Creek (just east of Thompson Falls) are 85.4 and 45.5 degrees F in July and 34.0 and 19.5 degrees F in January. Snowy winters are common, with winter months generating up to 19-21 inches of snow. Average annual precipitation is spread evenly throughout the year, but November, December, and January snows are noteworthy with an annual average total precipitation of 28.71 inches.

Table 1. Climatic Summary
Thompson Falls, Montana (248207)
Period of Record : 8/ 1/1911 to 1/31/1956

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	33.4	39.4	48.6	60.1	69.2	76.2	87.3	86.3	75.2	61.1	43.7	35.5	59.7
Average Min. Temperature (F)	17.8	20.5	26.2	32.7	38.9	44.9	49.4	47.6	41.0	34.2	26.8	21.7	33.5
Average Total Precipitation (in.)	2.13	1.56	1.84	1.45	1.75	1.88	0.91	0.82	1.29	1.84	2.26	2.46	20.19
Average Total Snowfall (in.)	12.4	7.5	4.7	0.4	0.1	0.1	0.0	0.0	0.1	0.8	3.9	9.4	39.4
Average Snow Depth (in.)	5	4	1	0	0	0	0	0	0	0	0	2	1

Note: Source is the Western Regional Climate Center, wrcc@dri.edu

General Description of the Source Water

The majority of drinking water in the Clark Fork River Valley comes from wells installed into both the unconfined and confined valley fill aquifers that are present in the valley fill sediments along various river stretches between the Coeur d'Alene and Cabinet Mountains, and from deep bedrock wells within the valley and along the valley margins. The well logs for the Sanders County Water District PWS wells and other wells in the area suggest that there are some laterally extensive clay and/or silt layers, but these probably don't constitute actual confining units for groundwater. It appears that the Sanders County Water District wells are drawing water from an unconfined aquifer present in the alluvial sediments in the area. Groundwater in the valley aquifer generally flows from the surrounding mountains and toward the stream valleys, and within the river valley toward the Clark Fork River. Then as the it approaches the center of the valley and the river, the groundwater probably flows to the northwest, which is parallel or sub-parallel to the Clark Fork River. As the groundwater flows northwest in the Clark Fork River Valley, a majority of it will eventually discharge into the river somewhere along it's extent in places where the bedrock is shallow and the alluvium is thin. This would likely occur in places where the valley narrows and river rapids are seen as the river drains across bedrock. Because the author believes that the aquifer used by the Sanders County Water District is unconfined within alluvial gravels, it is considered to hydrogeologically have a high sensitivity to contamination. This sensitivity will be discussed in more detail in the next chapter.

The Sanders County Water District PWS operates 2 production wells that are located west of town (Figure 3). The wells are drilled and installed to 64 and 70 feet deep into unconfined alluvial aquifer water bearing units. The static water level for the production wells were recorded at the time of drilling at 21 and 22 feet below ground surface (bgs) respectively. There does not appear to be a great difference in elevation between the wells. A geologic map of the sedimentary units/rock types in the area is depicted on Figure 4. No information was found on the groundwater flow directions beneath areas within the alluvium around the wells, but it is assumed that it basically flows parallel or sub-parallel to the direction of surface water flow in local streams and the river. This groundwater flow direction would be generally to the northwest. A summary of well construction and the lithologic logs for the PWS wells and some of the surrounding domestic wells are contained in Appendix A and C.

The Public Water Supply

The Sanders County Water District PWS (MT0000385) is classified by DEQ as a Community Non-Transient PWS. Its source wells are identified in the DEQ PWS Database as Well 1 and Well 2. This DEQ Database output and summary is found in Appendix A. This information is accompanied by a summary of water quality data for the wells. The wells appear to have been completed in what can be characterized as river alluvium sand and gravel deposits. According to the Department of Environmental Quality, Public Water Supply Section, the PWS has 100 active service connections that serve approximately 183 residents. The population served is assumed to vary little throughout the year. The source wells have a common header. There does appear to be a water storage tank and water treatment facility associated with the water system prior to distribution. Table 2 is a tabular summary of the Sanders County Water District PWS facilities as listed in the DEQ PWS Section database (also found in Appendix A). The most recent DEQ Sanitary Surveys, well logs, and other evaluations for this system are found in Appendix B.

Table 2. PWS Facilities
Sanders County Water District PWS (MT0000385)

Operator / Contact Person & Address	**James Heffernan (Admin. Contact)** **Glenn Randal Wilkerson (Operator)** **Sanders County Water District** **PO Box 208** **Paradise, Montana 59856** **Phone: 406/ 826-5712 or 406/ 826-3011**	
Class	Community Non-Transient	
Intake Source Code	**WL002**	**WL003**
Well/Intake Name	**Well 1**	**Well 2**
Status	Active	Active
Common Headers	**CH001** Common Header for Wells 1 & 2	
Treatment Plant	TP for Wells 1 & 2 Treatment involves full time disinfection by gas chlorination	
Treatment Plant ID	**TP002** **/ EP502** Active	
Distribution System	**DS001** **/ SP001** Active	
Storage Facility	ST001, this is a 150,000 gallon above ground steel water tank	
Pressure Control Assembly	It doesn't appear that there are any pressure control tanks used for this system.	

Water Quality and Regulatory History

The Sanders County Water District PWS wells and system have been sampled as part of regular water quality monitoring for public water supplies. The up-to-date bacteriological and chemical analytical results are displayed on tables within Appendix A of this report. The data found in these data tables begins in 1995. These data tables are presented along with output from the DEQ PWS Section database and relevant correspondence or reports drawn from DEQ files. Standards compliance with regulated contaminants occurs on a variety of sampling schedules. The BACT (bacteriological) and chemical analytical data contain no exceedences of any of the regulated contaminants. Chronic low concentrations of nitrate and a few other inorganic constituents were seen in past sample analyses, but the concentrations were low. Nitrate concentrations ranged from 0.57 to 3.07 mg/L, which has been below the MCL of 10 mg/L. The most recent records indicate that disinfection by means of gas chlorination is being used on the Sanders County Water District PWS.

Facilities, businesses, offices, shops, schools, and residences within the service area of the Sanders County Water District are provided water by the PWS. Any of the residences or facilities in or around Paradise must use private onsite septic disposal, as no community sewage treatment system is present.

CHAPTER 2
DELINEATION

Delineation Process

The source water protection regions, the delineated land areas that contribute water to wells used by the Sanders County Water District are identified in this chapter. For any given water source, three management or source water protection regions are usually identified. These 3 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 wellhead, spring collection box, or surface water intake. Human activity in this area can have an immediate impact on water quality by introducing contaminants to the area around an intake. As such, careful management of this Control Zone is critical to protect a PWS. The Inventory Region usually represents the zone of contribution to the well, which can approximate a three-year groundwater time-of-travel (TOT) or an approximate 1-mile radius around a wellhead. The Inventory Region comprising a 1-mile radius circle around a well is often a conservative value that is used either for convenience or when insufficient geologic or hydrogeologic information is available about an area or if details are lacking on the construction of a production well. In certain circumstances where a PWS well taps into an aquifer that has been characterized as confined, the Inventory Region can be limited to a 1,000-foot radius around the wellhead, and the inventory of potential contaminant sources is only completed for those sources within 1,000 feet of the well. Activities or contaminant releases in the Inventory Region have the potential to reach a PWS well in a period approximating a few years. In circumstances where there appear to be interactions between surface water and the groundwater source or if a surface water body is present within the Inventory Region, a Surface Water Buffer can be delineated. The Surface Water Buffer encompasses approximately 0.5 miles on either side of the river and/or streams and about 10 miles upstream along the primary stream channel(s). The Recharge Region is the largest of the regions and represents the entire aquifer or an area that contributes water to the local aquifer and over time supplies water to a well. This extended region of groundwater recharge is often, but not always inclusive of the limits of a watershed. At times an entire watershed is too large to be realistically manageable by a PWS or community, so a subsection of that watershed can be delineated as the Recharge Region. Long-term water quality at a PWS is affected by large contaminant sources, accidental chemical releases, or extensive land use activities in the Recharge Region. Table 3 summarizes how these source water protection regions are determined.

Table 3. Criteria for Delineating Source Water Protection Regions

If Your Source of Water Is:	Delineate These Water Protection Regions	Method For Each Region	Minimum Distance Values & Type of Inventory Required
Ground Water that is: • **Unconfined or Semi-confined*** • **Confined** *Ground Water that is hydraulically Connected to Surface Water also needs the following ……… →	Control Zone Inventory Region Recharge Region Control Zone Inventory Region Recharge Region Surface Water Buffer	Fixed radius Fixed radius Topography Fixed radius Fixed radius Topography Fixed Distance	Distance – 100 feet Distance – ~1 mile or 3 Year Groundwater TOT Limits of the watershed Distance – 100 feet Distance – 1000 feet Limits of the watershed In addition to the Inventory Region, a one-half mile surface water buffer will extend upstream a distance corresponding to a 4-hour TOT but not to exceed ten miles or the nearest intake. The buffer will not exceed the extent of the watershed. Inventory is limited to pathogens and nitrate sources.
Surface water	Spill Response Region Watershed Region	Fixed Distance Topography	One-half mile buffer extending upstream a distance corresponding to a 4-hour TOT but not to exceed ten miles or the nearest intake. Buffer will not exceed the extent of the watershed. Limits of the watershed

Note: The highlighted choices above appear to be the appropriate selections for this Sanders County Water District PWS.

Hydrogeologic Conditions

The following is a description of the sediments, bedrock, and groundwater in the Clark Fork River valley in the vicinity of Paradise. This information is relevant because the rock units and sediments comprise the aquifer(s) (the water bearing formations) into which the Sanders County Water District PWS wells are installed. The hydrogeology is a description of the presence and movement of groundwater in the bedrock and within the Clark Fork River valley. This discussion is intended to help the reader understand where the PWS wells are obtaining their groundwater and the vulnerability of that source of water to potential contamination. Most of the following information was drawn from Alt and Hyndman (1990) and other sources. The Sanders County Water District PWS wells are installed into and drawing water from water-bearing units that appear to be unconfined.

Geology

The bedrock of the Cabinet and Coeur d'Alene Mountains is primarily Belt SuperGroup sedimentary rock of Precambrian age. The Belt SuperGroup rock is comprised of formations of metasediments primarily quartzite, argillite, with some carbonate (limestone) units (Kendy and Tresch, 1996). Relative to their age, they are not highly deformed. The region is extensively faulted with two main sets of fault zones. Ancient and modern streams have exploited these fault zones and created many of the stream and the river channels seen today. The first set is a series of northwest trending strike-slip faults running at about 45° Northwest. The displacement along these faults is right-lateral with the eastern side of the fault moving southeast relative to the western side of the fault. The amount of displacement is not known. The northwest trending zone that is currently occupied by the Clark Fork River channel between Plains and the Idaho border is called the Hope Fault Zone. A parallel zone runs through Saint Regis south to Missoula. A second set of faults is categorized as thrust faults (reverse faults) that trend north to south through the region. Thrust faults are a result of foreshortening of the continental crust in this region due to compressive tectonic forces (collisions between continental plates). Near the end of the Mesozoic Age the younger sediments that covered this area were somehow removed and displaced to the east along the north-south trending faults. This material ended up located to the east and is collectively called the overthrust belt. The uncovered older sediments (mostly Precambrian) were allowed to float upward (there was less mass above them) and some steeper angled faults cut through the reverse faults. These steep, near vertical faults are attributed to the process of unloading with the older rocks floating upward unevenly with breakage between areas of unequal buoyancy. The Clark Fork River valley was not glaciated at any point in the recent geologic past. However, it was occupied by and the avenue that glacial Lake Missoula used to drain catastrophically to the west. Alt and Hyndman (1990) suggest that during the repeated draining of the lake through this valley, the flow volume reached 8 to 10 cubic miles of water per hour. This repeated flooding scoured the valley down to the bedrock in places and left a considerable volume of coarse sediment in localized bars along the river channels. This scouring also left tall stream terraces along the flank of many of the wider valleys along the river. A geologic map is presented on Figure 4.

A detailed stratigraphy of sediments in the area of Plains has never been carefully worked out. Bedrock is exposed on both flanks of the valley as rock outcrops on the Cabinet and Coeur d'Alene Mountains. The deepest part of the valley (and the part containing the thickest sediments) is probably located just east of the present-day river channel. The depth to bedrock in the center of the valley is thought to be 200-300 feet bgs in the area of Plains. Lithologic logs for many area wells suggest the presence of laterally continuous silt and clay layers deposited at various depths (see Appendix C). The lateral extent of these silt and clay rich layers is not precisely known, but it is reasonable to suppose that they are not laterally extensive across the valley. Layers of sand, coarse sand, gravel, and boulders appear to interfinger with the finer silt and clay units throughout their extent. The most recent deposits of sand and gravel were deposited by modern stream action and make up the present valley floor beneath and surrounding the active river channel.

Hydrogeology

Groundwater is a widely used source of water for the residents in the Clark Fork River valley. It appears that there is a laterally extensive unconfined aquifer in the area of Plains. The unconfined aquifer has groundwater flowing from the valley flanks and toward the river, then parallel to sub-parallel to surface water flow in the river. The precise stratigraphy and the lateral extensiveness of the stratigraphy in the area has never been determined due to the low number of complete lithologic and well logs in the vicinity of town. It does seem clear that the Sanders County Water District's 2 production wells are drawing water from the same unconfined water-bearing units that are within the valley fill sediments along the east flank of the river valley. This aquifer has to be bounded by the lower conductivity Precambrian bedrock that underlies and surrounds the valley. The water table (unconfined) aquifer is recharged by local streams draining the surrounding mountains, discharge from the Clark Fork River, and by infiltration of precipitation. It should be noted that most streams exiting the mountain canyons often drain most or all of their water into the shallow aquifer and have a dry channel that extends to the Clark Fork River's edge. Any confined aquifer(s) that are present are probably recharged predominately by water moving from the fractured rock into the coarser and higher conductivity materials in the bottom of the valley's bedrock trough. Inter-aquifer movement by water has not been studied in this area and is not understood.

Groundwater flow direction is based upon several factors. In fractured bedrock, groundwater flows primarily downhill and eventually discharges at points where the water moving through the rock or sediment intersects with the ground surface. Movement of water through fractured rock is almost exclusively through the interconnected fractures, which is called secondary porosity. Generally groundwater in the unconfined and confined aquifers flow from high ground toward low ground and eventually discharges to surface water or it enters the shallower water-bearing units/aquifers. Within the area of the Sanders County Water District wells and within the unconfined aquifer, groundwater flow is probably toward the valley center and the Clark Fork River. It is believed to flow away from the mountains then turn northwest to flow sub-parallel and parallel to the river.

PWS Source Information and Aquifer Properties

What is known about the wells used by the Sanders County Water District PWS is summarized in Table 4 below.

Table 4. Well Information and Aquifer Properties
Sanders County Water District PWS (MT0000385)

Source Name	Well 1	Well 2
Source ID	WL002	WL003
Well Location	Tie Plant Service Road, to the north	Tie Plant Service Road, to the south
Date Completed	29 April 1988	29 April 1998
Total Depth (ft bgs)	70	64
Perforated Interval (ft bgs)	45-52 52-70 (this second interval looks like a non-perforated silt trap)	39-46 46-64 (this second interval looks like a non-perforated silt trap)
Static Water Level (ft bgs)	22	21
Pumping Water Level (ft bgs)	22.75	21.55
Draw Down (ft)	0.75	0.55
Q or Yield (gpm)	270	230

The unconfined alluvial aquifer used by the Sanders County Water District PWS is characterized as having High Source Water Sensitivity to contamination. This is based on criteria used by the DEQ Source Water Protection Program as outlined on Table 5. The interpretation of the author is that that the wells are located in an area where the water-bearing formations are not topped or locally confined by low conductivity materials of clay or silt and the aquifer isn't under pressure that is greater than atmospheric pressure. Recharge to the aquifer is from the probably mostly from infiltration from local streams and the river.

Table 5. Source Water (Aquifer) Sensitivity

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

Delineation Results

The delineations for the source water protection regions were done based on the fact that the Sanders County Water District PWS wells are withdrawing water from the same water-bearing zones within a shallow unconfined aquifer. The Control Zones are delineated to provide a minimum 100-foot radius buffer around the wellheads. An Inventory Region was delineated for the PWS production wells based on a heavily modified 1-mile fixed radius circle around the wellheads. Very little information was found to support confidence in the calculation of a 1-year groundwater time-of-travel (TOT) distance. Therefore the Inventory Region was simply delineated to enclose the area around the wells and upgradient of the wells (south) between the river and the mountain range front. The region extends up the McLaughlin Creek drainage a short ways; then south to include the Clark Fork River bar located just west of the confluence between the Clark Fork River and the Flathead River. Although the Inventory Region isn't very circular, it is felt that the Inventory Region as the author designed it is conservative and protective of public health and it encloses most of the potential contaminant sources located upgradient of the wells. Figure 5 and Figure 6 depict the Inventory Region for the Sanders County Water District PWS. For use in the determination of Susceptibility discussed in Chapter 4 of this SWDAR, a 1-year groundwater TOT was arbitrarily assigned as the Clark Fork River as it meanders from the east side of the valley to the west side. Therefore the land around the wells and the town of Paradise are within the nominal 1-year groundwater TOT distance and the land south of that on the west side of the river is between the 1- to 3-year TOT distances. Potential contaminant sources located within the Inventory Region will be discussed in the next chapter.

It should be noted that the Clark Fork River flows right through the center of the Inventory Region and the wells draw water from a shallow unconfined aquifer that probably does have some interaction with the river. According the DEQ Source Water Protection Program criteria, a Surface Water Buffer was delineated to enclose the area on either side of the river or larger stream channels for a distance of 10 miles upstream. A short distance up McLaughlin Creek was also included. The Surface Water Buffer is depicted on Figure 7. The Recharge Region is depicted on Figure 8. It is described as encompassing the entire watershed surrounding and upstream of the town of Paradise. In a practical sense, the Recharge Region is not much larger than the Surface Water Buffer and probably doesn't capture very many more potential contaminant sources. Few noteworthy potential contaminant sources are present in the Surface Water Buffer or in the Recharge Region, but these will be discussed in the next chapter.

Limiting Factors

Although groundwater behavior has been well studied in some locations along the Clark Fork River valleys, limited work has actually be done around the community of Paradise. The were probably some limited groundwater investigations associated with the BN Tie Plant that is located northeast of town, but none of that information (other than the well logs) was available at the time of this report. There are very few lithologic logs recorded for wells in the area of Paradise, so some generalizations had to be made. As such, some reasonable assumptions and generalization had to be made about groundwater movement based on the well logs that were available, the sediments recorded during drilling, well yields, and the proximity of the wells to surface water. It should be noted that groundwater behavior beneath specific locations is very difficult to predict with any confidence. Groundwater flow direction fluctuates seasonally and from year to year, which adds a complication to any models of groundwater behavior beneath specific areas. Additionally, the best models of groundwater movement assume that the aquifer is homogenous, isotropic, and that groundwater flows almost exclusively in a horizontal direction. The reality is that none of these assumptions are precisely true. But assuming these aquifer characteristics to be generally true aids in the development of a simple working model of groundwater movement. The author has made several conservative assumptions in the delineation of the source water protection areas and the development of this report. The author used his professional judgment and reliance on some basic hydrogeologic principals to define the aquifer boundaries and groundwater movement. However the report can and should be revised if more data becomes available that significantly alters the assumed groundwater flow direction(s) or the assumptions about other hydrogeologic conditions (such as groundwater velocity or the confinement of the aquifer). As the maps and figures were developed for this SWDAR, readily available published maps, reports, and databases were used to plot the various features and facilities depicted. Since the author did not have a personal knowledge of each of these facilities, input and corrections provided by the PWS operators or managers is critical to ensuring the information contained in this chapter is accurate and complete.

CHAPTER 3
INVENTORY

Inventory Method

An inventory of potential sources of contamination was conducted for the Sanders County Water District PWS within the Control Zone, Inventory Region, Surface Water Buffer, and Recharge Region. Potential sources of all primary drinking water contaminants and Cryptosporidium were identified and noted, however, only significant potential contaminant sources were selected for detailed inventory and the susceptibility evaluation that occurs in Chapter 4 of this SWDAR. It should be noted that the inventory emphasizes potential contaminant sources. Inclusion of a facility or business in the inventory does not indicate that it is an actual polluter. The exception to this would be known hazardous waste sites where past releases have occurred, areas with known onsite contamination, locations with leaking underground storage tanks (LUSTs), or wastewater dischargers.

The inventory for the Sanders County Water District PWS focuses on all activities in the Control Zones for the wells; certain types of municipal/public and private facilities or land uses in the Inventory Region; large sources of pathogens and nitrates along the river (in the Surface Water Buffer); and general land uses and large facilities in the Recharge Region. The following databases have been searched in an effort to identify generators, storage facilities, and land uses that could be potential generators of contamination.

> Step 1: Urban and agricultural land uses were identified from the U.S. Geological Survey's Geographic Information Retrieval and Analysis System (http://nris.state.mt.us/gis/datalist.html). Sewered and unsewered residential land uses were identified from boundaries of sewer coverage obtained from municipal wastewater utilities.
>
> Step 2: As appropriate, 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 PWS system operator and/or system managers are familiar with the area included in the Inventory Region will have 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: Major road and rail transportation routes were identified throughout the Inventory Region (http://nris.state.mt.us/gis/datalist.html).

Step 6. All land uses and facilities that generate, store, or use large quantities of hazardous materials were identified within the Inventory Region and the Recharge Region, and were identified on the base map.

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

Of the documents examined for this SWDAR, there was no indication of the presence of activities or potential contaminant sources within 100 feet of the production wells. Specifically, the most recent Sanitary Survey (1999) did not highlight any activities or other potential contaminant sources in the Control Zones. The wells appear to be located in just northeast of an old locomotive turn-around and southeast of the entrance to the BNSF tie treatment plant service road The wells appear to have a common header are secure within locked well buildings. No activities are known or believed to occur near the wellheads that could be considered potential contaminant sources within the Control Zone. Access to the wells appears to be strictly limited to authorized persons.

Inventory Region

The area within the Inventory Region for the Sanders County Water District PWS wells (as depicted on Figure 5 and Figure 6) includes the residential area for the town of Paradise. It doesn't appear that there is any community/municipal sewer system for the homes or other facilities in the area of Paradise serviced by the Sanders County Water District, so any residents in the area must be serviced by private onsite septic systems. Septic density is an estimation that is based upon the 2000 US Census for population and the shapes of areas of septic density are based upon census population blocks. Areas of increased septic density have the potential to chronically leak poorly treated sewage effluent into the subsurface and impact groundwater quality. The available data indicate that the residential area of the town of Plains is a high-density area of private onsite septic systems. Unfortunately, this area is directly upgradient from the 2 production wells. In addition, any active businesses, schools, or other facilities in this area (especially along Highway 200) can probably be considered to have large capacity septic systems providing onsite septic treatment and disposal. Large capacity septic systems are typically systems that service at least 20 people per day. These systems are not documented, so it is difficult to determine their presence, actual usage, or precise locations. Land use within the Inventory Region for the Sanders County Water District PWS is low intensity residential, grazing, timber, fallow cropland, and other non-classified agricultural land (Figure 5 and Figure 6). It does not appear that there is any irrigated agricultural land within the Inventory Region. Since no irrigation was noted and no large concentrations of animals have been recorded in the area, the significance of any agricultural land on potential water quality at the PWS wells is dramatically reduced and the agricultural land uses noted above are not considered a threat to this PWS. The agricultural land uses noted on Figure 5 and Figure 6 is a data set that is based on tax appraisal of land values. Figure 5 and Figure 6 depicts the Inventory Region and nearby potential contaminant sources. A routine search of old permitting records indicated that there is an old (closed) landfill located just south of town and upgradient of the wells. An out-of-service petroleum pipeline crosses the region east of the wells as does both the highway and railroad lines. Table 6 is a general listing of the potential contaminant sources known to be present around and within the Inventory Region of the Sanders County Water District PWS. This is a short list, because it appears that there are few potential contaminant sources near the wells.

Table 6. Potential contaminant sources
In and Around Paradise
Sanders County Water District PWS (Refer to Figure 5, Figure 6, and Figure 7)

Contaminant Source	Contaminants	Description
Area of High Density of Private Septic Systems (in-town)	Pathogens, Nitrate, other organic and inorganic chemicals	Waste water discharged to drainfields that may contain improperly disposed chemicals or these systems may not completely eliminate nitrate and pathogens from the effluent; these systems may have a cumulative effect where taken together they may affect water quality at the wells
Grazing and Other Agricultural Land Use	Nitrate, Herbicides and Pesticides (SOCs)	Possible over application, misuse, or spillage of these chemicals in the vicinity of the wells.
Paradise Refuse Disposal (closed landfill)	Nitrate, SOCs, VOCs, metals, other	Although the landfill is supposedly closed, it may not have been lined and is therefore capable of allowing leached contaminants to reach groundwater upgradient of the wells.
BNSF Tie Treating Facility (this looks like it is outside of the Inventory Region and downgradient from the wells)	Creosote, other SOCs	Soil and groundwater contamination associated with the former tie treating facility
Large capacity septic systems and the BGN RV Dumpsite in-town along Highway 200	Pathogens, Nitrate, other organic and inorganic chemicals	Waste water discharged to drainfields that may contain improperly disposed chemicals or these systems may not completely eliminate nitrate and pathogens from the large volume of effluent
Paradise Grade School UST (underground fuel storage tank)	VOCs, petroleum hydrocarbons	Leakage from the UST into soil and groundwater
Out-of-service petroleum pipeline	VOCs, petroleum hydrocarbons	Leakage from the line into soil and groundwater upgradient from the wells
Highway and Railroad	VOCs, SOCs, Nitrate, metals, other	Large volume but infrequent spills along these transportation corridors upgradient from the wells

Table 6. Potential contaminant sources
In and Around Paradise
Sanders County Water District PWS (Refer to Figure 5, Figure 6, and Figure 7)

Contaminant Source	Contaminants	Description
Paradise Refuse Disposal Landfill (closed)	VOCs, SOCs, Nitrate, metals, other	It is unknown if the landfill was lined and what exactly was placed in the landfill. It is assumed that chemicals / contaminants have the potential to leach out of the landfill and impact groundwater upgradient of the PWS wells.

Note: The grazing and other agricultural land use is not really considered a serious threat to the PWS because the records available did not indicate that this was irrigated land.

Surface Water Buffer
The Surface Water Buffer as depicted on Figure 7 extends along both sides of the Flathead and Clark Fork Rivers for a distance of approximately 10 miles upstream of Paradise. Within the buffer, there is a small amount of residential development along the river, a few businesses (with large capacity septic systems), the out-of-service petroleum pipeline, the railroad, and Highways 135 and 200. A very small amount of irrigated cropland was identified at the confluence of the 2 rivers, but overall, the percentage of the area in irrigated crops is low. The inventory results suggest that other than the infrequent but large scale spills along the highway or railroad, there are no significant potential contaminant sources of nitrate or pathogens within the Surface Water Buffer.

Recharge Region
The Recharge Region as delineated for this SWDAR is depicted on Figure 8. It is a moderately sized watershed that encloses the entire portion of the Clark Fork River and Flathead River valleys just upstream of Paradise. It actually captures a small amount of the watershed above the area described by the Surface Water Buffer. A number of abandoned and inactive mines did show up in the region, but it isn't clear if any significant mine waste (tailings) is associated with any of them. Mine waste impacted sediment is present in drainages southwest and northwest of the region, but outside of the Recharge Region boundaries. No major land uses in the Recharge Region were identified as significant potential contaminant sources (it is essentially all forested). As with the inventory of the Surface Water Buffer, few significant potential contaminant sources were identified within the Recharge Region.

Inventory Update

To make this SWDAR a useful document in the years to come, the managers / certified water system operators for the Sanders County Water District public water supply should update the inventory for their records every year. Changes in land uses or the presence of new potential contaminant sources should be noted and additions made as needed. This updated inventory should be submitted to DEQ at least every 5 years to ensure that this report/plan stays current in the public record.

Inventory Limitations

The accuracy of this potential contaminant source inventory is limited in several respects. The inventory is based on data that is readily available through state documents, published maps and reports, GIS data, and discussions with people that are familiar with the area. Documentation may not be readily available on some potential sources. An example of this is any large capacity septic systems that may be present within or near the Inventory Region, which are difficult to identify or locate for the inventory. The BNSF Railroad Tie Treating facility did not show up on any of the DEQ Permit Databases, but was relatively obvious on air photos and topographic maps of the area. Additionally, some contaminant sources may show up on an inventory, but may not have accurate coordinates associated with them. Alternately, DEQ may have somewhat incomplete or outright erroneous information on the nature or the extent of certain facilities. As a result of the unknowns, all potential contaminant sources may not have been identified or recognized as being significant potential contaminant sources. The author of this SWDAR is depending on local PWS managers and operators for site-specific knowledge. Their initial review of this document has been sought and their comments incorporated.

CHAPTER 4
SUSCEPTIBILITY ASSESSMENT

General Discussion

The Susceptibility of the Sanders County Water District PWS production wells to various types of contamination is assessed in the following paragraphs. The proximity of a potential contaminant source to a spring or well intake, potential contaminant migration pathways, and the density of potential non-point contaminant sources all determine the threat of contamination, referred to here as hazard.

Hazard Determination

The criteria used to determine the hazard of significant potential contaminant sources within the Inventory Region as it was delineated in this SWDAR is described in Table 7 below. Note that this table is specific to PWSs that draw their water from unconfined aquifers. The determination of hazard is somewhat different for other types of water sources. Hazard and the existence of barriers to contamination determine susceptibility, which is described in Table 8 below. The lithology recorded for Sanders County Water District PWS wells and other wells in the area is mostly alluvial sand and gravel. Confining units, if present, do not appear to be laterally continuous and don't actually constitute the top of a confined aquifer in the area of Paradise. According to Table 7 below, any point source within the 1-year groundwater TOT distance will have a high hazard, any located between 1-year and 3-year TOT will have a moderate hazard, and any that are located outside of that will have a low or negligible hazard. For this SWDAR, a 1-year groundwater TOT distance was arbitrarily assigned as the river located west and south of town. The river bar located south of town on the far side of the river is assigned as being between the 1- and 3-year groundwater TOT distance. The boundaries were assigned for convenience, to follow easily recognizable features on the ground, and to best represent the areas where potential contaminant sources would be of greatest threat to water quality at the PWS wells. Of the potential contaminant sources, private onsite septic systems are the greatest potential contaminant source. Of next greatest concern are contaminants associated with spills along the highway and the railroad that pass near the wells. For a list of contaminant sources within the Inventory Region, refer to Table 9 below. Agricultural land occupies a large part of the region, but no irrigated land is present. As such this land use presents a negligible hazard.

Table 7. Hazard of potential contaminant sources.
For Water Sources Using Unconfined Aquifers.

Potential Contaminant Source	High Hazard	Moderate Hazard	Low Hazard
Point Sources	Within 1 year TOT	Between 1 to 3 years TOT	Over 3 years TOT
Septic Systems	More than 300 per sq. mi.	50 – 300 per sq. mi.	Less than 50 per sq. mi.
Municipal Sanitary Sewer (percent land use)	More than 50 percent of region	20 to 50 percent of region	Less than 20 percent of region
Cropped Agricultural Land (percent land use)	More than 50 percent of region	20 to 50 percent of region	Less than 20 percent of region

Notes:

- Highlighted areas are those probably relevant to the Sanders County Water District PWS Inventory Region.
- Key to the highlighted choices above is the interpretation of the lithologic logs suggesting that the PWS wells withdraw water from an unconfined aquifer. In this situation, most of the potential contaminant sources that showed up in the inventory are located south and/or east of the wells.

Susceptibility Determination

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 a PWS well intake. First, hazard is rated by the proximity of a potential contaminant source to the well(s) or it is based on the percentage of the Inventory Region occupied by a certain type of source/land use (from Table 7). Then the presence of barriers is used to come up with a susceptibility rating. Susceptibility ratings are determined individually for each significant potential contaminant source and/or contaminant based on Table 8. These susceptibility ratings are the evaluation of the vulnerability of wells to the more significant potential contaminant sources and are presented on Table 9.

Table 8. Susceptibility, based on Hazard and Barriers.

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

Discussion of the Susceptibility Assessment

A summary of the susceptibility assessment for Sanders County Water District PWS production wells is located in Table 9. What follows is a brief discussion of the susceptibility assessment for the significant potential contaminant sources that the PWS is most susceptible. Because a contaminant source has not been identified in the inventory or susceptibility assessment of this report, it doesn't mean that the potential for contamination does not exist or is not a threat. So, if potential contaminant sources were present near or upgradient of the PWS, it would be prudent to understand the threat from these sources. It appears that there are not any significant contaminant sources present in the area between the 1- and 3-year groundwater TOT. It also appears that there are few contaminant sources that were identified in the Surface Water Buffer or the Recharge Region. The only contaminant source identified outside of the Inventory Region were several abandoned mines, a couple of rock quarries, and some large capacity septic systems associated with riverside resorts or campgrounds (see Figure 7 and Figure 8). Of significance is the fact that a number of serious mine impacted stream channels were identified, but these were all outside of the Recharge Region and would not impact water quality upgradient from the PWS wells (Figure 8).

Table 9. Susceptibility Assessment Results

Sanders County Water District PWS – Significant Potential Contaminant Sources within the Inventory Regions

Contaminant Source	Contaminant	Hazard	Hazard Rating	Barriers	Susceptibility	Management Recommendations
Area of High Density of Private Septic Systems east and south of the PWS	Pathogens, Nitrate, other	Wastewater discharged to drainfields that may contain improperly disposed chemicals or systems that may not adequately eliminate nitrate and pathogens from the effluent	**High**	None Known	**Very High**	Aggressive promotion of the design and installation of advanced septic systems in the area; education (incl. posters and placards) to reduce improper disposal of chemicals; and possible development and incorporation of town into a municipal/community sewer system with a WWTP. Involvement of PWS managers/operators in this process is critical.
Large Capacity Septic Systems in town	Pathogens, Nitrate, other	Wastewater discharged to drainfields that may contain improperly disposed chemicals or systems that may not adequately eliminate nitrate and pathogens from the effluent	**High**	None Known	**Very High**	Aggressive promotion of the design and installation of advanced septic systems in the area; education (incl. posters and placards) to reduce improper disposal of chemicals; and possible development and incorporation of town into a municipal/community sewer system with a WWTP. Involvement of PWS managers/operators in this process is critical.
Highway and Railroad Line	VOCs, SOCs, Nitrate, other	Infrequent but very large-volume releases of contaminants along these transportation corridors and in proximity to the wells; ongoing weed control by railroad	**High**	Some limited emergency response capability is available locally and from nearby communities; Highway is isolated from the wells by the double railroad line and associated drainage pattern	**Moderate**	Promote local training and the allocation of resources for spill response and cleanup; examine and alter drainage along these corridors (as needed) to remove contaminants from the area of the wells; consider construction of a berm and/or drainage ditch between the railroad and the wells; coordinate with railroad to reduce herbicide use in or around the area of the city wells.
Petroleum Pipeline located east and south of wells	VOCs, petroleum hydrocarbons	Fuel spills or releases to surface or to groundwater that can reach the PWS wells	**High**	Pipeline is not active, but still contains some petroleum; drainages associated with the highway and the railroad will carry surface releases away from the wells	**Moderate**	Promote good local emergency response training and locally allocated emergency response resources; promote good working relationship with the petroleum pipeline managers and owners to promote monitoring and cleanup as needed
UST Site at the school	VOCs, petroleum hydrocarbons	Fuel spills or releases to surface or to groundwater that can reach the PWS wells	**High**	Secondary containment of tank; continuous monitoring of inventory	**Moderate**	Promote good housekeeping and BMPs; promote site remediation / cleanup as needed; promote groundwater monitoring; continue active and regular inventory monitoring

Table 9. Susceptibility Assessment Results

Sanders County Water District PWS – Significant Potential Contaminant Sources within the Inventory Regions

Contaminant Source	Contaminant	Hazard	Hazard Rating	Barriers	Susceptibility	Management Recommendations
Paradise Refuse Disposal Landfill (closed)	VOCs, SOCs, Nitrate, metals, other	It is unknown if the landfill was lined and what exactly was placed in the landfill. It is assumed that chemicals / contaminants have the potential to leach out of the landfill and impact groundwater upgradient of the PWS wells.	**High**	Landfill is classified as being closed and no longer receives refuse; no know contamination is present at or is known to be leaching from the site	**Moderate**	Promote site remediation / cleanup as needed; promote capping of the landfill to reduce leaching of contaminants; promote coordination with the DEQ managers for the site (to stay on top of the status of the site)
Grazing and Other Agricultural Land Use	Nitrate and SOCs	Any concentrations of animals or irrigated pasture and hay may mobilize nitrates or other ag chemicals, which may reach groundwater	**Low**	McLaughlin Creek The agricultural land is not currently being irrigated and no records exist to suggest that large numbers of animals are kept in a confined feeding operation (CAFO)	**Low**	Attempt to keep animal numbers on pastures low and well dispersed, promote good agricultural BMPs, keep agricultural activities away from the wellhead(s)

Note:

- The stratigraphy at both well locations suggest that the wells draw water from a shallow unconfined aquifer.
- Septic density is based on the 2000 US Census with the boundaries representing Census Blocks. The Census Blocks are approximate boundaries.
- Large capacity septic systems are usually associated with any business, shop, school, or other facility. But these facilities' septic systems do not show up in the inventory as they are not tracked by any database that is accessible by the author.
- BMPs are Best Management Practices appropriate for the business in question, and are especially relevant to practices that reduce the release of contaminants to the surrounding environment.
- The agricultural land use is based on land appraisal for tax purposes and an examination of the air photo. Hay windrows are seen on the air photo used for Figure 3, Figure 5, and Figure 6. The Montana State Library's Natural Resource Information System made this data and the photos available.

Private Onsite Septic Systems

There is an area where there is a high density of private septic systems located east and southeast of the PWS wells (the residential area for Paradise) as depicted on Figure 5, and Figure 6. Septic density within the Inventory Region as a whole is low, but areas of concentrated or elevated septic density can be treated much like point sources in the susceptibility determination. Therefore this area is assigned a high hazard due to its density and proximity to the wells. There are an unknown number of large capacity septic systems in Paradise and especially along the main street of town (Highway 200). The difficulty with the concentration of private onsite septic systems and what large capacity septic systems are in the area is that there are typically a percentage of these systems that are in poor shape and are poorly maintained. As such, they are chronically discharging poorly treated septic effluent to the shallow aquifer located upgradient of the wells. When enough septic systems are present in an area (even if well maintained), they can have a measurable long-term impact on groundwater quality in downgradient wells. The area containing a high density of septic systems and the large capacity septic systems are assigned a high hazard. No barriers were recognized as being in-place between these septic systems and the water supply wells. With no barriers, the wells are considered to have a very high susceptibility to contamination from these sources. It should be noted that the PWS wells have a history of moderate levels of nitrate in routine water samples, which suggests that the wells may be demonstrating impacts from nearby septic system effluent. This community would strongly benefit from the development of a program to either replace existing septic systems with advanced septic effluent treatment systems or develop a community sewer system with a centralized wastewater treatment plant.

Highway and Railroad Corridors

Both the highway and the railroad run the length of the Inventory Region and pass upgradient from the PWS's wells. Although major accidents and spills are a very infrequent event, a large spill could be catastrophic and seriously impact water quality on a permanent basis. These corridors are considered to have a high hazard. It was difficult to identify the barriers in-place between the transportation corridors and the wells. The barriers assumed to be in-place are the fact that the railroad line and the longitudinal drainage pattern associated with the railroad will stand between releases along the highway and the wells. It is also assumed that local and nearby emergency responders have some training and resources to deal with large spills along the highway and railroad line and these responders will at minimum mitigate a large spill until other larger resources can be brought to bear on the site. With a couple of barriers in-place, the PWS wells have a moderate susceptibility to contamination from major spills along the highway and/or the railroad line.

Petroleum Pipeline

The petroleum pipeline is currently not being used to ship petroleum through the area. This petroleum is shipped by truck and rail to Thompson Falls where it is placed in a pipeline and shipped to the west. The pipeline that runs parallel to the Flathead and Clark Fork Rivers may contain residual petroleum and is a continued potential contaminant source. The pipeline passes through the town east of the residential area and east of both the highway and the railroad line. It is assumed that the highway and railroad will cause any surface releases to be diverted away from the wells. As such there appears to be a couple of barriers in-place between the contaminant source and the wells. Thus the wells are thought to have a moderate susceptibility to contamination originating in the pipeline.

UST At the Grade School

This underground storage tank is recorded as not having any leaks or releases associated with it's operation. It is assigned a high hazard as it is within the 1-year groundwater TOT distance. Although no specific information is known about the tank, a couple of barriers are assumed to be in-place. These barriers are the presence of some type of secondary containment and the continued monitoring of inventory (to detect leaks). It is unknown if there are other engineering or management barriers in-place for this tank. With multiple barriers, the PWS wells are thought to be moderately susceptible to contamination from the UST at the school.

Paradise Refuse Disposal Landfill

This landfill located just south of town is recorded as being closed. Little other information was available on the status or nature of this facility. It isn't known if the landfill was constructed with a liner or was finished off with a cap (to prevent or reduce leaching). As such, it is assumed that it is an ongoing potential contaminant source and was assigned a high hazard. Credit was given as barriers for: the landfill being historic and closed, and that there is not known contamination migrating offsite (as far as the author could determine). With a couple of barriers in-place, the PWS wells are probably only moderately susceptible to contamination from the landfill.

Summary of Susceptibility Assessment Results

The Sanders County Water District public water supply uses 2 wells that are located directly west of town and between town and the Clark Fork River. The wells appear to be drawing water from a shallow unconfined aquifer that may or may not be in communication with the river. The unconfined groundwater beneath the area of the Sanders County Water District PWS wells is believed to flow approximately toward the northwest and sub-parallel to the Clark Fork River as depicted on Figure 6. The Inventory Region was established as seen on . An inventory was conducted for the area and inventoried potential contaminant sources listed on Table 6. Some of these inventoried contaminant sources are outside of the Inventory Region for the wells and do not show up in the susceptibility assessment of Table 9, but are listed there to bring them to the attention of the owners and managers of the PWS. The Inventory Region contains only a few significant potential contaminant sources as seen on Table 9. The Sanders County Water District PWS wells have a very high susceptibility to contamination from the area of high septic density located east and southeast of the wells. This area is the residential area of Paradise itself. Paradise would be very well served to consider the development of a centralized sewer collection system and wastewater treatment plant to carry off and remove septic waste from town. The PWS wells are moderately susceptible to contamination originating from: the highway and the railroad, a petroleum pipeline, a single UST associated with the grade school, and with a closed landfill located south of town. The surrounding agricultural land is not currently irrigated and thus is not viewed as a hazard to the wells.

CHAPTER 5
MONITORING WAIVERS

General Discussion of Waivers

This chapter addresses the Sanders County Water District PWS (MT0000385) that DEQ is classified as a Community Non-Transient public water supply. The authors' recommendation is based upon the determination of susceptibility as described in the previous chapter.

<u>Monitoring Waiver Requirements</u>

The 1986 Amendments to the Safe Drinking Water Act require that community and non-community PWSs sample drinking water sources for the presence of volatile organic chemicals (VOCs) and synthetic organic chemicals (SOCs). The US EPA has authorized states to issue monitoring waivers for the organic chemicals to systems that have completed an approved waiver application and review process. All PWSs in the State of Montana are eligible for consideration of monitoring waivers for several organic chemicals. The chemicals diquat, endothall, glyphosate, dioxins, ethylene dibromide (EDB), dibromochloropropane (DBCP), and polychlorinated biphenyls are currently excluded from monitoring requirements by statewide waivers.

Types of Waivers

<u>Use Waivers</u>

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

<u>Susceptibility Waivers</u>

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

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

Susceptibility Waiver for Unconfined Aquifers

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

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

The objective of the Susceptibility Waiver application is to assess the potential of organic chemical migration from the surface to the unconfined aquifer. The general procedures make use of a combination of site-specific information pertaining to the location and construction of the source, monitoring history of the source, geologic characteristics of the vadose zones, and mobility and persistence characteristics of the organic chemicals. The zone of contribution of the unconfined groundwater source must be defined and plotted. Groundwater flow directions, gradients, and a 3-year time-of-travel should be described. All surface bodies within 1,000 feet of the PWS well(s) must be plotted. Analytical monitoring history of the PWS well and nearby wells should also be provided.

Susceptibility Waiver for Confined Aquifers

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

The susceptibility of a confined aquifer relates to the probability of an introduced contaminant to travel from the source of contamination to the aquifer. Susceptibility of an aquifer to contamination will be influenced by the hydrogeologic characteristics of the soil, vadose zone (the unsaturated geologic materials between the ground surface and the aquifer), and confining layers. Important hydrogeologic controls include the thickness of the soil, the depth of the aquifer, the permeability of the soil and vadose zones, the thickness and uniformity of low permeability and confining layers between the surface and the aquifer, and hydrostatic head of the aquifer. These factors will control how readily a contaminant will infiltrate and percolate toward the groundwater.

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

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

The objective of the susceptibility waiver application is to assess the potential of organic chemical migration of contaminants into water that is used as a source. The general procedures make use of a combination of site-specific information pertaining to the location and construction of the water source development, monitoring history of the source, geologic/hydrologic characteristics of the source water, and chemical characteristics of the organic chemicals pertaining to their mobility and persistence in the environment. The area of contribution to the aquifer into which the PWS intake is installed must be defined and plotted. This should describe the subsurface stratigraphy, groundwater and aquifer characteristics, well construction, groundwater flow direction(s), and a listing (and a map) of other wells in the area that draw from the same formations. All surface bodies within 1,000 feet of the PWS well(s) must be plotted. Analytical monitoring history of the PWS well(s) should also be provided as part of the susceptibility waiver application.

Waiver Recommendation of this SWDAR

Based on past monitoring results and the susceptibility assessment of the Sanders County Water District PWS (as it is now configured, using 2 production wells withdrawing groundwater from alluvial materials under shallow unconfined conditions), the PWS is probably not eligible for monitoring waivers. DEQ records suggest that the PWS currently has no monitoring waivers in place. Based on the monitoring history for the wells, the inferred geology of the area, the nature of the aquifer from which the wells draw water, the results of the inventory, and the susceptibility assessment of this SWDAR, the Sanders County Water District PWS production wells are very vulnerable to a host of potential contaminants, but of greatest significance is the contamination associated with private onsite septic systems in town. For monitoring waiver consideration, the Sanders County Water District PWS should submit a letter to DEQ requesting the specific monitoring waivers. If requested by DEQ, the PWS may also need to provide additional information regarding chemical use in the area within or around the Inventory Region.

REFERENCES

Alt, David, and Hyndman, Donald W., **1990**, **Roadside Geology of Montana**, Mountain Press Publishing Company, Flathead.

Alt, David, and Hyndman, Donald W., **1998, Northwest Exposures, A Geologic Story of the Northwest,** Mountain Press Publishing Company, Flathead.

Alden, W.C., **1953, Physiography and glacial geology of western Montana and adjacent areas**, U.S. Geologic Survey Professional Paper 231, 200 p.

Board of Water Well Contractors, **Administrative Rules of Montana**, 01/30/**2001**. **36.21.656-.660**

Fetter, C.W., **Applied Hydrogeology**, **1994**, 3rd Edition, Prentice Hall, Upper Saddle River, New Jersey.

Freeze, R. Allan and Cherry, John A., **1979. Groundwater,** Prentice-Hall, Inc.

Kendy, E., and R.E. Tresch, **1996**, **Geographic, Geologic, and Hydrologic Summaries of Intermontane Basins of the Northern Rocky Mountains**, Montana: U.S. Geological Survey Water Resources Investigations Report 96-4025, 233 p.

Heath, Ralph C., **1974. Ground-water Regions of the United States**, U.S. Geological Survey, Water Supply Paper 2242, Washington D.C., 78p.

Montana Bureau of Mines and Geology, **tabular well information, 2000**:
http://mbmgsun.mtech.edu/ & http://mbmggwic.mtech.edu/

Montana Bureau of Mines and Geology Open File Report 99, 132 p., **1982. Nobel, R.A., Bergantino, R.N., Patton, T.W., Sholes, B.C., Daniel, Faith, and Schofield, Judeykay**. Occurrence and characteristics of groundwater of Montana—Volume 2, The Rocky Mountain Region

Montana Department of Environmental Quality, Permitting and Compliance Division: **1999. Sanitary Survey,** for the Sanders County Water District PWS - PWS # MT0000385, and other correspondence.

Montana Department of Environmental Quality, Permitting & Compliance Division and the Drinking Water Assistance Program - Montana Water Center: **Ground Water Manual for Small Water Systems, January 1999**.

Montana Department of Environmental Quality, **Source Water Protection Program**, **1999**. Approved by EPA in November 1999, inclusive of **personal communications in 2004** with Joe Meek & others.

Montana State Library - Natural Resource Information Service, **2000. Graphical and tabular information**:
http://nris.state.mt.us/mapper/

Montana State Library - Natural Resources Information System (NRIS) **2000 map base of the USGS Topographical coverage** at 1:24,000 scale in MrSID format.

Raines, G.L. and B.R. Johnson, **1996**. **Digital Representation of the Montana State Geologic Map**: U.S. Geological Survey Open File Report 95-691, 19 p.

U.S. Department of Commerce, **2003, Climatic Summary of the United States Supplement for 1914 Through 2002**, Montana: Washington. D.C. Department of Commerce, Weather Bureau, Climatology of the United States no. 86-20, p11 and 60. Specific data came from the website: wrcc@dri.edu

U. S. Environmental Protection Agency (US EPA), **1991**. **Manual of Small Public Water Supply Systems**, US EPA Office of Water (WH-550), EPA 570/9-91-003.

U.S. Geological Survey, **2000**. **National Landcover Dataset, Montana**. 30-meter electronic digital landcover / land use data set interpreted from satellite imagery.

GLOSSARY

Acute Health Effect. An adverse health effect in which symptoms develop rapidly.

Alkalinity. The capacity of water to neutralize acids.

Bgs. Below Ground Surface. This is the measure of a borehole or depth to features in the borehole or well (i.e., The static water level is 25 feet bgs.)

Best Management Practices (BMPs). Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Coliform Bacteria. Bacteria found in the intestinal tracts of animals. Their presence in water is an indicator of pollution and possible contamination by pathogens.

CAFO. Confined animal feeding operation, which is typically registered by the State of Montana.

CECRA. This is the 1987 Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA) and provides Montana DEQ with similar authorities as provided under the federal Superfund Act (CERCLA). Montana CECRA sites are typically facilities that do not fall under the jurisdiction of the federal program.

Class V UICs. These are underground injection control wells that are classified as Class V by the US EPA. These are often dry wells, floor sumps, stormwater sumps, and large capacity septic systems. Although regulated, these systems have typically not been identified and listed in a central database, so the names, locations, or nature of these systems have not been established.

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 that inhibits the flow of water.

Delineation. A process of mapping source water management areas.

Effective Porosity. The percent of soil, sediment, or rock through which fluids, such as air or water, can pass. Effective porosity is always less than total porosity because fluids can not pass through all openings.

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

Hazard. A measure of the potential of a contaminant leaked from a facility to reach a public water supply source. Proximity or density of significant potential contaminant sources determines hazard.

Hydraulic Conductivity. A coefficient of proportionality describing the rate at which water can move through an aquifer.

IOCs. Inorganic Chemicals

Inventory Region. A source water management area that encompasses an area expected to contribute water to a public water supply well within a fixed distance or a specified groundwater time-of-travel distance.

Large Capacity Septic Systems. As defined by the US EPA Underground Injection Control (UIC) Program, these are septic systems that serve more than 20 persons per day for a period greater than 6 months of the year.

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.
mg/L. Milligrams per Liter is also called parts per million (ppm).

Ug/L. Micrograms per Liter is also called parts per billion (ppb). 1 ppb = 0.001 ppm, and 1 ppm = 1,000 ppb

Nitrate. An important plant nutrient and type of inorganic fertilizer. In water the major sources of nitrates are 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.

Pathogens. A bacterial organism or virus 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.

Porosity. The percent of soil, sediment, or rock filled by air, water, or other fluid.

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

POTW. Publicly Owned Treated Wastewater facility, typically a municipal sewer treatment plant with a wastewater discharge.

SIC Code. The U.S. Standard Industrial Classification (SIC) Codes classify categories of businesses. SIC Codes cover the entire range of business categories that exist within the economy.

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

Susceptibility (of a PWS). The 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. 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, non-point, and natural sources. The TMDL program was established by section 303(d) of the Clean Water Act to help states implement water quality standards.

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

Transmissivity. The ability of an aquifer to transmit water.

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

Volatile Organic Compounds (VOC). Any organic compound which evaporates readily to the atmosphere (e.g. fuels and solvents).

Recharge Region / 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.

WWTP. Wastewater Treatment Plant.

Note: Definitions are taken from EPA's Glossary of Selected Terms and Abbreviations and other sources.

APPENDICES

APPENDIX A

DEQ PWS Section’s Database Output and Water Quality Data

APPENDIX B

Sanitary Survey
GWUDISW Evaluation
PWS Well Logs

APPENDIX C

Well/Geologic Logs for Area Wells
BNSF Tie Facility Information

APPENDIX D

<u>Concurrence Letter</u>