Manhattan Christian Schools
Public Water System

PWSID # MT0001279

SOURCE WATER DELINEATION AND ASSESSMENT REPORT

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Contact Person:

Sylvia Ypma
Certified Operator #4521

Manhattan Christian Schools
8000 Churchill Road
Manhattan, MT 59714

Phone: (406) 282-7261

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INTRODUCTION

Carolyn DeMartino, a Water Quality Specialist with the Montana Department of Environmental Quality (DEQ), and Aubrey Smartt, a DEQ Intern, completed the Manhattan Christian Schools (PWSID# 01244) Source Water Delineation and Assessment Report (SWDAR). Sylvia Ypma, at (406) 282-7261 is the certified operator for the Manhattan Christian Schools Public Water Supply (PWS).

Purpose

This Source Water Delineation and Assessment Report is intended to meet the technical requirements for the completion of the delineation and assessment for the Manhattan Christian Schools Public Water System (PWS) as required by the Montana Source Water Protection Program (DEQ, 1999) and the federal Safe Drinking Water Act (SDWA) Amendments of 1996 (P.L. 104-182).

The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to protect public drinking water supplies from contamination. A major component of the Montana Source Water Protection Program is "delineation and assessment". Delineation is a process of mapping source water protection areas, which contribute water used for drinking. Assessment involves identifying locations or regions in source water protection areas where contaminants may be generated, stored, or transported, and then determining the relative potential for contamination of drinking water by these sources. The primary purpose of this source water delineation and assessment report is to provide information that helps Manhattan Christian Schools PWS to protect its drinking water source.

Limitations

This report was prepared to assess impacts from potential contaminant sources to the Manhattan Christian Schools PWS, and is based on published information and information obtained from local residents familiar with the community. The terms "drinking water supply" or "drinking water source" refer specifically to the source of the Manhattan Christian Schools public water supply and not any other public or private water supply. Also, not every potential or existing source of groundwater or surface water contamination in the Manhattan Christian Schools area have been identified. Only potential sources of contamination in areas that contribute water to its drinking water source are considered.

The term "contaminant" is used in this report to refer to constituents for which maximum concentration levels (MCLs) have been specified under the national primary drinking water standards, and to certain constituents that do not have MCLs but are considered to be significant health threats.

CHAPTER 1
BACKGROUND

The Community

Study Area

Churchill is located in the Camp Creek Hills west of the Gallatin Valley, in the western part of Gallatin County (Figure 1). The area is comprised primarily of farm and ranchland. The economy of the Churchill area includes agriculture and small businesses in the area. Many area residents work in the larger communities in the valley as the population of the county grows.

The Community

Manhattan Christian Schools, a combined elementary and high school, is located in the unincorporated town of Churchill in Gallatin County of southwestern Montana (Figure 1). Bozeman is the largest city in the area, located approximately 15 miles east of Churchill. Belgrade is the largest community with commercial services in the area. According to the U.S. Census Bureau the population of Gallatin County in 2000 was 67,831 with the population of the Amsterdam-Churchill vicinity at 727. Manhattan Christian Schools serves, from the surrounding area, approximately 40 individuals during the summer and 380 in the winter.

Churchill is bisected by Highway 288 (Churchill Rd.), which runs through town. Interstate 90 runs east to west about 8 miles north of the community. There is no railway service in the Churchill vicinity.

The surrounding area is agricultural, growing primarily small grains, alfalfa and potatoes. Several dairy and beef cattle operations are also present in the area. An implement dealer and auto dealer are two other large businesses in the area both lying on the northern outskirts of the community. Two subdivisions, one completed with another in development, are present on the outskirts of Churchill. The community also includes two churches, and a retirement home.

The primary water users are residential area, and agricultural irrigation systems. Domestic water in the area is obtained from private wells. Agricultural irrigation water is derived from wells and from the Low-line canal and its offshoot ditches, which brings water from the Gallatin River to the area. The entire Churchill community, including the neighboring unincorporated community of Amsterdam, is served by a single sewer system with settling ponds approximately three miles away.

Other public water supplies are located in the Manhattan Christian Schools PWS vicinity (Figure 2). These systems have been listed in Table 1 for informational purposes. The SWDAR for the Churchill Retirement Home has been completed. The SWDAR for Amsterdam School District #75 is in progress.

Table 1. Manhattan Christian Schools Area Public Water Supplies

Public Water Supply Name	PWSID#	Class
Churchill Retirement Home	01375	Community
Amsterdam School District #75	01244	Non-Transient Non-Community

Climate

The climate of the Churchill vicinity is typical of southwestern Montana. Based on the Western Regional Climatic Center data for Manhattan (the closest weather station) for the period of record, annual precipitation averages 12.29 inches. Monthly average precipitation ranges from 0.41 inches in December to 2.32 inches in June. Summer thunderstorms and winter snows provide a majority of the precipitation in the area. The annual mean snowfall in the Manhattan area is 41.6 inches. Periodic drought cycles (as defined by moving annual precipitation averages less than 10 inches) occur every 6 to 7 years. A summary of the available climatic data for this area is presented in Table 2.

Table 2. Climatic Summary
Manhattan, Montana (245351)
Period of Record Monthly Climate Summary
Period of Record: 2/1/1952 to 6/30/1983

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	Insufficient Data												
Average Min. Temperature (F)	Insufficient Data												
Average Total Precipitation (in.)	0.56	0.42	0.77	1.00	2.16	2.32	1.04	0.96	1.21	0.82	0.61	0.41	12.29
Average Total Snow Fall (in.)	9.3	5.7	8.7	4.7	0.9	0.0	0.0	0.0	0.2	1.2	4.8	6.1	41.6
Average Snow Depth (in.)	3	2	1	0	0	0	0	0	0	0	0	1	1

Percent of possible observations for period of record.
Max. Temp.: 0.0% Min. Temp.: 0.0% Precipitation: 97.5% Snowfall: 94.6% Snow Depth: 93.3%
Source: Western Regional Climate Center, wrcc@dri.edu

Geographic Setting

The community of Churchill and Manhattan Christian Schools are located in the western part of the Gallatin Valley approximately 15 miles west of Bozeman and just east of Camp Creek and west of the Gallatin River in the NW¼NE¼ of Section 13, Township 1 South, and Range 3 East (Figure 1). Churchill is located on the Madison plateau, located in the Camp Creek Hills above the Gallatin River valley to the east. The Madison Plateau is part of the Camp Creek Hills representing a broad set of small hills that separate the Madison and Gallatin River valleys. The elevation at Churchill is approximately 4,550 feet above mean sea level (MSL), with the higher elevations of the Camp Creek Hills at over 5,500 feet MSL. Churchill is geographically located at 45° 75' N latitude and 111° 28' W longitude. Camp Creek flows north until it empties into the Gallatin River 7 miles north of Manhattan Christian Schools. Godfrey Creek flows north along the floor of a drainage between hills on the eastern edge of Churchill. The Godfrey Creek Watershed is a tributary from the Camp Creek Hills to part of the Gallatin River Watershed. The United States Geological Survey Hydrologic Unit Code (HUC) for the Lower Gallatin River system, which includes the Godfrey Creek Watershed, is 10020008120. Camp Creek flows north in a drainage parallel to Godfrey Creek, located approximately one mile west of Godfrey Creek.

The Camp Creek Hills and Gallatin Valley are surrounded on three sides by mountains. The Bridger Mountains lie approximately 20 miles to the east, the Gallatin Range about the same distance to the south and the Tobacco Roots a little farther away to the west. To the north are the Horseshoe Hills.

Geology

This section provides an overview of the geology in the vicinity of the Manhattan Christian Schools PWS. The geology of the area can be used to determine the locations, boundaries, and hydraulic properties of local aquifers. An understanding of hydrogeologic conditions also provides an explanation for the sensitivity of local aquifers to potential contamination sources.

Manhattan Christian Schools obtain their water from a well drilled into the semi-confined Tertiary Sediments that are overlain by Quaternary and/or Tertiary aged alluvium (Figure 3). The Tertiary sediments are part of a thick sequence of material that fills both the Gallatin and Madison River Valleys as a single structural basin, the Three Forks Basin. A series of steep normal faults along the fronts of the Bridger and Gallatin Ranges bound the Three Forks basin on the east. There is no obvious faulting bounding the basin on the north, south, or west. Precambrian bedrock forms most of the basin floor with Tertiary sediments of the Bozeman Group filling the entire basin. Where these sediments are not exposed, they are overlain by Quaternary and/or Tertiary aged alluvium (Kendy and Tresch, 1996).

The Tertiary sediments fill the Three Forks Basin as a continuous sequence, with pre-Tertiary bedrock present at the basin boundaries. The Camp Creek Hills that separate the two valleys represent the surface of the modern drainage system incised into the older basin fill material, the Tertiary beds. The Tertiary beds have an estimated thickness up to 5,000 feet in the central part of the Basin near Belgrade and Churchill (Davis et. al., 1965). The Tertiary beds represent deposits of wind blown sediments, river sediments, and lakebed sediments with large quantities of volcanic materials such as tuffs intermixed with some material eroded from older rocks in the area. These deposits are generally semi-consolidated rocks, but are not as hard or consolidated as Pre-Tertiary bedrock located outside of the valley.

The Public Water Supply

The Manhattan Christian Schools PWS is classified as a non-transient non-community system under the Federal Safe Drinking Water Act, because the system is not a community water system, but does regularly serve at least 25 of the same persons over six months per year. The Manhattan Christian Schools PWS serves 40 summer and 380 winter non-transient residents via 2 active service connections.

The most recent sanitary survey indicates that Manhattan Christian Schools obtains its water through a 6-inch steel well drilled in 1950 to a depth of 147 feet (WL002). At the time it was drilled, the well had a yield of 30 gallons per minute. The well is located just south of the school building. A diagram of the site layout is included in Appendix A. Two captive-air pressure tanks are located in the well pit. The water is treated by a water softener located in the boiler room in the basement of the main school building. A copy of the well, with information on well lithology and construction data, is included in Appendix B.

Water Quality

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

Manhattan Christian Schools Water Quality

The Manhattan Christian School's water quality is routinely monitored for compliance with drinking water standards. Bacteriological monitoring is conducted monthly. Compliance with other drinking water standards is based on additional sampling on a variety of schedules. Within the past five years there have been no detections of coliform in the Manhattan Christian Schools PWS. Nitrate plus nitrite as nitrogen ranging from 1.53 milligrams per liter (mg/L) to 2.26 mg/L has been detected in Manhattan Christian School's water within the past five years but remains below the maximum contaminant level of 10 mg/L (DEQ SDWIS database).

Appendix C contains a summary of the water quality for Manhattan Christian Schools compiled from the Montana Bureau of Mines and Geology (MBMG) Ground Water Information Center (GWIC).

CHAPTER 2
DELINEATION

The source water protection area, the land area that contributes water to Manhattan Christian Schools PWS well, is identified in this chapter. The management areas identified within the source water protection area include the control zone, inventory region, and surface water buffer. The control zone is an area at least 100-foot radius around the well. The management goal of the control zone, also known as the exclusion zone, is to protect against the direct introduction of contaminants into the well or in the immediate area surrounding each well.

The inventory region represents the zone of contribution of the well, which is an area at least 1-mile radius around the well. The management goal of the inventory region is to focus on pollution prevention activities at potential contaminant sources where it is likely that contaminated water would flow into the well within a relatively short time frame.

A surface water buffer zone has been delineated around Godfrey Creek to account for the interaction of surface water and groundwater. The surface water buffer includes ½-mile buffer around associated surface waters for 10 miles upstream of the groundwater zone of contributions or to watershed limits, whichever distance is shorter. The management goal of the surface water buffer is to protect against the introduction of pathogens and nitrates into the well through surface water-groundwater interaction.

Hydrogeologic Conditions

Manhattan Christian Schools is located in the Gallatin Valley of the Three Forks Basin. The floor of the basin is composed of Precambrian bedrock that is overlain by thick sequences of Tertiary-aged sediments, which in turn are overlain by Quaternary and Tertiary alluvium. The Camp Creek Hills separate the Gallatin and Madison River Valleys. Ground water flow in the Camp Creek Hills is interpreted to generally follow topography from the higher elevations towards the major rivers in the valleys below. According to the well log, the Manhattan Christian Schools PWS well is completed in Tertiary sediments. Tertiary sediments beneath the Gallatin Valley produce large enough yields to support both drinking water and irrigation uses. Basin-fill aquifers throughout the Gallatin Valley are unconfined. Area bedrock has a low permeability and does not readily transmit groundwater.

Recharge to the basin fill aquifer is most likely from infiltration of precipitation, leakage from irrigation canals, and stream losses. For purposes of this assessment, the Godfrey Creek watershed is considered to represent the limits of the recharge area for the Manhattan Christian Schools well.

The Manhattan Christian Schools well is completed in semi-confined, semi-consolidated valley fill, therefore, based on this aquifer type and the criteria listed in Table, the aquifer supplying groundwater to the Manhattan Christian Schools well would have moderate source water sensitivity to potential contaminant sources.

Table 3. Source Water Sensitivity Criteria

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

Conceptual Model and Assumptions

The Manhattan Christian Schools PWS is located in the Gallatin River Valley of the Three Forks Basin. Precambrian bedrock forms the floor of the basin. Tertiary sediments of the Bozeman Group fill the entire basin. Where these sediments are not exposed, they are covered by Quaternary and/or Tertiary aged alluvium. Groundwater located in the Tertiary sediments supplies water to the Manhattan Christian Schools PWS well. Recharge to the aquifer is most likely from infiltration of precipitation, irrigation canal leakage, and losses from area streams.

Well Information

Well information for the Manhattan Christian Schools well is presented in Table 4.

Table 4. Manhattan Christian Schools PWS Source Well Information

Information	Well #1
PWS Source Code	002
Well Location (T, R, Sec)	T1S, R3E, 13NWNE (CA)
Latitude/ Longitude	45.7485/ 111.3015
MBMG #	90741
Water Right #	N/A
Date Well was Completed	5/26/1950
Total Depth	147'
Perforated Interval	N/A

Table 4. Manhattan Christian Schools PWS Source Well Information	
Information	**Well #1**
Static Water Level	103'
Pumping Water Level	127'
Drawdown	24'
Test Pumping Rate	30 GPM

Delineation Results

Methods and Criteria

DEQ's Source Water Protection Program specifies methods and criteria used to delineate subregions of the source water protection area for Manhattan Christian School's well. A control zone, an inventory region, and a surface water buffer have been delineated for this well.

Delineation Regions

A 1-mile radius fixed radius inventory region was delineated around the Manhattan Christian Schools' well (Figure 4). A surface water boundary was also delineated around Godfrey Creek (Figure 5). The surface water boundary extends ½ mile downstream of the Manhattan Christian Schools well to 10 miles upgradient of the well with a ½ mile buffer adjacent to all shorelines.

Limiting Factors

Delineation of the modified 1-mile fixed radius inventory region for the Manhattan Christian Schools PWS well assumes that the aquifer is homogeneous, isotropic, and of infinite aerial extent. Aquifer materials are seldom homogeneous and groundwater flow within an aquifer is generally not uniform or strictly two-dimensional. Withdrawal rates also vary over time. Additionally, the total amount of recharge to the aquifer system from irrigation canals, precipitation, and area streams is unknown and can vary seasonally.

CHAPTER 3
INVENTORY

An inventory of potential contaminant sources was conducted within the Manhattan Christian Schools PWS well control zone, inventory region, and surface water buffer. Potential sources of all primary drinking water contaminants and Cryptosporidium were identified, however, only significant potential contaminant sources were selected for the detailed inventory. Significant potential contaminants in the Manhattan Christian Schools inventory region include nitrate, pathogens, fuels, solvents, agricultural chemicals, and metals.

The potential contaminant source inventory for Manhattan Christian Schools focuses on all activities in the control zone, certain sites or land use activities in the inventory region, and general land uses and large facilities in the surface water buffer. A listing of potential contaminants in the Manhattan Christian Schools area by Standard Industrial Classification (SIC) codes is located in Appendix D.

Inventory Method

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

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

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

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

Step 4: A business phone directory was consulted to identify businesses that generate, use, or store chemicals in the inventory region. Equipment manufacturing and/or repair facilities, printing or photographic shops, dry cleaners, farm chemical suppliers, and wholesale fuel suppliers were targeted by Standard Industrial Codes.

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

Step 6. All significant potential contaminant sources were identified in the inventory region and land uses and facilities that generate, store, transport, or dispose large quantities of hazardous materials were identified within the recharge region.

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

1) Large quantity hazardous waste generators
2) Landfills
3) Hazardous waste contaminated sites
4) Underground storage tanks
5) Major roads or rail transportation routes
6) Cultivated cropland
7) Animal feeding operations
8) Wastewater lagoons or spray irrigation
9) Septic systems
10) Sewered residential areas
11) Storm sewer outflows
12) Floor drains, sumps, or dry wells
13) Abandoned or active mines

Inventory Results/Control Zone

Land use in the 100-foot control zone consists of the school building, which holds classrooms, a gym, and an office. No significant potential contaminant sources were identified in the control zone.

Inventory Results/Inventory Region

Land cover within the inventory region consists primarily of agricultural land at 82% and grassland at 11% (Figure 6). Other types of land cover in the inventory region and their percentages are also identified on Figure 6. A municipal sewer covers 35% of the inventory region (Figure 7). Significant potential contaminant sources in the inventory region in addition to those already listed in the control zone are listed in Table 5 and identified on Figure 8.

Table 5. Significant potential contaminant sources in the Manhattan Christian Schools PWS Inventory Region

Potential Source	Map Figure ID No.	Potential Contaminants	Hazard
Agricultural Land	Figure 6	SOCs, nitrates, pathogens	Agricultural chemicals migrating into area groundwater
Municipal Sanitary Sewer	Figure 7	Nitrates and pathogens	Sewer main failure
Other Area Septic Systems	Figure 7	Nitrates and pathogens	Leaching to area groundwater

Agricultural Land – Agricultural chemicals used on cropland could potentially migrate into area groundwater.

Municipal Sanitary Sewer - Sanitary sewer mains, if old or if a rupture were to occur could allow untreated effluent to leach into area groundwater.

Other Area Septic Systems – Private septic systems are located all around the well. Nitrates and pathogens could leach into area groundwater from the septic tanks, associated piping, and the drain field if malfunctions occur.

Inventory Results/Surface Water Buffer

Land cover within the surface water buffer consists primarily of agricultural land at 80% and pastureland at 14% (Figure 9). Since the 1990's, water quality projects have been conducted to improve water quality in the Godfrey Creek Drainage. However, some dairy and beef cattle confinement areas continue to allow cattle direct access to the creek. Area cattle owners should be encouraged to continue using agricultural best management practices in the watershed to keep cattle away from the Godfrey Creek especially upstream of the Manhattan Christian School PWS well.

Other types of land cover in the recharge region and their percentages are also identified on Figure 9. 77% of the surface water buffer region has a low septic density, but there is an area of moderate septic density as well as a municipal sewer system near the well (Figure 10).

Potential contaminant sources within the surface water buffer are the same as those found in the inventory region with the addition of Montana Highway 84 and additional irrigation ditches.

Inventory Limitations

The potential contaminant inventory was conducted using various databases to acquire readily available information. Information was also obtained where possible, from individuals familiar with Manhattan Christian Schools. Consequently, unregulated activities or unreported contaminant releases may have been overlooked. The use of multiple sources of information, however, should ensure that the major threats to the Manhattan Christian Schools well have been identified.

Inventory Update

To make this SWDAR a useful document in the years to come, the owners, manager, or the certified water system operator(s) for the public water supply for Manhattan Christian Schools should update the inventory for their records every year. Changes in land uses or potential contaminant sources should be noted and additions made as needed. The complete inventory should be submitted to DEQ at least every 5 years to ensure that this report/plan stays current in the public record.

CHAPTER 4
SUSCEPTIBILITY ASSESSMENT

Susceptibility is the potential for a public water supply to draw water contaminated by inventoried sources at concentrations that would pose concern. Susceptibility is assessed in order to prioritize potential pollutant sources for management actions by local entities, in this case Manhattan Christian Schools

The goal of Source Water Management is to protect the source water by 1) controlling activities in the control zone, 2) managing significant potential contaminant sources in the Inventory Region, and 3) ensuring that land use activities in the surface water buffer pose minimal threat to the source water. Management priorities in the Inventory Region are determined by ranking the significant potential contaminant sources identified in the previous chapter according to susceptibility. Alternative management approaches that could be pursued by Manhattan Christian Schools to reduce susceptibility are recommended.

Susceptibility is determined by considering the hazard rating for each potential contaminant source. Hazard for unconfined wells is based on the criteria identified in Table 6.

Table 6. Determination of Hazard of Potential Contaminant Sources For Unconfined Wells

Potential Contaminant Sources	High Hazard Rating	Moderate Hazard Rating	Low Hazard Rating
Point Sources	Within close proximity to the well	Further away from and upgradient of the well	In close proximity to the upgradient inventory region boundary
Septic Systems (density)	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

The existence of barriers that decrease the likelihood that contaminants will enter into the Manhattan Christian Schools well also determines susceptibility (Table 7). Barriers to contamination can be anything that decreases the likelihood that contaminants will reach a spring or well. Barriers can be engineered structures, management actions, or natural conditions. Examples of engineered barriers are spill catchment structures for industrial facilities and leak detection for underground storage tanks. Emergency planning and best management practices are considered management barriers. Thick clay-rich soils, a deep water table or a thick saturated zone above the well intake can be natural barriers.

Table 7. Relative Susceptibility to Specific Contaminant Sources as Determined by Hazard and the Presence of Barriers

	High Hazard Rating	Moderate Hazard Rating	Low Hazard Rating
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

Significant potential contaminant sources in the Manhattan Christian Schools well control zone and inventory region are identified in Table 8 along with their hazard ratings.

Table 8. Significant potential contaminant sources in the Manhattan Christian Schools PWS Control Zone and Inventory Region

Source	Map Figure ID No.	Potential Contaminants	Hazard	Hazard Rating
Agricultural Land: Pasture/Hay, Row Crops, & Small Grains	Figure 6	SOCs, nitrates, and pathogens	Ag chemicals leaching into area groundwater	High
Municipal Sanitary Sewer	Figure 7	Nitrates and pathogens	Leaching to area groundwater	Moderate
Other Area Septic Systems	Figure 7	Nitrates and pathogens	Leaching to area groundwater	Moderate

The susceptibility of the Manhattan Christian Schools well to each potential contaminant source is assessed separately. The susceptibility ratings for each significant potential contaminant source and each associated contaminant are presented in Table 9. Management recommendations indicate how significant potential contaminant sources could be better managed to prevent impacts to the Manhattan Christian Schools well are also provided in Table 9.

Table 9. Susceptibility Assessment for Significant Potential Contaminant Sources in the Manhattan Christian Schools PWS Control and Inventory Regions

Source	Map Figure ID No.	Contaminant	Hazard	Hazard Rating	Barriers	Susceptibility	Management Recommendations
Municipal Sanitary Sewer	Figure 7	Nitrates and pathogens	Untreated effluent leaking from sewer mains	High	Clay layer; unsaturated thickness	Moderate	Periodically inspect sewer mains and replace any damaged sections
Other Area Septic Systems	Figure 7	Nitrates and pathogens	Leaks in septic tanks, collection lines, drain field malfunction, and infiltration of untreated effluent into area groundwater	Moderate	Clay layer; unsaturated thickness	Low	Encourage proper operation and maintenance of other septic systems in the inventory region
Agricultural Land	Figure 6	SOCs, nitrates and pathogens	Ag chemicals leaching into area groundwater	Moderate	Clay layer; unsaturated thickness	Low	Promote the use of Best Management Practices on nearby agricultural land

Susceptibility Assessment Results

The susceptibility assessment results for each significant potential contaminant source identified are described below:

Agricultural Land – Hazard is ranked high because the amount of agricultural land in the inventory region is above 50 percent. The overall susceptibility of the well is ranked moderate as multiple barriers the overlying 30-foot clay layer and the amount of unsaturated thickness below the ground surface were identified as barriers to contamination.

Municipal Sanitary Sewer – Hazard is ranked moderate because 35% of the inventory region is covered by the sewer system. The overall susceptibility of the well is ranked low, as multiple barriers the overlying 30-foot clay layer and the amount of unsaturated thickness below the ground surface were identified as barriers to contamination.

Other Area Septic Systems – Hazard is ranked moderate based on 14 percent moderate septic density to the southwest and northeast of the well. The overall susceptibility of the well is ranked low, as multiple barriers the overlying 30-foot clay layer and the amount of unsaturated thickness below the ground surface were identified as barriers to contamination.

Management Recommendations

The Manhattan Christian Schools Source Water Delineation and Assessment Report was prepared to assist the Manhattan Christian Schools PWS owner, PWS operator, and customers to protect the well. The report provides information concerning the aquifer that supplies water to the Manhattan Christian Schools well, identifies the control zone, inventory region, and surface water buffer and within each of these protection areas identifies the significant potential contaminants that may impact the PWS well. If the management recommendations included in Table 10 are implemented by the Manhattan Christian Schools PWS, they may be considered additional barriers that will reduce the susceptibility of Manhattan Christian School's well to specific potential contaminant sources and their associated contaminants. Management recommendations fall into the following categories:

- Education
- Sewage disposal system maintenance and leak detection
- Advanced Treatment Septic System
- Stormwater management
- Agricultural best management practices
- Emergency Response Plan
- Source Water Protection Plan

Education - Educational workshops provided to the general public by the city, county, or state promote safe handling and proper storage, transport, use, and disposal of hazardous materials. Ongoing training provided to designated emergency personnel such as the Manhattan Christian Schools PWS operator will promote the efficiency and effectiveness of emergency responses to hazardous material spills that may occur in the vicinity of the well. Likewise, educational workshops provided to rural homeowners will

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

Sewage Disposal System Maintenance and Leak Detection – Periodic inspection and proper maintenance of the sanitary sewer and area septic systems will reduce the susceptibility of Manhattan Christian School's well to contamination from these potential contaminant sources.

Advanced Treatment Septic System - Installation of advanced septic treatment systems such as sand filters can limit contamination from new rural residential developments.

Stormwater Management – Stormwater planning should address potential contaminant sources and drainage control. Potential contaminant source control can be accomplished through educational programs focusing on residential and commercial chemical use, disposal, and recycling. Drainage control and pollutant removal can be accomplished through the use of vegetated detention basins at outfall locations. The construction of storm runoff wetlands can go a long way to reducing the amount of non-point pollutants.

Agricultural Best Management Practices (BMPs) – Promote the use of BMPs that address mixing and application of fertilizers and pesticides. These are a viable alternative to prohibition of their use. Also promote BMPs that may be utilized to minimize surface runoff and soil erosion on cultivated fields. The use of BMPs that promote keeping cattle away from Godfrey Creek should also be encouraged. This would also reduce the amount of nitrates and pathogens entering Godfrey Creek especially upstream of the Manhattan Christian School PWS well.

Emergency Response Plan – An emergency response plan would be of significant benefit to the Manhattan Christian Schools administrator and water operator. The usefulness and effectiveness of an emergency response plan are maximized if the plan contains a clear listing of all emergency contacts, emergency numbers, and resources available to Manhattan Christian Schools and Gallatin County to respond to an emergency situation, such as a hazardous material spill, at Manhattan Christian Schools.

Source Water Protection Plan – The next phase of source water protection for the Manhattan Christian Schools would be for the owner and the water operator to take the information presented in this source water delineation and assessment report and use it to continue development of a Source Water Protection Plan. The Source Water Protection Plan would clearly identify: 1) strategies to reduce the likelihood of contaminant releases within the inventory region, 2) the procedures to follow (emergency response plan) in the event that the Manhattan Christian Schools well becomes threatened by regulated contaminants, and 3) identify alternate sources of drinking water.

CHAPTER 5
MONITORING WAIVERS

Monitoring Waiver Requirements

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

Use Waivers

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

Susceptibility Waivers

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

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

Susceptibility Waiver for Confined Aquifers

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

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

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

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

Susceptibility Waiver for Unconfined Aquifers

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

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

water. Consequently, unconfined aquifers can be susceptible to contamination by organic chemicals migrating from the ground surface to groundwater.

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

Waiver Recommendation

Currently, the Manhattan Christian Schools PWS has no monitoring waivers for their well. For waiver consideration, based on monitoring history or a demonstration that certain chemicals were/are not used in the inventory region, the administrator and/ or the water operator for the Manhattan Christian Schools PWS will need to send a letter to the DEQ Public Water Supply Section requesting monitoring waivers. Additional information regarding chemical use on adjacent properties in the inventory region must accompany the waiver request letter.

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GLOSSARY*

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

Alkalinity. The capacity of water to neutralize acids.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Glacial. Of or relating to the presence and activities of ice or glaciers. Also, pertaining to distinctive features and materials produced by or derived from glaciers.

Geographic Information Systems (GIS). A computerized database management and mapping system that allows for analysis and presentation of geographic data.

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

Hazard. A relative measure of the potential of a contaminant from a facility or associated with a land use to reach the water source for a public water supply. The location, quantity and toxicity of significant potential contaminant sources determine hazard.

Hydraulic Conductivity. A constant number or coefficient of proportionality that describes the rate water can move through an aquifer material.

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

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

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

Lacustrine. Pertaining to, produced by, or formed in a lake or lakes.

Leaking Underground Storage Tank (LUST). A release from a UST and/or associated piping into the subsurface.

Maximum Contaminant Level (MCL). Maximum concentration of a substance in water that is permitted to be delivered to the users of a public water supply. Set by EPA under authority of the Safe Drinking Water Act to establish concentrations of contaminants in drinking water that are protective of human health.

Montana Bureau of Mines and Geology – Ground Water Information Center (MBMG/GWIC). The database of information on all wells drilled in Montana, including stratigraphic data and well construction data, when available.

Montana Pollutant Discharge Elimination System (MPDES). A permitting system that utilizes a database to track entities that discharge wastewater of any type into waters of the State of Montana.

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

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

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

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

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

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

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

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

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

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

Pumping Water Level. Water level elevation in a well when the pump is operating.

Recharge Region. A source water management region that is generally the entire area that could contribute water to an aquifer used by a public water supply. Includes areas that could contribute water over long time periods or under different water usage patterns.

Resource Conservation and Recovery Act (RCRA). Enacted by Congress in 1976. RCRA's primary goals are to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner.

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

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

Section Seven Tracking System (SSTS). SSTS is an automated system EPA uses to track pesticide producing establishments and the amount of pesticides they produce.

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

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

Source Water Protection Areas. For surface water sources, the land and surface drainage network that contributes water to a stream or reservoir used by a public water supply. For ground water sources, the area within a fixed radius or three-year travel time from a well, and the land area where the aquifer is recharged.

Spill Response Region. A source water management area for surface water systems that encompasses the area expected to contribute water to a public water supply within a fixed distance or a specified four-hour water travel time in a stream or river.

Standard Industrial Classification (SIC) Code. A method of grouping industries with similar products or services and assigning codes to these groups.

Static Water Level (SWL). Water level elevation in a well when the pump is not operating.

Susceptibility (of a PWS). The relative potential for a PWS to draw water contaminated at concentrations that would pose concern. Susceptibility is evaluated at the point immediately preceding treatment or, if no treatment is provided, at the entry point to the distribution system.

Synthetic Organic Compounds (SOC). Man made organic chemical compounds (e.g. herbicides and pesticides).

Total Dissolved Solids (TDS). The dissolved solids collected after a sample of a known volume of water is passed through a very fine mesh filter.

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

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

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

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

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

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

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

Underground Storage Tanks (UST). A tank located at least partially underground and designed to hold gasoline or other petroleum products or chemicals, and the associated plumbing system.

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

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

* With the exception of the definitions for Lacustrine, Phase II and Phase V Rules, and Standard Industrial Classification Code, definitions were adapted from EPA's Term References System (formerly known as Glossary of Selected Terms and Abbreviations) which can be found at:
http://www.epa.gov/trs/index.htm

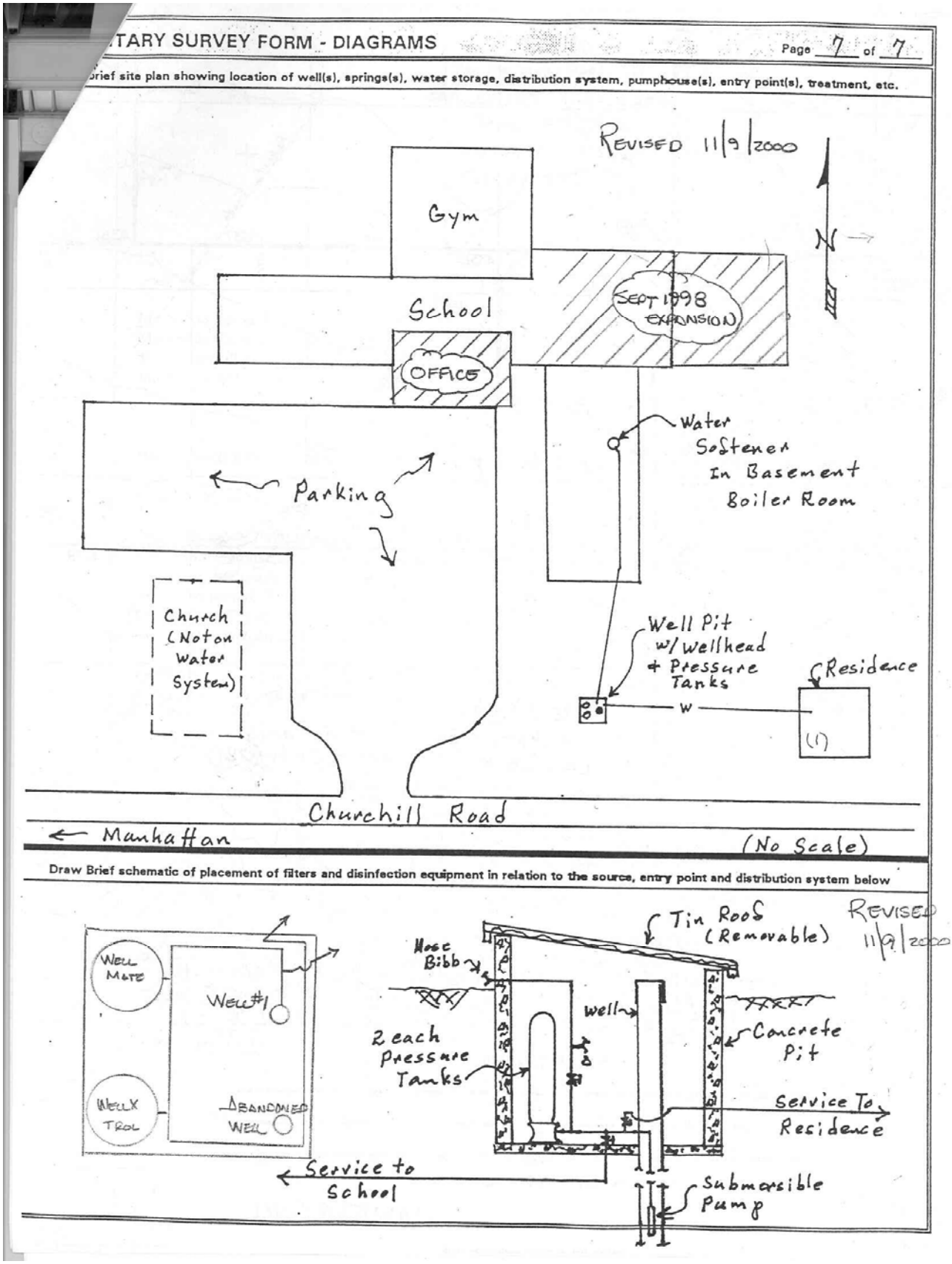
The definitions of glacial and lacustrine were taken from the Glossary of Geology by Robert L. Bates and Julia A. Jackson.

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

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

APPENDICES

APPENDIX A: Site Layout



APPENDIX B: Well Log

Montana Bureau of Mines and Geology
Ground-Water Information Center Site Report
MANHATTAN CHRISTIAN SCHOOL

Location Information

GWIC Id:	90741	Source of Data:	LOG
Location (TRS):	01S 03E 13 CA	Latitude (dd):	45.7485
County (MT):	GALLATIN	Longitude (dd):	-111.3015
DNRC Water Right:		Geomethod:	TRS-TWN
PWS Id:		Datum:	1927
Block:		Certificate of Survey:	
Lot:		Type of Site:	WELL
Addition:			
Site Notes:	DNRC MADISON PLATEAU WELL 29		

Well Construction and Performance Data

Total Depth (ft):	147.00	How Drilled:	CABLE
Static Water Level (ft):	103.00	Driller's Name:	VAN DYKEN
Pumping Water Level (ft):	127.00	Driller License:	WWC001
Yield (gpm):	30.00	Completion Date (m/d/y):	5/26/1950
Test Type:	BAILER	Special Conditions:	
Test Duration:	1.00	Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	120SDMS
Recovery Time (hrs):		Well/Water Use:	PUBLIC WATER SUPPLY
Well Notes:			

Hole Diameter Information

No Hole Diameter Records currently in GWIC.

Casing Information[1]

From	To	Dia	Description
0.0	147.0	6.0	

Annular Seal Information

No Seal Records currently in GWIC.

Completion Information[1]

No Completion Records currently in GWIC.

Lithology Information

From	To	Description
0.0	30.0	CLAYS
30.0	147.0	SAND & GRAVELS
147.0	152.0	SANDSTONE

[1] - All diameters reported are **inside** diameter of the casing.

APPENDIX C: Water Quality Data

Chemical	2002	2001	2000	1999	1998
Trichloroethane	__ __ __ __*	11/13/2001 **0 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**
Antimony	__ __ __ __*	11/13/2001 **0 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**
Arsenic	__ __ __ __*	11/13/2001 **0.007 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0.006 mg/L**
Barium	__ __ __ __*	11/13/2001 **0.05 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0.049 mg/L**
Beryllium	__ __ __ __*	11/13/2001 **0 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**
Cadmium	__ __ __ __*	11/13/2001 **0.0002 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**
Chromium	__ __ __ __*	11/13/2001 **0 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**
Dinoseb	__ __ __ __*	11/13/2001 **0 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**
Fluoride	__ __ __ __*	11/13/2001 **0.28 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **1.35 mg/L**
Mercury	__ __ __ __*	11/13/2001 **0 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**
Nickel	__ __ __ __*	11/13/2001 **0 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**
Nitrate + Nitrite (as N)	12/11/2002 **2.26 mg/L**	11/13/2001 **2.26 mg/L**	__ __ __ __*	11/15/1999 **2.07 mg/L**	06/22/1998 **1.53 mg/L** 12/11/1998 **2.16 mg/L**
Oxamyl	__ __ __ __*	11/13/2001 **0 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**
Polychlorinated Biphenyls (PCB)	__ __ __ __*	11/13/2001 **0 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**
Selenium	__ __ __ __*	11/13/2001 **0 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**
Simazine	__ __ __ __*	11/13/2001 **0 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**
Thallium	__ __ __ __*	11/13/2001 **0 mg/L**	__ __ __ __*	__ __ __ __*	12/11/1998 **0 mg/L**

*** No samples were collected**

APPENDIX D: Listing of Potential Contaminant Sources by SIC Code

NAME	ADDRESS	CITY	STATE	ZIP	PHONE	SIC1	SIC2	SIC3	SIC4	LATITUDE	LONGITUDE
Alan Miller Contracting Inc	6070 Century Dr	Manhattan	MT	59741	282-6037	152103				45.742320	-111.30780
Amsterdam Enterprises	7200 Churchill Rd	Manhattan	MT	59741	282-7234	152103	179403			45.773280	-111.30960
Amsterdam General Store	6680 Amsterdam Rd	Manhattan	MT	59741	282-7223	541105				45.758280	-111.32814
Amsterdam Public School	6360 Camp Creek Rd	Manhattan	MT	59741	282-7216	821103				45.728520	-111.34152
Auto Inn Garage	114 E Railroad Ave S	Manhattan	MT	59741	284-6869	508414				45.755460	-111.26868
Baker Taxidermy Studio	Highway 346	Manhattan	MT	59741	284-3350	769904				45.755460	-111.26868
Big Sky Precision Inc	301 E Railroad Ave N	Manhattan	MT	59741	284-3955	359903				45.858480	-111.33438
Bitterroot Trailer Sales Inc	310 Manhattan South Rd	Manhattan	MT	59741	284-4444	508306	556104	556105	559903	45.851700	-111.32658
Bozeman & Gallatin Vly Septic	201 W Washington	Manhattan	MT	59741	284-3325	171107	769902	735922		45.859980	-111.33108
Burns & Sons Auction Svc	210 Hemlock	Manhattan	MT	59741	284-6681	738901	738913			45.856560	-111.32586
C P Contracting	106 S Broadway	Manhattan	MT	59741	284-4133	152103				45.856320	-111.33312
Charlie Hoekema Trucking	3390 W Cedar Meadows Ln	Manhattan	MT	59741	282-7528	421307				45.773040	-111.26712
Churchill Equipment Co	7150 Churchill Rd	Manhattan	MT	59741	282-7252	508310	508304	508314	503904	45.773820	-111.30960
Churchill Stables	8062 Churchill Rd	Manhattan	MT	59741	282-7906	799968				45.762540	-111.30966
Compass Advisors-Business		Manhattan	MT	59741	282-6000	738999				45.755460	-111.26868
Danhof Chevrolet Inc	6605 Amsterdam Rd	Manhattan	MT	59741	282-7231	551102	551105	753801	753201	45.758280	-111.32562
Degroot Commercial Corp		Manhattan	MT	59741	282-6000	738922				45.755460	-111.26868
Direct Logistics	6060 Pleasant St	Manhattan	MT	59741	282-9430	501208				45.750780	-111.30666
Dyk & Sons Land & Cattle	1889 Yadon Rd	Manhattan	MT	59741	284-6041	515401				45.880800	-111.32760
Ebbinghausen Woodworking	PO Box 930	Manhattan	MT	59741	539-6862	152103	152112	154213		45.755460	-111.26868
Fisher Body Shop Inc	6835 Amsterdam Rd	Manhattan	MT	59741	282-7222	501213	371303	508419		45.758280	-111.33450
Gallatin River Ranch Ctr	591 Equestrian Loop Rd	Manhattan	MT	59741	284-3782	515907	799968			45.755460	-111.26868
Garrity Homes	125 S Broadway	Manhattan	MT	59741	284-4350	152112	655202			45.855960	-111.33348
Green Acres Mini-Storage	9220 Churchill Rd	Manhattan	MT	59741	282-7138	422503				45.750840	-111.30474
Handi Storage	1020 Apples Way	Manhattan	MT	59741	388-3400	422503				45.755460	-111.26868
Hawkeye Plumbing & Heating		Manhattan	MT	59741	282-7889	171105				45.755460	-111.26868
Headwaters Sprinklers	201 Hemlock St	Manhattan	MT	59741	284-3781	526136	078204			45.856380	-111.32586
Ken Dykema Trucking Inc	107 S Broadway St	Manhattan	MT	59741	284-3146	421303	421309			45.856320	-111.33312

L & F Food Farm	106 E Main St	Manhattan	MT	59741	284-3221	541105				45.755460	-111.26868
Manhattan Christian School	8000 Churchill Rd	Manhattan	MT	59741	282-7261	821103	839998			45.763200	-111.30966
Manhattan City Hall	103 S Broadway St	Manhattan	MT	59741	284-3235	911104				45.856380	-111.33306
Manhattan Elementary School	416 N Broadway	Manhattan	MT	59741	284-3250	821103				45.860460	-111.32856
Manhattan Fire Dept	PO Box 911	Manhattan	MT	59741	284-6224	922404				45.755460	-111.26868
NAME	**ADDRESS**	**CITY**	**STATE**	**ZIP**	**PHONE**	**SIC1**	**SIC2**	**SIC3**	**SIC4**	**LATITUDE**	**LONGITUDE**
Manhattan High School	200 W Fulton Ave	Manhattan	MT	59741	284-3341	821103				45.860760	-111.32970
Manhattan Plumbing & Heating	106 S Broadway	Manhattan	MT	59741	284-4133	171105	171102			45.856320	-111.33312
Manhattan School District	416 N Broadway	Manhattan	MT	59741	284-6460	821103				45.860460	-111.32856
Montana Auction Co	3150 Cameron Bridge Rd W	Manhattan	MT	59741	282-7337	738901				45.743640	-111.23040
Pioneer Machine	2721 Stagecoach Trail Rd	Manhattan	MT	59741	282-7391	359903	376998	503903		45.787260	-111.28392
Rls Construction	4180 Highline Rd	Manhattan	MT	59741	282-9061	179403				45.746640	-111.26862
Schindler Excavation		Manhattan	MT	59741	284-4103	179403				45.755460	-111.26868
Septic Tank Svc	201 W Washington St	Manhattan	MT	59741	586-8160	171107				45.755460	-111.26868
Thriftway	404 S Broadway	Manhattan	MT	59741	284-3343	541103				45.853860	-111.33582
Western Pines Livestock Beddng	3390 W Cedar Meadows Ln	Manhattan	MT	59741	282-7528	519119				45.773040	-111.26712
Whistle Stop Storage	414 E Main	Manhattan	MT	59741	284-6919	422503				45.755460	-111.26868

SIC	#	Description
02**	4	Agricultural production- livestock
07**	41	Agricultural services
1521		General contractors - single family houses
1541		Industrial buildings & warehouses
1611		Highway and street contstruction (not elevated)
1711		Plumbing, heating and air conditioning
1794		Excavation work
2011	0	Meat Packing Plants
2015	0	Poultry Slaughtering and Processing
2491	0	Wood Preserving
27**	26	Printing and publishing
3089		Plastics products, NEC
3295	0	Minerals and Earths, Ground or Otherwise Treated
33**	0	Primary metal industries
3599		Industrial and commercial machinery & equipment, NEC
3732	0	Boat Building and Repairing
3861	0	Photographic Film, Paper, Plates and Chemicals
3911	1	Jewelry, Precious Metal
3914	1	Silverware, Plated Ware, and Stainless Steel Ware
4011	3	Railroads, Line-haul Operating
4142		Bus charter service, except local
4212		Local trucking without storage
4213	19	Trucking, Except Local
4214	2	Local Trucking with Storage
4221	0	Farm Product Warehousing and Storage
4225	16	General Warehousing and Storage
4226	0	Special Warehousing and Storage, NEC
4231	0	Terminal and Joint Terminal Maintenance Facilities for Motor Freight Transportation
4581	3	Airports, Flying Fields, and Airport Terminal Services
4789	1	Transportation Services, NEC
49**	3	Electric, gas, and sanitary services
5012		Automobiles and other motor vehicles
5013		Motor vehicle supplies and new parts
5015		Motor vehicle parts, used
5043	0	Photographic Equipment and Supplies
5052	0	Coal and Other Minerals and Ores
5063		Electrical apparatus and equipment, wiring supplies & construction materials
5082		Construction and mining (except petroleum) machinery and equipment
5083		Farm & garden machinery and equipment
5084		Industrial machinery and equipment
5085		Industrial supplies
5087		Service establishment equipment
5093	3	Scrap and Waste Materials
5154	1	Livestock
5169		Chemicals and allied products, NEC
5171	0	Petroleum Bulk Stations and Terminals

SIC	#	Description
5172	6	Petroleum and Petroleum Products Wholesalers, Except Bulk Stations and Terminals
5191	4	Farm Supplies
5198	0	Paint, Varnishes, and Supplies
5261	9	Retail Nurseries, Lawn and Garden Supply Stores
5411		Grocery stores
5511		Motor vehicle dealers (new and used)
5521		Motor vehicle dealers (used only)
5531		Auto and home supply stores
5541	9	Gasoline Service Stations
5551		Boat dealers
5941		Sporting goods and bicylce shops
5983	0	Fuel Oil Dealers
5989	0	Fuel Dealers, NEC
5999		Miscellaneous retail stores, NEC
7216	0	Drycleaning Plants, Except Rug Cleaning
7221	6	Photographic Studios, Portrait
7261	3	Funeral Services and Crematories
7335	3	Commercial Photography
7342	1	Disinfecting and Pest Control Services
7384	4	Photofinishing Laboratories
7389		Business services, NEC
75**	31	General Automotive Repair Shops
7692	5	Welding Repair
7694		Armature rewinding shops
7699	20	Repair Shops and Related Services, NEC
7992	2	Public Golf Courses
7999		Amusement and recreation, NEC
8062	2	General Medical and Surgical Hospitals
8071	3	Medical Laboratories
8072	2	Dental Laboratories
8211		Elementary and secondary schools
8734	2	Testing Laboratories
9111		Executive offices
9224		Fire protection

APPENDIX E. Concurrence Letter