Centerville Public Water Systems

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SOURCE WATER DELINEATION AND ASSESSMENT REPORT

Report Date: November 28, 2000

TABLE OF CONTENTS

Table of Contents

Note: Appendices available upon request from the Montana Department of Environmental Quality or Public Water Supply

INTRODUCTION

Russell Levens, Hydrogeologist with the Montana Department of Environmental Quality (DEQ) completed this Source Water Delineation and Assessment Report. A draft of the report was mailed for review to Ed Cutlip, certified operator for the Centerville School; Nikki Clarke, owner of the Centerville Bar; and Betty Kolhepp, responsible person for the Centerville Water Users Association.

PURPOSE

This is a combined source water delineation and assessment report for three public water supplies in the town of Centerville: the Centerville School, Centerville Bar and Centerville Water Users Association (WUA). The information presented is intended to meet the technical requirements of 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 that 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 public water supplies in Centerville complete a source water protection plan to protect their drinking water sources.

Limitations

This report was prepared to assess threats to public water supplies in Centerville, 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 sources of public water supplies in Centerville and not any other public or private water supply. Also, not all potential or existing sources of groundwater or surface water contamination in the vicinity of Centerville are identified. Only potential sources of contamination in areas that contribute water to its drinking water sources are considered.

The terms "contaminant" and "toxin" are used in this report to refer to constituents for which maximum contaminant 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

Centerville is a small, unincorporated community, located 13 miles southeast of Great Falls in Cascade County (Figure 1). The population of Cascade County was estimated at 78,282 in 1999, most of which live in Great Falls.

Centerville is in a historical coal-mining district with many abandoned underground mines dating to the late 1800s south and west of town. Current residents in and around Centerville either farm, raise livestock, or work in Great Falls. The only business in town is the Centerville Bar.

The Centerville School, the Centerville WUA, and the Centerville Bar public water supplies serve a school, nine homes, a senior citizens center, and a bar. Private wells serve several homes and provide irrigation. Sewage is treated in individual septic systems throughout town.

Geographic Setting

Centerville is located along Sand Coulee Creek (HUC# 10030102120) between flat-topped benches that slope gently to the north away from the Little Belt Mountains (Figure 1). This tableland topography is dissected by generally north flowing tributaries of the Missouri River.

Centerville is at approximately 47.4° north-latitude and 111.4° west longitude and 3,600 feet above sea level. The average high and low temperatures at the nearest weather station in Great Falls are 85° and 56° in July and 34° and 14° in January. The climate is semi-arid with precipitation averaging 15 inches per year concentrated in May and June. Snowfall averages 46 inches per year. Wind is a constant presence on the bench tops, quickly blowing snow into coulees or melting it during chinooks, warm winds that can raise the air temperature 50° in a few hours. Irrigated and dryland small grains and hay or cattle grazing are the primary land uses.

General Description of the Source Water

The Centerville School obtains its water from a single 300-foot deep well completed in the Mission Canyon limestone of the Madison Group. The Centerville Bar and Centerville WUA have wells 460-feet and 210-feet deep respectively that also are completed in the Mission Canyon limestone. Besides the public water supply wells, 30 private wells that mostly tap the Mission Canyon limestone are listed in the Montana Bureau of Mines and Geology Ground Water Information Center database (locations of all wells are shown on Figure 2 and available well logs are included in Appendix D).

Table 1 List of geologic or hydrogeologic maps for the Centerville area

Type Of Map & Features	Scale	Area Covered	Reference
Potentiometric surface map of water in the Madison Group, Montana	1:500,000	Western half of state	Feltis, 1980
Contours in feet on the top of the Madison Group	1:500,000	Western half of state	Feltis, 1980, (2)
Geologic Map of the Southeast Great Falls Quad.	1:24,000	7.5 Minute Quad.	Osborne et al., 1987

The Madison Group and overlying Swift Formation are believed to behave as a single aquifer surrounding Centerville. Water infiltrates the Swift/Madison aquifer at its outcrops in the Little Belt Mountains and where it underlies alluvium along Sand Coulee and Cottonwood Creek south of Centerville. Water from the aquifer flows north and discharges in part to the Missouri River at Giant Springs near Great Falls.

The Public Water Supplies

The Centerville School serves 372 students, teachers, and other school staff through three active service connections during the school year. The system serves approximately seven employees in the summer. Untreated water is pumped to six 80-gallon pressure tanks in the school. The Centerville Bar public water supply serves two employees, approximately 50 bar patrons, and ten residents living in four homes per day through five service connections. Water is pumped from the bar’s well to a 3,000-gallon cistern located about 100 yards to the west. Water is chlorinated by pouring one gallon of Clorox down the well once a week. The Centerville WUA serves 12 residents living in five homes and approximately 90 members of a Senior Citizens Center. Water is stored in two 85-gallon pressure tanks.

The Centerville School is classified as a non-community, non-transient public water system because it does not serve year-round residents but does serve over 25 of the same persons for at least six months per year. The Centerville Bar and the Centerville WUA are classified as non-community, transient public water systems because they do not serve at least 25 year-round residents nor do they serve over 25 of the same persons for over six months of the year.

Water Quality

Analyses of groundwater and mine drainage near Centerville are available from a study conducted by the Montana Bureau of Mines and Geology (1987). The purpose of this study was to assess the impacts of mining on water quality in the Sand Coulee Creek drainage. Low pH and high sulfate concentrations resulting from oxidation of sulfide minerals contained in coal and adjacent rock characterize mine drainage (Table 2). Mine drainage that infiltrates shallow groundwater is neutralized as it contacts and reacts with soil and rock containing limestone or silicate minerals. Therefore, shallow groundwater impacted by mine drainage in the Centerville area has near neutral pH and elevated sulfate, calcium, magnesium, and total dissolved solids (TDS) (Table 2). Wells completed in the Madison Aquifer do not exhibit obvious signs of contamination by mine drainage. However, evidence presented in the Montana Bureau of Mines and Geology indicate that mine drainage has reached the Madison Aquifer near Centerville.

Table 2 Concentrations of major ions in wells in and near Centerville (MBMG) (* Madison Aquifer).

GWIC #	Depth ft	pH	Sc : S/cm	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	Fe mg/L	Mn mg/L	SiO_2 mg/L	HCO_3 mg/L	Cl mg/L	SO_4 mg/L	NO_3 mg/L	TDS
145504 Mine Drain	NA	3.03	1790	82.2	72.6	23.1	2.7	7.4	0.643	51.8	1.25	7	801	1.25	1090
2288 Alluvium	41.8	7.3	2655	334	207	71.1	3.4	0.35	0.023	30.2	627	33.2	1280	5.81	2274
2289*	200	7.6	624	82.2	29.1	12.4	2.3	0.02	11.8	236	0	145	0.69	--	527.3
2244*	158	7.6	617	75.8	26.5	11.8	2.5	0.01	11.8	234	0	133	0.88	--	506.0
2285	220	7.6	1115	97.3	89.4	22	8	0	8.7	234	0	428	1.83	--	903.4
2241	136	7.3	2094	319	119	41.2	4.3	0.02	0.004	27.2	483	28.7	924	15.9	1718
2242	70	7.8	930	66.3	75.6	15.9	2.7	0	9.7	452	0	84.4	11.1	--	731.8
2243	131	7.6	2172	354	115	27.7	5.5	0.02	0.004	25.3	507	18.9	937	3.67	1737

Each of the public water supply wells in Centerville are routinely monitored for compliance with drinking water standards. Bacteriological monitoring occurs monthly. Compliance with other drinking water standards is based on additional sampling on a variety of schedules. Nitrate was the only regulated contaminant detected at all public water supply wells in the last five years. Nitrate can come from human or animal wastes but also is naturally occurring. Nitrate levels ranged from 4.66 to 5.88 mg/L in Centerville School's well, 4.66 to 5.13 in the Centerville WUA's well, and 8.56 to 9.62 in the Centerville Bar's well. These nitrate levels are below the maximum contaminant level (MCL) of 10 mg/L set by the U.S. Environmental Protection Agency (EPA) but still are relatively high. Detection of fecal coliform in the Centerville WUA well during February 1998 resulted in the only violation of an MCL by a Centerville public water supply during the past five years.

CHAPTER 2

DELINEATION

The area that contributes water to public water supply wells in Centerville is identified in this chapter. Four management regions are mapped (control zone, inventory region, surface water buffer, and recharge region). The goal of management in the control zone is to protect against direct introduction of contaminants into public water supply wells or the immediate surrounding areas. The inventory region and surface water buffer should be managed to prevent release of contaminants that could flow to a public water supply before contaminant concentrations are reduced by natural processes. The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased usage. The four management regions delineated in this chapter are the same for all three public water supplies in Centerville to encourage coordinated management and because the three wells are reasonably close together.

Geologic Conditions and Aquifer Characteristics

Most of the following description of geologic conditions near Centerville is summarized from a report published by the Montana Bureau of Mines and Geology (MBMG) (Osborne et al., 1987). Bedrock in the vicinity of Centerville ranges from Mississippian age Madison Group to Cretaceous age Blackleaf Formation (Figure 3). The basal sandstone layer of the Blackleaf Formation and mudstone and sandstone layers comprising the Kootenai Formation top the benches around Centerville. Mudstone with minor sandstone layers and coal beds of the Morrison Formation outcrop along coulee walls. Coal in the area mines comes from seams at the top of the Morrison. Sandstone of the Swift Formation and limestone of the Madison Group outcrop along the base of coulees near Stockett and in the foothills of the Little Belt Mountains, and underlie alluvium along Sand Coulee Creek at Centerville.

Important aquifers near Centerville include sandstone layers in the Kootenai, Morrison, and Swift formations and limestone in the Mission Canyon Formation of the Madison Group. Alluvium filling coulee bottoms yields abundant water to wells but is contaminated by mine drainage and has generally been abandoned as a water source. Kootenai and Morrison aquifers mostly receive recharge from bench tops and discharge to underground mines or outcrops along coulees. The Madison Group and Swift Formation behave as a single aquifer unit that is the source of water for the three Centerville public water supplies. The Swift ranges from four to 40 feet of fine- to coarse-grained sandstone containing interbeds of shale and conglomerate. The top of the Madison Group is the Mission Canyon Formation consisting of gray limestone containing large voids or caverns in wells drilled in the Stockett area. Water recharges the Swift/Madison aquifer where it outcrops near Stockett and in the foothills of the Little Belt Mountains and where it subcrops beneath alluvium along coulees. Water from the Swift/Madison aquifer upwells through overlying formations to feed Giant Springs along the Missouri River at Great Falls.

Geologic structure near Centerville is characterized by a broad arch gently dipping toward the northwest from the Little Belt Mountains (Wilke, 1983). The regional bedrock dip near Centerville is 1.5° , N35° W (Daniel and others, 1986). Average orientations of near vertical fracture pairs that extend through the Kootenai, Morrison, and Swift formations as measured by Osborne, et al. (1987) were N35° E and N56° W at one location and N44° E and N50° W at another location. Orientations of Walker Coulee, Sand Coulee, and many lesser, unnamed coulees generally parallel the northeast trending fracture set.

According to Osborne et al. (1987), groundwater flow in the Kootenai follows the regional fracture trend to the northeast. In contrast, a potentiometric map prepared by Feltis (1980) indicates groundwater flow in the Swift/Madison aquifer is parallel to the regional bedrock dip with a hydraulic gradient of approximately 0.005. Static water levels in wells measured by Osborne, et al. (1987) indicate that vertical groundwater flow is downward from bedrock and alluvium overlying the Swift/Madison aquifer.

Table 3 List of Geologic or hydrogeologic research activities in the Centerville area

Title Of Project	Period Of Project	Location Or Area Covered	Project Objectives
Interaction Between Ground Water and Surface Water Regimes and Mining-induced Acid Mine Drainage (AMD) in the Stockett-sand Coulee Coal Field	1980-1983	Sand Coulee Creek Watershed	To formulate acid mine drainage mitigation techniques
Appraisal of Water in Bedrock Aquifers, Northern Cascade County, Montana	1979-1983	Northern Cascade County (780 sq. mi.)	To describe the occurrence and chemical quality of water in bedrock aquifers
Acid Mine Drainage Control in the Sand Coulee Creek and Belt Creek Watersheds, Montana 1983-1987; V.1 and V.2	1983-1987	Sand Coulee Creek and Belt Creek Watersheds	To test hydrogeologic techniques of acid mine drainage control

Conceptual Model

The source of public water supply wells in Centerville is limestone of the Mission Canyon Formation of the Madison Group (see cross-section in Figure 4). Recharge is from precipitation and losses from streams at outcrops near Stockett and in the foothills of the Little Belt Mountains. Downward leakage from alluvium and fractured bedrock that overlies the Swift/Madison aquifer is a source of recharge closer to Centerville. Groundwater flow direction is uncertain, but probably is within 45° of north. Because younger mudstone layers have been removed by erosion, the Swift/Madison aquifer probably is unconfined. Also, public water supply or private wells can enhance leakage from shallow groundwater if they are old or improperly constructed. Consequently, the aquifer is classified as shallow fractured or carbonate bedrock with high sensitivity.

Source-Wells

The Centerville School is served by a 300-foot deep well approximately 300 feet northwest of the school at the corner of Highway 227 (Stockett Road) and Spring Creek Road. The State of Montana drilled the well in 1989 to replace a shallower well that had been contaminated by mine drainage. The well yielded 100 gpm during a 24-hour pumping test conducted in 1990. The Centerville Bar uses a 210-foot deep well in the northwest corner of the bar. The bar's well was drilled sometime between 1904 and the 1920's and limited information is available about its construction. The Centerville WUA has a 460-foot deep well between houses at 674 and 676 Stockett Road (see map in Appendix A). The well yielded 43 gpm when it was drilled in 1986. The log for Centerville WUA's well indicates broken sandstone from ground surface to 105 feet and limestone to total depth. See Table 4 for completion details and Appendix D for logs for all wells.

Private wells listed in the Ground Water Information Center database for the Centerville vicinity are completed similar to the public water supply wells. Depths range from 107 to 430 ft with an average of 247 ft. Static water levels (SWL) and pumping water levels for private wells average 130 ft and 189 ft below the ground surface respectively. Yields reported on well logs range from 6 to 65 gallons per minute (gpm).

Aquifer Properties

Estimates including aquifer flow properties, well discharge rate, groundwater gradient, and ambient groundwater flow direction are used to estimate one-year and three-year times-of-travel in order to define boundaries of the inventory region and to determine susceptibility (Table 5). Aquifer flow properties estimated are transmissivity, hydraulic conductivity, thickness, and effective porosity. Pumping test data and representative published values were used to estimate transmissivity and hydraulic conductivity. Lithology descriptions from well logs and published data were used to estimate effective porosity and thickness. Maps of geologic structure and groundwater elevations were used to estimate groundwater gradient and flow direction. Equations used to calculate time-of-travel are included in Appendix B.

Properties of the Swift/Madison aquifer are naturally variable and there is limited data on them. Hydraulic conductivity estimates cover two orders of magnitude (high estimate = 100 X low estimate) and estimates of thickness and effective porosity cover one order of magnitude (high estimate = 10 X low estimate). Groundwater gradient could be in error by a factor of four and groundwater flow direction could fall within a 90° range. The accuracy of hydraulic conductivity estimates affects the accuracy of time-of-travel estimates the most because these hydraulic conductivity estimates are highly uncertain and because time-of-travel calculations are highly sensitive to different hydraulic conductivity estimates. Time-of-travel calculations also are highly sensitivity to different values of effective porosity and groundwater gradient, however, these properties are known more accurately than hydraulic conductivity. In the case of the Swift/Madison aquifer at Centerville, aquifer thickness and well yield have the least effect on the accuracy of time-of-travel estimates

Table 4 Source well information for public water supply wells in Centerville.

--	Centerville School (source #003)	Centerville Bar (source #002	Centerville Water Users (source #002)
MBMG #	122947	2305	123636
Water Right #	P103328	B216236	P094914
Latitude / Longitude	47.3897 ° / -111.1430 °	47.3898 ° / -111.1437 °	47.3910 ° / -111.1442 °
Date Completed	2/12/91	Between 1904 and 1930	4/2/1986
Depth	300 ft	210 ft	460 ft
Perforated Interval	290 – 300 ft	Unknown	420 – 460 ft
SWL Depth	165 ft	145 ft	175 ft
PWL Depth	166 ft	Unknown	340 ft
Drawdown	1 ft	Unknown	165 ft
Test Pumping Rate	100 gpm	Unknown	43 gpm
Specific Capacity	100 gpm/ft	Unknown	3.8 gpm/ft
Source Type	Shallow Fractured or Carbonate Bedrock	Shallow Fractured or Carbonate Bedrock	Shallow Fractured or Carbonate Bedrock

Hydraulic Conductivity and Transmissivity – Hydraulic conductivity is a measure of the ease at which water flows through porous materials such as rock or soil, and transmissivity is a measure of the ease at which water flows through the full thickness of an aquifer. Transmissivity is the product of hydraulic conductivity and aquifer thickness. A pump test to estimate transmissivity was conducted on the Centerville School's well shortly after it was drilled. Estimates of transmissivity obtained by analyzing the drawdown (water level changes) in the school's well and nearby wells ranged from 3,000 to 5,000 ft^2/day. Additional estimates of transmissivity were obtained from well yield data reported on well logs from nearby wells. Hydraulic conductivity was estimated from typical values for similar rocks published in texts and literature and calculated from estimates of transmissivity and aquifer thickness. Overall, hydraulic conductivity estimates ranged from 5- to 500-ft/day and transmissivity estimates ranged from 100- to 10,000-ft^2/day. Representative values of 50 ft/day and 2,500 ft^2/day were used for final calculations.

Thickness - There are not enough well logs available to accurately estimate the aquifer thickness. Therefore, aquifer thickness is estimated from the thickness of sandstone and limestone intercepted by wells in Centerville (approximately 350 feet), the total thickness of the Swift/Madison aquifer (probably several hundred feet), and the length of the screened intervals of Centerville School's and Centerville WUA's wells (10 to 40 feet). A conservative estimate of 50 feet was used for final calculations.

Effective Porosity - Total porosity is the percent of a rock occupied by voids. For limestone, total porosity can vary from one to 30 percent, depending on the porosity of the original sediment and subsequent cementing or dissolution (Freeze and Cherry, 1979). Effective porosity, or the porosity that water actually flows through, will be less than total porosity. An effective porosity of 5 percent is used for final calculations.

Groundwater Gradient and Flow Direction – A range of groundwater flow directions is estimated from the regional dip of the Swift/Madison aquifer and the strike of steep dipping fractures in the vicinity of Centerville (Osborne et al., 1987). The range of groundwater gradient is estimated from the regional dip of the Swift/Madison aquifer (0.015) and a potentiometric map (0.005) (Feltis, 1965). A value of 0.01 is used. To account for uncertainty in groundwater flow direction a 45-degree range of groundwater flow directions was used to define the lateral boundaries of the inventory region.

Well Production – A single inventory region common to all three public water supplies in Centerville is mapped here, therefore the combined well production is used in time of travel calculations. Well production was estimated at 14,500 to 29,000 gallons per day by using estimates obtained from the Manual of Small Public Water Supply Systems (EPA, 1991). Minimum usage was estimated to be 25 gallons per pupil per day for the Centerville School, 75 gallons per day per full time resident served by the Centerville Bar and Centerville Home Owners Association, and 25 gallons per day for non-residents.

Maximum usage was obtained by multiplying minimum usage by two to take into account summer irrigation.

Table 5 Estimates of input parameters used to delineate the source water protection area

Input Parameter	Range	Value Used
Hydraulic Conductivity	5 - 500 ft/day	50 ft/day
Thickness	10 - 200 ft	50 ft
Transmissivity	100 – 10,000 ft^2/day	2,500 ft^2/day
Effective Porosity	1-20 %	5 %
Gradient	0.005 - -0.015	0.01
Well Production	14,500 – 29,000 gal/day	29,000 gal/day
Flow Direction	N35ºW - N40ºE	N45ºW - N45ºE
One-Year Time-of-Travel Distance	950 ft - 3.5 mi	4,200 ft
Three-Year Time-of-Travel Distance	2,000 ft - 10.4 mi	11,700 ft

Delineation Results

DEQ's Source Water Protection Program (DEQ, 1999) specifies methods and criteria used to delineate source water management areas. Following this guidance, 100-ft radius control zones are delineated around each well. Further, a three-year time-of-travel and outcrops of the Swift/Madison aquifer along Sand Coulee and Cottonwood Creek mark the boundary of the common inventory region (Figure 5). Outcrops of the Swift/Madison aquifer are included in the inventory region because time-of-travel estimates are highly uncertain in aquifers, such as the Swift/Madison aquifer, where large voids may be encountered. Time-of-travel is difficult to estimate under these conditions because water can flow much faster than expected where voids form interconnected conduits. Outcrops are areas where water can infiltrate directly to the aquifer and potentially follow these conduits to wells in Centerville. Further, the distance from outcrops of the Swift/Madison aquifer to Centerville is within the range of possible three-year time-of-travel distances shown in Table 5.

The surface water buffer includes all land and water between benches for ten miles upstream from Centerville. A fixed 1,000-ft buffer delineates the surface water buffer when coulees are less than 1,000 feet wide (Figure 5). Outcrops in the foothills of the Little Belt Mountains delineate the recharge region.

Limitations

The reader should keep in mind that this delineation is based on estimated properties and groundwater flow conditions. Conclusions based on this interpretation are uncertain because the extent and properties of the aquifer, and the direction and rate of groundwater flow are not known precisely. Nonetheless, conservative selection of parameters for time-of-travel calculations should assure that the source water protection areas delineated for Centerville include all significant potential contaminant sources.

CHAPTER 3

INVENTORY

Potential sources of contamination were inventoried to assess the susceptibility of public water supplies in Centerville to sources to contamination. Potential sources of contaminants subject to primary drinking water standards, and certain unregulated contaminants such as cryptosporidium, were identified for each public water supply well. The inventory focuses on all activities in the control zone, municipal and private facilities in the inventory region, potential sources of nitrate and microbial contaminants in the surface water buffer, and general land uses and large facilities in the recharge region.

Regulated contaminants and consequently the scope of potential contaminant source inventories differ according to public water supply classification. These regulatory differences arise because health effects vary between contaminants and because the pattern of water consumption at different classes of public water supplies differs. For example, transient, non-community public water supplies such as the Centerville Bar and the Centerville WUA monitor for nitrate and microbial contamination as indicated by the presence of coliform bacteria. Health effects associated with these contaminants can occur immediately and, therefore, bar patrons can become ill after limited exposure. Non-transient, non-community public water supplies such as the Centerville School monitor for volatile organic contaminants (VOCs), synthetic organic chemicals (SOCs), and inorganic contaminants such as metals in addition to coliform bacteria and nitrate. Health effects from exposure to VOCs, SOCs, and metals at typical concentrations encountered in ground water typically occur only after long-term sustained exposure. Therefore, because students at the Centerville School consume water from the public water supply regularly over a longer period of time they are more susceptible to exposure to VOCs than, for example, patrons at the Centerville Bar. In accordance, sources of VOCs, SOCs, and metals will only be identified in the inventory for the Centerville School. Sources of nitrate and microbial contaminants will be identified in the inventory for the Centerville Bar and Centerville WUA, as well as the Centerville School.

Inventory Method

Databases were searched to identify businesses and land uses that are potential sources of regulated contaminants. The following steps were followed:

Step 1: Urban and agricultural land uses were identified from landcover data collected by the Montana Gap Analysis project (Redmond et al., 1998).

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 on the basis of business type.

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

Inventory Results/Control Zone

The Stockett Road is within 100 feet of the Centerville School well. Infrequent truck shipments of fuel to local communities and area farms, as well as the school itself, are potential contaminant sources. Exact locations of septic systems are unknown but one or more are probably within the control zones of the Centerville Bar and Centerville WUA wells. No septic systems are located within 100 ft of the Centerville School wells.

Inventory Results/Inventory Region-Surface Water Buffer

Landcover in the inventory region and surface water buffer is predominantly grass, shrubs, and scattered cultivated cropland. Potential contaminant sources include large capacity septic systems at the Centerville School, septic systems at individual homes both within and outside Centerville, abandoned mines, underground storage tanks, and sanitary sewer and wastewater lagoon for the Town of Stockett (Figure 6, Figure 7, and Table 6). In addition, small quantities of pesticides, fuels, and solvents are stored at residences and pesticides are used for weed and insect control near all three wells.

Table 6 Potential contaminant sources in the control zones, inventory region, and surface water buffer.

Source	Potential Contaminant	Hazard
Stockett Road	Fuels	Accidental spills
Cultivated Cropland	Pesticides and fertilizers	Spills or excess application
Large Capacity Septic System	Nitrate and microbial contaminants	Infiltration of untreated sewage
Residential Septic Systems	Nitrate and microbial contaminants	Infiltration of untreated sewage
Stockett Wastewater Lagoons	Nitrate and microbial contaminants	Leaks
Stockett Sanitary Sewer	Nitrate and microbial contaminants	Leaks
Underground Storage Tanks	Heating Oil	Leaks
Abandoned Coal Mines	Metals	Infiltration of drainage from mines

Inventory Results/Recharge Region

Roughly 30 percent of the recharge region is cultivated dryland or irrigated crops and the remainder is grassland or shrubs. Hogs and other livestock are raised at a concentrated animal feeding operation (CAFO) approximately six miles southeast of Centerville and small farmsteads are scattered throughout the remainder of the recharge region. Herbicides and fertilizer applied on cropland, fuels stored at farmsteads, and animal waste from the CAFO applied on cropland are potential contaminant sources in the recharge region.

Inventory Update

The certified operator for each public water supply should update the inventory for his or her records every year. Changes in land uses or potential contaminant sources should be noted and additions made as needed. A complete inventory should be submitted to DEQ every five years.

Inventory Limitations

The potential sources of contaminants for the three public water supplies in Centerville were identified from readily available information. Unregulated activities or unreported contaminant releases may have been missed; however, multiple sources of data were used to help ensure that any major threats are identified.

CHAPTER 4

SUSCEPTIBILITY ASSESSMENT

Susceptibility is the potential for a public water supply well to be contaminated by one of the sources inventoried in the previous chapter. Hazard ratings and the presence of barriers determine susceptibility (Table 7). Hazard ratings are determined by the proximity of a potential contaminant source to a well. Point contaminant sources within a one-year time-of-travel of any of the public water supply wells in Centerville are given a high hazard rating and all other point sources in the inventory region are given a moderate hazard rating. Hazard for cropland is based on the percent of the inventory region or surface water buffer cultivated for dryland or irrigated crops. Hazard for septic systems is based on their density as estimated by population density. Barriers can be engineered structures, management actions, and/or natural conditions. Examples of engineered barriers are liners in wastewater treatment lagoons and double-walled underground fuel storage tanks. Chemical management plans and procedures for safe mixing and application of agricultural chemicals are considered management barriers. Finally, thick clay soils, a thick unsaturated zone above the water table, and a deep well can be natural barriers.

In addition to hazard and barriers, susceptibility depends on the public water supply classification. The Centerville School is susceptible to contamination by sources of fuels, herbicides, fertilizer, microbial contaminants, and nitrate whereas the Centerville Bar and Centerville WUA are only susceptible to contamination from sources of microbial contaminants and nitrate. Again, as discussed in the introduction to the inventory section this difference relates to the health effects of the different contaminants and the pattern of water consumption at each public water supply.

Table 7 Susceptibility to specific contaminant sources as determined by hazard and the presence of barriers

--	High Hazard	Moderate Hazard	Low Hazard
No Barriers	Very High Susceptibility	High Susceptibility	Moderate Susceptibility
One Barrier	High Susceptibility	Moderate Susceptibility	Low Susceptibility
Multiple Barriers	Moderate Susceptibility	Low Susceptibility	Very Low Susceptibility

The following are brief descriptions of the susceptibility assessments for each source included in Table 8.

All Centerville Public Water Supplies (sources of microbial contaminants and nitrate)

Residential Septic Systems –Population density and septic density is generally low in the inventory region and surface water buffer. The highest population density is in Stockett which is served by a sanitary sewer. Consequently, hazard for septic systems is rated low. Susceptibility also is rated low because the combination of a thick unsaturated zone and depths of well intakes is a barrier.

Large Capacity Septic System – The school septic system is classified as a large capacity septic system and, therefore, is treated as a significant point contaminant source for susceptibility assessment purposes. Hazard is rated high because the septic system is located within a one-year time-of-travel distance of all three wells. Susceptibility is rated high instead of very high because the combination of a thick unsaturated zone and depths of well intakes is a barrier.

Stockett Sanitary Sewer – Hazard is rated low because the sewered area is a small percent of the inventory region or surface water buffer. Susceptibility is rated low because the combination of a thick unsaturated zone and depths of well intakes is a barrier. Also, the Stockett sanitary sewer was installed within the last ten years and should be in good condition.

Stockett Wastwater Lagoon – Hazard is rated moderate because the lagoon is located in the inventory region but outside the one-year time-of-travel distance. Susceptibility is rated low because there are multiple barriers provided by the lagoon liner and the combination of a thick, unsaturated zone and depths of well intakes.

Cultivated Cropland **–** Hazard of nitrate contamination is rated low because less than 20 percent of the inventory region or surface water buffer is cultivated cropland. Susceptibility also is rated low because the combination of a thick unsaturated zone and depths of well intakes is a barrier.

Centerville School (sources of fuels, herbicides, and metals)

Stockett Road – Hazard is rated high for the Centerville School public water supply because Stockett Road crosses the edge of the control zone of its well. Susceptibility is rated high instead of very high because the well was grouted to a depth of 140 ft, constituting a barrier.

Abandoned Mines – Hazard is rated high for the Centerville School public water supply because acidic water containing metals discharges from mine openings within a one-year time-of-travel distances from its well. Susceptibility is rated high instead of very high because the combination of a thick unsaturated zone and depths of well intakes provides a barrier.

Cultivated Cropland **–** Hazard of herbicide contamination is rated low because less than 20 percent of the inventory region or surface water buffer is cultivated cropland. Susceptibility is rated low because the combination of a thick unsaturated zone and depths of well intakes provides a barrier.

Underground Storage Tank – Hazard for the 10,000 gallon heating oil tank at the Centerville School is rated high because it lies within a one-year time-of-travel distance from the school well. Susceptibility is rated moderate because spill prevention and/or leak detection, and the combination of a thick unsaturated zone and depths of well intakes provide multiple barriers.

Centerville Bar (nitrate and microbial contaminants)

Bar Septic System – The septic system at the Centerville Bar is within 100 feet of the well and, therefore, is rated a high hazard. Because the well is old and little information is available on its construction there are no barriers and susceptibility is rated very high.

Centerville WUA (nitrate and microbial contaminants)

Residential Septic Systems – Individual septic systems within 100 feet of the Centerville WUA well receive a high hazard rating. Susceptibility is rated high instead of very high because construction of the Centerville WUA well constitutes a barrier based on its recent construction and information available from its well log.

Table 8 Susceptibility to significant potential contaminant sources in the inventory region and surface water buffer.

--	Source	Contaminant	Contaminant Origin	Hazard Rating	Barriers	Susceptibility	Management
All Centerville Public Water Supply Wells	School Septic System	Nitrate and Microbial Contaminants	Drain field leachate	High	Thick unsaturated zone and deep intake	High	Ensure proper operation
	Stockett Wastwater Lagoon	Nitrate and Microbial Contaminants	Leaks through liner	Moderate	Thick unsaturated zone and deep intake, Lagoon liner	Low	Monitor for leaks
	Residential Septic Systems	Nitrate and Microbial Contaminants	Drain field leachate	Low	Thick unsaturated zone and deep intake	Low	Inspect for proper operation
	Sanitary Sewer	Nitrate and Microbial Contaminants	Leaks from sewer lines	Low	Thick unsaturated zone and deep intake	Low	Monitor for leaks
	Cultivated Cropland	Nitrate	Spills or excessive application	Low	Thick unsaturated zone and deep intake	Low	Provide information to land owners on proper chemical use

Centerville School Only	Stockett Road	Motor Fuels	Spills	High	Well Construction	High	Emergency Planning
	Underground Storage Tank	Heating Oil	Leaks or spills during filling	High	Thick unsaturated zone and deep intake, Leak detection/leak prevention	Moderate	Monitor for leaks
	Abandoned Mines	Metals	Infiltration of mine drainage	Moderate	Thick unsaturated zone and deep intake	Moderate	Monitoring
	Cultivated Cropland	Pesticides and Fertilizer	Spills or excessive application	Low	Thick unsaturated zone and deep intake	Low	Provide information to land owners on proper chemical use
Centerville Bar Only	Bar Septic System in Control Zone	Nitrate and Microbial Contaminants	Drain field leachate	High	None	Very High	Ensure proper operation
Centerville WUA Only	Septic Systems in Control Zone	Nitrate and Microbial Contaminants	Drain field leachate	High	Well Construction	High	Ensure proper operation

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GLOSSARY*

Acute Health Effect. An adverse 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.

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.

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.

Hardness. Characteristic of water caused by presence of various chemical compounds. 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.

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

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

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.

Nitrate. An important plant nutrient and type of inorganic fertilizer. In water, the major sources of nitrate pollution are septic tanks, sanitary sewers, feed lots and fertilizers.

Nonpoint-Source Pollution. Pollution sources such as stormwater runoff 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. Bacterial organisms 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.

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

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

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

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.

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

Susceptibility (of a PWS) The potential for a public water supply to draw water with contamination that would pose concern

Synthetic Organic Compounds (SOC). Manmade 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.

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.

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

Volatile Organic Compounds (VOC). Organic compounds which evaporates readily to the atmosphere.

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