Golden Age Village

Source Water Delineation and Assessment Report

Golden Age Village

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Introduction

Golden Age Village is located near the community of North Galstonbury about one and one-half miles southwest of Emigrant (Figure 1). Approximately 150 people reside year-round in modular housing units and about 30 students attend school at the site on a seasonal basis. Golden Age Village to obtains water from two wells (Figure 1). Both wells are believed to be completed in Quaternary Glacial sediments, primarily sand and gravel alluvium (Figure 2). Shallow unconfined alluvial aquifers are classified as highly sensitive to potential contamination sources (Montana DEQ, 1999).

Monitoring and Enforcement Actions

Golden Age Village supply wells 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 depending on system classification and population served. The highest level detected in the Village's wells in the last five years was 0.47 mg/l, considerably below the maximum concentration level of 10 mg/l set by the U.S. Environmental Protection Agency (EPA). Golden Age Village has had one bacteria detect on April 6, 2004. However follow-up samples and analyses indicated that no bacteria were present and the source water was not contaminated.

Delineation of Source Water Protection Areas

Delineation involves mapping land areas that contribute water to the public water supply's well, and to define areas within which to prioritize source water protection efforts. Four types of management regions are identified; they are the 100-foot control zone, a one-mile fixed radius inventory zone, the recharge region based on watershed boundaries, and the surface water buffer zone (Figure 1 and Figure 6). Wells 1 and 2 are interpreted to be completed in Quaternary Glacial deposits (sand and gravel). Ground water flows to the wells primarily from the west through the glacial sediments on the east side of the Gallatin Range (Figure 4).

Inventory of Potential Contaminant Sources

An inventory of potential contaminant sources was conducted to assess the susceptibility of the two wells to contamination and to provide a foundation for source water protection planning. The inventory for Golden Age Village focuses on facilities that generate, use, or store potential contaminants and certain land uses in the inventory region delineated in the previous section. Potential contaminant sources identified in the source water protection regions include: multiple septic systems and drainfields, individual septic systems on adjacent land parcels, Highway 89, and agricultural land.

Susceptibility Analysis

The proximity of a potential contaminant source to a well or the density of non-point potential contaminant sources determines the threat of contamination, referred to here as hazard (Table 6). For Golden Age Village a one–mile fixed radius inventory zone in conjunction with hydrogeologic mapping were used to identify areas from where possible contaminants could enter Golden Age Villages' water supply. Hazard and the existence of barriers to contamination determine susceptibility (Table 7). Barriers can be anything that decrease the likelihood that contaminants will reach a well.

Susceptibility ratings are presented individually for each significant potential contaminant source in the inventory region (Table 8). Susceptibility ratings range from moderate to low for the potential contaminant sources identified within the source water protection areas. Management recommendations are listed along with the susceptibility analysis in Table 8.

INTRODUCTION

This Source Water Delineation and Assessment Report, also known as a SWDAR, was completed by Jim Stimson, Hydrogeologist with Montana Department of Environmental Quality (DEQ) and by interns Chris Gourley and Shonna Jorgensen.

Purpose

This report is intended to meet the technical requirements for completion of the delineation and assessment report 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 whereby areas that contribute water to aquifers or surface water bodies that are used to supply drinking water are identified on a map. These areas are called source water protection areas. Assessment involves identifying locations in the delineated 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 Golden Age Village protect its drinking water sources.

Limitations

This report was prepared to assess threats to the Golden Age Village public water system 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 Golden Age Village public water system and not any other public or private water system. Also, not all of the potential or existing sources of ground water or surface water contamination in the area are identified. Only potential sources of contamination in areas that contribute water to Golden Age Village public water system wells are considered.

The term “contaminant” is 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
Approximately 150 people reside year-round in 49 modular housing units. Another connection for the school is also present. Approximately 30 students attend school seasonally. Golden Age Village is located near the community of North Galstonbury about one and one-half miles southwest of Emigrant (Figure 1). The population of Park County was estimated at 15,982 in 1999 of which 7,626 live in Livingston.

Geographic Setting
Golden Age Village is located in the the Paradise Valley at approximately 45.3633^{o}-north latitude and 110.7664^{o}-west longitude. This location ranges from 5000 to 5200 feet above sea level and is within the Upper Yellowstone Watershed (HUC # 10070002). The Paradise Valley separates the Absaroka-Beartooth and Gallatin mountain ranges and is approximately 35 miles long and 5 miles wide at its widest point about 15 miles south of Carter's Bridge. At its southern end near the mouth of Yankee Jim Canyon the valley is about 0.8 miles wide and near Carter's Bridge at the northern end, the valley is about 0.5 miles wide. The elevation of the valley floor in the north (Carter's Bridge) is about 4,540 feet above sea level and 5,009 feet above sea level to the south near the mouth of Yankee Jim Canyon. Mountain peaks within both the Absaroka-Beartooth and Gallatin ranges rise above 10,000 feet above sea level and relief between the peaks and valley floor is on the order of 5,000 feet.

The average daily high and low temperatures at Livingston are 84.6°F and 51.7°F in July and 34.8°F and 16.2°F in January. Precipitation averaging 17.9 inches annually is heaviest in May and June. Average annual snowfall is 44.2 inches.

General Aquifer Setting
Golden Age Village to obtains water from two wells (Figure 1). Upper Well 1 was drilled on a hill about 500 feet southwest of the Village in 1985 to a depth of 120 feet and was cased with 8” diameter steel. Lower Well 2 was drilled on a hill about 200 feet from the village in 1986 to a depth of 130 feet, and it was cased with 8” diameter steel. Both wells are believed to be completed in Quaternary Glacial sediments, primarily sand and gravel alluvium (Figure 2). Shallow unconfined alluvial aquifers are classified as highly sensitive to potential contamination sources (Montana DEQ, 1999).

Water Quality
Water quality data from the Paradise Valley for 5 sites sampling springs and 5 others for wells comes from Clark, 1991. Calcium (Ca), sodium (Na), and bicarbonate (HCO_3) are the major dissolved constituents (Table 1). The pH averages just above being neutral at 7.3 and the total dissolved solid concentration ranges between 116 and 246 mg/l.

Table 1. Chemical analyses of water from the Paradise Valley, south of Livingston.

Hydrologic Source: Springs　**Publication: Clark, 1990**

Location	Ca	Na	Mg	K	HCO3 Field	HCO3 Lab	Cl	SO4
A1	1.36	0.45	0.68	0.09	2.19	2.02	0.13	0.38
A3	1.79	0.43	0.8	0.1	2.56	2.54	0.15	0.39
N1	1.63	1.25	0.65	0.11	3.94	3.45	0.15	0.5
A6	2.2	1.25	0.65	0.11	3.94	3.95	0.15	0.64
Average	1.74	0.80	0.73	0.10	3.11	2.90	0.14	0.50
Max	2.20	1.25	0.87	0.11	3.94	3.95	0.15	0.64
Min	1.36	0.43	0.65	0.09	2.19	2.02	0.13	0.38

Location	SiO2	Sr	SI c	pH Field	pH Lab	TDS (mg/l)	SC Field	SC Lab
A1	0.37	120	-0.84	6.9	7.21	156.17	256	267.9
A3	0.46	150	-0.82	6.62	6.97	188.2	300	317.1
A5	0.55	180	-0.46	7.71	7.4	205.3	312	336.1
N1	0.42	160	-0.07	7.85	7.85	180.8	295	308.2
A6	0.46	270	-0.13	7.36	7.48	246.5	398	424.4
Average	0.45	176	-0.46	7.29	7.38	195.39	312	331
Max	0.55	270	-0.07	7.85	7.85	246.50	398	424
Min	0.37	120	-0.84	6.62	6.97	156.17	256	268

Hydrologic Source: Wells Publication: Clark, 1990

Location	Ca	Na	Mg	K	HCO3 Field	HCO3 Lab	Cl	SO4
04S09E04daa	1.46	0.77	0.47	0.09	2.5	2.21	0.17	0.37
03S09E10adc	1.78	1.67	0.15	0.04	3.35	3.36	0.04	0.19
03S09E36bdd	1.78	0.6	0.32	0.08	2.76	2.49	0.03	0.21
03S09E35dbb	1.53	0.49	0.23	0.06	2.23	2.09	0.02	0.17
PS	1.38	0.49	0.18	0.06	1.85	1.93	0.02	0.14
Average	1.59	0.80	0.27	0.07	2.54	2.42	0.06	0.22
Max	1.78	1.67	0.47	0.09	3.35	3.36	0.17	0.37
Min	1.38	0.49	0.15	0.04	1.85	1.93	0.02	0.14

Location	SiO2	Sr	SI c	pH Field	pH Lab	TDS (mg/l)	SC Field	SC Lab	Geologic Source
04S09E04daa	0.51	150	-0.94	6.9	7.05	174.4	247	288.3	Qal*
03S09E10adc	0.21	75	0.014	8.29	7.87	185.9	335	352.3	Mmc
03S09E36bdd	0.2	43	-0.4	7.2	7.45	152.2	266	286.5	Qaf**
03S09E35dbb	0.16	36	-0.77	7.06	7.22	126.4	231	242.1	Qaf**
PS	0.18	32	-1.07	7.25	6.95	116.8	202	221.7	Qaf**
Average	0.25	67.2	-0.63	7.34	7.31	151.14	256	278	
Max	0.51	150	0.01	8.29	7.87	185.9	335	352	
Min	0.16	32	-1.07	6.9	6.95	116.8	202	222	

* Qal = Yellowstone Aquifer in Clark's Thesis

**Qaf + Alluvial Fan Aquifer in Clark's Thesis

Monitoring and Enforcement Actions

Golden Age Village supply wells 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 depending on system classification and population served. Nitrate can come from human or animal wastes but also occurs naturally. The highest level detected in the Village's wells in the last five years was 0.47 mg/l, considerably below the maximum concentration level of 10 mg/l set by the U.S. Environmental Protection Agency (EPA). Golden Age Village has had one bacteria detect on April 6, 2004. However follow-up samples and analyses indicated that no bacteria were present and the source water was not contaminated.

CHAPTER 2 - DELINEATION

The source water protection areas for Golden Age Village public water system are delineated in this chapter. The purpose of delineation is to map the source of the water supply's drinking water and to define areas within which to prioritize source water protection efforts. Four types of management regions are identified; they are the control zone, one-mile fixed radius inventory zone, the recharge region, and the surface water buffer zone.

The goal of management in the control zone is to avoid introducing contaminants directly into the water supply's well or immediate surrounding areas. The one-mile fixed radius inventory zone and surface water buffer zone should be managed to prevent contaminants from reaching the well before natural processes reduce their concentrations. The goal of management in the recharge region is to maintain and improve water quality over long periods of time or increased usage.

Hydrogeologic Conditions

Descriptions of hydrogeologic conditions in the Paradise Valley and Livingston areas from reports by Montagne and Chadwick (1982), Groff (1962), Roberts (1972), and Clark (1991) are summarized in this section. The Paradise Valley of the Yellowstone River separates the Absaroka Range to the east and Gallatin Range to the west. The high peaks of the Absaroka Range consist of Precambrian metamorphic rocks of the Beartooth Plateau (Figure 2). These rocks estimated to be nearly 3 billion years old were uplifted along deep-seated faults and sculpted by alpine glaciers. The Gallatin Range consists of Tertiary volcanic rock overlaying folded sedimentary layers and crystalline basement rock. At the northern-most end of the Paradise Valley, the Yellowstone River cuts through a canyon in steeply folded and faulted Paleozoic sedimentary rocks that make up the north end of both the Absaroka and Gallatin ranges.

Within the Paradise Valley, bedrock ranging in age from Precambrian through the Tertiary is exposed at the land surface. There are also younger deposits derived from glacial activity and the Yellowstone River. The Paradise Valley is interpreted to be a Basin and Range-style block faulted basin (Reynolds, 1979). The basin beneath the valley is tilted to the east, toward the Deep Creek normal fault that marks the western-most boundary of the Absaroka-Beartooth mountain front. The basin also dips to the south. Depth to bedrock near the north-end of the valley is estimated to be about 50 feet (Kirby, 1940 from Clark, 1991), while to the south, a deep well has penetrated nearly 6,000 feet of Tertiary and Quaternary rocks (Clark, 1991). In this regard, the basin beneath the Paradise Valley is comparable to the one beneath the Big Hole Valley in southwestern Montana (Clark, 1991, see also Levings, 1986). Because the alluvial aquifer thins to the north within the valley, some ground water flow is directed to the surface, as indicated by the Armstrong and Nelson springs. Movement along several geologic faults that cross the Paradise Valley may have contributed to thinning of the aquifer and the location of these springs. Ground-water flow gradients are thought to be directed upward from the aquifer toward the Yellowstone River alluvium in the north part of the valley. As a result, ground water likely exits the valley to the north as surface water rather than ground-water "underflow". In the middle and southern parts of the Paradise Valley, ground-water flow is generally from upland regions toward the Yellowstone River and then northward.

Published reports on ground-water resources in the Paradise Valley usually mention five potential aquifers including 1) Quaternary Yellowstone River alluvium, glacial outwash and alluvial fan deposits, 2) Miocene lake sediments in the vicinity of Hepburn Mesa, 3) Eocene volcanic lava flows, 4) the Mississippian age Madison Limestone, and 5) older bedrock formations of various ages. However, ground water is obtained primarily from shallow wells drilled into the Yellowstone River alluvium, glacial outwash and alluvial fan deposits which function essentially as a continuous aquifer (Clarke, 1991). The other potential aquifers listed do provide water to wells but they are often not as productive and reliable as the Yellowstone River alluvial aquifer. The Madison Limestone is considered to have potential as a reliable source of ground water but there are only a few wells completed in the Madison within the Valley. Again, as a general rule, bedrock formations that are older than the Madison are generally not considered to be reliable sources of ground water.

The Montana Ground Water Information Center (GWIC) records about 1,400 wells in the Paradise Valley. Of these, about 40% are less than 75 feet deep and 80% of the wells are less than 200 feet deep. The deepest well is 1,600 feet and is completed in a sand and gravel aquifer. Examining well depths within the Valley shows that wells north of Spring and Suce Creeks average about 74 feet deep with a average yield of 36 gallons per minute (gpm) while the average depth for wells to the south is about 142 feet and average yield is 29 gpm.

Golden Age Village is located near the community of North Galstonbury about one and on-half miles southwest of Emigrant. The two Golden Age Village wells serve 50 service connections. The water supply provides water to the same 150 people from day to day and to about 30 more students seasonally and is therefore considered a community water system. Water demand ranges from approximately 7,500 to 9,000 gallons per day assuming 50 gallons per day per resident (EPA, 1991). It is believed that wells 1 and 2 are completed in Quaternary Glacial deposits (sand and gravel). Ground water flows to the wells primarily from the west through the glacial sediments on the east side of the Gallatin Range (Figure 4).

Table 2. List of geologic or hydrogeologic maps available for the Livingston vicinity.

Description	Date	Area Covered	Reference
Local Geology	1964	Livingston 24K Quad	Roberts, A.E. 1964. Geology of the Livingston Quadrangle Montana, U.S. Geological Survey Geologic Quadrangle Maps of the United States, one-sheet.
Regional Geology	1972		Roberts, A.E. 1972. Cretaceous and Early Tertiary Depositional and Tectonic History of the Livingston Area, Southwestern Montana, Plates 1 and 3.

Conceptual Model

Aquifers within the Paradise Valley receive recharge from the melt-water moving off of the Gallatin Range to the west and the Absaroka-Beartooth Range to the east (Figure 3). Only a few of the larger stream tributaries flowing over the alluvial fans at the base of the Absaroka-Beartooth Range reach the Yellowstone River. The majority of the smaller tributaries have water flowing only in the upper reaches; the lower reaches are dry. This shows the streams lose water into the alluvial fan sediments and provide recharge to aquifers within these deposits. Clarke (1991) presented evidence that the water lost to the fans continues to flow into the Yellowstone River alluvium located down-gradient from the fans. In general, ground water flows from the upland areas toward the Yellowstone River and then northward toward the end of the valley in the vicinity of Carter's Bridge. The alluvial aquifer thins appreciably to the north resulting in several prominent springs emerging along the central part of the valley. The thinning likely causes ground-water flow in general to be directed upward and toward the Yellowstone River near the northern end of the Paradise Valley.

Source Wells

Golden Age Village wells 1 and 2 are both cased with 8” diameter steel, approximately 100 feet in depth, and located southwest of the village (Figure 1). At the time of the sanitary survey, they were both being utilized. Both had 5 horsepower submersible pumps that pumped water from the wells to a pump house at the southeast corner of the Village. Water was chlorinated in the pump house. Golden Age Village was in the process of changing from a 180,000 gallon bladder storage reservoir to pressure tank storage at the time the sanitary survey was completed.

Table 3. Information from drillers logs from wells near the Ranch Headquarters.

MBMG #	Upper Well #1	Lower Well #2
Location	05s08e32bdaa	05s08e32abcc
Date Completed	1985	1986
Depth	120	130
Screened Interval	80-120	110-130
SWL Depth - ft. below ground surface (ft. bgs)	89	60
PWL Depth - ft. bgs	120	130
Drawdown - ft.	31	70
Test Pumping Rate	100	100
Specific Capacity (gpm/ft)	3.2	1.4

Delineation

Methods and criteria for delineating source water protection areas are specified in the Montana Source Water Protection Program (DEQ, 1999). Source water protection areas delineated for Golden Age Village include controls zones for each well and common inventory and recharge regions (Figure 4 & Figure 6).

Control Zones - 100-foot radius control zones are delineated for the Village's wells; all sources of potential contaminants should be excluded in this region.

One-mile Fixed Radius Inventory Zone – The inventory zone is delineated as a modified one-mile fixed radius circle. The aquifer receives recharge water through both through the glacial deposits to the west. All sources of potential contaminants are inventoried in this region.

Recharge Region - On a broad scale, the entire Paradise Valley provides recharge to the alluvial aquifer used by the Golden Age Village public water supply. Efforts to maintain and improve water quality within the valley will benefit the Village and other public water supplies within the valley. Watersheds within the valley include the southern-most part of HUC# 10070002050, and hydrologic units 10070002010, 10070002020, 10070002030, and 10070002040. On a local scale, Golden Age Village wells receive recharge in a shorter time frame from a smaller area or sub-watershed surrounding the wells (Figure 6). Changes in land use and management of potential contaminant sources within the smaller watershed will have a more immediate affect on the Village's source water. The inventory for the recharge region includes both the smaller and larger watershed regions and focuses on potential sources of nitrate and pathogens. The goal of management in the recharge region is to maintain and improve the long-term quality of ground water in the alluvial aquifer.

Surface Water Buffer Zone – A surface water buffer zone was delineated for the stream separating the Village form the wells but it was determined that no significant potential sources were contained within this zone. The zone is therefore not shown.

Table 4. Note: Table 4 is omitted because time-of-travel calculations were not used to establish the inventory regions.

CHAPTER 3 - INVENTORY

An inventory of potential contaminant sources was conducted to assess the susceptibility of Golden Age Village wells to contamination and to provide a foundation for source water protection planning. The inventory for the Village focuses on facilities that generate, use, or store potential contaminants and certain land uses in the inventory region delineated in the previous section. Sources of all primary drinking water contaminants and cryptosporidium are identified, although only potential sources of contaminants that are the greatest threat to human health were selected for detailed inventory. The contaminants of greatest concern to Golden Age Village are nitrate, microbial contaminants, and agricultural chemicals including fertilizers and pesticides.

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: Land cover is identified from the National Land Cover Dataset compiled by the U.S. Geological Survey and U.S. Environmental Protection Agency (USGS, 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 SIC code.

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

Step 6: All significant potential contaminant sources were identified in the inventory region, sources of nitrate and microbial contaminants were identified in the surface water buffer, 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) 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 runoff
12) Floor drains, sumps, or dry wells

Inventory Results/Control Zones

The control zone for wells 1 and 2 are located on a hill southwest of the Village (Figure 4). There are several houses near these wells and two septic systems that serve the two of the houses and the Village. Measurements made by the public water supply operator indicate that the septic systems are at least 200 feet south-south west from the wells. Hazard assigned to the septic tanks is high because they serve more than 20 people per day and are considered large capacity. The susceptibility of the wells to the septic system is rated as moderate due to the fact that the septic tanks and drainfields are located cross or slightly down gradient of the wells and at setback distances of at least 200 ft.

Inventory Results/One-mile Fixed Radius Inventory Zone

Land cover in the inventory region of Ranch Headquarters is 78 percent grassland, 13 percent shrubland, 8 percent wetland (Figure 5). Grassland, shrubland, and wetlands are not considered potential sources of contamination. Golden Age Village has approximately nine septic drainfields. They are all located within the one-mile inventory zone and up gradient from the wells. Septic density in and around the Village is of moderate and high density. Septic systems are considered potential sources of pathogens. Large capacity septic systems are considered point sources of potential contaminants when they are located within the inventory region.

US Highway 89 runs through the lower part of the inventory region. There is a danger of contamination from hazardous spills or weed or pest control sprays. Spraying of weeds along the highway and access roads to the Village result in SOC's being used in the vicinity of the Village but probably not in close proximity to the wellheads. Spraying of de-icing chemicals could also be a concern for the Village. It appears that the highway is down-gradient of the two wells (Figure 1 and Figure 4).

Part of Fridley Creek is located within the inventory zone and may act as a local hydrologic barrier to shallow ground water moving from the north toward the wells. Grazing of livestock along the creek could pose a threat of pathogenic contamination to the aquifer. However, it is not clear if grazing occurs along the creek and due to the depth of the aquifer the creek is not considered a significant potential contaminant source.

No businesses that use or generate hazardous chemicals were identified in the inventory region. The most likely contaminants in the inventory region are microbial contaminants, nitrate and pesticides.

Table 5. Significant potential contaminant sources in the inventory region of Golden Age Village public water system wells.

Source	Contaminants of Concern
Golden Age Village septic drainfields	Microbial contaminants and nitrate
Septic system drainfields from surrounding properties	Microbial contaminants and nitrate
US Highway 89	Accidental spills of a variety of hazardous materials, SOC's from weed spraying.

Inventory Result/Recharge Region and Surface Water Buffer Zone

Land use in the recharge region represented by HUC 10070002010 is 59 percent forest, 29 percent grassland and 10 percent shrubland (Figure 5). As mentioned above, forest, grasslands, and shrubland are not considered potential contaminant sources. The main concern for the recharge and surface water buffer regions would have to be pathogen contamination from septic systems and possibly spills from the highway.

Inventory Update
The certified water system operator will update the inventory for his records every year. Changes in land uses or potential contaminant sources will be noted and additions made as needed. The complete inventory will be submitted to DEQ every five years.

Inventory Update
The Source Water Protection Program encourages the public water system operator to update the inventory for their records annually and update the Source Water Program every 5 years. Updates to the DEQ could be more frequent if land uses change or facilities are sited in the area that pose a threat to the public water supply.

CHAPTER 4 - SUSCEPTIBILITY ASSESSMENT

The susceptibility of Golden Age Village wells to contamination is assessed in this chapter. The proximity of a potential contaminant source to a well or the density of non-point potential contaminant sources determines the threat of contamination, referred to here as hazard (Table 6). For Golden Age Village, a one–mile fixed radius inventory zone in conjunction with hydrogeologic mapping of the alluvial aquifer were used to identify areas from where possible contaminants could enter the Village's water supply. High hazard is assigned to significant potential contaminant sources within the one-mile fixed radius of the Golden Age Village wells, moderate and low hazard were assigned to potential sources outside the one-mile fixed radius inventory zone depending on distance and number of barriers. Hazard and the existence of barriers to contamination determine susceptibility (Table 7).

Barriers can be anything that decrease the likelihood that contaminants will reach a 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 can be 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 6**.** Hazard of potential contaminant sources for Ranch Headquarters public water system.

	High Hazard	Moderate Hazard	Low Hazard
Point Sources of Contaminants	Within one-half mile of a well	From one-half to one mile (the limit of the inventory region)	Beyond the inventory region
Septic Systems	More than 300 per sq. mi.	50 – 300 per sq. mi.	Less than 50 per sq. mi.
Cropland (percent land use)	More than 50 percent of region	20 to 50 percent of region	Less than 20 percent of region

Table 7. Susceptibility to potential contaminant sources based on 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

Susceptibility ratings are presented individually for each significant potential contaminant source in the inventory region and the surface water buffer (Table 8). In addition, Golden Age Village wells may be susceptible to contamination from Class V injection wells that have not been identified.

Golden Age Village Septic Systems – Hazard is rated high because the there are nine septic systems and their drainfields are up-gradient from both wells. Susceptibility is rated moderate because a small stream separates the wells and the village with its septic systems. The stream will should act as a hydrologic barrier to contamination released to the shallow ground water system. In addition, the wells appear to be on the order of 1,000 feet from the Village. In summary, the stream, the setback distance from the Village and the depth of the wells are considered barriers to potential contaminants.

Other Septic Systems – Hazard assigned to the septic tanks is high because they serve more than 20 people per day and are considered large capacity. The susceptibility of the wells to the septic system is rated as moderate due to the fact that the septic tanks and drainfields are closer to the wells but appear to be located cross- or slightly down gradient of the wells and at setback distances of at least 200 ft.

US Highway 89 – Hazard is rated high because the high runs through the one-mile inventory zone. Susceptibility is rated as low to low because the highway is down-gradient and is about ½ mile or more from ~~a~~ the wells.

Management Recommendations
Management recommendations are listed along with the susceptibility analysis in Table 8. Some of these recommendations are beyond Golden Age Village's control and are intended for governmental entities such as the City of Livingston or Park County that have the authority or ability to implement them. If implemented, these recommendations can be considered additional barriers that will reduce the susceptibility of Golden Age Village's wells to specific sources and contaminants.

Table 8. Susceptibility assessment for Golden Age Village's wells.

Source	Contaminant	Hazard Rating	Barriers	Susceptibility	Management
Golden Age Village septic system drainfields	Bacteria / Nitrate	High	Stream barrier Distance from wells Well intake depths	Moderate	Properly operate and maintain the on-site septic system and distribution lines. A two to three year septic tank pumping maintenance schedule is recommended. Consider connecting to municipal sewer system, if available. Encourage and support city and county efforts to provide educational materials and workshops to the public on proper handling and disposal of industrial and household hazardous wastes and recycling.
Other septic system drainfields	Bacteria / Nitrate	High	Slightly down-gradient Setback distance of at least 200 ft. Well intake depths	Moderate	Same as above
Highway 89	Variety of hazardous materials	High	Down-gradient Distance form wells Well intake depths	Low	Encourage and support emergency planning, training of local emergency response personnel, use of levees and engineered storm drainage to carry any spills away and prevent infiltration into ground, cooperation with railroad managers or MDOT to reduce herbicide use.

Septic system upgrades - Re-locating the Golden Age Village's septic system to a more down-gradient location could lessen the hazard from the wastes and septic effluent. It is understood that re-location may not be possible due to land ownership issues. Re-engineering the systems could also help reduce the hazard rating. Installing a sand filter septic tank and a pressure-dosed drainfield are two possible improvements to consider.

Other septic systems – The distance of the septic systems from the wells has been provided and both were measured to be greater than 200 feet. The hazard rating is high while the susceptibility is rated moderate because there are multiple barriers present. Relocating the two septic systems to a more down-gradient position and increasing the setback distance would help lower the ratings.

Inventory and permitting or closure of Class V injection wells – The U.S. EPA is implementing a program to identify and permit or close sumps, floor drains, dry wells, or commercial septic systems that are potential contaminant sources. This program is being implemented gradually with EPA planning to complete an assessment for Livingston within the next year. EPA's first step is to mail shallow well inventory request forms to businesses that often have Class V injection wells (they concentrate on automotive service businesses). EPA makes decisions on permitting and closure based on responses they receive and subsequent inspections. Permit recipients are required to sample their shallow injection wells quarterly and ensure that the fluid being injected meets drinking water standards.

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Figures

Figure 1 – General Location Map

Figure 2 – General Geology Map

Figure 3 – Conceptual Model for Ground-Water Flow

Figure 4 – Inventory Region Map

Figure 5 – Land Use Map

Figure 6 – Recharge Region Map

APPENDICIES

Appendix A - Well Logs
Included in Sanitary Survey (Appendix B)

APPENDIX B – Sanitary Survey

Appendix C - Water Quality Monitoring History From DEQ PWS's Database

Appendix D – Concurrence letter and other correspondence

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.

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.

Delineation. A process of mapping source water management areas.

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

Hazard. A measure of the potential of a contaminant leaked from a facility to reach a public water system 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.

Inventory Region. A source water management area that encompasses the area expected to contribute water to a public water system within a fixed distance or a specified ground water 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 system. 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 nitrates are septic tanks, feed lots and fertilizers.

Nonpoint-Source. Pollution sources that are diffuse and do not have a single point of origin.

Pathogens. A bacterial organism 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. A system that provides piped water for human consumption to 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 system. 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.

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 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 system.

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

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

Synthetic Organic Compounds (SOC). Man made organic chemical compounds (e.g. 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). Any organic compound which evaporates readily to the atmosphere.

* Definitions taken from EPA's Glossary of Selected Terms and Abbreviations