HYDROGEOLOGIC ASSESSMENT OF THE SODA BUTTE SPRING FOR GROUND WATER UNDER THE DIRECT INFLUENCE OF SURFACE WATER

COOKE CITY WATER DISTRICT
PWSID #00187
P.O. Box 1084
Cooke City, MT 59020

MBMG Open-file Report 401-H

Prepared
for
Montana Department of Environmental Quality
Water Quality Division

by
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1.0 INTRODUCTION AND PURPOSE

This report summarizes the results of a hydrogeologic assessment for the spring source used by the Cooke City Water District (PWSID #00187). The Montana Bureau of Mines and Geology (MBMG) is under contract with the Montana Department of Environmental Quality (DEQ) to conduct preliminary assessments and hydrogeologic assessments for selected community water supplies. The project was funded under DEQ Contract Number 400022, Task Order Number 7.

The purpose of the hydrogeologic assessment was to determine if the Cooke City spring, which will be referred to as the "Soda Butte spring", used by the Water District (WD) is under the direct influence of surface water as defined in 40 CFR part 141. A field inspection of the spring area was completed in September 1997. **The results of the hydrogeologic assessment indicate that the spring may be under the direct influence of surface water as defined in 40 CFR part 141, due to insufficient filtration of water that collects around the spring-water collection structures.** This report summarizes data obtained during the field inspection and follow-up investigation that were used to make the above determination. Data on system location, construction, geology, hydrology, and water quality are summarized. Conclusions and recommendations are presented at the end of the report. Additional information is provided in appendices.

2.0 BACKGROUND

The Surface Water Treatment Rule (SWTR) of the Federal Safe Drinking Water Act of 1986 requires each state to examine public water supplies that use ground water to determine if there is a direct surface water influence. In Montana the Water Quality Division of DEQ is evaluating public water supplies for the SWTR. This project is known as the **Ground Water Under the Direct Influence of Surface Water (GWUDISW) program**. The SWTR defines ground water under the direct influence of surface water as any water beneath the surface with:

i) significant occurrence of insects or other macroorganisums, algae, or large diameter pathogens such as *Giardia lamblia*, or *Cryptosporidium*; or

ii) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH, that closely correlate to climatological or surface-water conditions.

Evaluation of a public water supply for the GWUDISW program begins with completion of a preliminary assessment (PA) form for each water source used by the public water supply. The PA form provides a score that indicates the potential of the source to be under the direct influence of surface water. If the PA score is over 40 points, the ground-water source is considered to be at risk of being under the direct influence of surface water, and under DEQ guidelines, further evaluation is required. Springs and infiltration galleries are automatically assigned a score of 40 points and must undergo more detailed evaluation. The evaluation may involve a hydrogeologic assessment (HA) and/or a water-quality assessment that could include a microscopic particulate analysis (MPA). This report is the HA for the Cooke City Water District's Soda Butte spring.

3.0 PRELIMINARY ASSESSMENT

The Cooke City WD uses water from a spring cluster that is referred to as the Soda Butte spring (source ID #003) in the MDEQ public water-supply files. Although two infiltration galleries are used to collect water for the system, they are treated as a single source. A completed PA form for the spring is included in appendix A. The spring was assigned a PA score of 70 points, indicating that it was at moderate risk of being under the direct influence of surface water. Following MDEQ guidelines, a hydrologic assessment of the spring source was then required because the PA score was greater than or equal to 40 .

4.0 SYSTEM DESCRIPTION

The town of Cooke City was founded in the mid 1800s by miners who were drawn by the gold deposits on nearby Republic and Miller mountains (James, 1995). During its heyday in the mid-1880s, it had a population of about 2,000 people, but as of 1999, the population of the town is probably less than 200 people, most of whom are only summer residents.

Many of the homes and cabins in Cooke City rely on private wells for drinking water, but a significant number are served by the WD's water system. The system supplies 60-100 gpm (English, 1997; Metesh and others, 1999) and has about 70 active service connections that serve a population of about 75 people (DEQ, 1998). The system is managed by the WD and is classified as a community public water supply by MDEQ. Information about the springs is tracked in the MBMG's Ground-Water Information Center (GWIC) database. The GWIC site ID number for the Soda Butte spring is M:158065.

4.1 Location

Cooke City is located in Park County in south-central Montana (figure 1), near the northeast entrance to Yellowstone National Park. The Soda Butte spring is located about 1.25 miles east of Cooke City and 0.75 mile west of Colter Pass. The legal description for the location of the spring is NW1/4 SE1/4 NW1/4 NE1/4 sec. 30, T. 9 S., R.15 E. The coordinates of the site are latitude 45°01'29"N, longitude 109°54'21"W. The elevation of the spring site is about 7,870 ft above mean sea level (amsl), while the elevation of the town of Cooke City is 7,600 ft amsl. The spring is accessed from town by following Highway 212 east about half a mile and then turning to the

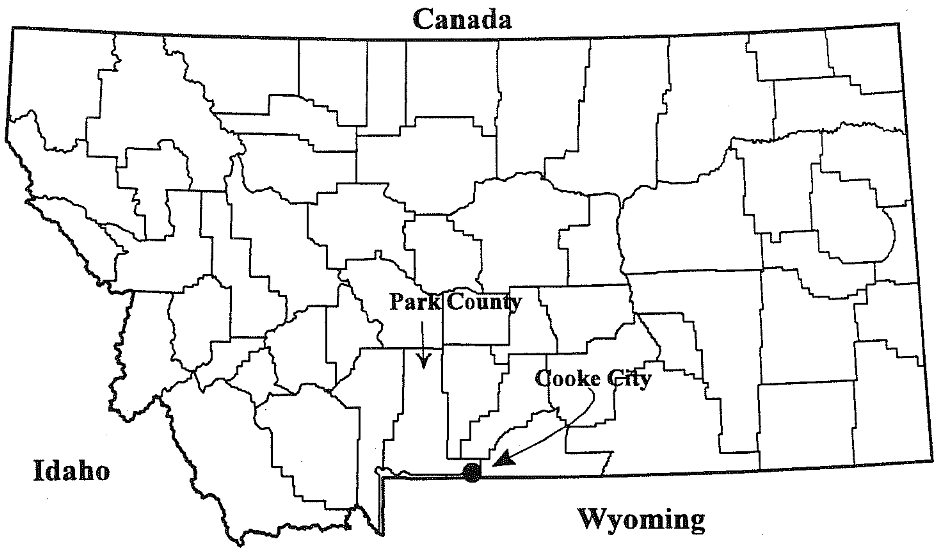

Figure 1. Cooke City is located in south-central Montana, several miles east of the northeast entrance to Yellowstone National Park. During the winter months, the only access to Cooke City is through Gardiner, Montana, via Highway 212.

right at the Forest Service's Soda Butte Campground. The spring is located a short distance beyond the end of the campground road. Figure 2 is a topographic map showing the location of the spring relative to the town.

4.2 Source History

The Soda Butte spring was first considered for development in 1980 to alleviate winter shortages caused by decreased flow from a spring source that the WD had developed on the mountainside north of Cooke City. However, at the time, the WD did not have the financial resources to move forward with the development (Cooke City Water Users Assoc., 1983). After the historic forest fires of 1988 damaged the distribution system for the north spring, the WD considered drilling a well to supply the system; however, when a permit application was submitted, the Yellowstone National Park Service objected (Brown, 1996). As an alternative, the WD developed the Soda Butte spring east of town. The date that the WD started to use the spring as a source was not available.

4.3 System Configuration

Figure 3 is a sketch map showing the general layout of the water-collection system at the Soda Butte spring. Detailed as-built plans for the collection system were not available.

There are two water-collection structures at the site. The one labeled "Collection Structure #1" on figure 3 consists of a concrete box installed in the hillside just above the point where a stream

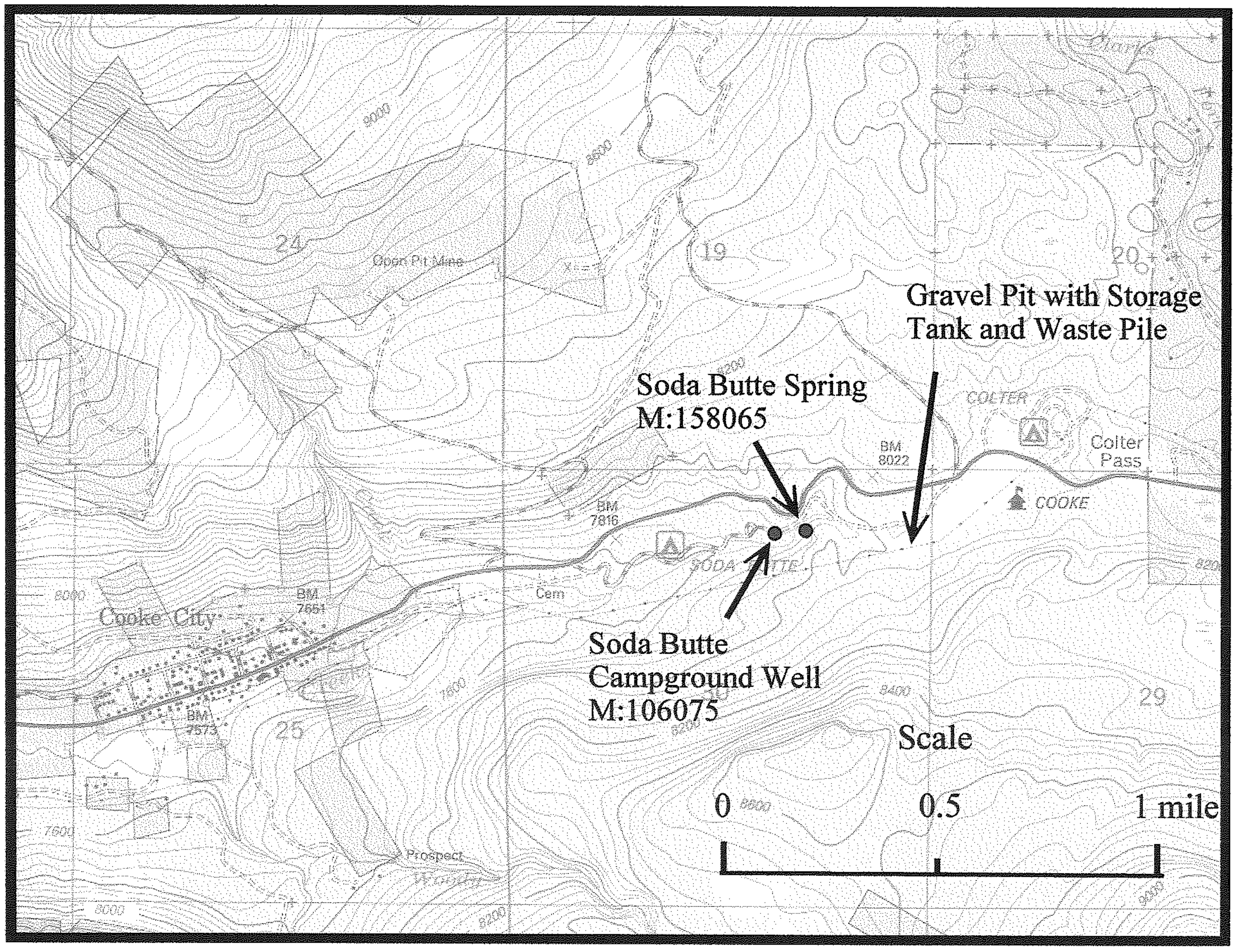

Figure 2. Topographic map of the Soda Butte spring area. Contour Interval: 40 ft. Modified from U.S. Geological Cooke City, Montana 7.5-min quadrangle (1991).

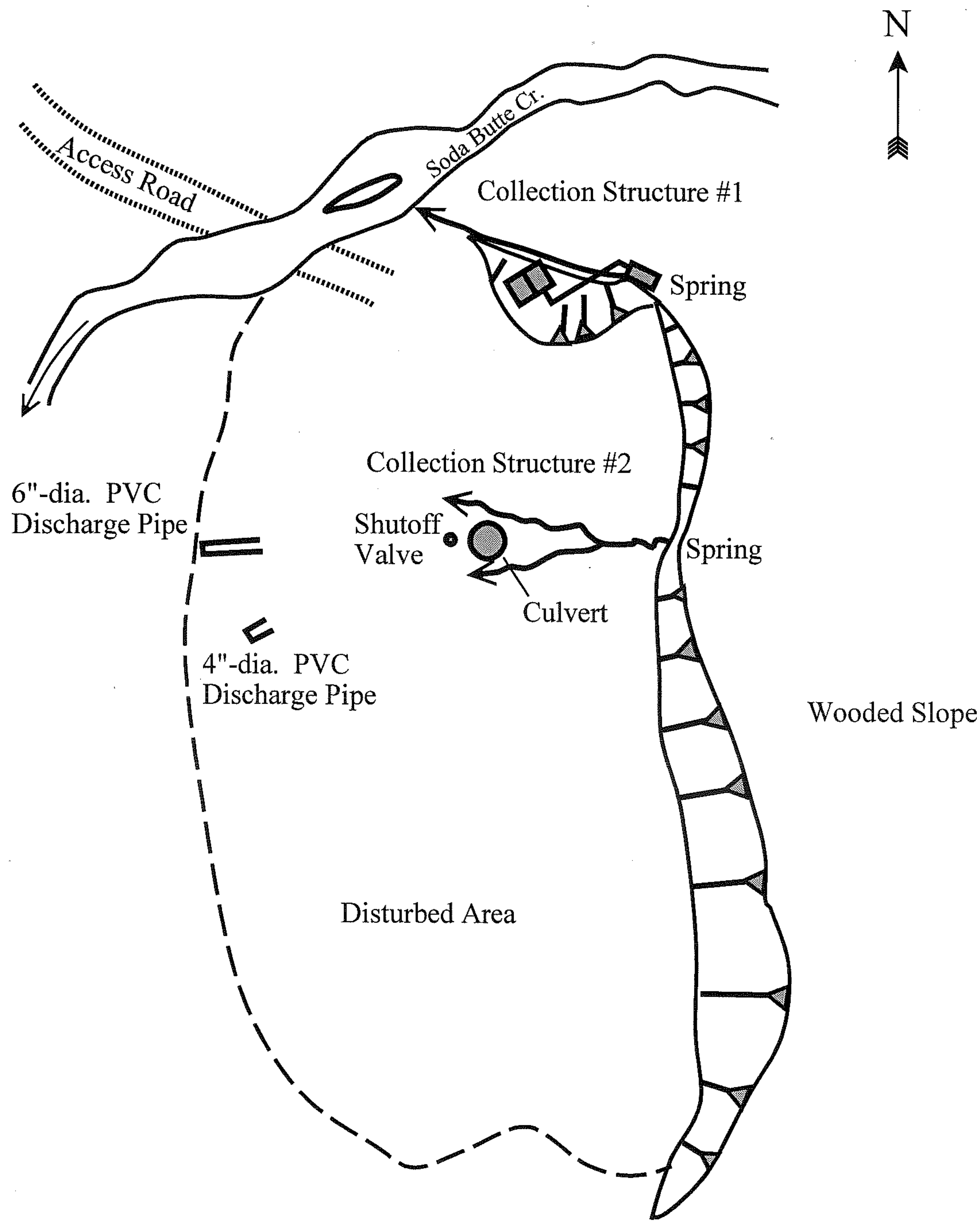

Figure 3. Sketch map of the Soda Butte spring area. Not to scale.

of water begins to flow. The concrete box is covered with lid and a plastic tarp to prevent entry of dirt and other debris (figure 4). A 4"-diameter PVC pipe runs from this box to another box with a concrete lid located a short distance downslope (figure 5). Water from the second box drains into a 4"-diameter PVC pipe that presumably connects to the mainline that runs to Cooke City.

Two access ports, one located along the pipe between the two boxes and another attached to the lower box, are used for adding liquid chlorine bleach or chlorine tablets to treat the water. The ports are capped but there are no locks to prevent tampering.

Collection structure #2 consists of a 3-foot-diameter metal culvert that is placed vertically in the ground (figure 6). The culvert is covered with a lid, but the lid does not lock and does not form a water-tight seal. It is report that water feeds into the culvert via buried collection pipes that radiate up slope, but it was not possible to verify this configuration during the field inspection (English, 2000). A second buried pipe drains water from the culvert and feeds it into the main line to Cooke City. A shutoff valve for this pipe is located in a 6-inch diameter PVC pipe next to the culvert.

Overflow discharge pipes are located a short distance downslope of the two collection structures. One is a 6-inch diameter PVC pipe with a screen; the other is a 4-inch diameter PVC pipe that carried a small flow (about 1 gpm) at the time of the field inspection.

5.0 GEOLOGY

5.1 Local Topography

The town of Cooke City is located along Soda Butte Creek, which flows through a deep glacial-trough valley that is surrounded by mountains to the north and south. The spring is located east of town, on a west-facing slope near the head of Soda Butte Creek. The general topography of the area is shown in figure 2.

The spring discharge area occurs at an abrupt break in slope. As shown in figure 6, the topography immediately around the springs appears to have been altered by recent construction activities.

5.2 Land Use

The spring is located on land administered by the U. S. Forest Service and is a short distance east of the Forest Service's Soda Butte Creek campground. Recreation is therefore the primary land use near the spring.

On Colter pass, about 3/4 mile east of the spring, there is a gravel pit that is used as a burial and burning area for construction waste and woody debris (figure 7). Figure 8 shows a large above-

Figure 4. The infiltration gallery for spring-water collection structure #1 is installed in glaciofluvial deposits. Note the blue plastic tarp draped over the top of the box.

Figure 5. The second concrete box for collection structure #1 is located a short distance downslope from the infiltration gallery. Note the small stream of water flowing past the box.

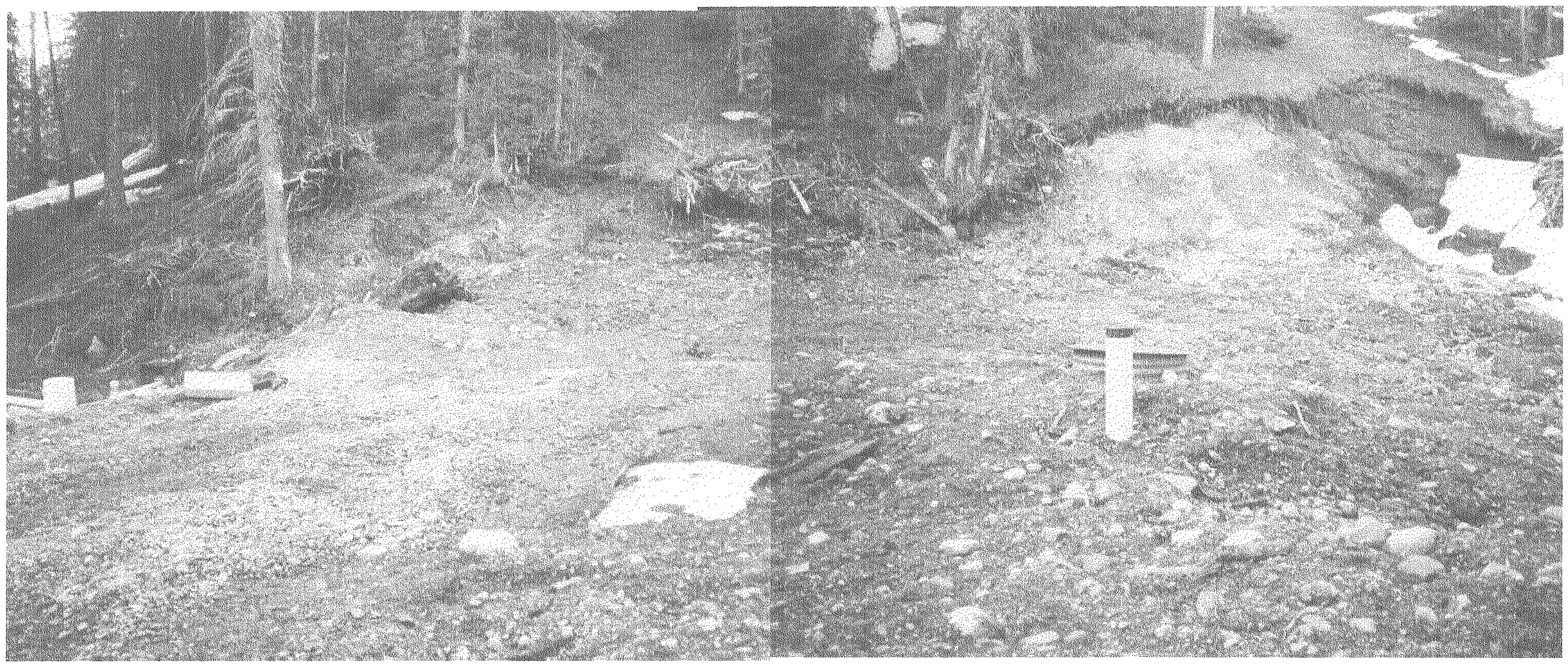

Figure 6. Collection structure #2 consists of a 3-ft diameter culvert installed vertically in the ground. The 6" PVC pipe in the foreground is an access for the shutoff valve for the line that carries water to the Cooke City main. Spring water flows from the open cut to the left of the culvert and PVC pipe. Collection structure #2 can be seen to the left.

Figure 7. A pile of construction waste and wood debris were located in a gravel pit upgradient of the Soda Butte spring at the time of the site inspection.

Figure 8. A large fuel(?) storage tank was located in the gravel pit upgradient of the Soda Butte spring at the time of the site inspection.

ground storage tank that is also located in this area. Because the spring is located downgradient of this gravel pit, the land use here is a concern. Disposal of liquid wastes or an accidental spill from the storage tank would directly threaten the water quality of the spring.

5.3 Regional Geology

Regionally, Cooke City is situated within the south-central portion of the Beartooth Uplift, a large fault-bounded structural block (Kirk, 1995). The spring area is within a regional northwest-trending structural low referred to as the Cooke City Sag Zone, which is considered to be a major crustal lineament (Foose and others, 1961). The Sag Zone separates Precambrian crystalline rocks to the north from Paleozoic sedimentary rocks, and younger intrusive and volcanic rocks to the south (Kirk, 1995).

Pleistocene glaciation has played a major role in shaping the Soda Butte Creek valley in which Cooke City is located. Pre-Bull Lake, Bull Lake, and Pinedale glaciers scoured the valley walls and bottom, carving the deep glacial-trough valley (Pierce, 1979). No deposits of pre-Bull Lake and Bull-Lake glaciation have been identified within the Cooke City area, probably due to later removal by Pinedale glaciers. During Pinedale glaciation, ice from five icecap source areas, including the Beartooth Plateau, coalesced to form the Northern Yellowstone Outlet Glacier (Pierce, 1979). This outlet glacier was up to 90 miles long and terminated in the Paradise Valley near Prey, Montana. In the Cooke City area, the glacial- ice surface built up to elevations of close to 10,000 feet during the Pinedale maximum, covering all but the highest peaks in the study area (Pierce, 1979; Locke, 1995).

Exposed bedrock and glacial deposits left behind after recession of the Pinedale glaciers have been modified during the last 7,000–10,000 years by mass wasting and alluvial and fluvial processes. Alluvial and fluvial processes during this period appear to have been strongly influenced by climatic variations and forest fires (Meyer and others, 1992; Meyer, 1993; Bingham and Meyer, 1994; Meyer and others, 1995). These processes and the resulting surficial deposits established the current hydrogeologic setting of the spring, which surfaces within a large glacial outwash deposit.

5.4 Local Geology

A geologic map of the spring area is shown in figure 9. The spring flows from glacial outwash deposits that consist of weakly stratified deposits of fine-grained material mixed with sand, and rounded gravel and cobbles (figure 6).

6.0 HYDROLOGY

6.1 Surface Water

Metesh and others (1999) estimated that the Soda Butte Creek basin above the Silver Gate entrance to Yellowstone National Park receives an annual mean of 56 inches of precipitation, much of which falls as snow. Data from a climate station located on the valley floor between the

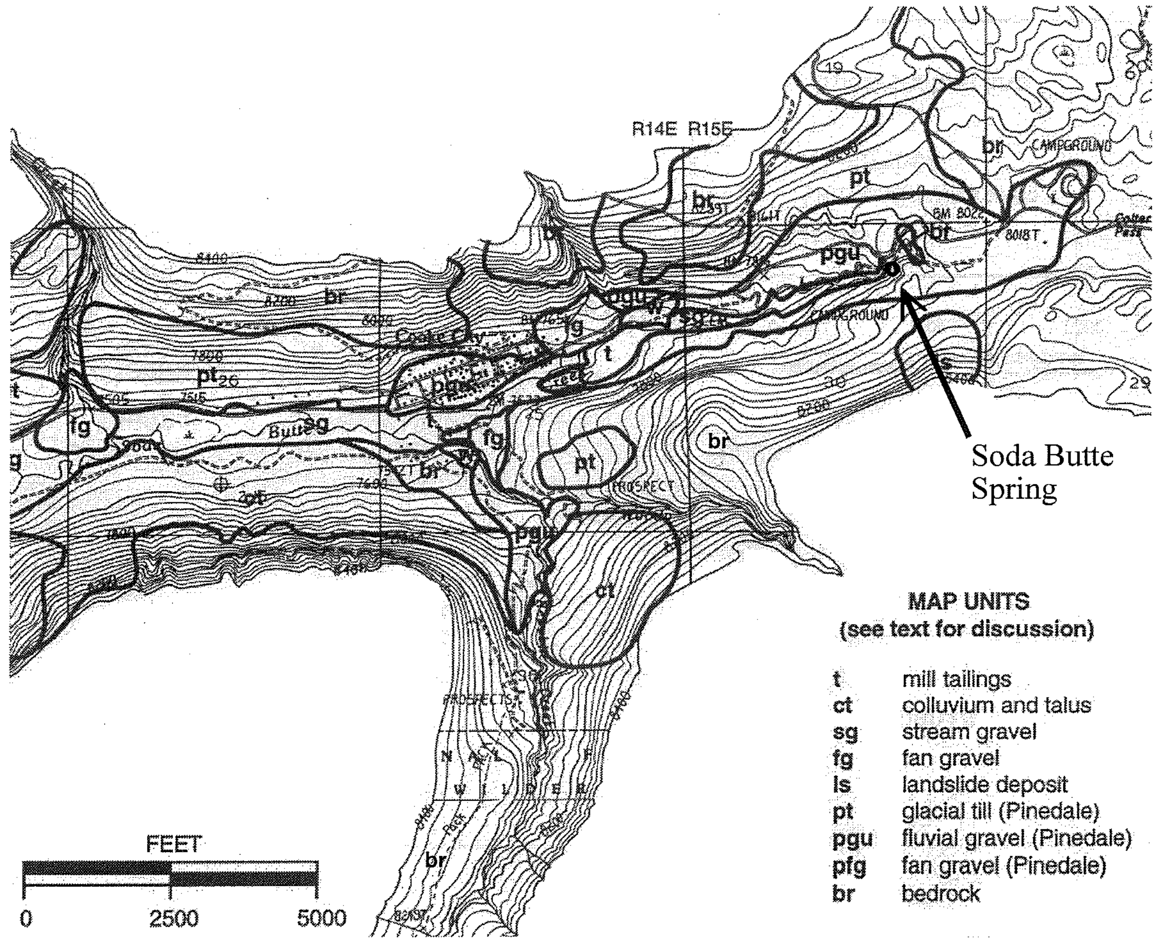

Figure 9. Surficial geologic map of the Cooke City area. The Cooke City spring emerges from glaciofluvial gravel deposited during the last ice age. Modified from geologic map in Metesh and others (1999).

towns of Cooke City and Silver Gate indicate that snowpack typically covers the area from late October through early May, and snowpack depth generally exceeds 35 inches in February and March (NWS, 1999). Maximum snowpack depth is probably greater at the spring site due to its higher elevation relative to the climate station.

When the snowpack melts during the spring, a significant amount of surface runoff probably occurs around the spring water-collection structures. It is possible that some of the snowmelt percolates into the structures because the tops of the boxes are only a few inches above ground and are not sealed tightly. Some runoff may also percolate into the outwash deposits in which the water-collection structures are completed.

Soda Butte Creek, located just west of the spring area, does not appear to influence the springs.

6.2 Regional Ground-Water Flow

Metesh and others (1999) described the hydrogeology of the Soda Butte Creek basin in detail. There are two principle aquifers: 1) the bedrock aquifer, which is typically in fractured and/or porous limestone, sandstone, and granite, and 2) the unconsolidated valley-fill aquifer, which is typically in the alluvial sediments near the creek. A third, relatively minor aquifer is the material on the valley margins, which includes landslide, alluvial fan, colluvial, and glacial outwash deposits. The aquifer associated with the Cooke City spring area falls into this third category.

Ground water in the Cooke City area originates as precipitation that falls within the Soda Butte Creek basin and percolates into the ground. Ground-water flow usually is controlled by topography and the hydraulic conductivity of the aquifer materials. Horizontal flow gradients are generally steep along the valley margin and more gentle along the valley bottom.

6.3 Local and Intermediate Ground-Water Flow

The Soda Butte spring is at the base of a thick Quaternary fluvial gravel deposit (labeled as "pgu" on figure 9) that consists of silt, sand and subrounded to rounded gravel and cobbles. The location of the spring is probably controlled by water-table elevation. The aquifer appears to be highly transmissive, making it vulnerable to potential infiltration of contaminants at upgradient locations.

Presumably the horizontal ground-water flow direction near the spring is to the west. There does not appear to be a strong upward-flow gradient.

The main source of recharge to the aquifer is probably precipitation that infiltrates the ground further up the drainage.

7.0 WATER QUALITY

Water from the Cooke City spring system has been analyzed numerous times for inorganic, biological, and other constituents. The following section summarizes laboratory results that were obtained from the DEQ's water-quality files and from other sources.

7.1 Inorganic Chemistry

7.1.1 SC, pH, and Temperature

Specific conductance (SC), pH, and temperature data for samples from the Soda Butte spring (GWIC site ID: M158065) and a well located at the Soda Butte Creek Campground (GWIC site ID: M:106075) are summarized in table 1. The SC of the Soda Butte spring water appears to be fairly stable, ranging from 199-236 µS/cm@25°C during the period of record (1991-1998). The pH of the spring water ranges from 8.1 to 8.8, which is on the high end of normal for ground water. The two temperature readings for the water suggest that there is no unusual geothermal heating near the spring.

The Soda Butte Creek Campground well is the closest well to the Soda Butte spring, and it is probably completed in glaciofluvial deposits similar to those from which the Soda Butte spring flows. Not surprisingly, SC and pH of the well and spring waters are very similar.

7.1.2 Major Ions and Nutrients

Major ion data for the Soda Butte spring are summarized in table 2. The most abundant ions in the spring water are calcium (Ca) and bicarbonate (HCO_3). The Ca and HCO_3 concentrations are very similar to the concentrations observed in the ground water sampled from the well at the Soda Butte Creek Campground and are typical for ground water in the valley fill materials throughout the Silver Gate/Cooke City area (English, 1999; Metesh and others, 1999).

Nitrate and phosphate concentrations in the spring water are well below the EPA drinking water standard of 10 mg/L (table 3). The nutrient levels in the spring water are similar to those observed in the campground's well water.

7.1.3 Metals, Arsenic and Asbestos

Concentrations of heavy metals and arsenic measured in the spring water are summarized in table 4. The data show that the concentrations of all the listed analytes are below their respective maximum contaminant levels (MCLs) for drinking water. A comparison of the spring data with other water-quality data for the Silver Gate/Cooke City area (English, 1999; Metesh and others, 1999) indicated that the values are typical for ground water in the area.

In 1993 a water sample was collected to determine if asbestos particles were present in the spring water. No asbestos particles were found (Marble, 1993).

Table 1. SC, pH, and temperature data for the Soda Butte spring area

Site Name: / GWIC ID:	Cooke City - Soda Butte Spring M:158065			Soda Butte Campground Well M:106075			
Date	SC (µS/cm @25°C)	pH (S.U.)	Temp. (°C)	SC (µS/cm @25°C)	pH (S.U.)	Temp. (°C)	Data Source
09/26/91	--	8.34	--	--	--	--	MDEQ (1996)
09/17/93	236	8.28	--	--	--	--	MDEQ (1996)
10/02/96	199	8.12	--	--	--	--	MDEQ (1996)
09/24/97	228	8.8	4.8*	--	--	--	GWIC (2000)
08/04/98	--	--	--	238	8.3	--	GWIC (2000)
10/08/98	216*	8.2*	4.4*	--	--	--	GWIC (2000)

* Field measurements

Table 2. Major ion data for the Soda Butte spring area.

Date	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Fe (mg/L)	Mn (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	F (mg/L)	Data Source
Soda Butte Spring												
09/26/91	39.3	7.5	1.8	1.5	<0.01	<0.005	48. *	0.	1.8	4.4	<0.1	MDEQ (1996)
08/09/93	--	--	--	--	--	--	--	--	--	4.	0.05	MDEQ (1996)
09/17/93	36.4	6.4	1.	--	<0.01	<0.005	--	--	--	<6	<0.1	MDEQ (1996)
09/24/97	33.6	6.2	1.09	.746	<0.005	<0.001	138.	6.72	<0.5	3.36	--	GWIC (2000)
Soda Butte Campground Well												
08/04/98	32.4	6.17	1.16	.612	<0.005	<0.001	151.	0.	<0.5	5.35	--	GWIC (2000)

* Reported value seems too low based on comparison with cation concentrations.

Table 3. Nutrient data for the Soda Butte spring area.

Location:	Cooke City (Soda Butte) Spring			Soda Butte Campground Well			
GWIC ID:	M:163261			M:106075			
Date	NO_3 as N (mg/L)	NO_3 plus NO_2 as N (mg/L)	PO_4 as P (mg/L)	NO_3 as N (mg/L)	NO_3 plus NO_2 as N (mg/L)	PO_4 as P (mg/L)	Data Source
09/26/91	--	0.20	--	--	--	--	MDEQ (1996)
08/09/93	--	0.17	--	--	--	--	MDEQ (1996)
09/17/93	--	0.14	--	--	--	--	MDEQ (1996)
04/11/94	--	0.20	--	--	--	--	MDEQ (1996)
06/20/95	--	0.15	--	--	--	--	MDEQ (1996)
09/24/97	--	0.09	<0.05	--	--	--	GWIC (2000)
08/04/98	--	--	--	--	0.094	<0.05	GWIC (2000)

Table 4. Metals and arsenic data for the Soda Butte spring.

Date	As (µg/L)	Ba (µg/L)	Be (µg/L)	Cd (µg/L)	Cr (µg/L)	Cu (µg/L)	Pb (µg/L)	Hg (µg/L)	Se (µg/L)	Th (µg/L)	Data Source
MCL[1]	50	2,000	4	5	100	1,300	15	2	50	2	U.S. EPA (2000)
Cooke City (Soda Butte) Spring											
09/26/91	<1	58	--	<1	<5	--	<1	<0.2	<1	--	MDEQ (1996)
09/17/93	<1	50	--	<1	<1	--	<1	<1	<1	--	MDEQ (1996)

[1] MCL: Maximum contaminant level in drinking water permitted by the U.S. EPA

7.1.4 Radiological Constituents

No radiological data were found for the Soda Butte spring.

7.2 Organic Chemistry

A water sample collected from the spring on September 17, 1993 was analyzed for synthetic organic and volatile organic (EPA method 524.2) compounds. The concentrations of all analytes were below the method detection limits.

7.3 Microbiological Water Quality

Bacterial data contained in the DEQ database for the 3-year period prior to February, 2000 showed that there were no violations of the total coliform rule. The last non-acute violation documented for the system occurred in June 1995 (Brayton, 2000).

No microscopic particulate analysis (MPA) data are available for the spring.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Determination of Direct Surface Water Influence

The results of the hydrogeologic assessment indicate that the Soda Butte spring may be under the direct influence of surface water as defined in 40 CFR part 141. This conclusion is based on the following observations:

- Surface runoff may be able to flow into the collection structures because the structures are completed low to the ground and do not have sanitary seals that would prevent water entry.
- The depth at which water enters the collection structures is unknown because as-built construction plans are not available.
- An MPA sample has not been collected from the system.

8.2 Recommendations

Based on the hydrogeologic assessment, it is recommended that:

1. The collection structures should be improved to prevent possible entry of surface water.
2. MPA sampling be conducted during May or June to determine if a microbiological water-quality problem exists.
3. A fence be placed around the spring area to prevent tampering with the water-collection system.

4. Locking caps or lids be placed on all system access points to prevent tampering.

5. Use of the gravel pit on Colter Pass be restricted to prevent possible contamination of the ground-water supply. The aquifer that feeds the Soda Butte spring receives recharge from this area and is this highly vulnerable to contamination.

REFERENCES

Bingham, M. K., and Meyer, G. A., 1994, Flood history since 1800 in relation to late Holocene climate change and stream incision, Yellowstone National Park: *Geological Society of America Abstracts with Programs*, v. 26, n. 6, p. 5.

Brayton, M., 2000, Telephone conversation between Mike Brayton (DEQ) and Richard Marvin (MBMG) on April 5, 2000.

Brown, G., 1996, Personal communication between Gary Brown (Cooke City resident) and Alan English (MBMG) on October 2, 1996.

Cooke City Water Users Association, 1983, Letter from CCWUA to Dan Fraser (MDHES) dated November 21, 1983.

Elliot, J. E., 1979, Geologic map of the southwest part of the Cooke City quadrangle, Montana and Wyoming: U.S. Geological Survey Miscellaneous Investigations Series, Map I-1084, scale 1:24,000.

English, A., 1997, Unpublished field notes prepared by Alan English (MBMG) on September 24, 1997.

English, A., 2000, Telephone conversation between Alan English and Richard Marvin (MBMG) on April 12, 2000.

Foose, R. M., Wise, D. U., and Garbarini, G. S., 1961, Structural geology of the Beartooth Mountains, Montana and Wyoming: *Geological Society of America Bulletin*, v. 72, p. 1143-1172.

James, H. L., 1995, Geologic and historic guide to the Beartooth Highway, Montana and Wyoming: Montana Bureau of Mines and Geology Special Publication 110, 133 p.

Ground-Water Information Center, 2000, Water-quality data downloaded from GWIC database: Montana Bureau of Mines and Geology.

Kirk, A. R., 1995, Bedrock structure and hydrogeology of the New World Project, Park County, Montana: Unpublished report for Montana Department of State Lands, January 25, 1995, 33 p.

Kirk, A. R., Johnson, T. W., and Elliott, J. E., 1993, Geology and mineral deposits of the New World district, Park County, Montana: *Society of Economic Geologist Newsletter*, n.2.

Locke, W. W., 1995, An equilibrium Yellowstone icecap *in* Late Pleistocene-Holocene evolution of the northern Yellowstone landscape: Friends of the Pleistocene, Rocky Mountain Cell Field Conference Guidebook, August 25-27, 1995, 6 p.

Marble, J., 1993, Letter from Justin Marble (MDHES) to Bill Sommers (Cooke City Water District) dated September 17, 1993.

Metesh, J., English, A., Lonn, J., Kendy, E., and Parrett, C., 1999, Hydrogeology of the upper Soda Butte Creek basin, Montana: Montana Bureau of Mines and Geology Report of Investigation 7, 66 p.

Meyer, G. A., 1993, Holocene and modern geomorphic response to forest fires and climate change in Yellowstone National Park: University of New Mexico Ph.D. dissertation, 402 p.

Meyer, G. A., Anderson, J. R., Bingham, M. K., O'Hara, P. M., Simpson, E. D., and Pierce, K. L., 1995, Road Log, Chief Joseph Campground to Lamar Ranger Station, Yellowstone National Park via Highway 212 *in* Late Pleistocene-Holocene evolution of the northern Yellowstone landscape: Friends of the Pleistocene, Rocky Mountain Cell Field Conference Guidebook, August 25-27, 1995, 27 p.

Meyer, G. A., Wells, S. G., Balling, R. C., Jr., and Jull, A. J. T., 1992, Response of alluvial systems to fire and climate change in Yellowstone National Park: Nature, v. 357, p. 147-150.

Montana Department of Environmental Quality, 1998, Unpublished data from public water-supply files maintained by the Montana Department of Environmental Quality (MDEQ), Helena, Montana.

Montana Department of Health and Environmental Science, 1992, Public water-supply water-quality database printout.

National Weather Service, 1999, National Weather Service-Western Regional Climate Center. Internet database query May, 1999 via internet @ http://www.wrcc.dri.edu.

Pierce, K. L., 1979, History and dynamics of glaciation in the northern Yellowstone National Park area: U.S. Geological Survey Professional Paper 729-F, 90 p.

Pierce, W. G., 1957, Heart Mountain and South Fork detachment thrusts of Wyoming: American Association of Petroleum Geologists Bulletin, v. 41, no. 4, p. 591-626.

Pierce, W. G., 1960, The "break-away" point of the Heart Mountain Detachment Fault in northwestern Wyoming *in* Geological Survey Research 1960: U. S. Geological Survey Professional Paper 400-B, p. B236-B237.

U. S. Environmental Protection Agency, 2000, Drinking water standards: Available at http://www.epa.gov/OGWDW

APPENDIX A

COMPLETED
PRELIMINARY ASSESSMENT FORM

Cooke City Water District (PWSID 00187)
Spring (source ID 003)

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY
Metcalf Building
1520 E. 6th St.
Helena, MT 59620-0901

Preliminary Assessment of Groundwater Sources that may be under the Direct Influence of Surface water

SYSTEM NAME Cooke City Water District PWS ID#00187
SOURCE NAME Soda Butte Spring (source ID#003) COUNTY Park
DATE 4/6/2000 NC NTNC C POPULATION 75

Index Points

A. TYPE OF STRUCTURE (Circle One)

Well	GO TO SECTION B
Spring	40
Infiltration Gallery/Horizontal Well	40

B. HISTORICAL PATHOGENIC ORGANISM CONTAMINATION

History or suspected outbreak of *Giardia,* or other pathogenic organisms associated with surface water with current system configuration	40
No history or suspected outbreak of *Giardia* .	0

C. HISTORICAL MICROBIOLOGICAL CONTAMINATION (Circle all that apply)

Record of acute MCL violations of the Total Coliform Rule over the last 3 years (circle the one that applies)

No violations	0
One violation	5
Two violations	10
Three violations	15

Record of non-acute MCL violations of the Total Coliform Rule over the last 3 years (circle the one that applies)

One violation or less	0
Two violations	5
Three violations	10
DHES-verified complaints about turbidity . . .	5

D. HYDROLOGICAL FEATURES

Horizontal distance between surface water and the source

greater than 250 feet	0
175 - 250 feet	5
100 - 175 feet	10
less than 100 feet	15
unknown	15

E. WELL CONSTRUCTION

Poorly constructed well (uncased, or casing not sealed to depth of at least 18 feet below land surface), or casing construction is unknown .	15
In wells tapping unconfined or semiconfined aquifers, depth below land surface to top of perforated intervals or screen	
greater than 100 feet	0
50 - 100 feet	5
25 - 50 feet	10
0 - 25 feet	15
unknown	15

F. WELL INTAKE CONSTRUCTION

In wells tapping unconfined or semiconfined aquifers, depth to static water level below land surface	
greater than 100 feet	0
50 - 100 feet	5
0 - 50 feet	10
unknown	10
Poor sanitary seal, seal without acceptable material, or unknown sanitary seal type . . .	15

TOTAL SCORE 70

PRELIMINARY ASSESSMENT DETERMINATION (Circle the one that applies)

i) PASS: Well is classified as groundwater.
ii) FAIL:. Well must undergo further GWUDISW determination.
iii) FAIL: Spring or Infiltration Gallery; must undergo further GWUDISW determination.
iv) FAIL: Well will PASS if well construction deficiencies (section E or F) are repaired.
v) FAIL: Well may PASS if well construction details (section E or F) become available.

ANALYST Richard Marvin ANALYST AFFILIATION MBMG

COMMENTS: ______