MONTANA BUREAU OF MINES AND GEOLOGY
OPEN-FILE REPORT
MBMG 401-J

HYDROGEOLOGIC ASSESSMENT OF THE STOCKETT, MONTANA PUBLIC WATER SUPPLY FOR GROUND WATER UNDER THE DIRECT INFLUENCE OF SURFACE WATER

STOCKETT WATER AND SEWER DISTRICT
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Prepared
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INTRODUCTION AND PURPOSE

This report summarizes the results of a Hydrogeologic Assessment of the public water supply source for the city of Stockett, Montana (PWSID #00579) (Figure 1). 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 communities. The project was funded under DEQ contract number 400022, task order number 7.

The purpose of conducting this hydrogeologic assessment is to determine if the ground-water source used for the public water supply for the Stockett Water and Sewer District (SWSD) is under the direct influence of surface water as defined in 40 CFR part 141. Field inspections by the Department of Health and Environmental Sciences, Water Quality Bureau have occurred on Feb. 3, 1981; Jan. 26, 1983; June, 1983; Oct. 27, 1983; Feb. 4, 1988; Feb. 1, 1990; May 8, 1990; Apr. 23, 1992; Oct. 26, 1995; and Apr.29, 1996. On Aug. 6, 1997 the system was inspected by the Montana Bureau of Mines and Geology on behalf of the Montana Department of Environmental Quality. Mrs. Beverly Pepos of the SWSD accompanied the technicians on field inspections and provided background information. **The city supply system currently includes an infiltration gallery and a bedrock supply well. The results of this assessment indicate that the infiltration gallery, as a ground-water source used by the city of Stockett, is probably not under the direct influence of surface water. However, its proximity to surface water indicates a**

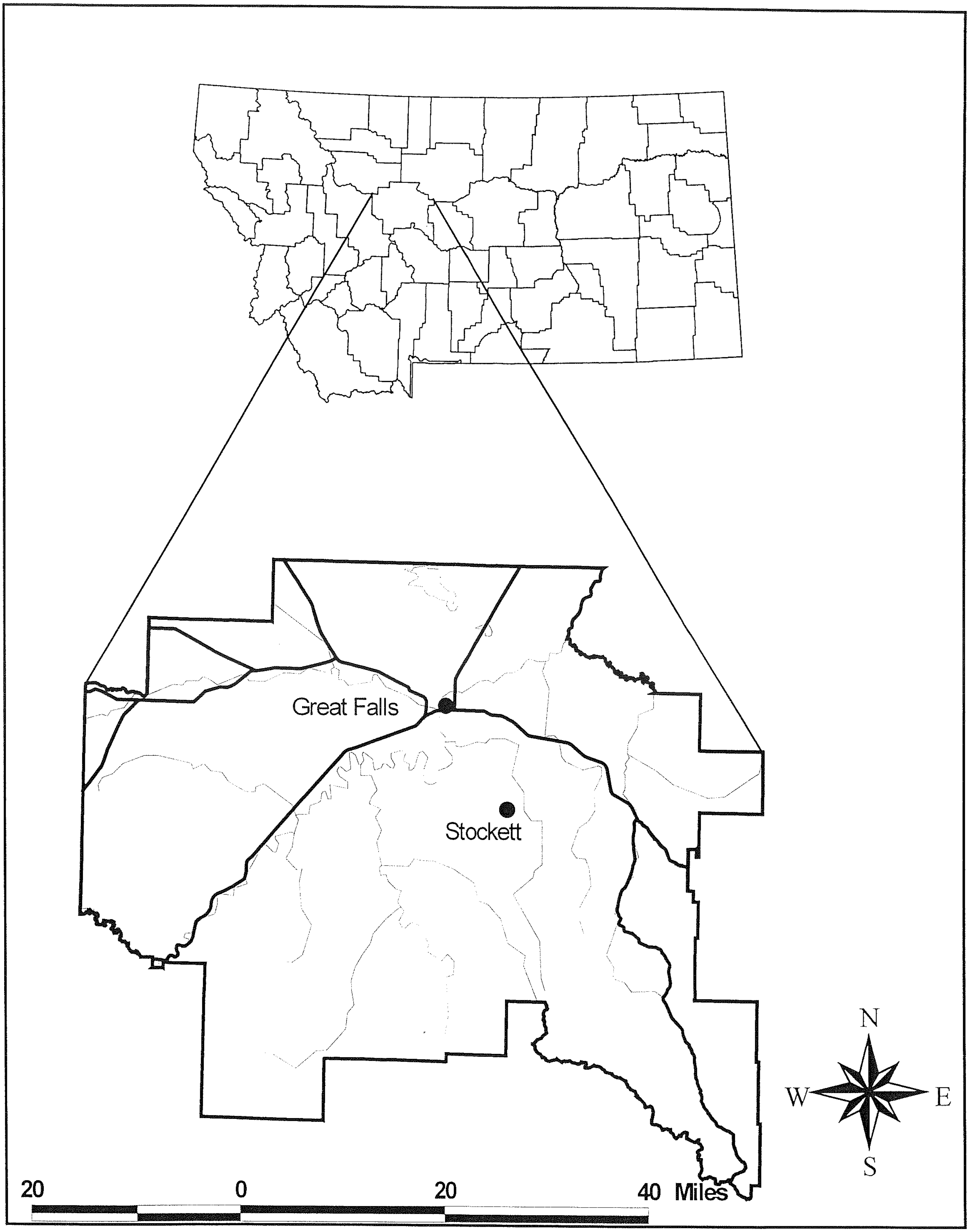

Figure 1. Site location map.

need for micro-particulate analysis (MPA) testing. The bedrock supply well is determined to not be under the direct influence of surface water. This report summarizes information obtained during the inspection and follow-up investigation, which was used to make the determination. Information on system location and construction, geology, hydrology, and water quality are summarized. Conclusions and recommendations are presented at the end of the report. Site-access maps and photographs taken during the site inspection are provided as appendices.

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 (WQD) of DEQ is evaluating public water supplies for compliance with the SWTR. This project is known as the **Ground Water Under the Direct Influence of Surface Water (GWUDISW) program**. The SWTR provides the following definition of ground water under the direct influence of surface water.

Any water beneath the surface of the ground with:

I) significant occurrence of insects or other microorganisms, algae, or large diameter pathogens such as *Giardia lambia*, or *Cryptosporidium*; or

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

The evaluation begins with a Preliminary Assessment (PA). If the PA indicates that the ground-water supply may be under the influence of surface water, further study is required. Further study may include conducting a hydrogeologic assessment, a water quality assessment or conducting Microscopic Particulate Analysis (MPA) sampling.

PRELIMINARY ASSESSMENT

The City of Stockett draws water from an infiltration gallery constructed in the alluvium of Cottonwood Creek and a supply well that is used during periods of high runoff and high usage when the gallery collection system is unable to meet demand. A 100,000-gallon-capacity tank is used as temporary storage for the collection system. A completed preliminary assessment form for the gallery is included as Appendix A. The well was not scored as it is considered to be constructed too deep (830 feet, in the Madison Formation) to be directly influenced by surface water. The well is intended to continue being an important component of the permanent water supply system for the city.

Fifty-five points were assigned to the infiltration gallery, which is constructed in surficial alluvium adjacent to Cottonwood Creek. Cottonwood Creek is an intermittent stream. Forty points were assigned for the structure being an infiltration gallery. The horizontal distance to a surface water body is 100 feet, and the integrity of the laterals are not known, so a score of 15 was assigned. There has been only one report of coliform bacteria between January, 1993 and March, 2000 (personal communication, B. Pepos, March, 2000). Presence of coliform bacteria was reported on the 29th of April, 1996 but coliform bacteria was not detected in repeat samples. The total score of 55 indicates the source is at risk of being under the direct influence of surface water, and requires additional evaluation. It is recommended that micro-particulate analysis (MPA) samples be collected during annual high and low water flow in Cottonwood Creek during the next year.

In September, 1989 the gallery collection system was upgraded, a dike between the creek and the clearwell repaired, and no flooding of the facility has since been reported. The water is chlorinated for safety. Under current plans, the infiltration gallery will continue to be the main water source for the city supply system. The infiltration gallery is a gravity flow system and is far cheaper to operate on a continuous basis than a deep well which requires power for pumping.

The standard Preliminary Assessment Form designed by the Montana Department of Environmental Quality does not account for mitigation by means of protective water control or containment structures. Part A of the Preliminary Assessment Form (Appendix A) requires an assessment of 40 points for an infiltration gallery regardless of any protective structures. Part D requires an assignment of 15 points for any water intake being within 100 feet of a stream, also without regard to any mitigating control structures.

SYSTEM DESCRIPTION

Location

The city of Stockett is located in Cascade County, predominantly on the west side of Cottonwood Creek approximately fifteen miles south-east of Great Falls (figure 1). Access to the site is shown on the map in Appendix B. The infiltration gallery is about 1.5 miles southeast of the town, on the eastern side of Cottonwood Creek in the valley bottom. The legal description of the collection gallery is: Township 18 North, Range 5 East, Section 6, Tract CCCA (Latitude 47 20' 08", Longitude 111 09' 15"). The clearwell for the infiltration gallery is at an elevation of approximately 3,745 feet. The storage tank is located at an elevation of approximately 3,720 feet in Township 19 North, Range 4 East, Section 36, Tract CADB, (Latitude 47 9' 59", Longitude 47 21' 15") 1 1/4 miles north and ½ mile west of the collection facility in the town of Stockett. The bedrock supply well is located in Lot 25, Block 7, south of the storage tank, next to the Post Office, and in the front yard of the owner of the supply well, Mr. Robert T. Klasner.

The Stockett Water and Sewer District (SWSD) provides water for the community of Stockett, which has a population of approximately 225. There is no major manufacturing in the city, water is used for domestic purposes, fire fighting, and minor commercial interests. On a typical day less than 20,000 gallons are used. Highest usage, which approaches 80,000 gallons per day, is during the summer when residents use the water for lawn and garden irrigation. The high usage during the irrigation season raises the annual mean daily production to about 31,500 gallons.

The SWSD (Figure 2) consists of a collection gallery, a metering vault, a chlorination unit, a pipeline connecting the collection facility to the town, a supply well, a storage tank, and a distribution system. The distribution system (Figure 3) includes 17 fire hydrants, 4 of which are on dead ends. On September 26, 1996, 93 hookups were reported to be on the system.

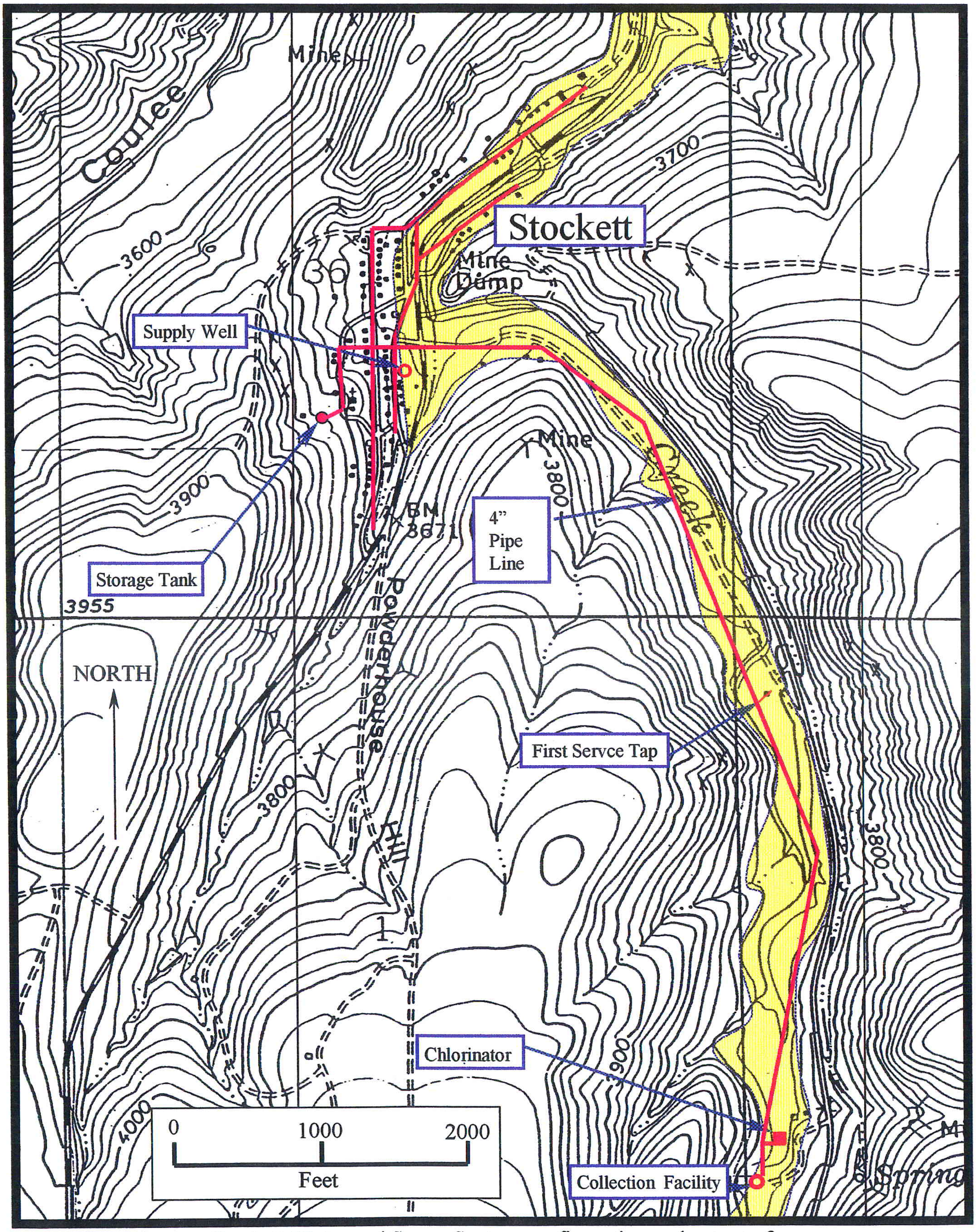

Figure 2 Stockett Water and Sewer System configuration and extent of Quaternary alluvium in Cottonwood Creek valley.

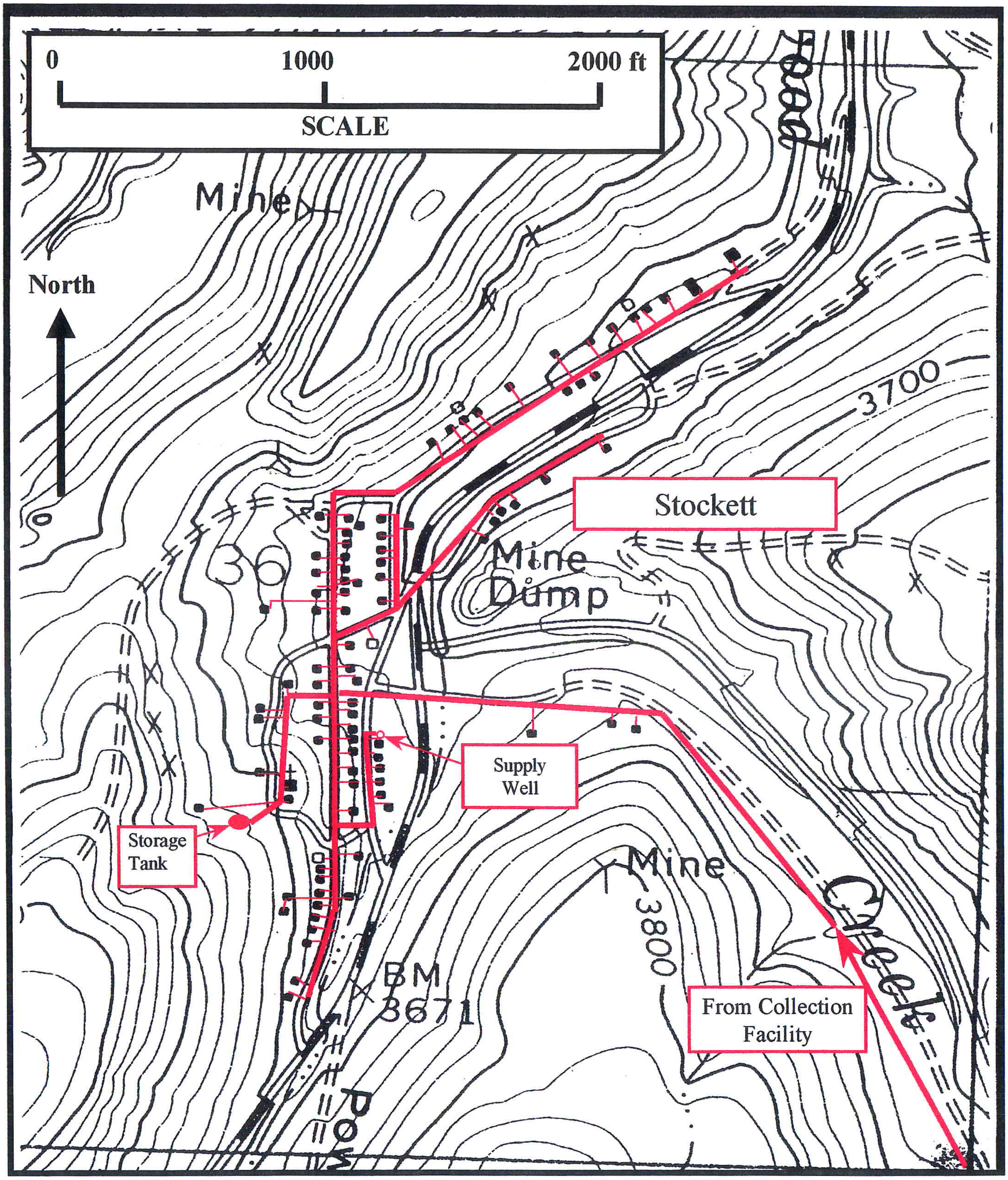

Figure 3. Components of Stockett Water and Sewer District System.

Source history

Earlier water supply sources for residents of Stockett were wells drilled in the alluvium along Cottonwood Creek (Figure 2). At some point prior to 1981 the Stockett Water Users Association was formed. A supply well was drilled by R. T. Klasner in 1977 but was not used until the summer of 1984. During the interim period a radial-gallery collection facility was constructed in the alluvium of Cottonwood Creek about 1 ½ miles south of Stockett near an abandoned mine mouth and at the site of a perennial spring. A pipeline was laid connecting the collection facility to the town, a distribution system was installed to service businesses and residences, and a number of fire hydrants were connected.

The necessity for the construction and operation of the above described system resulted from the contamination of private shallow wells by cesspools, septic tanks and sewage leachate-infiltration systems which were constructed in the same alluvial aquifer as were the private water supply wells.

The Stockett Water Users Association partially redesigned and reconstructed the water supply system in 1989. On September 1, 1988 the responsibility for water quality and quantity monitoring was assumed by Mrs. Beverly Pepos, a resident of Stockett. In June of 1992 the Stockett Water Users Association became the Stockett Water and Sewer District under Permit No. 00579.

System Configuration

Construction details of the Stockett water supply, treatment and distribution system are herein described as configured during the 1989 reconstruction period. Photographs of the surrounding area, the infiltration gallery clearwell, the meter vault and chlorinator are included as Appendix B. The clearwell is located about 100 feet to the east of the Cottonwood Creek thalweg. Two radial infiltration galleries extend from the clearwell, one to the west in the direction of the creek, the other to the east, opposite the creek in the direction of the mine mouth and spring. Both are nominally 100 feet long (Figure 4). This configuration was used to intercept the flow of groundwater through the alluvium of Cottonwood Creek. The elevation of the creek is approximately 3750 feet (MSL). The base of the clearwell is about 17 feet below land surface.

A 4-inch diameter pipeline exits the clearwell to the north. The pipeline parallels Cottonwood Creek northward for about a mile and then one-quarter mile west where it is joined to the main Stockett distribution system (Figure 2). Water exits the clearwell by gravity flow. Approximately 300 feet to the north of the collection facility a meter is installed in a vault to measure the flow through the system. Next to the meter vault is a sodium hypochlorite chlorination unit. Five gallons of 12.5% hypochlorite are mixed with 30 gallons of water to form the treatment solution. This unit is adjusted to charge the system with 0.50 to 1.00 mg/l of chlorine at the injection point. The chlorinator has a flow-paced meter which operates from the main meter. When the main meter stops, no hypochlorite is fed to the system. There is approximately ½ mile of pipeline between the delivery point and the first service tap, which should permit adequate mixing and residence time.

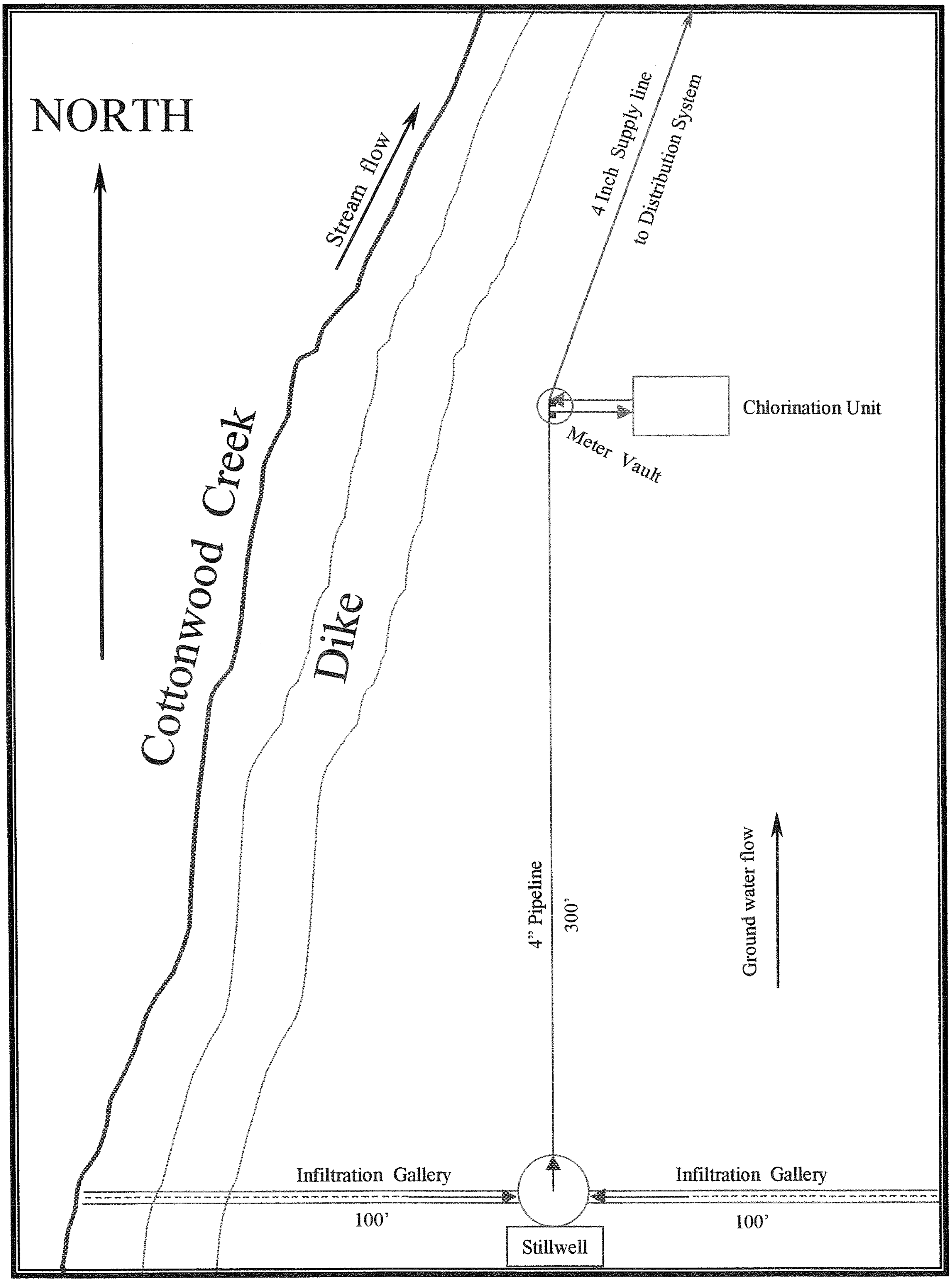

Figure 4 Stockett Infiltration Gallery and Chlorination Unit. Not drawn to scale.

The unit is monitored on a daily basis by Beverly Pepos who is licensed as a Class 4 Certified Operator.

A supply well located in Lot 25, Block 7, is used to augment the supply during shortages and, if needed, to replace the gallery infiltration system in the event that it should be flooded by Cottonwood Creek (Figure 2). Flooding has not occurred since the dike was repaired in 1989. The well has been used to augment the flow from the gallery in the summer months when demand for irrigation of lawns and gardens exceeds the available flow. The typical demand is less than 20,000 gallon per day. Irrigation season demand can approach 80,000 gallons per day. The well is manually operated when used as an augmentation system. The operator turns on the pump when the level is low in the tank, indicating that the infiltration gallery flow is not sufficient to keep up with demand. A few residents near the tank have reported low pressure during such periods. When the tank is full and pumping continues, water actually exits at the infiltration gallery and recharges the alluvium through the infiltration galleries.

A 20-foot high, 100,000-gallon capacity storage tank is located about 300 yards southwest of the supply well. The working capacity of the tank is about 90,000 gallons, because the gravity flow from the gallery can only fill the tank to a level of 18.5 feet due to the relative elevations of the facilities (personal communication, B. Pepos, March, 2000).

Seventeen fire hydrants are on the system, 4 of which are on dead ends. The 4 dead end hydrants are flushed annually to insure their serviceability.

GEOLOGY

Local Topography and Land Use

Stockett lies within the Missouri River drainage on the north flank of the Little Belt Mountains in semiarid west-central Montana. Great Falls, 15 miles northwest of Stockett, receives an average of about 15 inches of precipitation per year. Average annual temperature for Great Falls is 45.3 degrees F. The average monthly maximum temperature is 82.8 degrees F. in July and the average monthly minimum is 11.2 degrees F. in January, based on records from 1948 to 1999 available from the National Climatic Data Center through the Desert Research Institute web page (http://www.wrcc.dri.edu/summary/climsmmt.html).

The Little Belt Mountains, south of Stockett, form a drainage divide between the Missouri and Smith Rivers. The highest point on the divide is Green Mountain, about 7,544-ft above sea level, contrasting with the elevation at Stockett of about 3,700 ft. The divide consists of high ridges capped by erosion-resistant Cambrian sediments and highlighted by Tertiary intrusives and granites (Vuke, in review). Valleys are typically formed in softer shale units.

The abandoned coal mines near Stockett are in the Great Falls coal field (Fisher, 1909). Recharge to the mine voids is dominated by percolation of infiltration on summer fallow, stubble, and wheat fields overlying the mine plus infiltration on outcrops of the

Morrison coal and sandy outcrops of the overlying Kootenai Formation (Wheaton and Brown, in review). Ground-water flows through the local aquifer system in colluvium and alluvium, and as vertical leakage through fractures to the coal, sandstone and limestone aquifers. Land use in the recharge areas is limited to wheat farming, ranching, and a few scattered home sites.

Long narrow topographic ridges slope northward from the Little Belt Mountains. The local streams are cut into long narrow valleys with steep sides ranging generally from 200 to 400 feet in height (Figure 5). The valley bottoms tend to be only a few hundred feet wide and are covered with 20 to 30 feet of alluvial sand and gravel fill. Surface-water flow is intermittent or ephemeral in most local watercourses. Cottonwood Creek is ephemeral in its upper reaches and perennial in the lower reaches. Base flow through the alluvium is fed by natural springs emanating from local aquifers and from abandoned mine portals.

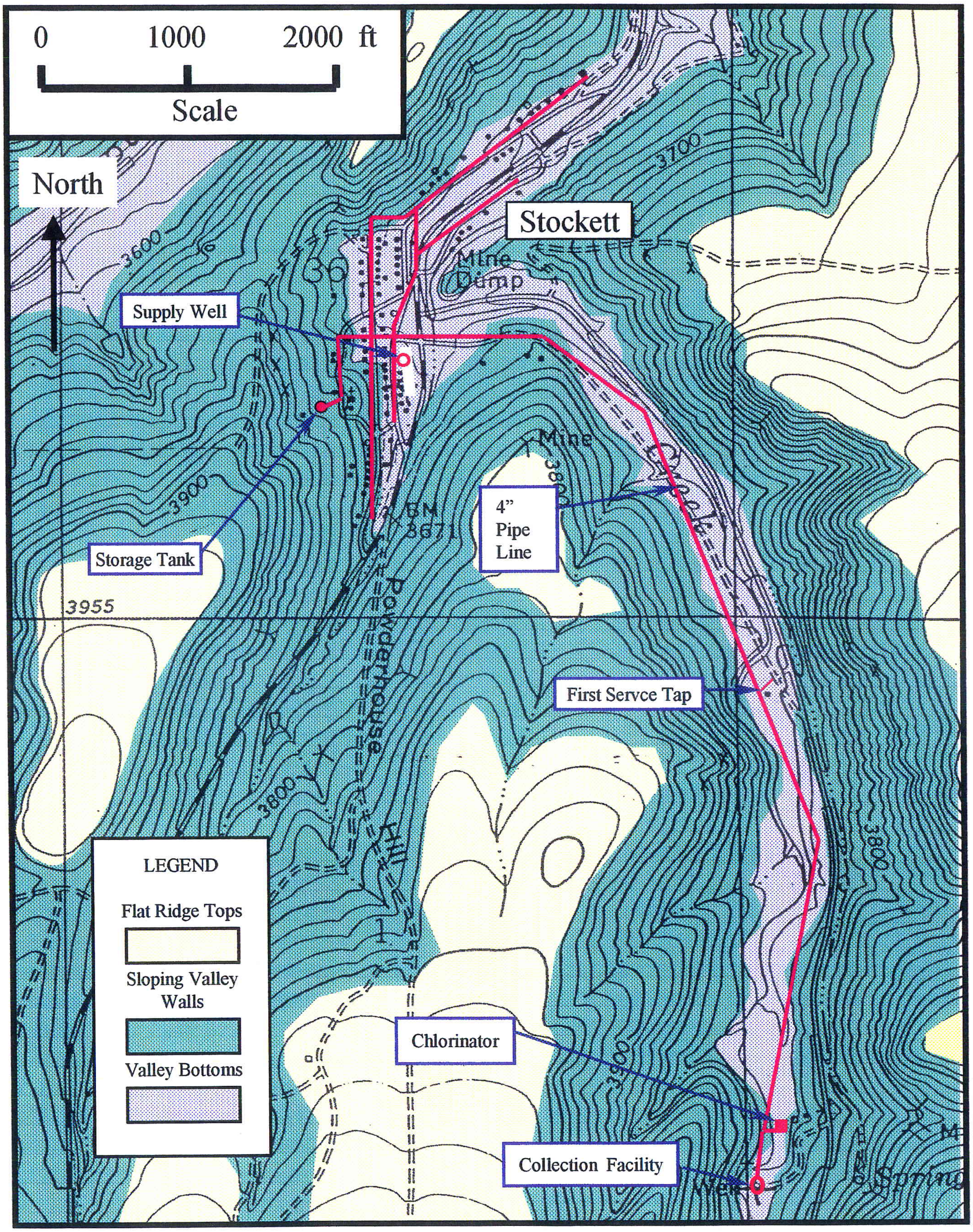

Figure 5 Topographic setting of the Stockett city water supply system

Regional Geologic Setting

Details and discussions of bedrock geology in the area are primarily from two sources: Vuke, (in review) and Fisher, C. A., (1909). The large regional Sweetgrass Arch and the South Arch, which is a subset, strike northwest from the Little Belt Mountains. The Sweetgrass Arch continues to Canada. The South Arch continues to the northwest, ending near Conrad, Montana. These structures give a gentle northward dip to the rock units in the Stockett area. Minor faults and folds have been mapped in the general area. Upstream (south) of the infiltration gallery, a small northeast-striking anticline crosses Cottonwood Creek valley (Vuke, in review).

Stockett is in the north central portion of the Great Falls coal field, and is underlain by sedimentary rocks from Cambrian to Cretaceous in age. Geomorphic features near Stockett are controlled by the Mississippian Mission Canyon Formation, the Jurassic Morrison Formation, and the overlying Cretaceous Kootenai Formation. The Quadrant Formation is absent on the north flank of the Little Belt Mountains indicating post Mississippian uplift and erosion in the area. The exposed units are described in the following section.

Local Geology

The Mississippian Mission Canyon Formation (Mm) is the oldest exposed formation near Stockett (Figure 6, based on Vuke, in review). The upper 98 feet of the formation is exposed along Cottonwood Creek north of town. The Mission Canyon Formation is dominantly a medium gray micritic limestone containing stromatolites, solution breccia and black chert nodules in beds up to 6 inches thick. Crinoids, brachiopods, coral and bryozoans are present locally. The Jurassic Swift Formation sits directly on the Mission Canyon Formation.

The Swift Formation (not shown on map due to scale) consists of a coquina of pelecypod shells and interbeds of gray shale. The basal unit consists of rounded black chert pebbles and clasts of Mission Canyon Limestone up to cobble size. The formation varies from 3 to 39 feet in thickness, and is gradationally overlain by the Jurassic Morrison Formation.

The Morrison Formation (Jm) contains light greenish gray mudstone and shale and interbedded lenses and beds of gray micrite and fine to medium grained calcareous limonitic sandstone. Black shale and bituminous coal occur at the top of the formation in most areas. This coal is the only one of commercial thickness in the Great Falls Coal Field (Fisher, 1909). In some areas a gray shale occurs at the top of the formation. Locally, the formation ranges from 82 to 93 feet in thickness.

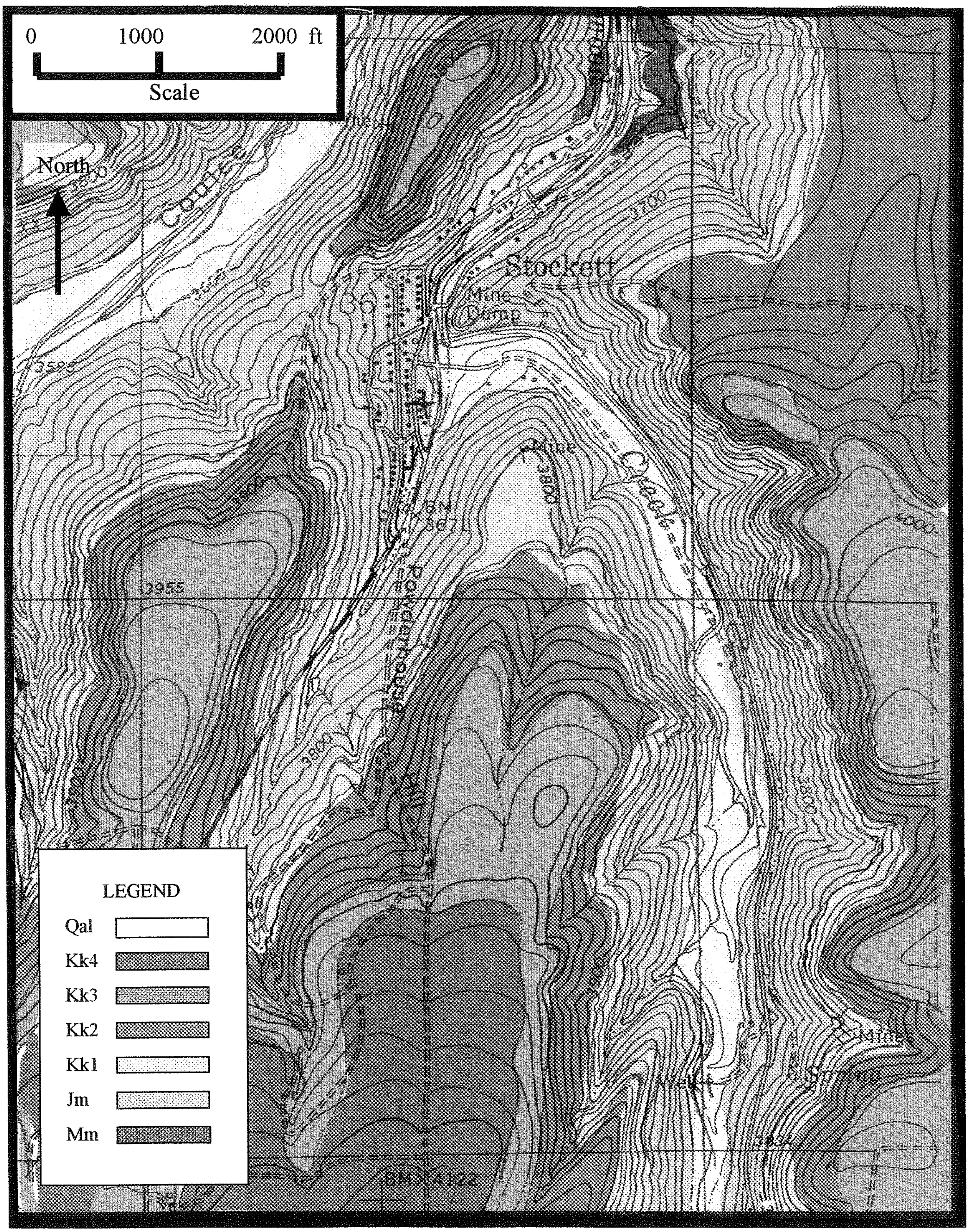

Figure 6 Generalized Geologic Setting in the Stockett Area

Cascade County produced over half of the coal production in Montana during the early part of the twentieth century, all of which was from this single, wide-spread seam in the upper Morrison Formation. Stockett is located in the Sand Coulee coal sub-area which is 6 miles wide and 30 to 40 miles long (Fisher, 1909). The Stockett area is characterized by coulees cut deeply into local rocks, which expose the coal bearing zone along many of the valley slopes.

Near the infiltration gallery is an abandoned underground coal mine, the No. 6 mine. Morrison coal is 10 feet thick in this area, and is a black to grayish black with bands of pitch-black coal with a vitreous luster running through it. The minable coal is separated into benches by carbonaceous shale or bone and by bony coal. The Kootenai Formation unconformably overlies the coal bed.

The Kootenai Formation is a sequence of basal Cretaceous fluvial-deltaic sandstone and shale units. The Formation is divided into 4 members in the Stockett area. Conglomeratic sandstones and gray sandstones are volumetrically the predominant lithologic units of the lowest member of the Formation (Kk1). This conglomerate contains abundant coal rip-up clasts from the underlying Morrison Formation (Vuke, 1998). The other 3 members include a poorly resistant gray and red mudstone (Kk2), light gray sandstone and shale (Kk3), and red to maroon clayey, platy bedded sandstone (Kk4). The sandstone beds range in thickness from a few inches,where interbedded with shale, to more than 90 ft. They vary in thickness over relatively short distances but, due to their resistant nature, can commonly be traced for considerable distances as a series of cliffs and benches which contain the local coal bed.

Unconsolidated alluvial (Qal) deposits occur in the Cottonwood Creek valley and tributary valleys. Alluvial material is typically light brown sand, silt, and clay containing lenses of coarser material. Alluvial thickness in the Cottonwood Creek valley is probably about 20 feet.

HYDROLOGY

Surface Water

Cottonwood Creek flow was measured by the USGS during 1995 and 1996 at a gaging station located about 1 mile downstream from Stockett, in Township 19 North, Range 4 East, Section 25. Average mean-daily discharge at the Cottonwood Creek gaging station for 1995 was 1.61 cubic feet per second (cfs), and 0.12 cfs for 1996 (U.S. Geological Survey, 1998). The stream bed is dry during several months of the year. The highest reported daily mean flow on record was on May 15, 1995 at a rate of 18 cfs and periods of no flow were reported during the winter months of both years. Discharge rates show seasonal fluctuations, which are strongly influenced by precipitation events.

Water quality in Cottonwood Creek exhibits seasonal fluctuations that lag about 3 months behind the changes in flow rates. High discharge in 1995 started in April and continued until August. In July total dissolved solids load in the water, as indicated by specific conductance, began increasing from 655 umhos/cm to a high of 1370 umhos/cm in September (U.S. Geological Survey, 1998). Iron, aluminum, sulfate and other dissolved constituents typical of acid-mine drainage also increased, while pH values decreased. Apparently, spring precipitation during that time increased the recharge to underground mines and after a delay, increased discharge from mine sources, causing water quality to deteriorate.

Ground Water

Several aquifer systems exist in the Stockett and Cottonwood Creek Drainage area. At depth, a series of regional aquifers include the Mission Canyon Formation, coals in the Morrison Formation and sandstones in the Kootenai Formation (Wheaton and Brown, in review). These systems are recharged in outcrop areas along the northern flanks of the Little Belt Mountains, in higher valleys where streams cross outcrops and on ridge tops from infiltration, especially in wheat field and summer fallow areas. Flow in aquifers beneath Stockett is north toward the Missouri River.

The Mississippian Mission Canyon Formation is the most significant regional aquifer in the area. It discharges over 300 cubic feet per second at Giant Springs along the Missouri River near Great Falls (Patton, 1983). The Jurassic Morrison coal produces very little water, due to the lack of cleat developed in the coal, but the coal is significant due to storage in the saturated mine voids. The Cretaceous Kootenai sands transmit water mainly through fractures, and provide water to springs, wells and provides baseflow to streams.

Ground-water flow in the Cottonwood Creek alluvium generally parallels the creek bed which meanders along the valley floor (Figure 2). The Cottonwood Creek alluvial aquifer is recharged by direct precipitation, infiltration of surface water and base flow issuing from bedrock aquifers (predominantly the Kootenai sands) which subcrop beneath the alluvium. Ground-water flow in Cottonwood Creek alluvium continues throughout the year, even though the creek bed is dry during fall and winter months. Flow in the alluvium consistently supplies nearly 20,000 gallons per day to the Stockett Water and Sewer District.

WATER QUALITY

Regular Stockett Water and Sewer District (SWSD) monitoring sites and those visited during this study are shown on Figure 7. Existing analytical data from the SWSD plant operator, DEQ public water supply file, the MBMG Ground Water Information Center (GWIC) database were reviewed to assess the quality of water currently supplied in the Stockett system. Data from GWIC and SWSD are included in Appendix C.

Inorganic Chemistry

Based on two sample results on file at MBMG, Cottonwood Creek alluvium, the source for the city water supply, provides water dominated by ions of calcium and bicarbonate and has a total dissolved solids concentration of about 430 mg/L. The pH is essentially neutral, measured in the field at 6.85 and 7.1. The sample taken from the SWSD collection gallery in August, 1997 had a temperature of 8.7 C, and a specific conductance of 730 umhos/cm. Trace metals were either below or only slightly above minimum detection limits. All values are well within acceptable drinking water standards.

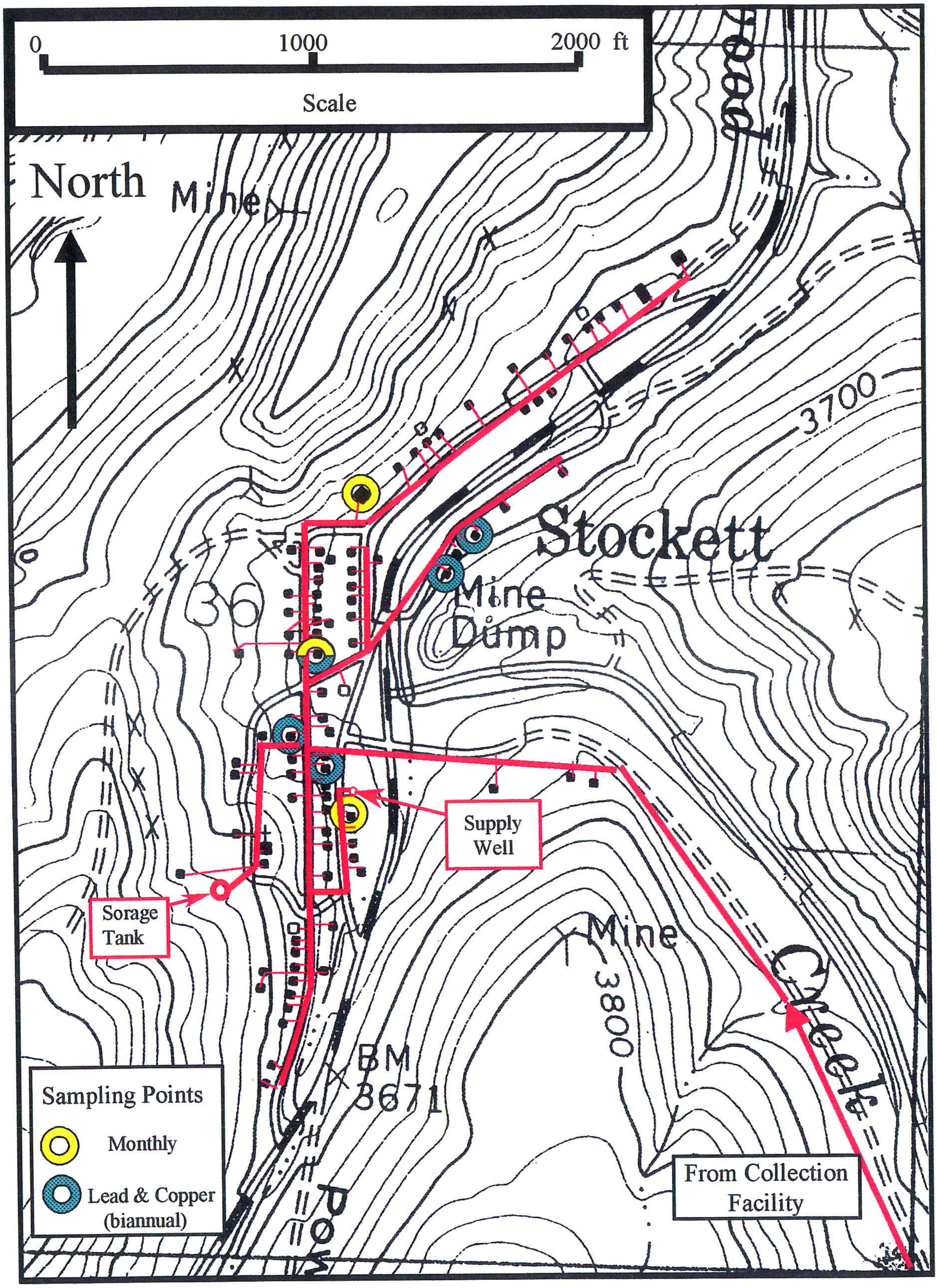

Figure 7 Stockett Public Water System Sampling Points

Turbidity problems have not been reported since Beverly Pepos became the system operator in 1989 (personal communication, B. Pepos, April, 2000). One report of turbidity concerns is on file, dated January 1, 1983.

Samples were collected and analyzed for tritium concentration in an effort to correlate sources of water with the supply water at the infiltration gallery. Values at a ranch spring 1 mile east and mine portal discharge are strikingly similar to the public water system at 30 and 26 tritium units (tu) respectively. Water in the alluvium at the infiltration gallery also contains 26 tritium units, indicating a strong similarity to the mine discharge and shallow ground water at the spring. Rather than indicating continuity of flow between the ranch spring, mine, and city supply, this probably indicates that all three sources are recharged by similar local infiltration and water from these sources may generally be +less than about 40 years old. Deep bedrock units are most likely not adding significant quantities to the alluvial flow.

In the past, Stockett residents reported that high iron problems occur in the spring when ephemeral acid mine discharge (AMD) flows from the mine portal (Osborne and others, 1983). No iron problems have been reported since the system upgrade in 1989.

During August, 1983, pH was 7.33 and 8.26 in two measurements in Cottonwood Creek up stream from the SWSD collection system, and specific conductance was 418 and 476 umhos/cm. Downstream at Stockett, pH was 3.16 and specific conductance was 1,641 umhos/cm demonstrating the effect of AMD (Osborne, and others, 1983).

Microbiological Water Quality

The Stockett Public Water Supply is tested for coliform on a monthly basis at sites shown on Figure 7. Coliform was detected in October, 1989, January, 1990, and in April 1996. No positive tests have occurred since 1996. Based on the data available, the city supply does not appear to have any consistent bacterial contamination problems.

GENERAL OBSERVATIONS

In addition to the hydrogeologic assessment, general observations related to the Stockett Water and Sewer District system design and water quality were recorded during field inspections. These comments have been presented in this report and are summarized here. The following items were noted:

1) The Stockett infiltration gallery on Cottonwood Creek has not been flooded nor has it directly shown affects of surface water since the dike was repaired and the collection systems upgraded in 1989.

2) There is no current evidence of direct flow between surface water in the creek and the collection system. The system does not become turbid during high surface-water flow, and bacteria are not detected in samples.

3) The collection system consistently delivers nearly 20,000 gallons of water per day, even when the creek is dry. The ground-water system has enough storage and maintains enough flow without immediate surface-water recharge to meet the withdrawal of the SWSD.

4) In 1989 the laterals were buried deeper than the previous system. This decreases the chances of direct surface water influence.

5) Insufficient data exist for a Water Quality Determination of direct surface water influence. This determination would require collecting water temperature data, or another similar parameter, on a regular basis to identify seasonal variations in detail.

CONCLUSIONS AND RECOMMENDATIONS

Determination of Direct Surface-water Influence

1) Based on the field inspection, literature review, water-level trends, water chemistry, and turbidity observations, the infiltration gallery collection laterals do not appear to be in direct hydraulic connection with surface water of Cottonwood Creek. No doubt recharge to the alluvium occurs from surface-water flow, however the alluvium appears to be providing sufficient retention and filtration to be classified as a ground-water source.

2) The Stockett water-supply collection gallery has a low risk of direct surface water influence unless the dike is overtopped or breached during a high runoff event.

3) Direct response in the collection gallery from flow in Cottonwood Creek has not been observed.

Supporting Evidence

1) Samples taken in September of 1989, January of 1990, and April of 1996 tested positive for coliform, but all repeat samples were negative. There have been no positive tests since April, 1996.

2) Four samples were taken on April 29, 1996, 2 reported coliform present, 1 reported heavy growth of non-coliform and one reported coliform absent. These coliform samples were taken in April during the spring runoff period. Measured flow in Cottonwood Creek on this date was low (0.86 cfs) (USGS, 1998). Repeat samples did not detect coliform.

3) Turbidity is not visible in the gallery collection system during periods of flow in the creek.

Mitigating Conditions

1) The water supply comes from alluvial ground water which is recharged by infiltration of precipitation, from seepage from Cottonwood Creek when it is flowing, and from subcropping bedrock aquifers.

2) The injection system delivers chlorine directly into the distribution system plumbing. The residual chlorine levels indicate the method is working well and provides an effective control in the event of entry of live organisms into the public water supply system.

4) Surface flow only occurs during a few months of the year.

5) Surface water recharges the alluvium only during precipitation events and spring runoff or when flow occurs in the stream bed.

6) Seasonal variations in chemistry in the SWSD systems have not been detected.

7) The supply well completed in the Mission Canyon aquifer provides an alternative to the spring collection system in the event of contamination.

Recommendations

Further evaluation of the Stockett Water and Sewer District supply, under the Ground Water Under the Direct Influence of Surface Water (GWUDISW) Program is recommended. It is recommended that Microscopic Particulate Analysis (MPA) samples be collected from the infiltration gallery clearwell during spring high water and during a fall period of no flow in Cottonwood Creek in order to better determine if a direct connection exists between surface flow and the incoming water.

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APPENDIX A

Completed Preliminary Assessment Form

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY
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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 Stockett Water & Sewer Dist PWS ID# 579

SOURCE NAME Cottonwood Coulee Alluvium COUNTY Cascade

DATE 8-6-97 NC NTNC (C) POPULATION 225

Index Points

A. TYPE OF STRUCTURE (Circle One)

Well	GO TO SECTION B
Spring	40
Infiltration Gallery	(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 ....Since..1990.............	(0)
One violation	5
Two violations	~~10~~
Three violations	15

2 first sample positive, but repeats were all negative

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

Last violation was in 1990

DHES-verified complaints about turbidity ..N/A	5

D. HYDROLOGICAL FEATURES

Horizontal distance between a surface water and the source

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

E. WELL CONSTRUCTION

Unknown well construction	30
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 interval 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

Unknown intake construction	25
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 55

PRELIMINARY ASSESSMENT DETERMINATION (Circle the one that applies)

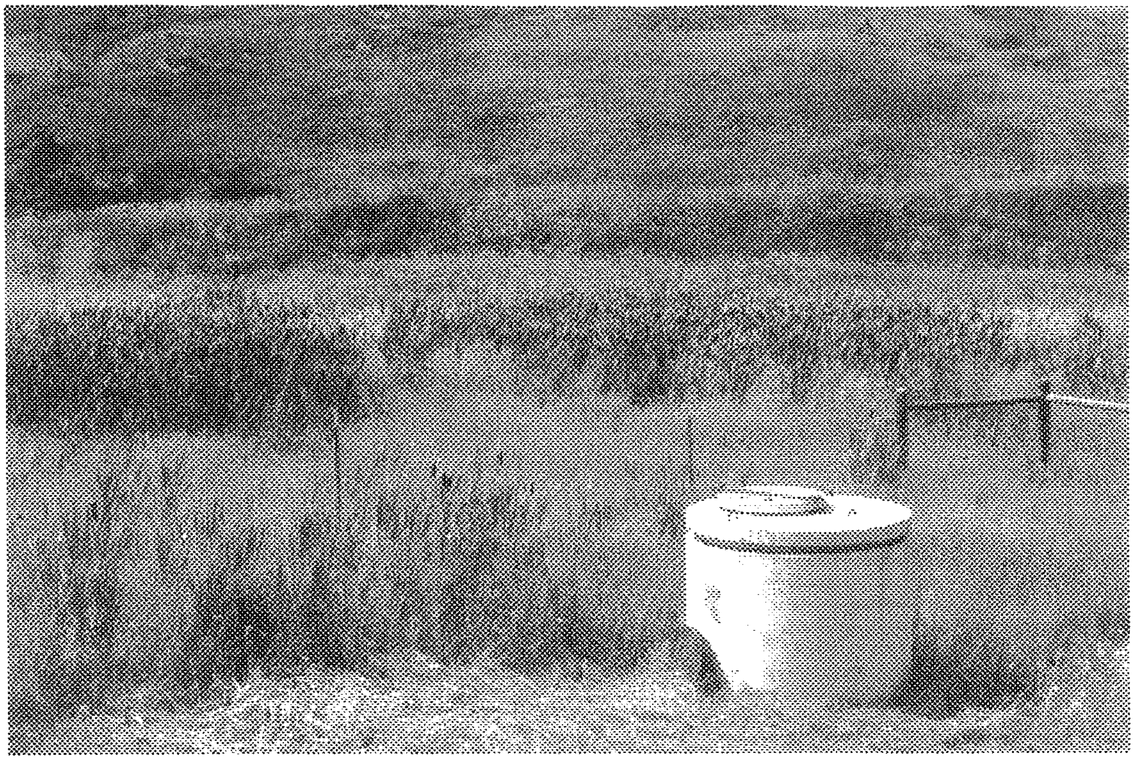
i) PASS: Well is classified as groundwater.
ii) FAIL: Well must undergo further GWUDISW determination.
iii) FAIL: Spring or Infiltration Gallery; must undergo further GWUDISW determination.
iv) FAIL: Well will PASS if well intake construction deficiencies (section F) are repaired.
v) FAIL: Well may PASS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

ANALYST [signature] ANALYST AFFILIATION MBMG

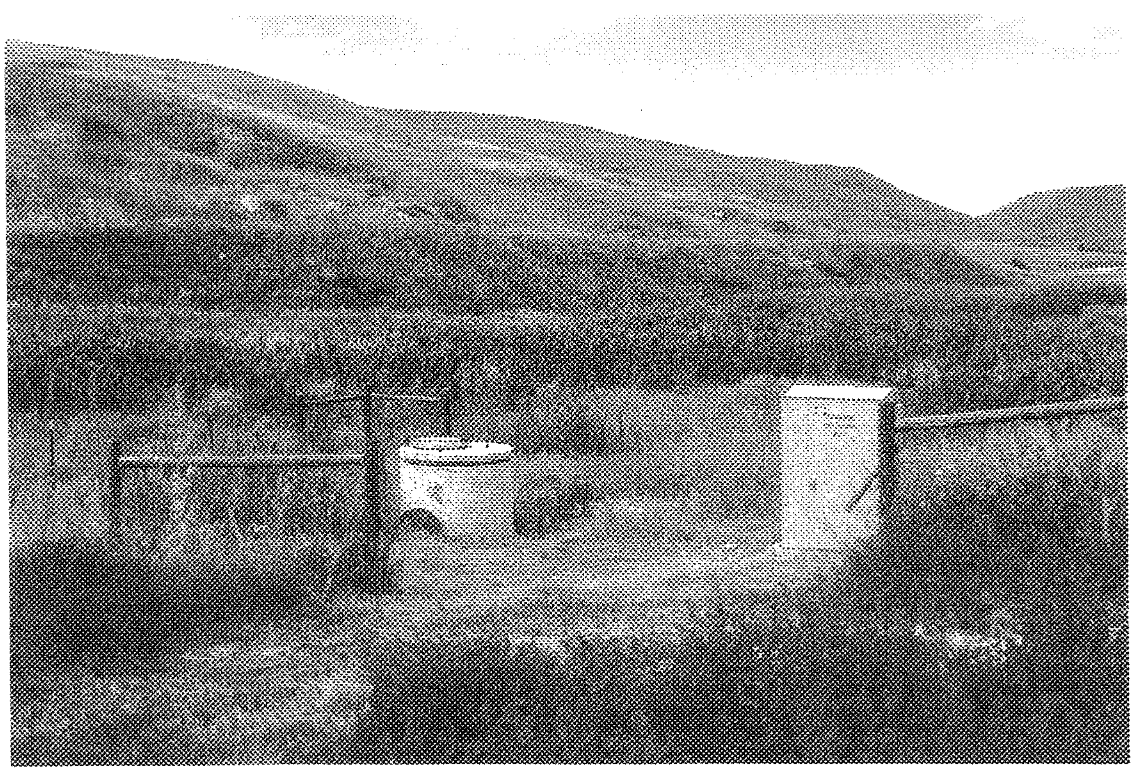
COMMENTS:

APPENDIX B

Photographs of the supply system and surrounding area

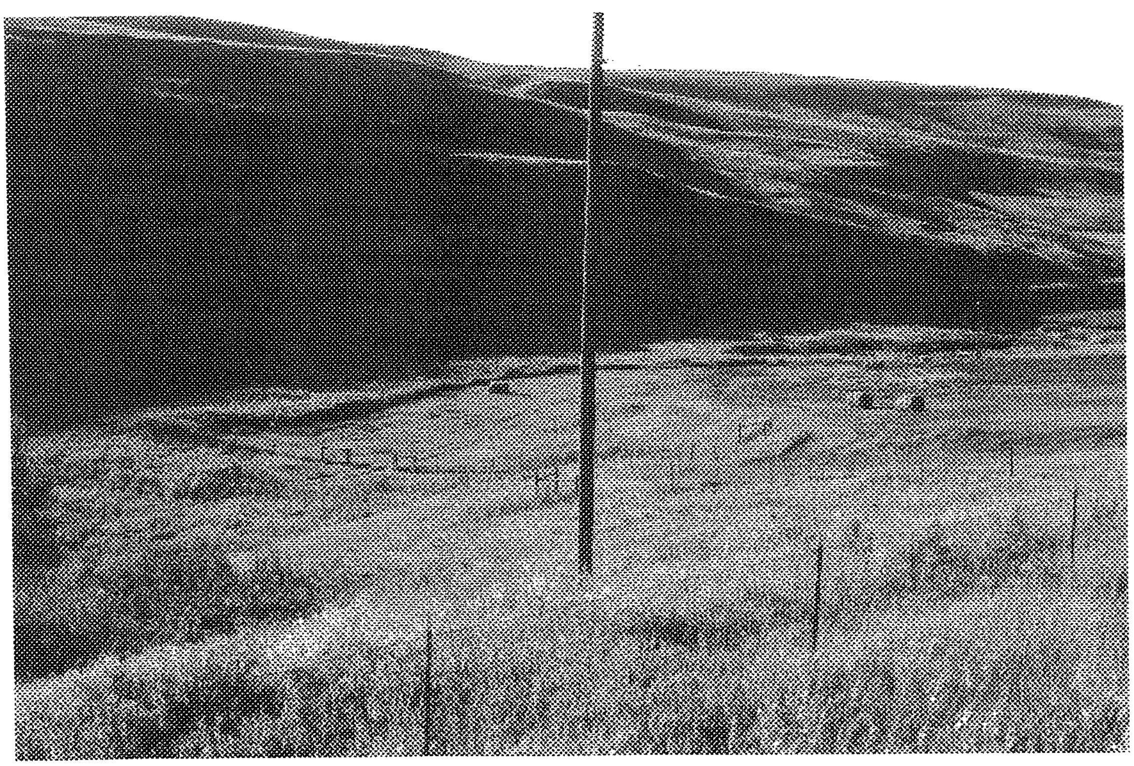


Stilling well for Stockett city water supply infiltration gallery.



Metering vault on left, chlorination facility on right, for Stockett city water supply system. View is looking northwest.

View of Cottonwood Creek looking northwest. Stockett city water supply collection gallery is just right of center of the picture, near the valley bottom.



View of Cottonwood Creek Valley looking northwest. Stockett city water supply metering building is near the right edge of the photo. The collection gallery is near the left under the mound covered with Russian Thistle just inside the gate.

APPENDIX C

Results of water-quality analyses

Montana Bureau of Mines and Geology
1300 West Park Street, Butte MT 59701 (406) 496-4167

Analytical Laboratory Report
Analysis Id: **1998Q0178**

State:	MT	**County:**	CASCADE
Latitude - Longitude:	47d20m8s N 112d10m15s W Datum1927	**Site Location:**	18N 05E 6 CCCA 1
Topographic Map:	STOCKETT 7 1/2'	**Site Id:**	162423
Geologic Source:	ALLUVIUM (QUATERNARY)	**Project:**	AMDCOAL *PWSINV
Drainage Basin:	MISSOURI RIVER BTWN MARIAS RIVER AND	**Station Id:**	
Agency + Sampler:	MBMG * JRW	**Sample Source:**	WELL
Field Number:	SWSD	**Land Surface Altitude:**	3760.00
Date + Time:	06-AUG-97 14:00:00	**Sample Media:**	
Lab + Analyst:	MBMG * BJK	**Sustained Yield / Method:**	
Date Complete:	21-Oct-97	**SWL above (-) /below MP:**	
Release Flag:	YES	**Total Depth:**	
Sample Handling:	3120	**Casing Diameter (in):**	
Method Sampled:	BAILED	**Casing Type:**	
Procedure Type:	DISSOLVED	**First Completion Type:**	
Water Use:	PUBLIC WATER SUPPLY	**First Perforation Interval:**	

Site Name: STOCKETT WATER AND SEWER DISTRICT

	mg/L	**meq/L**		**mg/L**	**meq/L**
Calcium (Ca):	104.0	5.19	**Bicarbonate (HCO3):**	433.1	7.10
Magnesium (Mg):	38.31	3.15	**Carbonate (CO3):**	0.0	0.00
Sodium (Na):	13.92	0.61	**Chloride (Cl):**	4.9	0.14
Potassium (K):	5.18	0.13	**Sulfate (SO4):**	67.1	1.40
Iron (Fe):	<.003	0.00	**Nitrate (as N):**	2.9	0.21
Manganese (Mn):	<.002	0.00	**Fluoride (F):**		
Silica (SiO2):	11.205		**OrthoPhosphate (as P):**	<.05	0.00
Total Cations:		9.10	**Total Anions:**		0.00

Field Chemistry and Other Analytical Results (units as specified).

Calculated Dissolved Solids:		**Total Hardness as CaCO3:**	417.37
Sum of Diss. Constituents:		**Field Hardness as CaCO3:**	
Field Conductivity (Micromhos):	730	**Total Alkalinity as CaCO3:**	355.22
Lab Conductivity (Micromhos):	760.00	**Field Alkalinity as CaCO3:**	
Field pH:	6.85	**Ryznar Stability Index:**	6.50
Laboratory pH:	7.36	**Langlier Saturation Index:**	0.43
Water Temp. (C):		**Sodium Adsorption Ratio:**	0.30
Air Temp. (C):		**Field Redox (mV):**	-36.00
Nitrite (mg/L as N):	<.05	**Field Dissolved O2 (mg/L):**	
Field Nitrate as N (mg/L):		**Phosphate, TD, (mg/L as P):**	Not Rptd
Ammonia (mg/L NH4):	Not Rptd	**Field Chloride (mg/L):**	
Bromide (mg/L Br):	44.	**Hydroxide Alkalinity as OH-:**	Not Rptd
PCP (ug/L):	Not Rptd	**T.P. Hydrocarbons (ug/L):**	Not Rptd

DISSOLVED Trace Element results (ug/L)

Aluminum (Al):	93.4	**Cadmium (Cd):**	<2.	**Mercury (Hg):**	Not Rptd	**Tin (Sn):**	Not Rptd
Antimony (Sb):	<2.	**Chromium (Cr):**	8.1	**Molybdenum (Mo):**	<10.	**Titanium (Ti):**	<10.
Arsenic (As):	<1.	**Cobalt (Co):**	<2.	**Nickel (Ni):**	13.3	**Thallium (Tl):**	Not Rptd
Barium (Ba):	209.2	**Copper (Cu):**	<2.	**Silver (Ag):**	<1.	**Vanadium (V):**	<5.
Beryllium (Be):	<2.	**Lead (Pb):**	<2.	**Selenium (Se):**	1.6	**Zinc (Zn):**	26.3
Boron (B):	49.3	**Lithium (Li):**	20.	**Strontium (Sr):**	371.	**Zirconium (Zr):**	<20.

Miscellaneous Parameters

Phosphate T Dis (mg/L - P)	L.2	Redox Potential (Mv)	-36	Thallium Diss. (ug/L-Tl)	L5

Explanation: mg/L = milligrams per Liter, ug/L = micrograms per Liter, meq/L = milliequivalents per Liter, ft = feet, mg/Kg = milligrams per Kilogram, pC/L = picoCuries per Liter

Qualifiers: A = Hydride atomic absorption, E = Estimated due to interference, H = Exceeded holding time, N = Spiked sample recovery not within control limits, P = Preserved sample, S = Method of standard additions, * = Duplicate analysis not within control limits.

Sample Condition: CLEAR

Field Remarks:

Lab Remarks:

Note: In correspondence, please refer to Lab Number: 1998Q0178

Print Date: 10-Apr-2000

Montana Bureau of Mines and Geology
1300 West Park Street, Butte MT 59701 (406) 496-4167

Analytical Laboratory Report
Analysis Id: **1983Q0445**

State:	MT	**County:**	CASCADE
Latitude - Longitude:	47d20m11s **N** 112d10m15s **W** **Datum**	**Site Location:**	18N 05E 6 CCBC 1
Topographic Map:	STOCKETT 7 1/2'	**Site Id:**	2167
Geologic Source:	ALLUVIUM (QUATERNARY)	**Project:**	
Drainage Basin:	MISSOURI RIVER BTWN MARIAS RIVER AND	**Station Id:**	
Agency + Sampler:	MBMG * KLK	**Sample Source:**	WELL
Field Number:	STOCK	**Land Surface Altitude:**	3750.00
Date + Time:	15-JUN-83 09:08:00	**Sample Media:**	
Lab + Analyst:	MBMG * FNA	**Sustained Yield / Method:**	
Date Complete:	12-Aug-83	**SWL above (-) /below MP:**	
Release Flag:	YES	**Total Depth:**	13 ft - Reported
Sample Handling:		**Casing Diameter (in):**	
Method Sampled:	PUMPED	**Casing Type:**	
Procedure Type:	Dissolved	**First Completion Type:**	
Water Use:	DOMESTIC	**First Perforation Interval:**	

Site Name: UP COTTONWOOD CREEK BEFORE DOLENAS HOUSE *

	mg/L	meq/L		mg/L	meq/L
Calcium (Ca):	90.0	4.49	**Bicarbonate (HCO3):**	389.	6.38
Magnesium (Mg):	41.8	3.44	**Carbonate (CO3):**	0.0	0.00
Sodium (Na):	12.0	0.52	**Chloride (Cl):**	4.9	0.14
Potassium (K):	3.5	0.09	**Sulfate (SO4):**	70.8	1.47
Iron (Fe):	.006	0.00	**Nitrate (as N):**	7.07	0.50
Manganese (Mn):	.003	0.00	**Fluoride (F):**	.4	0.02
Silica (SiO2):	11.6		**OrthoPhosphate (as P):**		
Total Cations:		8.55	**Total Anions:**		8.51

Field Chemistry and Other Analytical Results (units as specified).

Calculated Dissolved Solids:	433.72	**Total Hardness as CaCO3:**	396.78
Sum of Diss. Constituents:	631.10	**Field Hardness as CaCO3:**	
Field Conductivity (Micromhos):	717	**Total Alkalinity as CaCO3:**	319.05
Lab Conductivity (Micromhos):	969.90	**Field Alkalinity as CaCO3:**	324.00
Field pH:	7.10	**Ryznar Stability Index:**	6.74
Laboratory pH:	7.34	**Langlier Saturation Index:**	0.30
Water Temp. (C):		**Sodium Adsorption Ratio:**	0.26
Air Temp. (C):		**Field Redox (mV):**	
Nitrite (mg/L as N):	Not Rptd	**Field Dissolved O2 (mg/L):**	
Field Nitrate as N (mg/L):		**Phosphate, TD, (mg/L as P):**	Not Rptd
Ammonia (mg/L NH4):	Not Rptd	**Field Chloride (mg/L):**	
Bromide (mg/L Br):	Not Rptd	**Hydroxide Alkalinity as OH-:**	Not Rptd
PCP (ug/L):	Not Rptd	**T.P. Hydrocarbons (ug/L):**	Not Rptd

Dissolved Trace Element results (ug/L)

Aluminum (Al):	<30.	**Cadmium (Cd):**	<2.	**Mercury (Hg):**	Not Rptd	**Tin (Sn):**	Not Rptd
Antimony (Sb):	Not Rptd	**Chromium (Cr):**	<2.	**Molybdenum (Mo):**	<20.	**Titanium (Ti):**	13.
Arsenic (As):	.8	**Cobalt (Co):**	Not Rptd	**Nickel (Ni):**	10.	**Thallium (Tl):**	Not Rptd
Barium (Ba):	Not Rptd	**Copper (Cu):**	14.	**Silver (Ag):**	<2.	**Vanadium (V):**	2.
Beryllium (Be):	Not Rptd	**Lead (Pb):**	<40.	**Selenium (Se):**	.8	**Zinc (Zn):**	6.
Boron (B):	50.	**Lithium (Li):**	18.	**Strontium (Sr):**	340.	**Zirconium (Zr):**	<4.

Miscellaneous Parameters

Alkalinity Fld (CaCO3) 324.00

Explanation: mg/L = milligrams per Liter, ug/L = micrograms per Liter, meq/L = milliequivalents per Liter, ft = feet, mg/Kg = milligrams per Kilogram, pC/L = picoCuries per Liter

Qualifiers: A = Hydride atomic absorption, E = Estimated due to interference, H = Exceeded holding time, N = Spiked sample recovery not within control limits, P = Preserved sample, S = Method of standard additions, * = Duplicate analysis not within control limits.

Sample Condition: COLOR SMELL TASTE OK

Field Remarks:

Lab Remarks:

Note: In correspondence, please refer to Lab Number: 1983Q0445

Print Date: 10-Apr-2000

PWSID-SOURCE.ID	SYSTEM NAME..................	sample date	smpltype	smplcount	RESULT	FECAL.RESULT	method	comments.................
00579*001	STOCKETT WATER & SEWER DIST	09-19-96	R	1	0		PA	PA NEGATIVE
00579*001	STOCKETT WATER & SEWER DIST	08-20-96	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	07-09-96	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	06-17-96	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	05-22-96	R	5	0		MF	<1/100ML
			R		0		MF	<1/100ML
			R		0		MF	<1/100ML
			R		0		MF	<1/100ML
			R		0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	05-07-96	S	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	04-29-96	C	4	0		PA	COLIFORMS ABSENT
			C		5		PA	COLIFORMS PRESENT
			C		5		PA	COLIFORMS PRESENT
			V		OLD		PA	HEAVY GROWTH NON COLIFORMS
00579*001	STOCKETT WATER & SEWER DIST	04-24-96	R	1	3		MF	3/100
00579*001	STOCKETT WATER & SEWER DIST	03-12-96	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	02-12-96	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	01-23-96	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	12-18-95	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	11-20-95	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	10-25-95	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	09-19-95	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	08-22-95	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	07-11-95	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	06-13-95	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	05-22-95	R	1	0		MF	<1/100 CL2 0.5 MODERATE TU
00579*001	STOCKETT WATER & SEWER DIST	04-12-95	R	1	0		MF	<1/100ML TURBID
00579*001	STOCKETT WATER & SEWER DIST	03-14-95	R	1	0		MF	<1/100ML CL2 0.5
00579*001	STOCKETT WATER & SEWER DIST	02-21-95	R	1	0		MF	<1/100 ML
00579*001	STOCKETT WATER & SEWER DIST	01-17-95	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	12-27-94	R	1	0		MF	<1/100 ML
00579*001	STOCKETT WATER & SEWER DIST	11-21-94	R	1	0		MF	<1/100ML
00579*001	STOCKETT WATER & SEWER DIST	10-26-94	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	09-20-94	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	08-22-94	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	07-27-94	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	06-28-94	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	05-11-94	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	04-12-94	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	03-15-94	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	02-22-94	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	01-27-94	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	12-29-93	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	11-29-93	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	10-12-93	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	09-28-93	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	08-25-93	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	07-27-93	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	06-17-93	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	05-19-93	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	04-27-93	R	5	0		MF	
			R		0		MF	
			R		0		MF	
			R		0		MF	
			R		0		MF	
00579*001	STOCKETT WATER & SEWER DIST	03-12-93	C	4	0		PA	

09:38:28 21 OCT 1996

PWSID-SOURCE.ID	SYSTEM NAME..................	sample date	smpltype	smplcount	RESULT	FECAL.RESULT	method	comments..................
			C		0		PA	
			C		0		PA	
			C		0		PA	
00579*001	STOCKETT WATER & SEWER DIST	03-09-93	R	1	5		MF	TNTC WITH COLIF
00579*001	STOCKETT WATER & SEWER DIST	02-24-93	R	1	0		MF	
00579*001	STOCKETT WATER & SEWER DIST	01-28-93	R	1	0		MF	

***

48 Rows Processed