TOWN OF TWIN BRIDGES
PWS
SOURCE WATER PROTECTION PLAN

PWSID # MT0000349

SAM NOVICH,
Certified Operator

BETTY SYKES, MAYOR
SWP Contact

Phone: (406) 684-5243

Table of Contents

Tables

Appendices

Chapter 1

Acknowledgments

This Source Water Protection Plan was completed by Damschen-Entranco, Helena, Montana. The inventory was completed by Sam Novich of the Town of Twin Bridges.

Purpose and Scope

To meet the requirements of the federal SDWA, Public Law 104-182, Montana has implemented a source water protection program in which each community submits a plan for certification review following a format prescribed by the Department of Environmental Quality (DEQ).

This report is intended to meet the technical requirements for the completion of the source water protection plan for Twin Bridges, Montana as required by the Safe Drinking Water Act (SDWA).

A source water protection plan is designed to protect the water used by public water systems from contamination. For ground water based systems the plan establishes protected areas overlying the aquifer yielding water to the well and extends upgradient a prescribed distance. An Inventory Region is delineated based on a time of travel calculation and this area is then inventoried to identify potential contaminant sources. Management of the potential contaminant sources is considered, priorities are established, and recommendations made to the local governing body. Source water protection planning is necessary to provide an early warning mechanism in the event of upgradient contamination, however, preventing the contamination of a water supply through education and public awareness remains the primary goal.

Most instances of source water contamination become known when trace levels of a contaminant are detected through routine monitoring. Drinking water systems that have completed a source water protection plan will have information on groundwater flow and aquifer hydraulic characteristics or the surface water flow system as well as a contaminant source inventory and thus will be in a good position to determine the best response to ensure the continued quality of the water supply.

The Community

The Town of Twin Bridges, Montana is located in western Madison County, Section 27, Township 3 South, Range 6 West. The Town is situated at the junction of Montana Highways 287 and 41, near the confluence of the Ruby, Beaverhead and Big Hole Rivers (Appendix A).

The 1990 U.S. Census determined that the population of Twin Bridges was 374, down 14.4 percent from the 1980 census figure of 437. The economy of Twin Bridges is based on the surrounding agriculture community and tourism.

The wastewater collection system for the Town of Twin Bridges (Appendix B2) consists of approximately 16,200 linear feet of eight-inch gravity sewer. In addition, it is estimated that there is an additional 5,000 linear feet of four-inch service connections that extend from residences to the mains. The core of the central wastewater collection system was installed in 1963 and is composed of asbestos pipe. In the years since the original installation, numerous additions and extensions have been performed by private contractors utilizing PVC pipe. Because of the relatively flat topography that Twin Bridges is situated in and the presence of periods of high groundwater, two lift stations were required during initial construction to allow for conveyance of sewage in the system. The lift stations were replaced as part of a wastewater improvements project in 1990. The locations of these lift stations as well as the entire collection system layout are shown in Figure 6. The main lift station for conveying raw wastewater influent to the treatment facility is situated at the northeast corner of Town. Raw wastewater from the Twin Bridges collection system outfalls through an eight-inch gravity asbestos cement pipe to the lift station facility. Raw wastewater accumulates in a standard 72-inch inside diameter reinforced concrete manhole (wet well) situated next to an 84-inch reinforced concrete manhole which houses the pumps (dry well). Both of the manholes were set on reinforced cast-in-place concrete slabs. Controls and pumps at the main lift station have begun to show signs of age and should be renovated before a major problem develops. The exact capacity of the pumps is unknown although it

is estimated at around 400 GPM. The lift station pumps the wastewater to the treatment facility via 2600 linear feet of six-inch, class 100 asbestos cement pipe.

With the exception of the old children's home which has its own facilities, all of the wastewater generated in the community of Twin Bridges is delivered to a central lagoon treatment facility located one-half mile north of Town. The Twin Bridges wastewater treatment facility was constructed in 1963. The facility was designed as a two-cell discharging facultative treatment lagoon and is situated on property owned by the Town of Twin Bridges. An adjacent small water course, Bayers Irrigation Ditch, which eventually drains into the Jefferson River, provides for a point to discharge the effluent from the facility. The treatment facility consists of two earth-berm lagoons, inlet and outlet structures and miscellaneous piping associated therewith. The facility is operated by personnel of the Town of Twin Bridges and is inspected periodically by the Water Quality Bureau of the Montana Department of Environmental Quality. The ponds were lined and new piping and inlet and outlet structures were installed in 1990. Calculations for the 1990 facility improvements showed that the existing treatment facility should handle flows for a population of 600 people and probably more. However, groundwater infiltration and other factors may affect this projection. An analysis is underway to determine the current status and future needs for the sewer system.

Economic Base. Twin Bridges is a ranching/farming community of about 375 people located in southwestern Montana. A small portion of the economic base involves tourism and recreation in the form of fishing and hunting, which support several motels, restaurants, and gasoline stations.

Industrial Activities. There is no heavy industry in Twin Bridges. The only manufacturing facility is the Winston fly rod shop on the south end of the town. There is also a tire shop that offers welding services.

Major Transportation Routes. Montana State Highways 41 and 287 merge at Twin Bridges. North of Twin Bridges, Highway 41 connects with roads leading to Whitehall and Butte. To the south it passes through Dillon. Highway 287 leads southeastward out of Twin Bridges to Virginia City, and eventually merges with U.S. 287 in Ennis.

A railroad line operated by Montana Rail Link runs through Twin Bridges. This line is used almost exclusively for the transport of essentially inert mineral products from a mine in Alder to the Twin Bridges area.

The town also hosts a small paved airstrip about a mile east of town.

Geographic Description. The Town of Twin Bridges lies in an intermontane valley on the Beaverhead River just upstream of its confluence with the Big Hole River. The prominent mountains in the area include the Tobacco Root Range to the east, the Highland Mountains to the northeast and the Ruby Range to the south. The Town lies within the flood plain of the Beaverhead River. Pediment benches rise from the valley about one mile east of Town.

General Description of the Source Water

Aquifer Geology. The local aquifer is hosted by locally-derived Tertiary- and Quaternary-aged valley fill. These deposits include alluvial fan material and younger fluvially re-worked river channel sands and gravels. The older, deeper coarse-grained silt, sand and gravel formations are punctuated by volcanic ashfall beds that are reported in well logs as grey to white clay or bentonite. In many places the ash beds serve as hydraulic barriers locally in the relatively complex ground-water system. While there are significant differences in the host material and hydraulic characteristics of ground water from place to place, the valley-fill ground-water system as a whole may be treated as a single aquifer with significant aquitards reducing vertical migration. More specific information is included in the following chapter.

Sensitivity Ranking. The aquifer supplying Twin Bridges' water supply lies at a depth of 165 to 240 feet below the ground surface within unconsolidated and semi-consolidated gravel and sand alluvium. A number of natural barriers occur in the form of clay beds that lie between the surface and the supply aquifer, and the aquifer is locally confined or semi-confined. Thus, the aquifer is considered to have a low sensitivity to contamination. Since there are documented petroleum releases in Twin Bridges, but no known maximum contaminant limit exceedences within the past five years, the aquifer may be conservatively considered to be moderately susceptible to the documented exposure to contaminants.

Public Water Supply System

Demographics, Water Sources, Distribution System. The Town of Twin Bridges= domestic water system consists of two wells, a distribution system and a water storage reservoir. The major facilities utilized are depicted in Appendix C. A Water Improvements Construction Project in 1999 made major improvements to Twin Bridges' water system. These improvements included a new storage tank, transmission main, pump controls and replacement of the majority of the distribution system.

Both well pumps are Floway Vertical Turbines with U.S. Motors. New Consolidated Electric telemetry controls were added in 1999. These controls operate the tank between preset levels with the second well pump starting at a low level. Pumps #1 and #2 alternate and both will run if the water level reaches a pre-set low level. Both high level and low-level alarms are provided.

The new transmission line consists of AWWA C900 twelve-inch diameter PVC pipe with Mueller 12-inch gate valves. The new distribution mains installed in 1999 consist of AWWA C900 8- and 6-inch pipe with Mueller gate valves. The majority of fire hydrants are six-inch Mueller Super Centurion 250.

Twin Bridges' original water distribution system consisted of a series of mains and laterals that transport the water to individual service lines. The system is comprised primarily of 4-inch, 6-inch and 8-inch cast iron, (CI) Transite, (TR) and polyvinyl chloride (PVC) mains along with numerous gate valves and fire hydrants. In addition, several small diameter lines (1-, 12-, 2-inch poly and steel pipe) are used to further distribute water to users.

The original system, which was installed in 1917, consisted of 4-, 6-, and 8-inch cast iron mains with lead caulked joints. This network was located primarily along Main Street and Madison Street from First Avenue to Eighth Avenue and along Bridge Street from Fourth Avenue to Eighth Avenue with east to west connectors on First Avenue, Third Avenue, Fourth Avenue and Eighth Avenue. New cast iron mains were installed along Main Street in the early 1960s when the highway was redone. The Transite lines were added during the late 1960s and early 1970s. PVC lines have been installed from the late 1970s on. The 12-inch steel lines are extensions from the original system dating back to the early 1900s. As can be seen, the system has continued to grow over the years via extensions and additions constructed by individuals and Town personnel.

Service lines from the water mains to individual residences and commercial units consist primarily of 3/4-, and 1-inch copper and black plastic pipe. The Town's preference for service lines is black plastic and therefore they encourage the use of that material. Service lines from the curb valve to the structure are the responsibility of individual users.

A new 300,000-gallon bolted steel on grade reservoir was constructed east of Town as part of the 1999 project. Water is pumped up to the tank through a 12-inch PVC transmission main and is gravity fed to the distribution system through the same transmission main.

Influencing Factors. The mayor and Town Council are ultimately responsible for the overall management of the water system of Twin Bridges. The physical management of the system is the responsibility of the Town Maintenance Supervisor.

The 20-year anticipated growth of the Town will be accommodated by improvements made to the water system during the 1999 project.

Source-Water Protection Management. The Source Water Protection will be implemented by the Town's Public Works Director. Management decisions will be made by the Town Council, Mayor and Public Works Director. The following is a list of public officials and phone numbers:

Sam Novich, Public Works Director, 684-5243
Betty Sykes, Mayor, 684-5243

Organic Chemical Monitoring Waivers. The Town of Twin Bridges has received an Organic Chemical Monitoring Waiver from the Department of Environmental Quality. It is a partial waiver for a specific set of organic compounds. A copy of the Organic Chemical Monitoring Waiver can be viewed in Appendix H.

Chapter 2

Delineation

The purpose of this chapter is to describe how the source water protection area for the Twin Bridges public water-supply system (PWS) was determined. This "delineated area" defines the portion of the aquifer, groundwater flow system, or surface water drainage basin which contributes water to the Twin Bridges PWS. The delineated area includes the zone of contribution to the well or intake up to the hydrogeologic or hydrologic divide as determined by application of the analytical equations for ground water flow and simple hydrogeologic mapping. The delineated source water protection area for Twin Bridges public water-supply system has been subdivided into three regions for prioritization and ease in management. These three areas include the Control Region, Inventory Region, and Recharge Region.

For groundwater-based systems the Control Region is also known as the exclusion zone and is the 100-foot radius around the well. Generally, spills or leaks of certain contaminants and some land uses within this region are also considered likely to contaminate the source water but early detection, response, and remediation will prevent the long term loss of water quality.

The Control Region for the water-supply sources for Twin Bridges includes a 100-foot radius around the existing wells. The delineation is based upon available data and field observations described below.

The Inventory Region shall include the area hydraulically up-gradient from the wells within the Town limits..

The Recharge Region represents the recharge area for the portion of the aquifer contributing water to the Twin Bridges water-supply system. Because the principal sources of water could include areas quite distant from Twin Bridges, it is impractical to delineate a protective region. However, more localized sources of contamination lie in places that near recharge zones or at intermediate locations. For these reasons a wider Recharge Region shall not be delineated at this point in time, but a more restricted area in the shape of a semi-circle one mile in diameter based upon the northern town boundary shall be employed.

Sources

The water supply consists of two wells, with Well #1 located near the alley south of West Sixth between Main Street and Madison Street, and Well #2 near the corner of West Sixth Avenue and Bridge Street (Appendix C). Well #1 is 195 feet deep and was pump-tested at 1,000 gallons per minute (gpm). The static water level was recorded as 6 feet below ground level and the pumping level was recorded as 71 feet below ground level. The well contains twelve-inch-diameter number 80 stainless steel well screen at the intervals 163 to 166 feet, 168 to 170 feet, and 188 to 193 feet.

Well #2 is 240 feet deep with a reported static water level of 5 feet below ground surface. This well was pump-tested at 1,070 gpm with a reported pumping level of 67 feet. The well was constructed with number 80 stainless steel well screen at the 130 to 140 foot interval and the 229 to 239 foot interval. The logs of these wells are included in this report as Appendix D.

Geological and Aquifer Conditions

General Description . The Town of Twin Bridges lies along the east bank of the Beaverhead River just below its confluence with the Ruby River. The town itself is situated on Recent (Holocene epoch—12,000 years ago to present) deposits that comprise clay- to cobble-sized clasts in typical stream-related deposits. The margins of the valleys are underlain by benches of older deposits composed of variably-cemented alluvium and colluvium. The central portions of the valleys are thought to consist of similar deposits some depth below the more recently deposited fluvial material. Bedrock lies many hundreds, perhaps thousands of feet below the central portion of the valley. These older deposits are thought to be up to mid-Tertiary (22.5 million years) in age.

The aquifer in the immediate vicinity of Twin Bridges is typical of the region. Ground water is contained within unconsolidated and partially consolidated silt, sand and gravel. Prominent features include strata and lenses of very

fine-grained material of variable extent, prolific sand and gravel water-bearing zones, and zones of cemented sand and gravel in which water flow is controlled by fractures. The town of Twin Bridges is underlain by a sequence of unconsolidated sediments, with the coarser beds being saturated within just a few feet of the ground surface.

In general, most of the water-bearing zones in the Beaverhead and Ruby River valleys are interconnected to some degree. The static water levels in the municipal wells were reported to be very close to that of the uppermost saturated zone, but the water levels could not be measured for this study. It is difficult, therefore, to know if the system in the vicinity of Twin Bridges is confined or open. As noted above, the entire system is considered to be a single aquifer on a regional scale, but contains fine-grained strata that clearly act as barriers to vertical flow. There appears to be good lateral flow through the horizontal beds.

Site-Specific Studies. The logs of the two municipal wells indicate the presence of silty material near the top of the hole, with much coarser material underlying the silt at depths of only seven or eight feet below ground surface. The correlation between these two logs is very poor, which is somewhat unusual considering that they are only about 400 feet apart. Some of the discrepancies between these two logs are probably differences in detail of description by the driller. For example, discrete strata described in the log of well #2 from 4,490 to 4,540 MSL are simply noted as Aheaving coarse sands, claybound and wet≅ over the same section of the log of Well #1. The latter description generally encompasses the former. However, clear stratigraphic differences also occur, such as the section just below 4,490 feet. Well #1 traversed heaving wet sand for over 40 feet whereas Well #2 was drilled through dry clay. In fact, Well #1 has two perforated intervals in clean sand at elevations that are described as dry clay in Well #2.

In addition to the two active supply wells, Twin Bridges has an older, unused well at the City shop. This well, is 169 feet deep, and is perforated between 157 and 169 feet (Appendix D). No log is available for this well, and an on-site inspection revealed that the casing is plugged less than ten feet from the collar.

There is also a relatively deep well west of the Beaverhead River on the campus of the former Montana Children=s Center (MCC). This well is 207 feet deep, and is perforated from 161 to 164 feet (Appendix D). The log of this well shows a very different stratigraphic sequence than the two municipal supply wells, with far fewer clay zones noted on the MCC log. The near-surface silt bed noted in the other well logs is also missing at the MCC well.

The Montana Department of Transportation (MDOT) drilled an irrigation well in 1973 south of Twin Bridges (Appendix D). This is a relatively shallow well compared with the other water-supply wells described above, but provides valuable insight into the hydrogeology of the area. Any correlation of the stratigraphy described in this well with that in any of the other wells is tenuous, at best. In general, however, the log descriptions conform with those for other wells in that ground water is found at a relatively shallow depth (eight feet below ground surface) and multiple saturated zones were encountered.

In addition to these wells, four monitoring points were installed by the Town. These are denoted as the East Well, the North Well, the West Well, and the South Well. These installations were constructed of perforated Schedule 40 perforated PVC pipe set vertically in backhoe excavations. Town personnel measured the static water levels in these installations

A number of studies related to underground storage tank (UST) leaks have been undertaken in Twin Bridges. The locations of these leaks along with the locations of suspected leaks are shown on Figure 2. Most of the known contamination has remained in the uppermost saturated zone, above the silt/clay stratum. Consequently, the numerous monitoring wells and piezometers that have been installed to study the various contaminant plumes are screened very near the ground surface. In conjunction with these wells, four stand pipes were installed by the Town in the early 1990s to facilitate the measurement of the water table. In all, at least 40 borings have been drilled in Twin Bridges, with nearly half of those completed as monitoring wells or piezometers. Thus, good subsurface information is available, as is a good opportunity to obtain water table elevation data across the entire town.

Lateral Extent of Ground Water. The Beaverhead and Ruby River valleys are underlain by ground water within unconsolidated and partially-consolidated alluvial deposits. Evidence of this can be obtained through the large number of domestic wells in the region. Ground-water monitoring wells at the old Twin Bridges landfill, which lies about one mile east of the town, are screened within poorly-sorted, unconsolidated sand and gravel (Damschen &

Associates, 1995). Static water levels at the landfill range in the vicinity of 4,640 feet above mean sea level (MSL), which is some 20 feet higher than the ground-water elevations of the shallow saturated zone in Twin Bridges.

Further to the south, a similar ground-water situation exists in the Town of Sheridan. There, a shallower saturated zone lies 15 to 20 feet below the ground surface and a deeper, possibly confined aquifer lies at a depth of 100 to 150 feet. Sheridan is some nine miles from Twin Bridges, and it is difficult to delineate specific ground-water interactions. However, it is clear from the stratigraphic information available that the various saturated zones are probably interconnected via convoluted pathways associated with the different sand- and gravel-dominated deposits.

Aquifer Thickness. The total thickness of the water-bearing sedimentary structures in the Ruby-Beaverhead River Valleys is not known. Some suggest that the alluvial and colluvial deposits could be several thousand feet thick, and the underlying bedrock may also host fracture-controlled aquifers. The alluvial aquifer being tapped by most of the local wells can be considered to be many hundreds of feet thick in most places.

Structural Controls of Ground-Water Flow. The ground-water flow is controlled by interstitial conditions in the unconsolidated alluvial and colluvial strata that serve as the regional aquifers. Some cemented units regionally may exhibit fracture control of ground-water flow, particularly in the older Tertiary bench deposits. However, none of the well logs described any strata meeting this description.

Rate and Direction of Ground-Water Flow. The rate of ground-water flow was not directly measured for this study. Rates of flow in sand and gravel aquifers in the intermontane valleys of Montana typically range from a few tenths of a foot per day to many tens of feet per day. It is important to note that the Montana Bureau of Mines and Geology has tested the Twin Bridges water supply and found that the water has taken from 30 to 50 years to reach the wells (Ted Duaime, Montana Bureau of Mines and Geology, personal communications, 2001). Assumptions regarding ground-water flow rates are included in the Modeling section below. Shallow installations reflected a ground-water flow direction essentially parallel to the Beaverhead River valley (Appendix E).

It is important to note that localized changes in ground-water flow have been observed in the Twin Bridges area. For instance, there is anecdotal evidence that an underground storage tank leak at the Three Rivers Cenex was first detected at a point due west of the facility about 75 feet from facility despite the apparent northerly flow direction. This would indicate that the uppermost ground-water flow may be influenced by local structural or temporal controls.

Delineation Method. A paucity of data creates a dilemma for the development of various protection zones. However, an examination of available data leads to a simple and effective delineation method.

Several crucial facts dictate how the ground-water flow may be interpreted. First, the source aquifer does not appear to be well connected to the overlying aquifers, although the stratigraphy reported in the well logs indicates the presence of a very complex aquifer system. An anecdotal report from Atlatl, Inc., 121002 Browns Gulch Road, Butte, Montana, 59701 indicates that no measurable change in ground water levels could be seen in the uppermost saturated zone when the #2 well was pumping. This would indicate that the near-surface ground water is not well connected to the deeper water found at the screened intervals of the supply wells, or sufficient water is available from the Beaverhead River to interfere with the drawdown. In addition, a number of fuel releases from underground storage tanks have been documented in Twin Bridges, including one that reached to within a few tens of feet from the #2 well. The other spills have been up-gradient from the source wells, at least as far as the uppermost saturated zone is concerned. No organic chemicals have been detected in any of the public water supply samples that have been analyzed to date. Regardless of the mechanism, it is quite clear that chemical releases at or near the ground surface have not reached the screened intervals of the wells, in spite of the fact that the spills occurred within a few tens of feet of the well heads and the spills may be decades old.

Recharge areas for the source aquifer do not appear to be local. Some water may be entering the substrate through the channel of the Ruby River, but the static water level of the near-surface ground water appears to lie very close to the level of the river surface. It may be that there is ground-water discharge to the river. Regardless, the Ruby and the Beaverhead Rivers are atypical for many western freestone mountain stream due to their relatively heavy suspended load and very fine-grained bedload. The presence of very thick accumulations of volcanic ash in the mountains that form the headwaters of these rivers lend to the unusual abundance of fines in the stream banks and

overbank flood areas. These fine-grained deposits provide for significant retardation of vertical movement of water within the Town boundary.

As noted above, water from the Twin Bridges supply exhibits a 30- to 50-year travel time. Therefore, it is presumed that much of the recharge for the source aquifer originates in the Tobacco Root and Ruby ranges. Some recharge may also occur along the Tertiary-aged benches between the river valley and the mountain ranges in the form of over-irrigation and leakage through irrigation canals, although the numerous barriers to vertical flow would imply that direct recharge atop the aquifer is probably not a significant influence on deeper-lying saturated zones. Since the source of the ground water underlying Twin Bridges is very difficult to ascertain, a very wide area of potential recharge is outlined on the figure in Appendix E.

The entire aquifer system underlying the Ruby and Beaverhead valleys comprises fluvial (stream) and alluvial deposits, which tend to possess zones that have better hydraulic connectedness in a lateral direction than in a vertical direction. Thus, contaminants cannot readily migrate from the ground surface to depths in the range of hundreds of feet without first dispersing laterally down-gradient. This seems to be the situation in the case of the fuel leaks found throughout Twin Bridges, which have been at a number of locations across the town (Appendix B1, B2, and B3). A number of reports available from the Montana Department of Environmental Quality report the depth of migration of fuel-related contaminants at these leaks. Damschen-Entranco staff observed contaminated soil to depths of no more than 4.5 feet below ground surface during the excavation of a water line west of the Wagon Wheel motel. This particular site hosted two tanks over 40 years old, and the leak source was suspected to be underground supply lines. Thus, it is clear that light non-aqueous phase liquids do not readily migrate vertically downward. Heavier contaminants may be able to migrate in a vertical direction more readily via advection, but lateral dispersion in underlying coarse strata is likely to reduce the impact on water quality at the depth of the screened intervals in the wells.

Again, no tracer studies appear to have been conducted in the Twin Bridges area, and aquifer test data are non-existent or as yet unpublished. Thus, determining the time of travel from the recharge zone, or the even the precise zone of contribution, is extremely difficult. However, more general properties of the ground-water flow system can be estimated, and these estimates may be used to aid in the determination of the inventory Region.

Modeling. An attempt was made to input the available data into the EPA's Wellhead Protection Area (WHPA) model. This model predicts drawdown, flowpaths, and capture zones. Unfortunately, the absence of concrete values for important inputs such as transmissivity and aquifer thickness render the modeling effort almost academic. However, the general effect of pumping may be characterized by using estimated values for various model inputs.

A range of inputs was applied as a means to approximate the aquifer response to pumping and develop a sense of the capture zone that might exist. The following facts were taken into account in the derivation of the estimates used for the input:

-the wells can produce 1,000 gpm or more with about 60 feet of drawdown;
-the aquifer may or may not be thoroughly interconnected;
-zones of very low permeability were encountered during drilling;
-the screened intervals in both wells were set in zones of extremely high permeability;
-the thickness of the aquifer cannot be determined from available data;
-the influence of the Beaverhead River on the aquifer cannot be clearly delineated;
-the hydraulic gradient cannot be clearly delineated;
-the porosity of the aquifer cannot be clearly delineated, and;
-the hydraulic conductivity of the aquifer has not been measured.

The following assumptions were made for the completion of the model:

-maximum discharge only occurs from one well at a time;
-maximum daily discharge is 24,000 cubic feet per day;
-the transmissivity of the aquifer is 2,500 ft^2/day;
-hydraulic gradient is 0.007 (from near-surface gradient);
-porosity is 0.30;

-aquifer thickness is 250 feet;
-that the aquifer is regionally unconfined, and;
-there is no influence on the withdrawal zone by the Beaverhead River.

These assumptions are arguable, but until some hard data can be collected to verify various aspects of the ground-water system, they will suffice for this level of estimation. The key elements for the modeling involve the transmissivity, porosity, discharge, thickness, and hydraulic gradient. The discharge can be determined from the records of use available from the Town of Twin Bridges. The highest use rate calculated was 24,000 cubic feet per day.

The transmissivity of the aquifer cannot be calculated. However, the fact that the wells can produce 1,000 gpm through 20 feet or fewer of perforated or screened interval indicates that the aquifer is prolific in its more permeable zones. The thickness and transmissivity have been manipulated in this instance to result in a hydraulic conductivity of 10 ft/day, which is a very realistic value for a prolific sand and gravel aquifer.

Since the actual hydraulic gradient of the pumped zones cannot be calculated, the near-surface gradient has been substituted. This value has a very high potential for error, but given the high productivity of the aquifer, the impact from pumping is not expected to be minimal.

The thickness of the aquifer is unknown. For the purposes of this exercise, it is assumed that the aquifer is 250 feet thick, which is the approximate thickness of the deeper of the two wells.

The porosity is estimated from the ranges offered by Fetter (1988).

For the purposes of the model the aquifer is treated as unconfined, but, as noted above, this may not be the case locally due to the presence of widespread clay- and silt-rich strata that serve as flow barriers. The entire valley-fill aquifer can be treated as a single body from a regional standpoint, but there are local barriers that will retard the vertical movement of water. Just such a barrier has been encountered within ten feet of the ground surface everywhere within the town limits. However, for the purposes of this model, the confined or unconfined nature of the aquifer is unimportant. The results are based upon differences in head elements, not the empirical values used for head input. Thus, the capture zone will be the same regardless of the head elements: The key to the protection of the well then becomes that of limiting activities and recognizing the presence or absence of barriers.

The result of the WHPA modeling is presented in Appendix F and in the attached diskette. The capture zone is for a three-year time of travel is about 750 feet in diameter for both wells. The model used a maximum pumping rate for the wells, and the hydraulic gradient appears little affected on the output map generated by WHPA. This is probably a reasonably accurate reflection of what actually happens a this particular location, and either well will behave as predicted by the model. Since only one well pumps at a time, and since the wells are similar in construction, it appears that the zone of influence is similar for both well. The models were run separately because the wells do not ever pump simultaneously. One must continue to bear in mind that there are some very critical elements of the system that are unknown, and therefore presentation of such modeling results may not reflect the actual behavior of the ground water under pumping conditions. For example, there are no data available indicating the actual ground-water flow direction at the depths of the screens in the two supply wells. It may well be quite different than the flow direction found at the surface. The flow direction of ground water less than a mile to the east of Twin Bridges at the old landfill is nearly due west. In addition, there may well be discharge zones underlying the wells that result in strong vertical influences on the ground-water flow.

In spite of the uncertainties involved in this particular model, the Control and Inventory Regions delineated below are probably reasonable considering the input values that were used. However, the model results are only estimates because input parameters cannot be measured due to the absence of appropriate installations and test results. Until such time as the pertinent data can be generated, these results shall have to suffice in order to meet the State of Montana requirements for the completion of a source-water protection plan certification. The conservative approach is to use an Inventory Region that includes all of the Town that can be legally regulated.

Limiting Factors

No sub-surface field studies were conducted for this evaluation. Instead, available data and data collected from existing shallow field installations were used to develop the model. Such data and estimates do not always allow for accurate predictions regarding the response of ground water to pumping or for the determination of contaminant pathways or capture zones.

The preparers of this document provide no guarantee that the behavior of contaminants in ground water will adhere to the proposed model outlined above. It is impossible without significant improvements in data quality to provide an accurate prediction of ground-water flow, hence, contaminant transport and fate. In order to properly ascertain the aquifer characteristics, a full schedule of aquifer testing must be conducted, including pumping tests using independent monitoring wells screened within the aquifer(s) being tapped.

As additional information becomes available, this Plan should be revised. The Montana Bureau of Mines and Geology and the Montana Department of Natural Resources conduct ongoing studies of ground water. Additional data can be supplied by these agencies as it becomes available. Inquiries to this effect can be made at five-year intervals so that the Source Water Protection Plan can be updated in conjunction with the Comprehensive Growth Plan.

Chapter 3

Inventory Method

The inventory was conducted by Town personnel and by Awindshield≅ inspection. The inventory sheets are included herein as Appendix G.

Results—Control Region

Supply well #1, which is situated next to the Town Hall and fire station (Appendix B1, B2, and B3), lies in an area that is zoned as mixed commercial/residential. There are no existing conditions within a 100-foot radius of the well that would warrant any additional restrictions or protection. The well is housed in a secure concrete structure.

Supply well #2 is situated in a residential zone about two block west of Well #1 (Appendix B1, B2, and B3). There are no commercial activities being undertaken within a 100-foot radius of the well. This well, too, is housed in a secure concrete structure.

The greatest threat to either of these wells within their Control Regions involves the possibility of incidental occurrences, such as inadvertent spills or vehicular accidents. Remnants of the fuel spill near the Wagon Wheel motel, southeast of well #2, may still exist in the soil and uppermost saturated zone. However, the migration paths of the fuel have been well documented, and most of the contaminated soil has been removed.

The Emergency Operation Plan for Madison County, Montana, which has been adopted by the Town of Twin Bridges, shall provide the guidelines for emergency procedures in the event of an accident

Results—Inventory Region

There are currently five sites where ground-water contamination has been detected. These have all been addressed by the Montana Department of Environmental Quality (DEQ). The locations of the sites are noted on the map in Appendix B1, B2, and B3. An abbreviated list of these sites is included in the table below and in Appendix G, the inventory forms. They are all related to leaking underground tanks and involve petroleum products, primarily gasoline. It appears that these have had no adverse effects on the water supply system because required routine testing has not produced any evidence of contamination.

Results—Recharge Region

Since recharge is likely to include parts of the Tobacco Root mountains and the Ruby range, as well as some portions of the Ruby River and Beaverhead River valleys, an Inventory Region would encompass a wide area. The relatively long transport distances and, presumably, times of travel, would minimize the threat posed to the Twin Bridges water supply from activities generally associated with the recharge areas. Such activities include livestock grazing, growing hay, and other agricultural pursuits. The Twin Bridges landfill is located about 1.5 miles east of town, and has been closed under Montana Department of Environmental Quality regulations. The site is currently in the final stages of groundwater monitoring, and does not pose any significant threat to the Twin Bridges water-supply system.

Susceptibility to Contamination

Contaminant Inventory

Table 1. Contaminant Inventory for Twin Bridges, Montana	
Source Category	**Information**
Septic Systems	none w/in Town boundary
Animal Feeding Operations	N/A
EPA Regulated Facilities	N/A
Class V Injection Wells	N/A
Wastewater Treatment	N/A
MPDES Wastewater Discharges	N/A
Highways, Roads, Railroad, Pipelines	SR 287, SR 41, BN spur, Town streets
Land Use	urban, suburban in immediate vicinity; agricultural within 1,000 feet.
Underground storage tank leaks (number correspond with inventory sheets and map locations, Appendix B)	
1. Wagon Wheel Motel	gasoline UST/pipe leak--closed
3. Banks Enterprises	closed gasoline UST
4. Madison County Shop	gasoline UST leak
5. Twin Bridges Public Schools	gasoline UST leak
6. Montana Rail link	above ground fuel storage tank leak
7. Three Rivers Cenex	gasoline UST leak

Hazard Determination for the Wells

The greatest threat to the drinking water source in Twin Bridges involves surface spills from transportation accidents or underground tank releases of petroleum products. The most vulnerable pathway is the area directly proximal to the well casing, or down the well casing itself. The complex hydrostratigraphic environment along with the very high volume of water moving through the valley-fill aquifer will dilute any near-surface contaminants prior to them reaching the well screens. Proper well construction through the fine-grained sediments near the ground surface has thus far prevented contaminants from reaching ground water tapped by the municipal wells.

The Beaverhead River flows through the Town of Twin Bridges. The Beaverhead River and the Ruby River, which meets the Beaverhead a short distance upstream from Twin Bridges, represent potential hazards to the ground water should there be a significant interaction between surface water and ground water. Ted Duaime of the Montana Bureau of Mines and Geology has conducted age-dating analysis on the ground water from each of the two supply wells. He found that the water from the wells has been in the ground between 30 and 50 years, and possibly as much as 70 years (Ted Duaime, personal communication; unpublished letters to the Town of Twin Bridges). This eliminates the possibility that contaminants introduced into the Beaverhead or Ruby Rivers could constitute any significant threat to the ground-water supply. This also supports the anecdotal evidence that static water levels around the wells are essentially unaffected when pumping is under way.

The hazard determination outlined in Table 2 and the susceptibility assessment in Table 3 are based upon the

proximity of the hazards to the water-supply wells, the presence of natural barriers to vertical flow, a 30- to 50-year travel time for the ground water from the recharge zone to the well intakes, and the fact that the wells are properly constructed and the annular spaces are properly sealed.

Table 2.
Hazard Determination Table for Twin Bridges, Montana

Source Type	Hazard	Hazard Rating
Sewage Systems (%total land area)	nitrates/pathogens leaching to ground water	High (>50% land area)
Cropped Agricultural Land	nitrates/pathogens leaching to ground water	Low (<20%)
Other Significant Point Sources (3 year TOT)		
Wagon Wheel Gas Station, 310 N. Main (UST)	VOCs, SOCs due to spills/leaks	high
Bo's Service Station, 101 S. Main (UST)	VOCs, SOCs due to spills/leaks	low
Madison County Shop, 305 3rd Ave. E. (UST)	VOCs, SOCs due to spills/leaks	low
Twin Bridges School Bus Barn, 201 S. Madison	VOCs, SOCs due to spills/leaks	low
Montana Rail Link line, along east Town line	VOCs, SOCs due to spills/leaks	low
3 Rivers Cenex, 325 S. Main	VOCs, SOCs due to spills/leaks	low
Highways (1 w/in 3 year TOT)	VOCs, SOCs due to spills/leaks	low

Inventory Updates

Inventories shall be updated annually or as new businesses are integrated into the community and reported to the DEQ every five years. The inventories shall be submitted to the DEQ in conjunction with the updating of the Town's Comprehensive Plan, which will be submitted concurrently with this document.

Table 3. Susceptibility Assessment for the Town of Twin Bridges, Montana				
Contaminant Source	**Contaminant**	**Hazard Rating**	**Barriers**	**Susceptibility**
Sewage System (<20% land usage)	nitrate, heavy metals	high	2-year plan for system improvements	high
Cropped Agricultural Land (<20% land usage)	nitrates, herbicides	low	dilution (30- to 50-year recharge); well intake depth >50 feet (>200 feet)	very low
Highways--MT Highway 287	VOC, SOC due to spills	high	dilution (30- to 50-year recharge); well intake depth >50 feet (>200 feet)	moderate
Wagon Wheel Gas Station, 310 N. Main	petroleum fuel	high	dilution (30- to 50-year recharge); well intake depth >50 feet (>200 feet)	moderate
Bo's Service Station, 101 S. Main	petroleum fuel	low	dilution (30- to 50-year recharge); well intake depth >50 feet (>200 feet)	very low
Madison County Shop, 305 3rd Ave. E.	petroleum fuel	low	dilution (30- to 50-year recharge); well intake depth >50 feet (>200 feet)	very low
Twin Bridges School Bus Barn, 201 S. Madison	petroleum fuel	low	dilution (30- to 50-year recharge); well intake depth >50 feet (>200 feet)	very low
Montana Rail Link line, along east Town line	petroleum fuel, railroad ROW	low	dilution (30- to 50-year recharge); well intake depth >50 feet (>200 feet)	very low
3 Rivers Cenex, 325 S. Main	petroleum fuel	low	dilution (30- to 50-year recharge); well intake depth >50 feet (>200 feet)	very low

Chapter 4

Management

The goal of the Source water Protection Plan is to, 1) protect the source water by keeping potentially polluting materials and activities out of the Control Region, and, 2) to manage the Inventory Region to ensure land use activities pose minimal threat to the source water.

The management approach to the Source Water Protection Plan for Twin Bridges is based upon the rural nature of the community and the relatively small population. Since there is no heavy industry, and since contamination problems are being mitigated, actions by Town personnel will be minimal. Community education and understanding of the Source Water Protection Plan is the primary goal, and can be achieved through simple distribution of literature and public notices. A regulatory approach is also warranted for the protection of the Town, but is of a minimal and very general nature. Limits to heavy industrial activities may be implemented for the specific purpose of the Source Water Protection Plan, but other planning strategies, such as zoning, may also serve as protective measures.

Control Region Management. There are no activities currently within the Control region that require oversight. The primary threats involve vehicular accidents or flooding from the Beaverhead River. Water ordinances shall be put into place that will limit the types of activities that may be undertaken proximal to the wells. The Town's Comprehensive Plan refers to this Source Water Protection Document as a guide for zoning restrictions to be implemented to ensure protection of the ground water. Ordinances will be put into place some 12 to 18 months after approval of the Comprehensive Growth Plan.

Inventory Region Management. The known contamination sources involve leaking underground storage tanks and lines that have either been removed or corrected. Potential threats still remain from the existing tanks at active filling stations, but current monitoring requirements will ensure the protection of the ground water at those sites. Ordinances will be put into place that will limit the types of activities that may be undertaken proximal to the wells. Zoning restrictions will be implemented 12 to 18 months after approval of the Comprehensive Growth Plan.

Recharge Region Management. The sources of the ground water supplying Twin Bridges may be remote enough that protective actions by the Town are not warranted. Much of the recharge zone lies within U.S. Forest Service or Bureau of Land Management boundaries. Activities apt to take place there involve mining and logging, which are regulated fairly strictly on both the state and federal levels. In addition, the recharge sources are far enough removed that time of travel considerations reduce the potential impact of those activities.

Management Implementation. The Source Water Protection Plan will likely be implemented via a set of ordinances put into place by the Town Council. The Town Council has developed its Comprehensive Growth Plan so that it specifically addresses this Source Water Protection Plan, and more specifically the Control Region Management and Inventory Region Management. The Town can zone the Control Region and Inventory Region to ensure protection of the Towns' source water upon approval of the Comprehensive Growth Plan. At the time of this writing, no ordinances are in place. Any such rules will be adopted in conjunction with the Town's Comprehensive Growth Plan, which will be submitted to the State of Montana concurrently with this document. Implementation of both Plans will probably be in place 12 to 18 months after approval by the State. The protection of the ground water will likely be tied to the development of business licenses and/or building permits.

The Town Council may also implement the distribution of information sheets at the appropriate time for the education of the general populace. These sheets should include a general description of this document and its purpose, location of the Town wells, and the adopted water ordinances that specifically address source water protection.

Documents, permits and regulations regarding the water-resource protection policies of the Town of Twin Bridges can be obtained at the Town Hall.

Chapter 5

Emergency Planning

The emergency plan identifies the principal threats to the source water, designates an emergency coordinator, and then describes a series of potential responses planned in the event a problem arises. Other important aspects of the plan include an estimate of the equipment and material that would be needed in the event of an emergency,

Identification of Possible Disruption Threats

The Madison County Emergency Operations plan will serve as the guide in the event of an emergency that might affect the integrity of the supply wells or the ground water.

If an emergency occurs, the Town of Twin Bridges will need to notify the water users. Because of the small population, it would be practical to notify all water users door to door and inform them verbally or with an information sheet. The Town should also post notices at all local businesses.

The Town of Twin Bridges has two wells that can each independently supply the Town with water. The wells are alternated in use throughout the year. The process of switching the Town=s water supply between wells is simple and can be performed by the Town operator.

The greatest threats to the water system involve accidental spills of hazardous material along the main thoroughfares, flooding from the Beaverhead River, and underground storage tank leaks. There are no manufacturing or storage facilities that represent major threats to either of the wells.

Designation of an Emergency Coordinator

The emergency coordinator for the Town Bridges is currently Douglas Denson, Fire Chief, Twin Bridges Volunteer Fire Department. The contact phone number is 911.

The emergency coordinator is familiar with the county and state DES procedures and is responsible for contacting the appropriate officials should a spill or other threat to the source water occur. The Madison County DES coordinator 24-hour phone number is 911. The State of Montana 24 hour Spill Hotline phone number is (406) 444-6911.

Equipment and Material Resource

The principal identified threats to the wells are limited to spills and flooding within the Control Region. Resources that may be needed to respond to a spill are absorbent materials and heavy equipment for berm construction and excavation. The Town of Twin Bridges has a backhoe and dump truck. This equipment can be run by the Town Water Operator. The town also has access to sand bags and soil to help in containment. Should additional resources be needed due to the magnitude or chemical nature of a spill, the Town of Twin Bridges will contract with an emergency response firm properly trained and equipped. A list of possible contractors is maintained and updated by the DEQ Enforcement Division at (406) 444-0379.

A catastrophic loss of water will require the contracted services of a water hauler, a design engineer, and a well driller.

Procedures to Shut Down the Well

The well or intake can be turned off and isolated from the water supply system. Important valves are located as shown on Appendix C. Under ideal conditions the system can operate without the supply by using water in the water storage tank for approximately 48 hours. Well or intake shut down is the responsibility of the certified operator or backup.

Coordination Procedures

The Town of Twin Bridges SWP Plan has been made available to Madison County DES coordinator. Additionally, reportable spills will be handled as per the mandated reporting requirements as follows:

Agricultural chemical or fertilizer spills will be reported to the MT Department of Agriculture (406) 444-5400
Any refined petroleum product such as gasoline, diesel, asphalt, road oil, kerosene, fuel oil, and derivatives of mineral, animal, or vegetable oil spills in excess of 25 gallons will be reported to the DES hotline (406) 444-6911.

Procedures to Communicate with Water Users

The nature of the PWS should allow the source water to be isolated from the distribution system in the event of a spill in the Control Region which threatens source water quality. If it is determined that the source water was exposed to a contaminant the well or intake will remain off line until sampling proves the water to be safe, an evaluation done in cooperation with the MT DEQ, PWS Section.

If an emergency occurs, the Town of Twin Bridges will need to notify the water users. Because of the small population, it would be practical to notify all water users door-to-door, and inform them verbally or with an information sheet. The Town should also post notices at all local businesses.

Source of Emergency Water

The Town of Twin Bridges has two wells that can each independently supply the Town with water. The wells are alternately in use throughout the year. The process of switching the Town=s water supply between wells is simple, and can be performed by the system operator.

If the well is out of service for more than 48 hours, an emergency supply of water may need to be arranged. The short-term plan is to haul water using a DEQ approved water hauler from a DEQ approved water source. Should this be necessary, a hauler will be contracted and a short-term plan relating to the source water and disinfection requirements will be submitted to DEQ-PWS Section for approval.

Should a total loss of water occur, the services of a design engineer and well driller will be retained to assess the options. Plans and specifications for any new well will require DEQ-PWS Section review and approval prior to construction.

Disinfection and Resumption of Water Service

The well, storage tank, or distribution system can be disinfected for bacteriological contamination as per the Town of Twin Bridges water system standard disinfection and tank cleaning procedures under the direction of the certified operator. Normal water service resumption will occur after sample results indicate the supply is safe as approved by DEQ-PWS Section and the certified operator.

Important Emergency Contacts and Phone Numbers

Table 4.
Contacts for the Public Water-Supply system for Twin Bridges, Montana.

Contact Name	Title	Phone	Responsibility
Sam Novich	Public Works Director	684-5243	
Betty Sykes	Mayor, Twin Bridges	684-5243	
Twin Bridges Fire Department	Fire Chief	911	
"Montana 24 hr. Spill Hotline"		(406) 841-3911	All reportable spills.
Greg Murfitt	MT Dept of Agriculture	(406) 444-5400	All agricultural chemical or fertilizer spills or response questions.
DEQ Enforcement Division		(406) 444-0379	Responds to any event which will pollute surface or ground waters.

Chapter 6

Alternate Water Sources

Twin Bridges' existing water supply is obtained entirely from groundwater via two wells. The locations of the two wells, referred to as Well #1 and Well #2, are noted on the figures in Appendices A , B1, B2, and B3. Reported capacities of the wells, based on pump curves provided by Floway, are summarized in Table 7 of the system water analysis performed by Damschen & Associates, Inc. (1995).

Table 5 summarizes pertinent data for each of the two wells. Additional information regarding the wells (well logs, water rights, etc.) are included in Appendix D. It should be noted that water right information for the Town is not clear at this point. The water right has been granted by the DNRC for Well #1. However the water right for Well #2 is not final pending adjudication of the basin in future years.

Table 5.
Summary of Existing Wells, Twin Bridges, Montana Public Water Supply

	Depth	Test Pumped Flow[(1)]	Current Pumping Capacity[(2)]
Well #1	193 Feet	1000 gpm	940 gpm
Well #2	240 Feet	1070 gpm	950 gpm
Total		**2070 gpm**	**1890 gpm**

1) Information obtained from original well logs.
2) Based on flow information provided by Floway Pumps.

The water supplies are untreated except for occasional sterilization following repairs or bad sample results. At the present time, federal regulations do not require treatment of groundwater supplies although disinfection rules are expected to be implemented sometime after the year 2000.

Evaluation of Existing Water Supply

Supply Requirements . WQB 1, formerly the Recommended Standards for Water Works (also known as Ten States Standards) has been adopted by the Montana Water Quality Bureau as its standard for Community Water Systems. WQB 1 requires that a minimum of two groundwater sources be provided for each community so that a backup is available in the event one or more sources must be taken out of service. Twin Bridges currently meets this standard with its two wells.

Table 6. Town of Twin Bridges Pertinent Well Data		
Data	**Well #1**	**Well #2**
1. Location	East Sixth Ave btwn Main St. & Madison St.	West Sixth Ave. & Bridge St.
2. Completion Date	August 1963	October 1979
3. Surface Casing	12-inch grouted to 85 feet	24-inch grouted to 84 feet
4. Casing Diameter	12-inch	12-inch
5. Slotted Screen	162-166; 168-170 188-193	130-140; 229-239
6. Total Depth	193 feet	240 feet
7. Test Pump	1000 gpm w/71 feet of drawdown	1070 gpm w/67 feet of drawdown
8. Water Right	1000 gpm up to 1617 AC-FT/YR	1000 gpm up to 1622 AC-FT/YR
9. Pump Characteristics		
a. Manufacturer	Floway	Floway
b. Type	Vertical Turbine	Vertical Turbine
c. Serial #	63-4792	75-6862
d. Stages	7	7
e. Rated Capacity	940 gpm @ 180 tdh	950 gpm @ 170 tdh
f. Brake Horsepower	56	56
g. Efficiency	78	77
h. Motor	US Electric Motors, Hollow-shaft, 60 hp, 1800 rpm, 60 cycle 3 phase, 440 V	US Electric Motors, Hollow-shaft, 60 hp, 1770 rpm, 60 cycle 3 phase, 230/460 V

WQB 1 further requires that "the total developed groundwater source capacity shall be equal to or exceed the design maximum day demand and equal or exceed the design average day demand with the largest providing well out of service". Therefore, the system should be supplied with a flow of approximately 169 gpm for the present population of 407 or 250 gpm for a future projected population of 600 to meet peak daily demands. As shown by Table 5, this requirement is attained. To meet the requirements of average daily demands without the largest pump in service, Well #1 must provide 93 gpm for the present population and 138 gpm for the 2015 population. The total production of Well #1 is 1000 gpm as indicated in Table 6. Therefore it appears that the current supply system easily meets the requirements of WQB 1 for the present flows and the projected 2015 flows.

A standard rule of thumb with a groundwater supply system is that no well should operate more than twelve hours per day to satisfy peak water demands. Should both wells run for twelve hours straight, 1,360,800 gallons (12 hours x 60 minutes x 1890 gpm) could be supplied. This easily exceeds the 360,000 gallons required for the projected peak daily demand. Thus the aquifer should not be stressed and the pump lives should be maximized.

Peak hourly flows can be expected to last no more than two to four hours. These peaks typically occur during midmorning and/or late afternoon when people are at home and irrigation is heaviest. The wells can meet the demands of the peak hourly flow of 500 gpm. If for some reason the well(s) cannot meet peak hourly demands, this should not be a problem since the storage tank is available to provide transition through the peak demand periods by supplementing the wells.

In summary, according to the reported volumes of the wells, it appears that the existing two wells are more than sufficient to supply the Town with the required domestic flows as long as the population remains within the projections through 2015 and no significant growth is experienced within the study area.

References

Burger, H. Robert, III, 1967, Bedrock geology of the Sheridan District, Madison County, Montana: Montana Bureau of Mines and Geology Memoir 41, Butte, Montana, 22 pages, 2 plates.

Damschen & Associates, Inc., 1995a, Water system analysis for the Town of Twin Bridges, Montana: unpublished evaluation submitted to the Town of Twin Bridges, Montana, May, 1995.

Damschen & Associates, Inc., 1995b, Sampling and analysis plan for the Twin Bridges landfill, Madison County, Montana: unpublished document submitted to the Montana Department of Environmental Quality Permitting and Compliance Division, 20 pages, 1 plate.

Fetter, C.W., 1988, Applied Hydrogeology: Merrill Publishing Company, Columbus, Ohio, 592 pages.

Klepper, M.R., 1950, Geologic reconnaissance of parts of Beaverhead and Madison Counties, Montana: U.S. Geological Survey Bulletin 969-C, U.S. Government Printing Office, pages 55-85, 1 plate.

Appendix A.
Vicinity Map

Appendix B.
Water-Supply Distribution, Wastewater Collection System and Known Ground-Water Contaminants Base Maps

Appendix C.
Public Water Supply Site Map (Zoning, SWP Zones)

Appendix D.
Well Logs

Appendix E.
Aquifer Recharge Region Map

Appendix F.
Three-Year Time-of-Travel Capture Zone for a Pumping Well, Determined on the Basis of Estimated Hydraulic Properties

Appendix G.
Inventory Sheets

Appendix H.
Organic Chemical Monitoring Waiver