

**SOURCE WATER ASSESSMENT
FOR
Bighorn Mountain KOA**

June 30, 2004

PROJECT: 424-001

ASSESSMENT COMPLETED BY: TRIHYDRO CORPORATION

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Introduction

People who live in or visit the state of Wyoming enjoy pristine natural resources. One of the most important of these resources is drinking water. In 1973, the Wyoming legislature passed the Environmental Quality Act and directed the Wyoming Department of Environmental Quality (DEQ) to both preserve the surface and groundwater resources of the state, and to prevent, reduce, and eliminate water pollution.

In 1996, the United States Congress passed the Safe Drinking Water Act Amendments that required all states having the responsibility for administering the federal rules and regulations of this Act, or “primacy”, to develop a Source Water Assessment and Protection (SWAP) Program. Although Wyoming is the only state that does not have primacy, DEQ recognized the value and benefit of SWAP to help protect public water systems (PWSs). During the 1998 legislative session, the Wyoming Legislature authorized DEQ to set aside 10%, or \$1.2 million, of the 1997 federal Drinking Water State Revolving Fund monies to develop a SWAP program and to complete Source Water Assessments.

The SWAP Program is a two-part program consisting of source water assessments and source water protection plans. The completion of a source water assessment involves determining a source water area for each PWS, assessing the sources of contamination within this source water area that have the potential to affect the drinking water supply, evaluating the susceptibility of the water supply to contamination by each of these potential sources of contamination, and finally, writing an assessment report that contains a summary of all the information gathered during the assessment. Due to Wyoming’s unique primacy status, the completion of source water assessments for all PWSs is voluntary. The DEQ has completed a source water assessment for each PWS that has requested one. Local governments, PWSs, and citizens can then use these assessment reports to develop a source water protection plan that outlines the measures that the community or PWS believes are appropriate to protect their drinking water supply. These measures may include management plans, clean up efforts, public education, or zoning changes.

DEQ Coordination

DEQ contracted and worked closely with the Trihydro Corporation (Trihydro) and Lidstone and Associates, Inc. (Lidstone) to complete the source water assessments. Trihydro and Lidstone were selected because of their geologic experience, Geographic Information System (GIS) expertise, and their knowledge of many PWSs in Wyoming. PWS delineations were completed by the firm most familiar with the geology/hydrology of the area.

The Wyoming Association of Rural Water Systems (WARWS) also provided a great deal of assistance. WARWS published newsletters, helped sign up PWSs for assessments, and helped operators understand and review draft assessments. They also provided valuable input throughout the development and implementation of the SWAP program.

Source Water Area Delineation

The first step in completing the Source Water Assessment was to delineate, or determine, the source water area, or the area that contributes water to the well or intake. In order to protect public water supplies, community leaders, planners, and PWS operators must have information regarding the land area that contributes water to the PWS's wells or intakes. Potential sources of contamination located upstream or upgradient from a water source could reach and possibly impact the water system and its customers. Trihydro and Lidstone delineated three contaminant inventory zones within each source water area for the purpose of inventorying possible sources of contaminants that could affect drinking water quality. The following listing of the three zones provides additional information on their intent:

- **Zone 1** is called the "Accident Prevention" or "Sanitary Protection Zone" and is located within a 100 foot radius of the well or intake. The potential for contaminants released within this zone to affect the quality of PWS water is highest.
- **Zone 2** lies immediately beyond Zone 1 and is called the "Attenuation Zone." Contaminants released within this zone are within close proximity of the well or intake and the chances of their reaching the well or intake is still high. Zone 2 for surface water systems included an area 1000 feet on either side of the perennial streams that extended upstream of the intake for a distance of 15 miles, or the distance from the intake to the headwaters of the drainage contributing water to that intake. Zone 2 for groundwater systems represented a 2-yr time of travel (TOT) that was determined using the best, and most conservative hydrogeologic data available.
- **Zone 3** is the area farthest from the well or intake. Contaminant sources within this zone are less likely to reach the well or intake in quantities that could affect water quality. Zone 3 for surface water sources includes the entire stream drainage basin from Zone 2 to the basin headwaters. Zone 3 for groundwater sources extends from the edge of Zone 2 and represented the estimated 5-yr TOT.

Trihydro and Lidstone used readily available information to determine the locations of each well, spring, infiltration gallery, or surface water intake. No fieldwork or site visits to individual PWSs were conducted to verify the accuracy of the location data. The location of each water source was initially obtained from DEQ or United States Environmental Protection Agency (EPA) databases. Information received from the respective PWS operators on their well information sheets, photographs of individual water sources, the Wyoming State Engineers (SEO) well information database, Wyoming Water Development Commission reports, and Trihydro/Lidstone company experience were also used to locate each water source as accurately as possible.

To determine the source water area(s) for each well or surface water intake, Trihydro and Lidstone reviewed a variety of geologic, hydrologic, and hydrogeologic sources, and incorporated that data into a Geographical Information System (GIS). For PWSs utilizing surface water sources, Hydrologic Unit Codes (HUC) and 7.5-minute U.S. Geological Survey (USGS) topographic maps were used to identify the basin perimeters that contribute water to the surface

water intake. For those systems utilizing groundwater sources, Trihydro and Lidstone reviewed information from the following sources to develop source water areas: the EPA's sanitary surveys, the EPA's early 1980s reports on the occurrence and characteristics of groundwater in each basin of the state, the Wyoming State Engineer's Office (SEO) water rights database, University of Wyoming Master's theses, USGS geologic and hydrogeologic reports, Driscoll's Groundwater and Wells book, Wyoming Water Development Commission reports, Wyoming Water Research Institute reports, and previous delineations completed by other consultants, the Wyoming Geologic Survey and WARWS.

The methods and techniques that were used to delineate the contaminant inventory zones within each source water area were consistent for all surface water systems. However, for groundwater systems, professional geologists for Trihydro and Lidstone considered aquifer type (confined, unconfined, alluvial, etc.), flow system type (porous, or conduit), and PWS type to determine which delineation method was appropriate for each well, as shown on **Figure 1**. For groundwater sources, Trihydro and Lidstone geologists used the most appropriate conservative methodology, which closely followed the EPA-approved Wyoming Wellhead Protection Program Guidance Document.

Contaminant Inventory

An inventory of contaminant sources that lie within the source water areas and have the potential to adversely impact the quality of the water supply was conducted within each contaminant inventory zone. Knowledge of potential contaminants may encourage communities to implement and manage a source water protection area, and enable a PWS to plan for necessary improvements in treatment capabilities, develop emergency response plans, or allow time to remediate the source of contamination. The principal contaminants of concern include those regulated under the Safe Drinking Water Act in addition to microorganisms such as *Cryptosporidium*, and exposure to nitrates.

Contaminant inventories for Potential Sources of Contamination (PSOCs) used information obtained from EPA, DEQ Water Quality Division, DEQ Solid and Hazardous Waste Division, DEQ Land Quality Division, DEQ Abandoned Mine Lands, Wyoming Oil and Gas Conservation Commission, the Wyoming State Geological Survey, the U.S. Department of Transportation, and the Wyoming Department of Agriculture Technical Services databases. Examples of regulated activities or facilities include wastewater treatment plants; confined animal feeding operations; underground injection wells; chemical or hazardous waste use, production, or storage sites; and landfills. These permitted contamination sources produce materials that are regulated by state or federal laws. These databases are also tabulated according to contaminant type in the susceptibility section. Information from citizens and PWS operators played a vital role in verifying land uses and locations of regulated PSOCs.

There are two basic types of contaminant sources, point and non-point, that were evaluated based on their proximity to the water source. Point sources are usually associated with a single location, like an underground storage tank, underground injection well, oil and gas well, coal bed

methane (CBM) well, a solid/hazardous waste facility or a National Pollutant Discharge Elimination System (NPDES) outfall. Point sources are usually regulated and are required to have permits.

In contrast, non-point source pollution results from land use patterns and transportation corridors. Urban land use was considered of greatest concern followed by irrigated agriculture, non-irrigated agriculture, and then forested areas. Forested areas were included to evaluate the potential risks of increased runoff and water quality problems following forest fires. Transportation corridors, including pipelines, railroads, and highways, are a high concern because of the nature of the materials being transported. All remaining land uses were considered low risk.

To evaluate the potential impact of these contaminants, an extensive inventory was conducted in Zones 1, 2, and 3 for both surface and groundwater sources. As part of the inventory, the assistance of local representatives and PWS operators was requested to verify the locations of regulated and non-regulated potential sources, land use boundaries, and to identify any historical sources of contamination.

The Susceptibility Analysis Process

The final step in developing the source water assessment for each PWS was to analyze the susceptibility of each water source with respect to the identified PSOCs. DEQ defines the susceptibility of a PWS as the potential for each well or surface water intake to draw water that has been contaminated by pollutants at concentrations that would pose concern. Susceptibility must be determined for each water supply well or intake used by the PWS. Contaminants may reach the intake or well by infiltration through geologic strata and overlying soil, direct discharge into surface or groundwater, overland flow, or contamination of upgradient groundwater. Contaminants may also enter the water source at the well, intake, or the conveyance. A conveyance is defined as the pipe, canal, or aqueduct between the well or intake and the first form of treatment, or where the water enters the distribution system if there is no treatment.

Water system susceptibility is related to three factors that were evaluated as part of this source water assessment. The first was the physical integrity of the well, intake, and conveyances. The second factor was the sensitivity of the land area through which potential contaminants may reach the well or intake. This included the geologic, hydrologic, and land cover characteristics of the watershed, well location, or aquifer source area. The third factor was the nature of the potential contaminants. Potential contaminants include specific point sources and any land uses that may contribute contaminants to the water supply. For point sources, the type of potential contaminants, the location of the contaminant sources relative to the well or intake, and confirmation of a contaminant release were also considered.

Data that were used to quantitatively evaluate the susceptibility of each water source to potential contaminants were acquired from sources of data readily available for all PWS in the state. The susceptibility of each PWS is based on delineated source water areas, DEQ contaminant

inventories, 1:500,000 scale land use maps compiled by the University of Wyoming, EPA sanitary surveys, EPA's Safe Drinking Water Information System database, and DEQ and Wyoming SEO well or intake permits.

Step 1: Well or Intake Integrity Score

The first step in the susceptibility analysis was to determine the integrity score for each well or intake. The well or intake was assigned a score after being evaluated for a series of factors. The factors and the points associated with them are described below. Each well or intake received a score between 1 and 13. If sanitary surveys, permits, or completion records were not available or did not contain the appropriate information, a maximum score was assigned for that particular factor as a default. Scores for each PWS water source are listed in the Well or Intake Integrity tables located at the back of this document.

If the well or intake was constructed prior to 1983, it was assigned 3 points, between 1983 and 1993, 2 points, and 1 point if constructed after 1993. The points assigned to completion dates reflect DEQ's confidence in the standards applied to the design, construction, and completion of wells and intakes at the time of construction. Conveyance structures were scored based on the length, the risk of damage, and the degree to which the transported water is exposed to contaminants. Short conveyances, less than 1 mile, received a score of 0 points, while conveyances greater than 1 mile received 1 point. Open conveyances and conveyances at risk to structural damage received 1 point.

Well integrity was also evaluated on the basis of four additional factors. The first and most critical of these was the presence of a surface seal that is in good condition. DEQ believes that the surface seal is a good indicator of the overall well condition. Wells that had a surface seal were assigned a score of 0 points and wells that did not have a surface seal were assigned a score of 5 points. The second factor was the presence of a good annular seal. However, this information is less easily obtained, so an assumption about the annular seal was made based on the presence of a surface seal. If a well had an annular seal it was assigned a score of 0 points, wells without an annular seal received 1 point. The third factor was the protection of the vicinity immediately around the wellhead from contaminant sources. This is usually accomplished by enclosing the wellhead in a well or pump house, or a fenced off area. If the wellhead was protected, the well received 0 points, but unprotected wells were assigned 1 point. The fourth factor is the protection of the wellhead from flooding. For instance, the ground around the wellhead should be sloped away from well to encourage water and any water-borne contaminants to move away from rather than towards the well. Wells that were considered protected from flooding were assigned 0 points, wells not protected were assigned 1 point.

The integrity of surface water systems was also evaluated based on three additional criteria. The first of these was the presence of a screen. A screen, or series of screens, will prevent debris from interfering with the water treatment process. The presence of a screen yielded 0 points, while intakes without a screen scored 3 points. Secondly, screens must be inspected and cleared of debris regularly to remain effective. Intakes that were not inspected regularly scored 2 points. Finally, access to the area immediately surrounding the screen location should be restricted. If the area around the intake was not protected, the intake scored an additional 2 points.

Step 2: Water Source Sensitivity

The second step in the susceptibility analysis was to determine the well or intake sensitivity score on the basis of aquifer or watershed conditions and the confirmed detection of chemical contaminants in raw or treated water. Wells were assigned a score between one and ten. Intakes were assigned a score of five or ten. Scores for each PWS water source are listed in the attached Water Source Sensitivity scoring tables located in the back of this document.

The inherent sensitivity of the aquifer or watershed was combined with indicators of contamination observed within the last five years. If no information was available, the maximum score was assigned as a default for that particular scoring criterion. Documented chemical detections at a well or intake within the last 5 years scored an additional 5 points. A chemical detection indicates that a pathway exists for contaminants to enter the system.

DEQ assumed that all surface water systems were highly sensitive to contamination (default score of 5 points) due to the fact that streams, rivers, and open conveyances directly and rapidly convey released contaminants. A maximum total of 10 points was possible for surface water intakes.

For groundwater systems, Trihydro and Lidstone determined the sensitivity of each groundwater source based on the type of aquifer in which the wells were completed. Porous flow confined aquifers were considered to be the least vulnerable type. Shallow alluvial, fractured, karst, and some unconfined aquifers are more vulnerable to contamination from surface contaminant sources. To evaluate the sensitivity of unconfined aquifers throughout the state, Trihydro and Lidstone used a statewide map of uppermost aquifer sensitivity that was developed using depth to water, recharge and overlying soil characteristics, land slope, vadose zone characteristics, and other hydrogeologic characteristics. Aquifer sensitivity, based on the map, ranged from 1-5 points. Wells that were completed in fractured rock or limestone aquifers received a score of 5 points. Shallow wells completed in alluvium (less than 65 feet deep), could be under the influence of surface water, and received a score of 5 points. Confined aquifers under normal porous flow conditions received a score of 1 point. Groundwater source sensitivity scores ranged from 1 to 10 points.

Step 3: Well or Intake Rating

A well or intake rating was developed from the integrity and sensitivity scores. A water source sensitivity score was determined by adding the well or intake integrity score to the water source sensitivity score. A well or intake rating of low, medium, or high was assigned based on the total number of points scored; low (2-8 points), medium (9-15 points), high (16-23 points). The rating for each well or intake was then combined with the contaminant ratings to determine the final susceptibility for each respective well or intake.

Step 4: Contaminant Ratings

The fourth step in the susceptibility analysis was to rate potential sources of contamination that were located within the contaminant inventory zones delineated for each well or intake. Three categories of contaminants were developed for this rating process: regulated point sources, non-point sources including land uses, and transportation corridor sources.

Point sources were evaluated using the following three critical pieces of information: the contaminant type; the location of the potential source of contamination in relation to the well or intake; and the contaminant release status. For the purposes of the susceptibility analysis, contaminants have been grouped into the following two types on the basis of their DEQ facility or contaminant codes: 'Serious Contaminants' and 'Other Contaminants.' Microorganisms, nitrates/nitrites and carcinogens are considered 'Serious Contaminants,' while 'Other Contaminants' includes the remainder of the contaminants listed in the federal drinking water standards. Point sources identified in the contaminant inventory will have one or both types of potential contaminants. The most serious contaminant type present was assigned a contaminant rating. This process was completed for each point source identified in the contaminant source inventory.

The point source contaminants were also rated on the location of the potential source of contamination in relation to the well or intake (Zone 1, 2, or 3). The last factor in determining a contaminant rating is the contaminant release status. This factor is an indication of whether a potential source of contamination has released contaminants into the environment. Documented releases are typically found with potential sources of contamination like facilities with permitted discharges, groundwater pollution control sites, and leaking storage tanks.

All Serious or Other contaminants that were identified within Zone 1 and Zone 2, regardless of whether a documented release of those contaminants had occurred, were considered a high risk to the well or intake. A known release of a contaminant identified in Zone 3 was considered a medium risk to the well or intake. Contaminants identified in Zone 3 that were classified as a no known release, were considered a low risk to the well or intake.

All point source PSOCs are shown on the source water area delineation map(s). The General Point Source Contaminant Rating Matrix located in the general tables section at the back of this document, shows how the point source PSOCs were rated. The point source PSOCs that are located within the contaminant inventory zones are tabulated in the Point Source Susceptibility Table along with these final contaminant ratings, also located at the back of this document. For further details on any of these sources of contamination, contact the appropriate agency listed in Appendix A

Non-point sources of contamination were evaluated on the basis of the percentage of land use in the source water area for various activities. The General Land Use Rating Matrix is located in the general tables section of this document. For groundwater systems with modeled, calculated fixed radius (CFR) delineations, and delineations that were hydrogeologically mapped, the percentage of land use in Zones 1, 2, and 3 was evaluated. For all other delineations, including surface water watersheds, groundwater under the influence of surface water, and area-wide aquifer delineations, only Zones 1 and 2 were evaluated. The percent land use, the land use

contaminant rating, and the land use susceptibility ratings for each well/intake are also shown in the Land Use Susceptibility Table, located at the back of this document..

The transportation corridor contaminant ratings were determined by counting the number of each transportation corridor contaminant type within each contaminant inventory zone. The General Transportation Corridor Contaminant Rating Matrix shows how the transportation corridor contaminants were rated and is located in the general tables section. The transportation corridor contaminant rating and the transportation corridor contaminant susceptibility ratings are shown in the Transportation Corridor Susceptibility Table located at the back of this document.

Susceptibility Rating Implications

The susceptibility ratings developed during this assessment project are intended to show the PWS areas where contaminants have the greatest potential to impact their water supply.

High susceptibility ratings should be used to assist the PWS in future planning efforts. A source water protection plan is recommended regardless of a PWS's susceptibility ratings. Please contact WARWS at 307-436-8636 or Kim Parker, DEQ, at 307-777-7781 for additional guidance. There are also consulting firms like Trihydro and Lidstone that are available to help you complete your source water protection plans.

In many cases, high susceptibility ratings were caused by lack of data. As mentioned in the scoring process, whenever well or intake data were unknown, the highest score possible was assigned. One way to reduce the susceptibility would be to replace the unknown conditions with the known conditions associated with the particular well or intake in question. Restricting access to wells and intakes, ensuring well or intake physical integrity, enclosing wells and intakes, and enclosing and protecting conveyances are also ways to reduce your systems well or intake rating and reduce susceptibility to potential sources of contamination. Another way to reduce susceptibility would be to remove or mitigate existing PSOCs and prevent new sources from locating within your source water area.

It is possible that regulated point sources appear within your source water area when they should not or appear in the wrong location. It is very important to have regulated point sources located correctly. Regulated point sources in close proximity to your water source greatly affect your susceptibility ratings. Likewise, please keep in mind that your source water area map may be missing regulated point sources that should appear. Your system is potentially susceptible to these sources and they should be included in any future assessments and protection plans. Please contact Kim Parker, DEQ, at 307-777-7781 for assistance in alerting the appropriate regulatory programs if any errors in point sources are discovered.

Lastly, non-regulated or historical potential sources of contamination should not be overlooked when doing assessment updates and protection plans. For example, septic systems and dry cleaners are not regulated and therefore were not included in this assessment, but can have substantial impacts on water quality. Thorough local contaminant inventories that include such

historical and non-regulated potential contaminant sources should be conducted in conjunction with regulatory database inventories.

Water sources with high percentages of forested land in their watershed can experience significant water quality impacts if a larger portion of the landscape is burned. Surface water systems can expect high sediment loads and elevated levels of nitrates, phosphorus, heavy metals, organic carbon, and other chemicals. Forest fires can also cause water to have a smokey flavor.

All surface water systems, groundwater under the influence of surface water, and groundwater systems that rely on alluvial aquifers are vulnerable to drought conditions. PWSs should develop contingency plans that include water storage, water rationing, etc. that are adequate to sustain the PWS through drought cycles.

Technical Assistance

Management of the source water protection area involves knowledge of the resources available for protection efforts. Local planning teams, WARWS, and consultants such as Trihydro and Lidstone can assist with identifying the methods and means available to the community to achieve the desired land use changes necessary to protect the drinking water source. The process of developing management strategies for regional aquifer watershed protection areas may require the collaboration of all municipalities, counties, and land management agencies affected by the protection area.

In addition, DEQ may be able to support protection plan activities by providing financial and technical assistance to PWSs. For instance, low-interest loans may be available through the State Revolving Fund program. These monies may be used for the acquisition of land critical to source water protection, the remediation of contaminant sources, or other protection plan development or implementation activities. For additional information on potential funding opportunities, contact Brian Mark of the DEQ at (307) 777-6371. Local planning teams may also request technical assistance from DEQ while developing protection plans. DEQ will provide assistance to local planning committees to the extent possible given personnel and budgetary constraints. For technical assistance, contact Kim Parker of the DEQ at (307) 777-7781.

DEQ is currently working with EPA to develop a waiver program for volatile and synthetic organic chemicals. The EPA will likely require the PWS to have a completed source water assessment in order to apply for this type of waiver. The EPA may also require the development of a protection plan to be eligible for these waivers. A developed protection plan may also aid the PWS by reducing costs associated with upcoming proposed regulations such as the Groundwater Rule.

Source Water Protection Plans

This Source Water Assessment is the necessary first step toward developing a Source Water Protection Plan. This assessment provides the technical basis for future protection measures. DEQ considers the protection of drinking water resources and the development of source water protection plans to be the long-term goal of the program.

In addition to the information provided in this assessment, DEQ requires three other components in a protection plan. A contingency plan, a section discussing management strategies for all potential sources of contamination inventoried within the source water area, and some method to update the protection plan on a regular basis are required components of a protection plan.

Contingency plans describe how a PWS would handle a contamination event or the loss or interruption of a water supply. Examples of components that local planning teams can include in a contingency plan are: options for replacing a water source; customer notification plans; emergency response plans; water storage plans; and measures to promote water conservation, if necessary.

The process of developing effective management strategies is the most important aspect of preventing drinking water contamination. Management strategies can also be the most difficult and time-consuming step when developing a source water protection plan. Each PWS must balance the responsibility of protecting the water supply with past, current and future land uses to determine what management strategies are appropriate and can be supported by the community.

DEQ also requires the regular review and update of the source water protection plans. Regular reviews will help the local planning team constructively deal with new trends, issues, and activities within the community.

This assessment is not the end product. Please use the information in this assessment as a tool to develop a protection plan for your PWS. Once a drinking water supply becomes contaminated, a community or PWS is faced with the difficult and costly task of upgrading treatment facilities or locating an alternative drinking water source. DEQ believes that preventing contamination is the key to keeping Wyoming's drinking water supplies safe.

SOURCE WATER ASSESSMENT SUMMARY FOR Bighorn Mountain KOA

PWS Source Water Assessment Summary

The Bighorn Mountain KOA is a non-community groundwater system located in Sheridan County. The system serves 150 people through 80 service connections from May 1st to October 31st. The system is supplied by three wells that draw water from the Fort Union formation. The facility also includes pump houses that filter and disinfect the water, five treated water storage tanks and the interconnecting transmission system. The water sources scored medium with respect to the combined integrity and aquifer sensitivity ratings. The Bighorn Mountain KOA scored high with regards to land use susceptibility, point source susceptibility and transportation corridor susceptibility.

Delineation Methods

This water system is a non-community system that draws water from a porous sedimentary formation. Calculated fixed radius methods were implemented to estimate the 2-year and 5-year time of travel radii for the groundwater flow system. The CFR used well information from the sanitary survey and aquifer parameters were similar to those reported by the Water Resources Research Institute Study of groundwater in the Powder River Basin.

Calculated fixed radius (CFR) is an appropriate method to use when groundwater flow to the well, spring or tunnel can be characterized as porous. This process was implemented for small communities that derive water from deeper, confined aquifers, or for non-community water systems. A factor of safety (FS) of 1.5 was applied to all systems where portions of the data were suspect. At the ground surface, the radius can be used to delineate an area around the well to be used for wellhead protection. The radius is the distance from the well to a point where groundwater (and contaminant) can reach the well over a specified time period. Input data requirements are limited, consisting of the pumping rate, open (screened interval) of the well, porosity of the aquifer, and the selected time of travel (2 years and 5 years).

Groundwater Sources

The Bighorn Mountain KOA draws water from the Fort Union Formation. Recharge to these wells occurs in the outcrops of the Fort Union Formation, near the wells, and general flow to the wells is under artesian conditions from southwest to northeast. Additional information on these wells is included on the attached Well Information Sheets. As shown on the enclosed source water area delineation map, contaminant inventory zones 2 and 3 were delineated using CFR methods. Zone 2 has a calculated radius of 572 feet for BMKOA #1 and 673 feet for wells #2 and #3. Zone 3 has a calculated radius of 904 feet for BMKOA #1 and 1,064 feet for wells #2 and #3.

Integrity Summary

Bighorn Mountain KOA uses three wells, two of which are approximately 165 feet deep and one that is approximately 380 feet deep. The #2 and #3 wells were constructed prior to 1983 when less stringent construction standards were required by the State of Wyoming. The BMKOA #1 well was constructed between 1983 and 1993 when moderately strict construction standards were required by the State of Wyoming. Records show that all three wells were properly sealed to protect against surface infiltration of potential contaminants and flooding around the wellhead. However, records indicate that the wells lack adequate protection in the immediate vicinity around the wellhead from contaminant sources. Well #3 also is lacking an annular seal and all three wells are at risk of conveyance structure damage due to previous interruptions in their use. Therefore, as shown on the Integrity Summary Table, the BMKOA #1 well received a score of 4, the wells #2 and #3 both received a score 6.

Water Source Sensitivity Summary

As shown on the Source Sensitivity Summary Table, the wells received a sensitivity score of 6. The wells received a score of 1 for aquifer sensitivity because they draw water from a confined aquifer through porous media flow. The wells received the score of 5 for chemical sensitivity due to documented chemical detections in the groundwater.

Water System Susceptibility Rating

Susceptibility is defined as the potential for a public water supply to draw contaminated water at concentrations that would pose a threat or concern to human health. In general, the Big Horn Mountain KOA scores high for land use susceptibility because much of the land surrounding the water sources is irrigated cropland. The overall point source contaminant susceptibility rating is high due to a wastewater discharge site within Zone 1 of the water sources. The water sources were assigned a high transportation corridor susceptibility score because their source water zones are in proximity to I-90. Susceptibility ratings for each type of potential contaminant source are summarized on the attached susceptibility tables.

A review of your PWS's routine water analysis results revealed that one or more chemicals that are considered contaminants in drinking water were detected at some time within the last five years. Chemical detections have a large impact on your PWS's sensitivity score because it may indicate that there is a pathway for contaminants to reach the water supply. However, it is likely that these chemicals are present only in small amounts and are not a danger to your health. Some of these chemicals may also occur naturally in water.

For more information about which chemicals were detected, please contact the PWS for a copy of the most recent Consumer Confidence Report or water analysis results. Chemical detections at levels that are a concern to human health are reported on the EPA's website: http://www.epa.gov/enviro/html/sdwis/sdwis_query.html. To see if your PWS has exceeded the federal primary or secondary drinking water standards, just click on the State of Wyoming and then type in the name of your PWS. Consumer Confidence Reports are prepared by the PWS on a yearly basis. The reports should include information about any chemicals found in the water, even those found at very low levels. Please contact Kim Parker at DEQ, 307-777-7781, or

WARWS for assistance. You may also contact EPA to find out what contaminants were detected. You may have to fill out a Freedom of Information Act request to obtain the water test results for your PWS. Please call EPA's Safe Drinking Water Hotline at 1-800-426-4791.

The table below illustrates the decision rules used to categorize each system's Integrity and Susceptibility scores described in Step 3.

Well or Intake Rating Scoring			
	Low	Medium	High
Combined Integrity and Sensitivity Scores	2 - 8	9 - 15	16 - 23

The decision matrix below illustrates how each land use type receives a contaminant rating based on the percentage of land usage that corresponds to each contaminant inventory zone.

		Land Use Contaminant Rating		
		Low	Medium	High
% Land Use	Urban	<5%	5-10%	>10%
	Irrigated Cropland	<20%	20-40%	>40%
	Non-Irrigated Cropland	<40%	40-80%	>80%
	Forested Land	<20%	20-40%	>40%

The point source contaminant susceptibility rating is determined for each well or intake using the decision matrix below. The well/intake rating is compared with the point source contaminant rating for each contaminant inventory zone to produce each susceptibility rating.

General Point Source - Contaminant Matrix						
	Zone 1		Zone 2		Zone 3	
	Known Release	No Known Release	Known Release	No Known Release	Known Release	No Known Release
Serious Contaminants Microorganisms, nitrates/ nitrites, carcinogens	High	High	High	High	Medium	Low
Other Contaminants Remaining primary and secondary drinking water contaminants	High	High	High	Medium	Medium	Low

The transportation corridor susceptibility rating is determined for each well or intake using the decision matrix below. The well/intake rating is compared to the transportation corridor contaminant rating for each contaminant inventory zone to produce the final susceptibility ratings. The ratings for each zone were determined regardless of the length that each pipeline, railroad line, or highway intersected each contaminant inventory zone.

General Transportation Corridor - Contaminant Rating Matrix

		Contaminant Inventory Zone		
		Zone 1	Zone 2	Zone 3
Transportation Corridor	Pipeline	High	High	Low
	Railroads	High	High	Low
	State Highways	High	High	Low
	Interstate Highways	High	High	Low

A final susceptibility rating was determined for each type of contaminant by comparing the contaminant rating with the well or intake rating, using the decision matrix below. A final susceptibility rating was determined for each type of potential contaminant, land use, point source, and non-point source.

General Susceptibility Rating Matrix

		Contaminant Rating Matrix		
		High	Medium	Low
Well or Intake Integrity Rating	High	High	High	Medium
	Medium	High	Medium	Low
	Low	Medium	Low	Low

PWS-Specific Tables

The following tables, specific to each well or intake, summarize your system's susceptibility using the scoring matrices described above. A specific PSOC susceptibility table may be missing because that type of PSOC was not found within your source water delineation area.

Bighorn Mountain KOA Water Sources

Water Source Type*	PWS Well ID	Source Name
GW	5600242-101	BMKOA #1
GW	5600242-102	WELL #2
GW	5600242-103	WELL #3

- * GW - Groundwater
- * SW - Surface Water
- * GU - Groundwater under the influence of surface water

Well or Intake BMKOA #1 (5600242-101)

Groundwater

Integrity & Sensitivity Scores for BMKOA #1 (5600242-101)

Step 1:

Score Type: Well or Intake Integrity

Water Source: Fort Union Fm

Criterion	Condition	Score
Risk of conveyance structure damage?	HIGH	1
Conveyance structure length	SHORT	0
Annular seal present?	YES	0
Well protected from flooding?	YES	0
Wellhead protected (enclosed, fenced)?	UNPROTECTED	1
Surface seal present	YES	0
Well completion date	BETWEEN 1983 AND 1993	2
Total Integrity Score		4

Step 2:

Score Type: Water Source Sensitivity

Water Source: Fort Union Fm

Criterion	Condition	Score
Confirmed chemical contaminant detection?	Yes	5
Sensitivity	CONFINED AQUIFER	1
Total Sensitivity Score		6

Step 3:

Final Well or Intake Rating: BMKOA #1 (5600242-101)

Well or Intake Rating for BMKOA #1	MEDIUM	10 (Integrity + Sensitivity)
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Well or Intake BMKOA #1 (5600242-101)

Well Or Intake BMKOA #1 (5600242-101)

Step 4:

Score Type: Land Use Susceptibility

CFR Zone 1

Land Use Type	Land Use Percentage	Land Use Contaminant Rating	Land Use Susceptibility Rating
Urban Land	0	Low	Low
Irrigated Cropland	100	High	High
Non-Irrigated Cropland	0	Low	Low
Forested Land	0	Low	Low
Other Land Uses	0	Low	Low

CFR Zone 2

Land Use Type	Land Use Percentage	Land Use Contaminant Rating	Land Use Susceptibility Rating
Urban Land	0	Low	Low
Irrigated Cropland	99	High	High
Non-Irrigated Cropland	0	Low	Low
Forested Land	0	Low	Low
Other Land Uses	1	Low	Low

CFR Zone 3

Land Use Type	Land Use Percentage	Land Use Contaminant Rating	Land Use Susceptibility Rating
Urban Land	3	Low	Low
Irrigated Cropland	88	High	High
Non-Irrigated Cropland	0	Low	Low
Forested Land	0	Low	Low
Other Land Uses	8	Low	Low

These regulated contaminant sources appeared within Zones 1 and 2. The PSOC ID# can be used to located the PSOC on the delineation Map.

Point Source Susceptibility for BMKOA #1 (5600242-101)

Step 4:

Score Type: Point Source Susceptibility

Zone: CFR Zone 1

PSOC ID#	PSOC Name	PSOC Type	PSOC Contaminant Rating	PSOC Susceptibility Rating
58029	Big Horn Mountain KOA Sewage Plant	Wastewater Discharge	HIGH	HIGH

Well or Intake BMKOA #1 (5600242-101)

Transportation Corridor Susceptibility for BMKOA #1 (5600242-101)

Step 4:

Rating Type: Transportation Corridor Susceptibility

Zone: CFR Zone 2

Transportation Corridor Contaminant Type	Low	Medium	High
Pipeline	0	0	0
Railroad	0	0	0
State Hwy	0	0	0
Interstate Hwy	0	0	1

Zone: CFR Zone 3

Transportation Corridor Contaminant Type	Low	Medium	High
Pipeline	0	0	0
Railroad	0	0	0
State Hwy	0	0	0
Interstate Hwy	1	0	0

Well or Intake WELL #2 (5600242-102)

Groundwater Integrity & Sensitivity Scores for WELL #2 (5600242-102)

Step 1:

Score Type: Well or Intake Integrity

Water Source: Fort Union Fm

Criterion	Condition	Score
Risk of conveyance structure damage?	HIGH	1
Conveyance structure length	SHORT	0
Annular seal present?	UNKNOWN	1
Well protected from flooding?	YES	0
Wellhead protected (enclosed, fenced)?	UNPROTECTED	1
Surface seal present	YES	0
Well completion date	BEFORE 1983	3
Total Integrity Score		6

Step 2:

Score Type: Water Source Sensitivity

Water Source: Fort Union Fm

Criterion	Condition	Score
Confirmed chemical contaminant detection?	Yes	5
Sensitivity	CONFINED AQUIFER	1
Total Sensitivity Score		6

Step 3:

Final Well or Intake Rating: WELL #2 (5600242-102)

Well or Intake Rating for WELL #2	MEDIUM	12 (Integrity + Sensitivity)
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Well or Intake WELL #2 (5600242-102)

Well Or Intake WELL #2 (5600242-102)

Step 4:

Score Type: Land Use Susceptibility

CFR Zone 1

Land Use Type	Land Use Percentage	Land Use Contaminant Rating	Land Use Susceptibility Rating
Urban Land	0	Low	Low
Irrigated Cropland	100	High	High
Non-Irrigated Cropland	0	Low	Low
Forested Land	0	Low	Low
Other Land Uses	0	Low	Low

CFR Zone 2

Land Use Type	Land Use Percentage	Land Use Contaminant Rating	Land Use Susceptibility Rating
Urban Land	0	Low	Low
Irrigated Cropland	99	High	High
Non-Irrigated Cropland	0	Low	Low
Forested Land	0	Low	Low
Other Land Uses	1	Low	Low

CFR Zone 3

Land Use Type	Land Use Percentage	Land Use Contaminant Rating	Land Use Susceptibility Rating
Urban Land	3	Low	Low
Irrigated Cropland	88	High	High
Non-Irrigated Cropland	0	Low	Low
Forested Land	0	Low	Low
Other Land Uses	8	Low	Low

These regulated contaminant sources appeared within Zones 1 and 2. The PSOC ID# can be used to located the PSOC on the delineation Map.

Point Source Susceptibility for WELL #2 (5600242-102)

Step 4:

Score Type: Point Source Susceptibility

Zone: CFR Zone 1

PSOC ID#	PSOC Name	PSOC Type	PSOC Contaminant Rating	PSOC Susceptibility Rating
58029	Big Horn Mountain KOA Sewage Plant	Wastewater Discharge	HIGH	HIGH

Well or Intake WELL #2 (5600242-102)

Transportation Corridor Susceptibility for WELL #2 (5600242-102)

Step 4:

Rating Type: Transportation Corridor Susceptibility

Zone: CFR Zone 2

Transportation Corridor Contaminant Type	Low	Medium	High
Pipeline	0	0	0
Railroad	0	0	0
State Hwy	0	0	0
Interstate Hwy	0	0	1

Zone: CFR Zone 3

Transportation Corridor Contaminant Type	Low	Medium	High
Pipeline	0	0	0
Railroad	0	0	0
State Hwy	0	0	0
Interstate Hwy	1	0	0

Well or Intake WELL #3 (5600242-103)

Groundwater Integrity & Sensitivity Scores for WELL #3 (5600242-103)

Step 1:

Score Type: Well or Intake Integrity

Water Source: Fort Union Fm

Criterion	Condition	Score
Risk of conveyance structure damage?	HIGH	1
Conveyance structure length	SHORT	0
Annular seal present?	NO/UNKNOWN	1
Well protected from flooding?	YES	0
Wellhead protected (enclosed, fenced)?	UNPROTECTED	1
Surface seal present	YES	0
Well completion date	BEFORE 1983	3
Total Integrity Score		6

Step 2:

Score Type: Water Source Sensitivity

Water Source: Fort Union Fm

Criterion	Condition	Score
Confirmed chemical contaminant detection?	Yes	5
Sensitivity	CONFINED AQUIFER	1
Total Sensitivity Score		6

Step 3:

Final Well or Intake Rating: WELL #3 (5600242-103)

Well or Intake Rating for WELL #3	MEDIUM	12 (Integrity + Sensitivity)
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Well or Intake WELL #3 (5600242-103)

Well Or Intake WELL #3 (5600242-103)

Step 4:

Score Type: Land Use Susceptibility

CFR Zone 1

Land Use Type	Land Use Percentage	Land Use Contaminant Rating	Land Use Susceptibility Rating
Urban Land	0	Low	Low
Irrigated Cropland	100	High	High
Non-Irrigated Cropland	0	Low	Low
Forested Land	0	Low	Low
Other Land Uses	0	Low	Low

CFR Zone 2

Land Use Type	Land Use Percentage	Land Use Contaminant Rating	Land Use Susceptibility Rating
Urban Land	0	Low	Low
Irrigated Cropland	99	High	High
Non-Irrigated Cropland	0	Low	Low
Forested Land	0	Low	Low
Other Land Uses	1	Low	Low

CFR Zone 3

Land Use Type	Land Use Percentage	Land Use Contaminant Rating	Land Use Susceptibility Rating
Urban Land	3	Low	Low
Irrigated Cropland	88	High	High
Non-Irrigated Cropland	0	Low	Low
Forested Land	0	Low	Low
Other Land Uses	8	Low	Low

These regulated contaminant sources appeared within Zones 1 and 2. The PSOC ID# can be used to located the PSOC on the delineation Map.

Point Source Susceptibility for WELL #3 (5600242-103)

Step 4:

Score Type: Point Source Susceptibility

Zone: CFR Zone 1

PSOC ID#	PSOC Name	PSOC Type	PSOC Contaminant Rating	PSOC Susceptibility Rating
58029	Big Horn Mountain KOA Sewage Plant	Wastewater Discharge	HIGH	HIGH

Well or Intake WELL #3 (5600242-103)

Transportation Corridor Susceptibility for WELL #3 (5600242-103)

Step 4:

Rating Type: Transportation Corridor Susceptibility

Zone: CFR Zone 2

Transportation Corridor Contaminant Type	Low	Medium	High
Pipeline	0	0	0
Railroad	0	0	0
State Hwy	0	0	0
Interstate Hwy	0	0	1

Zone: CFR Zone 3

Transportation Corridor Contaminant Type	Low	Medium	High
Pipeline	0	0	0
Railroad	0	0	0
State Hwy	0	0	0
Interstate Hwy	1	0	0

**POINT SUSCEPTIBILITY SUMMARY TABLE
FOR Bighorn Mountain KOA
Point Source Susceptibility Summary**

It may appear from the results of this point source susceptibility summary table that your system has too many PSOCs influencing the final ratings. In some cases, a specific PSOC falls within a specific contaminant inventory zone shared by multiple wells or intakes. When this is the case, that PSOC will be scored for each intake. For example, an underground storage tank may appear within a contaminant inventory zone shared by four different wells. This would cause that single storage tank to be entered into the table four times, or once for each well or intake.

Point Source Type	Low	Medium	High
Wastewater Discharge	N/A	N/A	3

- * Illustrates the number of PSOCs in a particular rating class for all water sources
- * N/A - Not Applicable