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City of Creede
Source Water Protection Plan

Mineral County, Colorado
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For the Community Water Provider:
City of Creede: ID # CO0140500

Cover Photo: Dana Brink

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ACRONYMS

AST	Aboveground Storage Tank
BLM	Bureau of Land Management
BMP	Best Management Practice
CCR	Consumer Confidence Report
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CRWA	Colorado Rural Water Association
CWPP	Community Wildfire Protection Plan
DOC	Dissolved Organic Carbon
DWR	Division of Water Resources
EAP	Emergency Action Plan
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Administration
FPD	Fire Protection District
GIS	Geographic Information System
MCL	Maximum Contaminant Level
MOU	Memorandum of Understanding
NDMC	National Drought Mitigation Center
OWTS	Onsite Wastewater Treatment System
PSOC	Potential Source of Contamination
SDWA	Safe Drinking Water Act
SWAA	Source Water Assessment Area
SWAP	Source Water Assessment and Protection
SWPA	Source Water Protection Area
SWPP	Source Water Protection Plan
USFS	United States Forest Service
SDA	United States Department of Agriculture
USGS	United States Geological Survey
WQCC	Water Quality Control Commission
WQCD	Water Quality Control Division

EXECUTIVE SUMMARY

There is a growing effort in Colorado to protect community drinking water sources from potential contamination. Many communities are taking a proactive approach to preventing the pollution of their drinking water sources by developing a source water protection plan. A source water protection plan identifies a source water protection area, lists potential contaminant sources and outlines best management practices to implement to decrease risks to the water source. Implementation of a source water protection plan provides an additional layer of protection at the local level beyond drinking water regulations.

The City of Creede values a clean, high quality drinking water supply and decided to work collaboratively with area stakeholders to develop a source water protection plan (SWPP). The source water protection planning effort consisted of public planning meetings and individual meetings with water operators during the months of January 2015 through September 2015 at the Creede City Hall. During the development of this SWPP, a steering committee was formed to develop and implement this SWPP. The Colorado Rural Water Association was instrumental in this effort by providing technical assistance in the development of this SWPP.

The City of Creede (Creede) obtains their drinking water from two ground water wells in the Willow Creek alluvium. The source water protection area (SWPA) includes a portion of the lower Willow Creek watershed and Rio Grande River drainage basin. This SWPA is the area that Creede has chosen to focus its source water protection measures to reduce source water susceptibility to contamination.

The steering committee conducted an inventory of potential contaminant sources and identified other issues of concern within the SWPA that may impact the City's drinking water sources. The steering committee prioritized the list of issues of concern as mining, sewerage system leaks, wastewater lagoons, wildland fires, floods, spills on roads, airport facility, fuel storage tanks, septic systems, growth and development, damage to wellheads, drought, car wash facility, automotive repair facility, dam failure, landfill and residential use.

The steering committee developed several best management practices that may help reduce the risks from the potential contaminant sources and other issues of concern. The best management practices are centered on the themes of building partnerships with community members, businesses, and local decision makers; raising awareness of the value of protecting community drinking water supplies; and empowering local communities to become stewards of their drinking water supplies by taking actions to protect their water sources.

At the completion of this plan, members of the steering committee will meet to develop an action plan of BMPs to implement during 2016. It is recommended that the SWPP be reviewed at a frequency of once every three years or if circumstances change resulting in the development of new water sources and source water protection areas, or if new risks are identified.

INTRODUCTION

The City of Creede (Creede) operates a community water supply system that supplies drinking water to 290 residents and businesses located within Mineral County, Colorado. Creede obtains their drinking water from two ground water wells in the alluvium of Willow Creek, a tributary of the Rio Grande. Creede recognizes the potential for contamination of the source of their drinking water, and realizes that it is necessary to develop a protection plan to prevent the contamination of this valuable resource. Proactive planning and implementing contamination prevention strategies are essential to protect the long-term integrity of their water supply and to limit their costs and liabilities.[1]

Table 1. Primary Contact Information for the City of Creede

PWSID	PWS Name	Name	Address	Phone
CO0140500	City of Creede	Water Operator	P.O. Box 457 2223 N. Main Street Creede, CO 81130	719-658-2276

Purpose of the Source Water Protection Plan

The Source Water Protection Plan (SWPP) is a tool for the City of Creede to ensure clean and high quality drinking water sources for current and future generations. This SWPP Plan is designed to:

- Create an awareness of the community's drinking water sources and the potential risks to surface water and/or groundwater quality within the watershed;
- Encourage education and voluntary solutions to alleviate pollution risks;
- Promote management practices to protect and enhance the drinking water supply;
- Provide for a comprehensive action plan in case of an emergency that threatens or disrupts the community water supply.

Developing and implementing source water protection measures at the local level (i.e., county and municipal) will complement existing regulatory mandates implemented at the state and federal governmental levels by filling any gaps through local management strategies that are collaboratively developed.

[1] The information contained in this Plan is limited to that available from public records and the City of Creede at the time that the Plan was written. Other potential contaminant sites or threats to the water supply may exist in the source water protection area that are not identified in this Plan. Furthermore, identification of a site as a "potential contaminant site" should not be interpreted as one that will necessarily cause contamination of the water supply.

Protection Plan Development

The Colorado Rural Water Association's (CRWA) Source Water Protection Specialist, Colleen Williams, helped facilitate the source water protection planning process. The goal of the CRWA's Source Water Protection Program is to assist rural and small communities served by public water systems to reduce or eliminate the potential risks to drinking water supplies through the development of source water protection plans, and provide assistance for the implementation of prevention measures.

The source water protection planning effort consisted of a series of public planning meetings and individual meetings (Table 2). Information discussed at the meetings helped the City of Creede develop an understanding of the issues affecting source water protection for the community. The steering committee then made recommendations for management approaches to be incorporated into the SWPP. In addition to the planning meetings, data and other information pertaining to the SWPA was gathered via public documents, internet research, phone calls, emails, and field trips to the SWPA. A summary of the meetings is represented below.

Table 2. Planning Meetings

Date	Purpose of Meeting
September 2, 2014	Provided a presentation to the Creede Town Council on Colorado Rural Water Association's Source Water Protection Program and developing a source water protection plan for the City of Creede.
January 27, 2015	First Planning Meeting - Presentation on the process of developing a source water protection plan for the City of Creede. Review of Colorado's source water assessment for City of Creede and the delineation of the source water protection area.
February 17, 2015	Second Planning Meeting – Continued the discussion on the delineation of the source water protection area to include the surface water recharge area of the Rio Grande River watershed.
March 30, 2015	Third Planning Meeting – Special meeting between the City of Creede and Mineral County to discuss source water protection.
May 13, 2015	Fourth Planning Meeting – Developed an inventory of potential contaminant sources and issues of concern within the source water protection area. The steering committee completed a source water assessment and protection risk assessment to prioritize the issues of concern.
June 17, 2015	Fifth Planning Meeting – Developed a list of best management practices to include in the SWPP to address the issues of concern and decrease risk to the source waters.
August 12, 2015	Sixth Planning Meeting – Reviewed and edited the draft source water protection plan; and set the date for the final edits.
September 16, 2015	Seventh Planning Meeting – Revisions to draft source water protection plan including source water protection area.

Stakeholder Participation in the Planning Process

Source water protection was founded on the concept that informed citizens, equipped with fundamental knowledge about their drinking water source and the threats to it, will be the most effective advocates for protecting this valuable resource. The City of Creede's source water protection planning process attracted interest and participation from 27 stakeholders including local citizens and landowners, water operators, local and county governments, and agency representatives (Table 3). During the months of January 2015 - September 2015, seven stakeholder meetings were held at the Town Hall in Creede to encourage local stakeholder participation in the planning process. Input from these participants was greatly appreciated.

Table 3. Table of Stakeholders who Participated on the Steering Committee

Stakeholder	Title	Affiliation
Eric Grossman	Mayor	City of Creede
Teresa Wall	Board of Trustees	City of Creede
Catherine Kim	Board of Trustees	City of Creede
Kay Wyley	Board of Trustees	City of Creede
Elizabeth Zurn	Board of Trustees	City of Creede
Molly McDonald	Board of Trustees	City of Creede
Heather DeLonga	Board of Trustees	City of Creede
Clyde Dooley	Manager	City of Creede
Robert Schlough	Water Operator	City of Creede
Randi Snead	Town Clerk	City of Creede
R. Scott Lamb	Board of Commissioners	Mineral County
Ramona Weber	Board of Commissioners	Mineral County
Don Hollenshead	Board of Commissioners	Mineral County
Janelle Kukuk	Administrator	Mineral County
Martha Williamson	District Ranger	U.S. Forest Service Rio Grande Ranger District
Guinevere Freer	Coordinator	Willow Creek Restoration Committee
Randy McClure	General Manager	Rio Grande Silver
Ron Carpenter	Water Operator	Deep Creek Water & Sanitation
David Osborn	Regional Field Manager	Colorado Department of Safety
Ginger Alexander	Resident	
Dale Gail	Resident	
Debby Roughton	Resident	
Daryl Grant	Resident	
Greg Pearson	Resident	
Shelly Parham	Resident	
Zeke Ward	Resident	
Colleen Williams	Source Water Specialist	Colorado Rural Water Association

Development and Implementation Grant

The City of Creede was awarded a $5,000 Development and Implementation Grant from the Colorado Department of Public Health and Environment (CDPHE) in December 2014. This funding is available to community public water systems that are committed to developing and implementing a SWPP. Creede intends on using this funding to implement management approaches that are identified in this plan.

WATER SUPPLY SETTING

Location and Description

The City of Creede is a small rural community located in Mineral County in southwest Colorado at the headwaters of the Rio Grande River. Creede is located at Latitude 37°50'57"N, Longitude 106°55'31"W at an elevation of 8,852 feet. Creede is situated along State Highway 149, 21 miles northwest of South Fork and State Highway 160. According to the U.S. 2010 Census Bureau, Creede has a total area of 0.6 square miles (1.6 km^2) and a population of 290 residents. The population in 2000 was 377 and has decreased 23.1% by 2010 (DOLA, 2012).

The City of Creede, incorporated in 1892, is the only incorporated municipality in Mineral County and its county seat. A mayor and six town trustees govern Creede's municipal affairs. The City of Creede obtains its drinking water supply from two groundwater wells in the alluvium of Willow Creek, a tributary of the Rio Grande. The source water protection area includes a portion of the Willow Creek and Rio Grande watersheds surrounding Creede's wells (Fig. 1).

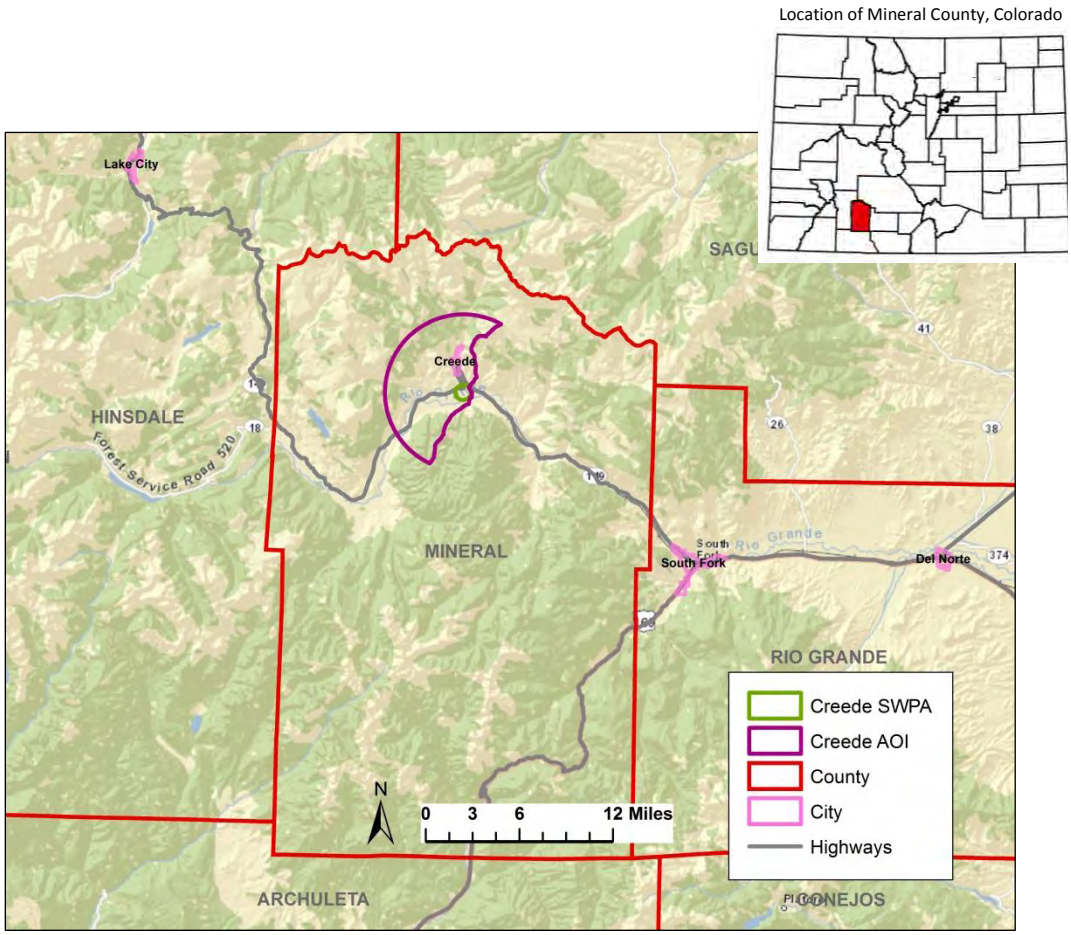


Figure 1. Regional setting map.

Physical Characteristics

The City of Creede's source water protection area in the Willow Creek and Rio Grande watersheds lies within the Southern Rocky Mountain province physiographic area that encompasses the center of the state and runs its entire north-south length. The Rio Grande watershed sits in south-central Colorado, occupying approximately 7,500 square miles and containing just under 10% of the state's land area. Headwaters for the Rio Grande River originate in the San Juan Mountain range that flanks the watershed to the west. Elevations range up to 14,000 feet in the highest peaks of the San Juans (DiNatale, 2014). Altitudes in the Rio Grande watershed range from approximately 11,000 feet along the southernmost boundary of the AOI to approximately 8,629 feet in the valley basin SWPA.

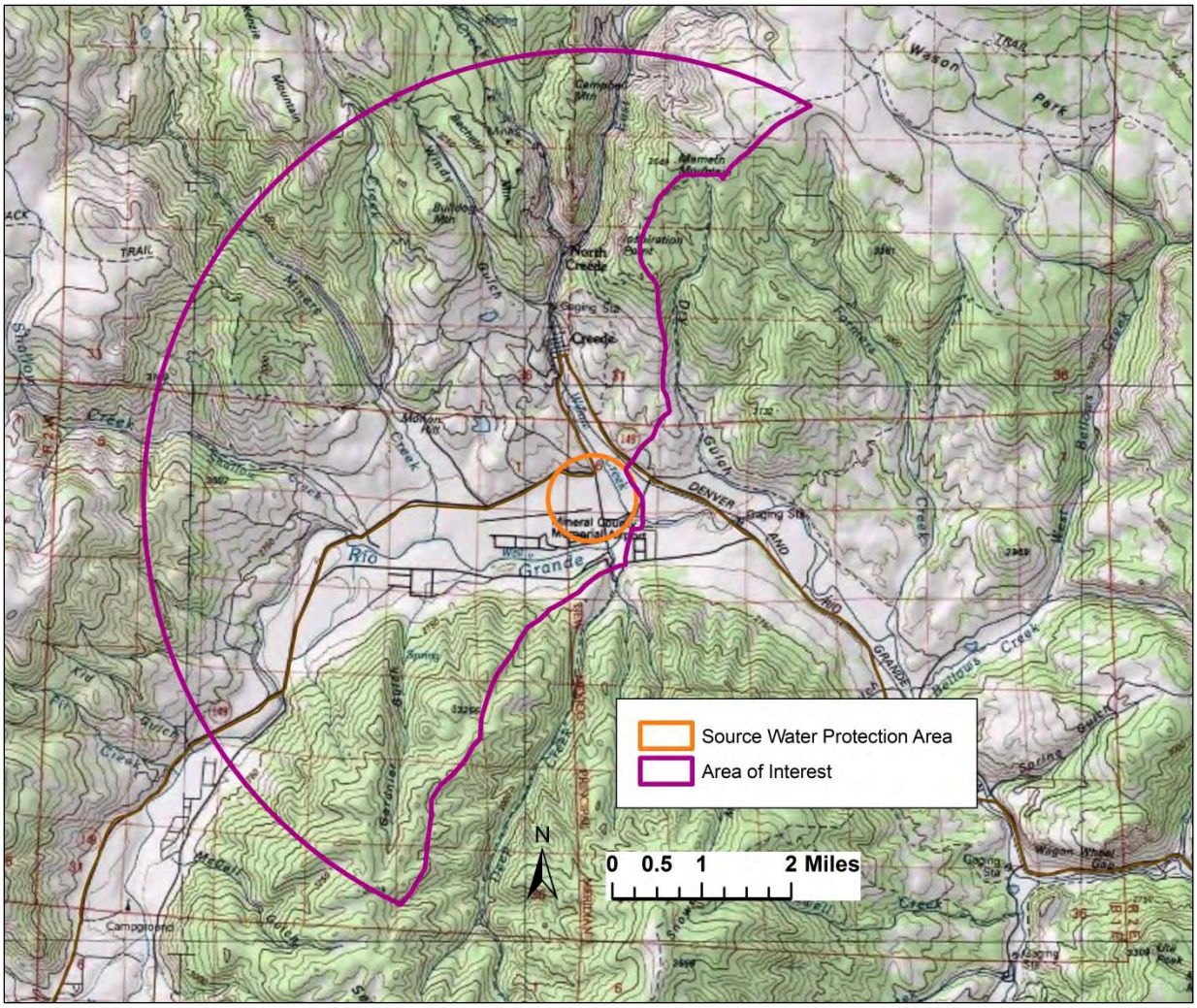


Figure 2. Topographic map of the Source Water Protection Area.

Ecological Regions

The source water protection area (SWPA) and area of interest (AOI) lies mostly within the Grassland Parks and Volcanic Subalpine Forest ecological regions (Fig. 3). The Grassland Parks ecoregion consists of high intermontane (between mountains) valleys with water available to support natural grasslands. Mountain grasslands occupy large areas characterized by low precipitation, cold temperatures, and relatively fine textured soils – all factors that discourage tree growth (Benedict, 1991). Grasslands with bunchgrasses are dominant, and include Arizona fescue, Idaho fescue, mountain muhly, bluebunch wheatgrass, needle-and-thread, Junegrass, and slender wheatgrass. There are only a few trees or shrubs, and if present, they are widely scattered and mature.

The steep, mountainous Volcanic Subalpine Forests ecoregion, occurring between 9,000 and 11,000 feet, is composed of volcanic and igneous rocks, predominately andesitic with areas of basalt. The region is found mainly in the San Juan Mountains, which have the most rugged terrain and the harshest winters in the Southern Rockies of Colorado. The area is highly mineralized, and gold, silver, lead, and copper have been mined. This zone is characterized by Englemann spruce, subalpine fir, and aspen forests that support a variety of wildlife (Omernick and Griffith, 2008).

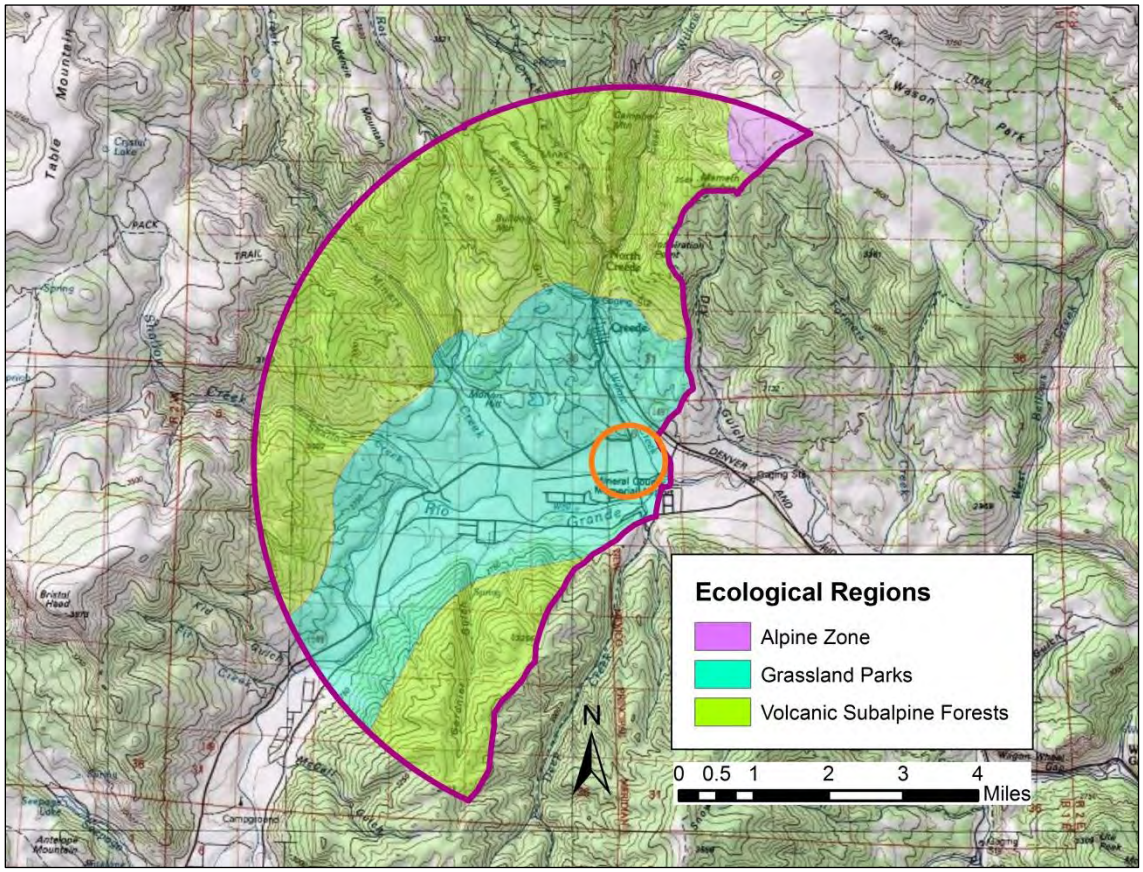


Figure 3. Map of the ecological zones within the Source Water Protection Area and Area of Interest.

Climate

The climate within the SWPA and AOI is dependent on elevation and location, with precipitation increasing moderately with altitude. Average annual precipitation ranges from about 11 inches in the lower watershed to about 33 inches in the higher mountains (Fig. 4). The majority of precipitation occurs during heavy spring snow and late summer monsoon rains. Mineral County experiences cold winters and moderate summers and approximately 300 days of sunshine per year. The high mountains and alpine valleys experience an average high winter temperature of 48 degrees and low of zero, though low temperatures often reach 20 below. Average summer temperatures are 70-75 degrees during the day, but can reach a high of 91 degrees. Average temperatures at night are 52 degrees, but can drop into the 40s (MCMHMP, 2010).

Most of the precipitation that falls on the land surface during storm events flows directly into drainages, streams, and rivers as runoff. Some of the water will infiltrate the soil and recharge the underlying aquifers. The average runoff for the watershed is 20 inches at the top of the ridges and 5-10 inches in the lower watershed (Topper et al, 2003).

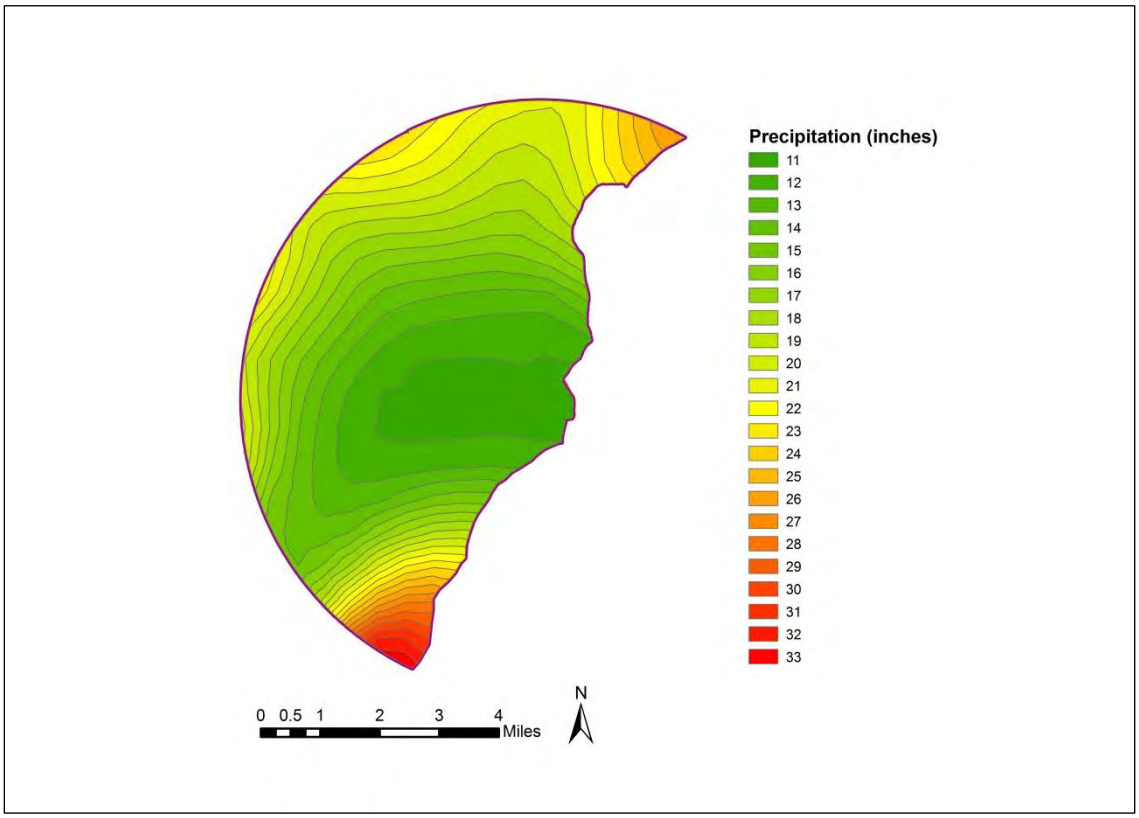


Figure 4. Average annual precipitation map of the Source Water Protection Area and Area of Interest.

Land Ownership and Use

The Source Water Protection Area and Area of Interest lie within both public and private lands (Fig. 5). The private land includes land within the unincorporated areas of Mineral County. The public lands include Rio Grande National Forest land managed by the U.S. Forest Service (USFS) Divide Ranger District.

Land use includes residential development, businesses, recreation (camping, hiking, climbing, fishing, mountain biking, x-country skiing, horseback riding, tourism, sightseeing), big game hunting, mining, grazing, wildlife habitat and other.

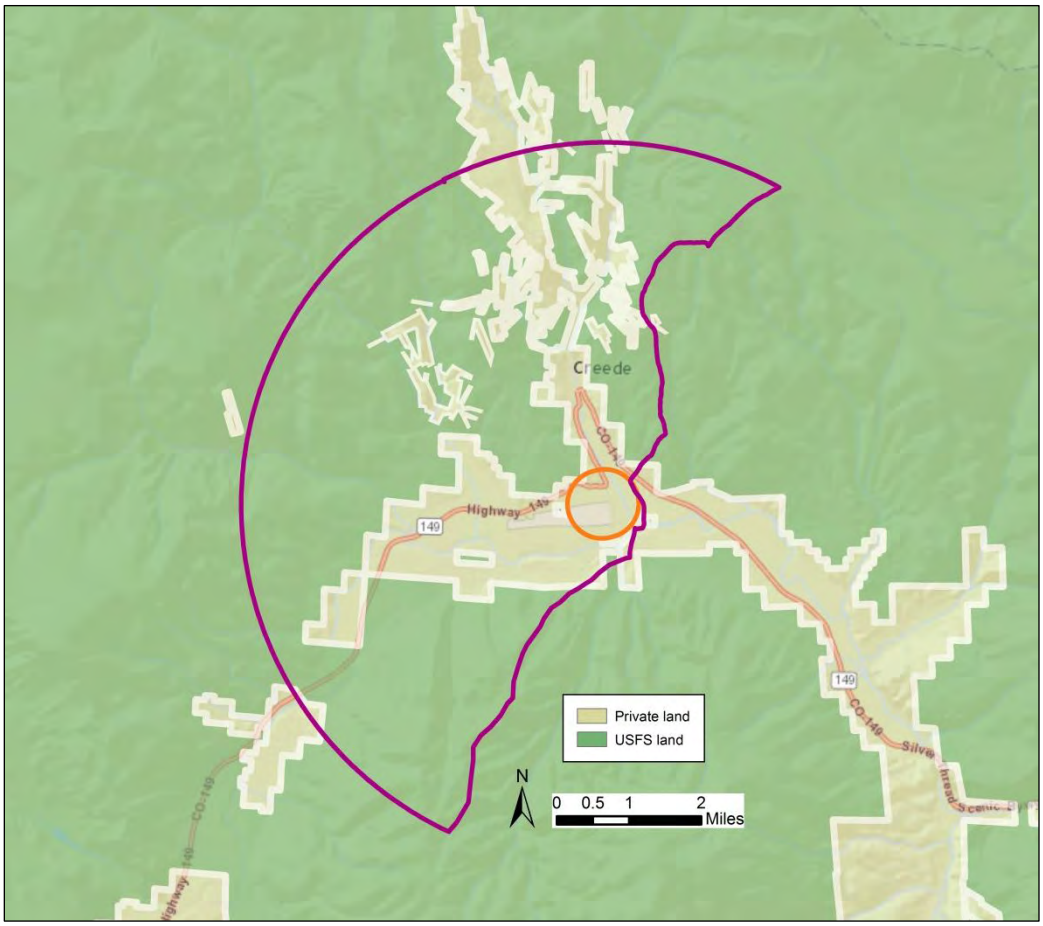


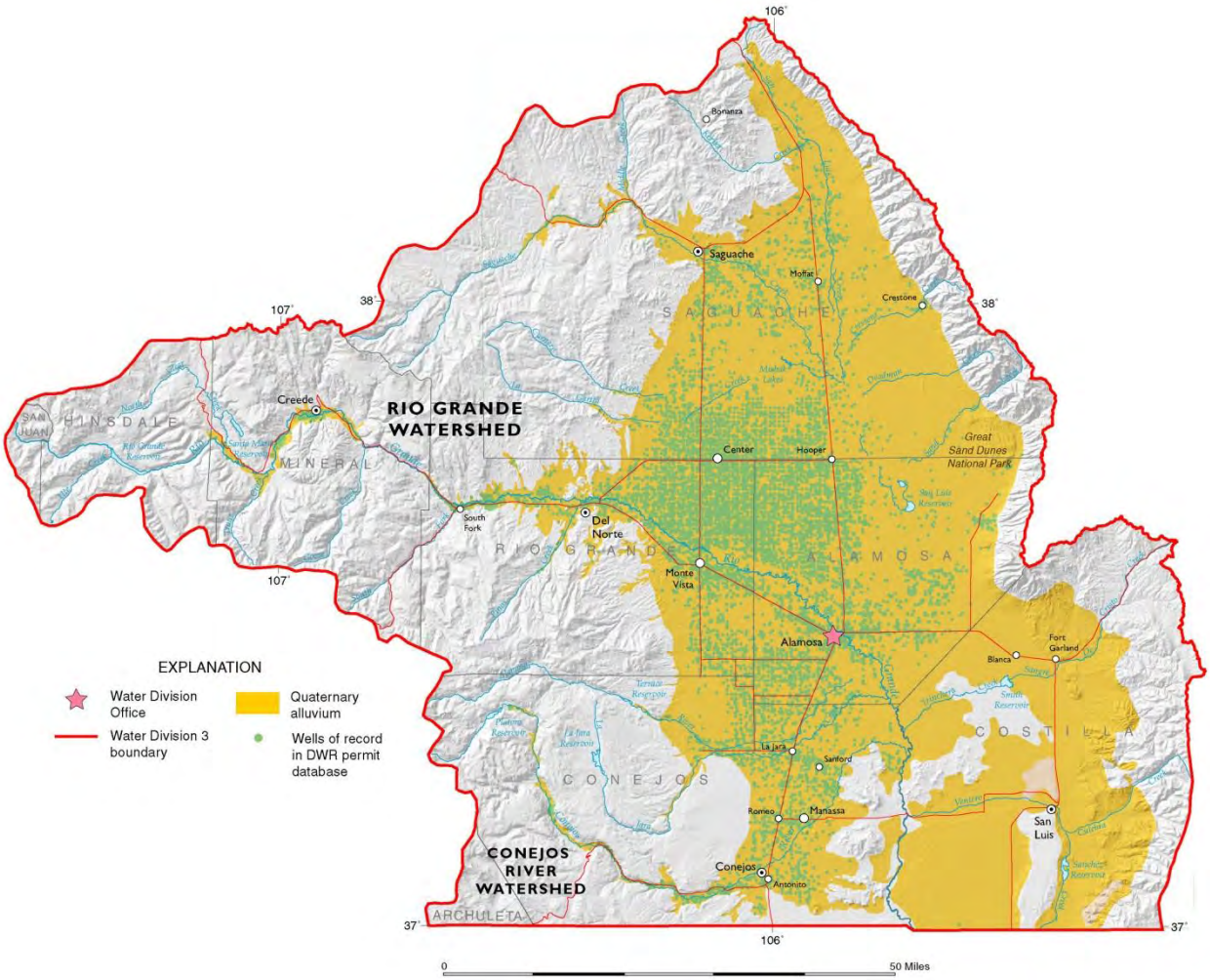
Figure 5. Land owners within the Source Water Protection Area and Area of Interest.

WATER QUALITY

Hydrologic Setting

The City of Creede obtains its drinking water supply from two groundwater wells in the alluvium of Willow Creek, a perennial tributary of the Rio Grande River. The source water protection area (SWPA) lies within the Rio Grande watershed (Hydrologic Unit Code 13010001) in Mineral County and drains approximately 0.74 square miles (475 acres).

The Rio Grande River Basin is part of Colorado Water Division 3 with the office of the Division Engineer in Alamosa (Fig. 6). Division 3 administers all water resources of the upper Rio Grande Basin in Colorado. This area encompasses approximately 7,500 square miles (Topper et al, 2003).



SOURCE: GROUND WATER ALTLAS OF COLORADO

Figure 6. Map including the Rio Grande River Basin

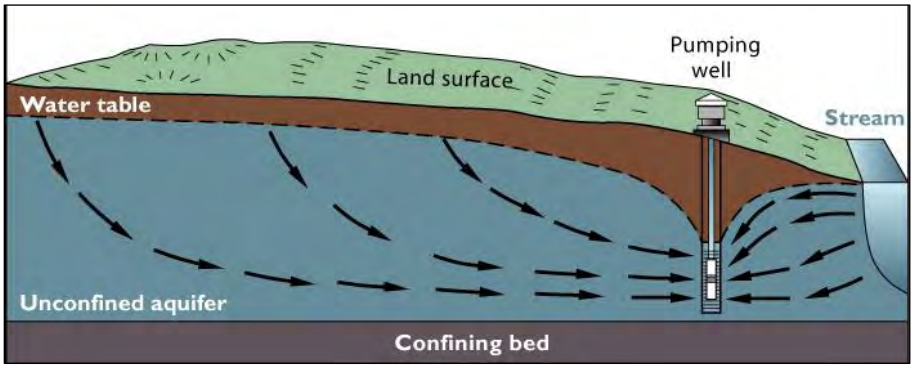
Alluvial Aquifer

An aquifer is a groundwater reservoir composed of soil and rock that are saturated with water and sufficiently permeable to yield water in a usable quantity to wells and springs. Aquifers provide two important functions: 1) they transmit ground water from areas of recharge to areas of discharge, and 2) they provide a storage medium for useable quantities of ground water. An alluvial aquifer is an aquifer with geologic materials deposited by a stream and that retains a hydrologic connection with the depositing stream (Fig. 7). Alluvial aquifers (alluvium) are generally composed of clay, silt, sand, gravel or similar unconsolidated material.

The City of Creede's wells are located in the alluvial fan of Willow Creek, which is a braided stream with several active stream channels that carry coarse-grain alluvial material as is described in the Creede well logs. Willow Creek is perennial, with the USGS gauge records (near Creede) showing flows generally in the range of 4 to 10 cfs in winter and 60 to 140 cfs in summer. Comparison of water levels in area wells with the stream elevation indicates that the stream is in hydrologic connection with the aquifer from which the Creede wells draw water (Harmon, 2010).

Based on review of other well logs in this locality, the alluvium may be over 200 feet thick in the location of the City's wells. The most productive part of the alluvium is in the uppermost 100 to 120 feet. The average saturated thickness of the alluvial aquifer of Willow Creek is 85.5 feet. The Willow Creek alluvial aquifer has an average aquifer transmissivity of 134,550 gpd/ft and an average hydraulic conductivity of 210 ft/day (Harmon and Saenger, 2011). Transmissivity is a term used to describe the ease with which groundwater can flow through the saturated thickness of an aquifer. The aquifer's hydraulic conductivity is a measure of its ability to transmit water from areas of recharge to areas of discharge.

Recharge to the Willow Creek alluvial aquifer can occur from mountain-front recharge, infiltration of water from Willow Creek, and from direct infiltration of precipitation. Mountain-front recharge occurs from subsurface inflow of ground water from the mountain and mountain-stream channel recharge.



SOURCE: GROUND WATER ALTLAS OF COLORADO

Figure 7. Depending upon its location and rate of discharge, a pumping alluvial well can capture flow from the groundwater and adjacent stream.

Groundwater Protection

Groundwater protection is managed as two separate issues of quantity and quality in Colorado. Quantity issues are managed through the Colorado Division of Water Resources/Office of the State Engineer. The Division of Water Resources administers and enforces all surface and groundwater rights throughout the State of Colorado, issues water well permits, approves construction and repair of dams, and enforces interstate compacts. The Division of Water Resources is also the agency responsible for implementing and enforcing the statutes of the Groundwater Management Act passed by the Legislature as well as implementing applicable rules and policies adopted by the Colorado Groundwater Commission and the State Board of Examiners of Water Well Construction and Pump Installation Contractors.

Under the Clean Water Act, every state must adopt water quality standards to protect, maintain and improve the quality of the nation's surface waters. Water quality is protected by the Colorado Water Quality Control Act through a number of state agencies. The Colorado Department of Public Health and Environment is the lead agency. The Colorado Water Quality Control Commission is responsible for promulgating groundwater and surface water classifications and standards. Colorado's Water Quality Control Commission has established basic standards for groundwater regulations that apply a framework for groundwater classifications and water quality standards for all waters within their jurisdictions. Standards are designed to protect the associated classified uses of water or a designated use. The groundwater classifications are applied to groundwaters within a specified area based upon use, quality and other information as indicated in Regulation No. 41, "The Basic Standards for Ground Water'"(CDPHE, 2008). Statewide standards have been adopted for organic chemicals and radionuclides. Significant areas of the state have been classified for site specific use classification and the remainder of the state's groundwater is protected by interim narrative standards.

Classifications and standards are implemented by seven separate state agencies through their rules and regulations for activities that they regulate. Regulated activities include: mining and reclamation, oil and gas production, petroleum storage tanks, agriculture, Superfund sites, hazardous waste generation and disposal, solid waste disposal, industrial and domestic wastewater discharges, well construction and pump installation, and water transfers.

Colorado has a proactive groundwater protection programs that include monitoring groundwater for agricultural chemicals and pesticides, issuing groundwater discharge permits; voluntary cleanup program, permitting for large hog farm operations, and educational programs. In addition, water wells must have a permit and meet minimum standards of construction and pump installation.

Drinking Water Supply Operations

Water System Information

The City of Creede operates a municipal water supply system that provides drinking water to the 290 year round residents, part time residents, visitors, and commercial users of Creede. The State of Colorado Department of Public Health and Environment lists the daily average of water users per day for the City of Creede as 1,965. The City's water system consists of ground water supply, storage, treatment, and distribution facilities.

Figure 8. The City of Creede's historic Main Street.

The City has two groundwater wells constructed in 1994 and 1995 and drilled into the Willow Creek alluvial aquifer. Well #1 has a total depth of 122 feet and Well #2 is 115 feet deep (Table 4). Well casing for Well #1 is perforated at intervals starting at 62 feet and Well #2 at 57 feet (DWR, 2004). This is the level that water from the alluvium is drawn into the well. The wells recharge quickly after draw down has ceased. The static water level has been relatively steady. The cone of depression, the area around each well that water is drawn from when pumping occurs, is typically a 200-foot diameter around each wellhead. The cone of depression expands outward from a pumped well until it reaches the nearest point at which ground water recharge is encountered (a "recharge boundary"). The closed recharge boundary is Willow Creek. It is likely that the cone of depression due to the Creede wells does not expand outward greater than ~1,500 feet from the wells (Harmon and Saenger, 2011)

Table 4. Well Data

Well Name	CDPHE Source ID	State Engineers Permit No.	Total Depth of Well (ft.)	Maximum Pumping Rate (GPM)
Creede Well #1	140500-003	46925-F (61905-F)	122	500
Creede Well #2	140500-004	46924-F (61906-F)	115	500*

* Combined pumping rate of both wells not to exceed 500 GPM

Raw water from the wells is pumped into the near-by treatment plant and treated with chlorine. The treated water is pumped 2.19 miles via underground pipeline to the City's 121,612 gallon lower water storage tank built in 1973. The upper water storage tank built in 1982, holding 143,937 gallons is 2.23 miles from the treatment plant. The total amount of stored water is 265,549 gallons. The treated water is distributed via gravity to residents and commercial customers through a network of 6.41 miles of underground pipes to 328 service connections or taps (Schlough, 2015). The size of the service area is approximately .505 square miles. Both the wells and treatment plant are located on Mineral County land leased by the City of Creede.

The City of Creede provides an Annual Drinking Water Quality Report with the Consumer Confidence Report (CCR) to the public that provides information on the results of their water monitoring program. The 2015 report is available at the Creede City Office located at 2223 North Main Street, Creede, Colorado or online at www.creedetownhall.com. The City is currently in compliance with all State water quality regulations.

Water Supply Demand Analysis

The water system currently has the capacity to produce 649,440 gallons per day. Current estimates by the water system indicate that the average daily demand is approximately 210,233 gallons per day in 2014. Peak use is during the summer with a highest of 466,700 gallons per day (July 3, 2014). Lowest is in January 2014 with average daily usage of 157,219 gallons per day.

Using these estimates, the water system has a surplus average daily demand capacity and a surplus average peak daily demand capacity per day. The city's water rights are adequate to supply a population more than double the current size of the city. The water demand estimator is included in the Appendices of this report.

The City of Creede has evaluated its ability to meet the average daily demand of its customers in the event the water supply, or its water source, becomes disabled for an extended period of time due to potential contamination. The evaluation indicated that the City of Creede may not be able to meet the average daily demand of its customers if its only water source became disabled for an extended period of time. The ability of the City of Creede to meet either daily or peak demand for an extended period of time is also affected by the groundwater supply as well as the amount of treated water the water system has in storage at the time a water source becomes disabled.

The City of Creede recognizes that potential contamination of its groundwater source could potentially result in having to treat the groundwater and/or abandon the water source if treatment proves to be ineffective or too costly. To understand the potential financial costs associated with such an accident, Creede evaluated what it might cost to replace one of its water sources (i.e., replacement of the well and the associated infrastructure) if this occurs. The evaluation did not attempt to estimate treatment costs, which can be variable depending on the type of contaminant(s) that need(s) to be treated. The evaluation indicated that it could cost millions in today's dollars to find a new water source.

The potential financial and water supply risks related to the long-term disablement of one or more of the community's water sources are a concern to the steering committee. As a result, the steering committee believes the development and implementation of a source water protection plan for Creede can help to reduce the risks posed by potential contamination of its water source(s). Additionally, the City of Creede has developed an emergency response plan or contingency plan to coordinate rapid and effective response to any emergency incident that threatens or disrupts the community water supply.

OVERVIEW OF COLORADO'S SWAP PROGRAM

Source water assessment and protection came into existence in 1996 as a result of Congressional reauthorization and amendment of the Safe Drinking Water Act. The 1996 amendments required each state to develop a source water assessment and protection (SWAP) program. The Water Quality Control Division, an agency of the Colorado Department of Public Health and Environment (CDPHE), assumed the responsibility of developing Colorado's SWAP program. Colorado's SWAP program is a two-phased process designed to assist public water systems in preventing potential contamination of their untreated drinking water supplies.

Source Water Assessment Phase

The Assessment Phase for all public water systems consists of four primary elements:

1. Delineating the source water assessment area for each of the drinking water sources;
2. Conducting a contaminant source inventory to identify potential sources of contamination within each of the source water assessment areas;
3. Conducting a susceptibility analysis to determine the potential susceptibility of each public drinking water source to the different sources of contamination;
4. Reporting the results of the source water assessment to the public water systems and the general public.

The Assessment Phase involves understanding where the City of Creede's source water comes from, what contaminant sources potentially threaten the water sources, and how susceptible each water source is to potential contamination.

Source Water Protection Phase

The Protection Phase is a voluntary, ongoing process in which all public water systems have been encouraged to voluntarily employ preventative measures to protect their water supply from the potential sources of contamination to which it may be most susceptible. The Protection Phase can be used to take action to avoid unnecessary treatment or replacement costs associated with potential contamination of the untreated water supply. Source water protection begins when local decision-makers use the source water assessment results and other pertinent information as a starting point to develop a protection plan. The source water protection phase for all public water systems consists of four primary elements:

1. Involving local stakeholders in the planning process;
2. Developing a comprehensive protection plan for all of their drinking water sources;
3. Implementing the protection plan on a continuous basis to reduce the risk of potential contamination of the drinking water sources; and
4. Monitoring the effectiveness of the protection plan and updating it accordingly as future assessment results indicate.

SOURCE WATER PROTECTION PLAN DEVELOPMENT

Source Water Assessment Report Review

The City of Creede received their Source Water Assessment Report from the Colorado Department of Public Health and Environment in November 2004. During the Source Water Protection stakeholder meetings, the assessment report was reviewed and used as a starting point to guide the development of this Source Water Protection Plan. A copy of the Source Water Assessment Report for the city of Creede can be obtained by contacting the City or by downloading a copy from the CDPHE's SWAP program website located at: http://www.colorado.gov/cs/Satellite/CDPHE-WQ/CBON/1251596793639.

Defining the Source Water Protection Area

The State's Assessment Report included a delineated source water assessment area for the City's ground water sources. Delineation is the process used to identify and map the area around a pumping well that supplies water to the well or spring, or the drainage basin that supplies water to a surface water intake. The size and shape of the area depends on the characteristics of the aquifer and the well, or the watershed. The delineated source water assessment area provides the basis for understanding where the community's source water and potential contaminant threats originate.

The steering committee reviewed the state's delineated source water assessment area for the City of Creede's groundwater sources and decided to add an additional protection area for the City's wells. This additional protection area includes the lower Willow Creek watershed and a portion of the Rio Grande River drainage basin within a 2,500 foot radius surrounding the wells, approximately 0.74 square miles (Fig. 9). This protection area is where the community has chosen to implement its source water protection measures in an attempt to manage the susceptibility of their source water to potential contamination. The City also identified an Area of Interest (AOI) within a 5-mile radius surrounding the wells.

Source Water Protection Zones

The source water protection area includes the following protection zones:

> ***Zone 1*** *is defined as a 500-foot radius around the groundwater wells. This area is of critical concern because of its proximity to the wells. Zone 1 is the location of the Mineral County Airport buildings, water treatment plant, and gravel access road to the new K-12 school.*

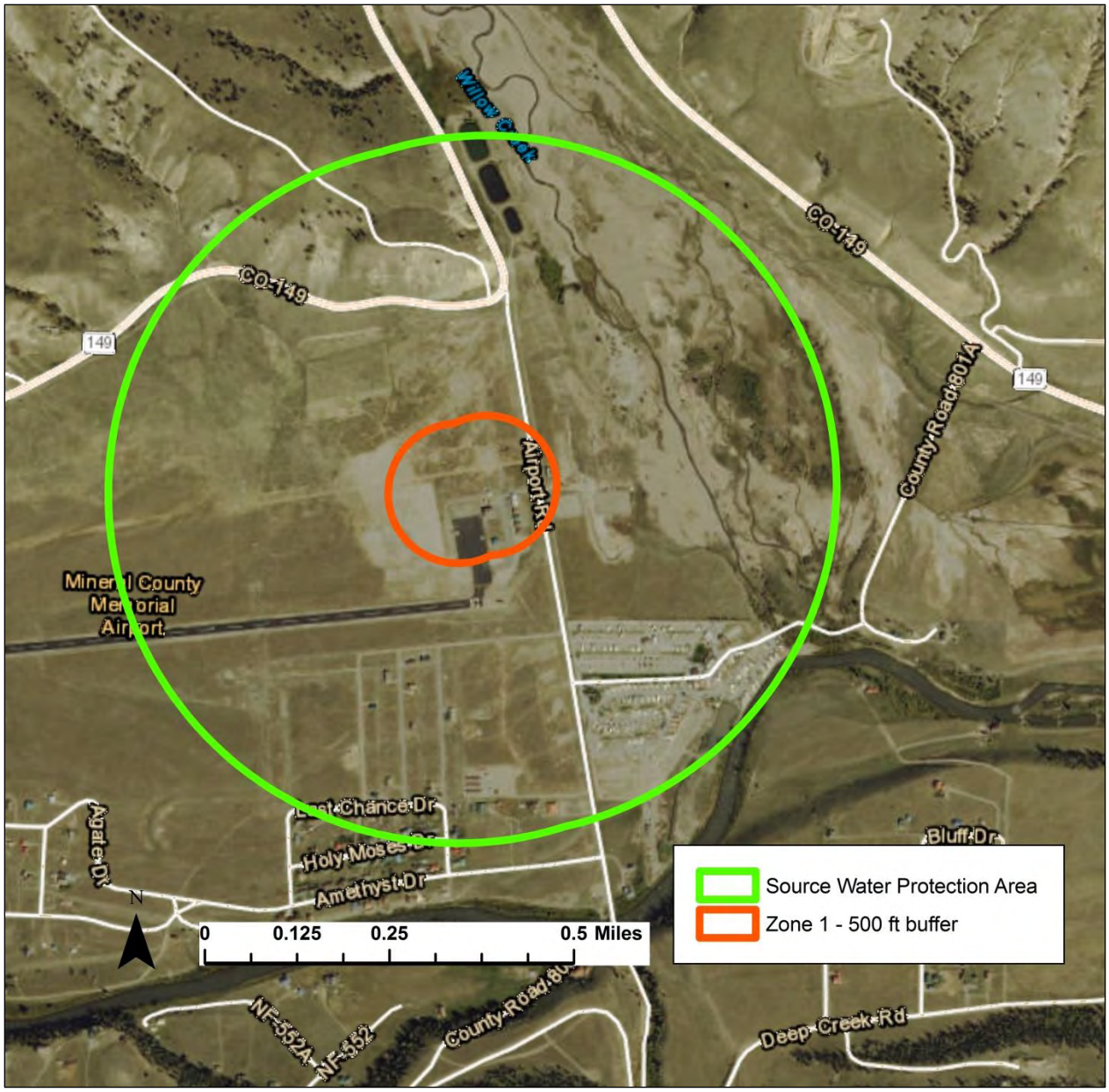


Figure 9. Map of the City of Creede's Source Water Protection Area.

Potential Contaminant Source Inventory

The State's Source Water Assessment Report identified potential sources of contamination (PSOCs) that might be present within the source water assessment areas. In 2014, CDPHE provided the city of Creede with geographic information system (GIS) information on these potential contaminant sources located within the assessment areas. The steering committee conducted a more accurate and current contaminant source inventory of the source water protection area. This report will only reflect the current inventory.

Discrete contaminant sources (point sources) were inventoried using selected state and federal regulatory databases including: mining and reclamation, oil and gas operations, above and underground petroleum tanks, Superfund sites, hazardous waste generators, solid waste disposal, industrial and domestic wastewater dischargers, solid waste sites, and water well permits.

Dispersed contaminant sources (nonpoint sources) were inventoried using recent land use, land cover and transportation maps of Colorado, along with selected state regulatory databases. A table of Contaminants Associated with Common PSOCs is included in the Appendices of this report.

The steering committee identified other areas of concern to add to the potential contaminant source inventory, combining these into a list of issues of concern within the Source Water Protection Area and Area of Interest that may impact the City of Creede's drinking water sources.

Issues of Concern

- Mining (active, abandoned, future)
- Spills on roads
- Airport facility
- Sewerage system
- Waste water treatment lagoons
- Damage to wellheads from accident
- Septic systems
- Residential use
- Growth/development
- Landfill
- Fuel storage tanks
- Auto Repair shop
- Car wash facility
- Wildland fire
- Floods
- Dam failure
- Drought

Priority Strategy

The steering committee used the SWAP Risk Assessment Matrix developed by CRWA to prioritize the issues of concern (Table 5). Using SWAP Risk Assessment Matrix, the steering committee considered the following criteria when estimating the risk of each issue of concern.

1. **Impact to the Public Water System** – The risk to the source waters increases as the impact to the water system increases. The impact is determined by:

    - **Migration Potential or Proximity to the Water Source** - The migration potential generally has the greatest influence on whether a contaminant source could provide contaminants in amounts sufficient for the source water to become contaminated at concentrations that may pose a health concern to consumers of the water. Shorter migration paths and times of travel mean less chance for dilution or degradation of the contaminant before it reaches water sources.

    - **Contaminant Hazard** - The contaminant hazard is an indication of the potential human health danger posed by contaminants likely or known to be present at the contaminant source. Using the information tables provided by CDPHE (see Appendices), the steering committee considered the following contaminant hazard concerns for each contaminant source:

        - **Acute Health Concerns** - Contaminants with acute health concerns include individual contaminants and categories of constituents that pose the most serious immediate health concerns resulting from short-term exposure to the constituent.

        - **Chronic Health Concerns** - Contaminants with chronic health concerns include categories of constituents that pose potentially serious health concerns due to long-term exposure to the constituent. Most of these chronic health concern contaminants include the remaining primary drinking water contaminants.

    - **Potential Volume** - The volume of contaminants at the contaminant source is important in evaluating whether the source water could become contaminated at concentrations that may pose a health concern to consumers of the water in the event these contaminants are released to the source water. Large volumes of contaminants at a specific location pose a greater threat than small volumes.

2. **Probability of Occurrence** – The risk to the source waters increases as the relative probability of damage or loss increases. The regulatory compliance history for regulated facilities and operational practices for handling, storage, and use of contaminants were utilized to evaluate the likelihood of release.

The steering committee determined whether each issue of concern is in the water system's Direct Control (i.e., water system can take direct measures to prevent), Indirect Control (i.e., water system cannot directly control the issue, but can work with another person or entity to take measures to prevent) or No Control (i.e., PSOC or issue of concern is outside the control of the public water system and other entities) (Table 5). This determination of control in conjunction with the estimation of risk to the source water(s), helped guide the prioritization of the issues of concern in a way that best fits the needs and resources of the community.

Table 5. Potential Contaminant Source Prioritization using SWAP Risk Assessment Matrix

Potential Source of Contamination or Issue of Concern	Controllable (Direct, Indirect, No)	Impact to Water System (Insignificant, Minor, Significant, Major, Catastrophic)	Probability of Occurrence (Rare, Unlikely, Possible, Likely, Certain)	Risk (Very Low, Low, Moderate, High, Very High)
Mining (active, abandoned, future)	Indirect	Major	Possible	High
Spills on roads	No	Minor	Possible	Moderate
Airport facility	Indirect	Major	Unlikely	Moderate
Sewerage system and lagoons	Direct	Major	Possible	High
Fuel storage tanks	No	Major	Possible	High
Septic systems	Indirect	Significant	Possible	Moderate
Residential use	No	Minor	Rare	Very low
Car wash facility	Indirect	Minor	Unlikely	Low
Landfill	Direct	Minor	Unlikely	Low
Automotive Repair Shop	Indirect	Minor	Possible	Moderate
Wildland fire	No	Major	Likely	High
Floods	No	Catastrophic	Possible	High
Dam failure	No	Catastrophic	Rare	Low
Growth/development	Indirect	Minor	Possible	Moderate
Damage to wellheads	No	Minor	Possible	Moderate
Drought	No	Significant	Possible	Moderate

DISCUSSION OF ISSUES OF CONCERN

The following section provides a description of the issues of concern that have been identified in this plan, describes the way in which they threaten the water sources and outlines best management practices. The purpose of this section is as a guidance document to understand the issues. The prioritized list of issues of concern includes:

High Risk: Mining, sewerage system and lagoons, fuel storage tanks, wildland fires and floods

Moderate Risk: Spills on roads, airport facility, private fuel storage tanks, septic systems, automotive repair shop, growth/development, damage to wellheads, and drought

Low Risk: Car wash facility, landfill and dam failure

Very Low Risk: Residential use

Surface and Groundwater Contaminants

Many types of land uses have the potential to contaminate source waters: spills from tanks, trucks, and railcars; leaks from buried containers; failed septic systems, buried or injection of wastes underground, use of fertilizers, pesticides, and herbicides, road salting, as well as urban and agricultural runoff (Fig. 10). While catastrophic contaminant spills or releases can wipe out a water resource, groundwater degradation can result from a plethora of small releases of harmful substances. According to the U.S. EPA, nonpoint-source pollution (when water runoff moves over or into the ground picking up pollutants and carrying them into surface and groundwater) is the leading cause of water quality degradation (GWPC, 2008).

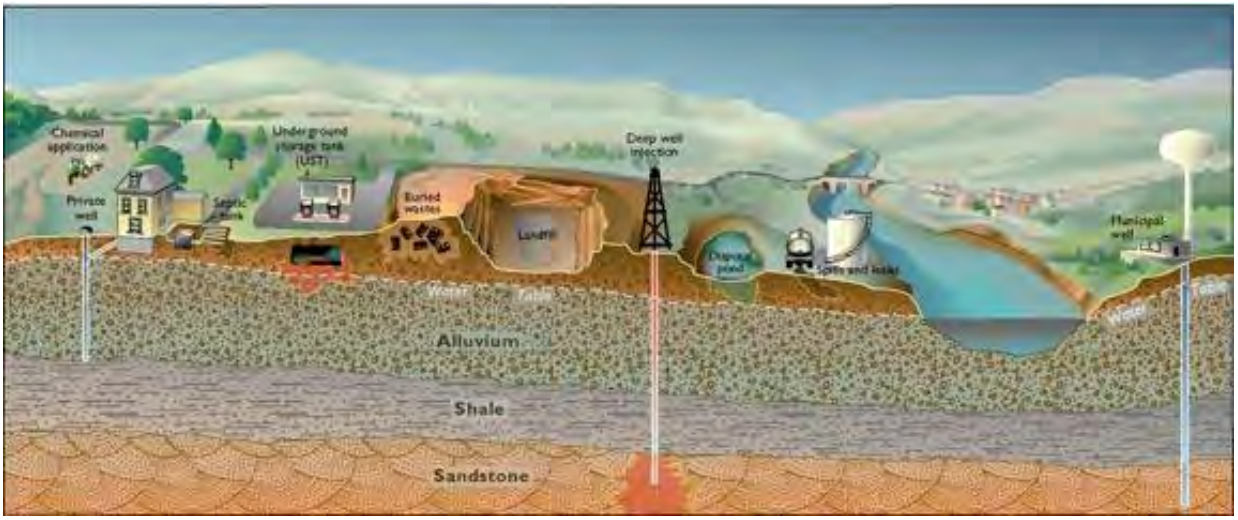


Figure 10. Schematic drawing of the potential source of contamination to surface and groundwater.

Mining

The area of interest (AOI) for the city of Creede lies within the historic Creede Mining District, an area of approximately 47 square miles in Mineral County near the upper Rio Grande River in the east San Juan Mountains. The district encompasses much of the Willow Creek drainage system, Miners Creek, and land along the north side of the Rio Grande River. This district produced silver, lead, gold, and zinc and was one of Mineral County's most important mining districts. Silver mined from this district accounted for the majority of this district's production (CGS, 2015).

Figure 11. Historic mine structure in the Miners Creek drainage.

Mining in Creede followed several boom and bust cycles from 1893 until 1973, and most often correlated with the rise and fall of silver prices. Only a few mining operations continued from 1973, and in the mid 1980's the last mine closed.

Abandoned Mine Lands

Mining practices during the early days allowed the mine owners to simply abandon their mines without consideration of the impact on streams, water quality, slope stability and safety. Many old mining properties contain abandoned mine workings, mine waste and/or mill tailings. Multiple historic mine sites including tailings piles are located within the Miners and Willow Creek drainages (Fig. 12). Information on mineral resources in the Area of Interest was obtained from the U. S. Geological Survey.

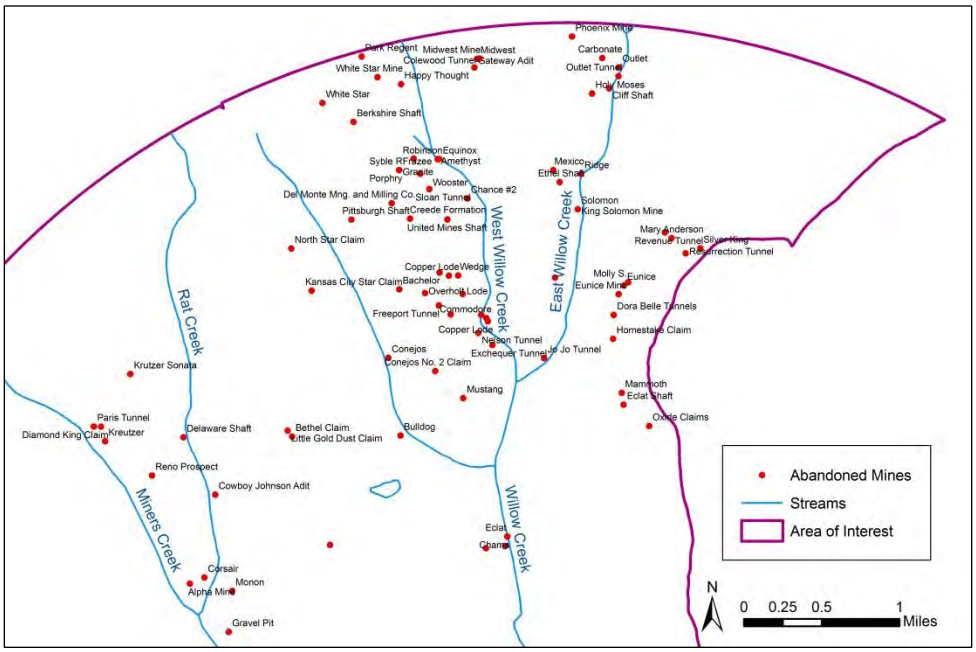


Figure 12. Map of the abandoned mines, adits and tunnels in the Creede AOI.

Permitted Mines

Thousands of unpatented claims and small exploratory mining operations throughout Colorado exist, most of which were never recorded in state or local government offices. It was not until 1973 that the State of Colorado required mines to be permitted. Current mining permit data obtained from the Colorado Division of Reclamation, Mining, and Safety indicate that there are two active permitted mines in the SWPA (Table 6).

Table 6. Active Permitted Mines within the Source Water Protection Area

Mines	Permittee	ID Number	Commodity Mined
Bulldog Mine Operation	Rio Grande Silver, Inc.	M1977215	Silver, Gold, Lead
Airport Corner Pit	Navajo Development Company, Inc.	M2007057	Material for construction

Bulldog Mine Operation

The Homestake Mining Company operated the Bulldog Mine from 1965 to 1985 producing approximately 25 million ounces of silver and 24,300 tons of lead. Rio Grande Silver, Inc., current owner of the Bulldog Mine, is permitted to conduct underground exploration and development work into the submerged zones of the old Bulldog Mine. The mine water will be delivered via pipeline to a water treatment plant for treatment prior to being discharged into Willow Creek. After dewatering, the process of mine rehabilitation and development for exploration will occur. Waste rock from the mining operation will be stored at the existing 9400 portal site and a second storage site near the existing lined surge pond (Fig. 13).

The Bulldog Mine operation is located in the Willow Creek and Miners Creek drainage basins. While most of the new mining operation will occur within the Willow Creek drainage, some of the operation will occur within the Miners Creek basin. These include the construction of a water treatment plant, pipelines, and the east Waste Rock Storage Facility; and use of the existing lined surge ponds (Hecla, 2015).

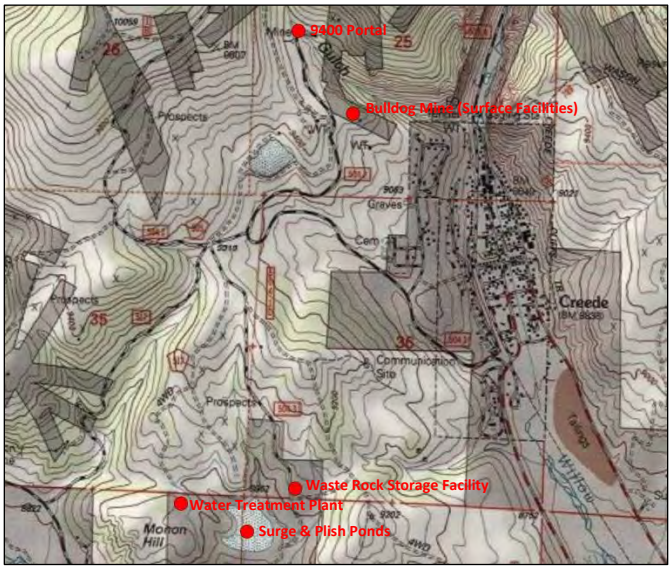


Figure 13. Plan of operation map for the Bulldog Mine.

Mineral Resource Extraction

There are unpatented mining claims filed on public and private land within the watershed. As of July 2015, there are 207 unpatented mining claims filed with the Bureau of Land Management (BLM) within the Creede AOI (Fig. 14). Both the U.S. Forest Service and the BLM have authority on both federal surface and federal mineral interests (subsurface) with the BLM being the permitting agency. The unpatented claims on public lands are handled by the Bureau of Land Management, while the ones on private lands are handled by the Colorado Division of Reclamation, Mining and Safety.

Mineral rights on land within AOI that are owned by the federal government are identified in Figure 14 below. Mineral rights are the right of ownership of the mineral resources under/in a tract of land (generally subsurface). Mineral resources also include oil and gas. Information on the location of federal subsurface mineral rights land can be found on the Colorado Oil and Gas Conservation's website using the interactive mapping software online. The BLM maintains Surface and Mineral Land Status maps showing ownership status (i.e., federal, state or private ownership). The potential for future minerals development in Mineral County depends on the future economic and resource needs on both public and private lands.

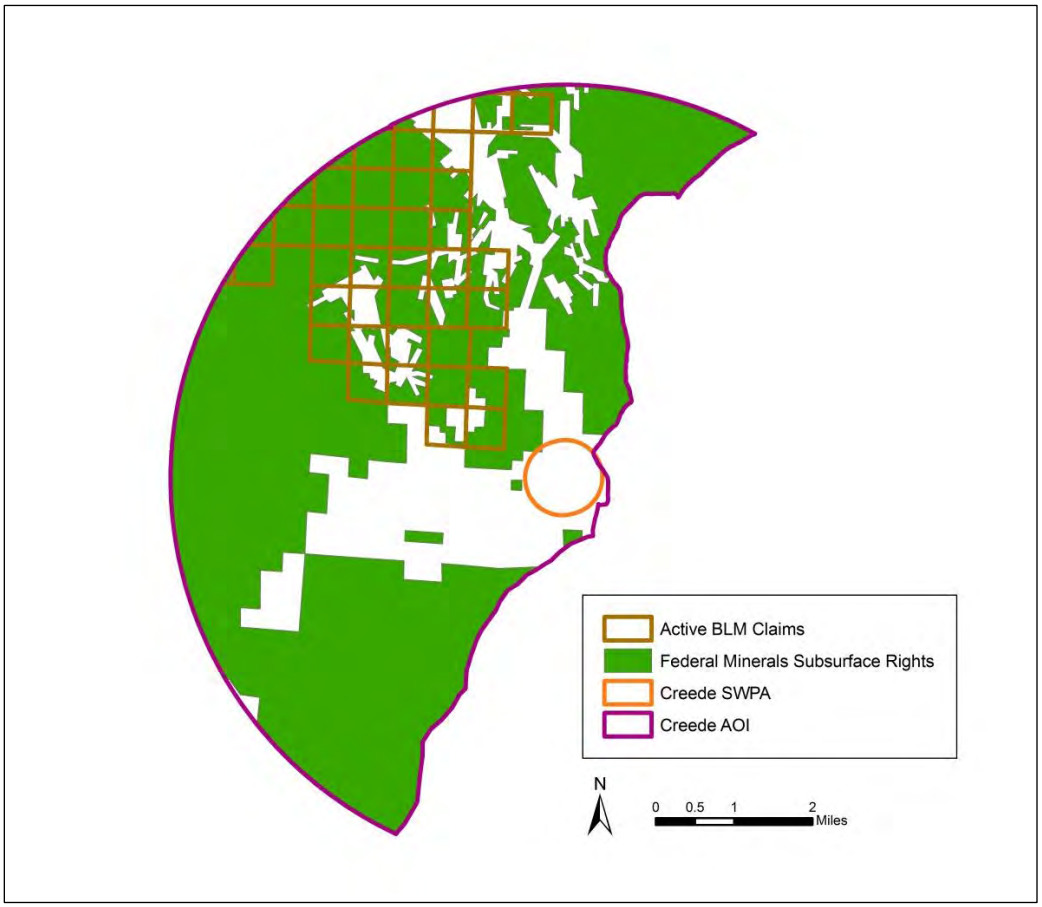


Figure 14. Map of areas where future mineral development may occur.

Water Quality Concerns

The historic mining activity has resulted in a potential for heavy metal and other mining-related contamination to occur throughout the Creede AOI. Active and inactive mining operations have a potential to contaminate drinking water supplies from either point source discharges (i.e., mine drainage tunnels of flowing adits) or nonpoint source discharges from run-off over waste rock or tailing piles. Acidic, metal-laden water emanating from inactive mines and waste rock piles has a potential to impair aquatic life in adjacent streams, and to a lesser degree threaten human drinking water sources.

Mining Recommendations:

1. Stay informed and participate in collaborative effort underway to mitigate impacts from mining within the Creede SWPA and AOI.
2. Evaluate water quality monitoring data to characterize the effects of mining, mined land reclamation activities and impact of abandoned mine lands.
3. Participate in the River Watch program to monitor the raw water quality upstream of the City's wells.
4. Get involved in the review process for new mining activity permits at the State and County level including unpatented claims on both public and private lands. Contact Johnie Abad, Colorado Division of Reclamation, Mining and Safety for hearing notifications at (303) 866-3567 or Johnie.A.Abad@state.co.us. Regularly check the DRMS website http:mining.state.co.us/Pages/Home.aspx for activity in the Creede area.
5. Frequently check the County website to keep informed of any mine related permits, hearings, and opportunities to submit comments.

Transportation on Roads

The source water protection area, located outside the boundaries of the City of Creede, is accessed by two-lane paved and native surface roads on county land. Highway 149, the main route through Mineral County and the City of Creede is also called the Silver Thread Scenic Byway, designated as a National and State Scenic Byway in 1990. Within the near zone adjacent to the City's wells, lie a network of native surface roads accessing the newly built K-12 school, the Mineral County Airport, and residential subdivisions.

Roads in the SWPA and AOI are maintained by Mineral County Road and Bridge Department, U.S. Forest Service Rio Grande National Forest, and Colorado Department of Transportation. The roads in the protection areas are used for residential, utility, school, business, tourism and recreational access. Thousands of visitors travel over the Silver Thread Scenic Byway every year, with the majority of use occurring in summer and fall.

Vehicular Spills

Vehicular spills may occur along the transportation route within the source water protection area from trucks that transport fuels, septic waste and other chemicals that have a potential for contaminating the source waters. Accidental spills of small amounts of contaminants may not be detected or reported and are often diluted with rain water or snowmelt, potentially washing the chemicals into the soil or nearby waterways. Large spills require immediate emergency response from the local fire department to ensure contaminants do not enter the source waters.

Motor vehicle leaks may also occur in parking areas at the school and airport. Motor vehicles leaks are a major source of water pollution to both surface and ground water. Vehicular leaks on the roadway may runoff during storm events and deliver contaminants from the road surface into nearby creeks. Runoff from roads may have a high concentration of toxic metals, suspended solids, and hydrocarbons, which originate largely from automobiles (Gowler and Sage, 2006).

A release of any chemical, oil, petroleum product, sewage, etc., which may enter waters of the state of Colorado (which include surface water, ground water and dry gullies and storm sewers leading to surface water) must be reported immediately to CDPHE. Spills and incidents that have or may result in a spill along a highway must be reported to the nearest law enforcement agency immediately. The Colorado State Patrol and CDPHE must also be notified as soon as possible (CDPHE, 2009). More information on "Environmental Spill Reporting" can be found in the Appendices of this report.

During winter, road maintenance personnel plow and apply a salt and sand mixture as a deicer to roads within the source water protection area. A recent study conducted by the U.S. Geological Survey demonstrates a detrimental impact from road-salt runoff to surface water affecting the stream water quality and aquatic life (Corsi, et al, 2010). Salt contributes to

increased chloride levels in groundwater through infiltration of runoff from roadways. Unlike other contaminants, such as heavy metals or hydrocarbons, chloride is not naturally removed from water as it travels through soil and sediments and moves towards the water table. Once in the groundwater, it may remain for a long time if groundwater velocity is slow and it is not flushed away. Chloride may also be discharged from groundwater into surface water and can account for elevated levels of chloride throughout the year, not just in winter. In high concentrations for extended periods, chloride in streams is toxic to aquatic life (Wood, et al, 2005).

Figure 15. Placing signage along the road corridor within the source water protection area is one way of educating travelers on how to notify emergency personnel if a contamination should occur.

Transportation Corridor Recommendations:

1. Educate the public on how to respond to a hazardous spill by calling 911. This can be done with signage on roadways along with information in a public brochure distributed to residents and visitors in the protection area (Fig. 16). Obtain prior approval from the County Planning Department prior to constructing signage on roadways

2. Work with local emergency response teams to ensure that any spill within the protection area can be effectively contained and proper protocols are followed for clean-up of hazardous materials spilled within the transportation corridors. Refer to the County Emergency Management Plan.

3. Provide a copy of the Source Water Protection Plan and map of the SWPA and AOI to Mineral County Road and Bridge Department, U.S. Forest Service Rio Grande National Forest, Mineral County Fire Protection District and CDOT.

4. Request to be notified by Mineral County when a hazardous spill occurs within the SWPA.

5. Purchase small spill kits to be used by utility, managers, and responders within the SWPA.

Public Land Management

Public lands within the Creede AOI, owned by the federal government, are managed by the U.S. Department of Agriculture's Forest Service. The source waters for the City of Creede AOI originate on Rio Grande National Forest land managed by the Divide Ranger District located at 13308 West Highway 160, Del Norte, Colorado. There is also a satellite office for the Divide Ranger District located in Creede at 304 South Main Street. The source waters have a potential to be directly affected by land use or forest management activities and decisions.

Protecting Water Resources

A principal purpose for which the Forest Reserves (predecessor to the National Forest System) were established was to "secure favorable conditions of water flows" (Organic Act of 1897). Throughout its history, the U.S. Forest Service has had a very diverse and broad mission of multiple use management outlined by the Federal Land Policy and Management Act. The Act requires a balance of outdoor recreation and preservation of wildlife habitat, air and water, and other scenic and historical values with environmentally responsible commercial development of the land and its resources. The USFS mandate to manage lands for multiple-use requires balancing present and future resource use with domestic water supply needs as well as many other needs.

One of the long-term management goals of the Rocky Mountain Region is to manage the forest for water resources:

> *"Protect the resource. Maintain, and where opportunities exist, restore watershed and forest health to ensure full watershed function exhibiting high geomorphic, hydrologic, and biotic integrity. Ensure that forest management activities occur in a manner that will adequately protects the integrity of watersheds" (USFS, 2010).*

In October 2009, the Forest Service Rocky Mountain Region and the State of Colorado Department of Public Health and Environment (CDPHE) signed a Memorandum of Understanding (MOU) to establish a framework to work together on issues regarding the management and protection of water quality on state defined Source Water Assessment Areas on National Forest System lands in Colorado. Under this agreement, the Forest Service recognizes a CDPHE-delineated Source Water Area as a "Municipal Supply Watershed" per definition in USFS Manual 2542 (FSM, 2007). Municipal watersheds are to be managed under multiple use prescriptions as specified in the Rio Grande National Forest Land and Resource Management Plan (Forest Plan). The need to protect public water supplies is to be recognized when developing management area prescriptions. The MOU was updated in 2014 and included in the Appendices of this report (MOU, 2014).

Forest Plan

At the district level, the Divide Ranger District adheres to the management directives established under the 1996 Revision of the Land and Resource Management Plan (Forest Plan) for the Rio Grande National Forest. The Forest Plan identifies management area prescriptions with directions for activities and management practices to be followed within the specified area (Fig. 16) (USDA, 1996). The Rio Grande National Forest is currently revising its Forest Plan and has completed the Assessment Phase of the revision.

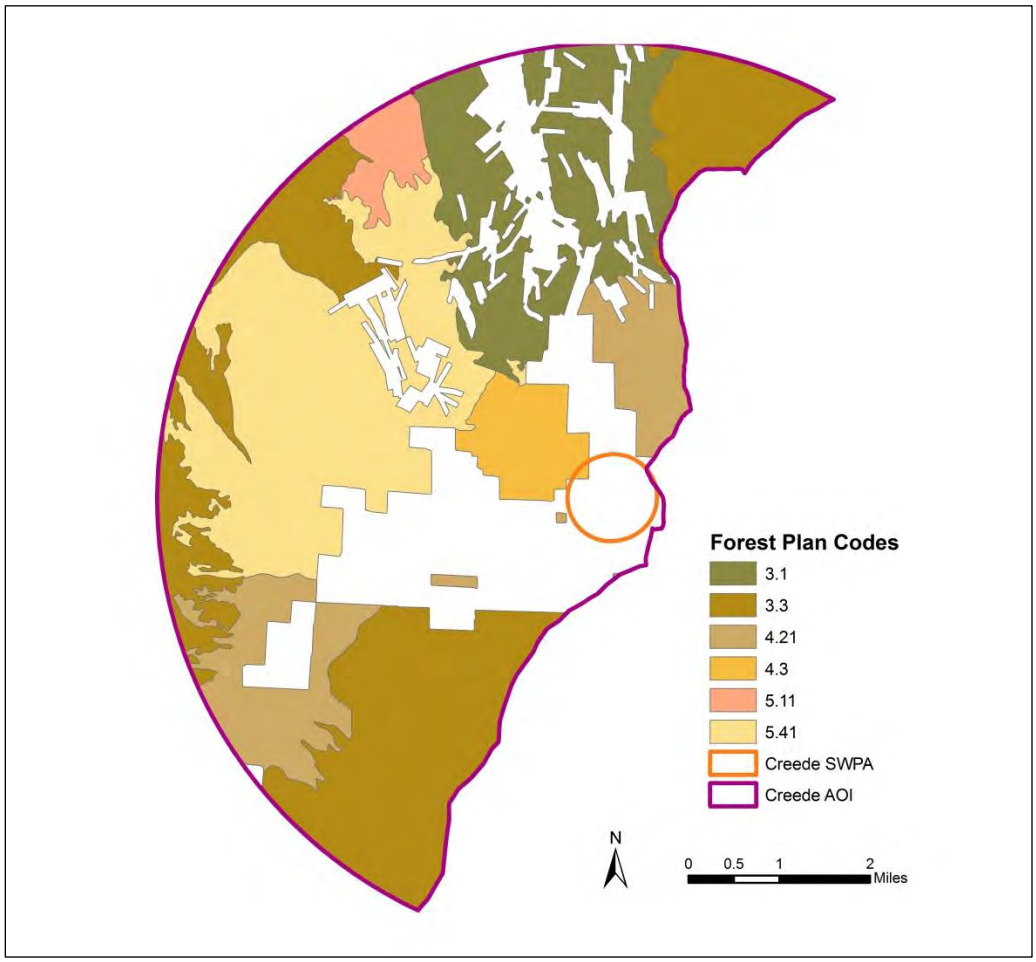


Figure 16. The Forest Service land within the Creede Area of Interest has the following management area prescription:

- 3.1 – Special Interest Areas
- 3.3 – Backcountry
- 4.21 – Scenic Byways or Railroads
- 4.3 – Dispersed Recreation
- 5.11 – General Forest and Rangelands Forest Vegetation Emphasis
- 5.41 – Deer and Elk Winter Range

Forest Health Conditions

The overly dense forests throughout the Rocky Mountains are concentrated with older age classes of trees that lack diversity in age and size. This lack of diversity, along with intense competition for resources has left many forest stands vulnerable to insect and disease attacks and widespread damage. In Colorado, the mountain pine beetle (*Dendroctonus ponderosa*) has affected 3.4 million acres since 1996. The epidemic has ended in many areas of Colorado, as mature trees have been depleted in the core outbreak areas.

The U.S. Forest Service Rocky Mountain Region 2 conducts aerial and ground surveys annually over western conifer and aspen forest to detect damage caused by defoliating insects. The aerial detection survey conducted in 2012-2014 provides us with current information on insect damage in and surrounding Creede's protection area as indicated in Figure 17 (USFS, 2014).

Tree mortality is a continuing problem in high-elevation subalpine fir (*Abies lasiocarpa*). The 2012-2014 survey showed pockets of subalpine fir mortality in the AOI and surrounding area. The subalpine fir mortality in these areas is from both insects and disease. Mortality is attributed to a combination of the western balsam bark beetle (*Dryocoetes confuses*) and two species of root decay fungi (*Armillaria* sp. and *Heterobasidion annosum*) (Harris et al, 2011).

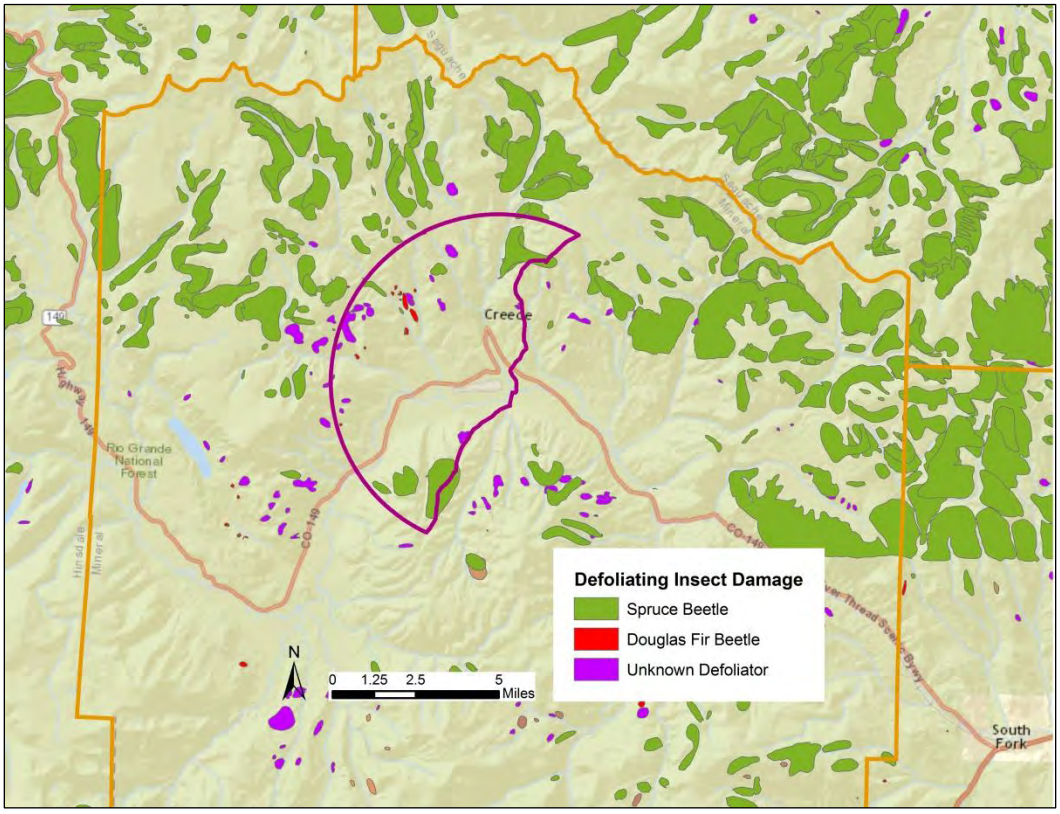


Figure 17. Map of the defoliating insect damage in and surrounding the Creede SWPA and AOI from the 2012-2014 aerial surveys.

Timber Harvesting and Fuels Management

Forest management activities, such as timber harvesting and fuels management, can potentially generate several forms of non-point pollution. Disturbance of land surfaces from road construction, log landings, and skid trails is the primary cause of sediment transport into streams from this activity. Other potential impacts include debris from timber harvesting ending up in the stream, oils and fuels used in machinery washing into streams, and an increase in temperature levels as a result of clearing timber along stream banks. Implementing water conservation practices, BMPs, guidelines, and proper design criteria are typically effective in preventing or reducing sediment delivery to water bodies (SJNF, 2008). All forest management activities include BMPs consistent with the Revised Rio Grande Forest Plan to maintain and protect water quality.

Public Land Recommendations:

1. Keep informed and participate in public land management issues/activities at the district and regional level including: Forest Plan revisions, fuels reduction plans, environmental analysis documents for vegetation management projects, allotment range management plans, wilderness designations, timber management plans, travel management and other outreach opportunities. Provide written comments to public land managers on source water protection concerns.

2. Provide the Divide Ranger District with a copy of the Source Water Protection Plan and GIS shape files on the location of the intake and protection area.

3. Actively foster an open, collaborative relationship with the following groups to protect water quality in the watershed: U.S. Forest Service Divide Ranger District; Mineral County; Willow Creek Restoration committee; Rio Grande Silver, Inc.; Deep Creek Water and Sanitation; Division of Reclamation, Mining and Safety; Colorado Department of Public Health and Environment; and the Environmental Protection Agency.

4. Support efforts to improve watershed conditions (i.e., fuels reduction activities, wildfire assessment, and reclamation projects).

Wildland Fires

Wildland fires have burned throughout the upper Rio Grande watershed throughout history as observed by charred stumps, snags and large aspen stands dating back to the late 1800s. Wildfires were less prevalent during the 1900s due in part to a moister climate and to rapid initial attack of small fires. The recent increase in wildfire numbers and intensity is attributable to a dense forest with fuel build-up from a century of fire suppression and thus more vulnerable to high-intensity fires than it was historically. The prolonged drought, low fuel moistures and periods of high winds also makes the forest more prone to hot wildfires (MCFPD, 2009). Most of Colorado's wildfires are caused by lightning strikes from the many thunderstorms that pass through the state on a regular basis during the summer months.

Community Wildfire Protection Plan

In 2009, the Mineral County Fire Protection District (FPD) completed their Community Wildfire Protection Plan (CWPP), which covers the northern part of Mineral County that is located near the headwaters of the Rio Grande River. The Mineral County FPD provides both structural and wildland fire protection to private lands in Mineral County. The U.S. Forest Service provides protection for the public land that cover approximately ninety five percent of the county.

The overall risk within Mineral County FPD from wildland fire varies depending upon a wide variety of factors such as fuel hazards; risk of ignition and wildfire occurrence; community values at risk; and local preparedness and protection capability. The CWPP identified the following subdivisions within the SWPA and AOI as having a moderate fire hazard risk based on slope, aspect and vegetation: River Crest Acres, Moonshine Mesa Ranch, Moonshine Mesa, Carnan Ranch Estates, Vista Grande Elk Valley, and Holiday Acres (Fig. 18).

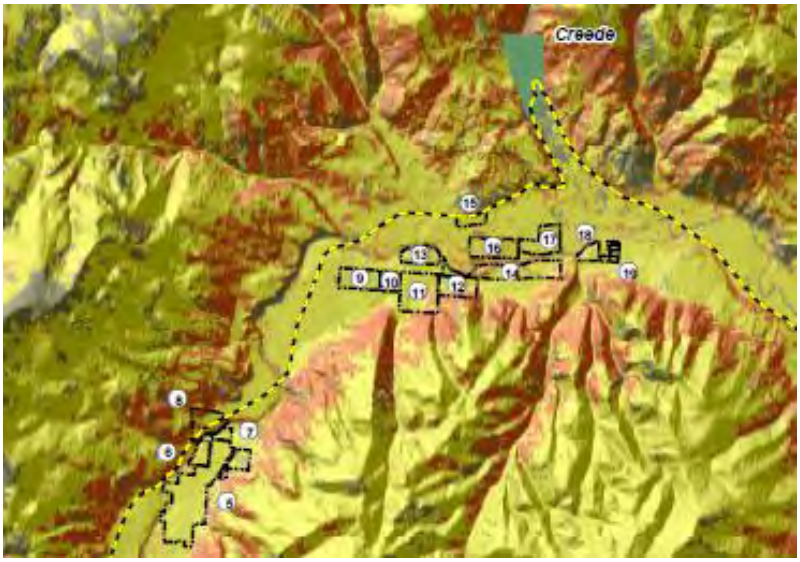


Figure 18. Map of fire hazard risk in areas near the city's wells.

The Community Wildfire Protection Plan identifies strategies for the community and land managers to implement to reduce the impacts of wildfire to the community and maintain a healthy watershed. Essential to the success of the plan is the involvement of the private landowners who are responsible for completing mitigation work on their own lands (MCFPD, 2009).

Water Quality Effects from Fire

The degree to which wildfire degrades water quality and supply depends on wildfire extent and intensity, post-wildfire precipitation, watershed topography, and local ecology. Potential effects of wildfire on municipal water supplies and downstream aquatic ecosystems include the following:

- Changes in the magnitude and timing of snowmelt runoff, which influence filling of water-supply reservoirs,
- Increased loading of streams by nutrients (nitrogen and phosphorus), dissolved organic carbon (DOC), major ions, and metals,
- Post-fire erosion and transport of sediment and debris to downstream water-treatment plants, water-supply reservoirs, and aquatic ecosystems, and
- Changes in source-water chemistry that can alter drinking water quality (Writer & Murphy, 2012).

Variable source-water quality presents challenges for drinking-water providers. Drinking-water treatment processes operate more effectively when source-water quality is constant, DOC concentrations are below 5 milligrams per liter (mg L–1), and turbidity (an indicator of suspended material) is less than 20 nephelometric turbidity units (NTU). Elevated nitrate concentrations can promote algal growth in water supply reservoirs, which can increase DOC concentrations and lead to disagreeable taste and odor (Writer & Murphy, 2012).

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Post-fire impacts to water quality occurred during “first flush” storm events, snowmelt, and high intensity thunderstorms. Thunderstorms can transport substantial amounts of sediment and debris from hillslopes of the burned area into the source waters. Even though the city of Creede’s drinking water source is from the alluvial aquifer, there may be a potential for impact to the shallow groundwater from a catastrophic wildland fire in the nearby watershed. The U.S. Forest Service conducts Burned Area Emergency Response (BAER) assessments following wildfire and identifies possible treatments to reduce the effects of wildfire on municipal water supply.

Wildland Fire Recommendations:

1. Refer to the Mineral County Fire Protection District’s Community Wildfire Protection Plan as guides to understand wildfire risks and measure that may reduce risk.
2. Share maps, GIS shapefiles, and Emergency Notification Cards with the USFS and County.
3. Support fuels reduction efforts on public and private lands.

Drought

According to the U.S. Drought Monitor web site run by the National Drought Mitigation Center (NDMC) at the University of Nebraska, Colorado is experiencing severe drought. The Drought Monitor listed two-thirds of Colorado in extreme drought. The NDMC maintains climate and drought data for the entire United States and publishes regular updates on the web.

Drought is an extended period of months or years when a region has a deficiency in its water supply whether surface or groundwater. When precipitation is reduced or deficient over an extended period of time, this shortage will be reflected in declining surface and groundwater levels. Drought conditions have prevailed throughout the upper Rio Grande Basin through much of the past decade, including the driest year on record in 2002.

In Colorado, temperatures have increased by approximately two degrees between 1997 and 2006. Climate models project Colorado will warm by four degrees by 2050. This, combined with a seasonal shift in precipitation, warmer spring temperatures, and increase evaporation rates, will result in an impact to Colorado's water resources (CWCB, 2008). The Rio Grande Basin is expected to experience warmer temperatures and receive decreased precipitation. Variability in weather is projected to increase due to climate change. More frequent extreme weather events such as drought, flood and early runoff are expected. Extreme weather events such as drought, flood and early runoff put a strain on infrastructure and require different policies than with the more consistent climate that Colorado has experienced in the past (DiNatale, 2014).

Drought conditions may result in both short term and long term impacts. In order to appropriately address and reduce drought-related impacts, it is imperative for municipal water providers throughout the state to anticipate and plan for droughts. The Colorado Water Conservation Board recommends that water providers develop a Drought Mitigation Plan to preserve essential public services and minimize the adverse effect of a water supply emergency. The drought plan would identify actions and procedures for responding to a drought-related water supply shortage before an actual water supply emergency occurs.

Drought Recommendations:

1. Stay informed on the effects of future climate changes and impacts to the water sources.
2. Understand the vulnerability of the City's water supply and assess the need to build additional water storage.
3. Monitor the U.S. Drought Monitor monthly to stay informed on drought conditions in Colorado.
4. Prepare plans for rapid response to severe wildfire, flood, drought and geologic events.
5. Implement water conservation measures as needed.

Flooding

Flooding was identified by the steering committee to be a high risk to create a major impact to the city of Creede's water system. Flooding occurs when soils become saturated from prolonged rains and/or snowmelt runoff during spring months. If runoff or rain continues, water begins to accumulate faster than it can be absorbed or carried away in stream channels, stream levels begin to rise and eventually overflow the normal stream channel.

The Rio Grande River is the greatest source of flood hazards. Mineral County is particularly vulnerable to flooding related to severe weather events between May and June when snowmelt runoff is flowing. There were six documented major flood events in Mineral County between 1970 and 2005 (35-year period). Therefore, there is a 17% chance of a major flood event occurring any given year. The probability of a major flood event occurring in Mineral County is once every 5.8 years (MCMHMP, 2010).

A general flood event occurs over a minimum period of at least a few hours and can take days to reach flood crest height as seen with the September 2013 flooding in Boulder County, Colorado. A flash flooding event is usually short in duration and can happen so fast that little warning can be given. Flash flooding can also occur from upstream dam failure.

Localized flooding and debris-flow activity producing sediment-laden water can threaten or destroy bridges, culverts, and any other structures in the floodplain. Erosion from flood events can undercut and destroy structures that would otherwise receive little damage from inundation.

The potential for flooding can change and increase through various land use changes (development in the floodplain) and changes to land surface (wildfires). Wildfires create hydrophobic soils, a hardening or "glazing" of the earth's surface that prevents rainfall from being absorbed into the ground, thereby increasing runoff, erosion, and downstream sedimentation of channels (MCMHMP, 2010). Climate-driven changes to the hydrological system may likely increase the frequency, magnitude, and cost of extreme weather events.

Flooding Recommendations:

1. Include flood preparedness and an evacuation plan in the County's Emergency Response Plan, Hazard Mitigation Plan and the local fire departments plan.

2. Refer to the Mineral County Multi-Hazard Mitigation Plan.

3. Continue to pursue obtaining a FIRM floodplain map from FEMA for Mineral County.

Dam Failure

Dams are manmade structures built for a variety of uses, including flood protection, power, agriculture, water supply, and recreation. Dams are typically constructed of earth, rock, concrete, or mine tailings. Two factors that influence the potential severity of a full or partial dam failure are the amount of water impounded and the density, type, and value of development and infrastructure located downstream.

Dam failures can result from any one or a combination of the following causes:

- Prolonged periods of rainfall and flooding, which result in overtopping
- Inadequate spillway capacity resulting in excess overtopping flows
- Internal erosion caused by embankment or foundation leakage, piping, or rodent activity
- Improper design, maintenance or negligent operation
- Earthquake
- Upstream dam failure

Dam safety and dam failure is a concern to the City of Creede, whose water infrastructure lies directly downstream in the Rio Grande's riparian corridor. There are 30 dams in Mineral County, 3 of which lie within the Creede AOI: Bristol Head #2 reservoir, Santa Maria reservoir, and Broadacre Lake (MCMHMP, 2010). Further upstream within Hinsdale County there are 3 dams: Rio Grande, Continental and Road Canyon Reservoirs (Table 7). If the Rio Grande Reservoir breached it would impact the City of Creede. If the Road Canyon Reservoir breached it would impact the Rio Grande Reservoir and the City of Creede. If the Continental Reservoir breached it would impact the Santa Maria Reservoir (HCAHMP, 2003)

There are no known previous dam failures in Mineral and Hinsdale County. There is less than 1 percent chance of occurrence in the next 100 years. The State of Colorado requires Emergency Action Plans (EAPs) for all High and Significant Hazard dams due to the increased potential for loss of life and/or property damage in the event of a dam failure. These plans help to manage and mitigate the risks posed by the county's dams. Should an emergency arise, the dam owner should refer to preplanned EAP procedures for issuing an early warning and notifying downstream emergency management authorities of the situation. All 3 dams in Mineral County within the AOI have EAPs.

The State's Dam Safety Program is administered by the Colorado Division of Water Resources' Dam Safety Branch. The branch carries out two principal duties of the State Engineer: to determine the safe storage level of reservoir dams in the state; and to approve plans and specifications. The branch conducts scheduled dam safety field inspections of existing dams.

Table 7. Dams within the Creede Area of Interest

Name	Drainage	Owner	Type	Purpose	Built	Storage (Acre-Ft)	Inspection Date	County	Hazard Potential
Bristol Head #2	Seepage Creek	John Rhoads	Earth	Irrigation	1928	540	10/28/2008	Mineral	
Santa Maria	Boulder Creek-OS	Santa Maria Reservoir Company	Earth	Irrigation	1911	49,400	7/18/2012	Mineral	
Broadacre Lake	Shallow Creek	La Soleil, LLC	Earth	Recreation	1956	130	8/25/2011	Mineral	
Road Canyon Reservoir	River Road Canyon Creek	Colorado Parks and Wildlife	Earth	Recreation	1908	1,367	7/13/2011	Hinsdale	Medium
Rio Grande Reservoir	Rio Grande River	San Luis Valley Irrigation District	Earth	Irrigation	1914	52,192	7/17/2012	Hinsdale	Medium
Continental Reservoir	North Clear Creek	Santa Maria Reservoir Company	Earth	Irrigation	1914	22,679	7/17/2012	Hinsdale	Medium

SOURCE: NATIONAL INVENTORY OF DAMS, U.S. ARMY CORPS OF ENGINEERS

Dam Failure Recommendations:

1. Monitor conditions of the reservoir/lakes dams in the upper Rio Grande watershed that have a potential to impact the city of Creede and its water resources: Bristol Head #2, Santa Maria, Road Canyon, Rio Grande, and Continental reservoirs; and Broadacre Lake.
2. Obtain reports from the Colorado Division of Water Resources annual dam inspection.
3. Consider implementing remote, electronic dam/river flood monitoring systems.
4. Ensure that all dam owners within the Creede AOI have Emergency Action Plans (EAPs).
5. Include dam failure warning, preparedness and an evacuation plan in the City of Creede and Mineral County's Emergency Response Plan.
6. Provide dam owners a copy of the source water protection plan.

Airport Facility

The Mineral County Memorial Airport lies in close proximity to the City of Creede's wells; some within the 500 feet surrounding the wells (Fig. 19). The airport was constructed in 1942 and is owned by Mineral County. The facility consists of a 6880 x 60 ft. asphalt runway and several airplane hangars. Aircraft operators average 38 flights per week (FAA, 2015). The airport site is unattended and currently has no fuel tanks for refueling onsite. In the near future, there are plans for constructing aboveground fuel tank(s) for storage of aviation fuel.

Figure 19. The Mineral County Memorial Airport lies in close proximity to the city of Creede's wells.

Operations and development activities at airports have the potential to affect water resources. The main impact occur as a result of fuel spills during storage, transport and refueling; stormwater runoff over impervious surfaces (i.e., runways); storage of chemical product by airport owners or tenants; and maintenance activities. Chemicals used during airplane maintenance activities center around airplane modifications and engine degreasing. The pollutants of concern include antifreeze, battery acid, oil, grease, paint, and solvents. Volatile organic chemicals are used and may be disposed of on airport property. It is important to prevent the discharge of pollutant to storm water from aircraft, vehicle, and equipment maintenance activities.

Stormwater runoff waters could have a negative impact on both soil and groundwater since it may contain a relatively high concentration of contaminant. The contaminants with the highest risk are the perfluorochemicals (PFCs), benzene, trichloroethylene and carbon tetrachloride. PFCs are a concern because they do not break down in the environment.

Stormwater runoff can be impacted by the usage of chemical for snow and ice removal (Nunes et al, 2011). The pollutants of concern with deicing activities include ethylene glycol and propylene glycol. The Federal Aviation Administration requires airlines and airports that operate during icy conditions to perform deicing and anti-icing of aircraft and airfield pavement. This ensures the safety of passengers and cargo operations. However, when performed without discharge controls in place, these deicing operations can result in environmental impacts. Airports are required to obtain stormwater discharge permits under the NPDES program and ensure that wastes from deicing operations are properly collected and treated.

Best management practices to prevent or minimize exposure of industrial activities to stormwater include good housekeeping, preventative measures, spill prevention and response, facility user training, and stormwater management. It is the responsibility of airport owners to ensure contaminants from their site do not contaminate the valuable groundwater resources.

Airport Activities Recommendations:

1. Ensure appropriate measures are implemented to prevent, control, and/or mitigate spills at the airport facility.

2. Ensure all airport users are trained on the proper handling of materials and on spill control practices to prevent spills from contaminating ground water.

3. Ensure aircraft maintenance activities are conducted inside covered facilities and that any chemical spills/leaks are cleaned up quickly.

4. Provide training for airport facility users on the importance of good housekeeping practices to ensure that there is zero discharge to the soil and groundwater from their maintenance activities.

5. Require universal spill kits be kept inside each building, at fueling site and training conducted on use of kits.

6. Perform visual inspections daily of the fueling area.

7. Require secondary containment for fuel storage tanks.

8. Design fueling areas to prevent storm water runoff by the following: covering fueling areas; diverting stormwater around fueling are; and construct fueling pads with drain and collection system to capture fuel spills and stormwater.

9. Post signage at fueling site educating plane owners on spill prevention and notification; avoid overfilling aircraft during fueling operations; and nearby ground water resources to protect.

Public Relations and Communication

One cannot overemphasize the importance of engaging the local community in the protection of the water quality of the source waters. One of the goals of this Source Water Protection Plan is to create an engaged community that will want to become stewards of their watershed. Providing opportunities to the public to become informed on the workings of the City can include City Board meetings, web-postings on the City's website, community gatherings and special meetings. Fostering good public relations can prevent local citizens from becoming disenfranchised with local government and creating negative effects on the community. Providing opportunities at local meetings for citizens to voice their concerns and participate in the decision making can help to create a healthy empowered community.

Waste Water System

The City of Creede operates a wastewater treatment plant (WWTP) and sewerage collection system for the City and adjacent subdivisions. The WWTP provides sewerage treatment for the City and Deep Creek Water and Sanitation District, which operates a wastewater collection system for subdivision properties in the SWPA and AOI near the airport. The WWTP's lagoons are located east of the City's wells within the SWPA. The WWTP is permitted under the CDPHE National Pollutant Discharge Elimination system (NPDES) regulations to discharge effluent into Willow Creek within the SWPA.

Sanitary sewer systems are designed to collect and transport to wastewater treatment facilities the municipal and industrial wastewaters from residences and commercial buildings. Over the years, many of these systems have experienced major infrastructure deterioration due to inadequate preventative maintenance and replacement programs. These conditions have resulted in deteriorated pipes, manholes, and pump stations that allow sewage to exit the systems (exfiltration) and contaminate adjacent ground and surface waters (Fig. 20). Untreated sewage often contains high levels of suspended solids, pathogenic microorganisms, toxic pollutants, nutrients, oxygen-demanding organic compounds, oil and grease, and other pollutants (Amick and Burgess, 2000).

Sewer leaks can occur from tree root invasion, soil slippage, seismic activity, loss of foundation due to washout, flooding and sewage back up, among other events. High pressure systems will push leaks to the soil surface where they can be easily detected by sight or odor. Systematic inspection of sewer lines, exclusion of hazardous waste, and adherence to modern construction and maintenance specifications are necessary preventative measures for protection of groundwater sources from sewer leaks.

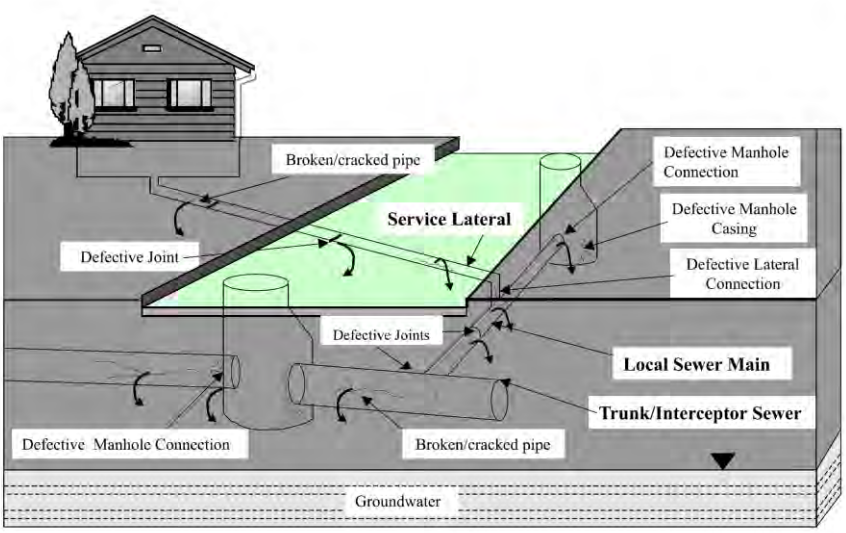

Figure 20. Sanitary sewer system components and exfiltration (loss of water) sources.

Septic Systems

Within the source water protection area, there are properties that rely on septic systems to dispose of their sewage. A septic system is a type of onsite wastewater treatment system (OWTS) consisting of a septic tank that collects all the sewage and a leach field that disperses the liquid effluent onto a leach field for final treatment by the soil (Fig. 21).

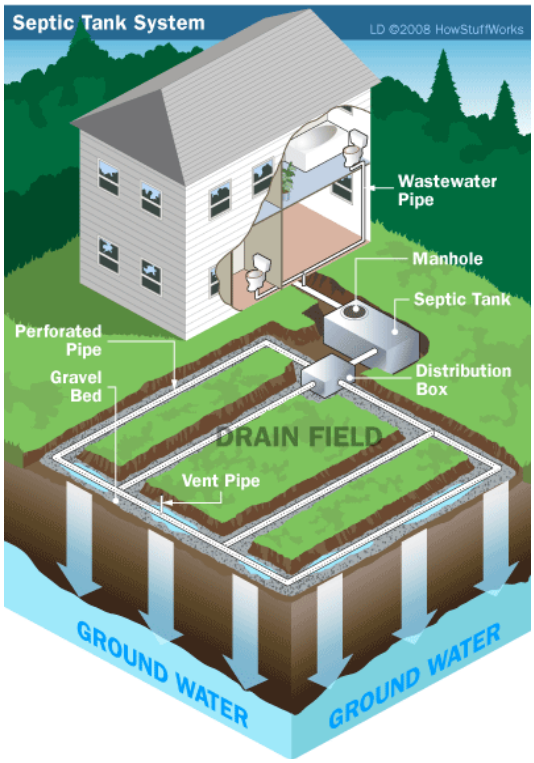

Figure 21. Onsite wastewater treatment system diagram.

Septic systems are the second most frequently cited source of groundwater contamination in our country. Unapproved, aging, and failing septic systems have a large impact on the quality and safety of the water supply. The failure to pump solids that accumulate in the septic tank will also eventually clog the lines and cause untreated wastewater to back up into the home, to surface on the ground, or to seep into groundwater. If managed improperly, these residential septic systems can contribute excessive nutrients, bacteria, pathogenic organisms, and chemicals to the groundwater.

In Mineral County, onsite wastewater treatment systems are permitted by the county administrator's office. The county administers and enforces the minimum standards, rules, and regulations outlined in the state of Colorado's Revised Statutes (CRS 25-10-105).

Wastewater and Septic System Recommendations:

1. Ensure proper maintenance of wastewater treatment plant, lagoons and sewerage system in the SWPA to prevent contamination of groundwater from pipes leaking and effluent discharge.
2. Develop an emergency response plan for spill and notification to the public in the event of a spill or broken pipes.
3. Educate property owners within the SWPA on the proper use and maintenance of their septic system and how the source of their drinking water can be affected by an inadequate functioning septic system. Develop a list of property owners in the SWPA.
4. Encourage the County to educate property owners when they apply for a septic permit on the link between good septic practices and protecting groundwater.

Car Wash Facility

A commercial car wash facility is planned in the near future within the SWPA near the airport. Managing vehicle washing near drinking water sources is important because the wash water has a potential for percolating through the soil and contaminating the ground water resources. The contaminants in vehicle wash water can cause a variety of health effects, including kidney damage, circulatory system problems, increased cancer risk, and delays in physical or mental development.

Wastewater from the car wash facility will be required to drain into the sanitary sewer provided by the Deep Creek Water and Sanitation District. The design and operation of the washing facility is important to ensure zero discharge onto the ground surface. Warning signs should be posted for facility users instructing them not to dump vehicle fluids, pesticides, solvents, fertilizers, organic chemicals, or toxic chemicals into catch basins. Catch basins are chambers or sumps that collect runoff and channel it to the sanitary sewer.

Wash areas should be located on well-constructed and maintained, impervious surfaces (i.e., concrete) with drains piped to the sanitary sewer. The wash area should extend for at least four feet on all sides of the vehicle to trap all overspray. Enclosing wash areas with walls and properly grading wash areas prevent dirty overspray from leaving the wash area, allowing the overspray to be collected from the impermeable surface. The impervious surfaces should be marked to indicate the boundaries of the washing area and the area draining to the designated collection point.

Regular cleaning of wash areas and grit traps or catch basins can minimize or prevent debris such as point chips, dirt, cleaning agents, chemicals, and oil and grease from being discharge in drains. Using alternative cleaning agents such as phosphate-free, biodegradable detergents for vehicle washing will reduce the amount of contaminants entering drains (EPA, 2001).

Car Wash Recommendations:

1. Ensure the car wash is designed and constructed to prevent zero discharge into the soil and groundwater in the SWPA.
2. Require the operation and maintenance of the facility is conducted in a manner to prevent runoff from the site.
3. Regularly inspect the facility to ensure proper procedures are followed to prevent groundwater contamination.
4. Conduct employee training of operation and maintenance procedures, proper disposal practices, general housekeeping activities, and spill prevention to prevent any pollutants from entering the groundwater.

Automotive Repair Shop

The automotive repair industry is a leading producer of hazardous waste among small businesses. The steering committee identified automotive repair facilities as a potential source of contaminants to the source water protection area. The facility of concern is located within the boundaries of the City of Creede within 200 feet of Willow Creek in the Creede Area of Interest.

Automotive repair shops generate waste when they clean auto parts, change vehicle fluids, and repair and replace equipment. These hazardous wastes have a potential of being discharged to sewers, storm drains, and stormwater runoff into the nearby ground or surface water.

Some actions that an automotive repair and maintenance business can take to help promote drinking water protection area listed below. The steering committee recommends providing this information to the auto repair facility.

Auto Repair/Maintenance Recommendations:

1. Ensure that the operation and maintenance of the facility is conducted in a manner to prevent runoff from the site. Meet with the owner of the facility to discuss prevention management approaches.

2. Encourage the use of the following management approaches to prevent pollution from the site:
    - Replace chlorinated organic solvents with non-chlorinated ones like kerosene or mineral spirits. Use non-hazardous cleaning material when possible
    - Never pour wastes into a storm drain, septic tank, or on the ground. Do not allow floor-cleaning wastewater to runoff of facility into the ground.
    - Run a dry shop. Install drop pans and trays throughout the shop. Use rags and dry absorbent materials for spills. Sweep, vacuum or mop the shop floor rather than hose it down.
    - Be prepared to handle spills. Clean small spills immediately with dry absorbent. Have a spill kit readily available so spills can be cleaned up quickly and properly. Train employees on proper spill response and post emergency numbers in a visible location.
    - Keep liquid containers on impermeable surfaces and store within a berm or other secondary containment to prevent spills from running off into your drains or yard.
    - Ensure proper installation and maintenance of equipment and structures that store and transport chemicals and wastewater through your shop.
    - Properly maintain equipment to reduce waste from leaks or equipment breakdowns.
    - Monitor parked vehicles for leaks, and place pans under leaks to collect the fluids for proper disposal or recycling.

Fuel Storage Tanks

There are 16 permitted fuel storage tank sites (5 active and 11 inactive) within the City of Creede's SWPA and AOI (Fig. 22). Information on the status of Aboveground Storage Tanks (AST) and Underground Storage Tanks (UST) within the source water protection area was obtained from the Colorado Department of Labor and Employment Division of Oil and Public Safety's database via their Colorado Storage Tank Information (COSTIS) website at http://costis.cdle.state.co.us (Table 8).

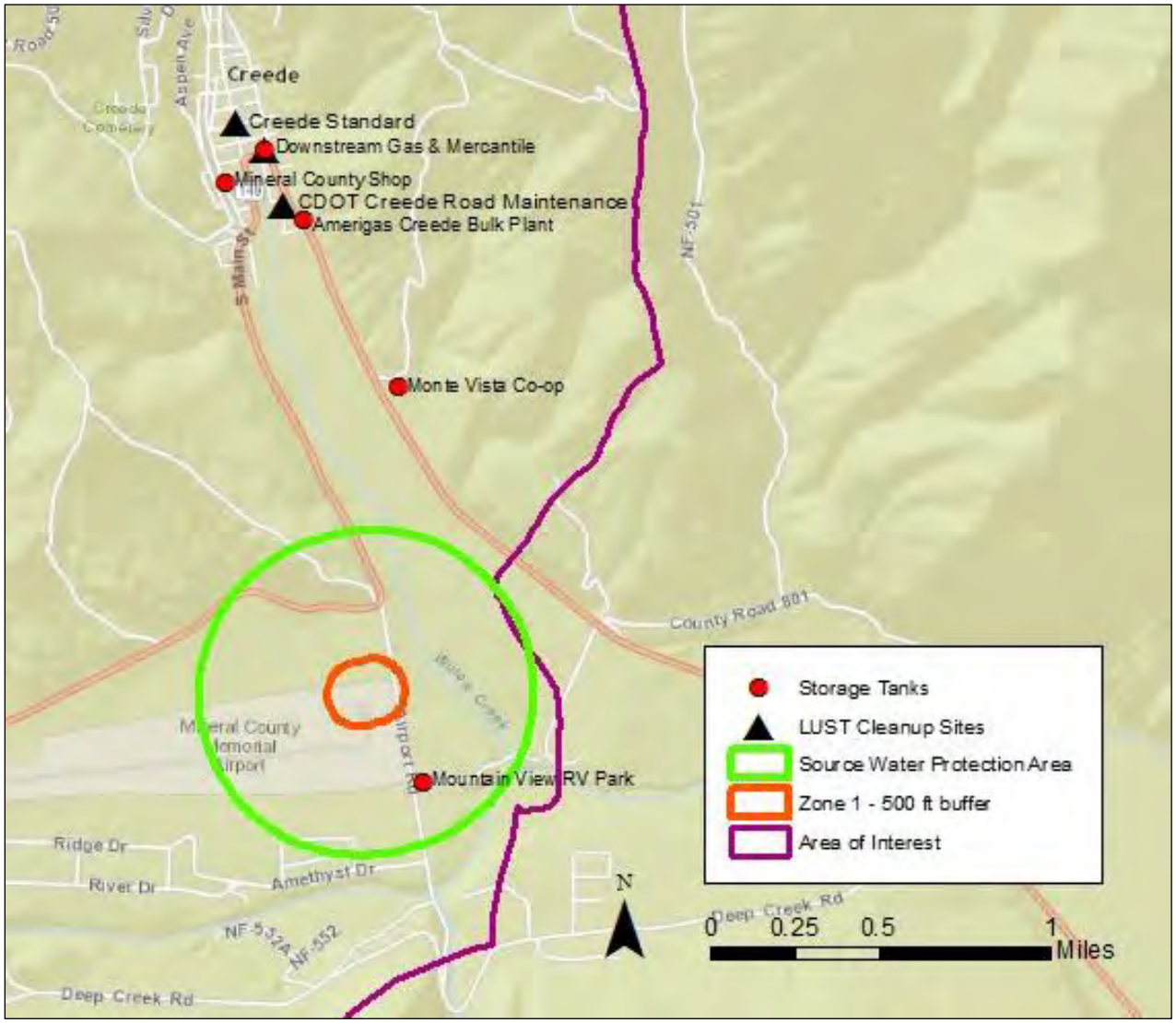

Figure 22. Active storage tank facilities and LUST sites within the source water protection area and area of interest.

Table 8. Storage Tanks within the Source Water Protection Area and Area of Interest

Tank Facility Site	Facility ID #	Status	Spill Event	Information
Downstream Gas & Mercantile 117 East 7th Street	6032	Active	x	5 Underground Storage Tanks (UST) (3 in use, 2 closed). Confirmed Release in 1998 and LUST cleanup completed in 1999.
Amerigas Creede Bulk Plant 21346 Hwy 149	16617	Active		7 tanks (1 LPG in use and 6 closed)
Rio Grande Enterprises, LLC 24263 Hwy 149	19529	Inactive		1 Liquid Propane Gas (LPG)
Freemons General Store 39354 Hwy 149	10936	Inactive		1 Aboveground Storage Tank (AST) closed in 2014
Creede School K-12 450 Corsair Drive	19672	Inactive		2 LPG tanks installed in 2014
Mountain View RV Park 539 Airport Road	18390	Active		1 LPG in use
Creede Standard 5th and Creede Avenue	362	Inactive	x	4 UST closed. Confirmed Release in 1992 & 1998. LUST cleanup completed in 1998.
Bull Dog Mine 623 Road E5	19384			4 tanks (1 LPG closed)
Mineral County Shop 812 Loma	2790	Inactive		1 UST closed
Mineral County Shops 912 Rio Grande Avenue	14638	Active		4 tanks (I AST in use, 3 AST closed)
Monte Vista Co-op Hwy 149 & CR 501	18627	Active		1 LPG tank in use (LPG Bulk Plant installed 2008)
Tyrus B. Poxson Box 189	3613	Inactive		2 UST closed
Pearl Lakes Trout Club Inc. Forest Service Road 515 & 516	7928	Inactive		I UST closed
CDOT Creede Hwy 149	7318	Inactive	x	2 UST closed. Confirmed Release in 1989, LUST cleanup in 1992 and completed in 1996.
Bristol View Guard Station (USFS) Hwy 149	1692	Inactive	x	1 UST closed. Confirmed Release in 1990 and LUST cleanup completed 1997.
David K. Strate San Juan Ranch	6471	Inactive		3 tanks (2 UST closed)

Storage Tank Spills

Four of the storage tank facilities have had underground storage tank spills events, recorded as Confirmed Releases (Table 6). A release means any spilling, leaking, emitting, discharging, escaping, leaching, or disposing of a regulated substance from a storage tank into groundwater, surface water or soils. The owner/operator must report a suspected release within 24 hours and investigate suspected releases within seven days. After confirming a release and conducting the initial response and abatement, the owner/operator must continue further source investigation, site assessment, characterization and corrective actions .All of the sites were cleaned up by the State with federal funding through the Leaking Underground Storage

Tank (LUST) Trust Fund financed by a 0.1 cent tax on each gallon of motor fuel sold nationwide (EPA, 2012).

Spills from leaking underground storage tanks (LUST) sites can contaminate the groundwater and present other hazards (Fig. 23). The leaky underground storage tank releases gasoline or "liquid phase hydrocarbon." The gasoline descends through the unsaturated soil zone to the water table. Because gasoline is lighter than water, gasoline floats on the water table and remains relatively close to the land surface.

The gasoline releases compounds like benzene, toluene, ethylbenzene, and xylenes (BTEX) and methyl tert-butyl ether (MTBE) to the groundwater and they are carried in the direction of groundwater flow. The most hazardous compounds in groundwater (the BTEX compounds) are quite volatile and carcinogenic. The extent of contamination is defined by the concentration of benzene (from 10 to 10,000 parts per billion) in the groundwater.

Besides the potential for being consumed in drinking water, volatile compounds can enter nearby buildings. In poorly ventilated buildings, the compounds can accumulate and present a health risk through inhalation. In buildings, the volatile compounds can also present an explosion hazard (Ryan, 2006).

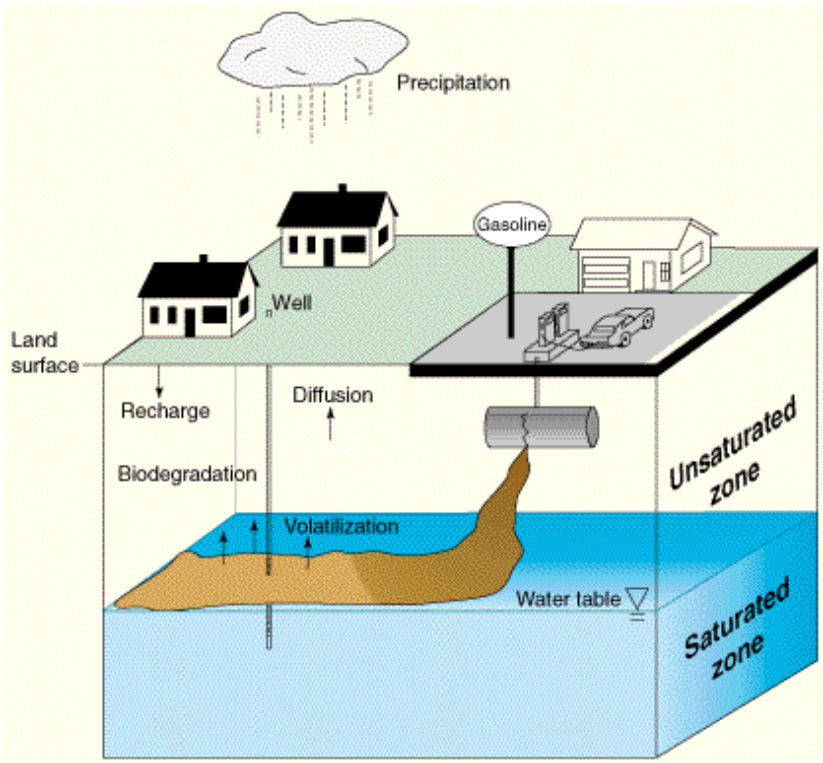

Figure 23. Schematic of a leaking underground storage tank.

Private Fuel Storage Tanks

Rural residents of the source water protection area may have private aboveground storage tanks (AST) containing gasoline for vehicular fuel. The private aboveground storage tanks are a concern because they may be old, subject to leakage and not properly contained. It only takes a small amount of petroleum to contaminate the ground or surface water. The steering committee recommends maintaining a contact list of residents within the source water protection area who have fuel storage tanks used for vehicular fuel.

Figure 24. An aboveground fuel storage tanks with secondary containment.

Fuel tanks should be inspected visually on a regular basis and properly seated on a type of secondary containment structure to prevent spills, allow leaks to be easily detected, and prevent spills from reaching the ground. The containment area should be able to hold 110% of the tank capacity plus freeboard for precipitation. Secondary containment for ASTs must be impermeable to the materials stored (Fig. 24). Methods include berms, dikes, liners, vaults, and double-walled tanks. A manually controlled sump pump should be used to collect rainwater that may accumulate in the secondary containment area. Any discharge should be inspected for petroleum or chemicals prior to being dispersed/released. Accumulated minor spillage, over time, may result in a film or sheen on collected rainwater, making it unsuitable for discharge to the soil or drains. Periodic cleanup of the containment areas (e.g., sweeping with a broom and using limited absorbent) can prevent unnecessary dirt and contaminant buildup.

Fuel Storage Tank Recommendations:

1. Maintain a current inventory and information on the status of regulated above and underground storage tanks in and near the SWPA and AOI using the Colorado Storage Tank Information (COSTIS) website at http://costis.cdle.state.co.us. Storage tank information from this site includes: facility, tank, owner, and events.

2. Identify Leaking Underground Storage Tank (LUST) events that have occurred within the SWPA and AOI using the State's database COSTIS. Contact the Colorado Department of Labor and Employment Division of Oil and Public Safety (303-318-8000) for information regarding LUST events within the SWPA. Contact the Public Records Center for a file review at (303) 318-8521 or (303) 318-8522. Monitor progress on any remedial action conducted for the known contamination sites.

3. Develop an inventory of residential or farm unregulated storage tanks within the SWPA and AOI.

4. Provide information to tank owners on how they can implement storage tank practices to prevent petroleum products from leaking onto the ground (i.e., secondary containment).

Residential Practices

The City of Creede's source water protection area includes rural residential dwellings that use chemicals in their home or operations. Common household practices may cause pollutants to runoff residential property and enter the surface or groundwater as indicated in the picture below (Fig. 25). Prevention of groundwater contamination requires education, public involvement, and people motivated to help in the effort. Public education will help people understand the potential threats to their drinking water source and motivate them to participate as responsible citizens to protect their valued resources.

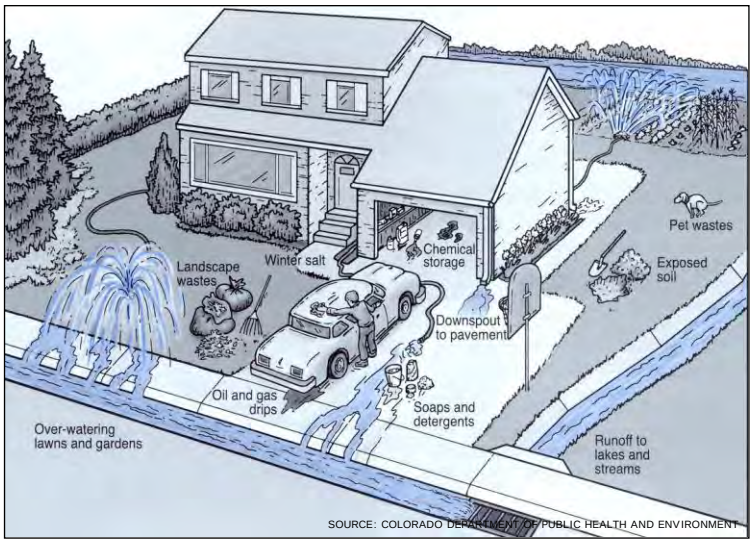

Figure 25. Common household practices may cause pollutants to runoff residential property and enter the surface or groundwater.

Recommendations for Residents:

1. Properly Dispose of Chemicals and Motor Oil – Never pour on the ground, down the drain, or toilet. Participate in household hazardous waste collection events.

2. Use Fertilizers, Herbicides and Pesticides Properly - Apply chemicals according to label instructions and avoid runoff. Do not exceed recommended application rates. Use only if necessary.

3. Properly Dispose of Drugs and Personal Care Products – Participate in medication drop off campaigns. If non available, pour medications into a sealable plastic bag and add kitty litter, sawdust, coffee grounds, or glue and deposit in the trash along with unused personal care products.

4. Dispose of Pet Waste Properly – Flush pet wastes down the toilet, put into the garbage, or bury under 8 inches of soil. Pick up your pet waste when walking your dog.

5. Use Water Wisely – Check for plumbing leaks, use water-saving showerheads and faucets, water laws morning or evenings, avoid over watering, and direct runoff onto vegetative buffers.

6. Purchase Safer Alternative Products – Choose natural alternatives or Green Products.

Growth and Development

The subdivisions located within the source water protection area have a total of 574 platted lots. In 2000, 42% of the lots were built on and 58% vacant (MCCCP, 2000). As of 2015, there are 225 single units built, 15 mobile homes, and 334 vacant residential lots (Table 9, Fig.26).

Table 9. Subdivisions and Lots within the Source Water Protection Area in 2015

Subdivision	Single Family Units	# Mobile Homes	# Vacant Residential Lots	Total lots in each subdivision
Rivercrest Acres	28	0	37	65
Moonshine Mesa	38	0	34	72
Moonshine Mesa Ranch	17	0	13	30
Carnan Ranch Estates	7	0	10	17
Vista Grande	7	0	9	16
Holiday Acres #1	12	1	4	17
Holiday Acres #2	9	8	8	25
Holiday Acres #3	23	6	14	43
Elk Valley	28	0	5	33
Creede Haven #1	46	0	21	67
Creede Haven #2	0	0	95	105
Creede Haven #3	0	0	84	84
Total	225	15	334	574

SOURCE: MINERAL COUNTY

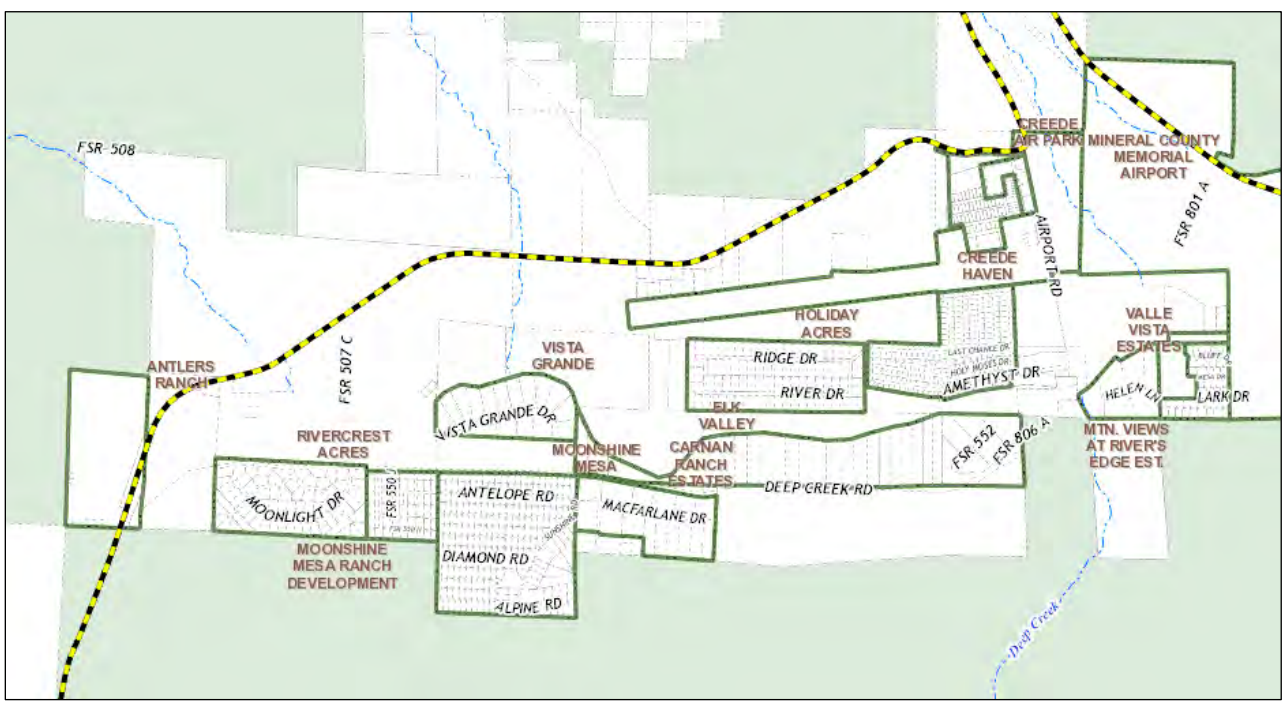

Figure 26. Map of the subdivisions within the source water protection area.

Mineral County has evaluated future population growth and housing needs as indicated in the Mineral County and the Town of Creede Community Plan (Community Plan) completed in 2000. Existing vacant residential parcels in the county would satisfy demand through 2020 at an annual average population growth rate of 2 percent. The existing vacant residential parcels would not accommodate the number of additional units needed at 5 percent average annual growth rate. Total demand for housing units would exceed buildout of existing lots by 235 units in the county (MCCCP, 2000). If Mineral County continues the trend toward providing more residences, there may be additional housing units along the Rio Grande stream corridor.

The Community Plan identifies the preferred growth scenarios with new subdivisions, future business/industrial park and cluster development to preserve open space. Future residential and commercial development in the airport area near the city's wells may have a potential for impacting the water quality of the groundwater alluvial aquifer that supply water to the City of Creede.

The Creede School District has just completed building its new K-12 school that opened in August 2015 for the school year. The school is located on a gravel road that runs next to the city of Creede's wells and water treatment facility. The wellheads are sealed and have no protective structure around them. Damage to the wellheads from a vehicular accident was identified by the steering committee as a potential risk with an increase in traffic on the school road. Encroachment by construction of buildings near the wells has been minimal until recently with the building of the school. The new school can accommodate growth and the site has plenty of space for expansion.

Mineral County and the City of Creede entered into a lease agreement that established the parcel of land on which the city's wells are drilled and the water treatment plant is constructed. This parcel could be enclosed by fence and access limited to authorized personnel only for wellhead protection.

Land Use Planning and Growth Recommendations:

1. Provide Mineral County with a copy of the Source Water Protection Plan and GIS mapping information of the source water protection area and encourage them to overlay this area on their land use maps.

2. Request to be notified by Mineral county officials of land use hearings or meetings regarding land within the SWPA and actively participate in the process to ensure protection of groundwater resources.

3. Participate in future master plan revisions to ensure that planning decisions reflect the desire to protect the City of Creede's drinking water source.

4. Construct fencing or a protective structure around the wells to protect the site from accidents or vandalism.

SOURCE WATER PROTECTION MEASURES

Best Management Practices

The steering committee reviewed and discussed several possible best management practices that could be implemented within the Source Water Protection Area to help reduce the potential risks of contamination to the community's source water. The steering committee established a "common sense" approach in identifying and selecting the most feasible source water management activities to implement locally. The focus was on selecting those protection measures that are most likely to work for the community. The best management practices were obtained from multiple sources including: Environmental Protection Agency, Colorado Department of Public Health and Environment, Natural Resources Conservation Service, and other source water protection plans.

The steering committee recommends the best management practices listed in Table 10, "Source Water Protection Best Management Practices" be considered for implementation by:

- City of Creede
- Mineral County
- U.S. Forest Service Divide Ranger District
- Mineral County Fire Protection District
- Willow Creek Restoration Committee
- Deep Creek Water and Sanitation District
- Rio Grande Silver, Inc.
- Colorado Rural Water Association
- Visitors to the Source Water Protection Area

Evaluating Effectiveness of Best Management Practices

The City of Creede is committed to evaluating the effectiveness of the various source water best management practices that have been implemented. The public will be informed by updates at town meetings and in the annual Consumer Confidence Reports on the outcomes of the various source water best management practices implemented. It is recommended that this Plan be reviewed at a frequency of once every 1-3 years or if circumstances change resulting in the development of new water sources and source water protection areas, or if new risks are identified.

The City of Creede is committed to a mutually beneficial partnership with the Colorado Department of Public Health and Environment in making future refinements to their source water assessment and to revise the Source Water Protection Plan accordingly based on any major refinements.

Table 10. Source Water Protection Best Management Practices

Issue	Management Approach	Partners
Transportation	1. Educate the public on how to respond to a hazardous spill by calling 911. This can be done with signage on roadways along with information in a public brochure distributed to residents and visitors in the protection area . Obtain prior approval from the County Planning Department prior to constructing signage on roadways	City of Creede
	2. Work with local emergency response teams to ensure that any spill within the protection area can be effectively contained and proper protocols are followed for clean-up of hazardous materials spilled within the transportation corridors. Refer to the County Emergency Management Plan.	City of Creede Mineral County Mineral County FPD
	3. Provide a copy of the Source Water Protection Plan and map of the SWPA and AOI to Mineral County Road and Bridge Department, U.S. Forest Service Rio Grande National Forest, Mineral County Fire Protection District and CDOT.	City of Creede
	4. Request to be notified by Mineral County when a hazardous spill occurs within the SWPA.	City of Creede
	5. Purchase small spill kits to be used by utility, managers, and responders within the SWPA.	City of Creede
Wildland Fires	1. Refer to the Clear Creek County Community Wildfire Protection Plan and Watershed/Wildfire Assessment Report as guides to understand wildfire risks and measure that may reduce risk.	City of Creede
	2. Share maps, GIS shapefiles, and Emergency Notification Cards with the USFS and County.	City of Creede Colorado Rural Water Association
	3. Support fuels reduction efforts on public and private lands.	City of Creede Mineral County

Table 10. Source Water Protection Best Management Practices

Issue	Management Approach	Partners
Mining	1. Stay informed and participate in collaborative effort underway to mitigate impacts from mining within the Creede SWPA and AOI.	City of Creede
	2. Evaluate water quality monitoring data to characterize the effects of mining, mined land reclamation activities and impact of abandoned mine lands.	Rio Grande Silver, Inc. Willow Creek Restoration Committee
	3. Participate in the River Watch program to monitor the raw water quality upstream of the City's wells.	
	4. Get involved in the review process for new mining activity permits at the State and County level including unpatented claims on both public and private lands. Contact Johnie Abad, Colorado Division of Reclamation, Mining and Safety for hearing notifications at (303) 866-3567 or Johnie.A.Abad@state.co.us. Regularly check the DRMS website http:mining.state.co.us/Pages/Home.aspx for activity in the Creede area.	City of Creede
	5. Frequently check the County website to keep informed of any mine related permits, hearings, and opportunities to submit comments.	City of Creede
Flooding	1. Include flood preparedness and an evacuation plan in the County's Emergency Response Plan, Hazard Mitigation Plan and the local fire departments plan.	Mineral County
	2. Refer to the Mineral County Multi-Hazard Mitigation Plan.	Mineral County
	3. Continue to pursue obtaining a FIRM floodplain map from FEMA for Mineral County.	Mineral County
Fuel Storage Tanks	1. Maintain a current inventory and information on the status of regulated above and underground storage tanks in and near the SWPA and AOI.	City of Creede Mineral County
	2. Identify Leaking Underground Storage Tank events that have occurred within the SWPA and AOI.	City of Creede
	3. Develop an inventory of residential or farm unregulated storage tanks within the SWPA and AOI.	
	4. Provide information to tank owners on how they can implement storage tank practices to prevent petroleum products from leaking onto the ground (i.e., secondary containment).	City of Creede

Table 10. Source Water Protection Best Management Practices

Issue	Management Approach	Partners
Public Land Management	1. Keep informed and participate in public land management issues/activities at the district and regional level including: Forest Plan revisions, fuels reduction plans, environmental analysis documents for vegetation management projects, allotment range management plans, wilderness designations, timber management plans, travel management and other outreach opportunities. Provide written comments to public land managers on source water protection concerns.	City of Creede Willow Creek Restoration committee Mineral County
	2. Provide the Divide Ranger District with a copy of the Source Water Protection Plan and GIS shape files on the location of the intake and protection area.	Colorado Rural Water Association
	3. Actively foster an open, collaborative relationship with the following groups to protect water quality in the watershed: U.S. Forest Service Divide Ranger District; Mineral County; Willow Creek Restoration committee; Rio Grande Silver, Inc.; Deep Creek Water and Sanitation; Division of Reclamation, Mining and Safety; Colorado Department of Public Health and Environment; and the Environmental Protection Agency.	City of Creede
	4. Support efforts to improve watershed conditions (i.e., fuels reduction activities, wildfire assessment, and reclamation projects).	City of Creede
Wastewater and septic systems	1. Ensure proper maintenance of wastewater treatment plant, lagoons and sewerage system in the SWPA to prevent contamination to groundwater from pipes leaking and effluent discharge.	Deep Creek Water and Sanitation District
	2. Develop an emergency response plan for spill and notification to the public in the event of a spill or broken pipes.	Deep Creek Water and Sanitation District
	3. Educate property owners within the SWPA on the proper use and maintenance of their septic system and how the source of their drinking water can be affected by an inadequate functioning septic system. Develop a list of property owners in the SWPA.	City of Creede Mineral County
	4. Encourage the County to educate property owners when they apply for a septic permit on the link between good septic practices and protecting groundwater.	Mineral County

Table 10. Source Water Protection Best Management Practices

Issue	Management Approach	Partners
Growth and Development	1. Provide Mineral County with a copy of the Source Water Protection Plan and GIS mapping information of the source water protection area and encourage them to overlay this area on their land use maps.	City of Creede Colorado Rural Water Association
	2. Request to be notified by Mineral County officials of land use hearings or meetings regarding land within the SWPA and actively participate in the process to ensure protection of groundwater resources.	City of Creede
	3. Participate in future master plan revisions to ensure that planning decisions reflect the desire to protect the city of Creede's drinking water source.	City of Creede
	4. Construct fencing or a protective structure around the wells to protect the site from accidents or vandalism.	City of Creede
Dam Failure	1. Monitor conditions of the reservoir/lakes dams in the upper Rio Grande watershed that have a potential to impact the City of Creede and its water resources: Bristol Head #2, Santa Maria, Road Canyon, Rio Grande, and Continental reservoirs; and. Broadacre Lake.	Reservoir Owners
	2. Obtain reports from the Colorado Division of Water Resources annual dam inspection.	Mineral County
	3. Consider implementing remote, electronic dam/river flood monitoring systems.	Reservoir Owners
	4. Ensure that all dam owners within the AOI have Emergency Action Plans (EAPs).	Reservoir Owners Mineral County
	5. Include dam failure warning, preparedness and an evacuation plan in the city of Creede and Mineral County's Emergency Response Plan.	City of Creede Mineral County
	6. Provide dam owners a copy of the source water protection plan.	City of Creede

Table 10. Source Water Protection Best Management Practices

Issue	Management Approach	Partners
Municipal Utilities	1. Inspect and protect groundwater wells; be knowledgeable of the emergency response plan, and provide Information concerning the SWPP and implementation measures in the annual Consumer Confidence Report (CCR).	City of Creede
	2. Conduct water quality monitoring according to a monitoring plan.	City of Creede
	3. Implement contingency plan in the event of a disruption in the water source.	City of Creede
	4. Use alternative power source in the event of a power outage (i.e., generator).	City of Creede
Drought	1. Stay informed on the effects of future climate changes and impacts to the water sources.	City of Creede
	2. Understand the vulnerability of the City's water supply and assess the need to build additional water storage.	City of Creede
	3. Monitor the U.S. Drought Monitor monthly to stay informed on drought conditions in Colorado.	Mineral County City of Creede
	4. Prepare plans for rapid response to severe wildfire, flood, drought and geologic events.	Mineral County City of Creede
	5. Implement water conservation measures as needed.	City of Creede
Car Wash Facility	1. Ensure the car wash is designed and constructed to prevent zero discharge into the soil and groundwater in the SWPA.	Mineral County
	2. Require the operation and maintenance of the facility is conducted in a manner to prevent runoff from the site.	Mineral County
	3. Regularly inspect the facility to ensure proper procedures are followed to prevent groundwater contamination.	Mineral County
	4. Conduct employee training of operation and maintenance procedures, proper disposal practices, general housekeeping activities, and spill prevention.	Car Wash Managers

Table 10. Source Water Protection Best Management Practices

Issue	Management Approach	Partners
Airport Activities	1. Ensure appropriate measures are implemented to prevent, control, and/or mitigate spills at the airport facility. 2. Ensure all airport users are trained on the proper handling of materials and on spill control practices to prevent spills from contaminating ground water. 3. Ensure aircraft maintenance activities are conducted inside covered facilities and that any chemical spills/leaks are cleaned up quickly. 4. Provide training for airport facility users on the importance of good housekeeping practices to ensure that there is zero discharge to the soil and groundwater from their maintenance activities. 5. Require universal spill kits be kept inside each building, at fueling site and training conducted on use of kits. 6. Perform visual inspections daily of the fueling area. 7. Require secondary containment for fuel storage tanks. 8. Design fueling areas to prevent storm water runoff by the following: covering fueling areas; diverting stormwater around fueling are; and construct fueling pads with drain and collection system to capture fuel spills and stormwater. 9. Post signage at fueling site educating plane owners on spill prevention and notification; avoid overfilling aircraft during fueling operations; and nearby ground water resources to protect.	Mineral County and Airport Users

Table 10. Source Water Protection Best Management Practices

Issue	Management Approach	Partners
Automotive Repair/Maintenance	1. Ensure that the operation and maintenance of the facility is conducted in a manner to prevent runoff from the site. Meet with the owner of the facility to discuss prevention management approaches.	City of Creede
	2. Encourage the use of the following management approaches to prevent pollution from the site: • Replace chlorinated organic solvents with non-chlorinated ones like kerosene or mineral spirits. Use non-hazardous cleaning material when possible • Never pour wastes into a storm drain, septic tank, or on the ground. Do not allow floor-cleaning wastewater to runoff of facility into the ground. • Run a dry shop. Install drop pans and trays throughout the shop. Use rags and dry absorbent materials for spills. Sweep, vacuum or mop the shop floor rather than hose it down. • Be prepared to handle spills. Clean small spills immediately with dry absorbent. Have a spill kit readily available so spills can be cleaned up quickly and properly. Train employees on proper spill response and post emergency numbers in a visible location. • Keep liquid containers on impermeable surfaces and store within a berm or other secondary containment to prevent spills from running off into your drains or yard. • Ensure proper installation and maintenance of equipment and structures that store and transport chemicals and wastewater through your shop. • Properly maintain equipment to reduce waste from leaks or equipment breakdowns. • Monitor parked vehicles for leaks, and place pans under leaks to collect the fluids for proper disposal or recycling.	City of Creede

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APPENDICES

A. Contingency Plan*

B. Source Water Assessment Report and Appendices

C. Meeting Agendas and Presentations

D. Contact List of Stakeholders Invited to Participate

E. Citizen Guides

F. Contaminant Health Concerns

G. Additional Resource

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I. Glossary

*Notice: This public document will only include information that is not deemed sensitive to the safety and operation of the individual community's water plan operation. Appendices marked with a * are only included in the Public Utility's report or kept on file at their office. All other documents are included on the CD located in the back pocket of this report. All documents can be reprinted.*