City of Boulder
Source Water Protection Plan

July 2017

TABLE OF CONTENTS

Figures

Tables

ACRONYMS

Acronym	Definition
ANS	Aquatic Nuisance Species
AWWA	American Water Works Association
BAER	Burned Area Emergency Response
BCPH	Boulder County Public Health
BFC	Boulder Feeder Canal
BLM	Bureau of Land Management
BMP	Best Management Practice
BTEX	Benzene, toluene, ethylbenzene and xylenes
C-BT	Colorado-Big Thompson
CEC	Contaminant of Emerging Concern
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
COGCC	Colorado Oil and Gas Conservation Commission
CPW	Colorado Parks and Wildlife
CRWA	Colorado Rural Water Association
DRMS	Colorado Department of Reclamation and Mining Safety
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information System
INSTAAR	Institute of Arctic and Alpine Research
LTER	Long Term Ecological Research
MGD	Million Gallons per Day
MOU	Memorandum of Agreement
NEPA	National Environmental Policy Act
NICHE	Nederland Interagency Council on Homeless Encampments
NLCD	National Land Cover Dataset
Northern Water	Northern Colorado Water Conservancy District
OEM	Office of Emergency Management (City and County)
OSMP	Open Space and Mountain Parks (City of Boulder)
OWTS	Onsite Wastewater Treatment System
PSOC	Potential Source of Contamination
RCRA	Resource Conservation and Recovery Act
SWAP	Source Water Assessment and Protection
SWPA	Source Water Protection Area
SWPP	Source Water Protection Plan
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
VOC	Volatile Organic Carbon
WTP	Water Treatment Plant
WWTF	Wastewater Treatment Facility

ACKNOWLEDGMENTS

The City of Boulder (city) is grateful to the many stakeholders who committed to a year-long process and many in-person meetings to develop this Source Water Protection Plan, and to the Colorado Department of Public Health and Environment for providing grant funding. City staff thank Paul Hempel from Colorado Rural Water Association and John Duggan from CDPHE for assisting with meeting planning and facilitation. Thank you to key members of the stakeholder group who routinely attended meetings and/or provided valuable feedback to help develop this document: Eric Schroder (USFS), Erin Dodge (Boulder County Public Health), Andrew Notbohm (OEM), Mike Chard (OEM), Ted Plank (Boulder County Transportation), Jonas Feinstein (USDA), Nicole Bratsos and Chris Pelletier (Town of Nederland), Mitch Galnick (Lake Valley Estates Golf Club), Kristin Cannon (DNR), Mindy May (CPW), and Kayla Evans (Arapaho Ranch). And thank you to the many city staff involved in the process: Kate Dunlap, Michelle Wind, Eric Johnson, Kim Hutton, Bret Linenfelser, Craig Skeie, Edward Stafford, Andy Pelster, and Bethany Collins.

EXECUTIVE SUMMARY

The City of Boulder (city) is fortunate to have several high-quality sources of drinking water, and protecting the water supply is central to the city's water supply management and planning efforts. In April 2016, the city received a grant from the Colorado Department of Public Health and Environment, and facilitation assistance from the Colorado Rural Water Association to formalize current and future protection efforts in a Source Water Protection Plan (SWPP). The city invited nearly 50 stakeholders representing 20 local, state, and federal agencies and organizations, as well as business and land owners, to participate in the SWPP development process. Over the course of a year, the stakeholder group worked to: delineate the source water protection area, identify potential sources of contamination (PSOC), and identify and prioritize voluntary best management practices that the city and its partners can implement to protect the water supply at its source.

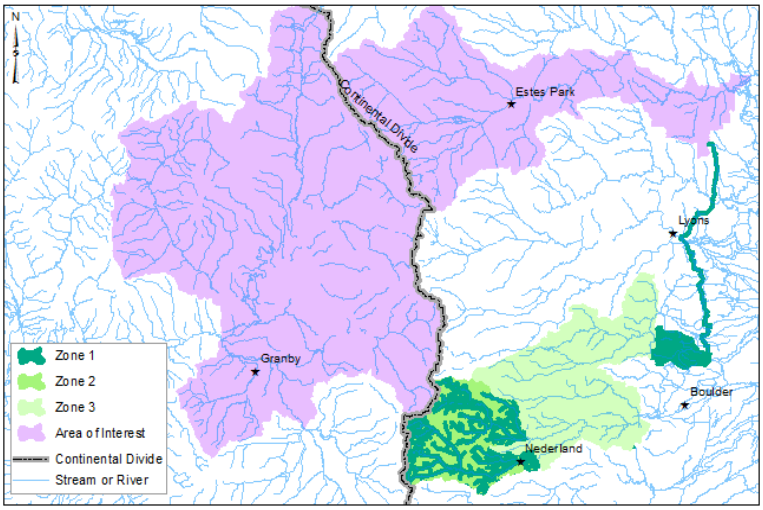

Figure 1. Source Water Protection Area zones.

The city's Source Water Protection Area includes three zones (Figure 1). The city will focus protection efforts primarily in Zone 1, which includes the direct drainages to the source waters. Nearly two dozen types of PSOCs were identified and reviewed during the stakeholder process. Because the city's water comes from several distinct settings, the stakeholder group estimated susceptibility to each PSOC for individual watersheds separately. Overall, the potential for stormwater runoff and erosion/sediment transport impacts from wildfire and floods were among the highest ranked PSOCs. Some watersheds were estimated to be moderately susceptible to contamination from PSOCs that are not currently impacting the system, but are closely monitored by the city for future changes in prevalence (e.g., oil and gas development and aquatic nuisance species). For many PSOCs there is no documented impact, but city staff continue to monitor temporal and spatial changes in water quality to assess any changes (e.g., leaching septic systems, abandoned mine discharges, illegal hazardous waste dumping).

Through the stakeholder group's review and prioritization of the PSOCs, more than 50 voluntary best management practices were identified to protect the water supply. These practices have been compiled into an action plan in this SWPP that will serve as a guide for the city to work with partners towards minimizing potential water quality impacts to the reservoirs and tributaries that contribute to the city's water supply. The city will track best management practice implementation and will assess the effectiveness of implementing water supply protection activities through the city's ongoing water quality monitoring program.

1 INTRODUCTION

Source water protection has long been recognized as a necessary and often cost-effective component of a multi-barrier approach to providing clean, safe drinking water. The City of Boulder (city) relies on surface water supplies, including storage reservoirs. The water supply can be impacted by land use sources such as stormwater runoff from roads and developed areas, wildfire, septic systems, and drainage from abandoned mines. Activities and operations within reservoirs also have the potential to contribute sediment, chemicals, metals, pathogens, and other contaminants to source waters (Figure 2). Removing contaminants through treatment can be costly (or cost-prohibitive) and increasingly challenging as more contaminants become regulated at the state and federal level. Thus, minimizing the introduction of contaminants to the raw water supply is an important aspect of water supply planning.

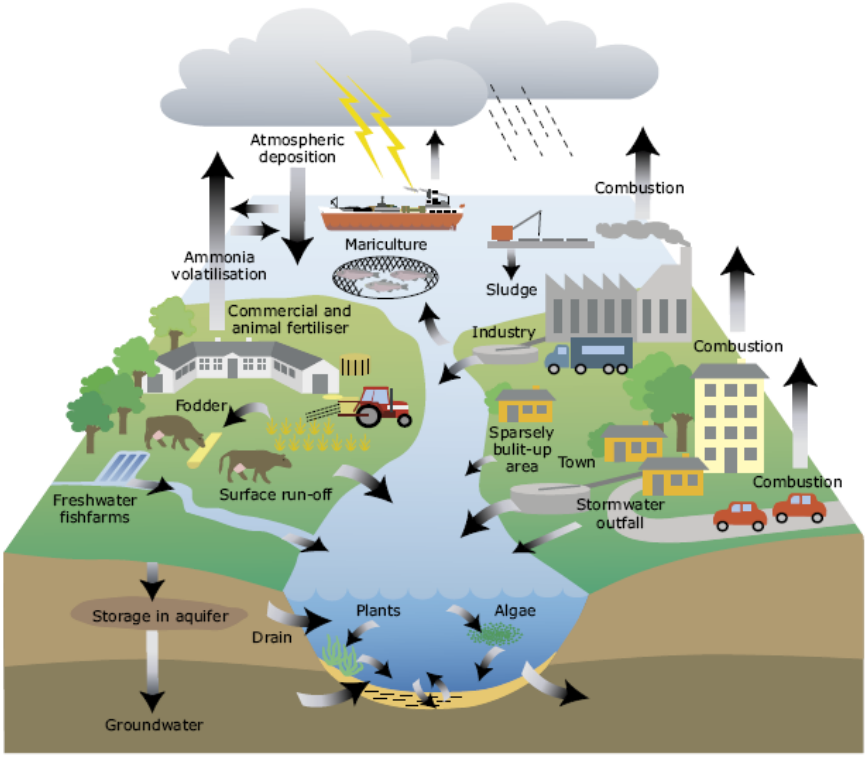

Figure 2. Schematic drawing of potential sources of contamination to surface water and groundwater.

The contents and organization of this report are presented in Figure 3. This public document will not be regularly updated. However, city staff will maintain updated versions of this document on file, with Section 6 and the appendix subject to regular updates as source water protection measures are implemented.

Figure 3. Report organization and contents.

1.1 Purpose of a Source Water Protection Plan

The City of Boulder, Public Water System ID CO0107152, is fortunate to have several high-quality water sources including the reservoirs and streams in North Boulder Creek and Middle Boulder Creek watersheds, and diversions from the upper Colorado River via Carter Lake and Boulder Reservoir. Source water protection is integral to the city's water supply planning. During the late 1800s the city worked to move the drinking water intake closer to the Continental Divide and upstream from mining activities that were introducing contaminants to the creeks. Since the early 1900s, public access to several of the city's water sources has been limited or prohibited, and the city implements a variety of programs that address watershed health and protection. The city's development of multiple sources also provides short- and long-term redundancy and operational flexibility. Overall, the city takes an active role in addressing land use and management issues by working in conjunction with and supporting governmental organizations, private landowners, and other watershed stakeholders to protect the water supply.

This Source Water Protection Plan (SWPP) builds upon previous efforts, and is a tool for the city to help ensure reliable and high-quality drinking water sources for current and future generations. The goals of this SWPP are to:

- Engage key land and resource managers in the SWPP development process and create an awareness of the community's drinking water sources and susceptibility to surface water quality impacts;
- Identify and prioritize existing and potential water quality impacts to the drinking water supplies;
- Serve as a guide for implementing best management practices to more effectively and efficiently allocate resources towards watershed protection activities; and
- Update the city's internal contingency plan, which lays out a coordinated approach for responding rapidly, effectively and efficiently to any emergency incident that threatens or disrupts the community water supply.

Provided below are key source water management and protection efforts related to the city's drinking water supply:

- **Water Quality Monitoring Program** (1990-present)- The city has implemented a long-term source water monitoring program that includes chemical, physical, and biological data in the North and Middle Boulder Creek Watersheds and the Boulder Reservoir Watershed.
- **Boulder 2016 Water Efficiency Plan** (Rozaklis and Associates, LLC 2016)- This plan provides guidance for implementing water conservation programs in the city to achieve water conservation goals.
- **Town of Nederland Source Water Protection Plan** (Town of Nederland and CRWA 2014)- The Town of Nederland's 2014 SWPP covers Middle Boulder Creek, upstream from the town's intake. City staff were involved in the SWPP development process.
- **Boulder Reservoir Master Plan** (City of Boulder 2012)- This plan established management goals and objectives for land use and recreational activities on and around the reservoir. Several of the goals are directly related to source water protection, such as identifying and minimizing pollutant

sources, monitoring water quality, reducing the risk for infestation of aquatic nuisance species, and promoting visitor awareness and stewardship of the reservoir.

- **Source Water Master Plan** (MWH and AMEC 2009)- Volume 4 of the Water Utility Master Plan provides a framework for managing the city's source water to ensure that future water supply needs are met. The plan outlines watershed management and wildfire protection measures to protect the water supply.
- **Colorado Source Water Assessment Report for City of Boulder** (2004/2010)- The Colorado Department of Public Health and Environment (CDPHE) developed source water assessments for all Colorado public water systems, including the city.
- **Middle Boulder Creek Water Source Management Work Plan** (City of Boulder et al. 2002)- This work plan compiled information on Barker Reservoir watershed characteristics, operations, water quantity and quality, and system facilities. The plan includes a series of recommendations to protect the water supply at its source.
- **Water Source Impact Assessment** (Brown and Caldwell 1992)- This was the city's original SWPP providing a detailed review of the city's source water supplies, potential contaminant sources, and recommended management actions.

1.2 Colorado's SWAP Program

Congress passed the original Safe Drinking Water Act in 1974 to protect public health by regulating the nation's public drinking water supplies. The 1996 Safe Drinking Water Act amendments required states to develop and implement Source Water Assessment and Protection (SWAP) programs. CDPHE's Water Quality Control Division assumed responsibility for developing Colorado's SWAP, which was finalized and approved by the United States Environmental Protection Agency (EPA) in 2000 (CDPHE 2000). Colorado's SWAP program is an iterative, two-phased process designed to assist public water systems in preventing potential contamination of their untreated drinking water supplies. The two phases include the Assessment Phase and the Protection Phase as further described below (Figure 4).

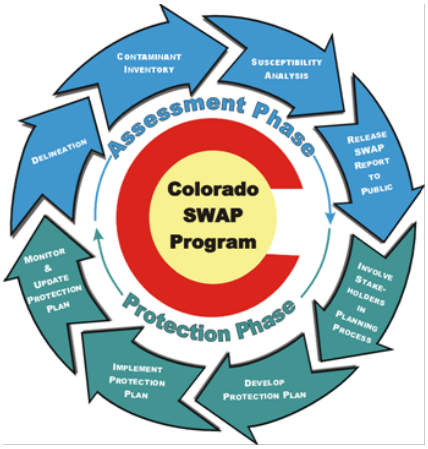

Figure 4. Illustration of the Source Water Assessment and Protection (SWAP) two-phased process (CDPHE 2015).

1.2.1 Source Water Assessment Phase

The Water Quality Control Division's Assessment Phase (see upper portion of Figure 4) consists of the following four elements for all public water systems in the state:

1. Delineating the source water assessment area,
2. Developing an inventory of potential sources of contamination (PSOC) within the assessment area,
3. Conducting an analysis to determine the potential susceptibility of each public water drinking water source to PSOCs, and
4. Reporting the results from the source water assessment to the public water systems and to the general public.

The Water Quality Control Division completed source water assessments for all public water systems in the state of Colorado, including the city, in 2004.

1.2.2 Source Water Protection Phase

The Protection Phase (see lower portion of Figure 4) for all public water systems consists of four primary elements:

1. Involving stakeholders in the source water protection planning process,
2. Developing a protection plan that identifies and prioritizes PSOCs and associated best management practices (BMP) to protect the water supply,
3. Implementing the protection plan and BMPs, and
4. Monitoring the effectiveness of the protection plan and updating it accordingly based on future assessments.

Following completion of the source water assessments, public water systems were encouraged to voluntarily implement programs and preventative measures to protect source water quality. The city considers source water protection integral to its water supply planning and is updating and formalizing the process through the development of this SWPP.

2 SOURCE WATER SETTING

The city's drinking water comes from North Boulder Creek, Middle Boulder Creek and diversions from the Upper Colorado River on the west slope. The city's water sources are treated at two different water treatment plants (WTP) — Betasso WTP and Boulder Reservoir WTP. A map of the source watersheds is presented in Figure 5.

The Betasso WTP, located in the foothills west of Boulder, treats water from North Boulder Creek, via Lakewood Reservoir, and Middle Boulder Creek, via Barker Reservoir and Kossler Reservoir. Public access to the Silver Lake Watershed (the headwaters of North Boulder Creek) has been prohibited since 1920 for water quality protection (MWH and AMEC 2009). Public access to Lakewood Reservoir is also prohibited.

The Boulder Reservoir WTP treats west slope water, and small amounts of east slope water, from Boulder Reservoir or the Boulder Feeder Canal (BFC), depending on the time of year. Northern Colorado Water Conservancy District (Northern Water) diverts water from the upper Colorado River by means of a series of pipelines, reservoirs and canals to Carter Lake, where it is then transported to Boulder Reservoir via the 21-mile St. Vrain Supply Canal and BFC. In this SWPP, the St. Vrain Supply Canal and Boulder Feeder Canal are collectively referred to as BFC. Boulder Reservoir is primarily fed by BFC, which generally flows early April through late October. BFC is managed and operated by Northern Water. The city will be participating in the 2018 construction of the Southern Water Supply Pipeline II, which will transport raw water from Carter Lake directly to the Boulder Reservoir WTP.

2.1 Water Supply Redundancy and Resilience

The city is fortunate to have three distinct sources of drinking water. Redundancy in the system allows the city to change water sources during maintenance (planned or emergency), or if a source becomes temporarily unusable (e.g., during the 2013 flood one water source became unusable). The city can also control some inflows and divert ditches or creeks away from drinking water reservoirs if needed. The redundancy and resilience in the water supply better positions the city to continue supplying customers with drinking water even in the event of short-term source or system contamination.

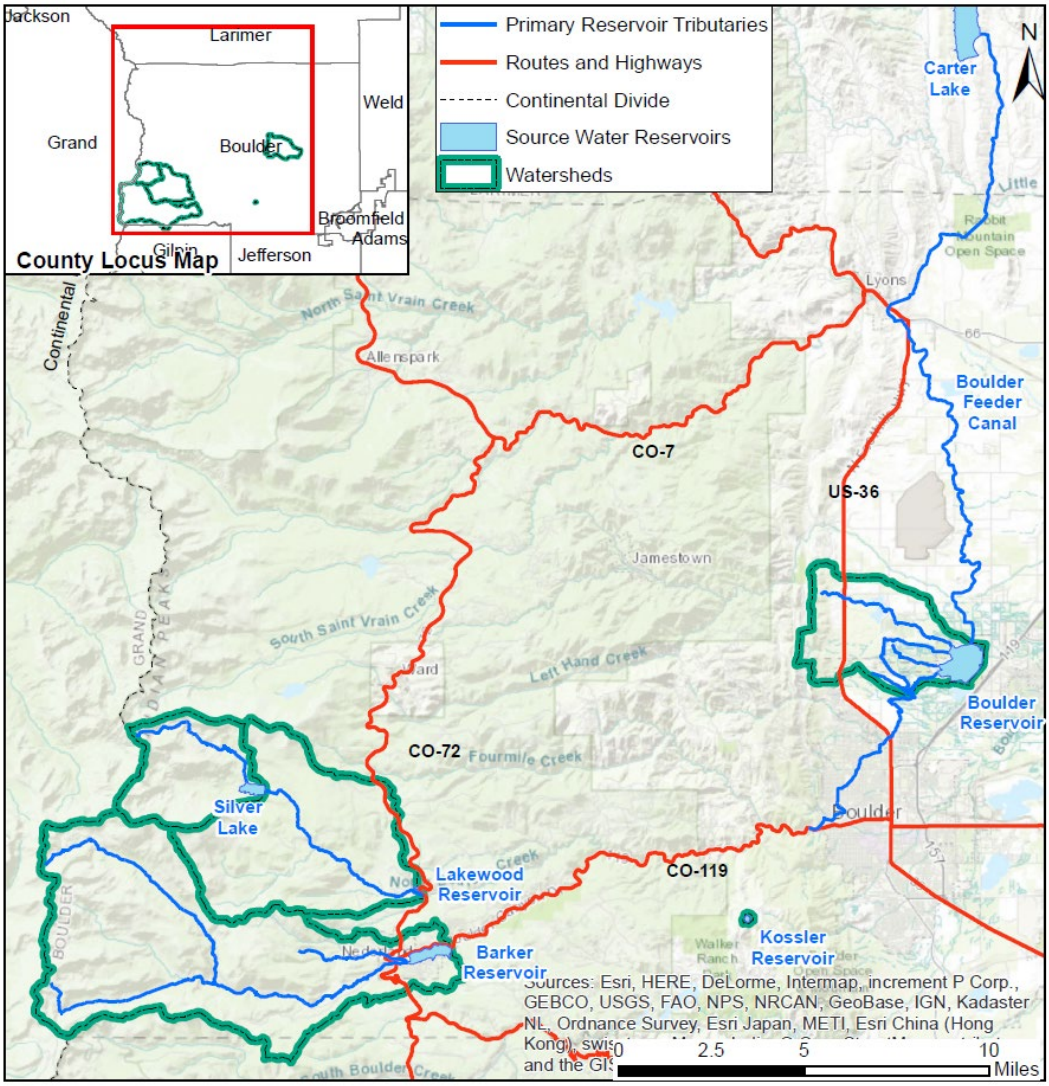

Figure 5. Source water reservoirs and watersheds.

2.2 Watershed Characteristics and Land Use

Lakewood Reservoir and Barker Reservoir watersheds are predominantly forested, and much of the Silver Lake Watershed is above timberline (Figure 6). In these upper watersheds, development is concentrated west of Barker Reservoir in the towns of Nederland and Eldora, with populations of 1,504 and 142, respectively (U.S. Census 2015). North Boulder Creek and Como Creek flow through Caribou Ranch, a privately-owned and agriculturally-managed tract of land in the Lakewood Reservoir Watershed. The United States Forest Service (USFS) manages 60% of the Lakewood Reservoir Watershed and 70% of the Barker Reservoir Watershed (NLCD 2014). The Silver Lake Watershed is owned by the city. Further details on the characteristics of these upper watersheds can be found at MWH and AMEC (2009), City of Boulder et al. (2002), and Brown and Caldwell (1992).

Much of the watershed and drainage area to Boulder Reservoir and the lower portion of BFC are used for agricultural purposes, open space, and residential (Figure 6) (NLCD 2014). The land west of Lake Valley

Estates and Golf Course and along BFC is primarily grassland. A portion of the land in Boulder Reservoir Watershed is owned by the city, and much of it is leased for agricultural use. Further details on the watershed characteristics can be found in City of Boulder (2012), MWH and AMEC (2009), and Brown and Caldwell (1992).

2.3 Water Quality

The city implements an extensive water quality monitoring program, routinely collecting and analyzing water quality samples at the source water reservoirs and tributaries. The data collected through the monitoring program are analyzed using statistical methods to allow city staff to identify trends or changes in water quality, comply with federal and state water quality regulations and city goals, understand water quality improvements or degradation from watershed activities, and detect potential sources of contamination. City staff re-evaluate the monitoring program annually and develop annual source water quality reports. Information on the city's drinking water quality is available online: https://bouldercolorado.gov/water/drinking-water-quality.

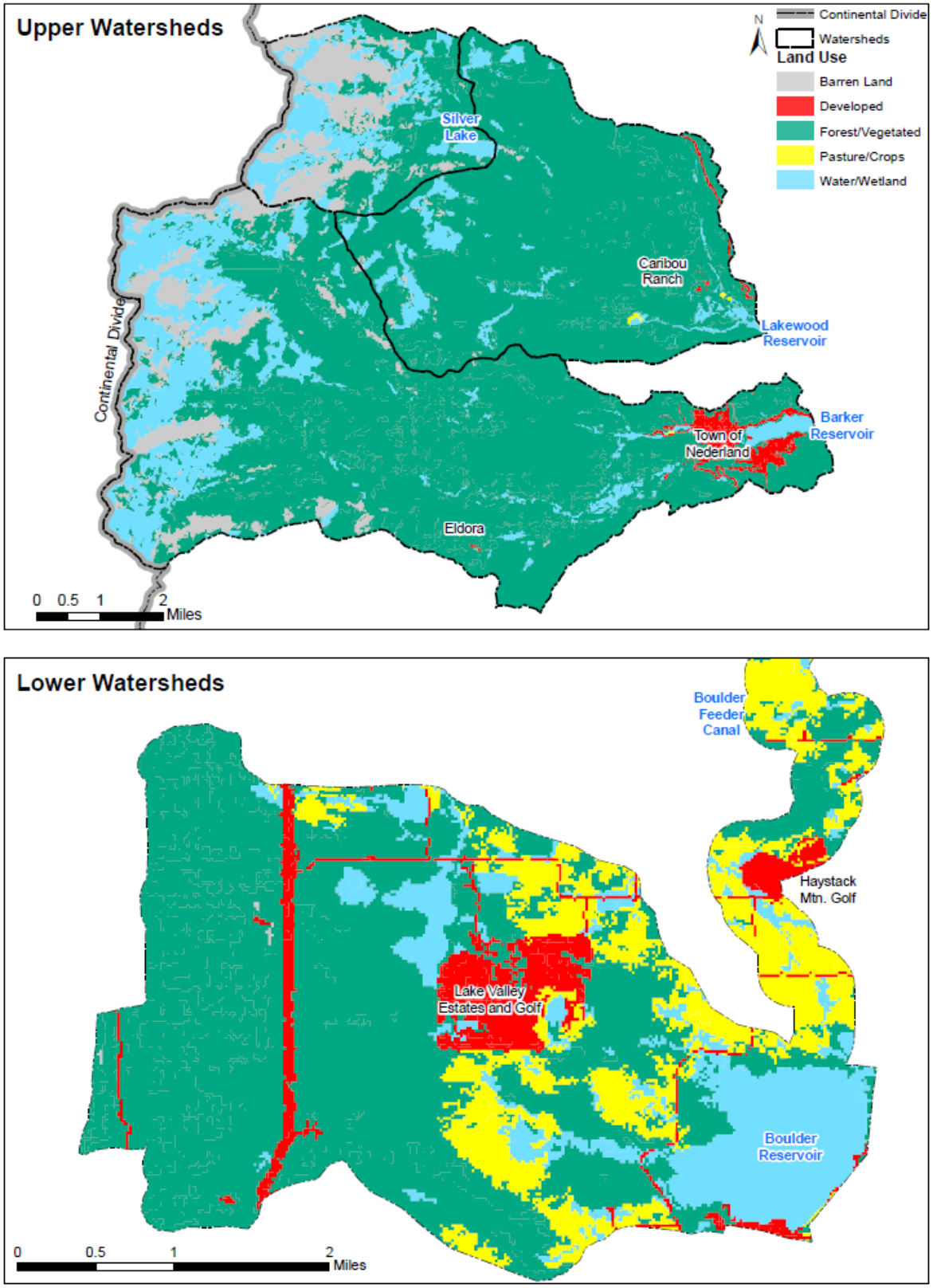

Figure 6. Land use patterns in the source water watersheds (NLCD 2014).

3 WATER SUPPLY DEMANDS AND GROWTH PROJECTIONS

The city owns approximately 18,900 acre-feet of storage in North Boulder Creek and Barker Reservoir and approximately 3,100 acre-feet of storage in Boulder Reservoir (with access to another 5,300 acre-feet during winter months).

The nominal treatment capacity of the Betasso WTP is 40 million gallons per day (MGD) and the Boulder Reservoir WTP's treatment capacity is 16 MGD. The water system service area includes three water distribution system pressure zones covering approximately 26 square miles (Figure 7) and serving an estimated 174,000 residents and commuters (City of Boulder 2016). Assuming similar employee commuting patterns, by 2040 the city is expected to provide drinking water to an estimated 219,000 individuals, or an approximate 26% increase compared to 2015 estimates (City of Boulder 2016).

The total annual treated water use in Boulder is approximately 5.9 billion gallons, or equivalent to an average of 142 gallons per capita per day (2012-2015 average) (Rozaklis & Associates, LLC 2016). Estimated buildout demands range from 5.9 to 7.8 billion gallons per year. While total annual water use significantly declined during the 2000 to 2015 period, future water use is projected to increase, despite expected reductions in indoor per capita use, as a function of climate change impacts, and population and employment growth (Rozaklis & Associates, LLC 2016). Preserving and protecting existing source water quality is a key component in the city's ability to meet buildout water demands.

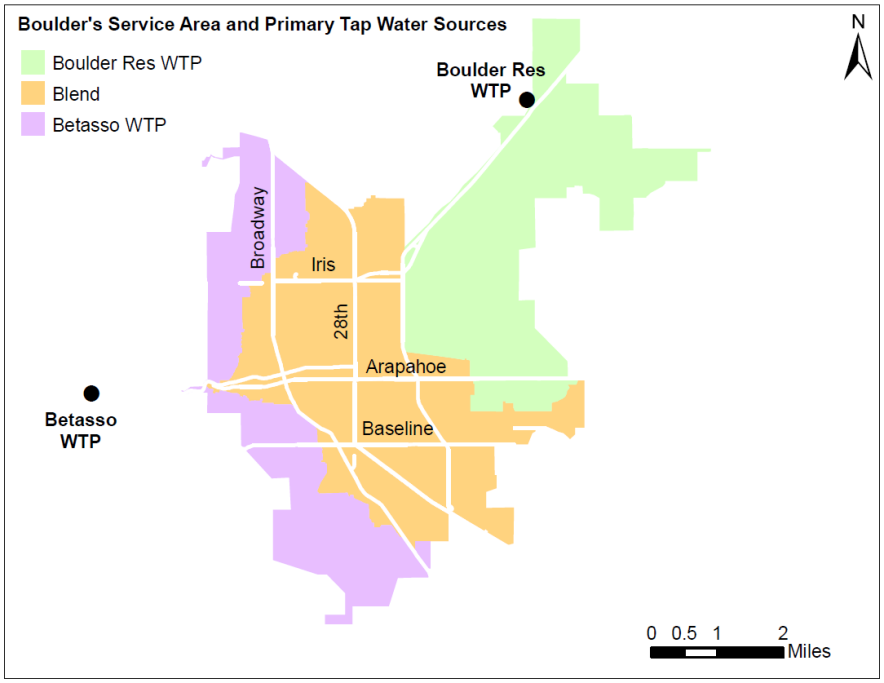

Figure 7. City of Boulder service area, which is comprised of three pressure zones. Primary tap water sources are shown, but all areas can be served by Boulder Reservoir WTP and Betasso WTP.

4 SWPP DEVELOPMENT PROCESS

4.1 Stakeholder Participation

The city coordinated with the Colorado Rural Water Association (CRWA) to organize a series of meetings with land and resource managers during May 2016 to June 2017 period. Information discussed during the meetings helped to inform the development of this SWPP. Nearly 50 stakeholders were invited to each meeting, including representatives from the following local, state, and federal agencies; organizations; developers; business owners; and ranch owners:

- U.S. Environmental Protection Agency
- U.S. Forest Service
- U.S. Department of Agriculture, Natural Resources Conservation Service
- Colorado Division of Water Resources
- Colorado State Forest Service
- Colorado Department of Transportation
- Colorado Department of Public Health and Environment
- Colorado Parks and Wildlife
- Boulder County
- City of Boulder
- Longmont and Boulder County Conservation District
- Larimer County
- Town of Nederland
- Eldora Mountain Resort
- Northern Colorado Water Conservancy District
- Left Hand Water Conservancy District
- Boulder Meadows Mobile Home Park
- Lake Valley Estates and Golf Course
- CEMEX
- Caribou Ranch
- Arapaho Ranch

The source water protection planning effort consisted of 11 stakeholder meetings, and the draft SWPP report was reviewed by the group in March 2017 and again in June 2017. A summary of the stakeholder meetings is presented below in Table 1.

Table 1. Description of stakeholder meetings.

Date	Location in Boulder, CO	Purpose/Description
5/12/2016	Alfalfa's Market	SWPP planning kickoff meeting.
6/23/2016	Boulder Public Library	Delineated the source water protection areas.
8/9/2016	Boulder Reservoir Drinking Water Treatment Plant	Reviewed PSOCs in the Barker Reservoir Watershed; Presentation from the Town of Nederland staff on their SWPP.

Date	Location in Boulder, CO	Purpose/Description
9/16/2016	Boulder Reservoir Drinking Water Treatment Plant	Special topic: abandoned mines and presentation from a representative of the state's Department of Reclamation and Mining Safety.
10/27/2016	Boulder Reservoir Drinking Water Treatment Plant	Special topic: onsite wastewater disposal systems and septic systems. Presentation from a representative of Boulder County's SepticSmart Program.
11/29/2016	Boulder Reservoir Drinking Water Treatment Plant	Special topic: agriculture, livestock, and wildlife in the watersheds. Panel discussion led by representatives from the U.S. Department of Agriculture's Natural Resources Conservation Service, Arapaho Ranch near Eldora, City of Boulder Utilities, and Boulder County Open Space and Mountain Parks.
1/25/2017	Boulder Reservoir Drinking Water Treatment Plant	Identified and prioritized PSOCs in the Boulder Reservoir watershed. Confirmed PSOC list and ranking for the upper watersheds.
2/28/2017	Boulder Reservoir Drinking Water Treatment Plant	Finalized the PSOC inventory for the Boulder Reservoir Watershed and the BFC source water protection area.
4/4/2017	Boulder Reservoir Drinking Water Treatment Plant	Reviewed the draft SWPP, which members of the committee commented on during the previous month. Began filling out the BMP action plan.
5/12/2017	Boulder Reservoir Drinking Water Treatment Plant	Continued to review and identify BMPs.
6/13/2017	Boulder Reservoir Drinking Water Treatment Plant	Reviewed stakeholder comments on the draft final SWPP report and BMP action plan. Solidified the list of BMPs and prioritization.

4.2 Defining the Source Water Protection Area

A source water protection area (SWPA) is the surface and subsurface areas within which contaminants are reasonably expected to reach a water source. The size and shape of the area depends on the characteristics of the watershed. The SWPA that was delineated as part of CDPHE's Source Water Assessment Report for the city (CDPHE 2010) provided the basis for understanding where the potential contaminant threats to the water supply originate. Using the results from CDPHE's Source Water Assessment Report as a starting point, city staff worked with the stakeholder group to refine the SWPA, taking into consideration topography, PSOC locations, raw water intake locations, and diversion control capabilities. The refined SWPA includes three zones and an Area of Interest, which were used to assist in evaluating PSOCs and prioritizing BMPs (see Figure 8):

- **Zone 1**- This is the primary zone of protection and is defined as a 1,000-foot buffer around BFC and all waterbodies within the 12-digit hydrologic unit code (HUC) subwatersheds for the Middle and North Boulder Creek watersheds upstream from Lakewood Reservoir and Barker Reservoir. This zone also includes the entire direct drainage basins for Boulder Reservoir and Kossler Reservoir. This zone is the area of highest vulnerability and should be afforded the highest level of protection.

- **Zone 2**- This is the secondary zone of protection and is defined as the remainder of the direct drainage basins for the Middle and North Boulder Creek watersheds above Lakewood Reservoir and Barker Reservoir, outside of Zone 1.
- **Zone 3**- This tertiary zone is defined as the indirect drainage basins to Boulder Reservoir (i.e., Left Hand Creek and Lower Boulder Creek watersheds). This is a tertiary protection zone because the diversions of ditches and streams to Boulder Reservoir can be controlled if needed.
- **Area of Interest**- This encompasses the upper Colorado River basin drainage area, which is managed by Northern Water.

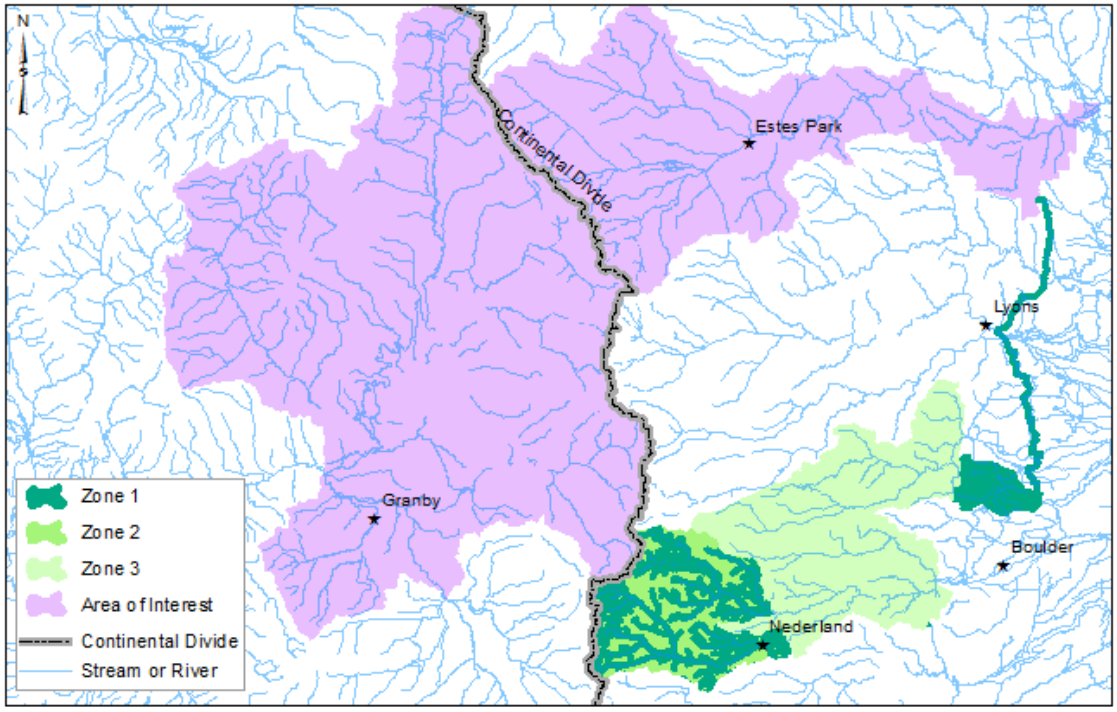

Figure 8. City of Boulder's Source Water Protection Areas and Area of Interest.

4.2.1 Area of Interest

The Colorado-Big Thompson (C-BT) Project watershed is considered an Area of Interest because it supplies water for multiple public water systems and Northern Water, and because these systems work directly with west slope communities and federal and state agencies to protect watershed health, forest health and resiliency in the C-BT watersheds. The city will continue partnering with Northern Water, other C-BT water users, and the west slope communities to promote watershed protection rather than directly implement BMPs in the region. Northern Water also carries out an extensive water quality monitoring program throughout the C-BT system.

4.3 Inventory of Potential Contaminant Sources

The Source Water Assessment Report developed by CDPHE for the city included an inventory of PSOCs dating to the 2001 to 2002 period. To ensure a more complete and current inventory of PSOCs for the

refined SWPA, city staff worked with the stakeholder group to develop an updated inventory of PSOCs. The inventory was developed in 2016 and 2017 by compiling data from local, county, state, and federal databases, and mapping the information in a Geographic Information System (GIS). City staff will continue to maintain an updated internal geodatabase of PSOC data as updates become available. The PSOCs are reviewed in Section 5 of this report, priority rankings are presented in Section 6, and detailed maps of PSOC locations are provided in Appendix A.

4.4 Strategy for Prioritizing Potential Contaminant Sources

Once the comprehensive inventory of PSOCs was developed, the stakeholder group prioritized each category to guide the implementation of BMPs. The process of prioritizing PSOCs factored in the following criteria (as described below): System Susceptibility, Water System Control, and the Best Management Practices (BMPs) associated with each item. Information in this section is from CRWA (2016).

4.4.1 System Susceptibility

The water supply's susceptibility to each PSOC is a measure of the water source's potential exposure to contamination. The stakeholder group utilized CRWA's *SWAP Matrix* (Figure 9), which assesses PSOC susceptibility by estimating the following:

Impact to the Public Water System – Source water susceptibility increases as the impact to the water system increases. Impact is determined by evaluating the human health concerns and potential volume of the contaminant source. The following descriptions provide a framework to estimate the impact to the public water system.

- Catastrophic - irreversible damage to the water source(s). This could include the need for new treatment technologies and/or replacing an existing water source(s).
- Major - substantial damage to the water source(s). This could include a loss of use for an extended period and/or the need for new treatment technologies.
- Significant - moderate damage to the water source(s). This could include a loss of use for an extended period and/or the need for increased monitoring and/or maintenance activities.
- Minor - minor damage resulting in minimal, recoverable, or localized efforts. This could include temporarily shutting off an intake or well and/or the issuance of a boil order.
- Insignificant - damage that may be too small or unimportant to be worth consideration, but may need to be observed for worsening conditions. This may necessitate developing administrative procedures to maintain awareness of changing conditions.

Probability of Impact – Source water susceptibility increases as the relative probability of damage or loss increases. The probability of impact is determined by evaluating the number of contaminant sources (e.g., the number of abandoned mines), the migration potential or proximity to the water source, and historical data. Each PSOC was estimated to have a certain, likely, possible, unlikely, or rare, probability of impact.

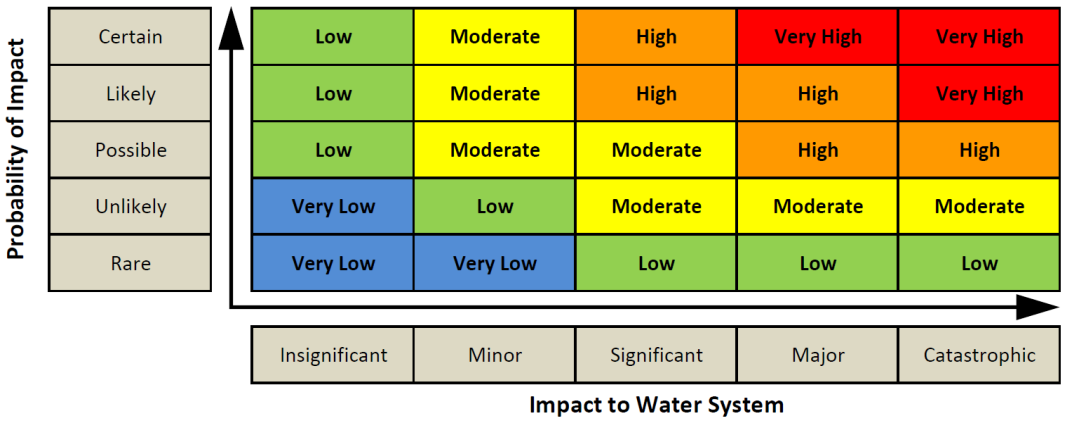

Figure 9. Colorado Rural Water Association's Source Water Assessment and Protection Matrix. (CRWA 2016)

4.4.2 Water System Control

The level of water system control describes the ability of the water system to take measures to prevent contamination or minimize impact. A PSOC that falls within a water system's jurisdiction (i.e. direct control), may be of higher priority since they can take direct measures to prevent contamination or minimize the impact.

- Direct Control – The water system can take direct measures to prevent.
- Indirect Control – The water system cannot directly control the issue, but can work with another person or entity to take measures to prevent.
- No Control – The PSOC is outside the control of the public water system and other entities.

4.4.3 Best Management Practices

Best Management Practices are the actions that can be taken within the SWPA to help assess water quality impacts, prevent contamination, or reduce the potential for contamination of the city's source waters. Section 6 of this document presents the ranked PSOCs and prioritized BMPs, which will serve as a guide for more efficiently and effectively applying resources towards source water protection.

5 WATER SUPPLY POTENTIAL CONTAMINANT SOURCES

During the stakeholder meetings, attendees reviewed the SWPA watershed-by-watershed to identify PSOCs and rank them in terms of water system susceptibility and probability of impact to the water supply (approach is detailed in Sections 4.3 and 4.4). The types of pollutants generally associated with each PSOC described in this section are presented in Table 2. Aquatic nuisance species (section 5.17) and climate change (section 5.19) are not included in the table because they are associated with a variety of water impacts to the system, and in the case of climate change, influence the frequency and intensity of wildfires, floods, and beetle kill spread.

Table 2. Pollutants of concern generally associated with the potential contaminant sources identified in the source water protection areas.

Potential Contaminant Source	Report Section	Turbidity	Sediment/ Erosion	Metals	Nutrients	Oil/Grease	VOCs*	Salts	Pathogens	Pesticides	CECs*
Stormwater Runoff, Road Maintenance, and Transportation	5.1	X	X	X	X	X	X	X	X	X	X
Recreation- Aquatic	5.2	X	X			X	X		X		X
Recreation- Terrestrial	5.2	X	X		X	X	X		X		X
Residential Practices	5.3			X	X	X	X	X	X	X	X
Business Practices	5.4			X	X	X	X	X	X	X	X
Agriculture- Crop Production	5.5	X	X	X	X			X		X	X
Agriculture- Livestock	5.5	X	X		X			X	X		X
Pesticide Applications	5.6							X		X	
Wastewater Treatment Facilities	5.7	X	X	X	X	X		X	X	X	X
Onsite Wastewater Treatment Systems	5.8	X	X	X	X	X		X	X	X	X
Hazardous Waste- Illegal Dumping	5.9			X		X	X	X	X	X	X
Hazardous Waste- Permitted, RCRA	5.9						X				
Storage Tanks	5.10					X	X			X	
Mining Activities	5.11	X	X	X	X			X			
Oil and Gas Development	5.12	X	X	X		X	X	X			
Wildlife	5.13	X	X		X				X		
Floods	5.14	X	X	X	X	X	X	X	X	X	X
Fire	5.15	X	X	X	X						
Beetle Kill	5.16	X	X								
Atmospheric Deposition	5.18			X	X					X	

**VOC=volatile organic compounds; CEC= contaminants of emerging concern, including pharmaceuticals, personal care and household products and hormones.*

5.1 Stormwater Runoff, Road Maintenance, and Transportation

Stormwater runoff from roads, parking lots, residential lawns, agricultural areas, and construction areas can transport pollutants to water resources. Paved surfaces and packed dirt roads minimize or prohibit stormwater from soaking into the ground prior to discharging directly to surface waters. Depending on the land use, runoff can carry elevated levels of sediment, metals, nutrients, bacteria, oils and grease, trash, fertilizers, and pesticides to waterways (Forests for Watersheds 2016). Road maintenance activities can contribute salts, deicers, and sand to receiving waterbodies. Elevated zinc concentrations may be indicative of road runoff from tires.

In the upper watersheds, stormwater runoff is primarily a concern around Barker Reservoir and its tributaries, where roads, parking areas, and hard-packed trails parallel streams. Untreated stormwater draining the downtown area of Nederland is transported directly to Barker Reservoir via Beaver Creek and an outfall north of Nederland's wastewater treatment facility (WWTF). Many of the storm drains in Nederland read "Dump No Waste- Drains to River." Route 119, or Boulder Canyon Drive, follows Barker Reservoir to the North and vehicles can overturn into Barker Reservoir. According to the Colorado Department of Transportation (CDOT), 2015 average annual daily traffic was 3,600 vehicles on Route 119 at Barker Reservoir. Traffic is expected to increase approximately 5% by the year 2036 (CDOT 2016). An estimated 1,400 average annual daily passengers pass through Nederland up Eldora Road, which follows Middle Boulder Creek (Boulder County Transportation 2016).

Figure 10. Construction project to divert an outfall over BFC.

Stormwater and field drainage is discharged directly to BFC via several outfalls along the length of the canal. Over the years, the city has worked with Northern Water to divert outfalls away from BFC to minimize water quality impacts (Figure 10). Runoff can also reach BFC through several road crossings and parallel roads along the 21-mile length of the canal. Boulder Reservoir receives runoff from the swim beach parking area; the boat storage lot, which includes a filling station; and the irrigated grass areas near the swim beach.

Stormwater pollutant loads and erosion can be exacerbated by floods. During the 2013 flood, turbid water in Boulder Reservoir and a breach in BFC prevented the Boulder Reservoir WTP from operating for several weeks. Even after source water quality improved, the WTP needed to be thoroughly cleaned before resuming treatment (see Section 5.16).

5.2 Terrestrial and Aquatic Recreation

The SWPA supports a variety of recreational activities including hiking, biking, dog walking, fishing, horseback riding, camping, picnicking, skiing, and snowshoeing. 2010 estimates indicate that the Arapaho-Roosevelt National Forest (part of which is in the SWPA) received over 5.4 million visitors in one year alone (USFS 2016). Eldora Mountain Resort supports an average of 271,000 visitors per year (USFS 2015). Recreational activities can have a variety of impacts to water resources. For example, improper disposal of waste from humans and dogs can enter waterways, and recreational users can degrade stream riparian

areas, particularly during heavy-use periods. Visitors can leave garbage and litter behind on trails, campsites, picnic areas, and waterways. Forest fire is also a concern, as the 2016 Cold Springs Fire in Nederland was started by illegal backcountry campers.

Aquatic recreation, including swimming, water skiing, and boating can also have water quality impacts. Recreation at Barker Reservoir is limited to shoreline activities such as walking and fishing. Boulder Reservoir is used for a variety of recreational activities and has a public swim beach that is open from Memorial Day through Labor Day. Several special events, including races and triathlons (see Figure 11), occur throughout this season at Boulder Reservoir, and the reservoir area is used for boating, biking, pedestrians, and dog walkers year-round. To understand potential water quality impacts to the reservoir, city staff collects weekly water quality samples from the swim beach for bacteria analysis. During heavy reservoir use days such as July 4th, water quality samples are analyzed for fuel-related compounds - benzene, toluene, ethylbenzene and xylene - to characterize boater impacts. To minimize water quality impacts from dog walkers, the city's Parks and Recreation staff provides bags for dog owners to pick up and takeout dog waste.

Figure 11. 2016 Iron Man at Boulder Reservoir.

5.3 Residential Practices

The SWPA includes suburban and rural residential land use areas, primarily near Barker Reservoir, Boulder Reservoir and along BFC. Few residents live near Kossler Reservoir and none of the properties have surface drainage to the Kossler watershed.

A variety of residential practices have the potential to impact downstream water quality. For example, runoff on residential properties can carry pet waste, soaps and detergents from car washing, lawn fertilizers, oil and gas from driveways, and winter salt and sand applications. These contaminants can enter storm drains and eventually reach source water supplies without prior treatment (Figure 12). Windblown garbage from open trash receptacles can litter neighborhoods and waterways. Improper disposal of pharmaceuticals and oil and grease down sink drains may be inadequately treated at WWTFs before discharging into source water supplies.

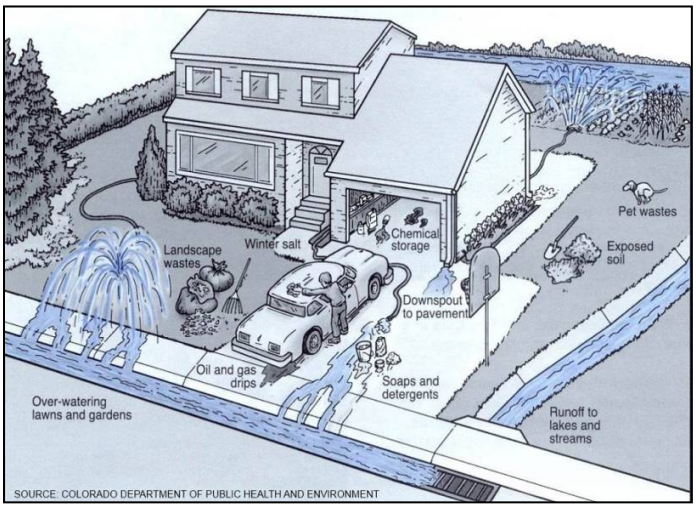

Figure 12. Potential sources of contamination from residences (Hill 2013).

5.4 Business Practices

Restaurants and other businesses that improperly dispose of waste, oil, and grease, have the potential to contaminate waterways and/or cause problems for WWTFs and onsite wastewater treatment systems (OWTS). If dumped down sink drains, oils, grease, and fats can coat and block pipes, and accumulate in pumps and equipment. Blockages can lead to sanitary sewer overflows, leaching from OWTS, and kitchen or basement backups. Any illegally disposed of waste can directly impact surface water and groundwater systems. Greenhouses and marijuana grow facilities should also properly dispose of irrigated water, given elevated concentrations of nutrients and pesticides. Within the SWPA, there are a number of restaurants and other businesses in the Town of Nederland, and along the length of BFC, primarily in the Town of Lyons. There are also three permitted marijuana grow facilities in the Boulder Reservoir Watershed. Appendix A, Figure 22 shows the locations of businesses, services, and permitted marijuana establishments.

5.5 Agricultural Activities

Without proper management, agricultural crop and livestock production can contribute a variety of contaminants to water resources. Waste from livestock can enter waterways directly or indirectly, contributing nutrients, bacteria, hormones, and antibiotic degradates. Livestock can degrade riparian areas, causing erosion and sediment transport. Pesticides and fertilizers applied to cropland can enter groundwater and surface water resources directly or via atmospheric deposition. Tilling can increase soil and sediment transport to streams via runoff or wind. Offsite flows from flood irrigation can transport contaminants associated with agricultural practices to nearby waterways.

In the upper watersheds, agricultural activities are minimal. Approximately 20 cattle reside at Caribou Ranch seasonally, and between Memorial Day and October 1st, the Sundance Café west of Barker Reservoir has approximately 20 horses. Crop production in the upper watershed is negligible.

In the lower watersheds, agricultural activities are more prominent. There are several livestock operations along BFC and in the Boulder Reservoir Watershed. While livestock do not have direct access to BFC, runoff has the potential to contribute pathogens, sediment, and nutrients to BFC. In the Boulder Reservoir Watershed, much of the land is owned by the city and leased for agricultural use (Figure 13). Boulder Valley Ranch is used for perennial hay production and the lessee keeps approximately 60 head of cattle, as well as horses, year-round. The cattle have some access to Dry Creek. North of the reservoir, the lessee keeps 150 cattle during the winter and spring (December through early May). The property is also used for hay production and irrigated pasture during the summer. Tail waters from this area have mostly been diverted over BFC, and for those that have not been, city staff tend to keep the outfalls closed unless there is an immediate threat of flooding or standing water that could damage the northern BFC dike. Flood irrigation is the primary form of irrigation in the watershed, and fertilizer is applied annually or via split application on the cropland.

Hobby farming, where residents keep a small number of farm animals, is popular in the Boulder area. Boulder County Public Health (BCPH) staff field several calls each year from residents reporting concerns of manure management, animal burials, and de-vegetation from farm animals such as llamas, horses, alpaca, sheep, and goats. Boulder County regulations allow for four animal units per acre (Boulder County Land Use Department 2013).

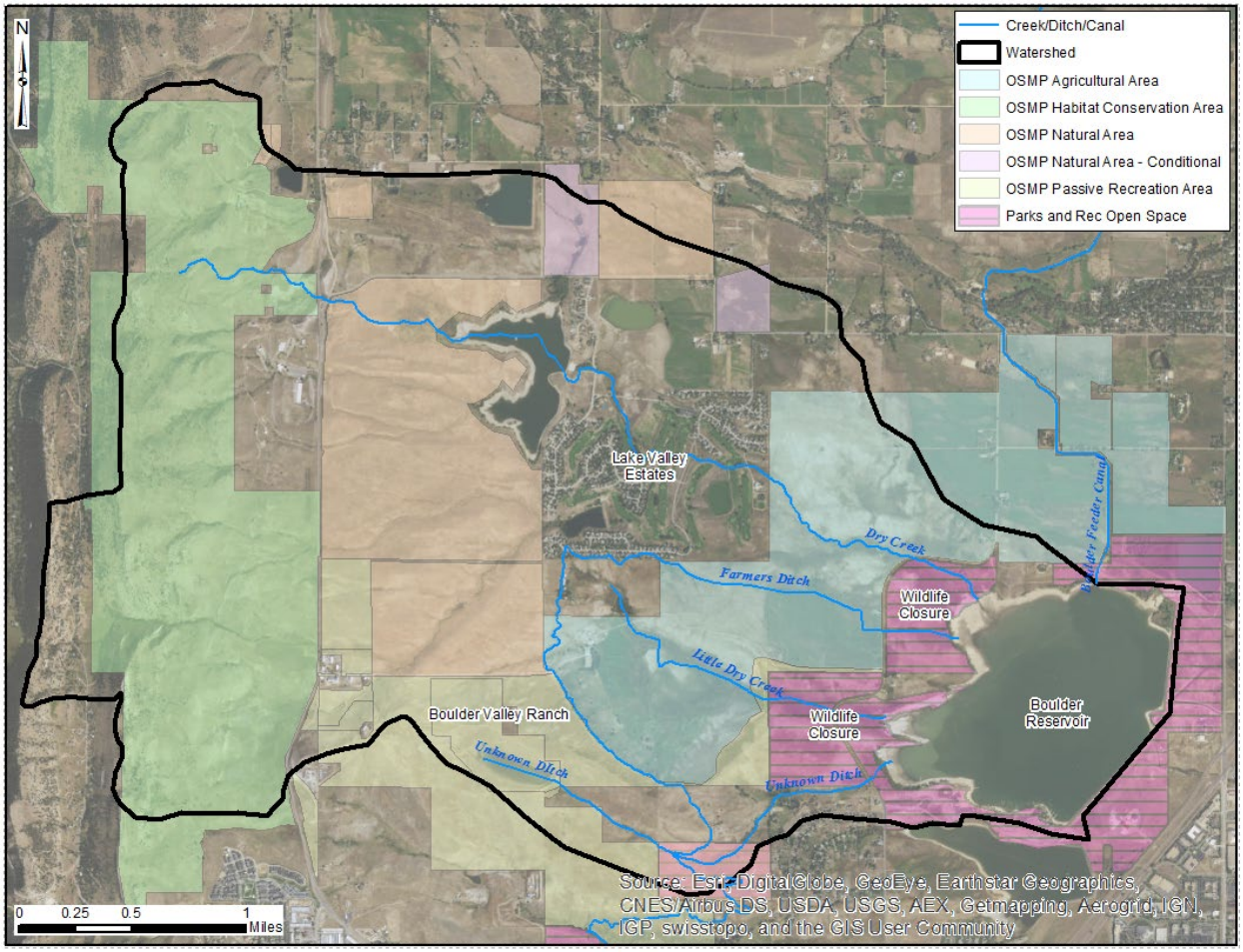

Figure 13. City land management in the Boulder Reservoir Watershed. OSMP=Open Space and Mountain Parks.

5.6 Pesticide Applications

Pesticides, including herbicides and insecticides, can reach the city's source waters via runoff. Herbicides are directly applied to BFC by Northern Water to control canal bank and aquatic plant growth. The city maintains regular communication with Northern Water about the timing of applications. The BCPH Mosquito Control program applies permethrin in specific areas throughout Boulder County via "ultra-low volume spray" at levels less than 0.0007 lbs/acre (BCPH 2017). As part of the city's emerging contaminant monitoring program, water quality samples from raw and treated drinking water are analyzed for dozens of pesticides. The data help city staff better understand the types pesticides in the raw water and removal efficiency during the water treatment process. Of the more than 100 pesticides monitored, only a few are detected, and those that are, are found at minute concentrations (nanogram/liter or parts per trillion).

5.7 Wastewater Treatment Facility Discharges

Treated wastewater discharges contribute nutrients, organic matter, chemicals from personal care and household products, pharmaceuticals, hormones, and bacteria to surface waters. Discharges can also elevate receiving water temperature and turbidity, and the increased nutrient loading can facilitate algal growth. Within the SWPA, there are four permitted WWTFs (see Appendix A, Figure 24).

5.7.1 Town of Nederland WWTF

The Town of Nederland's WWTF (permit CO0020222) discharges into Middle Boulder Creek near the west end of Barker Reservoir. Prior to April 2013, Nederland's WWTF was an aeration lagoon system providing secondary treatment. Despite contributing relatively little flow (i.e., less than 1% of the total) to Barker Reservoir, the WWTF effluent was responsible for a significant portion of the nutrient loading. To improve effluent quality and minimize phosphorus loading to Barker Reservoir, when Nederland began planning for WWTF upgrades, the city and Nederland entered into an Intergovernmental Agreement. The city contributed capital funding to enhance phosphorus removal and provides annual funding for operation and maintenance of the phosphorus removal process, per the Agreement. Since the upgrades were completed, WWTF effluent water quality has significantly improved, lowering nutrient levels and algal growth in Barker Reservoir. City staff continue to monitor effluent and reservoir water quality to better understand trends. Nederland staff also routinely monitor effluent quality and flow.

5.7.2 Lake Eldora WWTF

The Lake Eldora Water and Sanitation District has two sewage treatment lagoons at Eldora Mountain Resort (permit CO0020010). The system discharges to Peterson Lake, Peterson Creek, and eventually to Middle Boulder Creek. The permit 30-day average discharge is 0.03 million gallons per day. The lagoons were re-lined in 2012.

5.7.3 Mountain Research Station WWTF

The Mountain Research Station WWTF (permit COX631000) is located along Como Creek in the Lakewood Reservoir Watershed. Installed in August 2001, the Cycle-Let/ZenoGem WWTF consists of a three chamber, 10,000-gallon tank for biological processing with membrane filters and ultra-violet disinfection. The tank discharges into a pond with a storage capacity of 28,000 gallons. The pond is unlined and flows via groundwater into Como Creek, which is about 60 feet away and 20 feet lower in elevation. Treatment capacity is 14,400 gallons per day, though the average is 2,000 gallons per day during the June through August busy season (Pfeifer, G., email communication, 2017).

5.7.4 Fairways Metropolitan District WWTF

In the Boulder Reservoir SWPA, Lake Valley Estates' Fairways Metropolitan District WWTF (permit CO0048411) utilizes a lagoon system near Dry Creek. Effluent from the lagoon system is pumped to ponds for storage. After aeration and chlorination, the treated effluent is used to irrigate restricted areas of the golf course. The system's design capacity is 0.1073 MGD. When the ground is saturated due to heavy rain/snowfall, raw sewage can overflow from surcharges in the collection line. Overflows occurred for this reason most recently in May 2015 and May 2017. Overflows typically enter wetland areas and Dry Creek, approximately one mile upstream from Boulder Reservoir. City staff have monitored bacteria levels in Dry Creek near the reservoir during the overflow events, and levels have not significantly differed from background conditions, suggesting minimal impacts.

5.8 Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems are located throughout the SWPA on properties not hooked up to municipal WWTFs. OWTS' are most commonly referred to as septic systems, which are a type of OWTS consisting of a tank that collects sewage and allows solids to settle and greases/fats to float, before discharging liquid to a leach field for final filtration and treatment by soil (Figure 14). The tanks must be regularly maintained and inspected to ensure that they are properly functioning. Non-functioning, or inadequately maintained OWTS can contribute a variety of contaminants to groundwater, including bacteria, pathogens, nutrients, organic matter, and pharmaceuticals and household products.

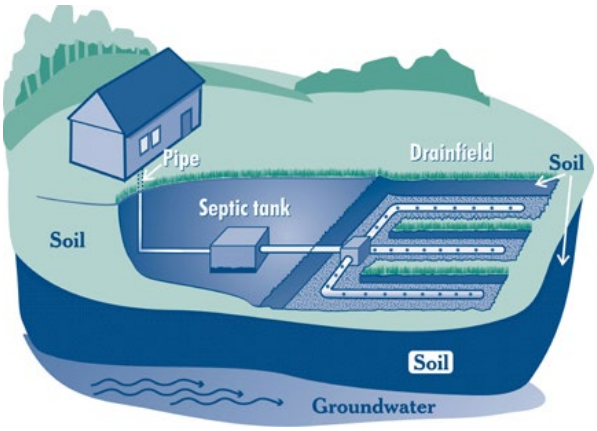

Figure 14. Septic system graphic.

Boulder County Public Health implements a comprehensive OWTS regulatory program. The program launched the SepticSmart campaign, which employs six strategies to ensure OWTS are permitted and operating safely (BCPH 2016):

1. Investigating complaints of potentially failed systems.
2. Requiring occupied dwellings to have an approved OWTS before issuing a building permit.
3. Requiring site inspections at the time of property transfer or sale.
4. Reaching out to properties that have OWTS that have not received final approval.
5. Reaching out to high risk areas.
6. Providing general education and outreach about OWTS permitting and maintenance.

Boulder County Public Health staff maintain a database of the status of OWTS permitting and approval, classifying OWTS into six categories depending on the level of public health risk, as shown in Table 3. Within the SWPA, the highest concentration of unapproved and high risk mailing OWTS is in Eldora and along the north fork of Middle Boulder Creek, upstream from Eldora. Owners of these systems are a higher priority for BCPH staff to contact regarding upgrades. There are also several unapproved OWTS south of Barker Reservoir and upstream from Lakewood Reservoir. Appendix A, Figure 23, contains a map showing the location and status of OWTS in the SWPA.

Table 3. SepticSmart classifications for Onsite Wastewater Treatment Systems (OWTS) in Boulder County.

OWTS Classification	Description
High Risk Mailing	These are the highest risk OWTS that SepticSmart is working with to bring into compliance within the next five years. These OWTS were identified through a series of analyses including reviewing property proximity to surface waters, depth to ground water, slope, etc. Evaluating these parameters enabled the development of risk values to rank the communities against each other and identify these particularly high-risk areas.

OWTS Classification	Description
Unapproved	These OWTS are outside of the city's sewer limits and include structures that were built, but a permit for an OWTS was never pulled. These systems may or may not have been built to code. Depending on lot/parcel size, density of unapproved systems and proximity to ground and surface waters, these systems could be considered high risk.
Permit Only	These OWTS owners received a permit but not final approval from the county. For these parcels, the owner took out a permit (mostly in the 1960s and 1970s) and received their certification of occupancy without going through the formal permitting process. These systems were never inspected. These are considered high risk areas.
Active Permit	These OWTS property owners have started the permitting process to get final approval from the county.
Final Approval Pending	These OWTS were approved but never received a final inspection.
Approved	These OWTS have been approved.

5.9 Hazardous Waste and Inactive Dump Sites

Illegal dumping of chemicals and other substances in the wilderness area or directly into creeks in the watershed is a concern. The extent to which spills and illegal chemical dumping occurs is unknown, though occasionally a resident will report such incidents to BCPH, CDPHE, or EPA. One known illegal dump site is Gordon Gulch north of Lakewood Reservoir on USFS land. In 2015, EPA performed an emergency cleanup and excavation of two pits containing unknown chemicals (For details, see EPA's website, EPA 2015).

5.9.1 Inactive Nederland Landfill

The Nederland landfill is located east of CO-119 on upper East Magnolia in Barker Reservoir Watershed. The landfill was closed in the 1970s, though the area appears to be used as an illegal shooting range and for pile burning. Some roofing debris and old lumber was observed during a 2016 site visit. While the site is in the Barker Reservoir Watershed, drainage runs through the Big Springs subdivision and forested areas before reaching the reservoir. Potential impacts from runoff or groundwater seepage are unknown, but are expected to be minor, if any.

5.9.2 Inactive North Boulder Dump

The 105-acre historic North Boulder Dump was located on the northern end of 26th Street, near the current Boulder Rifle Club. The dump site was used for approximately forty years, closing in 1965. While in operation, it received chemical waste from Syntex Inc., and chemical waste had been observed flowing off-site into a stream (Ecology and Environment, 1988). The site's Superfund eligibility was evaluated in 1988 by the firm Ecology and Environment, Inc. and at the time, the dump site was not expected to impact Boulder Reservoir (Ecology and Environment, 1988).

5.9.3 Raytheon RCRA Site

The Raytheon Aircraft Company facility (Facility ID COD007068646), formerly Beech Aircraft Corporation, is located within the Boulder Reservoir Watershed. From the mid-1960s until 1987, Beech Aircraft manufactured and tested components for the aerospace industry, including cryogenic hydrogen and oxygen tanks, and military training targets. Until September 1999, fueling of military training targets was also performed at this facility. Groundwater monitoring during the early 1990s revealed low residual concentrations of volatile organic compounds in the groundwater on the property (Williams 2010). In

2000, EPA and Raytheon Aircraft Company entered into a Corrective Action Order on Consent pursuant to Section 30008(h) of the Resource Conservation and Recovery Act (RCRA). The agreement required Raytheon to investigate the nature and extent of contamination on and around the site, conduct a Corrective Measure Study to evaluate cleanup alternatives, and implement the selected remedy. According to a spring 2016 report to CDPHE, monthly water quality samples collected from the two natural groundwater seeps on the property have been compliant with permit water quality limits since at least January 2011, with only one elevated detection of dissolved iron. The seep water quality samples are analyzed for the following constituents: trichloroethylene, cis-1,2 dichloroethylene, vinyl chloride, methylene chloride, dissolved manganese, dissolved and total recoverable iron, and chloroform (Essential Management Solutions 2016). The city continues to maintain communication with EPA and review Raytheon's public water quality reports regarding groundwater quality at the RCRA site.

5.9.4 Syntex RCRA Site

The Syntex Lyons Ground Water Cleanup Project (Facility ID COD980957823) northeast of Lyons outside of the Zone 1 SWPA along BFC, is a RCRA Corrective Actions site. The landfill was previously used by Syntex Chemicals, Inc. to dispose of chemical process waste and debris from 1964 to 1976 (Brown and Caldwell 1992). The site is now owned by Roche Pharmaceuticals. Groundwater on the property was contaminated from industrial chemical waste dumped on site, with plumes tested for diethyl ether, tetrahydrofuran, benzene, chlorobenzene, toluene, and 1, 2 dichloroethane (Williams 2010). The plume has been monitored quarterly since Syntex submitted a Plume Remediation Plan in 1988 to CDPHE. A series of recovery wells are in place to keep the plume boundary from spreading. The site was most recently inspected in November 2015 and no violations were noted (Mruz 2015).

5.10 Storage Tanks

Colorado's Department of Labor and Employment, Division of Oil and Public Safety regulates certain above- and underground- storage tanks that contain petroleum substances (except some compressed and liquefied gases). Underground storage tanks ≥110 gallons, and aboveground storage tanks with capacities ranging from 60 to 40,000 gallons are regulated by the Division of Oil and Public Safety (CO DLE 2017a). There are six regulated underground tanks in the SWPA. These include the city's 1,000-gallon fueling tank at Boulder Reservoir near the marina, used for fueling boats and city vehicles. The tank is aboveground and has a concrete liner around it. The gas in the tank is used to fuel boats and city vehicles. Since 1986, when data collection began, there have been 15 documented petroleum releases from storage tanks in the SWPA – eight were in the Barker Reservoir Watershed, and the remaining seven were in Lyons near BFC. Of the 15, two of the cases remain open (see Table 4).

Table 4. Petroleum releases investigated by Colorado's Department of Labor and Employment, Division of Oil and Public Safety (CO DLE 2017b).

Site Name	Address	Event ID	Release Date	Status
Shamrock #635	4206 Ute Hwy, Lyons	3061	9/15/1988	Open- Implementing Corrective Action Plan
Gasamat/Cigarette Store #127	22 W. 2nd St., Nederland	12361	10/6/2015	Open- Site Characterization Report Complete

5.11 Mining Activities

Figure 15. New Cardinal Mill mine (Denver Public Library Western History Collection)

During the late 1800s and early 1900s, the upper watershed areas supported mining for tungsten, gold, silver, and other metals (Figure 15). Ores were discovered in Caribou Hill in 1869 and the area was heavily mined until the price of silver dropped in 1893. Gold mining was initiated around 1882 in Happy Valley near the now town of Eldora, southwest of Caribou Hill. A second mining boom was sparked in Caribou Hill in 1915, when tungsten, a steel-hardening alloy, was discovered. By 1920, mining had significantly declined due to lower demand and prices, and was limited primarily to individuals sporadically reactivating abandoned mines into the mid-1900s (Moore et al. 1957, Nederland Area Historical Society 2016). The mines of Caribou Hill, subsequently called Wolf Tongue Mill, have been out of operation since 1972 (City of Boulder 1992).

The extensive historic mining in Boulder County increased mineralized rock exposure to atmospheric conditions, and created drainage pathways out of some mine tunnels. The primary concern for downstream water quality is drainage leaching through mine tailings, which can be laden with metals and chemicals that were used during the milling process. Of the hundreds of abandoned mines in the SWPA, only two sites are known to actively and continuously drain- Caribou and Cross mines, and the New Cardinal Mill mine, as described in the sub-sections below. Other mines may experience more episodic drainage, typically during spring. As of 2016, Colorado's Division of Reclamation, Mining and Safety (DRMS) staff has safeguarded approximately 115 mines within the SWPA, to keep people and dogs out of the mines. The safeguarding process does not involve treating mine discharges. (Crosby 2016). There are several mines of particular interest in the upper watersheds, one of which is active, as described below.

5.11.1 Costilla Pit

Costilla Pit (permit M1987040) is an active sand and gravel mine near Caribou Ranch in the Lakewood Reservoir watershed. The permit was originally issued in 1987 with a surety of $40,354. A surety is a financial obligation, or collateral, to help pay for reclamation in case the mine permittee defaults. The Costilla Pit mine is 9.7 acres in size and is operated by Southway Construction Company, Inc.

5.11.2 Cross and Caribou Mines

Cross and Caribou Mines near the top of Caribou Road west of Nederland, are historic gold mines that are currently inactive, though treated wastewater from the site is discharged to the headwaters of Coon Track Creek under the CDPHE permit (CO0032751). The onsite WWTF operates year-round, piping water from the mines to two rubber-lined sedimentation ponds with a design capacity of 0.103 to 0.458 MGD. The mine effluent is treated with hydrated lime to address elevated pH and to precipitate metals prior to discharging into the creek.

5.11.3 New Cardinal Mill

The New Cardinal Mill mine (Figure 15) off Caribou Road west of Nederland is owned by Boulder County. Opening in 1903, the site was used to mine and mill primarily tungsten and gold until 1914. After that point, the mine was in and out of operation until 1942. The mine discharges continuously, and the effluent is sampled monthly by Boulder County staff for metals per their CDPHE discharge permit (permit COG603078). Untreated effluent from the facility discharges to Coon Track Creek, upstream from the confluence with Hicks Gulch Creek. The permitted discharge rate is 30 gallons per minute.

5.11.4 Swathmore

The Swathmore mine is near the Town of Eldora and was secured by DRMS after it temporarily breached in September 2015. At the time, the mine discharged an estimated 4,500 gallons within an hour into Middle Boulder Creek, turning the creek orange. As a precaution, the city temporarily shut off the downstream Barker Reservoir intake. Staff from the city, Nederland, and EPA monitored in-stream water chemistry and sampled the creek for metals analyses. DRMS staff implemented a monitoring program at the mine to characterize the mine discharge quality.

5.12 Oil and Gas Development

The surge in U.S. oil and gas production since the mid-2000s is largely attributed to the use of hydraulic fracturing and directional (horizontal) drilling. The practice has made oil and gas development more economical, particularly in regions where the hydrocarbon bearing formations have low permeability and porosity, such as those in Colorado (COGCC 2017a). Boulder Reservoir Watershed and BFC are above the Wattenberg Field Complex and Niobrara shale formation, and are part of the "Boulder Oil Field," which was discovered in 1901 (Colorado Geological Survey 2004) See Figure 16, modified from EPA (2016). While not currently active, at peak production in 1909, annual oil production reached 85,000 barrels in the Boulder Oil Field (Colorado Geological Survey 2004).

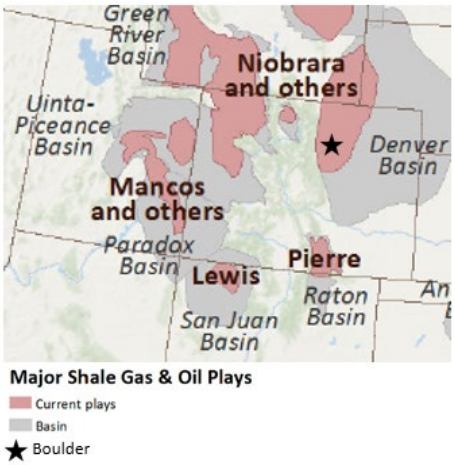

Figure 16. Major shale gas and oil plays in and around Colorado and Boulder. Modified Figure 3-2 from EPA (2016).

The 2016 EPA report on hydraulic fracturing concluded that "activities in the hydraulic fracturing water cycle can impact – and have impacted – drinking water resources…" (EPA 2016). According to EPA (2016), impacts to drinking water resources are more likely to result from the following activities:

- Spills of hydraulic fracturing fluids, chemicals, and produced water,
- Water withdrawals where water availability is low,
- Injecting hydraulic fracturing fluid into wells with compromised integrity, allowing gases and liquids to contaminate groundwater resources,

- Discharging untreated or poorly treated hydraulic fracturing wastewater to surface water or ground water, and,
- Storing hydraulic fracturing wastewater in inadequately lined or unlined pits, allowing liquids to leach into ground water resources.

Public surface drinking water sources have modest protections from oil and gas operations under Colorado Oil and Gas Conservation Commission (COGCC) Rule 317B. For classified water supply segments, Rule 317B protects up to five miles upstream from the WTP intake. Additional protections on oil and gas development are required within a half-mile of the source water. Further details on the state's regulations as they pertain to source water protection can be found at COGCC (2016) and AirWaterGas et al. (2016).

In the Boulder Reservoir and BFC SWPA, there are more than 200 abandoned oil and gas wells (COGCC 2017b). At the time this report was published, there were no active wells in the SWPA. A map of the wells is provided in Appendix A, Figure 26. As shown in Figure 26, most of the SWPA is in unincorporated Boulder County, and is therefore subject to County and state regulations. In April 2017, the Boulder County Commissioners approved revised oil and gas regulations via land use code amendments. Details on the amendments are available at Boulder County Land Use Department (2017).

5.13 Wildlife

Wildlife is an essential component of the ecosystems along Middle Boulder Creek and North Boulder Creek, which support healthy herds of elk, mule deer, and moose, as well as mountain lions, black bear, and small mammals. The raptor, waterfowl and small mammal population are more dominant in the Boulder Reservoir Watershed.

Figure 17. Moose near North Boulder Creek.

From May through October, a herd of approximately 50 elk reside in the Silver Lake Watershed. In autumn as snowpack increases, the elk move to lower elevations, around Caribou Ranch, on Delonde Creek west of Lakewood Reservoir, Sugarloaf, and Arapaho Ranch. Recent estimates from CPW suggest that there can be hundreds of elk on Caribou Ranch depending on the time of year (Cannon K., email communication, 2017).

When the elk settle along Delonde Creek, their presence can be detected by elevated bacteria levels in the city's source water quality samples collected downstream on North Boulder Creek. An increasing moose population is scattered between the high country, Caribou Ranch, Arapaho Ranch, and Gross Reservoir (Figure 17). Mountain lions appear to be the primary check on the moose, elk, and deer populations in the upper watersheds, displaying the typical predator-prey relationship and fluctuation in populations. Moose and elk populations are also maintained via hunting, which is limited to when they are passing through USFS land, Caribou Ranch, and lower elevations

The Boulder Reservoir watershed supports coyotes, prairie dogs, and 70 bird species including four Boulder County Birds of Special Concern. A large population of Canada geese reside year-round at Boulder Reservoir on the swim beach, docks, marina, and grassy areas. Water quality concerns associated with the goose population include bacteria, nutrient, and organic matter loading to the reservoir. To minimize the

impacts of goose waste on water quality, city staff has enhanced beach area night lighting to encourage goose relocation, and picks up goose waste on the beach and docks each day before the swim beach opens to the public. The city is investigating purchasing a mechanical device that attaches to a tractor, facilitating and expediting goose waste removal from the swim beach area.

5.14 Flooding

Flooding or runoff from peak rain events can impact water quality and potentially limit the ability to treat drinking water, as evidenced by the 2013 flood. In September 2013, dozens of communities along Colorado's Front Range were inundated with historic rainfall and subsequent flooding. During a one-week period, the Boulder area received more than 16 inches of rain, causing extensive flooding and damage throughout Boulder. The Boulder Reservoir WTP went offline prior to the storm event due to low demand, but turbid water in Boulder Reservoir and a breach in BFC that introduced sediment loads and turbidity, prevented the WTP from operating for several weeks. During the flood Sixmile Reservoir spilled into Boulder Reservoir (Figure 18). An estimated 576 emergency and recovery hours were spent during and immediately following the flood to prepare the WTP for operation. The water distribution system was not compromised by the floods and drinking water met all regulatory requirements. The Betasso WTP did not shut down during the event, and provided drinking water to customers.

Figure 18. Flooding caused Sixmile Reservoir to overflow across the road and into Boulder Reservoir.

Short-term impacts from the flood included increased debris and sediment in Boulder Reservoir, elevated turbidity levels, and increased concentrations of nutrients, chlorophyll *a*, total organic carbon, and bacteria. Two years' post-flood, Boulder Reservoir alkalinity, hardness and other water chemistry parameters remained elevated, though concentrations have been returning to pre-flood conditions.

5.15 Wildland Fire

The city's water supplies come from high elevation forested areas. Forest health and fires within these watersheds can significantly impact water quantity and quality and system infrastructure. How wildfire may impact water quality and supply depends on wildfire extent and intensity, post-wildfire precipitation, topography, and local soils and vegetation. Potential effects of wildfire on the city's water supplies, WTPs, and downstream aquatic ecosystems can include increased erosion and transport of sediment and debris; temporary WTP shutdowns; changes in the amount and timing of snowmelt runoff; damage to collection and controls infrastructure, and increased loading of nutrients, natural organic matter, and metals. For example, if sediment and debris accumulated in the city's reservoirs following a fire, the city could experience treatment challenges, increased operation maintenance costs, taste and odor issues, and a potential reduction in the city's usable water supplies (City of Boulder 2015). Figure 19 shows a picture of the 2016 Cold Springs wildfire in Nederland, which was started by illegal campers. To address concerns about wildfires started by illegal campers, as well as waste and trash left behind, city staff participate in the Nederland Interagency Council on Homeless Encampments (NICHE) group, which meets quarterly.

Figure 19. View of the Cold Springs Fire from Barker Reservoir (CBS Denver 2016).

Recognizing the potential impacts of fire on the water supply, the city worked with JW Associates, Inc. to perform a watershed hazard assessment and sediment transport analysis. Findings are briefly discussed in the subsections below (JW Associates 2014).

5.15.1 Wildfire Hazard Assessment

The wildfire hazard assessment prioritized 14-digit HUC sub-watersheds based on their potential impact on water quality post-fire via flood generation, debris flow, and increased sediment yields. The assessment methods are described by the Front Range Watershed Protection Data Refinement Work Group (2009), and the hazard ranking components included: wildfire hazard, flooding/debris flow hazard, and soil erodibility. The assessment suggests that Middle Boulder Creek watershed area between Nederland and Eldora has the highest potential for post-wildfire impacts to drinking water quality (see Appendix A, Figure 27).

5.15.2 Sediment Transport and Deposition

Wildfires can destabilize hillslopes, causing increased erosion and sediment transport to receiving waterbodies. Short-term impacts from sediment loading include elevated turbidity and treatment challenges. Long-term impacts can result from more severe burns with prolonged erosion and impacts to streams and if sediment transport decreases water supply reservoir capacity. In this sediment transport analysis, geomorphic indicators were used to categorize stream segments in the watersheds (see Appendix A, Figure 27):

- **Source Segments**- Steeper headwater streams that serve as a sediment sources.

- **Transport Segments**- Streams with intermediate slopes or straight, confined, channels that will likely move sediments from source segments, downstream.
- **Response Segments**- Wider, more sinuous stream segments with shallower slopes that will tend to accumulate sediment.

The analysis also identified stream junctions that have the highest potential for receiving large sediment deposits post-storm after a fire, because of abrupt changes in channel morphology. Specifically, where source and response stream segments meet, those areas may be at elevated risk for sediment accumulation. Wattles and sediment basins may be situated upstream from those locations to minimize sediment transport to downstream waterbodies.

Utilizing the findings from the wildfire hazard assessment and sediment transport and deposition, the city continues to work on multiple fronts to pre-plan for wildfire and minimize impacts to the water supply. Other efforts include: establishing and maintaining a communication network with wildfire first responders; mapping and ranking source water critical infrastructure in a Geographic Information Systems (GIS) for first responders; and developing a Wildfire Defense Plan.

5.16 Beetle Kill

Figure 20. Mountain pine beetle (USFS 2017a).

With drought, forest management changes, aging forests, and the changing climate, bark beetles have become more of a threat to forest health throughout the Rocky Mountains and other regions of the U.S. The USFS' Forest Health Monitoring program utilizes ground plots, aerial surveys, and other data to assess annual changes and trends in forest health, including bark beetle impacts. The 2016 Forest Health Monitoring results indicate widespread tree mortality from the western balsam bark beetle in the upper watersheds, primarily along the north and south forks of Middle Boulder Creek. Spruce beetles have caused tree mortality in a small portion of the upper Lakewood Reservoir Watershed. Mountain pine beetles have caused tree mortality in a small section outside of the watershed, south of Barker Reservoir (USFS 2017). A map of the forest health survey results is presented in Appendix A, Figure 28. Large swaths of dead or dying trees can serve as fuel, increasing fire risk and post-fire erosion (CO BLM 2012). Interestingly, recent research suggests that the new growth following beetle kill can be associated with higher nutrient uptake and lower stream nutrient concentrations (Rhoades et al. 2017).

The three EPA-registered insecticides used to prevent bark beetle infestation are carbaryl, permethrin, and bifenthrin. In the past, Eldora Mountain Resort sprayed lodge pole pine trees annually with carbaryl. Eldora Mountain Resort staff no longer use chemicals to control the spread of bark beetles, and instead debark, cut down, and/or remove dead trees as a mitigation approach. Localized chemical applications by private landowners may occur in the watersheds, but the extent is not known. City staff have monitored for carbaryl in source waters two to three times per year since 2009, and carbaryl has not been detected in Barker Reservoir or Lakewood Reservoir.

5.17 Aquatic Nuisance Species

Animal and plant aquatic nuisance species (ANS), including zebra and quagga mussels, the rusty crayfish, and Eurasian milfoil, can have myriad adverse impacts to water resources and ecosystems. Zebra and

quagga mussels are prolific reproducers, attach to water infrastructure and clog intakes, cover beach areas impacting recreational use, and are nearly impossible to eradicate (CPW 2017). Colorado has arguably one of the most advanced state-wide ANS programs and is the only state to have reported a decrease in infestation since the program was started.

Prior to 2011, quagga mussel larvae were detected in three Northern Water Colorado-Big Thompson project reservoirs including Granby Reservoir, Grand Lake, and Shadow Mountain Reservoir. Those reservoirs have since been delisted, and in January 2017 Pueblo Reservoir was delisted for mussels. There are currently no zebra or quagga mussel- positive waters in the state.

Since 2009, the city has implemented a Boulder Reservoir boat inspection program to prevent the introduction of ANS, and the reservoir is monitored twice during the summer for ANS. There have been no ANS detections in the reservoir. In May 2017, city staff intercepted a boat at Boulder Reservoir with attached mussels. The boat was decontaminated and sent to CPW for deconstruction and further decontamination. The recent event highlights the continued importance of inspecting all watercraft before they enter the reservoir.

5.18 Atmospheric Deposition

Atmospheric deposition is contributing nitrogen oxides (NO_x) and sulfur oxides (SO_x) to the alpine and subalpine regions of the Rocky Mountains, potentially impacting the ecological integrity and water quality in otherwise relatively un-impacted ecosystems (Clow et al. 2015). Sources of NO_x and SO_x, which contributes to water acidification and nutrient enrichment, are from within and outside Colorado, including car emissions, agricultural fertilizers, and coal combustion from power plants (Clow et al. 2015).

The Silver Lake Watershed is home to the Niwot Ridge Long Term Ecological Research (LTER) station, which provides a plethora of data and published research on climate change impacts, water quality changes, hydrology, snowmelt, and atmospheric deposition. Williams and Tonnesson (2000) report that annual wet inorganic nitrogen deposition nearly doubled at Niwot Ridge during the 1984 to 1996 period. Further, data collected in alpine lakes in the Rocky Mountains and in Green Lakes Valley (within the Silver Lake Watershed) suggest that the atmospheric deposition of inorganic nitrogen is associated with periodic episodes of lake acidification (Williams and Tonnesson 2000). City staff continue to analyze water quality data for trends and changes in chemistry.

5.19 Climate Change

Planning for climate change impacts is a key aspect of the city's water supply planning and management processes as it has the potential to affect both the quantity and quality of the city's water supply (Rozaklis & Associates, LLC 2016). In 2009 the city completed a Climate Change Vulnerability Study that evaluated the potential impacts of climate change on the city's water supply availability. In that study, under most climate change scenarios evaluated, the city would be able to meet its water supply level of service. The city is in the process of updating its water supply climate change analysis.

While most climate change models project a warmer future for Colorado, the models do not agree in their projections of changes in precipitation. The Climate Change of Colorado Report (Lukas et al. 2014) describes the potential impacts of climate change projections on water resources, including water availability and water quality, in Colorado. Because water quality is sensitive to water temperature, stream flow, runoff patterns, and precipitation patterns, the effects of climate change on the city's source

water quality will depend on how climate change manifests in the source water basins. For example, warmer land surface temperatures lead to warmer lake temperatures and consequently higher concentrations of dissolved organic matter in source water, which increases the cost and challenge of water treatment (Vogel et al. 2012). Climate change will also indirectly impact water quality as extreme weather events such as floods, droughts, and wildfires are expected to continue in Colorado with the changing climate and warming temperatures (Childress et al. 2015).

6 SOURCE WATER PROTECTION ACTION PLAN

6.1 Watershed Susceptibility to Potential Contaminant Sources

During the stakeholder meetings, the group estimated the probability of impact and impact to the water supply for each PSOC (Section 4.4). Together, the ratings estimate watershed susceptibility (very low to high) to contamination associated with each PSOC. Susceptibility varies by watershed for each PSOC because of PSOC prevalence, watershed characteristics, and/or preventative measures that are already in place to limit the probability of impact. Figure 21 provides a broad-brush overview of the susceptibility of the SWPA to contamination from each PSOC, based on how the PSOCs were rated for each individual watershed. The remaining tables present the estimated PSOC susceptibility for Barker Reservoir Watershed (Table 5), Kossler Reservoir Watershed (Table 6), Lakewood Reservoir Watershed (Table 7), Silver Lake Watershed (Table 8), Boulder Reservoir Watershed (Table 9), and Boulder Feeder Canal (Table 10). Beetle kill (section 5.16) was not ranked because the BMPs associated with bark and pine beetles pertain to wildfire risk and pesticide use. Climate change (section 5.19) was also not ranked given the myriad impacts to the water supply overall.

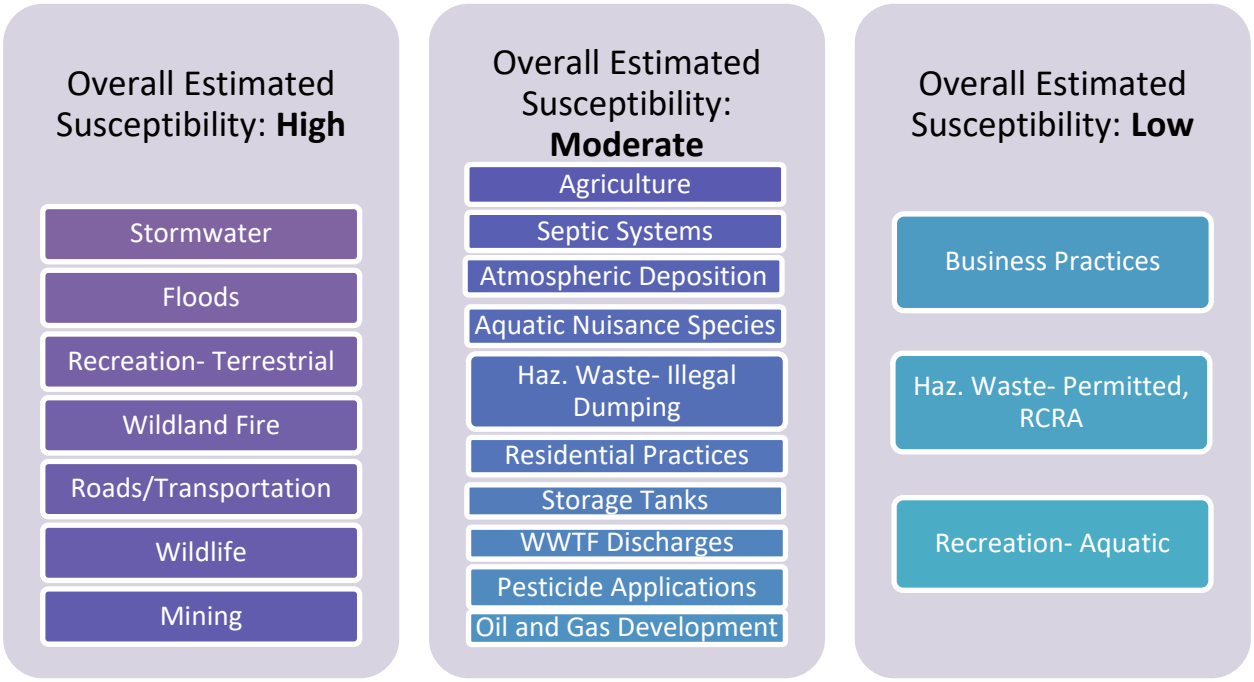

Figure 21. Estimated susceptibility of the Source Water Protection Area (i.e., multiple watersheds) to each PSOC.[◆]

[◆]*Susceptibility ratings: High = 3-4 watersheds were rated as having a high or moderate susceptibility to the PSOC; Moderate = 2 watersheds were rated as having a high or moderate susceptibility to the PSOC; and Low = 0-1 watersheds were rated as having a high or moderate susceptibility to the PSOC.*

Table 5. Barker Reservoir Watershed susceptibility assessment for potential contaminant sources.

Barker Reservoir Watershed PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Onsite Wastewater Treatment Systems	~740 OWTS in the watershed, many of the unapproved systems are in Eldora.	Likely	Significant	High
Stormwater Runoff and Discharges	Road runoff from Nederland into Beaver Creek and Barker directly. Fertilizer runoff from yards.	Certain	Significant	High
Wildland Fire	Natural and human caused.	Likely	Major	High
Aquatic Nuisance Species	Potential for spread via anglers, primarily.	Unlikely	Major	Moderate
Atmospheric Deposition	Impacts more likely to be observed in Silver Lake upstream from intake, but acidification can mobilize metals.	Likely	Minor	Moderate
Business Practices	Improper disposal of oils, grease, fats. Illegal dumping. Use of snowmaking chemicals at Eldora Mountain Resort. Soil and irrigation water disposal at Marijuana grow facilities.	Possible	Minor	Moderate
Floods	Erosion, increase in Nederland WWTF discharges and stormwater flows.	Possible	Significant	Moderate
Hazardous Waste-Illegal Dumping	Historical Nederland dump near Magnolia Road used as illegal dump site and shooting range. Illegal dumping in storm drains or directly to waterbodies. Possible chemical discharges related to meth manufacturing.	Possible	Significant	Moderate
Hazardous Waste-Permitted, RCRA	Mountain Autobody near Barker Reservoir. No recent violations. Has not been in use for ten years. Eldora landfill, Nederland landfill.	Unlikely	Significant	Moderate

Barker Reservoir Watershed PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Mining Activities	Abandoned mines throughout the watershed. Two historic mines discharge continuously, though water is treated with lime at one of them.	Possible	Significant	Moderate
Recreation-Terrestrial	Human and dog waste along Barker and MBC. Riparian degradation along Beaver Creek from urban uses, and along MBC from recreators, hikers, and campers. Hessie Trail and 4th of July Trail are of primary concern, but are farther upstream, near Eldora.	Certain	Minor	Moderate
Residential Practices	Waste disposal via household drains, dumping in backyards, inadequate lining for storage tanks.	Possible	Minor	Moderate
Roads and Transportation	Road salt, sand, and deicer applications. Oil leaks and spills, and car/tanker turnovers in Barker Reservoir.	Certain	Minor	Moderate
Storage Tanks	Some regulated, but mostly unregulated around Nederland and Eldora.	Possible	Significant	Moderate
Wastewater Treatment Facilities	Nederland WWTF discharges into Barker Reservoir; Eldora Mountain Resort WWTF treats in lagoons which eventually reach MBC. Inflows and infiltration from Nederland collection system.	Certain	Minor	Moderate
Wildlife	Elk, deer, moose, mountain lions.	Certain	Insignificant	Low
Agriculture- Crop Production	N/A	Rare	Insignificant	Very Low
Agriculture- Livestock	Sundance Café in Nederland has horse stables and offers rides.	Rare	Minor	Very Low
Pesticide Applications	Pine beetle kill near Eldora, but the resort no longer uses chemicals.	Rare	Insignificant	Very Low

Barker Reservoir Watershed PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Oil and Gas Development	The city owns mineral rights for Barker Reservoir area. Shale formations are not known to be in the watershed.	Rare	Insignificant	Very Low
Recreation- Aquatic	N/A	Rare	Insignificant	Very Low

Table 6. Kossler Reservoir Watershed risk assessment for potential contaminant sources.

Kossler Reservoir Watershed PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Wildland Fire	Natural or human caused. Soils could be re-stabilized fairly easily if needed.	Possible	Insignificant	Low
Wildlife	Deer, a few geese, small mammals	Unlikely	Minor	Low
Agriculture- Crop Production	N/A	Rare	Insignificant	Very Low
Agriculture- Livestock	Nearby resident has horses, but they are located outside of the watershed.	Rare	Insignificant	Very Low
Aquatic Nuisance Species	Limited public access.	Rare	Minor	Very Low
Atmospheric Deposition	Possible, but more likely at higher elevations. Also, the reservoir is a forebay so it has a short residence time.	Unlikely	Insignificant	Very Low
Business Practices	N/A	Rare	Insignificant	Very Low
Floods	Erosion is possible, but stormwater is diverted away from the reservoir.	Rare	Insignificant	Very Low
Hazardous Waste- Illegal Dumping	N/A	Rare	Insignificant	Very Low
Hazardous Waste- Permitted, RCRA	N/A	Rare	Insignificant	Very Low
Pesticide Applications	N/A	Rare	Insignificant	Very Low
Mining Activities	N/A	Rare	Insignificant	Very Low

Kossler Reservoir Watershed PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Oil and Gas Development	N/A	Rare	Insignificant	Very Low
Onsite Wastewater Treatment Systems	Nearby residence does have an OWTS but it is outside of the watershed. Also positive pressure of water seeping from Kossler, limits groundwater contamination.	Rare	Insignificant	Very Low
Recreation- Aquatic	Limited public access. No trespassing signs.	Rare	Insignificant	Very Low
Recreation- Terrestrial	Limited public access. No trespassing signs.	Rare	Insignificant	Very Low
Residential Practices	One house nearby but not in watershed. Also positive pressure of water seeping from Kossler, limits groundwater contamination.	Rare	Insignificant	Very Low
Roads and Transportation	Road is down gradient from the reservoir; stormwater diverted away from reservoir.	Rare	Insignificant	Very Low
Storage Tanks	N/A	Rare	Insignificant	Very Low
Stormwater Runoff and Discharges	Stormwater from road and residence diverted away from the reservoir.	Rare	Insignificant	Very Low
Wastewater Treatment Facilities	N/A	Rare	Insignificant	Very Low

Table 7. Lakewood Reservoir Watershed risk assessment for potential contaminant sources.

Lakewood Reservoir Watershed PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Floods	Somewhat of a buffer provided by mostly forested watershed.	Possible	Significant	Moderate

Lakewood Reservoir Watershed PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Hazardous Waste- Illegal Dumping	Gordon Gulch dump (illegal paint thinner disposal in hand-dug ditches). Other unknown dumping in watershed.	Possible	Significant	Moderate
Mining Activities	Several known closed mines and one active mine with a no discharge permit. Historically a heavily mined area.	Possible	Significant	Moderate
Recreation- Terrestrial	Camping, hiking, fishing, horseback riding, cross country skiing. Human and dog waste	Possible	Minor	Moderate
Storage Tanks	One permitted storage tank near NBC. Likely other non-regulated tanks.	Possible	Significant	Moderate
Stormwater Runoff and Discharges	Minimal development, few roads.	Possible	Minor	Moderate
Wildland Fire	Natural and human caused. The city does have flexibility in which intake to use, minimizing impacts.	Possible	Significant	Moderate
Wildlife	Elk, deer, moose, mountain lions. Elk herd resides along Delonde Creek during late fall/early winter.	Likely	Minor	Moderate
Agriculture- Livestock	Horses and cattle at Caribou Ranch.	Unlikely	Minor	Low
Onsite Wastewater Treatment Systems	A few houses nearby including at Caribou Ranch. Lakewood OWTS is downstream from reservoir; vault OWTS at the hydro facility.	Likely	Insignificant	Low
Roads and Transportation	Spills and oil leaks. Few roads in the watershed, mostly dirt roads.	Unlikely	Minor	Low
Agriculture- Crop Production	N/A	Rare	Insignificant	Very Low
Aquatic Nuisance Species	Possible introduction from anglers along NBC and Delonde Creek	Rare	Minor	Very Low

Lakewood Reservoir Watershed PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Atmospheric Deposition	Impacts more likely to be observed in Silver Lake upstream from intake, but acidification can mobilize metals. Lakewood Reservoir is a forebay so residence time is shorter.	Unlikely	Insignificant	Very Low
Business Practices	N/A	Rare	Insignificant	Very Low
Hazardous Waste-Permitted, RCRA	N/A	Rare	Insignificant	Very Low
Pesticide Applications	None known	Unlikely	Insignificant	Very Low
Oil and Gas Development	Future Caribou Ranch leases are possible but not known.	Rare	Insignificant	Very Low
Recreation- Aquatic	N/A	Rare	Insignificant	Very Low
Residential Practices	A few houses nearby including at Caribou Ranch.	Rare	Minor	Very Low
Wastewater Treatment Facilities	Mountain Research Station discharges to groundwater, which flows into Como Creek.	Rare	Minor	Very Low

Table 8. Silver Lake Watershed risk assessment for potential contaminant sources.

Silver Lake Watershed PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Atmospheric Deposition	NOx and SOx deposition from agriculture, industrial releases, and vehicles on the eastern side of the Front Range and in other states. Contributes to lake acidification, ecosystem changes.	Likely	Significant	High
Wildland Fire	The high elevation and large area above timberline decrease the risk.	Unlikely	Significant	Moderate

Silver Lake Watershed PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Recreation- Aquatic	Routine sampling from Niwot Ridge LTER staff.	Unlikely	Minor	Low
Recreation- Terrestrial	Routine sampling from Niwot Ridge LTER staff.	Unlikely	Minor	Low
Roads and Transportation	Cars and snowmobiles from city staff and Niwot Ridge staff.	Unlikely	Minor	Low
Storage Tanks	Caretaker house and at the Mountain Research Station. None close to waterbodies.	Possible	Insignificant	Low
Wildlife	Elk, deer, moose, mountain lions, marmots	Possible	Insignificant	Low
Agriculture- Crop Production	N/A	Rare	Insignificant	Very Low
Agriculture- Livestock	N/A	Rare	Insignificant	Very Low
Aquatic Nuisance Species	Public access prohibited	Rare	Minor	Very Low
Business Practices	N/A	Rare	Insignificant	Very Low
Floods	Possible but less risk at this elevation	Rare	Minor	Very Low
Hazardous Waste- Illegal Dumping	Public access prohibited	Rare	Insignificant	Very Low
Hazardous Waste- Permitted, RCRA	N/A	Rare	Insignificant	Very Low
Pesticide Applications	N/A	Rare	Insignificant	Very Low
Mining Activities	Abandoned mines in the watershed	Unlikely	Insignificant	Very Low
Oil and Gas Development	N/A	Rare	Insignificant	Very Low
Onsite Wastewater Treatment Systems	Caretaker house at Silver Lake.	Rare	Insignificant	Very Low
Residential Practices	Caretaker house at Silver Lake, activities at the Mountain Research Station.	Rare	Insignificant	Very Low
Stormwater Runoff and Discharges	Relatively undisturbed watershed	Rare	Insignificant	Very Low
Wastewater Treatment Facilities	N/A	Rare	Insignificant	Very Low

Table 9. Boulder Reservoir Watershed risk assessment for potential contaminant sources.

Boulder Reservoir Watershed PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Agriculture- Crop Production	Irrigation overflow and fertilizer runoff to Boulder Reservoir tributaries.	Certain	Significant	High
Agriculture- Livestock	Livestock grazing (primarily cattle) throughout watershed. Cattle have direct access to Dry Creek and other small drainages during certain times of year. Waste and manure runoff, and potential riparian degradation.	Likely	Significant	High
Floods	Flooding can increase erosion, cause sheet runoff into the reservoir. Can reduce/stop BFC inflows.	Possible	Major	High
Recreation- Aquatic	Swimming, boating, fishing, special recreation events.	Certain	Significant	High
Roads and Transportation	Dirt roads and the parking lot and paved roads near the swim beach area.	Likely	Significant	High
Stormwater Runoff and Discharges	Runoff and discharges from the parking lot and roads, irrigated grassy areas near the swim beach. Runoff from the Lake Valley Estates golf course area. Spill from Six Mile Reservoir spillway	Certain	Significant	High
Wildlife	Geese, raptors, prairie dogs. Geese associated with bacteria exceedances at swim beach. Nutrient loading to the reservoir.	Certain	Significant	High
Aquatic Nuisance Species	All watercraft are inspected. Reservoir monitored in the summer by CPW.	Unlikely	Major	Moderate
Pesticide Applications	Herbicides applied directly to BFC. Runoff from cropland as well. Insecticides applied periodically by Boulder County Mosquito Control.	Certain	Minor	Moderate

Boulder Reservoir Watershed PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Oil and Gas Development	Drilling possible on city- or county-owned land where the city and the County do not own the mineral rights; or on private land.	Possible	Significant	Moderate
Recreation- Terrestrial	Special events- running, cycling, parties on the beach. Anglers. Dogs swim at the beach during the winter (waste bags provided by the city). Horse riding along the trails.	Likely	Minor	Moderate
Wastewater Treatment Facilities	Fairways Metro District WWTF lagoon system. If there is a failure, it flows into wetlands and Dry Creek. The city has two lift stations near the swim beach that were upgraded in 2012 and 2013.	Possible	Minor	Moderate
Hazardous Waste- Illegal Dumping	Possible.	Unlikely	Minor	Low
Mining Activities	Closed mines in the watershed.	Unlikely	Minor	Low
Storage Tanks	The city's fueling station and tank near the marina at the reservoir. There is also a permitted storage tank at the Raytheon cleanup site.	Rare	Significant	Low
Wildland Fire	Grass fires are possible. Also, prescribed burns are performed in the watershed to improve habitat.	Unlikely	Minor	Low
Atmospheric Deposition	More of a concern at higher elevations.	Unlikely	Insignificant	Very Low
Business Practices	Few businesses in the watershed.	Rare	Insignificant	Very Low
Hazardous Waste- Permitted, RCRA	Raytheon is a RCRA site. Groundwater is routinely monitored.	Rare	Minor	Very Low
Onsite Wastewater Treatment Systems	A number of them throughout the watershed.	Unlikely	Insignificant	Very Low
Residential Practices	Few houses in the watershed.	Unlikely	Insignificant	Very Low

Table 10. Boulder Feeder Canal risk assessment for potential contaminant sources.

Boulder Feeder Canal PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Agriculture- Crop Production	Crop production runoff to drainages or directly to BFC.	Likely	Significant	High
Agriculture- Livestock	Livestock operations, and at least one horse stable, hobby farming, west of BFC.	Likely	Significant	High
Floods	BFC became unusable because of the 2013 flood and flows were delayed several months in 2014 due to maintenance and repairs.	Possible	Major	High
Stormwater Runoff and Discharges	Outfalls throughout BFC. Many have been diverted; some are tied to agriculture.	Likely	Significant	High
Pesticide Applications	Herbicides applied directly to BFC. Runoff from cropland as well. Insecticides applied periodically by Boulder County Mosquito Control.	Certain	Minor	Moderate
Mining Activities	12950 North Foothills Hwy- sand and gravel mine (PDK Investments, sold in Nov. 2016)- down gradient from BFC. Also three active mines near BFC (Dowe Flats Mine [CEMEX], Lyons Quarry [CEMEX], and Silica Quarry [CEMEX]). Mines along Left Hand Creek, which can drain into BFC.	Possible	Significant	Moderate
Oil and Gas Development	Possible on adjacent land in Larimer and Boulder counties.	Possible	Significant	Moderate
Onsite Wastewater Treatment Systems	Throughout BFC, but only the ones west of BFC are of concern. Shady Acres development has many OWTS.	Possible	Minor	Moderate
Residential Practices	OWTS cleanouts, meth chemical disposal, runoff from lawns.	Possible	Minor	Moderate
Roads and Transportation	Road crossings, sediment, salt, sand, deicing chemicals, runoff, spills. BFC only flows April-Oct. The only parallel road is owned and used by Northern Water.	Possible	Significant	Moderate

Boulder Feeder Canal PSOC	Details	Probability of Impact (Rare, Unlikely, Possible, Likely, Certain)	Impact to Water Supply (Insignificant, Minor, Significant, Major, Catastrophic)	Susceptibility (Very Low, Low, Moderate, High, Very High)
Wildlife	Geese, ducks, small mammals	Possible	Minor	Moderate
Business Practices	Businesses are primarily in Lyons, which are more likely to impact the St. Vrain River and not BFC.	Unlikely	Minor	Low
Hazardous Waste- Illegal Dumping	Possible, particularly at road crossings.	Unlikely	Minor	Low
Hazardous Waste- Permitted, RCRA	Syntex Lyons groundwater cleanup project RCRA site. Monitoring wells in place.	Unlikely	Minor	Low
Recreation- Terrestrial	Infrequent special events such as races where runners cross BFC.	Unlikely	Minor	Low
Storage Tanks	Some regulated, but mostly unregulated along the length of BFC.	Rare	Significant	Low
Wildland Fire	Grass fires are possible.	Unlikely	Minor	Low
Aquatic Nuisance Species	Canal closed to public access. ANS prevention program in place at Carter Lake and other upstream reservoirs.	Rare	Insignificant	Very Low
Atmospheric Deposition	More of a concern at higher elevations.	Rare	Insignificant	Very Low
Recreation- Aquatic	N/A	Rare	Insignificant	Very Low
Wastewater Treatment Facilities	Lyons WWTF discharges to the St. Vrain, not BFC.	Rare	Minor	Very Low

6.2 Prioritized Best Management Practices

This SWPP and BMP implementation will be led by the city's Water Quality and Environmental Services group within Public Works, Utilities. Staff will coordinate with other departments within the city, and with its partners and stakeholders. The status of BMP implementation will be updated and tracked internally by city staff. This public version of the report will not be regularly updated. In the following table, each BMP is associated with a symbol characterizing the status of implementation: ☐ = BMP still needs to be implemented; ➔ = BMP implementation is ongoing or will be implemented on an as-need basis.

Area of Concern	Watershed	Best Management Practice	Priority (1=high, 3=low)
Agriculture	Boulder Reservoir	☐ Coordinate with the city's OSMP to control water use during flood irrigation in the Boulder Reservoir Watershed and to evaluate potential alternatives to minimize water use and overflows.	1
Agriculture	Boulder Reservoir and BFC	☐ Coordinate with the city's OSMP to maintain a current map of the type of agriculture and livestock on city-owned property in the Boulder Reservoir watershed and along BFC.	1
Agriculture	Boulder Reservoir and BFC	☐ Evaluate the city's OSMP Property Management Plans to identify specific and mandatory actions that lessee's would be required to implement to protect water quality and quantity.	1
Agriculture	Boulder Reservoir and BFC	➔ Receive annual spring updates on upcoming fertilizer application locations, amounts, and timing from OSMP's lessee's in the SWPA.	1
Residential and Business Practices	All	➔ For construction activities occurring in Zone 1 of the SWPA, participate in the BMP identification process and potentially monitor to identify and rectify any water quality impacts. Key partners- Boulder County Land Use and various city departments.	1
General	All	☐ Provide copies of the final SWPP, GIS shapefiles of the protection zones and emergency response notification cards to local Fire Departments, Sheriff's Departments, OEM, USFS, Town of Nederland, Eldora Civic Association, County EERT, and any other agencies/departments involved in fire and land management.	1
General	All	☐ Work with Boulder County's Commissioners to develop a Memorandum of Agreement (MOU) to increase collaboration and protect the drinking water supply. Specific areas of collaboration and input: •Reviewing and providing input on any proposed or submitted oil and gas development projects in the SWPA. • Review and provide input on any new mining permits in the SWPA. •Reviewing large residential or business construction projects in the SWPA to ensure that proper BMPs are in place to protect downstream water resources. •Establish lines of communication and identify roles and responsibilities for each entity before, during, and after emergency events, such as a wildfire. •Review road maintenance schedules, and deicer applications within Zone 1 of the SWPA.	1
General	Upper Watersheds	☐ Develop a water quality annex for the city and OEM that identifies roles and responsibilities and water quality monitoring locations throughout the SWPA that could be sampled after an emergency event (e.g., wildfire, spill) to measure potential impacts. The plan would also identify and compile data from previously sampled and current monitoring stations.	1

Area of Concern	Watershed	Best Management Practice	Priority (1=high, 3=low)
Oil and Gas	Boulder Reservoir and BFC	☐ Work with the city's OSMP staff and their contracted firm to evaluate the oil and gas development potential and areas at risk within the Boulder Reservoir watershed and along BFC up to Carter Lake.	1
Onsite Wastewater Treatment Systems	All	☐ Work with BCPH staff to develop an updated GIS layer of the location and status of septic systems in the SWPA. Identify clusters of unapproved or high-risk septic systems in the SWPA. Update the GIS layer at least annually.	1
Storage Tanks	Boulder Reservoir	☐ Participate in the Boulder Reservoir South Shore Management planning process, particularly as it relates to construction activities at the Boulder Reservoir swim beach, diverting stormwater drainage, and installing a new fuel storage tank at the marina.	1
Wildland Fire	All	☐ Develop a flow chart with contact information and roles and responsibilities for the various entities involved during a wildfire (e.g., OEM, BCPH, fire districts, USFS, EOC, Nederland, Eldora Mountain Resort, Indian Peaks Wilderness Alliance, Middle Boulder Creek Coalition, USGS). Establish communication with U.S. Army Corps of Engineers for post-fire sediment basin permitting.	1
Wildland Fire	Upper Watersheds	☐ Research erosion control measures including a debris boom and silt curtain for Barker reservoir, coir silt checks for smaller tributaries, and wattles and ditch checks. Evaluate the possibility of hiring the Colorado Forest Restoration Institute to model sediment transport and determine appropriate locations for wattle placement.	1
Wildland Fire	Upper Watersheds	☐ Coordinate with Boulder County Land Use and USFS to Identify and compile a list of potential contractors with the following capabilities: dredging, mulch application, hillslope stabilization, sediment basin installation.	1
Wildlife	Boulder Reservoir	☐ Purchase a mechanical harvester to facilitate and expedite daily goose poop removal on the Boulder Reservoir swim beach and grassy areas.	1
Mining	Barker Reservoir	☐ Collect stream and mine drainage water quality samples along Coon Track and Beaver Creek to understand potential urban and mine impacts to water quality. Also work with DRMS and USGS to identify mine tailings at risk for erosion or exposure post-wildfire.	1
Recreation - Aquatic and Terrestrial	All	☐ Post Source Water Protection Area signage at Barker Reservoir and Boulder Reservoir. Evaluate the possibility of making the sign design consistent with the Keep it Clean signs along Boulder Creek. Coordinate with Nederland, CDOT and Boulder County Transportation on sign locations.	1
Agriculture	Boulder Reservoir and BFC	☐ Under OSMPs Agricultural Plan and Grasslands Plan, coordinate with OSMP staff to implement any needed water quality BMPs on the agricultural land in the Boulder Reservoir Watershed. Monitor before and after BMP implementation to characterize changes in water quality.	2
Pesticide Applications	Upper Watersheds	☐ Contact USFS' Boulder Ranger District to learn about any USFS insecticide application amount, timing, and locations within the SWPA.	2

Area of Concern	Watershed	Best Management Practice	Priority (1=high, 3=low)
Mining	Upper Watersheds	☐ Contact the Colorado Geological Survey about their working inventory of draining mines in the state.	2
Oil and Gas	Boulder Reservoir and BFC	☐ Work with COGCC and Boulder County on leases, and build a relationship with the local government designee, to protect the water supply during oil and gas operations. See Brighton as an example of the types of protections that could be in place.	2
Oil and Gas	Boulder Reservoir and BFC	☐ Review and document 317b coverage around Boulder Reservoir and Boulder Feeder Canal. Compare to the Boulder County protection buffers and regulations in the Land Use Code.	2
Onsite Wastewater Treatment Systems	All	☐ Work with BCPH staff to develop a GIS layer of septic failure occurrence within the SWPA.	2
Agriculture	Boulder Reservoir	☐ Tour Little Dry Creek and Dry Creek to identify areas at risk for erosion and sediment transport. Evaluate the need for fencing to restrict cattle access to the creek, revegetation opportunities, etc. Use BLMs Proper Functioning Condition assessment methodology.	2
Roads and Transportation	All	☐ Communicate with CDOT and Boulder County Transportation to keep informed on road maintenance practices and schedules within the SWPA including: grading, the application of magnesium chloride and dust abatement activities along with the BMPs utilized during these activities.	2
Storage Tanks	All	☐ Perform site visits with OPS staff as available in the SWPA (particularly in Zone 1) to gain a better understanding of where storage tanks are and learn about the various safety mechanisms in place. Work with OPS staff to identify those that may need secondary containment.	2
Wildland Fire	All	☐ Work with CDPHE and USFS to enter ranked critical infrastructure into USFS' Wildfire Decision Support System and Boulder County OEMs system. This capability may not be available for several years.	2
Wildland Fire	Upper Watersheds	☐ Review USFS' Arapaho Roosevelt Forest Website for projects to participate in (e.g., NEPA process for expanding land owner defensible space into USFS land).	2
Wildland Fire	Upper Watersheds	☐ Work with USFS, Boulder County Transportation and CDOT to perform a culvert evaluation and identify any undersized and/or broken culverts that may cause flooding post-fire.	2
Agriculture	All	☐ Work with Boulder County Extension Service and USDA's NRCS to perform education and outreach to small hobby farmers in the SWPA. See St. Vrain educational material.	3
Agriculture	Boulder Reservoir	☐ Perform special studies to identify the likely source(s) of increasing phosphorus in Boulder Reservoir. This may include water quality sampling upstream and downstream on Little Dry Creek and Dry Creek and analyzing Boulder Reservoir phytoplankton data to pinpoint if source is agricultural, geese, or primarily from erosion/geology.	3

Area of Concern	Watershed	Best Management Practice		Priority (1=high, 3=low)
Aquatic Nuisance Species	Barker Reservoir	☐	If not already distributed, provide Colorado Parks and Wildlife literature to Nederland businesses that sell fishing licenses, about what recreators and fishers can do to prevent the spread of aquatic nuisance species.	3
Aquatic Nuisance Species	Boulder Reservoir	➔	Continue to support Boulder Reservoir's ANS watercraft inspection program. If needed, discuss cost-sharing options within city departments for maintaining CPW's sampling at the reservoir.	3
Atmospheric Deposition	Silver Lake	➔	Remain on the Niwot Ridge LTER list serve and when possible, attend presentations and thesis dissertations pertaining to Niwot Ridge research.	3
Atmospheric Deposition	Silver Lake	➔	Continue to share water quality and phytoplankton data from Silver Lake watershed sampling with LTER staff, when requested.	3
Atmospheric Deposition	Upper Watersheds	☐	Evaluate LTER and USGS research on nitrate deposition and potential impacts post-wildfire in terms of elevated loading to surface waters.	3
Residential and Business Practices	Barker Reservoir	➔	Remain in the loop about the possible expansion of Eldora Mountain Resort. As needed, coordinate to implement BMPs to protect Middle Boulder Creek water quality and quantity.	3
Hazardous Waste	Boulder Reservoir	➔	Stay informed about ongoing groundwater remediation activities at the Raytheon and Syntex sites.	3
Hazardous Waste	Boulder Reservoir	☐	Evaluate surface water drainage from the North Boulder dump site to determine potential contamination to Boulder Reservoir. If the potential is nonexistent, then further sampling is not necessary. Site was sampled in the 1980s/90s.	3
Pesticide Applications	BFC	➔	Continue to communicate with Northern Water about herbicide applications along BFC to allow for adequate time to shut down the Boulder Reservoir WTP intake on BFC. Continue to participate in the semi-annual herbicide application meetings at Northern Water.	3
Mining	Upper Watersheds	➔	Collaborate with DRMS to facilitate abandoned mine closures in the watersheds, and any investigations of mine tailings, and drainages within the SWPA. Maintain a current database of abandoned mines and mine tailing locations.	3
Onsite Wastewater Treatment Systems	All	☐	Partner with BCPH staff in mapping groundwater depth. This may help with prioritizing unapproved septic systems for upgrades and identifying higher risk areas in the SWPA.	3
Onsite Wastewater Treatment Systems	Barker Reservoir	☐	Perform a special water quality monitoring study with USGS and BCPH to monitor water quality upstream, within, and downstream from Eldora to understand potential impacts from wastewater and abandoned mines. If appropriate hold a special workshop to offer free nitrate drinking water well testing in high risk areas to identify any leaking septic systems.	3

Area of Concern	Watershed	Best Management Practice	Priority (1=high, 3=low)
Onsite Wastewater Treatment Systems	All	☐ Work with Boulder County SepticSmart and CRWA to conduct an on-site septic system maintenance demonstration for homeowners at selected sites, such as in the neighborhood near Barker Reservoir. If needed, purchase a sludge monitoring device (sludge judge) for shared use by homeowners so that they can evaluate the scum levels in their septic tanks. Discuss septic maintenance outreach with Boulder Public Library and Nederland Library.	3
Recreation - Aquatic and Terrestrial	Boulder Reservoir	➔ Continue to monitor for BTEX at the Boulder Reservoir during high use periods in the summer. Also continue to coordinate with OSMP and Parks and Recreation staff on analyzing the data for compliance with city-established thresholds, including water quality thresholds.	3
Recreation - Aquatic and Terrestrial	Upper Watersheds	➔ Continue to participate in the quarterly NICHE meetings.	3
Recreation - Aquatic and Terrestrial	Upper Watersheds	☐ Coordinate with four-wheeling groups, Indian Peaks Wilderness Alliance, and other recreational groups on cleanup and restoration volunteer efforts.	3
Recreation - Aquatic and Terrestrial	Upper Watersheds	☐ Coordinate with USFS and the city's Parks and Recreation staff on placing educational signs at trail heads noting source water protection and using designated trash receptacles (if available) or packing in/packing out trash and dog waste (Hessie Trail, 4th of July Trail, around Boulder Reservoir).	3
Recreation - Aquatic and Terrestrial	Upper Watersheds	➔ Continue to evaluate Boulder County Parks and Open Space, Peak-to-Peak, and USFS' plans for trail and road maintenance, removal, and development. See NEPA for Magnolia Trails for details.	3
Residential and Business Practices	All	☐ Distribute education and outreach material to businesses and industries that explains how to properly store and dispose of oils/greases, toxic, and hazardous waste to protect water quality. Evaluate whether marijuana grow facilities within the SWPA should be provided educational material about disposing of irrigation water and soil. Advertise Boulder County's drug take-back program to residents and business owners. Work with Nederland community organizers, NICHE, and BCPH to facilitate a special tire disposal and hazardous waste collection day.	3
Residential and Business Practices	Upper Watersheds	☐ Evaluate the need for preparing an article for the Mountain Ear, highlighting source water protection. This could be a part of the city and Nederland WWTF Intergovernmental Agreement.	3
Recreation - Aquatic and Terrestrial	Barker Reservoir	☐ Conduct a site visit along Middle Boulder Creek and the 4th of July trail to evaluate riparian health and erosion, and potential slope stabilization projects.	3

Area of Concern	Watershed	Best Management Practice	Priority (1=high, 3=low)
Storage Tanks	All	➔ Maintain a current inventory and information on the status of regulated storage tanks in the SWPA from the state's Open Release Map website.	3
Wildland Fire	Upper Watersheds	☐ Maintain an inventory of fuels reduction/thinning projects in the SWPA including those performed by the city, Boulder County, USFS and the Town of Nederland. Review any future fuels reductions projects in the SWPA.	3

7 REFERENCES

AirWaterGas, Colorado Rural Water Association, Intermountain Oil and Gas BMP Project, and Western Resource Advocates. 2016. Protecting Source Water in Colorado During Oil and Gas Development. August 2016. http://westernresourceadvocates.org/publications/protecting-source-water-colorado-oil-gas-development/

Boulder County Land Use Department. 2013. Keeping Animals in Boulder County. March 7, 2013. http://www.bouldercounty.org/doc/landuse/p29keepinganimals.pdf

Boulder County Land Use Department. 2017. Land Use Code. Accessed June 21, 2017. https://www.bouldercounty.org/property-and-land/land-use/planning/land-use-code/

BCPH (Boulder County Public Health). 2017. Adult Mosquito Control. Accessed June 21, 2017. https://www.bouldercounty.org/environment/water/adult-mosquito-control/

BCPH (Boulder County Public Health). 2016. SepticSmart: Strategies to Address the Problem. http://www.bouldercounty.org/env/water/pages/septicsmartstrategies.aspx Accessed November 4, 2016.

Boulder County Transportation. 2016. Traffic Volume Map 2015. Current as of January 1, 2016. http://www.bouldercounty.org/doc/transportation/bctrafficvol.pdf

Brown and Caldwell 1992. Water Source Impact Assessment.

Cannon, K. 2017. Email exchanges with Kate Dunlap. March 20, 2017. Kristin.cannon@state.co.us.

CBS Denver. 2016. No Changes to Cold Springs Fire Activity Anticipated Overnight. July 11, 2016. http://denver.cbslocal.com/2016/07/11/fire-crews-attack-cold-springs-fire-aggressively/

Childress, A., E. Gordon, T. Jedd, R. Klein, J. Lukas, and R. McKeown. 2015. Colorado Climate Change Vulnerability Study: A Report by the University of Colorado Boulder and Colorado State University to the Colorado Energy Office. Edited by E. Gordon and D. Ojima. http://wwa.colorado.edu/climate/co2015vulnerability/co_vulnerability_report_2015_final.pdf

City of Boulder, GEI Consultants, Inc., Hydrosphere Resource Consultants, Western Environmental Analysts, Walker S.P., Brown & Caldwell, ERO Resources Corporation, GBSM, and K. Kranzush. 2002. Middle Boulder Creek Water Source Management Work Plan. July 5, 2002. Project 00364.

City of Boulder. 2012. Boulder Reservoir Master Plan. https://bouldercolorado.gov/parks-rec/reservoir-master-plan

City of Boulder. 2015. Pre- and Post-Fire Watershed Planning Update. Water Resources Advisory Board Agenda Item. July 20, 2015 meeting.

City of Boulder. 2016. 2016 Boulder Community Profile. October 3, 2016 draft. Accessed June 6, 2017. https://www-static.bouldercolorado.gov/docs/2016-community-profile-1-201610101422.pdf

CDOT (Colorado Department of Transportation). 2016. Traffic Data Explorer. Station 104337. Accessed December 12, 2016. http://dtdapps.coloradodot.info/otis/trafficdata#ui/0/2/2/station/104337/criteria/53175//true/true

CDPHE (Colorado Department of Public Health and Environment). 2000. Colorado Source Water Assessment & Protection. CDPHE, Water Quality Control Division. https://www.colorado.gov/pacific/cdphe/swap-assessment-phase

CDPHE (Colorado Department of Public Health and Environment). 2010. Revised Source Water Assessment Report, Boulder, City of. CDPHE, Water Quality Control Division. https://www.colorado.gov/pacific/cdphe/swap-assessment-phase

CDPHE (Colorado Department of Public Health and Environment). 2015. SWAP Protection Planning Template. Accessed October 19, 2015. https://www.colorado.gov/pacific/cdphe/swap-protection-planning-template

CO BLM (Colorado Bureau of Land Management). 2012. Bark Beetle Strategic Plan Colorado. May 2012. https://www.blm.gov/style/medialib/blm/co/field_offices/kremmling_field_office/documents/forestry.Par.96085.File.dat/Bark%20Beetle%20Strategic%20Plan%20FINAL.pdf

CO DLE (Colorado Department of Labor and Employment). 2017a. Storage Tank Regulations 7 C.C.R. 1101-14. May 1, 2017. Division of Oil and Public Safety. https://www.colorado.gov/pacific/ops/RegulationsStatutes

CO DLE (Colorado Department of Labor and Employment). 2017b. Open OPS Petroleum Release Events in Colorado. Division of Oil and Public Safety. https://data.colorado.gov/Environment/Open-OPS-Petroleum-Release-Events-in-Colorado/v5ut-qgp7

COGCC (Colorado Oil and Gas Conservation Commission). 2016. Series Drilling, Development, Production, and Abandonment. Rule 317B. http://cogcc.state.co.us/documents/reg/Rules/LATEST/300Series.pdf

COGCC (Colorado Oil and Gas Conservation Commission). 2017a. Frequently Asked Questions About Hydraulic Fracturing. Accessed March 16, 2017. Publication date unknown. https://cogcc.state.co.us/Announcements/Hot_Topics/Hydraulic_Fracturing/Frequent_Questions_about_Hydraulic%20Fracturing.pdf

COGCC (Colorado Oil and Gas Conservation Commission). 2017b. Well Surface Location Data and Directional Well Data. Downloaded on March 15, 2017. http://cogcc.state.co.us/data2.html#/downloads

COGCC (Colorado Oil and Gas Conservation Commission). 2017c. COGIS - Production Data Inquiry. Accessed March 16, 2017. http://cogcc.state.co.us/data.html#/cogis

CPW (Colorado Parks and Wildlife). 2017. Aquatic Nuisance Species. http://cpw.state.co.us/aboutus/Pages/ISP-ANS.aspx. Accessed January 27, 2017.

CRWA (Colorado Rural Water Association). 2016. SWAP Risk Assessment Matrix. Pueblo West, Colorado: Colorado Rural Water Association.

Clow, D.W., H.A. Roop, L. Nanus, M.E. Fenn, and G.A. Sextone. 2015. Spatial patterns of atmospheric deposition of nitrogen and sulfur using ion-exchange resin collectors in Rocky Mountain National Park, USA. Atmospheric Environment. 101:149-157. http://dx.doi.org/10.1016/j.atmosenv.2014.11.027

Colorado Geological Survey. 2004. Birth of an industry – Florence and Boulder oil fields, in *Rock Talk*, Colorado Geological Survey, Divisions of Minerals and Geology, Colorado Department of Natural Resources, v.7, no. 2, p. 9-13. http://coloradogeologicalsurvey.org/wp-content/uploads/2013/08/rtv7n2.pdf

Crosby, E. 2016. City of Boulder SWPP meeting presentation on abandoned mines and the Colorado DRMS. Meeting on September 16, 2016.

Ecology and Environment, Inc. 1988. Analytical Results Report, North Boulder Dump. Located in: Brown and Caldwell 1992. Water Source Impact Assessment.

EPA (U.S. Environmental Protection Agency). 2015. Gordon Gulch Dump. https://www.epaosc.org/site/site_profile.aspx?site_id=11095

EPA (U.S. Environmental Protection Agency). 2016. Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States. https://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=332990

Essential Management Solutions. 2016. Construction Report – CS010 Outfall 002A and 003A Trichloroethylene, cis-1,2 Dichloroethylene, and Vinyl Chloride, Methylene Chloride, Dissolved Manganese, Dissolved and Total Recoverable Iron, and Chloroform Limitation Progress Summary (2nd Quarter 2016) CDPS Permit Number COG-315176 Former Beech Aircraft Facility, Boulder, Colorado. June 30, 2016. To Ms. Andrea BeeBout (CDPHE) from Scott Andrews.

Forests for Watersheds. 2016. Watershed Forestry Resource Guide. Center for Watershed Protection and U.S. Forest Service. Accessed December 12, 2016. http://forestsforwatersheds.org/reduce-stormwater/

Front Range Watershed Protection Data Refinement Work Group. 2009. Protecting Critical Watersheds in Colorado from Wildfire: A Technical Approach to Watershed Assessment and Prioritization. http://www.jw-associates.org/Resources/Work%20Group%20Final%20Report%20V6.pdf

Hill, M. 2013. Source Water Protection for the Colorado River Partnership Source Water Protection Plan. Morgan Hill, Garfield County Public Health.

JW Associates, Inc. 2014. City of Boulder Pre and Post Fire Watershed Planning: Task 1 – Small Watershed Targeting & Zones of Concern Prioritization.

Leopold, M., G. Lewis, D. Dethier, N. Caine, and M.W. Williams. 2015. Cryosphere: ice on Niwot Ridge and in the Green Lakes Valley. Colorado Front Range. Plant Ecology & Diversity. 1:625-638. http://www.tandfonline.com/doi/full/10.1080/17550874.2014.992489

Lukas, J., J. Barsugli, N. Doesken, I. Rangwala, and K. Wolter. 2014. Climate Change in Colorado: A Syntehsis to Support Water Resources Management and Adaptation. A Report for the Colorado Water Conservation Board. Western Water Assessment. http://wwa.colorado.edu/publications/reports/index.html

Moore, F.B., W.S. Cavender, and E.P. Kaiser. 1957. Geology and Uranium Deposits of the Caribou Area, Boulder County Colorado. U.S> Department of the Interior. Geological Survey Bulletin 1030-N.

Mruz, R. 2015. Corrective Action Compliance and Operations and Maintenance Inspection, August 2015; Syntex Lyons Remediation Project, 15211 N. Dakota Ridge Rd., Lyons, Colorado; Compliance Order No.: 88-08-12-01, as amended in May 2011; EPA ID No.: COD981551286; M&E / 1.2. November 13, 2015. To Mr. Van Hosen (Syntex) from Mr. Mruz (CDPHE).

MWH and AMEC. 2009. Water Utility Master Plan: Volume 4 Source Water Master Plan. https://bouldercolorado.gov/water/water-utility-master-plan

Nederland Area Historical Society. 2016. Timeline. http://www.nederlandmuseums.org/timeline.html. Accessed November 4, 2016.

NLCD (National Land Cover Database). 2014. NLCD 2011 Land Cover. Re-published on October 10, 2014. http://www.mrlc.gov/nlcd11_data.php

Pfeifer, G. March 2017. Email exchanges with Kate Dunlap. Mountain Research Station Facilities Manager.

Rhoades, C., R.M. Hubbard, and K.J. Elder. 2017. A decade of streamwater nitrogen and forest dynamics after a mountain pine beetle outbreak at the Fraser Experimental Forest, Colorado. Ecosystems. 20(2):380-392. http://link.springer.com/article/10.1007/s10021-016-0027-6

Rozaklis and Associates, LLC. 2016. 2016 Water Efficiency Plan. October 2016. https://www-static.bouldercolorado.gov/docs/WEP_October_Final-1-201610180831.pdf

Town of Nederland and CRWA (Colorado Rural Watershed Association). 2014. Town of Nederland Source Water Protection Plan. http://nederlandco.org/wp-content/uploads/2015/01/Nederland_SWPP_FINAL_DRAFT_compressed.pdf

U.S. Census. 2015. American FactFinder. Nederland Town, Colorado and Eldora CDP, Colorado. Accessed 11/30/2015. http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml?src=bkmk

USFS (U.S. Forest Service). 2015. Eldora Mountain Resort Ski Area Projects Final Environmental Impact Statement: Appendices. February 2015. USDA Forest Service, Rocky Mountain Region, Roosevelt National Forest. http://www.eldoraeis.com/media/Eldora%20Mountain%20Resort%20Ski%20Area%20Projects_FEIS_Appendices_web.pdf

USFS (U.S. Forest Service). 2016. Annual Visitation Estimates by Site Type- Arapaho-Roosevelt NF, Round 3. http://apps.fs.fed.us/nfs/nrm/nvum/results/A02010.aspx/Round3

USFS (U.S. Forest Service). 2017. Aerial Detection Survey: Data Download. 2016 results updated by USFS on March 1, 2017. https://www.fs.usda.gov/detail/r2/forest-grasslandhealth/?cid=fsbdev3_041629

Vogel, J., E. Gordon, J. Brislawn, J. Barsugli, E. LeDolce, D. Mills, J. Smith, G. Aggett, and B. Harding. 2012. Boulder County Climate Change Preparedness Plan. Prepared for Boulder County Commissioners' Sustainability Office. https://www.bouldercounty.org/environment/sustainability/climate-change/preparedness-plan/

Williams, C. 2010. Left Hand Water District Source Water Protection Plan. Colorado Rural Water Association.

Williams, M., and K.A. Tonnesson. 2000. Critical loads for inorganic nitrogen deposition in the Colorado Front Range, USA. Ecological Applications. 10(6):1648-1665. http://www.jstor.org/stable/pdf/2641229.pdf

Appendix A. Maps of Potential Sources of Contamination

This section provides a series of maps showing the locations of PSOCs in the SWPA. GIS data were collected from a variety of entities and represent different periods, as described below. For visual display, the lower watershed maps only show BFC four miles upstream from the outlet at Boulder Reservoir.

Map: Businesses, services, agriculture, and road/stream crossings.

GIS Layer	Source Entity	Original GIS Layer Name	Date	Source Description
Marijuana Establishments	Boulder County Geospatial Open Data	Marijuana Establishments	Downloaded on March 8, 2017	Marijuana establishments are updated using the licensing information entered by the Boulder County Marijuana Licensing Authority.
Culverts	Created by Kate Dunlap (City of Boulder) by intersecting USGS NHD flowlines and CDOT roads	N/A	Created on June 1, 2016	An estimate of culvert locations based on road/stream crossings.
Other Businesses	CDPHE's original Source Water Assessment for the City of Boulder	PSOCs	Publication from 2004	Businesses and other PSOCs identified by CPDHE during their Source Water Assessment phase.

Map: Onsite Wastewater Treatment Systems (OWTS).

GIS Layer	Source Entity	Original GIS Layer Name	Date	Source Description
OWTS	Boulder County SepticSmart	OWTS	August 2014	OTWS and permit status in Boulder County.

Map: Permitted wastewater and stormwater discharges, and storage tanks.

GIS Layer	Source Entity	Original GIS Layer Name	Date	Source Description
Active Petroleum Storage Tanks	Colorado Division of Oil and Public Safety, Petroleum Section	Active permits	February 22, 2016	Regulated above ground and underground storage tanks.
Discharge Permits	CDPHE	Exported into GIS from CDPHE's Excel file	March 1, 2016	All active CDPS construction, industrial, and non-stormwater permits in Boulder, Larimer, and Gilpin Counties as of 03/01/2016.

Map: Locations of known historic and active mines.

GIS Layer	Source Entity	Original GIS Layer Name	Date	Source Description
Closed Mines by DRMS	Colorado DRMS, Emailed by Erica Crosby	Mines	August 9, 2016	Mines that DRMS has closed/safeguarded since the 1980s. It only includes mines where DRMS was granted permission to close them.
All other mines	Colorado DRMS	Mines	November 1, 2015	CO DRMS permitted mines, including construction and hardrock mines.

Map: Active and plugged oil and gas wells, including active and expired permits.

GIS Layer	Source Entity	Original GIS Layer Name	Date	Source Description
Active and plugged wells	COGCC	Wells	March 15, 2017	Active and plugged or abandoned oil and gas wells. The website is updated nearly daily.

Map: Wildfire hazard assessment and sediment transport mechanisms.

GIS Layer	Source Entity	Original GIS Layer Name	Date	Source Description
Stream Junctions	JW Associates (2014)	Stream Junctions	January 30, 2014	Streams intersections.
Streams	JW Associates (2014)	Streams	January 30, 2014	USGS NHD flowlines.
Fire Hazard Priority	JW Associates (2014)	Composite Hazard	January 30, 2014	Small watershed analysis of water quality impacts from wildfire.

Map: U.S. Forest Service's Forest Health Survey from 2016.

GIS Layer	Source Entity	Original GIS Layer Name	Date	Source Description
Forest Health Survey 2016	USFS	r216_flown and r216_dmg	March 1, 2017	Forest health survey results including beetle damage.

Businesses and Services

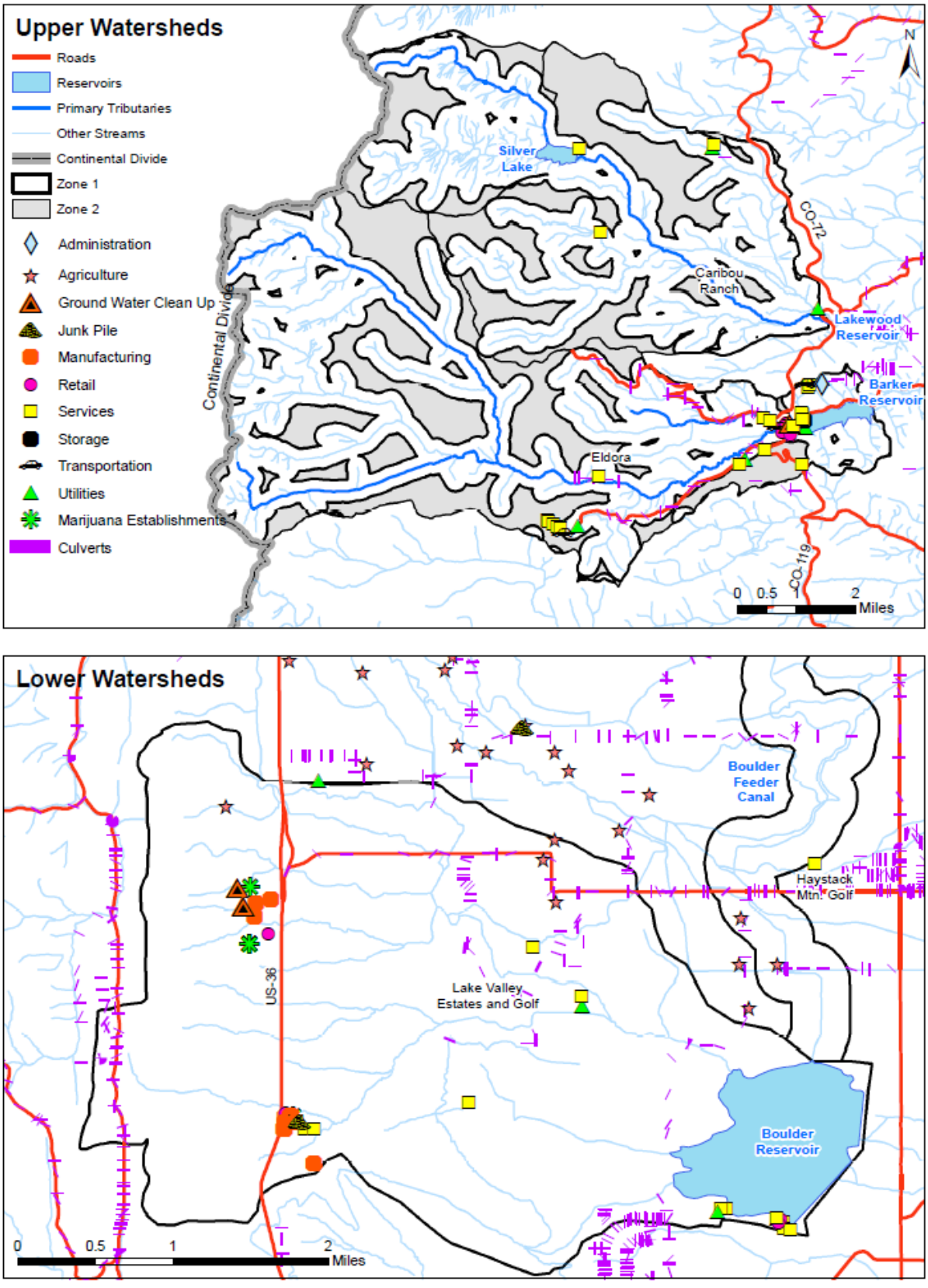

Figure 22. Businesses, services, agriculture, and road/stream crossings.

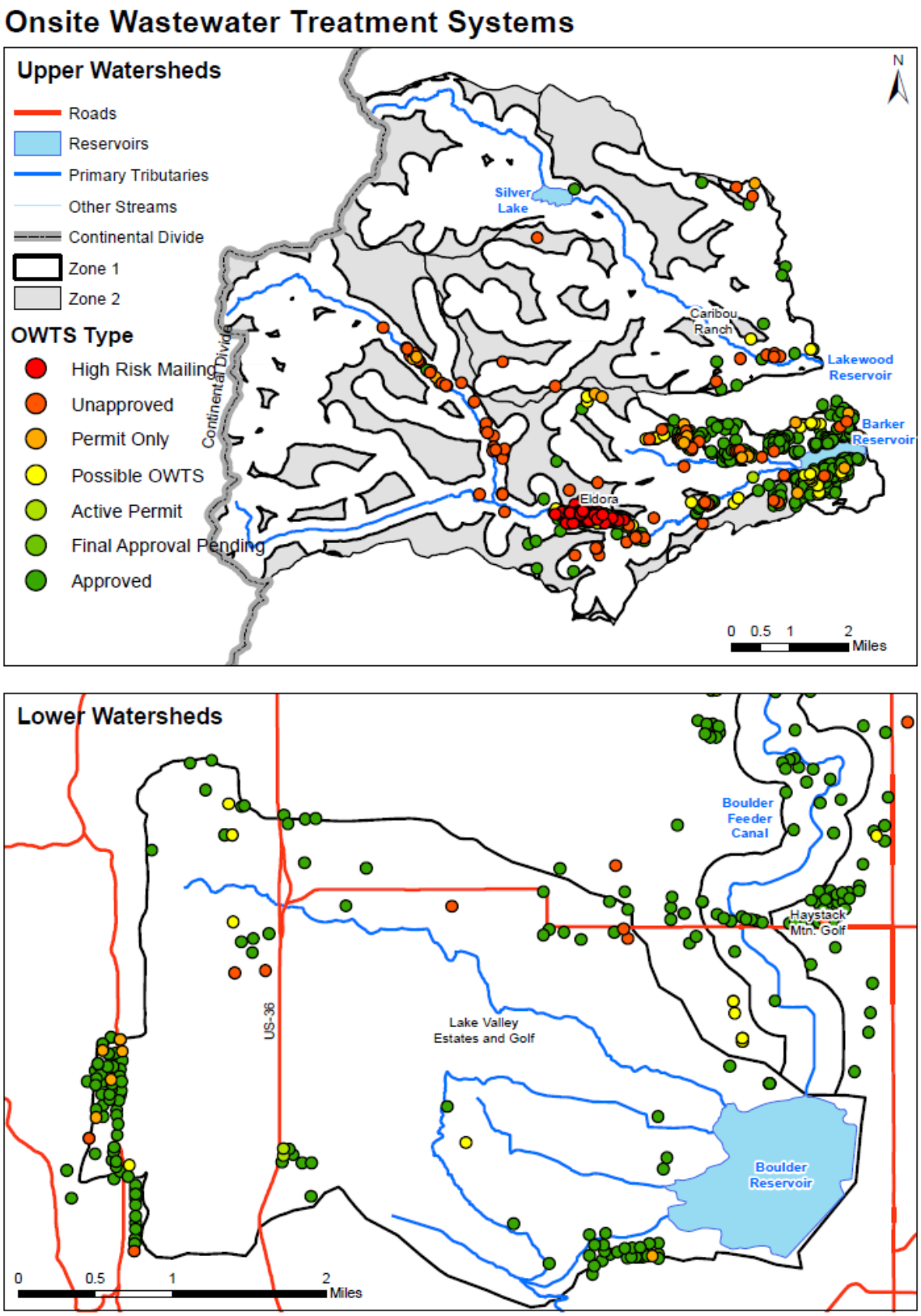

Figure 23. Onsite Wastewater Treatment Systems (OWTS).

Permitted Discharges and Storage Tanks

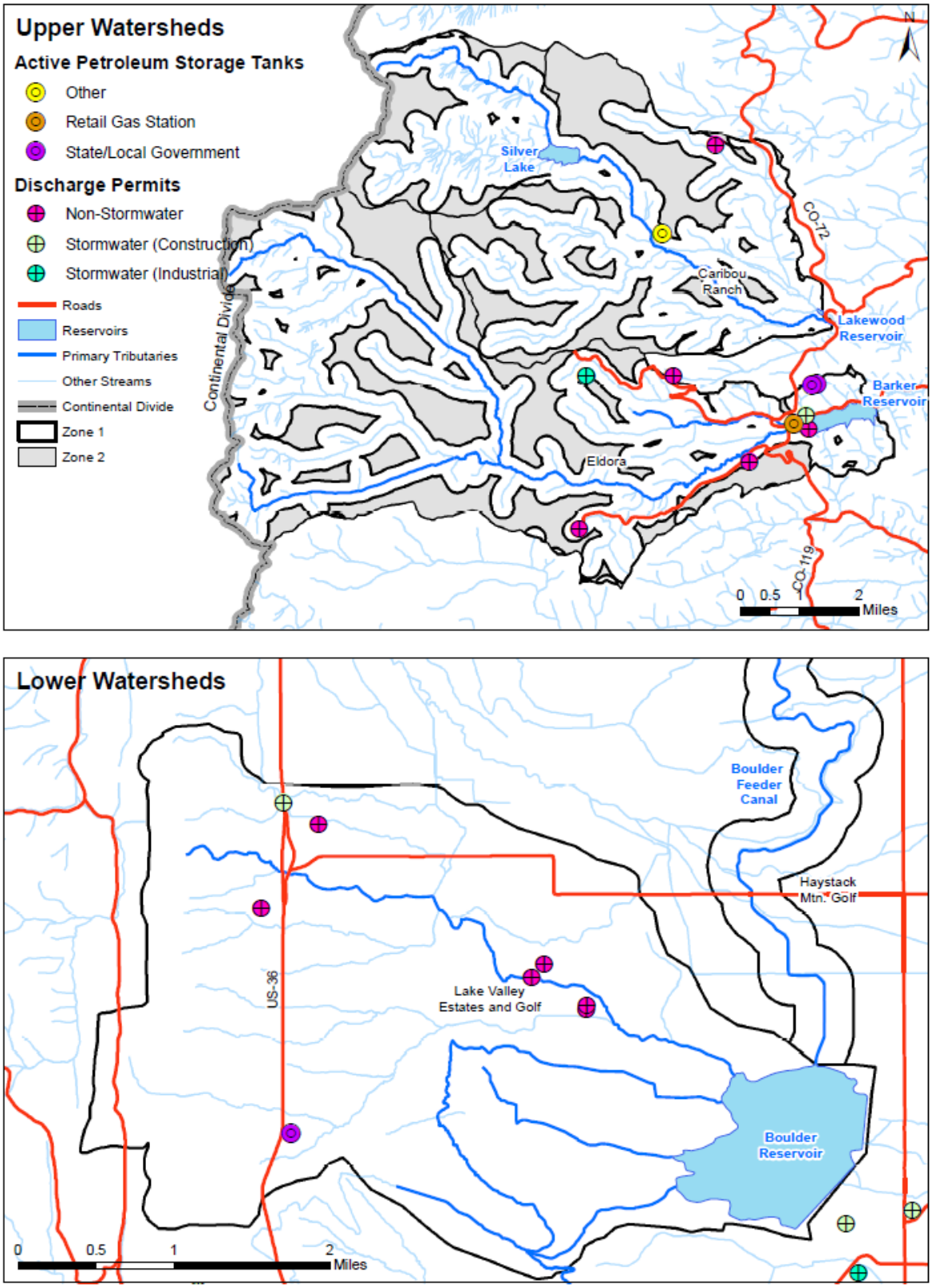

Figure 24. Permitted wastewater and stormwater discharges, and storage tanks.

Mining Activity

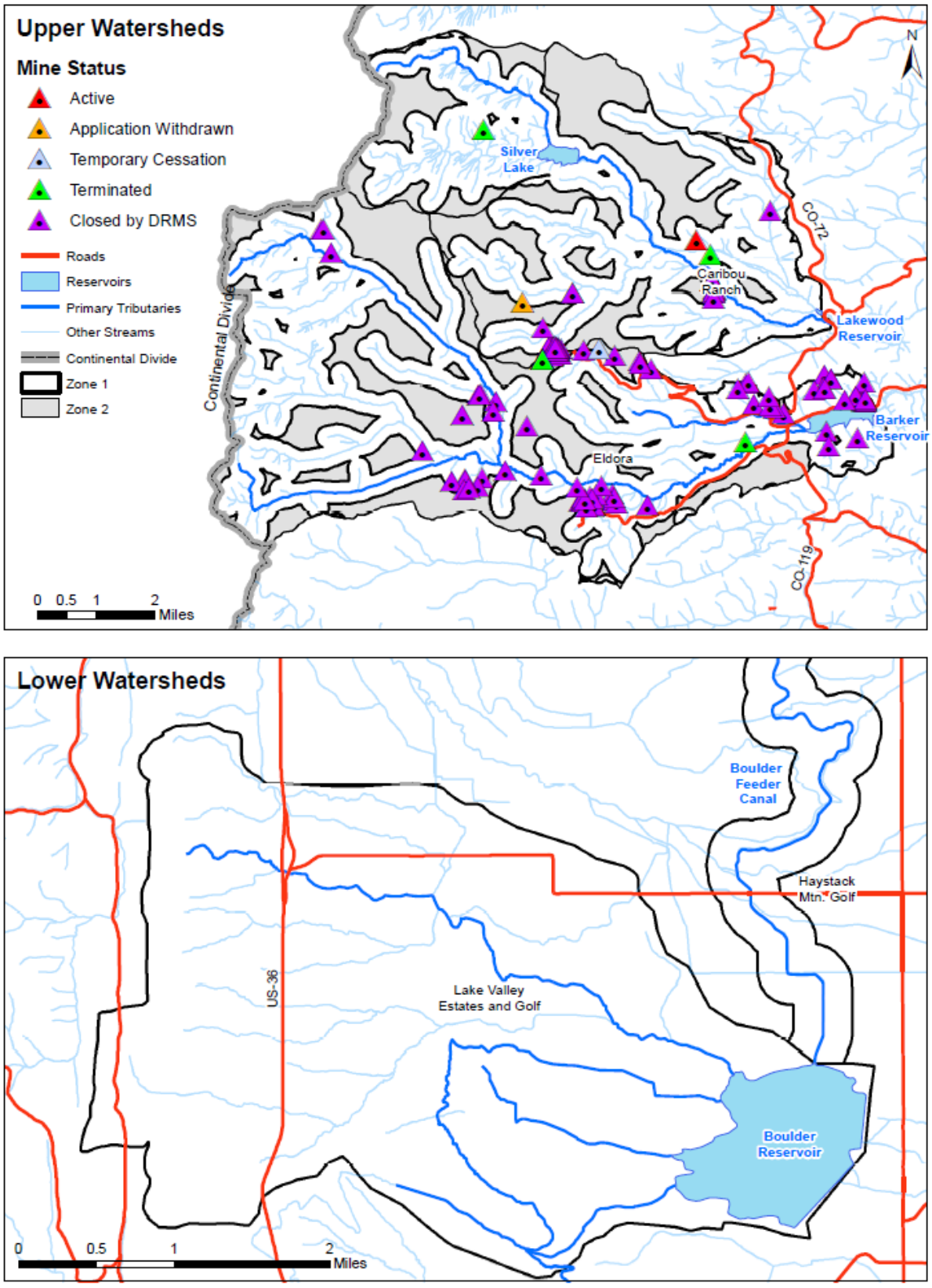

Figure 25. Locations of known historic and active mines.

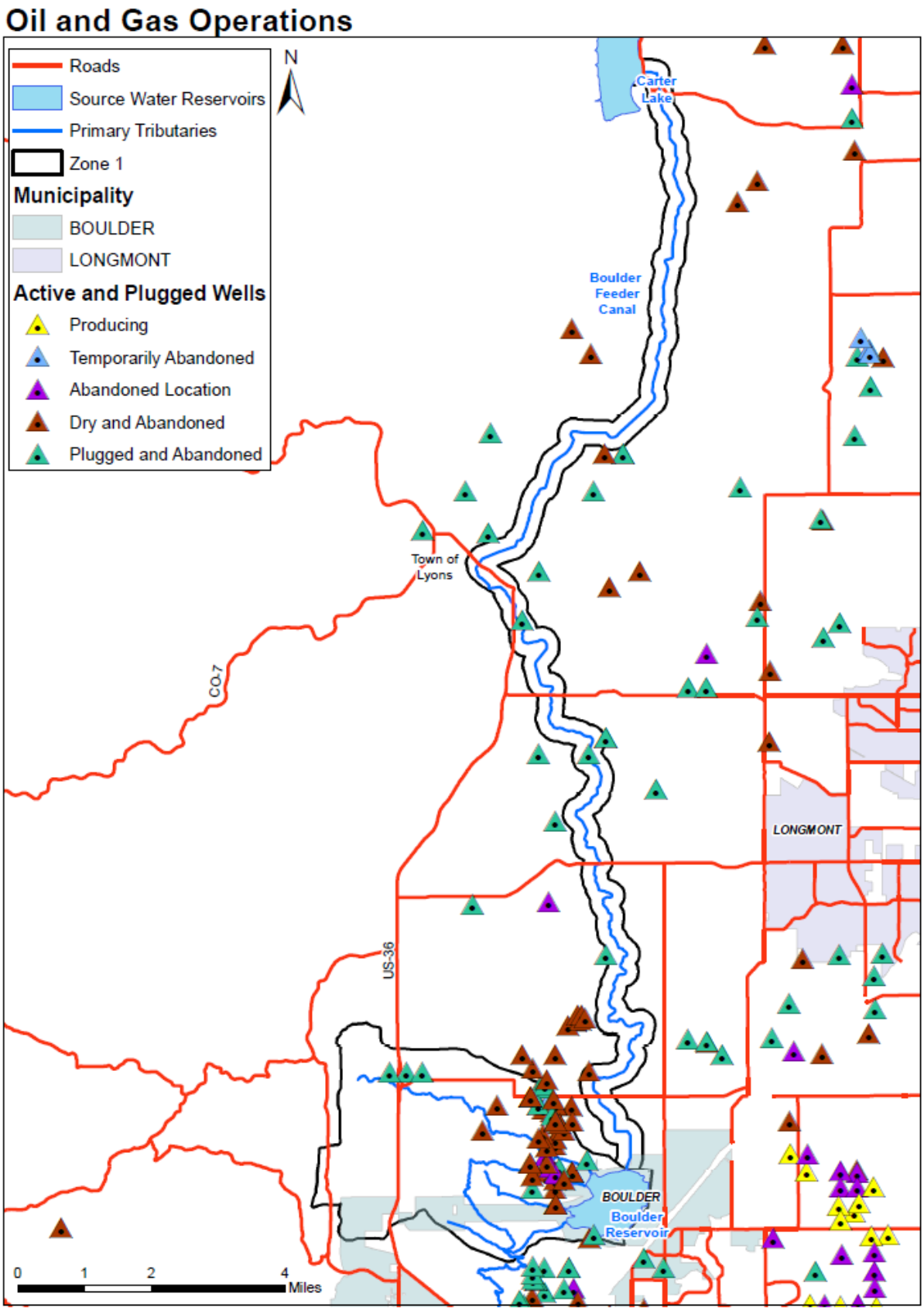

Figure 26. Active and plugged oil and gas wells, including active and expired permits.

Wildfire Hazard and Sediment Transport Analysis

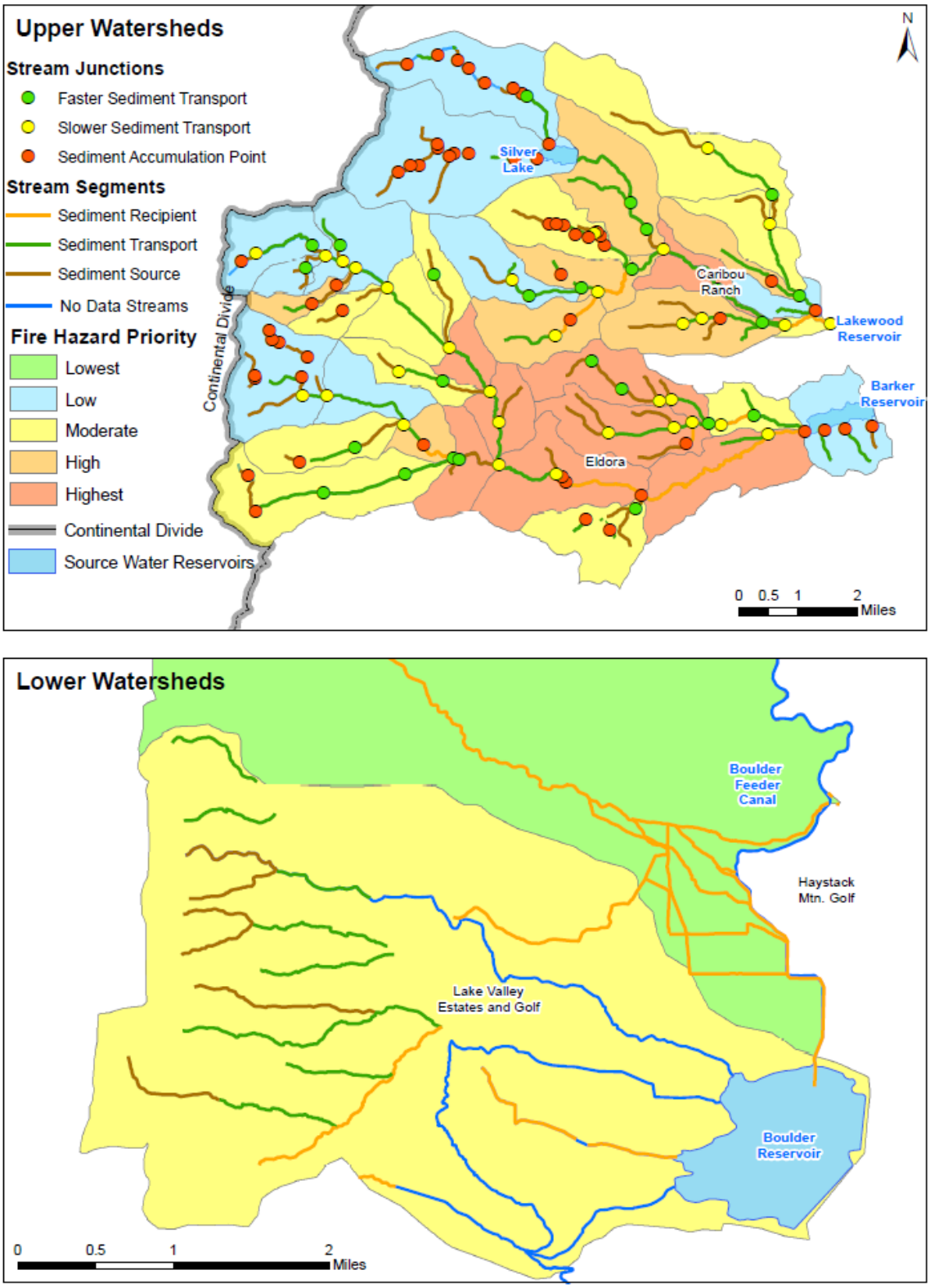

Figure 27. Wildfire hazard assessment and sediment transport mechanisms. All lower drainages shown near Haystack Mountain Golf have been diverted over BFC.

Forest Health

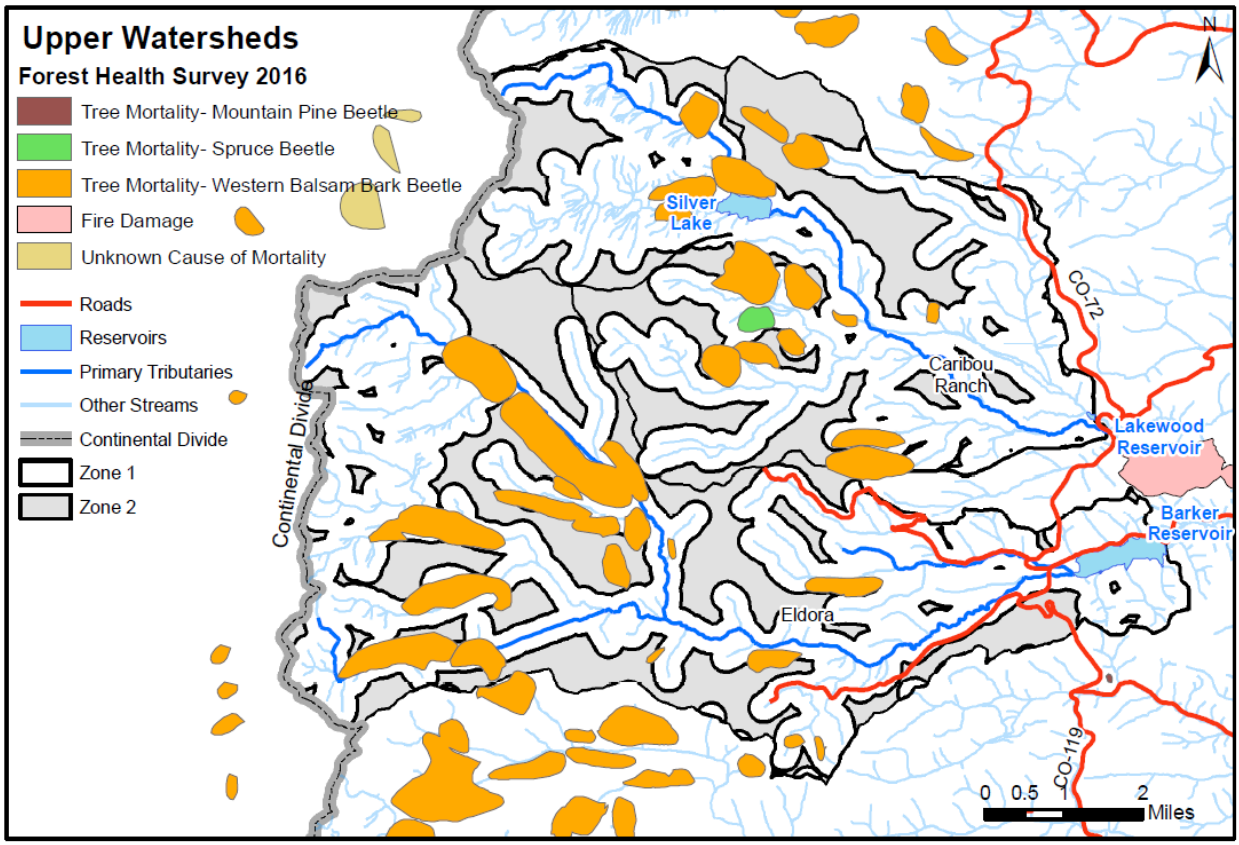

Figure 28. U.S. Forest Service's Forest Health Survey from 2016.