Town of Keenesburg
Source Water Protection Plan – Public Version

Weld County, Colorado
September 2022

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Colorado Rural Water Association
For the Community Water Provider:
Town of Keenesburg
PWSID# CO0162438

Primary Contact Information for Town of Keenesburg

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Cover Photo: Town of Keenesburg water tower. Photo taken by Naia Sottile Jan 2022.

This Source Water Protection Plan is a planning document and there is no legal requirement to implement the recommendations herein. Actions on public lands will be subject to federal, state, and county policies and procedures. Actions on private land may require compliance with county land use codes, building codes, local covenants, and permission from the landowner. This SWPP for the Town of Keenesburg was developed using version 7.12.2021 of the Colorado Rural Water Association's Source Water Protection Plan Template.

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COMMON ACRONYMS

AST	Aboveground Storage Tank
BMP	Best Management Practice
CAFO	Confined Animal Feeding Operation
CDPHE	Colorado Department of Public Health and Environment
COGCC	Colorado Oil & Gas Conservation Commission
CRWA	Colorado Rural Water Association
DWR	Division of Water Resources
EPA	Environmental Protection Agency
FMCSA	Federal Motor Carrier Safety Administration
GIS	Geographic Information System
GPD	Gallons Per Day
GUDI	Groundwater Under the Direct Influence of Surface Water
HA	Health Advisory
MCL	Maximum Contaminant Level
MGD	Million Gallons per Day
NRCS	Natural Resource Conservation Service
OEM	Office of Emergency Management
PSOC	Potential Source of Contamination
PWS	Public Water System
PWSID	Public Water System Identification
SDWA	Safe Drinking Water Act
SWAA	Source Water Assessment Area
SWAP	Source Water Assessment and Protection
SWPA	Source Water Protection Area
SWPP	Source Water Protection Plan
UIC	Underground Injection Control
USFS	United States Forest Service

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EXECUTIVE SUMMARY

The Town of Keenesburg values a clean, high-quality drinking water supply and decided to work collaboratively with area stakeholders to develop a Source Water Protection Plan (SWPP). The Source Water Protection Planning effort consisted of the involvement and cooperation of multiple stakeholders including water operators, local and federal governments, agency representatives, and town residents. With the participation of the stakeholders, a Steering Committee was formed, and Source Water Protection Planning meetings were held from January 2022 through November 2022. The Colorado Rural Water Association (CRWA) has been instrumental in this effort, by providing guidance and technical assistance throughout the process.

The Town of Keenesburg owns and operates ten groundwater wells, six of which are actively used as drinking water sources. To help the Town of Keenesburg focus its source water protection measures and therefore reduce their source water susceptibility to contamination, the following Source Water Protection Areas (SWPAs) were identified.

Wells within the Laramie-Fox Hills Aquifer:

- **Zone 1:** 500-foot radius surrounding the wells
- **Zone 2:** Two-year time of travel
- **Zone 3:** Five-year time of travel

Well within the Lost Creek Alluvium:

- **Zone 1:** 500-foot radius surrounding the well
- **Zone 2:** Township boundary and slightly North
- **Zone 3:** Lost Creek Alluvium boundary to the West and East, and boundaries drawn to the North and South of the well

To reduce the risks from Potential Sources of Contamination (PSOCs) and other issues of concern, the Steering Committee has developed a list of Best Management Practices (BMPs). The BMPs are centered around three objectives.

- **Objective One:** Building partnerships with community members, businesses, and local decision-makers
- **Objective Two:** Raising awareness of the value of protecting community drinking water supplies
- **Objective Three:** Empowering local communities to become stewards of their drinking water supplies by taking actions to protect their water sources

The following list highlights the highest priority potential contaminant sources and/or issues of concern and their associated best management practices. Each PSOC was given a priority ranking score of 1-5. These scores represent a combination of risk, level of control, and ease of best management practice implementation. Thus, PSOCs that were deemed most critical to address, and that were more easily mitigated with best management practices, were given a #1 priority. While the PSOCs that were least critical to address, or were difficult to mitigate, were given a #5 priority.

Private Groundwater Wells

Risk: Very High Score: 1

- Provide educational material to property owners on how to properly maintain active or abandoned wells and how to identify and properly seal abandoned wells

Per- and Polyfluoroalkyl Substances (PFAS)

Risk: Very High Score: 1

- Conduct testing for PFAS levels yearly by participating in the CDPHE PFAS grant testing program
- Post Health Advisory Notifications in the Consumer Confidence Report
- Continue to respond to and comply with regulations from the CDPHE and the EPA
- Ensure that industries within Town limits be free of PFAS/PFOS related substances

Oil & Gas Development

Risk: High Score: 2

- Continue to maintain a Local Governmental Designee (LGD) for the Town of Keenesburg, Mark Gray is currently the LGD for the Town
- Regularly monitor the COGCC Daily Activity Dashboard at https://cogcc.state.co.us/DAD.html for any new drilling permits, provide comments where appropriate
- Develop a Memorandum of Understanding (MOU) for future oil and gas negotiations

Security

Well Houses/Tank Sites/Well #11

Risk: Moderate/Moderate/High Score: 1

- Consider the option of adding entry alarms to the Town's Supervisor Control & Data Acquisition System (SCADA)
- Maintain existing SCADA monitoring and conduct daily site visits
- Add cameras at the Blending Station/Well #7, at the Booster Station, and at Well #11
- Add smoke/combination alarms to wellhouses
- Install locking bolts on wellheads (especially Well #11)
- Distribute an Emergency Response Notification Card to the Weld County OEM
- Take part in water system cybersecurity training through the EPA and DHS
- Visit the EPA's Cybersecurity Best Management Practices for the Water Sector website – including the vulnerability self-assessment tool
- Create a cybersecurity incident response protocol
- Review existing water system cybersecurity with the Information Technology Department, identify gaps and areas for improvement, including a National Institute of Standards and Technology audit

Biosolids:

Risk: High Score: 1

- Push for the requirement that biosolid waste be sampled for PFAS and heavy metals before application
- Stay involved with local and state meetings regarding the use of biosolids
- Stay abreast on the latest news and regulations regarding the use of biosolids

Commercial/Industrial 2:

Risk: Moderate Score: 3

- Maintain a current inventory of industrial facilities within Well #11 SWPAs and any violations within those areas
- Gather information about the industrial facilities' emergency response plans for spills and stormwater management
- Conduct a survey of area businesses and industries to determine waste disposal practices, types, and amounts of chemicals being utilized
- Work together with regulatory agencies to ensure that site visits and inspections are conducted on a routine basis and government regulations are followed and enforced when violations occur
- Build partnerships with industrial facilities and users within the protection area in order to encourage stewardship of their land and the protection of groundwater
- Work together with agencies to develop an ongoing groundwater and soil monitoring program to detect changes in groundwater quality
- Distribute education and outreach material to businesses and industries that explains how to properly store and dispose of oils/grease, toxic and hazardous waste, to protect water quality

Aboveground Storage Tanks (ASTs):

Risk: Moderate Score: 3

- Conduct targeted education and outreach to storage tank owners/operators on how to implement BMPs that prevent hazardous materials from infiltrating into the aquifer/alluvium
- Encourage installation of secondary containment for aboveground storage tanks on private and/or business properties
- Obtain and maintain database/GIS locations of storage tank locations within the SWPAs
- Monitor for violations/leak incidents

Transportation & Roads:

Risk: Moderate Score: 2

- Fortify perimeter of the wellhouses/wellheads, especially Wells #2, #8, & #11, with upgraded guard rails and/or bollards
- In preparation for a major incident, provide CDPHE and Weld County OEM with a written “Boil Order” for posting on their website
- Establish a special action protocol, in the event an incident occurs within the 500-foot radius (zone 1) of the wells
- Provide a copy of the SWPP and Emergency Response Notification Cards to the Weld County Road and Bridge Department
- Educate the public on how to report spills within the SWPA to “911”

Agriculture:

Risk: Moderate Score: 3

- Provide educational material to farmers and all well permit holders within the SWPAs, regarding the SWPP, the managing of fertilizer application, and the managing/reporting of accidents/spills
- Provide the local NRCS Field Office with a copy of the SWPP (public version)
- Introduce Conservation Districts and landowners to the NRCS SWP Initiative that emphasizes best practices relating to water quality and quantity, that protect drinking water sources and agricultural producers' land

The Steering Committee has recognized that the usefulness of this SWPP lies in its implementation and will begin to execute these best management practices upon completion of this Plan.

This Plan is a living document that is meant to be updated to address any changes that will inevitably occur. The Steering Committee will review this Plan at a frequency of once every one to five years, or if circumstances change resulting in new water sources and subsequently new source water protection areas, or if new risks are identified.

1. INTRODUCTION

Source water protection is a proactive approach to preventing the pollution of lakes, rivers, streams, and groundwater, that serve as drinking water sources. For generations, water quality has been taken for granted, and still today many people assume that their water sources are naturally protected. However, as water moves through and over the ground, contaminants may be picked up and carried to drinking water sources.

While a single catastrophic event may wipe out a drinking water source, the cumulative impact of minor contaminant releases over time can also result in the degradation of a drinking water source. Contamination can occur via discrete (point source) and dispersed (nonpoint source) sources (Figure 1). A discrete source contaminant originates from a single point, while a dispersed source contaminant originates from diffuse sources over a broader area. According to the US Environmental Protection Agency (EPA), nonpoint source pollution is the leading cause of water quality degradation (GWPC, 2008).

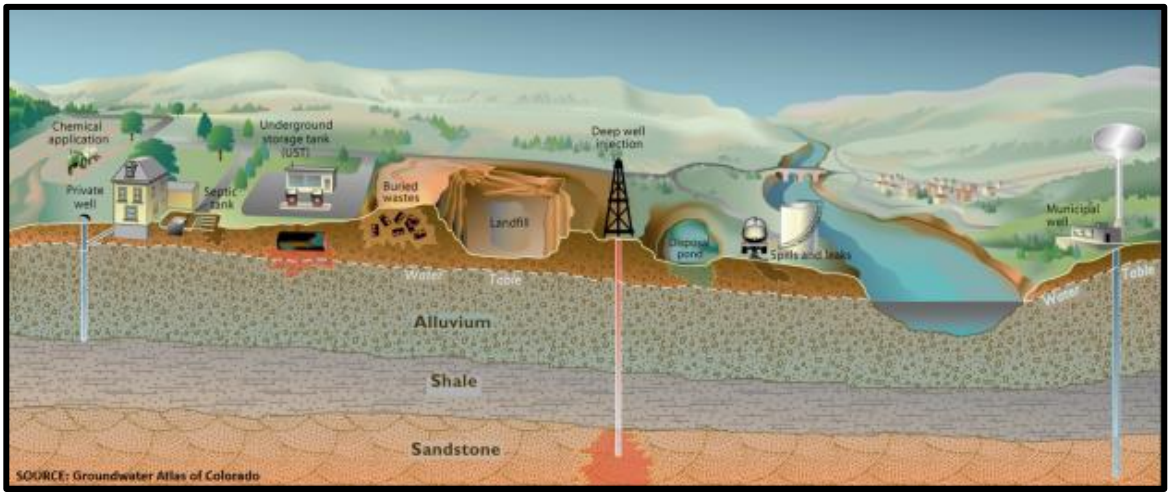

Figure 1: Schematic of the Potential Sources of Contamination to Surface and Groundwater

The Town of Keenesburg recognizes the potential for contamination of its drinking water sources and realizes that the development of this SWPP is the first step in protecting its valuable resources. Proactive planning is essential to protecting the long-term integrity of the Town's drinking water supply and essential to limiting costs and liabilities. This SWPP demonstrates the Town of Keenesburg's commitment to reducing the risks of contamination and preserving its drinking water supply.

1.1 Purpose of the Source Water Protection Plan

This SWPP is a tool for the Town of Keenesburg to ensure clean and high-quality drinking water sources for current and future generations. This SWPP is designed to:

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

Developing and implementing source water protection measures at the local level (i.e. county and municipal) will complement existing regulatory protection measures implemented at the state and federal governmental levels.

1.2 Background of Colorado's SWAP Program

Source water assessment and protection came into existence in 1996 as a result of Congressional reauthorization and amending of the Safe Drinking Water Act. These amendments required each state to develop a Source Water Assessment and Protection (SWAP) program. The Water Quality Control Division, an agency of the Colorado Department of Public Health and Environment (CDPHE), assumed the responsibility of developing Colorado's SWAP program and integrated it with the Colorado Wellhead Protection Program.

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 depicted in the upper and lower portions of Figure 2, respectively.

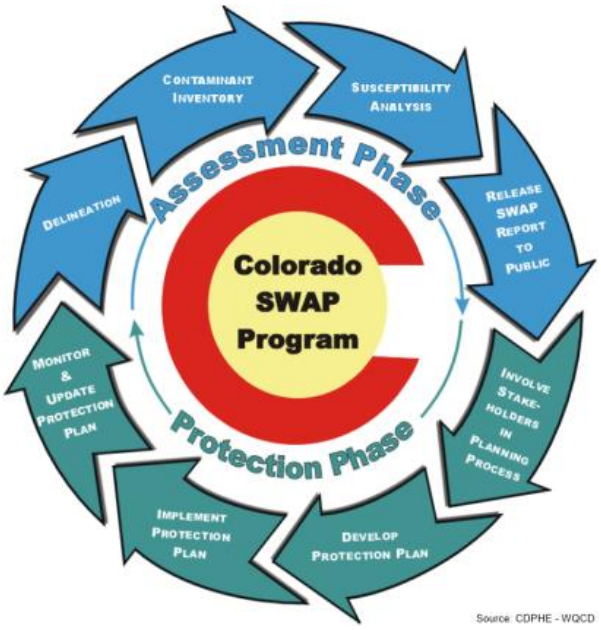

Figure 2: Source Water Assessment and Protection Phases

1.2.1 Source Water Assessment Phase

The Assessment Phase for all public water systems was completed in 2004 and consisted of four primary elements:

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

A Source Water Assessment Report (Appendices A and B) was provided to each public water system in Colorado in 2004, and outlines the results of this Assessment Phase.

1.2.2 Source Water Protection Phase

The Protection Phase is a non-regulatory, ongoing process in which all public water systems have been encouraged to voluntarily employ preventative measures to protect their water supply from the potential sources of contamination to which it may be most susceptible. The Protection Phase can be used to take action to avoid unnecessary treatment or replacement costs associated with potential contamination of the untreated water supply. Source water protection begins when local decision makers use the source water assessment results and other pertinent information as a starting point to develop a protection plan. As depicted in the lower portion of Figure 2, the source water protection phase for all public water systems consists of four primary elements:

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

The water system and the community recognize that the Safe Drinking Water Act grants no statutory authority to the CDPHE or to any other state or federal agency to force the adoption or implementation of source water protection measures. This authority rests solely with local communities and local governments.

The source water protection phase is an ongoing process as indicated in Figure 2. The evolution of the SWAP program is to incorporate any new assessment information provided by the public water supply systems and update the protection plan accordingly.

2. SOURCE WATER SETTING

2.1 Location and Description

The Town of Keenesburg is located in the Southeast portion of Weld County and has a long history as an agricultural community. The Town was originally established as a train stop to pick up livestock along the Chicago, Burlington, and Quincy Railroad in the early 1900s and was officially incorporated in 1919 (Gabel, 2019). The Town now has a population of approximately 4,450 residents and serves an estimated 802 water tap connections.

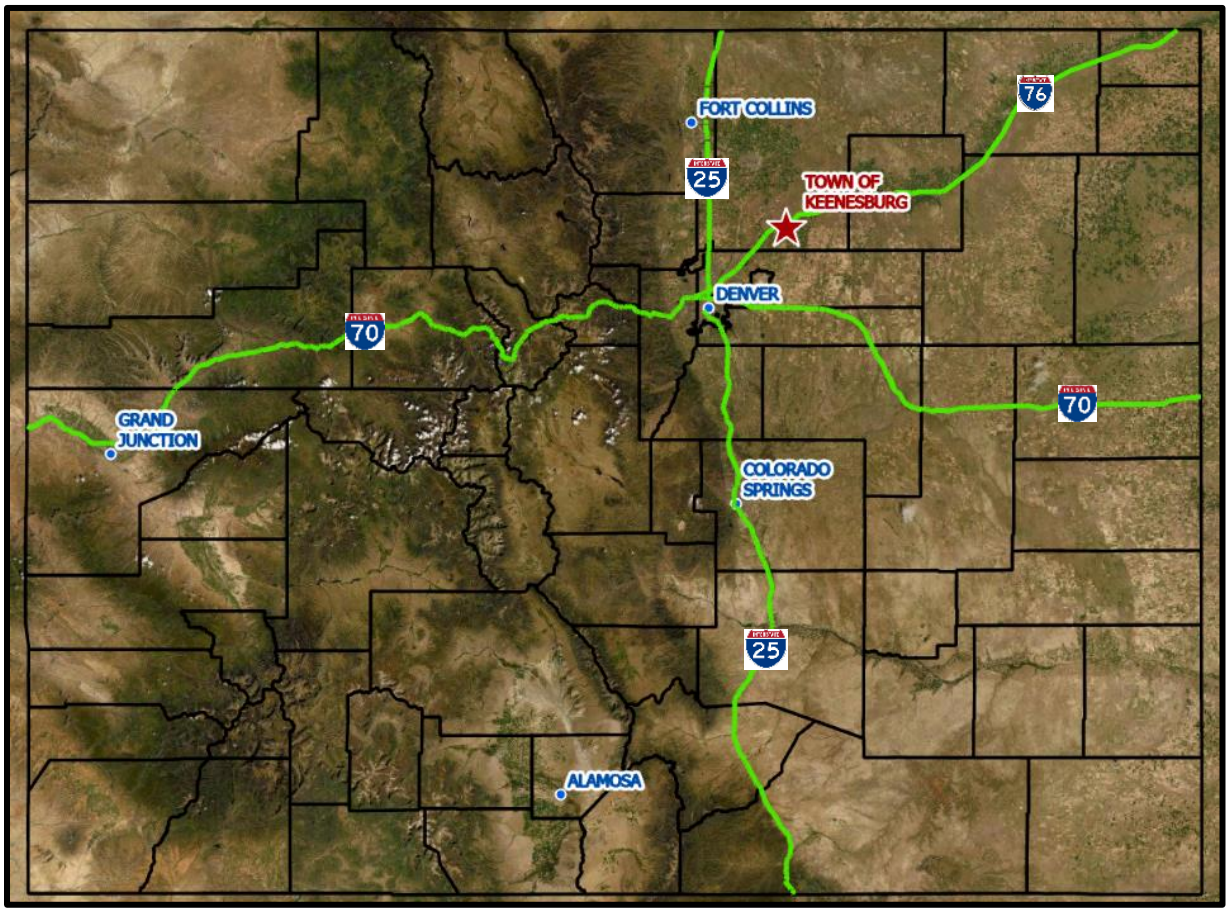

Figure 3: Location of the Town of Keenesburg in Colorado (CRWA)

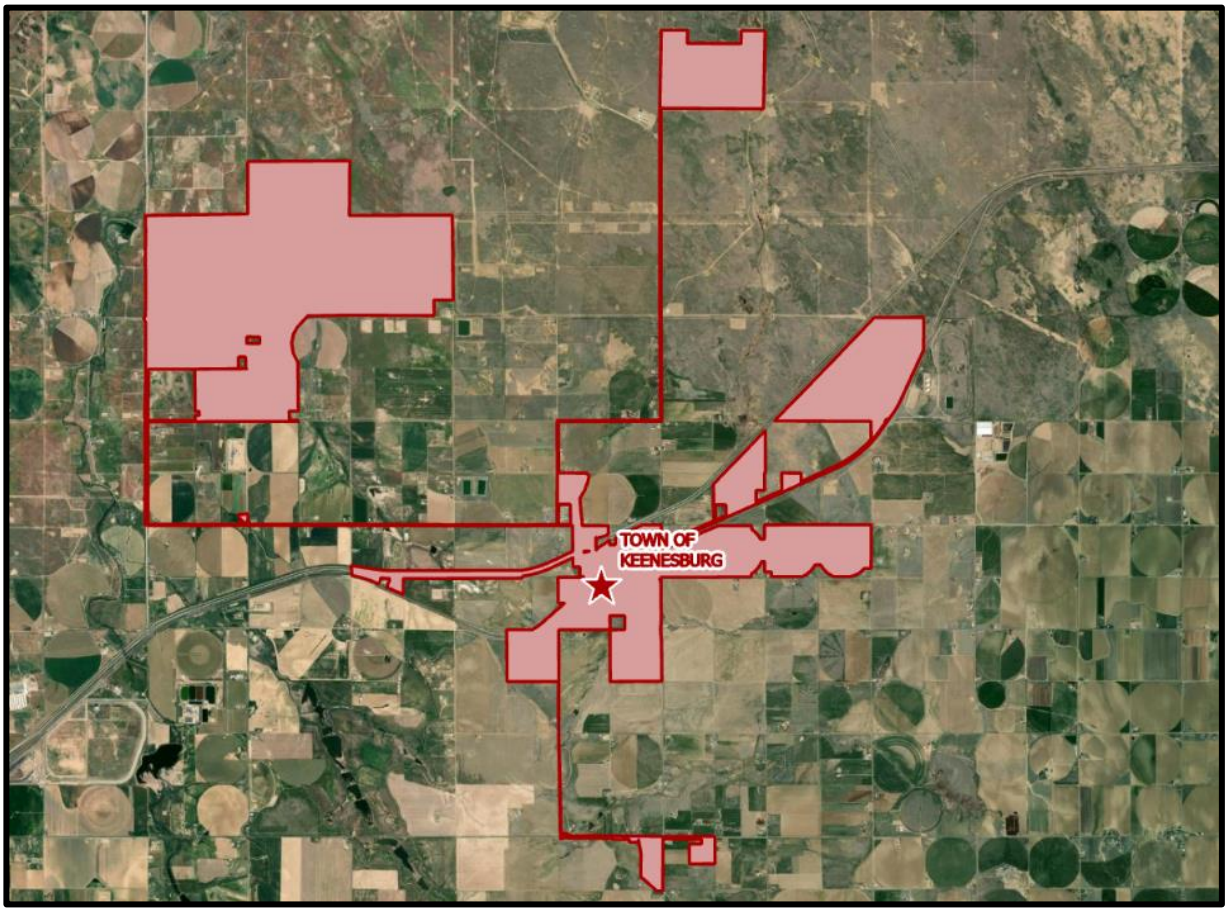

Figure 4: Town of Keenesburg Municipal Boundaries (CRWA)

2.2 Hydrologic Setting

The Town of Keenesburg obtains its drinking water from two groundwater sources, the Laramie-Fox Hills (LFH) Aquifer and the Lost Creek Alluvium (LCA). The LFH and the LCA are part of the Lost Creek Groundwater Management District.

The Laramie-Fox Hills Aquifer is a confined aquifer and consists of sandstone. Historically, water yields from the LFH range from 50 to 150 gallons per minute. Water quality within the LFH is generally considered *fair*.

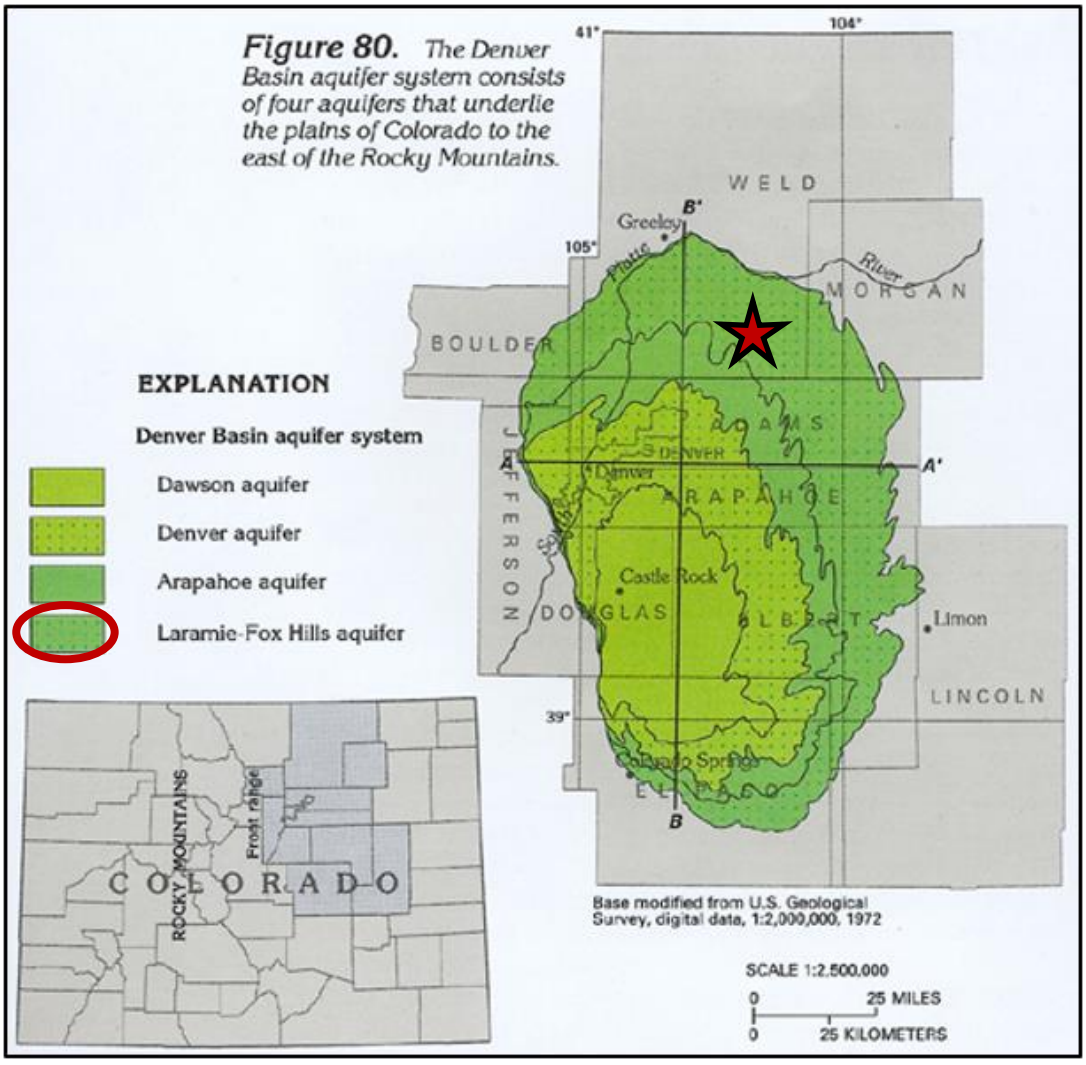

Figure 5: Denver Basin Aquifer System (USGS, 2016)

The Lost Creek Alluvium is an unconfined alluvium and consists of alluvial sediments. Water yields from the LCA range from 500 to 1000 gallons per minute. The recharge area for the LCA extends approximately 40 miles South of the intake and is comprised of precipitation, irrigation return flows, canal, and ditch seepage. The typical groundwater flow within the LCA is in a Northerly direction at approximately 315 feet per day. The water quality in the LCA is considered *fair*.

Because the LCA is an unconfined alluvium, soil permeability within the LCA is a determining factor of source water quality. The capacity of the most limiting soil layer to transmit water within the LCA varies between medium-low (.06 - .20 inches per hour) to high (2.00 – 6.00 inches per hour), with the average soil layer at medium-high to high (.57 – 2.00 inches per hour) (USDA NRCS, n.d.). Soil permeability and its effects on the Town of Keenesburg's water source within the LCA will be discussed further in Chapter 5.

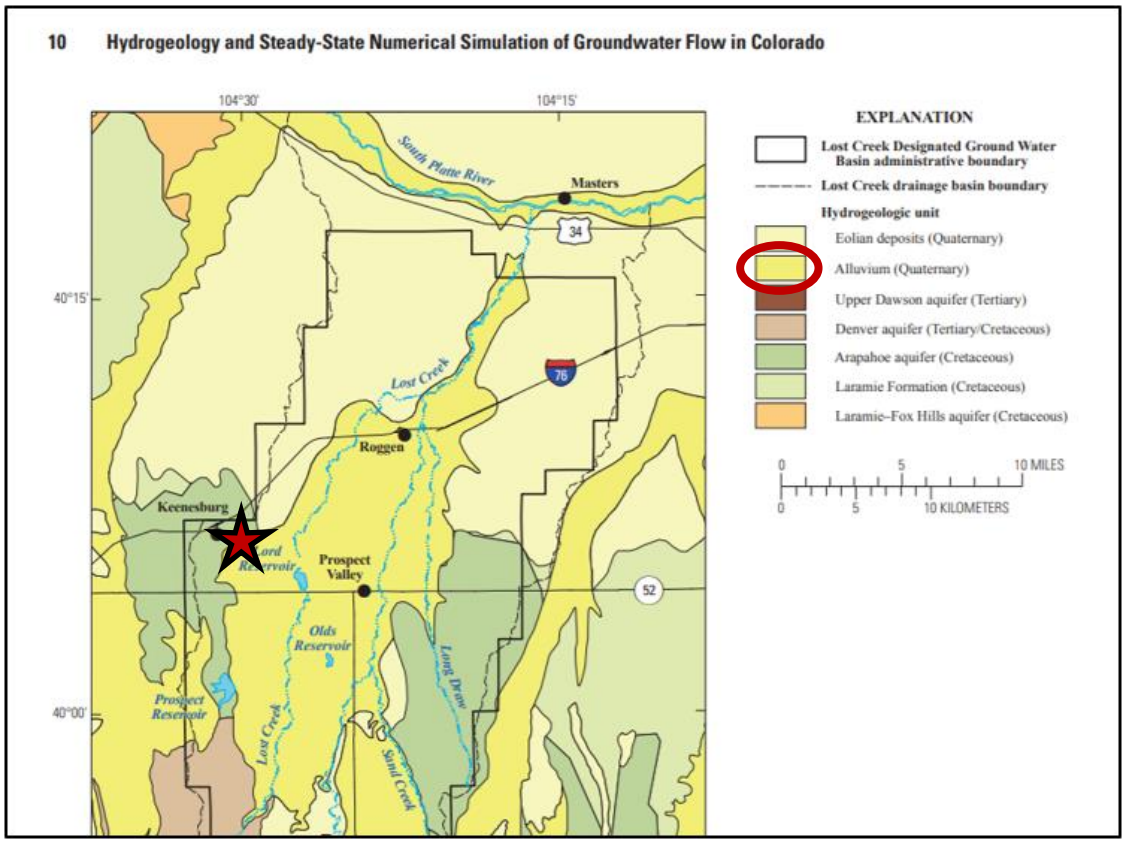

Figure 6: Geology of the Lost Creek Designated Ground Water Basin (USGS, 2016)

3. DRINKING WATER SUPPLY OPERATIONS

3.1 Water Supply and Infrastructure

The Town of Keenesburg owns and operates a total of ten groundwater wells. Nine are drilled into the LFH Aquifer, and one is drilled into the LCA. The wells within the LFH Aquifer range in depth from 380 feet to 910 feet. Of these nine wells, five are currently active. The well within the LCA is also active and is 95 feet deep. Raw water from each well is pumped from the wellhouse to the blending station. There the water is treated with chlorine and blended. The water from the LCA is considered hard water and is therefore blended with the softer water from the LFH at a 50/50 ratio. The Town of Keenesburg's water system stores its treated water in three storage tanks prior to distributing the drinking water. The Town has the maximum capacity to store 750,000 gallons of treated drinking water.

For the purposes of this SWPP, the ten wells have been divided into the following four main categories: Wells in Town (#'s 2, 4, 5, 8 & 14), South Wells (#'s 7 & 12), Roggen wells (#'s 9 & 10) and Well #11 (in the LCA). All wells, except Well #11, are drilled into the Laramie-Fox Hills Aquifer. Well #11 is the only well sourced from the Lost Creek Alluvium.

The following is a map of the Town of Keenesburg's well locations and a brief discussion of each of the wells, within their respective categories.

Figure Not Included in Public Version

Figure 7: Town of Keenesburg Source Water Well Locations (CRWA)

3.1.1 Wells in Town

Well #2 Sypian

Figure 8: Wellhouse #2 Sypian (CRWA)

Figure Not Included in Public Version

Figure 9: Location of Well #2 (CRWA)

- Located within the Town of Keenesburg
- Well is currently active

Well #4 Park

Figure 10: Wellhouse #4 Park (CRWA)

Figure Not Included in Public Version

Figure 11: Location of Well #4 (CRWA)

- Located within the Town of Keenesburg
- Well is currently active

Well #5 Flurries Pond

Figure 12: Wellhouse #5 Flurries Pond (CRWA)

Figure Not Included in Public Version

Figure 13: Location of Well #5 (CRWA)

- Located within the Town of Keenesburg
- Located near a flood plain (waters flow from West to East)
- Well is currently active

Well #8 Monitoring Well

Figure Not Included in Public Version

Figure 14: Location of Well #8 (CRWA)

- Located within the Town of Keenesburg
- This well is shut off from the water system and used as a monitoring well only
- Therefore, well is currently not active

Well #14

Figure 15: Wellhouse #14 (CRWA)

Figure Not Included in Public Version

Figure 16: Location of Well #14 (CRWA)

- Located outside of the Town of Keenesburg
- Well is currently active

3.1.2 South Wells

Well #7 Tank Site

Figure 17: Well #7 Tank Site (CRWA)

Figure Not Included in Public Version

Figure 18: Location of Well #7 (CRWA)

- Located outside the Town of Keenesburg
- Blending station and distribution site
- Blending station processes water from wells #2, #4, #5, #7, #14 and #11
- Well is currently active

Well #12 High School Well

Figure Not Included in Public Version

Figure 19: Well # 12 High School Well (CRWA)

Figure Not Included in Public Version

Figure 20: Location of Well #12 (CRWA)

- Located outside the Town of Keenesburg
- Storage tank is in use, but from the Town's water main only
- Well is currently not active

3.1.3 Roggen Wells

Roggen Wells #9 and #10

Figure Not Included in Public Version

Figure 21: Location of Well #9 (CRWA)

Figure Not Included in Public Version

Figure 22: Location of Well #10 (CRWA)

- Located outside the Town of Keenesburg
- Easement for well sites only, no access-easement
- Wells are currently not active

3.1.4 Well #11

Well #11 Lost Creek

Figure 23: Well #11 Lost Creek (CRWA)

Figure Not Included in Public Version

Figure 24: Location of Well #11 (CRWA)

- Located outside the Town of Keenesburg
- This well is considered a GUDI well
- Well is currently active

Table 1: Groundwater Supply Information

Water System Facility Name	Water Source Identification Number	Permit	Total Depth of Well (ft)	Yield (gpm)	Year Drilled
Well #2	CO0162438-002	2417-FP	860	76	1999
Well #4	CO0162438-004	31587-FP	850	50	1966
Well #5	CO0162438-005	23522-FP-R	701	150	1978
Well #7	CO0162438-007	23850-FP	910	150	1978
Well #8	CO0162438-008	57621-F	710	40	1979
Well #9	CO0162438-009	21703-FP	380	30	1977
Well #10	CO0162438-0010	21704-FP	403	30	1977
Well #11	CO0162438-0011	31652-FP	95	500	2011
Well #12	CO0162438-0012	3401-FP	903	50	1962
Well #14	CO0162438-0014	84983-F	800	150	2021

3.2 Water Supply Demand Analysis

The Town of Keenesburg's overall water treatment system has the maximum capacity to treat 750,000 gallons of drinking water per day. Current estimates by the water system indicate that the average daily demand is approximately 38,461 gallons per day (GPD) and that the average peak daily demand is approximately 162,000 GPD. Using these estimates, the water system has a surplus average daily demand capacity of 711,539 GPD and a surplus average peak daily demand capacity of 588,000 GPD.

Using the surplus estimates above, the Town of Keenesburg has evaluated its ability to meet the average daily demand and the average peak daily demand in the event that the water supply from one or more of its water sources becomes disabled for an extended period of time, due to potential contamination. The evaluation indicated that the Town may not be able to meet the average daily demand if as few as two (the LCA well and one LFH well) of the water sources become disabled for an extended period of time. The evaluation also indicated that the Town may not be able to meet the average peak daily demand if as few as two (LCA well and one LFH well) of the water sources becomes disabled for an extended period of time. The ability of the Town to meet either of these demands for an extended period of time is also affected by the amount of treated water the water system has in storage, at the time a water source(s) becomes disabled.

To understand the potential financial costs associated with such an accident, the Town of Keenesburg evaluated what it might cost to replace one of its water sources if this occurs. The evaluation indicated that it could cost approximately $400,000 in today's dollars to replace one of its water sources. As a result, the Steering Committee believes the development and implementation of a robust SWPP for the Town of Keenesburg can help to reduce the risks posed by potential contamination. In addition, the Town of Keenesburg has developed an Emergency Response/Contingency Plan to coordinate a rapid and effective response to any emergency incident that threatens or disrupts the community water supply. This plan is currently being updated due to changes that have occurred.

4. SWPP DEVELOPMENT

The Colorado Rural Water Association's (CRWA) Source Water Protection Specialist, Naia Sottile, helped facilitate the source water protection planning process. The goal of CRWA's Source Water Protection Program is to assist public water systems in minimizing or eliminating potential risks to drinking water supplies through the development and implementation of SWPPs.

The SWPP effort consisted of a series of public planning meetings and individual meetings. Information discussed at the meetings helped the Town of Keenesburg develop an understanding of the issues affecting source water protection for their community. The Steering Committee then made recommendations for best management practices to be incorporated into the SWPP. In addition to the planning meetings, data and other information pertaining to the Source Water Protection Area was gathered via public documents, internet research, phone calls, and emails. A summary of the meetings is represented below.

Table 2: Planning Meetings

Date	Location	Purpose of Meeting
January 5, 2022	In-person & Virtual	1st SWPP Workshop - Town of Keenesburg water system overview, Source Water Protection Plan overview, identify additional stakeholders, review CDPHE's Source Water Assessment Areas and potential contaminant source inventory, discuss timeline for completion of SWPP
February 2, 2022	Virtual	2nd SWPP Workshop – Special presentation by Todd Denning on the Lost Creek Groundwater Management District, develop Source Water Protection Areas, discuss PSOCs and assess risks
March 2, 2022	In-person & Virtual	3rd SWPP Workshop – Special presentation by David Dani with the CDPHE on PFAS, discuss PSOCS and assess risks
April 6, 2022	In-person & Virtual	4th SWPP Workshop – Discuss USDA Web Soil Survey, discuss PSOCS and assess risks
June 1, 2022	In-person & Virtual	5th SWPP Workshop – Special presentations on oil & gas development by Jacob Herzog with the Williams/Keenesburg Gas Plant and by Enden Nelson with Plains All American Pipeline, discuss oil and gas production/development in the area
July 6, 2022	In-person & Virtual	6th SWPP Workshop – Continue oil & gas production/development discussion and assess risks
October 5, 2022	In-person & Virtual	7th SWPP Workshop – Complete discussion on all PSOCs and assess risks, discuss BMPs
November 2, 2022	In-person & Virtual	8th SWPP Workshop – Complete discussion on BMPs, review SWPP draft

4.1 Stakeholder Participation in the Planning Process

Local stakeholder participation is vitally important to the overall success of Colorado's SWAP program. Source water protection was founded on the concept that informed citizens, equipped with fundamental knowledge about their drinking water source and the threats to it, will be the most effective advocates for protecting this valuable resource. Local support and acceptance of the SWPP are more likely when local stakeholders have actively participated in its development.

The source water protection planning effort consisted of public workshops with stakeholders, including the Public Works Director, town officials, local and state governments, agency representatives, local businesses, and residents. During the months of January 2022 to November 2022, to encourage local stakeholder participation, eight workshops were held live at the City's Public Works Department and virtually via Zoom. In addition, prior to each meeting, Stakeholders were notified and invited via email to the SWPP workshops.

From the stakeholder group, a Steering Committee was formed to help develop the SWPP. The Steering Committee's role in the planning process was to advise the Town of Keenesburg in the identification and prioritization of potential sources of contamination, as well as best management practices that can be voluntarily implemented to reduce the risks of potential contamination of the untreated source water.

All Steering Committee members attended at least two meetings and contributed to the planning efforts, from their areas of expertise. Their representation provided diversity and led to the creation of a thorough SWPP. The Town of Keenesburg and CRWA are very appreciative of the participation and input from the following participants.

Table 3: Stakeholders and Steering Committee Members

Stakeholder	Title	Affiliation	Steering Committee Member
Mark Gray	Public Works Director	Town of Keenesburg	X
Chrissy Danford	Public Works	Town of Keenesburg	
Jeremy Muse	Public Works	Town of Keenesburg	
Debra Chumley	Town Manager	Town of Keenesburg	X
Laurie Kuntz	Human Resources/Executive Admin	Town of Keenesburg	
Tom Dea	Water Engineer	Town of Keenesburg	X
Paul Anderson	Water Attorney	Town of Keenesburg	X
Ken Gfeller	Town Mayor	Town of Keenesburg	X
John Howell	Chairman of the Planning Commission	Town of Keenesburg	X
Curtis Baumgartner	Resident	Town of Keenesburg	
Kelly Graybill	Resident	Town of Keenesburg	
Todd Denning	Director, District 7, Engineer	Lost Creek Groundwater Management	X
Lori Saine	Weld County Commissioner	Weld County	
Denis Bradshaw	Weld County Emergency Management Department, EM Coordinator	Weld County	X
Dan Joseph	Weld County Environmental Health	Weld County	X
Naia Sottile	Source Water Specialist	Colorado Rural Water Association	X
Paul Hempel	Source Water Specialist	Colorado Rural Water Association	X
Mallory Hiss	Source Water Specialist	Colorado Rural Water Association	X
Peter Huisman	Water Circuit Rider	Colorado Rural Water Association	X
Dominic Davis	Wastewater Circuit Rider	Colorado Rural Water Association	
David Dani	Emerging Contaminants Coordinator	CDPHE	
Robert Murphy	Source Water Assessment and Protection	CDPHE	
Bailey Rapp	Area Conservationist	NRCS	

Stakeholder	Title	Affiliation	Steering Committee Member
Chris Mettenbrink	District Wildlife Manager	Colorado Parks and Wildlife	X
Bob Heldenbrand	Field Manager	Division of Homeland Security	X
Augie Sintas	Roadmaster	BNSF Railway	X
Annette Garrigues	Environmental Specialist	RMM/Williams Keenesburg Gas Plant	X
Matt Webre	Environmental Specialist	RMM/Williams Keenesburg Gas Plant	
Jacob Herzog	OPS Supervisor	RMM/Williams Keenesburg Gas Plant	
Enden Nelson	Damage Prevention Specialist	Plains All American Pipeline	
Michael Whitney	Pipeliner	Phillips 66	
Enrique Guerra	Pipeliner	Phillips 66	

4.2 Development and Implementation Grant

The Town of Keenesburg has been awarded a $5,000 Development and Implementation Grant from the CDPHE. This funding is available to public water systems and representative stakeholders committed to developing and implementing a source water protection plan. A one-to-one financial match (cash or in-kind) is required. The state approved this grant for the Town of Keenesburg on October 18, 2021; it expires on October 18, 2023. The Town of Keenesburg intends on utilizing the grant funds to implement the BMPs identified in this Plan.

4.3 Source Water Assessment Report Review

The Town of Keenesburg and the Steering Committee reviewed the Source Water Assessment Report. The Assessment results were used as a starting point to guide the development of appropriate BMPs to protect the source waters of the Town of Keenesburg from potential contamination. A copy of the Source Water Assessment Report for the Town can be obtained by contacting the Town or by downloading a copy from the CDPHE's SWAP program website located at: https://cdphe.colorado.gov/swap-assessment-phase.

4.4 Defining the Source Water Protection Area

A source water protection area is the surface and subsurface area within which contaminants are reasonably likely to reach a water source. The purpose of delineating a source water protection area is to determine the recharge area that supplies water to a public water source. Delineation is the process used to identify and map the area around a pumping well that supplies water to the well or spring, or to identify and map the drainage basin that supplies water to a surface water intake. The size and shape of the area depend on the characteristics of the aquifer and the well, or the watershed. The source water assessment area that was delineated as part of the Town of Keenesburg's Source Water Assessment Report, provides the basis for understanding where the community's source water and potential contaminant threats originate and where the community has chosen to implement its source water protection measures, in an attempt to manage the susceptibility of their source water to potential contamination.

After carefully reviewing their Source Water Assessment Report and the CDPHE's delineation of the Source Water Assessment Area for the Town's water source, the Steering Committee chose to modify it before accepting it as their Source Water Protection Area for this SWPP.

The revised SWPAs are divided into three tiers, which helped guide the potential contaminant source inventory and risk assessment determination during the development of this Plan. The theory behind this is that the closer the potential contaminant is to a drinking water intake, the quicker it can reach the intake, thus causing impairments and disruptions to the water system. The tiers will also help to guide the implementation of best management practices upon completion of this Plan. The Town of Keenesburg's Source Water Protection Areas are defined as:

Wells within the Laramie-Fox Hills Aquifer

- **Zone 1:** 500-foot radius surrounding the wells
- **Zone 2:** Two-year time of travel
- **Zone 3:** Five-year time of travel

Well within the Lost Creek Alluvium

- **Zone 1:** 500-foot radius surrounding the well
- **Zone 2:** Township boundary and slightly North
- **Zone 3:** Lost Creek Alluvium boundary to the West and East, and boundaries drawn to the North and South of the well

The Source Water Protection Areas are illustrated in the following maps:

Figure Not Included in Public Version

Figure 25: Town of Keenesburg Groundwater SWPAs Zones 1-3 (CRWA)

Wells in Town

Figure Not Included in Public Version

Figure 26: Wells in Town SWPA Zone 1 (CRWA)

Figure Not Included in Public Version

Figure 27: Wells in Town SWPA Zone 2 (CRWA)

Figure Not Included in Public Version

Figure 28: Wells in Town SWPA Zone 2 - Zoomed Out (CRWA)

Figure Not Included in Public Version

Figure 29: Wells in Town SWPA Zone 3 (CRWA)

Figure Not Included in Public Version

Figure 30: Wells in Town SWPA Zone 3 - Zoomed Out (CRWA)

South Wells

Figure Not Included in Public Version

Figure 31: South Wells SWPA Zone 1 (CRWA)

Figure Not Included in Public Version

Figure 32: South Wells SWPA Zone 2 (CRWA)

Figure Not Included in Public Version

Figure 33: South Wells SWPA Zone 3 (CRWA)

Figure Not Included in Public Version

Figure 34: South Wells SWPA Zones 1-3 (CRWA)

Roggen Wells

Figure Not Included in Public Version

Figure 35: Roggen Wells SWPA Zone 1 (CRWA)

Figure Not Included in Public Version

Figure 36: Roggen Wells SWPA Zone 2 (CRWA)

Figure Not Included in Public Version

Figure 37: Roggen Wells SWPA Zone 3 (CRWA)

Figure Not Included in Public Version

Figure 38: Roggen Wells SWPA Zones 1-3 (CRWA)

Well #11

Figure Not Included in Public Version

Figure 39: Well #11 SWPA Zone 1 (CRWA)

Figure Not Included in Public Version

Figure 40: Well #11 SWPA Zone 2 (CRWA)

Figure Not Included in Public Version

Figure 41: Well #11 SWPA Zone 3 (CRWA)

Figure Not Included in Public Version

Figure 42: Well #11 SWPA Zones 1-3 (CRWA)

4.5 Inventory of Potential Contaminant Sources and Other Issues of Concern

In 2001 – 2002, as part of the Source Water Assessment Report, a contaminant source inventory was conducted by the CDPHE to identify selected potential sources of contamination that might be present within the source water assessment areas. Discrete and dispersed contaminant sources were inventoried using selected state and federal regulatory databases, land use/land cover, and transportation maps of Colorado. The contaminant inventory was completed by mapping the potential contaminant sources with the aid of a Geographic Information System (GIS).

The Town of Keenesburg was asked by the CDPHE to 1) review the inventory information, 2) field-verify selected information about existing and new contaminant sources, and 3) provide feedback on the accuracy of the inventory. Through this SWPP, the Town is reporting its findings to the CDPHE.

After much consideration, discussion, and input from local stakeholders, the Town of Keenesburg and the Steering Committee developed a more accurate and current inventory of contaminant sources located within the Source Water Protection Areas, and other issues of concern that may affect the Town of Keenesburg's drinking water source.[1] In addition to the discrete and dispersed contaminant sources identified in the contaminant source inventory, the Steering Committee also identified other issues of concern that may impact the Town's drinking water source. Upon completion of this contaminant source inventory, the Town of Keenesburg has decided to adopt it in place of the original contaminant source inventory provided by the CDPHE.

4.6 Risk Assessment of Potential Contaminant Sources and Other Issues of Concern

After developing a contaminant source inventory and a list of issues of concern that are more accurate, complete, and current, the Town of Keenesburg prioritized each item to guide the implementation of the BMPs outlined in this SWPP (see Table 6: Source Water Protection Best Management Practices). The prioritization ranking of each potential contaminant source or issue of concern factored in the following criteria (as described below): the level of risk, the water system control, and the BMPs associated with each item.

4.6.1 Level of Risk – The level of risk for each contaminant source is a measure of the water source's potential exposure to contamination. When prioritizing, a water system may assign a higher priority ranking to a potential contaminant source that has a higher risk level than one of a lower risk level. The Town of Keenesburg utilized CRWA's *SWAP Risk Assessment Matrix,* which calculates the level of risk by estimating the following:

- **Probability of Impact** – The risk to the source waters increases as the relative probability of damage or loss increases. The probability of impact is determined by evaluating the number of contaminant sources, the migration potential or proximity to the water source, and the historical data. The following descriptions provide a framework to estimate the relative probability that damage or loss would occur within one to ten years.

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

- **Certain**: >95% probability of impact
- **Likely**: >70% to <95% probability of impact
- **Possible**: >30% to <70% probability of impact
- **Unlikely**: >5% to <30% probability of impact
- **Rare**: <5% probability of impact

- **Impact to the Public Water System** – The risk to the source waters increases as the impact to the water system increases. The impact is determined by evaluating the human health concerns and potential volume of the contaminant source. CDPHE developed information tables to assist with this evaluation (Appendices D, E, F, G). 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 the replacement of existing water source(s).
  - **Major** - Substantial damage to the water source(s). This could include a loss of use for an extended period of time 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 of time 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 could include the development of administrative procedures to maintain awareness of changing conditions.

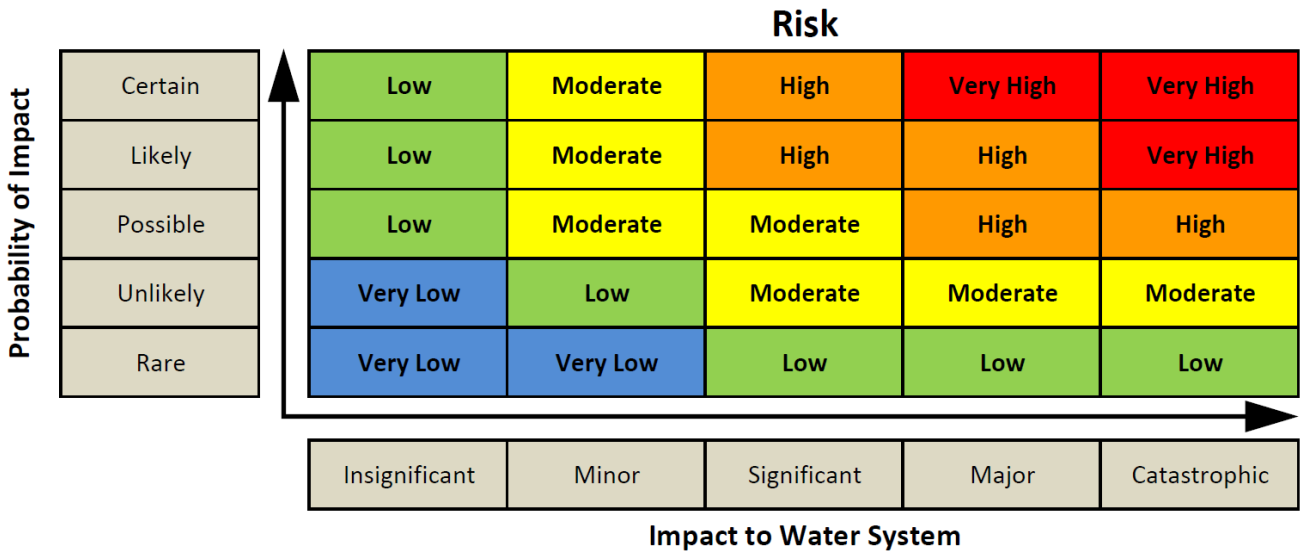

Figure 43: CRWA's SWAP Risk Assessment Matrix (CRWA)

4.6.2 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 potential contaminant source 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 (DC)** – The water system can take direct measures to prevent contamination or minimize impact.
- **Indirect Control (IC)** – The water system cannot directly control the issue but can work with another person or entity to take measures to prevent contamination or minimize impact.
- **No Control (NC)** – The PSOC or issue of concern is outside the control of the public water system and other entities.

4.7 Identifying Best Management Practices

BMPs are the actions that can be taken within the Source Water Protection Area to help reduce the potential risks of contamination to the community's source waters. The prioritization of the potential contaminant sources or issues of concern may be affected by the feasibility of implementing the BMPs that the Town of Keenesburg has developed (Table 6: Source Water Protection Best Management Practices).

The Town and Steering Committee ranked the potential contaminant source inventory and issues of concern using the CRWA's SWAP Risk Assessment Matrix. The PSOCs and rankings are listed in Table 4 below.

Table 4: Groundwater Potential Contaminant Sources and Issues of Concern Prioritization Table

PSOC or Issue of Concern	Well Category or Well Number	Proximity (SWPA Zones)	Probability of Impact	Impact to Water System	Risk	Control	Priority Ranking
Private Groundwater Wells (DWR)	Well #11	All	Likely	Catastrophic	Very High	IC	1
PFAS	Well #11	All	Certain	Major	Very High	DC/IC	1
Oil & Gas Development	Well #11	All	Possible	Major	High	IC	2
Security	Well #11	1	Possible	Major	High	DC	1
Biosolids	Well #11	All	Possible	Major	High	DC/IC	1
Commercial/Industrial 2	Well #11	2 & 3	Possible	Significant	Moderate	IC	3
Aboveground Storage Tanks ASTs	Well #11	2	Possible	Significant	Moderate	IC	3
Transportation & Roads	Well #2 & #8	1	Unlikely	Major	Moderate	IC	2
Transportation & Roads	Well #11	All	Possible	Significant	Moderate	IC	2
Security	Wellhouses	1	Possible	Major	Moderate	DC	1
Security	Tank Sites	1	Possible	Significant	Moderate	DC	1
Agriculture	Well #11	All	Possible	Minor	Moderate	IC	3
Commercial/Industrial 2	Wells within LFH Aquifer	2 & 3	Unlikely	Minor	Low	IC	4
Underground Storage Tanks USTs	Wells in Town	2	Rare	Significant	Low	DC	4
Aboveground Storage Tanks ASTs	Wells in Town	2	Rare	Significant	Low	DC	5

PSOC or Issue of Concern	Well Category or Well Number	Proximity (SWPA Zones)	Probability of Impact	Impact to Water System	Risk	Control	Priority Ranking
Transportation & Roads	Wells #4 #5 #7 #9 #10 #12 #14	2 & 3	Unlikely	Minor	Low	DC	4
Private Groundwater Wells (DWR)	Wells within LFH Aquifer	All	Rare	Catastrophic	Low	IC	1
Septic Systems	Well #11	All	Possible	Insignificant	Low	IC	1
Commercial/Industrial 1	All Wells	All	Rare	Insignificant	Very Low	IC	5
Petroleum Releases	Wells in Town	2	Rare	Minor	Very Low	IC	4
CDOT-Noxious Weeds	Well #11	All	Unlikely	Insignificant	Very Low	NC	5
Residential Practices	Wells in Town	All	Rare	Insignificant	Very Low	DC	1
Fertilizers (Parks & Lawns)	Wells in Town, South Wells	All	Rare	Insignificant	Very Low	IC	1
Stormwater Runoff	All Wells	All	Rare	Insignificant	Very Low	IC	1
Flooding (FEMA)	Wells in Town, Roggen	All	Rare	Insignificant	Very Low	NC	5
Oil & Gas Development	Wells within LFH Aquifer	All	Rare	Minor	Very Low	IC	4
Future Development	All Wells	All	Rare	Insignificant	Very Low	DC/IC	3
CAFOs	All Wells	All	Possible	Insignificant	Very Low	IC	5
Wildfire	All Wells	All	Rare	Insignificant	Very Low	IC	2
Mining	All Wells	All	Rare	Insignificant	Very Low	IC	5

5. DISCUSSION OF POTENTIAL CONTAMINANT SOURCES AND ISSUES OF CONCERN

The following section provides a brief description of potential contaminant sources and issues of concern (rated Moderate to Very High) that have been identified in this plan and describes the way in which they threaten the water source(s). The BMPs for each PSOC topic can be found in Table 6.

5.1 Private Groundwater Wells *Risk: Very High*

Private wells must be properly maintained, and out-of-service wells must be properly closed and sealed. Otherwise, they pose a threat to the quality of the groundwater source. Normally, groundwater flows through soil and bedrock formations, known as aquifers, which filter unhealthy organisms, minerals, and other substances. Water that enters an improperly maintained or abandoned well, bypasses this purification process. Contaminants could enter the aquifer directly through the unsealed well and may negatively affect the water quality in nearby wells. This can happen if a well cap is broken, in poor condition, or a wellhead does not extend high enough above the surface of the ground. These situations can allow groundwater runoff to enter the aquifer directly (Hempel, 2015).

Figure 44: Example of an Improperly Abandoned Well (CRWA)

The Town of Keenesburg has identified up to 33 abandoned wells and approximately 215 private wells, permitted through the Colorado Division of Water Resources (DWR), within the source water protection area of Well #11. These wells are located in the same aquifer/alluvium as the Town of Keenesburg's Well #11. However, it is not known the extent to which there are improperly maintained or abandoned wells within this area. The Town of Keenesburg considers the probability of impact to their water source, from an improperly maintained or abandoned well, to be likely and the impact to the water system could be catastrophic. Therefore, the risk of exposure to contamination from improperly maintained or abandoned wells is very high. The Town of Keenesburg feels that it is necessary to communicate with the landowners and businesses in the area and notify them of the Town's drinking water source.

Figure Not Included in Public Version

Figure 45: Abandoned Wells - Well #11 SWPAs (CRWA)

Figure Not Included in Public Version

Figure 46: Private Wells - Well #11 SWPAs (CRWA)

5.2 PFAS *Risk: Very High*

Per- and Polyfluoroalkyl substances (PFAS) are a diverse group of chemicals developed to resist heat, and repel oil, grease, stains, and water. They are made up of carbon-fluorine bonds, which are known to be extremely strong and highly resistant to breaking down in the environment. Thus, the name "forever chemicals". There are over 4,000 PFAS chemical compounds with highly variable chemical structures, behaviors in the environment, and therefore variable risks to public health. PFOA and PFOS are two common types of PFAS and are the primary concern for water systems due to their prevalence and extremely low Health Advisory (HA) limits. GenX and PFBS are two other PFAS with recent Final HAs, but based on sampling to date, are much less commonly detected at levels of concern in Colorado.

PFAS are used in the manufacturing of products such as firefighting foam, stain-resistant and waterproof coatings on furniture and clothing, adhesives, food packaging, non-stick cookware, cosmetics, electrical wire insulation, and plumber's tape. The wide array of industrial uses and consumer products containing these compounds results in PFAS chemicals found throughout the environment, in drinking water (groundwater and surface water), soil, and occasionally food products.

An ever-expanding body of scientific work has shown a connection between lifetime PFAS exposure and certain health effects, such as reproductive complications, developmental effects or delays in children, increased risk of some cancers, immune suppression, hormone imbalances, increased cholesterol, and obesity. Scientists estimate that 99% of humans have some level of PFAS in their blood.

The 2016 EPA Health advisory levels for PFOA + PFOS were set at 70 parts per trillion (ppt). However, on June 15th, 2022, the EPA released a new interim health advisory for PFAS levels in drinking water. These levels are several orders of magnitude lower than the 2016 levels. In response, the CDPHE is working with water systems to assess their PFAS levels being served to customers, to take steps to reduce immediate and long-term exposure where PFAS is detected, and to undertake public communication when the PFAS reporting limits exceed the new HA (CRWA & CDPHE, 2022).

The new EPA interim HA for PFOA and PFOS are:

- PFOA = 0.004 ppt
- PFOS = 0.02 ppt

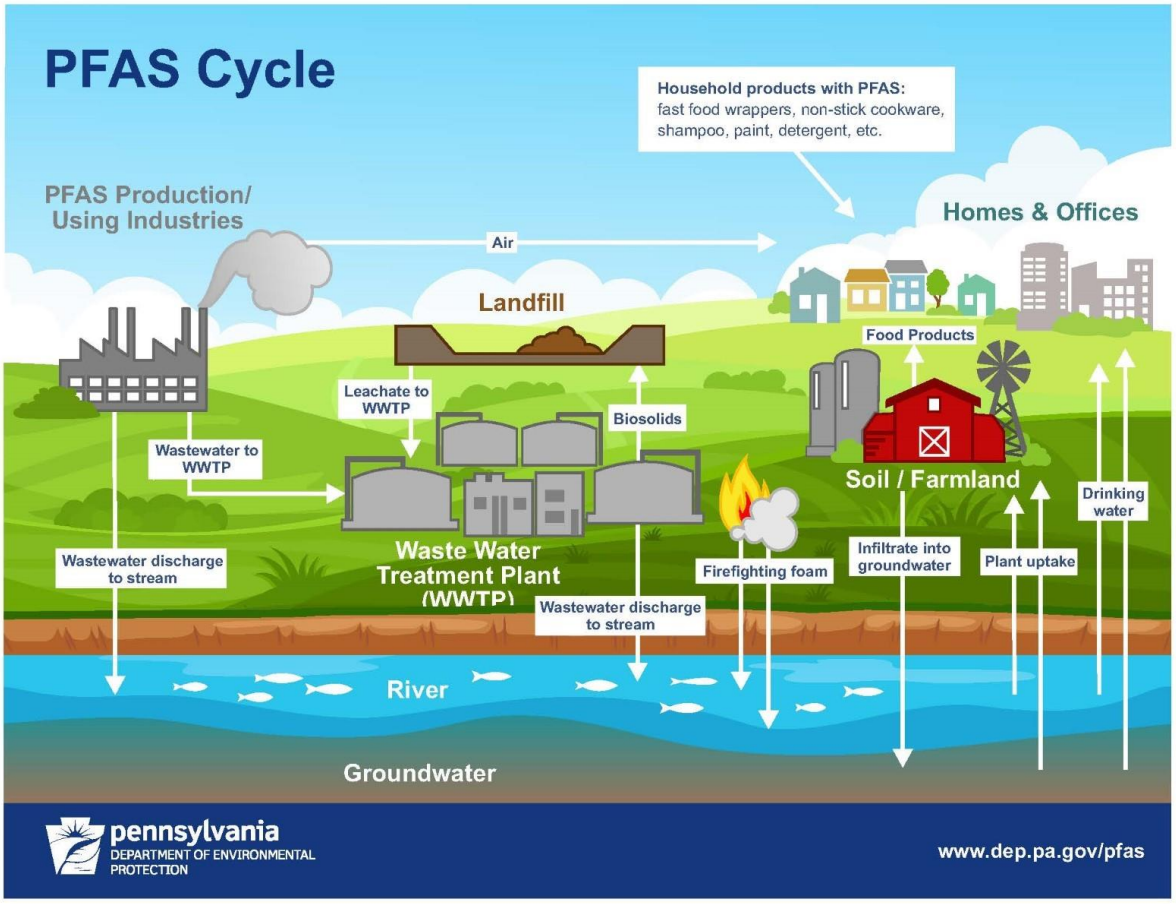

Figure 47: PFAS Cycle (PA Department of Environmental Quality)

In 2019 and 2022 the Town of Keenesburg had their wells tested for PFAS. The PFAS test results for all wells within the Laramie Fox-Hills Aquifer came back non-detect. Well #11 within the Lost Creek Alluvium showed some level of PFAS. However, the PFAS levels from 2019 to 2022 for Well #11 have declined. This could be due to a change in suspected environmental and industrial practices upstream.

The probability of impact, from PFAS to the Town of Keenesburg's Well #11 is certain and the impact to the water system could be major. Therefore, the risk of exposure to contamination from PFAS is very high. The town of Keenesburg feels that it is necessary to continue to test Well #11 for PFAS levels and monitor the results.

5.3 Oil & Gas Development *Risk: High*

"Weld County is the number one producer of oil and gas in the State. 84% of all crude oil production and 50% of all natural gas production in Colorado comes from Weld County" (Weld County, n.d.).

Essentially there are four stages of oil and gas development. Each stage comes with possible impacts to source water quality. They are as follows:

- Seismic exploration and discovery
    - Creates shock waves with the use of "thumper trucks"
    - This could pose a threat to nearby water well integrity
- Road and well pad construction
    - Soil erosion and sediment runoff from ground disturbance could contaminate groundwater and surface water
- Drilling, completion, production
    - Waste Ponds, tanks, and production equipment
        - Pits store drilling fluids or produced water and can be a significant PSOC to groundwater and surface water, if not properly constructed and maintained
        - Tanks store drilling fluids or produced water and can be a major PSOC when transferring liquids to trucks via spills, tank leaks, or related equipment failures
    - Poor Borehole Integrity
        - If the borehole is not properly cemented to the casing - oil, gas, and hydraulic fracturing fluid could escape and migrate up the borehole, and contaminate groundwater
    - Ongoing production and drilling of additional wells
        - An accident or an equipment failure involving any of the equipment or processes could result in leaks or spills
    - Trucking and transfer of liquids
        - Injection wells (Class II Wells) store Class II fluids associated with oil and natural gas production, when transferring liquids from production sites to Class II well sites, trucks (spills) or related equipment failures can be a major PSOC
- Interim and final reclamation
    - Surface, soil reclamation, and earthmoving can be a source of contamination to surface waters (Matt Samelson & Matt Sura, 2016)

The table below shows oil & gas development activity within the Town of Keenesburg's source water protection areas for each well category. The data for this table was retrieved from the Colorado Oil & Gas Conservation Commission (COGCC) website (COGCC Data, n.d.).

Table 5: Oil & Gas Development Activity - Town of Keenesburg's SWPAs (COGCC)

Oil & Gas Development	Wells in Town #2 #4 #5 #8 #14	South Wells #7 #12	Well #11 (GUDI)	Roggen Wells #9 #10
Wells (API Spots)	Zones 2 & 3	Zones 2 & 3		Zones 2 & 3
Oil & Gas Locations	Zones 2 & 3	Zones 2 & 3	Zones 2 & 3	Zones 2 & 3
Well Surface Location Data - Permits Pending				
Well Surface Location Data - Permits	Zone 2			
Oil & Gas Facilities - Pits Active			Zone 3	
Oil & Gas Facilities - Pits Closed	Zones 2 & 3	Zones 2 & 3	Zones 2 & 3	Zones 1, 2 & 3
Oil & Gas Facilities - Tank Batteries Active	Zone 3		Zone 2	Zones 2 & 3
Oil & Gas Facilities - Tank Batteries Closed			Zone 2	
Directional Well Data - Directional Lines Pending	Zone 3		Zone 3	
Directional Well Data - Directional Bottomhole Locations	Zones 2 & 3	Zones 2 & 3	Zone 3	Zone 3
Directional Well Data - Directional Lines	Zones 1, 2 & 3	Zones 2 & 3	Zone 3	Zone 3
Orphaned Wells				

Figure Not Included in Public Version

Figure 48: Oil & Gas Wells - Town of Keenesburg's SWPAs (COGCC)

Figure Not Included in Public Version

Figure 49: Oil & Gas Locations - Town of Keenesburg's SWPAs (COGCC)

Figure Not Included in Public Version

Figure 50: Oil & Gas Facilities - Pits - Town of Keenesburg's SWPAs (COGCC)

Figure Not Included in Public Version

Figure 51: Oil & Gas Facilities - Tank Batteries - Town of Keenesburg's SWPAs (COGCC)

Figure Not Included in Public Version

Figure 52: Oil & Gas Directional Lines - Town of Keenesburg's SWPAs (COGCC)

Figure Not Included in Public Version

Figure 53: Oil & Gas Directional Lines Pending - Town of Keenesburg's SWPAs (COGCC)

Expedition Water Services has a Class II well that operates within the Town of Keenesburg limits. According to the EPA, "Extraction of oil and gas usually produces large amounts of brine. Often saltier than seawater, this brine can contain toxic metals and radioactive substances. Brines can damage the environment and public health if discharged to water or land. Deep underground injection of brines in formations isolated from underground sources of drinking water prevents soil and water contamination" (EPA, 2022). The EPA has developed Underground Injection Control (UIC) Regulations for Class II wells. These regulations provide minimum requirements that work with the Safe Drinking Water Act (SDWA) of 1974, to protect underground sources of drinking water. State UIC Programs work with the EPA to approve, revise, and withdraw UIC programs that have been delegated to the state. Criteria and Standards – including technical standards for various classes of injection wells are included (EPA, 2022a).

In addition to regulations around Class II Wells, Well #11 is considered a GUDI well (groundwater under the direct influence of surface water). The COGCC has rules and regulations for oil & gas activity near and around GUDI Wells. These regulations can be found on the COGCC website under Regulation/Rules/400 Series – Operations and Reporting.

The Town of Keenesburg has decided to rate the risk of Potential Sources of Contamination, for Oil & Gas Development, separately for the wells within the Laramie-Fox Hills Aquifer and the Lost Creek Alluvium. Due to the depth of the wells and the confining layer of bedrock, the Town considers the probability of impact to the Laramie-Fox Hills Aquifer wells to be rare and the impact to the water system, minor. Therefore, the risk is considered very low. However, due to the shallow depth of Well #11 and the nature of the Lost Creek Alluvium, the Town considers the probability of impact to Well #11 to be possible and the impact to the water system, major. Therefore, the risk is considered to be high.

5.4 Security (Well Houses, Tank Sites, Well #11) *Risk: Moderate/Moderate/High*

Figure 54: Well House #5 Residential Area (CRWA)

Figure 55: Tank Site and Well #7 (CRWA)

Figure 56: Well #11 (CRWA)

5.4.1 Security

Maintaining secure access at well sites and drinking water treatment facilities is critical for drinking water safety. Maintaining secure locks, appropriate lighting, and operable cameras at these locations help maintain a secure drinking water system.

5.4.2 Cybersecurity

Cyber-attacks are a growing threat to infrastructure sectors. There have been many instances where business and facility operations have been disrupted due to cyber-attacks.

According to the US EPA Water Sector Cybersecurity Briefing:

> Cyber-attacks on water or wastewater utility business enterprises or process control systems can cause significant harm, such as:
>
> - Upset treatment and conveyance processes by opening and closing valves, overriding alarms or disabling pumps or other equipment;
> - Deface the utility's website or compromise the email system;
> - Steal customers' personal data or credit card information from the utility's billing system; and
> - Install malicious programs like ransomware, which can disable business enterprise or process control operations.
>
> These attacks can: compromise the ability of water and wastewater utilities to provide clean and safe water to customers, erode customer confidence, and result in financial and legal liabilities. (EPA, n.d.)

The Town of Keenesburg has decided to rate the Security risk for wellhouses, tank sites, and Well #11 separately. For wellhouses, the Town considers the probability of impact to be possible, and the impact to the water system to be minor. Therefore, the risk is considered moderate. For tank sites, the Town considers the probability of impact to be possible, and the impact to the water system to be significant. Therefore, the risk is considered moderate. And for Well #11, the Town considers the probability of impact to be possible, and the impact to the water system to be major. Therefore, the risk is considered high.

5.5 Biosolids *Risk: High*

Biosolids are a product of the wastewater treatment process. During treatment, the wastewater liquids are separated from the solids. The solids are then treated physically and chemically to make a nutrient-rich product known as biosolids. These biosolids are often spread onto agricultural fields for fertilizer. With the use of biosolids, there is the possibility of contaminating the soil, and therefore the nearby water source, with ammonia, nitrates, heavy metals, or PFAS. PFAS can be introduced into the agricultural environment through the land application of biosolids. PFAS can then be found in source water, soil, plants, and subsequently some food products. The Town of Keenesburg is concerned about the use of biosolids on the land above the Lost Creek Alluvium and within Well #11 Source Water Protection Areas. Due to the current possibility of the application of biosolids on the land within the SWPAs of Well #11, the Town considers the probability of impact to be possible, and the impact to the water system to be major. Therefore, the overall risk is considered high.

Figure 57: The Use of Biosolids in Agriculture (Mother Earth News, 2016)

5.6 Commercial/Industrial 2 *Risk: Moderate*

In the commercial and industrial sectors, there are EPA-regulated facilities that include stationary air emission sources, facilities with direct discharge permits under the National Pollutant Discharge Elimination System, generators and handlers of hazardous waste regulated under the Resource Conservation and Recovery Act, and public drinking water systems regulated under the Safe Drinking Water Act (USEPA, 2019). Improper storage and disposal of chemicals from these facilities can reach ground or surface water through a number of pathways. If substances from these businesses are accidentally or intentionally discharged into sewers, contamination of ground and/or surface water can occur (Office of Water, 2001c).

Several businesses, of the commercial/industrial type, operate and manage hazardous waste within SWPA Zone 2 of Well #11. The Town of Keenesburg considers the probability of impact to Well #11 from industrial practices, such as this, to be possible, and the impact to the water system to be significant. Therefore, the risk is considered Moderate.

Figure Not Included in Public Version

Figure 58: Hazardous Waste Management Site (CRWA)

5.7 Aboveground Storage Tanks ASTs *Risk: Moderate*

Aboveground Storage Tanks (ASTs) are tanks or other containers that are above ground, partially buried, bunkered, or in a subterranean vault. The majority of ASTs contain petroleum products (e.g., motor fuels, petroleum solvents, heating oil, lubricants, or used oil). ASTs may be found in airports, school bus barns, hospitals, automotive repair shops, military bases, farms, and industrial plants. Discharges of chemicals, petroleum, or non-petroleum oils from ASTs, can contaminate source water. Products spilled, leaked, or lost from ASTs may accumulate in soils or be carried away in storm runoff. Some of the causes for AST releases are holes from corrosion, failure of piping systems, or spills and overfills, as well as equipment failure and human operational error (Office of Water, 2001a).

Active ASTs are located on the Southwest corner of HWY 52 & 79 and within Zone 2 of the SWPA for Well #11. Therefore, the Town of Keenesburg considers the probability of impact to Well #11 from an AST release to be possible, and the impact to the water system to be significant. Subsequently, the risk is considered moderate.

Figure Not Included in Public Version

Figure 59: Location of ASTs within Zone 2 of Well #11 (CRWA)

5.8 Transportation & Roads *Risk: Moderate*

Motor vehicles, roads, and parking facilities are major sources of water pollution to both surface and groundwater. An estimated 46% of US vehicles leak hazardous fluids, including crankcase oil, transmission fluid, hydraulic fluid, brake fluid, and antifreeze, as indicated by oil spots on roads and parking lots, and rainbow sheens of oil in puddles and roadside drainage ditches. An estimated 30-40% of the 1.4 billion gallons of lubricating oils used in automobiles are either burned in the engine or lost in drips and leaks, and another 180 million gallons are disposed of improperly onto the ground or into sewers. Runoff from roads and parking lots has a high concentration of toxic metals, suspended solids, and hydrocarbons, which originate largely from automobiles (Gowler & Sage, 2006). Stormwater runoff can deliver contaminants from road surfaces into nearby source water. Figure 59 below illustrates groundwater contamination pathways from traffic and transport.

Additionally, vehicular spills may occur along the transportation route within source water protection areas. These spills or leaks from trucks that transport fuels, waste, and other chemicals, have the potential for contaminating source water. And subsequently, chemicals from accidental spills are often diluted with water, potentially washing the chemicals into the soil and infiltrating into the source water. These spills may contain Hazardous Materials (HAZMATs).

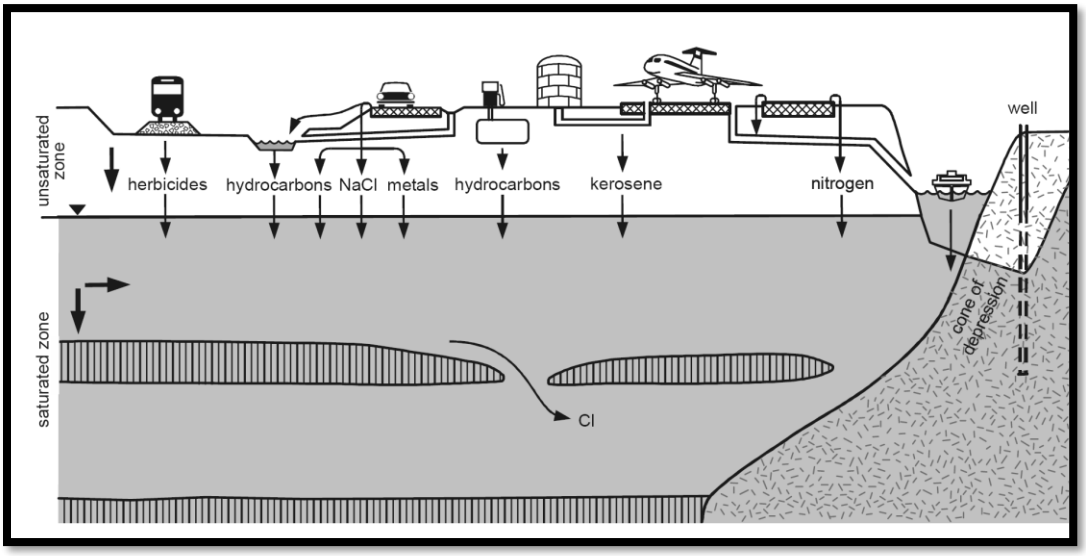

Figure 60: Groundwater Contamination Pathways from Transportation (Gowler & Sage, 2006)

HAZMATs are substances in quantities or forms that may pose a reasonable risk to health, property, or the environment. HAZMATs include such substances as toxic chemicals, fuels, nuclear waste products, and biological, chemical, and radiological agents. HAZMATs may be released as liquids, solids, gases, or a combination or form of all three, including dust, fumes, gas, vapor, mist, and smoke. HAZMAT spills have caused health problems, injuries, and even death in people and animals, and have damaged buildings, homes, property, and the environment. Given such dire consequences, it is reasonable to conclude that one may not encounter HAZMATs on a daily basis. The truth, however, is that many products containing hazardous chemicals are routinely used and stored in homes, and are transported every day on the nation's highways, railroads, waterways, and pipelines (NOAA, n.d.).

According to the United States Department of Transportation Federal Motor Carrier Safety Administration (FMCSA), a Hazardous Materials Route goes directly over the Lost Creek Alluvium and through Zone 2 of Well #11 (FMCSA, n.d.). In addition, the transportation of anhydrous tanks, diesel, and herbicides, along Weld County Rd 14 is a concern, as it passes directly through Zone 1 of Well #11. The Town of Keenesburg considers the probability of impact to Well #11 from transportation and roads to be possible, and the impact to the water system to be significant. Therefore, the risk is moderate.

Figure Not Included in Public Version

Figure 61: HAZMAT Route Shown in Orange (CRWA)

Figure Not Included in Public Version

Figure 62: WCR 14 - Well #11 Zone 1 (CRWA)

And last, vehicle accidents to water system infrastructure could also impact the drinking water supply. The Town of Keenesburg's Wellhouse #2 is located approximately 40 feet from the I-76 off-ramp. In addition, Well #8 is located next to the railroad and fuel depot. The Town of Keenesburg considers the probability of impact to Wells #2 & #8 to be unlikely. However, if something were to happen, the impact to the water system could be major. Therefore, the risk is considered moderate.

Figure 63: Well #2 Near the I-76 Off-Ramp (CRWA)

Figure Not Included in Public Version

Figure 64: Well #2 Near the I-76 Off-Ramp (CRWA)

Figure Not Included in Public Version

Figure 65: Well #8 - Near Railroad and Fuel Depot (CRWA)

5.9 Agriculture *Risk: Moderate*

Agricultural practices often involve the use of fertilizers. If improperly managed, elements of fertilizer can move into surface water through field runoff or leach into groundwater. Two main components of fertilizer that are of greatest concern to source water quality are nitrogen and phosphorus.

Improper or excessive use of fertilizer can lead to nitrate pollution of ground and/or surface water. Nitrogen fertilizer, whether organic or inorganic, is biologically transformed into a nitrate that is highly soluble in water. In this soluble form, the nitrate can readily be absorbed and used by plants. On the other hand, soluble nitrate is highly mobile and can move with percolating water out of the soil, thus making it unavailable for plant uptake. Fertilizer applications, therefore, need to match nitrogen applications to plant uptake, to minimize nitrate leaching and maximize efficiency.

As mentioned above, nitrogen-containing fertilizers can contribute to nitrates in drinking water. Consumption of nitrates can cause methemoglobinemia (blue baby syndrome) in infants, which reduces the ability of the blood to carry oxygen. If left untreated, methemoglobinemia can be fatal for affected infants. Due to this health risk, EPA set a drinking water Maximum Contaminant Level (MCL) of 10 milligrams per liter (mg/l) or parts per million (ppm) for nitrate measured as nitrogen (Office of Water, 2001b).

Applying fertilizer on cropland is a common agricultural practice in and around the Town of Keenesburg, as is the operation of Confined Animal Feeding Operations (CAFOs), such as dairies. As discussed earlier in this report, the soils above the LCA are considered medium-high to highly permeable. The land above the LCA within the SWPA is predominately cropland, with several CAFO operations. The combination of highly permeable soils, the use of fertilizers on cropland, and the operation of CAFOs, within the SWPAs for Well #11, give cause for concern. The Town of Keenesburg considers the probability of impact from agricultural practices to Well #11 possible, and the impact to the water system minor. Therefore, the risk of agricultural practices is considered moderate.

Figure Not Included in Public Version

Figure 66: Crop Circles SWPAs of Well #11 (CRWA)

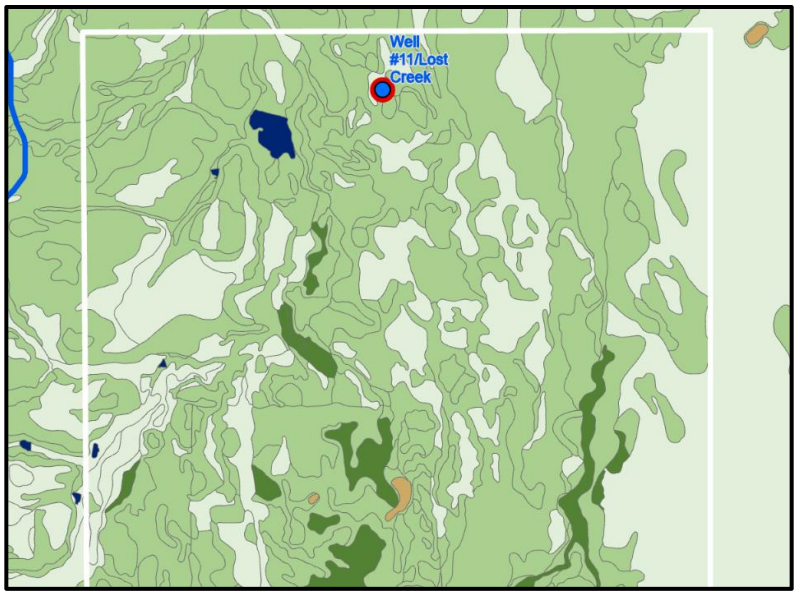

Figure 67: Soil Permeability Zone 2 of Well #11 (CRWA)

Capacity of the most limiting layer to transmit water (Ksat)	
Medium low - medium high	(.06 - .20 in/hr)
Medium high - high	(.57 - 2.00 in/hr)
High	(2.00 - 6.00 in/hr)
High - very high	(6.00 - 39.96 in/hr)

6. SOURCE WATER BEST MANAGEMENT PRACTICES

The Steering Committee reviewed and discussed several possible BMPs that could be implemented within the SWPAs to help reduce the potential risks of contamination to the community's source water. The Steering Committee established a "common sense" approach in identifying and selecting the most feasible source water management activities to implement locally. The BMPs were obtained from multiple sources including the EPA, CDPHE, Natural Resources Conservation Service, and other source water protection plans.

The Steering Committee recommends the BMPs listed in the following table be considered for implementation.

Table 6: Source Water Protection Best Management Practices

Issues	Town of Keenesburg Best Management Practices	Collaborating Partners
Private Groundwater Wells ***Well #11*** ***RISK: Very High*** ***All Other Wells*** ***RISK: Low***	1. Provide educational material to property owners on how to properly maintain active or abandoned wells and how to identify and properly seal abandoned wells	**Town of Keenesburg/Local Residents**
PFAS ***Well #11*** ***RISK: Very High***	1. Conduct testing for PFAS levels yearly by participating in the CDPHE PFAS grant testing program 2. Post Health Advisory Notifications in the Consumer Confidence Report 3. Continue to respond to and comply with regulations from the CDPHE and the EPA 4. Ensure that industries within Town limits be free of PFAS/PFOS related substances	**Town of Keenesburg, CDPHE, EPA**
Oil & Gas Development ***Well #11*** ***RISK: High***	1. Continue to maintain a Local Governmental Designee (LGD) for the Town of Keenesburg, Mark Gray is currently the LGD for the Town 2. Regularly monitor the COGCC Daily Activity Dashboard at https://cogcc.state.co.us/DAD.html for any new drilling permits, provide comments where appropriate 3. Develop a Memorandum of Understanding (MOU) for future oil and gas negotiations	**Town of Keenesburg/Weld County/COGCC**

Issues	Town of Keenesburg Best Management Practices	Collaborating Partners
<u>Security</u> ***Well #11*** ***RISK: High*** ***Tank Sites & Well Houses*** ***RISK: Moderate***	1. Consider the option of adding entry alarms to the Town's Supervisor Control & Data Acquisition System (SCADA) 2. Maintain existing SCADA monitoring and conduct daily site visits 3. Add cameras at the Blending Station/Well #7, at the Booster Station, and at Well #11 4. Add smoke/combination alarms to wellhouses 5. Install locking bolts on wellheads (especially Well #11) 6. Distribute an Emergency Response Notification Card to the Weld County OEM 7. Take part in water system cybersecurity training through the EPA and DHS 8. Visit the EPA's Cybersecurity Best Management Practices for the Water Sector website – including the vulnerability self-assessment tool 9. Create a cybersecurity incident response protocol 10. Review existing water system cybersecurity with the Information Technology Department, identify gaps and areas for improvement, including a National Institute of Standards and Technology audit	**Town of Keenesburg/Weld County OEM**
<u>Biosolids</u> ***Well #11*** ***RISK: High***	1. Push for the requirement that biosolid waste be sampled for PFAS and heavy metals before application 2. Stay involved with local and state meetings regarding the use of biosolids 3. Stay abreast on the latest news and regulations regarding the use of biosolids	**Town of Keenesburg/Lost Creek Groundwater Board/Weld County Health Department**

Issues	Town of Keenesburg Best Management Practices	Collaborating Partners
<u>Commercial/ Industrial 2</u> ***Well #11*** ***RISK: Moderate***	1. Maintain a current inventory of industrial facilities within Well #11 SWPAs and any violations within those areas 2. Gather information about the industrial facilities' emergency response plans for spills and stormwater management 3. Conduct a survey of area businesses and industries to determine waste disposal practices, types, and amounts of chemicals being utilized 4. Work together with regulatory agencies to ensure that site visits and inspections are conducted on a routine basis and government regulations are followed and enforced when violations occur 5. Build partnerships with industrial facilities and users within the protection area in order to encourage stewardship of their land and the protection of groundwater 6. Work together with agencies to develop an ongoing groundwater and soil monitoring program to detect changes in groundwater quality 7. Distribute education and outreach material to businesses and industries that explains how to properly store and dispose of oils/grease, toxic and hazardous waste, to protect water quality	**Town of Keenesburg/ECHO Enforcement and Compliance/CDPHE/Weld County Health and Environment**
<u>Aboveground Storage Tanks (ASTs)</u> ***Well #11*** ***RISK: Moderate***	1. Conduct targeted education and outreach to storage tank owners/operators on how to implement BMPs that prevent hazardous materials from infiltrating into the aquifer/alluvium 2. Encourage installation of secondary containment for aboveground storage tanks on private and/or business properties 3. Obtain and maintain database/GIS locations of storage tank locations within the SWPAs 4. Monitor for violations/leak incidents	**Town of Keenesburg/Division of Labor and Employment/Local Business**

Issues	Town of Keenesburg Best Management Practices	Collaborating Partners
Transportation & Roads ***Well # 11*** ***Well #2*** ***Well #8*** ***RISK: Moderate***	1. Fortify perimeter of the wellhouses/wellheads, especially Wells #2, #8, & #11, with upgraded guard rails and/or bollards 2. In preparation for a major incident, provide CDPHE and Weld County OEM with a written "Boil Order" for posting on their website 3. Establish a special action protocol, in the event an incident occurs within the 500-foot radius (zone 1) of the wells 4. Provide a copy of the SWPP and Emergency Response Notification Cards to the Weld County Road and Bridge Department 5. Educate the public on how to report spills within the SWPA to "911"	**Town of Keenesburg/CDPHE/Weld County OEM/CDOT/Weld County Road and Bridge/Public**
Agriculture ***Well #11*** ***RISK: Moderate***	1. Provide educational material to farmers and all well permit holders within the SWPAs, regarding the SWPP, the managing of fertilizer application, and the managing/reporting of accidents/spills 2. Provide the local NRCS Field Office with a copy of the SWPP (public version) 3. Introduce Conservation Districts and landowners to the NRCS SWP Initiative that emphasizes best practices relating to water quality and quantity, that protect drinking water sources and agricultural producers' land	**Town of Keenesburg/Well Permit Holders/Land Owners/NRCS**
Residential Practices ***Wells in Town*** **RISK: Very Low**	1. Provide educational materials to homeowners 2. Display BMP material on the Town's website 3. Include BMP educational information in the monthly utilities newsletter	**Town of Keenesburg/Town Residents**

Issues	Town of Keenesburg Best Management Practices	Collaborating Partners
Fertilizers (Parks & Lawns) ***Wells in Town, South Wells*** **RISK: Very Low**	1. Provide educational materials to homeowners and the Town's Ground Maintenance Department 2. Display BMP material on the Town's website 3. Include BMP educational information in the monthly utilities newsletter	**Town of Keenesburg/Town Residents**
Stormwater Runoff ***All Wells*** **RISK: Very Low**	1. Provide educational materials to homeowners and the Town's Ground Maintenance Department 2. Display BMP material on the Town's website 3. Include BMP educational information in the monthly utilities newsletter	**Town of Keenesburg/Town Residents**
Wildfire ***All Wells*** **RISK: Very Low**	1. Develop an emergency response plan specifically for Wildfire, with a map of curb stops 2. Incorporate this plan into the Town's Emergency Response/Contingency Plan 3. Provide the plan and curb stop information to the Southeast Weld Fire Protection District	**Town of Keenesburg/Weld County OEM/Southeast Weld Fire Protection District**

7. EVALUATING EFFECTIVENESS OF THE SWPP

The Town of Keenesburg is committed to evaluating the effectiveness of the BMPs that have been implemented. The purpose of evaluating the effectiveness is to determine if the various BMPs are being achieved, and if not, what adjustments to the SWPP need to be taken in order to achieve the intended outcomes. It is further recommended that this Plan be reviewed at a frequency of once every five years or if circumstances change resulting in the development of new water sources and SWPAs, or if new risks are identified.

The Town of Keenesburg is committed to a mutually beneficial partnership with the CDPHE in making future refinements to their source water assessment and revising the SWPP accordingly based on any major refinements.

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9. APPENDICES[2]

A. Town of Keenesburg Source Water Assessment Report

B. Town of Keenesburg Source Water Assessment Report Appendices

C. CRWA's SWAP Risk Assessment Matrix

D. Table A-1 Discrete Contaminant Types

E. Table A-2 Discrete Contaminant Types (SIC Related)

F. Table B-1 Dispersed Contaminant Types

G. Table C-1 Contaminants Associated with Common PSOCs

[2] All appendices will be forwarded to the Public Water System.