WATER SYSTEM CAPITAL IMPROVEMENT PLAN

TOWN OF MINTURN

September 30, 2019

Prepared by

SGM

118 West Sixth Street, Suite 200
Glenwood Springs, CO 81601
970.945.1004
970.945.5948 fax

Water System Capital Improvement Plan

Town of Minturn

Prepared By

Ryan Gordon, PE

SGM Project # 2017-258.005

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0.0 Executive Summary

Supply and Demand

The Town's potable water production requirements have been steady over the past 10 years, or so. The Town is at a crossroads and has limited ability to serve additional demand with current water resources and treatment capacity. Additionally, the Town relies solely Cross Creek as their water supply.

Raw Water System

The Town maintains the ability to divert raw water from Cross Creek and groundwater from Wells 3 and 4. This plan identifies a number of projects to address multiple raw water system challenges and develop additional raw water sources.

- Conveyance Pipelines. As a result of the configuration of the Well 4 pipeline, the Town is limited in how Well 4 water is used and is not in compliance with the CDPHE. The reconfiguration of this pipeline will allow the Town to resolve compliance issues and more effectively use their groundwater resources.
- Redundancy. The Town does not have a redundant water source and if Cross Creek was impaired for some reason it would possibly be challenging for the Town to meet the water demand. Furthermore, the amount of water the Town can get from Cross Creek limits the amount of growth the Town can accommodate. By developing the Towns water rights on the Eagle River the Town can secure a secondary water source and additional physical supply.

Water Treatment Plant

The Town's water plant struggles to meet CDPHE regulations during spring runoff and is limited in the quantity of treated water it can produce. While currently able to meet demand, future demand will strain the plant, additionally, the plant may not be able to produce water if the raw water source changes.

- Filtration. The Town utilizes slow sand filtration which is a biological process and is difficult to control and is not adaptable to changing circumstances. Rehabilitation of the filters carries significant risk that the effort will not solve the issues at the plant. SGM recommends that the Town upgrade the filtration process to membrane filters which will allow the Town to utilize and adapt to different raw water sources and increase water production rates while maintaining high quality potable water.

Distribution System

The Town maintains 2 water tanks and approximately 7 miles of distribution piping.

- Water Storage. Evaluation of the Town's water storage indicates that the system is in need of significant attention. The Maloit Park Tank is currently undersized and does not meet the fireflow storage requirements and needs to be expanded to meet fireflow and future development needs. The Minturn Tank, while currently sized adequately, is nearing the end of its useful life, is leaking and needs to be replaced.

- Water Mains. The Town's system is aging, water leaks have been a persistent problem and a replacement program have not been implemented to keep the system in good shape. To address the situation, the Town needs to implement a main replacement program that will systematically replace mains.

- Redundancy. This report includes recommendations to improve redundancy within the distribution system in order to increase water service reliability. These projects include connecting the Town Service area and the Maloit Service area.

- Water Loss. Beyond the water main replacement program, the Town should invest in a water loss detection system to effectively locate leaks that might be on the service lines or identify leaks that are not visible at the surface.

A prioritized summary of all of the recommended projects with estimated costs is provided in **Chapter 6.**

1.0 Introduction

1.1 Document Scope and Purpose

The Town of Minturn is a historic mining and railroad town incorporated in 1904. The Town owns and operates a potable water system to provide treated water to approximately 1,100 residents.

Previous water system planning studies include:

- 2009 Town of Minturn Water Master Plan

In 2017, the Town of Minturn selected SGM to be its water infrastructure engineer. In 2019, Minturn initiated this Water System Capital Improvement Plan project.

This document is not an evaluation of water availability or the Towns' water rights. This plan identifies and prioritizes critical water system capital improvement projects. The plan is intended to guide decision-making for the next 10 years as well as provide a basis for evaluating the suitability of Minturn's existing rates and fees and identifying many needed changes.

This document captures the results and recommendations compiled through a system-wide analysis. For this reason, design and cost estimates associated with each project are considered planning-level only. SGM advises Minturn to establish annual budgeting values for recommended projects it wishes to implement by initiating design in the year prior.

This document identifies projects based on the following:

- Existing and known upcoming regulatory requirements.
- Industry standards and/or AWWA recommendations.
- Staff-identified challenges.
- Water distribution system hydraulic modeling results.
- Anticipated development and projected demand associated with that development.
- Engineering judgement.

2.0 Water Demand Analysis and Supply Comparison

Chapter 2 presents historical and projected development and water demands and summarizes water sources and recommended improvements. Water demands are compared to existing water production capacity to verify that upcoming demands can be met.

2.1 Historical Connected SFEs

Minturn assigns Single Family Equivalents Equivalent Residential Units (SFEs) to its customers. Eagle River Water and Sanitation District (ERWSD) handles the billing for the Town and we are relying on ERWSD records for SFE counts. For water system planning, trends in the annual average number of SFEs are of most interest. SGM determined the average annual connected SFEs in Minturn's system by examining monthly billing records. Monthly billing records were obtained from Eagle River Water and Sanitation District (ERWSD). **Table 1** provides a summary of the historically connected SFEs for a recent 5-year period. Because the Town's water delivery system splits after the water treatment plant, we have made the distinction throughout this report between the "Maloit Park Service Area" and the "Town Service Area". Currently, there are approximately a total of 730 SFEs served by Minturn; 35.6 SFEs in the Maloit Park Service Area and 693 SFEs in the Town Service Area.

Table 1 Recent Annual Average SFEs

	Average Single-Family Equivalents					
	2014	**2015**	**2016**	**2017**	**2018**	**5-Year Average**
Town Service Area						
Commercial	83.8	84.9	84.9	84.5	87.7	104.8
Mixed Use	95.7	95.7	95.4	95.2	94.9	95.4
Residential	509	509.1	509.8	514.2	510.5	526.5
TOTAL	*688.5*	*689.7*	*690.1*	*694*	*693*	*691*
Maloit Park Service Area						
Commercial	15.5	20.6	20.6	20.6	20.6	19.6
Residential	16	16	16	17	15	16
TOTAL	*31.5*	*36.6*	*36.6*	*37.6*	*35.6*	*35.6*
Total						
Commercial	99.3	105.5	105.5	105.1	108.3	104.7
Mixed Use	95.7	95.7	95.4	95.2	94.9	95.4
Residential	525	525.1	525.8	531.2	525.5	526.5
TOTAL	**720**	**726.3**	**726.7**	**731.5**	**728.7**	**726.6**

2.2 Historical Water Production

Table 2 shows the monthly and total annual produced water volume for a recent five-year period. **Figure 1** graphically depicts the monthly data which has been recorded from the Town's master meters for each service area.

As with many water utilities, water production peaks in summer months when outdoor irrigation occurs. Peak day to average day production ratios for the Town Service Area range from 2.0 to 3.0 for the period, which is within the range of normal peaking factors for other communities in which potable water is used for irrigation.

Peak day to average day production ratios for the Maloit Park Service Area range from 2.73 to 5.8 which are above the normal range, however, the ratios exceeded the norm in 2017 and 2018 which coincide with batching water due to challenges meeting disinfection requirements.

Figure 1 Historical Monthly WTP Production

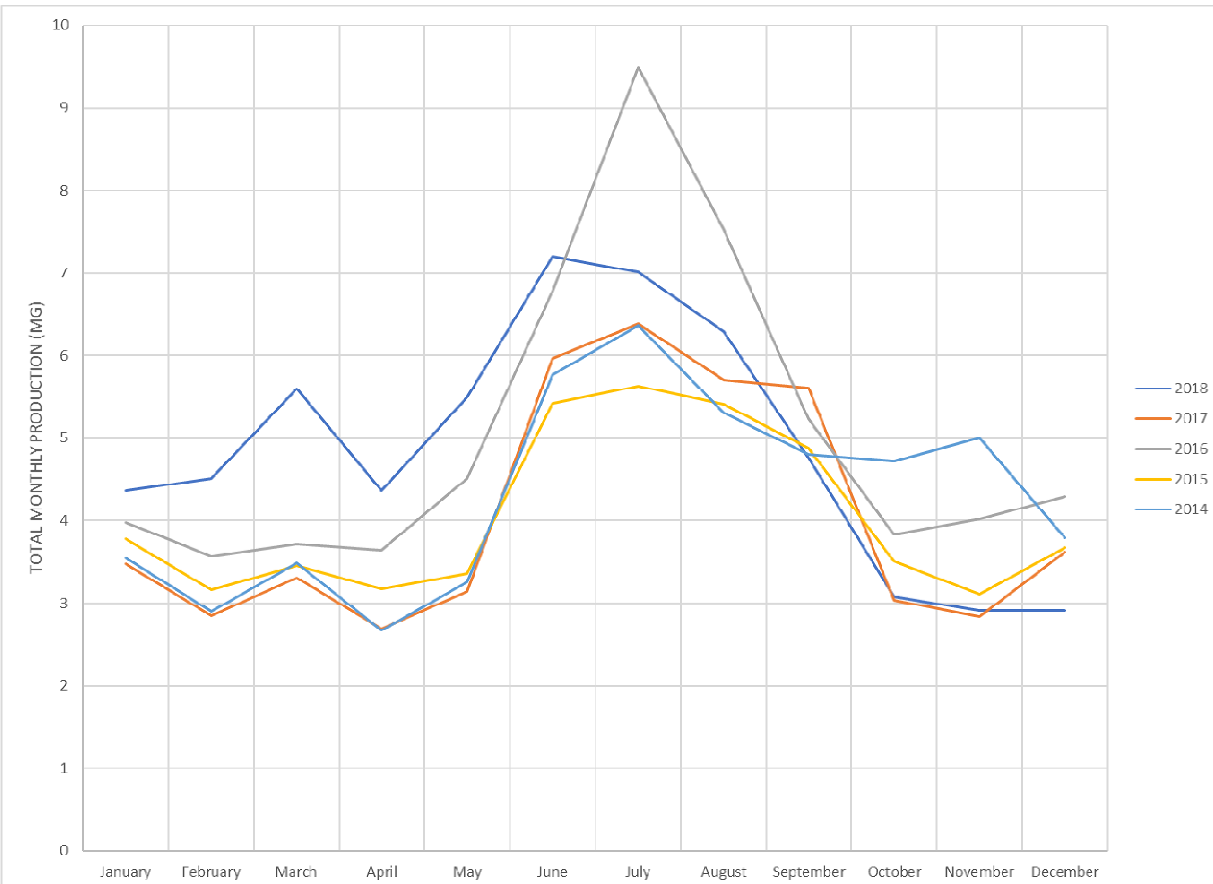


Table 2 Historical Water Produced (2014-2018)

Month	Total Produced Water (MG)									
	2014		2015		2016		2017		2018	
	Town Service Area	Maloit Service Area	Town Service Area	Maloit Service Area	Town Service Area	Maloit Service Area	Town Service Area	Maloit Service Area	Town Service Area	Maloit Service Area
January	4.63	0.12	3.63	0.14	3.87	0.11	3.38	0.09	4.27	0.09
February	2.78	0.13	3.05	0.12	3.47	0.09	2.77	0.08	4.42	0.09
March	3.34	0.14	3.28	0.17	3.60	0.12	3.22	0.09	5.50	0.10
April	2.54	0.12	3.02	0.16	3.55	0.09	2.62	0.08	4.26	0.10
May	3.10	0.16	3.12	0.24	4.38	0.14	3.00	0.14	5.36	0.14
June	5.57	0.20	5.12	0.31	6.60	0.18	5.77	0.19	6.98	0.22
July	6.14	0.23	5.20	0.42	9.31	0.18	6.22	0.17	6.81	0.21
August	5.09	0.21	4.91	0.50	7.37	0.16	5.56	0.14	6.14	0.16
September	4.60	0.21	4.36	0.52	5.10	0.13	5.47	0.13	4.59	0.16
October	4.56	0.16	3.31	0.20	3.71	0.11	2.93	0.11	2.92	0.16
November	4.86	0.14	2.99	0.12	3.93	0.09	2.74	0.10	2.72	0.19
December	3.66	0.13	3.52	0.16	4.19	0.11	3.51	0.12	2.77	0.21
Subtotal	50.87	1.95	45.51	3.05	59.08	1.52	47.19	1.44	56.75	1.83
Total	52.83		48.57		60.61		48.63		58.58	
Daily Production Statistics										
Peak Day (MGD)	0.278	0.019	0.285	0.023	0.367	0.014	0.395	0.023	0.368	0.022
Average Day (MGD)	0.139	0.005	0.125	0.008	0.161	0.004	0.129	0.004	0.156	0.005
Ratio	2.00	3.55	2.29	2.73	2.28	3.38	3.05	5.80	2.36	4.33

2.3 Unit Water Production Requirements

Unit water production requirements are defined as the daily volume of water the Town's treatment plant and wells need to produce to meet the demand of one (1) SFE of new development. SGM established the following recommended planning values based on current unit consumption rates in Minturn and other high-mountain communities as well as consideration of how water use in new development might compare to that within the existing Town, the potential impacts of a warming climate, trends in non-revenue water percentage with new development, system water loss etc. The recommended unit production values for planning are:

- Winter: 180 gpd/SFE
- Average Annual: 259 gpd/SFE
- Max. Month: 427 gpd/SFE
- Max. Day: 570 gpd/SFE

2.4 Development Projections

The Town provided SGM with information regarding two growth scenarios identified in **Table 3** as "Option 1: Cross Creek Only" and "Option 2: Cross Creek plus Eagle River

Wells." The growth scenarios are largely tied to the availability of water to support the growth. These are described below.

- *Option 1: Cross Creek Only* – Under this option the Town would continue to rely solely on Cross Creek for its water supply.
- *Option 2: Cross Creek plus Eagle River Wells* – Under this option the Town would continue to utilize Cross Creek water and also develop additional water resources on the Eagle River through a well field. This option includes moderate growth.

SGM has not evaluated if the levels of growth described below in Table 3 can be supported by the Town's water rights portfolio and augmentation supplies.

Table 3 Development Summary

		Option 1 Cross Creek Only	Option 2 Cross Creek plus Eagle River Wells
PROPERTY	**Service Area**		
Infill (Comm/Res/Ind)	Town	70	330
School District	Maloit Park	120	120
	Total	***190***	***450***

2.5 Current and Projected Future Water Production Needs

Tables 4, 5, and **6** showing projected additional, existing, and total future water production needs under the growth scenarios for the Town and Maloit Park service areas and the overall water system. Future water production figures are based on planning numbers and existing water production figures are based on actual data.

Table 4 – Overall Water Demands

	Additional Required Water Production (GPD)			
	SFEs	**Average Daily**	**Max. Month**	**Max. Day**
Option 1	190	49,210	81,100	108,300
Option 2	450	116,580	192,300	256,400
	Existing Water Production Requirements (GPD)			
	SFEs	**Average Daily**	**Max. Month**	**Max. Day**
Existing	728	147,700	233,500	333,000
	Total Future Water Production Requirements (GPD)			
	SFEs	**Average Daily**	**Max. Month**	**Max. Day**
Option 1	918	196,900	314,800	441,300
Option 2	1,178	264,300	425,900	589,400

Table 5 - Town Service Area Water Demands

	Additional Required Water Production (GPD)			
	SFEs	**Average Daily**	**Max. Month**	**Max. Day**
Option 1	70	18,130	29,890	39,900
Option 2	330	85,500	141,000	188,000

	Existing Water Production Requirements (GPD)			
	SFEs	**Average Daily**	**Max. Month**	**Max. Day**
Existing	691	141,700	224,500	314,400
	Total Future Water Production Requirements (GPD)			
	SFEs	**Average Daily**	**Max. Month**	**Max. Day**
Option 1	761	159, 800	254,500	354,400
Option 2	1,021	227,200	365,600	502,500

Table 6 - Maloit Park Service Area Demands

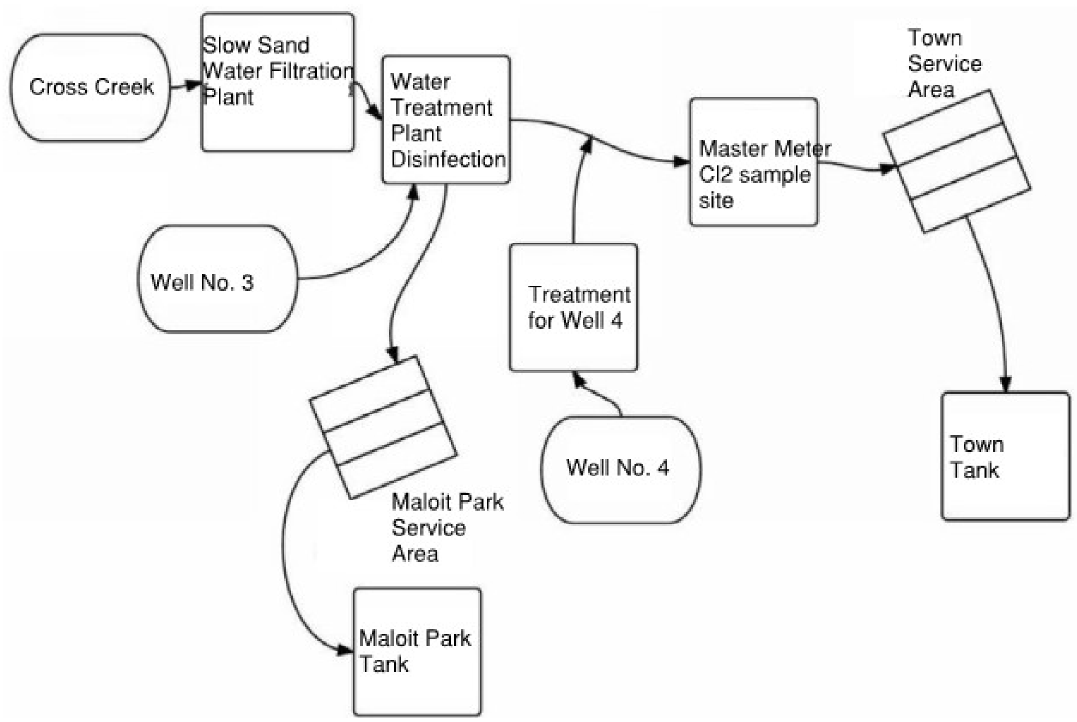
	SFEs	**Average Daily**	**Max. Month**	**Max. Day**
	Additional Required Water Production (GPD)			
	SFEs	**Average Daily**	**Max. Month**	**Max. Day**
Option 1	120	31,080	51,300	68,400
Option 2	120	31,080	51,300	68,400
	Existing Water Production Requirements (GPD)			
	SFEs	**Average Daily**	**Max. Month**	**Max. Day**
Existing	37	6,000	9,000	18,600
	Total Future Water Production Requirements (GPD)			
	SFEs	**Average Daily**	**Max. Month**	**Max. Day**
Option 1	157	37,100	60,300	87,000
Option 2	157	37,100	60,300	87,000

2.6 Sources of Water

The Town of Minturn's water supplies include surface water diverted and gravity fed from Cross Creek at a concrete diversion structure located approximately 1,600 feet upstream of the treatment plant in a 12-inch cast iron raw water pipeline.

The Town also has two groundwater wells (Well 3 and Well 4). Well 3 pumps water directly to the plant clearwell through a 4-inch pipeline. Well 4 waterline is connected to the existing transmission line from the plant to the town. This configuration does not meet CDPHE disinfection requirements and Well 4 has been classified as an emergency water supply until the Town can resolve and satisfy CDPHE disinfection requirements. **Figure 2** shows a schematic of the Town's current water system.

Figure 2 Minturn Raw Water System Schematic



2.6.1 Water Reliability and Redundancy

Currently the Town relies solely on Cross Creek and the groundwater wells for its water. Relying on a single water source carries risks to the Town in the event that Cross Creek water is limited either through low flow/drought conditions or the water quality is degraded through an event such as a forest fire or contaminated by a pollutant. It is advisable that the Town secure a secondary/redundant water source to be able to provide water to the Town if the primary water source is not available.

There are two options for a redundant water source as identified by the Town and their consultants and as presented to Council in September 2018; either develop the Town's existing Eagle River water rights or construct an interconnection to the ERWSD system. Developing the Eagle River water rights is presented in the next section. The infrastructure for interconnect with ERWSD is not analyzed in this document because future infrastructure is presumably to be provided by the future development.

3.0 Raw Water Improvement Projects

This plan includes three recommended projects to improve the raw water system. **Table 7** provides a cost estimate and proposed timing. A summary of the project is as follows.

3.1 Raw Water Screening Improvements

The existing inlet structure has a ½"x½" coarse screen to keep out large debris. The current screening openings is adequate for the slow sand filtration process, however if alternative treatment is used, better screening will assist to remove debris and protect treatment equipment.

3.2 Well 4 Pipeline Improvements

Well 4 connects to the main distribution pipeline to the Town service area. As previously discussed, CDPHE has determined this configuration is not acceptable. Additionally, this configuration does not allow Well 4 water to be delivered to the Maloit Park service area.

Constructing a new pipeline from Well 4 pump head to the existing clearwell will resolve the configuration issues and allow the Town to manage its water resources more effectively, see **Figure 3**.

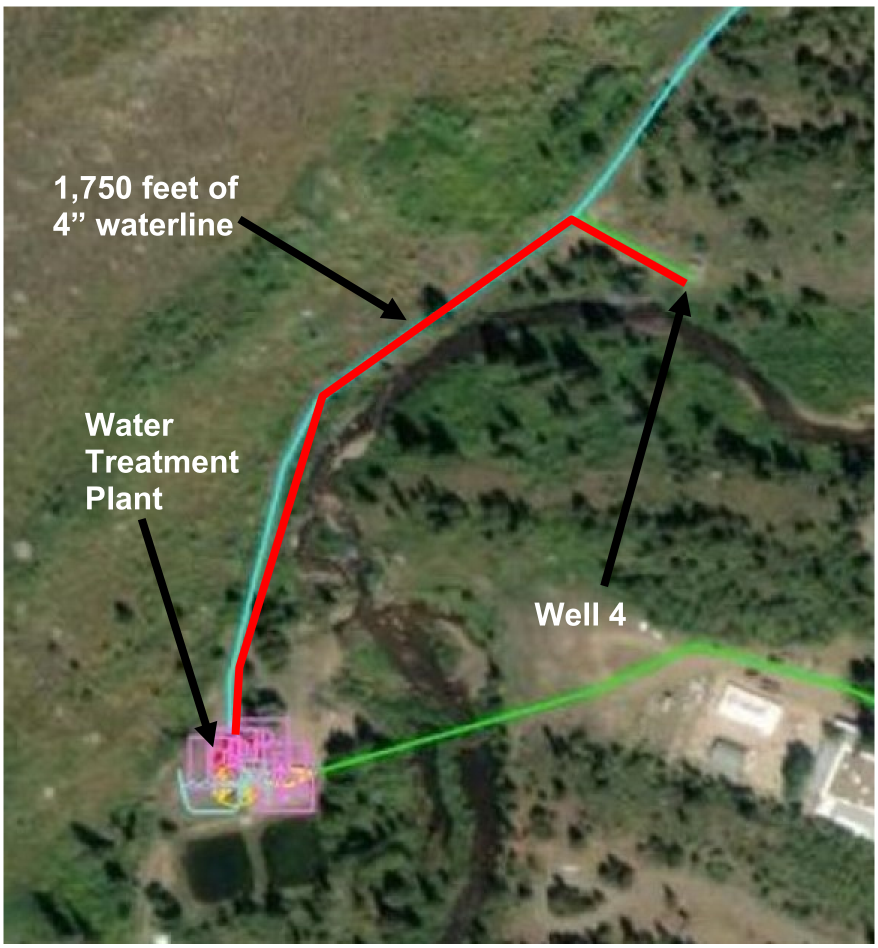


Figure 3 - Well 4 Pipeline

3.3 Eagle River Wells

Currently there is not a secondary or redundant water source available to the Town. Development of the Towns water rights on the Eagle River would provide this redundant water supply through the development of a well field as well as provide additional water resources for future growth.

Wells would be drilled on banks of the Eagle River. Based on conversations with drilling companies, the wells would likely be drilled using a combination of air rotary and cable tool rigs. For the purpose of this CIP it is assumed that water would be pumped to the existing water treatment plant site for treatment and distribution. It is assumed that the wells would be drilled on the western bank of the Eagle River, see **Figure 4**.

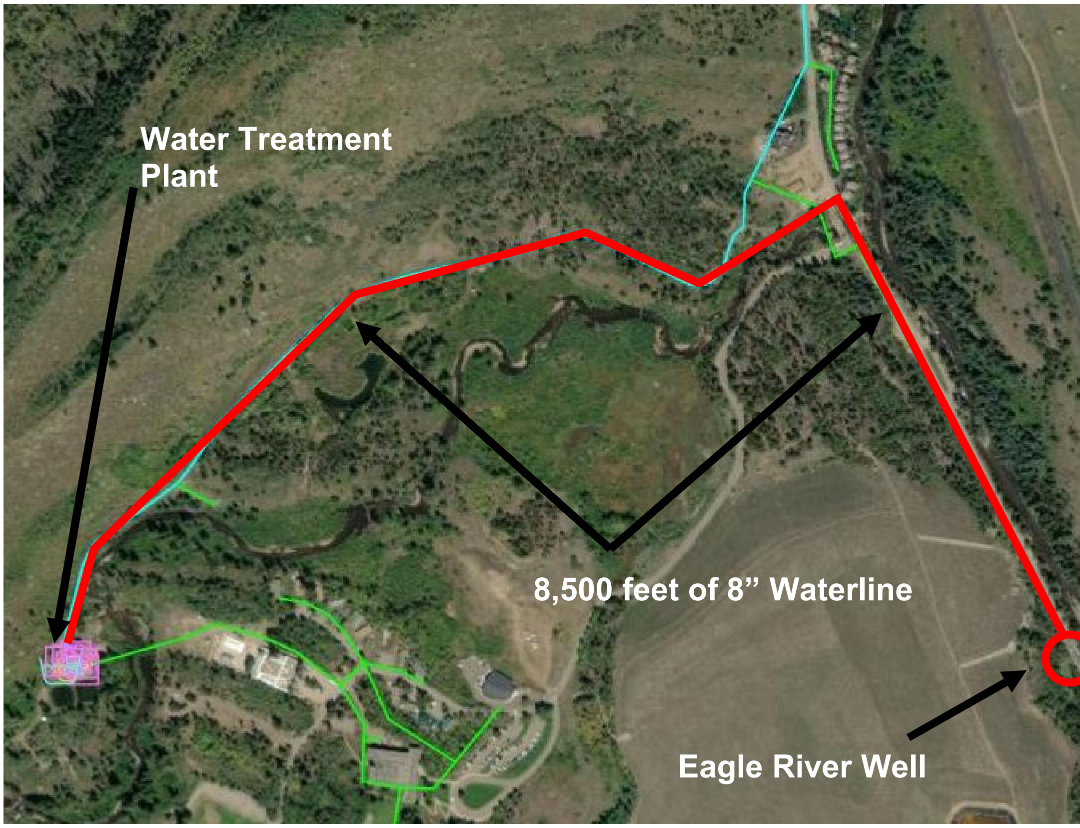


Figure 4 - Eagle River Wells and Pipeline

Table 7 Raw Water System Improvements Summary

Project	Purpose	Cost Est.
Raw Water Intake Improvements	Reduce O&M requirements and minimize sediment	$25K
Well 4 Pipeline Improvements	Come into compliance with CDPHE regulations and to fully utilize groundwater resources.	$230K
Eagle River Well Field and Pipeline	Provide additional water supply to support future growth and provide the Town with a redundant water supply	$5.2M

4.0 Water Treatment Plant Analysis

This chapter summarizes background, challenges and recommended projects associated with the Town's Water Treatment Plant (WTP).

4.1 WTP Background Information

4.1.1 Existing Water Facilities

The existing WTP consists of and intake structure off of Cross Creek, two groundwater wells (Well 3 and 4), three slow sand filters (filters 1 and 2 are located outdoors and filter 3 is indoors), a 25,000 gallon clearwell, sodium hypochlorite disinfection system and distribution pumps that deliver treated water to the Town and Maloit Park. All three filters discharge to a common clearwell through separate pipes. Sodium hypocholorite is dosed into the clearwell for disinfection.

Well 3 discharges directly to the clearwell. Well 4 feeds directly into the distribution line between the WTP and the Town. Well 4 is disinfected by sodium hypochlorite at the well pump, however, CDPHE has determined the piping configuration does not meet current regulations with regard to disinfection credits and has been categorized as an emergency supply. Well 4 cannot discharge into distribution system as currently operated unless under emergency conditions.

There are two separate distribution systems, Town Service Area and Maloit Park Service Area, that are fed from the clearwell. These systems have separate pumps, tanks and distribution pipelines.

4.1.2 Existing WTP Unit Processes

<u>Filtration</u>
Based on existing drawings titled "Water Treatment Plant Filter Addition," dated 1991, and discussions with Minturn staff, the filters consist of the following (note that the filters have not been deconstructed, rebuilt or rehabilitated since 1991 to allow for field verification):

- All filters have perforated PVC underdrain laterals supported in a 1 foot gravel layer.
  - Filters 1 and 2 laterals are 6"-diameter and spaced every 6 feet. The size and spacing of the perforations is unknown.
  - Filter 3 laterals are 4"-diameter and spaced every 5.5 ft. The size and spacing of the perforations is unknown.
- A geotextile fabric is provided above the gravel/laterals.
  - Filters 1 and 2 have a single layer of fabric.
  - Filter 3 has two layers of fabric with 2-inch of coarse sand between the fabrics.
- Approximately 3 to 3.5 feet of sand is provided above the collection laterals.
  - Filter 3 has a geotextile fabric between the sand layers at approximately 2 feet above the laterals.
- All filters have an overflow which sets the depth of water above the top of sand.
  - Water depth in Filters 1 and 2 is approximately 5.0 feet.
  - Water depth in Filter 3 is approximately 5.6 feet.

- Existing drawings and documentation do not provide the specifications for the gravel or filter sand. However, staff replaces sand that is removed during cleaning operations and this sand has an effective size (ES) of 0.15 to 0.3 mm and a uniformity coefficient (UC) of 3.0. These specifications meet the CDPHE criteria for sand.

The configuration of Minturn's slow sand filters generally follows accepted design practices in published design guides and literature. This includes the depth of the sand and height of water above the sand, both of which are critical components.

Filters 1 and 2 are located outdoors and are excavated into the existing ground. The filters are trapezoidal in cross section with 3:1 side slopes (horizontal:vertical). The various layers in the filters have different plan areas:

- Bottom of sand layer is 42 ft x 42 ft (1,764 sf)
- Top of the sand layer is 60 ft x 60 ft (3,600 sf)

Filter 3 is indoors and within a concrete basin. The concrete basin is 80 feet long and 40 feet wide (3,200 sf); all layers in the filter have the same area.

CDPHE design guidelines limit the maximum allowable filtration rate to 0.1 gpm/sf. **Table 5** shows that current hydraulic loadings for the existing filters are well below this maximum. Note that the CDPHE maximum loading rate does not imply that all slow sand filters can be operated successfully at that rate. It is an upper bound above which CDPHE believes the technology's application would create an unacceptably high risk to public health based on its inherent limitations.

Table 8 Slow Sand Filter Hydraulic Loading Rates

Filt. No.	Filter Area (ft^2)[1]	Filter Area (ft)[2]	Current Loading Rate (GPM/sf)[1]	Current Loading Rate (GPM/sf)[2]	Max. Loading Rate (GPM/sf)[3]	Current Flow-rate (GPM)[1]	Max. Allowed Flowrate (GPM)[3]
1	3,600	1,764	0.0167	0.034	0.1	60	360
2	3,600	1,764	0.0167	0.034	0.1	60	360
3	3,200	3,200	0.018	0.018	0.1	60	320
		Total Slow Sand Filter Capacity				180	1,040

1. Area based on top of sand layer
2. Area based on the bottom of sand layer
3. CDPHE Design Criteria for Potable Water. Water Quality Control Division. 2013.

Disinfection

Disinfection is achieved using hypochlorite to maintain a residual at the point of entry. Water from the filters and Well 3 discharged to the clearwell where chlorine is added. The clearwell is 25,000 gallons and does not have any baffling and therefore has a baffle factor of 0.1. The configuration and the size of the clearwell is not sufficient to achieve the required 1-log Giardia inactivation and 2-log virus inactivation. To achieve the required inactivation, the transmission pipelines and batching has been employed, further discussed below.

Town Service Area
The Town Service Area achieves the required disinfection requirements through the clearwell and the transmission pipeline. However, as described above, Well 4 is not able to operate due to lack of disinfection compliance.

Maloit Service Area
The Maloit Service Area cannot meet inactivation requirements using the clearwell and transmission pipeline due to contact time. In order to meet disinfection, water is “batched” in the clearwell. The clearwell is filled with filtered water and dosed with hypochlorite and held for the requirement time to achieve the required inactivation.

4.2 WTP Improvements

The slow sand filtration has served the Town well for many years, however, there are several factors and indicators that suggest this technology is not sustainable to reliably produce high quality drinking water to meet CDPHE regulations and future growth. However, it is clear that the following contributing factors warrant that the Town make significant improvements to the WTP to ensure efficient, manageable operations and reliable regulatory compliance.

- Water Quality Challenges are present during spring runoff with elevated turbidity levels in Cross Creek. The existing slow sand plant struggles to meet the permit turbidity limits during high turbidity events seen in spring runoff and the Town has had to shut down the slow sand filter plant and utilize the wells during runoff. This has been workable for the current demand but severely limits the ability of the Town to serve additional demand.
- Seasonal Operating conditions can have a significant impact on the operations, required maintenance and performance of slow sand filters. These impacts are generally more acute than for more highly engineered filtration systems and must be considered when evaluating the future use of these filters to serve the Town.
    - Winter- The outdoor filters can potentially freeze, potentially prohibiting their use for water production during the winter months. Ideally, outdoor filters should be drained and taken offline during winter to prevent ice from damaging the underdrain piping and/or disturbing the sand bed. CDPHE recommends that outdoor sand filters be enclosed.
    - The biological action of the filters, which is the key to their filtration performance, is reduced with low water temperatures. Operating at a slower filtration rate can help to counteract the effects of lower water temperature.
    - Spring - Spring runoff conditions often generate higher turbidity raw water, which typically yields shorter filter run times. Historically, Minturn has not seen turbidities greater than 5 NTU, or so, in water from Cross Creek. That said, spring runoff conditions are still the most challenging and they are concurrent with the start of the high water demand season in Minturn. Additionally, if water sources to the WTP are changed, or if there are disruptions to the Cross Creek watershed, such as a forest fire, spring runoff conditions may become more challenging in the future.
    - The filtration plant will need to be operating at peak flows during peak demand season, which occurs during the summer months. Plant operations will need to be carefully planned to ensure that the filters are cleaned and fully operational

prior to peak demand. When one of the Town's slow sand filters reaches the end of its filter run, drying, cleaning, and ripening, can require that the filter be off-line for 4+ weeks. This leaves the Town without a critical production source.

- As described in Section 3.1.2, the amount of water that the filters can produce is less than observed in other slow sand filter plants and the maximum permitted limit. The reasons for the low production is not known but could be due to blockage or clogging within the filter and it is possible the production rate may continue to fall without significant rehabilitation.
- Meeting regulatory requirements will continue to be challenging and will likely become more stringent in the future. Multiple tests are being conducted in 2019 to determine the ability and extent of the slow sand filters to produce water. While preliminary results suggest the filters are performing well, future performance will need to be validated and it is likely additional water quality testing will be necessary.

4.2.1 WTP Process Upgrade Alternatives Summary

In order to address changes to influent water quality at the WTP, a planning-level analysis was conducted to evaluate potential alternatives. The alternatives are summarized as follows:

Alternative 1. Filter Rehabilitation and Upgrades

Filter rehabilitation would entail completely removing and replacing all media, filter underdrain piping and the liner. Rehabilitation would attempt to address the low production rate and address regulatory and water quality challenges. However, rehabilitation does not guarantee that the filter issues are resolved. Slow sand filters are not mechanical, rather they are biological and there are significant risks that rehabilitation will not solve the issues and may lead to the filters not performing as designed which has been observed with other slow sand filter rehabilitations in Colorado.

CDPHE design criteria states the filters are to be indoors and while CDPHE has stated that they won't require them to be enclosed, there is a possibility that they will be required in the future. The large footprint associated with slow sand filters limit the ability to expand production in the future.

Alternative 2. Filter Replacement (Membrane Filters)

Membranes represent state-of-the-art filtration technology, are highly automated, and offer robust treatment and can handle a wide range of influent water quality conditions. Membranes have a small footprint which would fit within the existing plant site. Membranes are skid mounted and are module based therefore the capacity can be expanded easily. The systems are generally automated which simplify operation compared to conventional water filtration treatment plant.

It is assumed that existing clearwell would be repaired and kept in service as well as the Town and Maloit Park service pumps. The existing outdoor filters would be abandoned, and a new engineered metal building would be constructed in the footprint of one of the outdoor filters. The other filter would be repurposed to serve as the backwash holding pond for the membrane waste.

This analysis evaluated MEMCOR CPII low-pressure membrane ultrafiltration System. Two membrane trains, 1 duty and one standby, would be installed. Each train would house a 24 L40N membrane module capable of treating approximately 450 GPM.

Based on this information, SGM recommends that the Town pursue Alternative 2 – membrane filters. Given the costs and the risks of filter rehabilitation, the ability of membranes to manage a wide range of variable raw water parameters and the ability to easily expand plant capacity membranes are the most reliable technology to produce water for current and future conditions.

4.2.2 Clearwell Repairs

Existing clearwell has settled and groundwater is seeping in at pipe penetrations and at cracks in the concrete walls. Repairs to the existing clearwell are necessary to repair spalling concrete in the basin and repairs to ensure the clearwell is water tight. The interior of the clearwell should be repaired and recoated.

4.2.3 Water Treatment Plant Improvements Summary

Table 9 presents a summary of the water treatment plant improvement recommendations identified in this chapter.

Table 9 Water Treatment Plant Improvements Summary

Project	Purpose	Cost Est.
Construct new membrane filter plant	Improve the reliability of the water plant to deliver the quality and quantity of water needed for current and future growth	$3.8M
Construct new water plant building	New building to house membrane filtration equipment	$475K
Repairs and Modifications to the clearwell	Clearwell is cracked and needs repairs to extend the service life of the structure. The piping and controls need to be upgraded to improve the operations	$250K

5.0 Water Distribution System Analysis

Minturn maintains over 7 miles of potable water distribution piping, 2 water storage tanks, and 1 PRV station.

This chapter documents the capital improvements related to the water distribution system. Included in each improvement category is a description of the analysis criteria, assumptions and methodology used to develop recommendations.

5.1 Water Storage

Minturn maintains 2 water storage tanks (Minturn and Maloit Park tanks) and 708,000 gallons of combined stored water. The following summarizes the analysis and recommendations associated with water storage.

5.1.1 Minturn Water Tank Inspection and Evaluation

A dive inspection by Marine Diving Solutions was performed on October 3, 2015 and SGM performed an in-service floating inspection on May 7, 2019. The result of the inspection was that the existing Minturn Tank is near the end of its useful like and either significant rehabilitation or replacement is necessary. It is our recommendation to plan for a replacement of the tank as rehabilitation is a short term fix and deterioration will continue. Replacement analysis and options are presented in Section 5.1.2.

5.1.2 Evaluation of Tank Replacement Options

SGM evaluated three types of tanks: bolted steel tanks, welded steel tanks and concrete tanks.

Bolted Steel Tank

A factory-coated bolted carbon steel tank for water storage meeting the requirements of American Water Works Association (AWWA) D103.

A bolted steel water storage tank is composed of rolled steel tank panels connected at the lap joint by a bolted connection. A row of bolts, along with gasket material and sealant are used to seal each horizontal and vertical lap joint. The capacity of a bolted steel tank can be as large as 8 million gallons and typically includes an aluminum geodesic dome roof and a concrete foundation. Bolted tanks are typically factory coated for an ideal coating and curing environment, then transported and erected in the field.

Welded Steel Tank

A welded steel tank for water storage meeting the requirements of AWWA D100.

Similar to a bolted steel tank, a welded steel tank is composed of rolled carbon steel sheets or panels connected together by lap or butt-jointed welds. Due to the high strength of a welded connection, welded steel tanks are constructed to capacities up to 25 million gallons. Larger capacity welded steel tanks require roof framing members to support lateral and vertical loads. Typical foundation types include a concrete ringwall or deep foundation.

Concrete Tank

There are three design and construction methods for concrete tanks which include conventionally reinforced meeting the requirements of American Concrete Institute (ACI) 350, Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks meeting the requirements of AWWA D110, and Tendon-Prestressed Concrete Water Tanks meeting the requirements of AWWA D115. Conventionally reinforced concrete tanks are typically designed for capacities less than 250,000-gallon capacities.

<u>AWWA D110, Type III Strand-Wound, Prestressed Concrete Tank</u>
D110 Type III tanks are constructed with a continuous steel diaphragm which is permanently embedded in the finished tank wall. The diaphragm acts as a water barrier within the tank wall, providing assurance of water tightness. The tanks are constructed with bonded wire prestressing applied to the exterior wall, providing multiple layers of continuous prestressing. These tanks are typically constructed with a free-standing concrete spherical dome roof eliminating the needs for internal columns and roof framing. Wall and roof sections are cast-in-place in “casting beds” and erected similar to tilt-up construction prior to installation of the bonded wire prestressing. Shotcrete is applied to the bonded wire for protection and an aesthetic finish.

<u>AWWA D115 Tendon- Prestressed Concrete Tank</u>
D115 tanks do not utilize a steel diaphragm within the wall, instead waterstop materials are installed at all joints to provide a water-tight tank. Tendons are placed internal to the tank wall, which is threaded through a plastic duct and hydraulically jacked. Corrosion protection is applied by injecting grout into the plastic duct. D115 tanks are typically constructed with a column-supported, moderately sloped roof.

Advantages and Disadvantages

There are advantages and disadvantages applicable to all tank construction methods. A few of each are summarized in the table below. It is SGM’s opinion the greatest disadvantage with bolted and steel tanks are the continual maintenance required throughout the life-span of the tank. Concrete tanks require very little maintenance in comparison. All construction methods have challenges related to weather. Welding and coating operations are highly affected by low temperatures and moisture. Similarly, there are challenges with on-site pre-casting of concrete panels in inclement weather.

Table 10 Tank Advantages and Disadvantages

Tank Type	Advantages	Disadvantages
Bolted Steel (AWWA D103)	Lowest capital cost	Anticipated 30- to 45-year life-span
	Reduced construction duration from factory applied coatings and quick field erection	Gaskets and sealants at bolted connections deteriorate over time; very difficult to replace and maintain
	Aluminum dome roof as a design option allows for elimination of roof framing	Very difficult to recoat
	Tanks are typically designed by the in-house tank fabrication engineer utilizing modeling software	Poor construction
		Multiple contractors needed for site work, pipeline installation and foundation construction
Welded Steel (AWWA D100)	Full replacement tank designed to current regulations and codes	Steel tariffs have increased the price of steel; steel tanks are no longer as affordable as in previous years
	Numerous qualified steel fabrication and construction companies in the industry which improves competitive pricing	Requires interior and exterior surface preparation and recoating every 15 years for life of the tank
	Full penetration welding for water-tightness	Anticipated 75-year life span; requires maintenance beyond typical sandblasting and recoating, i.e., floor plate scanning and repairs, pitting repairs and roof framing repairs and replacement
	Exterior color selection available to camouflage with surroundings	Susceptible to corrosion for life of the tank
		Dome roof is not likely an option of the size of the tank; significant roof framing required to support vertical and horizontal loads which become cumbersome for maintenance and cleaning
		Additional expense associated with internal, external and below floor plate cathodic protection
		Longer construction duration for fabrication, erection, and field coating
		Inclement weather can affect welding and coating processes
Concrete Tank AWWA D110 Wire-Wound Tank	100-year life-span; minimal maintenance required	Specialized design and construction; Preload and DN Tanks are industry leaders which reduces competitiveness in the market, i.e., limited contractors in the industry compared to steel tanks
	Improved insulation; can be buried	Longer construction duration needed for casting of wall and roof panels and cure time
	Dome roof eliminates roof framing and internal columns; improves ease of cleaning	Some spall and crack repair may be needed during life of the tank
	Watertight steel diaphragm within the wall	
	Streamlined construction	

	process, i.e., simultaneous construction of the tank walls and floor	
	Concrete can be colored, and/or architectural finishes can be used for aesthetics	
Concrete Tank AWWA D115 Tendon Prestressed Tank	100-year life-span; minimal maintenance required	Specialized design and construction; D115 tanks are typically designed by a structural engineer, constructed by a general contractor and post-tensioned by a specialty contractor
	Watertight joints provided by internal waterstop material and joint sealant	Joints may require rehabilitation during life-span
	Improved insulation; can be buried	
	Concrete can be colored, and/or architectural finishes can be used for aesthetics	

New Construction Costs

The table below summarizes anticipated tank construction costs for a 0.60 MG tank, which are applicable to the tank construction only and exclude all items typical to the site which include access, foundation, site piping, site security. All appurtenances associated with the tank such as vents, access hatches, handrail, and ladders are included in the tank construction cost.

Table 11 Tank Unit Costs

Bolted Steel Tank	Welded Steel Tank	Prestressed Concrete Tank
~$1.05/gallon	~$1.20/gallon	~$1.45/gallon

Life Cycle Analysis

While bolted steel tanks may be the most cost effective for initial capital costs, the life-span of a bolted tank is not comparable to a welded steel or concrete tank primarily due to the need to replace the tank based on the useful life of the tank.

Bolted Steel Tank Maintenance

As seen in the existing bolted steel tank, the gasket and sealant materials have deteriorated at the bolted connections causing a number of leaks. Numerous repairs have been performed on the tank by underwater dive teams. To properly rehabilitate a bolted steel tank, the gasket and sealant materials should be replaced during recoating operations which can be a significant undertaking.

Maintenance costs for a bolted steel tank are extremely difficult to estimate as it is challenging to estimate the rate of corrosion at joints and bolts, required relining/coating for corrosion protection and replacement of gaskets. It is also extremely difficult to estimate the extent of the rehabilitation as each tank tends to be somewhat unique. For this analysis, it is assumed that the tank will need to be replaced every 45 years and that the gaskets and the interior liner needs to be replaced once before the lifespan of the tank expires. We have assumed that this effort is approximately $200,000 per repair event.

Welded Steel Tank Maintenance

A welded steel tank will need to be taken offline approximately every 15 years throughout the life of the tank to replace the internal and external coating system and perform steel pitting repairs and potentially roof framing repairs and/or replacement. Anticipating a 75-year life of a welded steel tank and maintenance scheduled every 15 years, the table below summarizes the anticipated costs associated with steel tank maintenance and are listed for the 0.60 MG tank. Traditionally construction costs would be escalated when projecting; however, for simplicity, recoating costs are recorded the same for each maintenance cycle. Applicable to both steel and concrete tanks, the Town is required to inspect and clean their tanks every 5 years per the requirements of Colorado's Primary Drinking Water Rule. These costs are applicable to either construction method and are therefore excluded from the lifecycle analysis.

Table 12 Welded Tank Maintenance Costs

0.60 MG Steel Tank Maintenance Schedule and Costs			
Year	**Maintenance Scheduled**	**Total Price**	Total 1st Maintenance Cycle Cost **$380,100**
15	Full abrasive blast and re-application of interior coating	$187,000	
15	Full abrasive blast and re-application of exterior coating	$175,000	
15	Engineering / Inspection Cost (estimated as 5%)	$18,100	
Year	**Maintenance Scheduled**	**Total Price**	Total 2nd Maintenance Cycle Cost **$401,100**
30	Full abrasive blast and re-application of interior coating	$187,000	
30	Full abrasive blast and re-application of exterior coating	$175,000	
30	Magnetic Flux Leakage (MFL scan) of floor plate	$15,000	
30	Floor plate repairs	$5,000	
30	Engineering / Inspection Cost (estimated as 5%)	$19,100	
Year	**Maintenance Scheduled**	**Total Price**	Total 3rd Maintenance Cycle Cost **$456,750**
45	Full abrasive blast and re-application of interior coating	$187,000	
45	Full abrasive blast and re-application of exterior coating	$175,000	
45	Magnetic Flux Leakage (MFL scan) of floor plate	$15,000	
45	Floor plate repairs	$8,000	
45	Roof framing repairs	$50,000	
45	Engineering / Inspection Cost (estimated as 5%)	$21,750	
Year	**Maintenance Scheduled**	**Total Price**	Total 4th Maintenance

60	Full abrasive blast and re-application of interior coating	$187,000	Cycle Cost **$401,100**
60	Full abrasive blast and re-application of exterior coating	$175,000	
60	Magnetic Flux Leakage (MFL scan) of floor plate	$15,000	
60	Floor plate repairs	$5,000	
60	Engineering / Inspection Cost (estimated as 5%)	$19,100	
75	Tank Replacement		
		Total Life Cycle Maintenance Cost	**$1,639,050**

Concrete Tank Maintenance
Little to no maintenance is required for AWWA D110/D115 tanks; however, concrete tanks should be inspected routinely following initial construction. Inspections should include examination of the surfaces to locate signs of possible deterioration or corrosion, including rust stains, efflorescence, cracks or leaks. The below table estimates the maintenance costs associated with a pre-stressed concrete tank.

Table 13 Concrete Tank Maintenance Costs

Concrete Tank Maintenance Schedule and Costs			
Year	**Maintenance Scheduled**	**Total Price**	Total 1st Maintenance Cycle Cost **$84,000**
30	Minor crack and concrete spall repair	$75,000	
30	Replacement gaskets and bolts on shell manways and roof access hatches; replacement vent screening	$5,000	
30	Engineering / Inspection Cost (estimated as 5%)	$4,000	
Year	**Maintenance Scheduled**	**Total Price**	Total 2nd Maintenance Cycle Cost **$141,750**
60	Crack and concrete spall repair	$75,000	
60	Replacement gaskets and bolts on shell manways and roof access hatches; replacement vent screening	$5,000	
60	Replacement anchorage for exterior and interior ladders and roof handrail	$5,000	
60	Exterior shotcrete repairs	$50,000	
60	Engineering / Inspection Cost (estimated as 5%)	$6,750	
Year	**Maintenance Scheduled**	**Total Price**	Total 3rd Maintenance Cycle Cost **$186,375**
90	Crack and concrete spall repair	$75,000	
90	Replacement roof access hatches and	$30,000	

	roof vents		
90	Replacement exterior and interior ladders	$20,000	
90	Replacement shell manway gaskets and bolts	$2,500	
90	Exterior shotcrete repairs	$50,000	
90	Engineering / Inspection Cost (estimated as 5%)	$8,875	
100	Tank Replacement		
		Total Life Cycle Maintenance Cost	**$412,125**

The tables above show the costs to maintain a steel tank can far exceed the cost of a prestressed concrete tank.

Cost Summary

It is assumed that a new bolted steel tank will be replaced at year 45, and a new welded steel tank will be replaced at year 75. When the tank is at the end of the design life (every 45 years for a steel bolted tank, 75 years for a welded steel tank), the replacement cost is the present day tank cost with an assumed 1.5% yearly inflation – the replacement costs shown are future costs.

The lifecycle maintenance costs summarized in the tables above are added to the initial capital cost associated with the construction of a bolted steel, welded steel or concrete tank. The following table summarizes the 100-year lifecycle costs for different asset lifespans. It is important to note, the replacement costs listed are for the tank only.

Table 14 Tank Lifecycle Costs

100-Year Lifecycle Cost Summary			
Cost Analysis over 100-Year Lifecycle	**Bolted Steel Tank**	**Welded Steel Tank**	**Prestressed Concrete Tank**
New Construction	$627,000	$720,000	$870,000
Replacement of Bolted Steel at Tank- Age 45	$1,230,000	N/A	N/A
Replacement of Welded Steel Tank - Age 75	N/A	$2,000,000	N/A
Replacement of Bolted Steel at Tank - Age 90	$2,500,000	N/A	N/A
Maintenance Costs	$600,000	$1,639,050	$412,215
Total Cost	**$4,957,000**	**$3,223,450**	**$1,282,215**

SGM recommends the Town consider prestressed concrete tanks for the future replacement of the existing 0.60 MG tank and the Maliot Tank. SGM recommends performing a tank selection study and perform preliminary design to analyze an AWWA D110 vs D115 pre-stressed concrete tank and perform a constructability review to address operational needs based on ability to construct a new tank concurrent with the existing operational tank or removing the existing tank from operation during construction and supporting the system needs with by-pass piping.

5.1.3 Water Storage Analysis – Volume

5.1.3.1 Water Storage Volume Analysis Criteria

SGM evaluated water storage using the concept of “tank service area.” A tank’s service area is defined as the pressure zone on which the tank floats plus the pressure zones below if those lower zones do not have storage.

Sufficient water storage capacity should be prepared for industry-standard criteria which are determined using the volume components of demand equalization, emergency supply and fire suppression. A description of these components is as follows:

- *Equalization storage* – the volume needed to meet the instantaneous water demands in the area served by a given tank (or tanks) that occur at a rate which is greater than the capacity of available water production and pumping facilities serving that area. The difference in instantaneous water demand and delivery capacity is typically calculated as peak hour demand (PHD) less maximum day demand (MDD) since production and pumping systems are often designed with a firm capacity that meets MDD. In this study, the duration of this event is taken as 6 hours. Since PHD is often calculated as two times MDD, the target *equalization volume was set to 25% of MDD*.

- *Emergency storage* - the volume needed to meet water demands during emergency conditions or a planned maintenance activity, which reduces or eliminates the ability to deliver water to an area served by a given tank (or tanks). Such an event might include:
  - a power outage
  - a mechanical failure of a production/pumping facility
  - a break on a critical water transmission line
  - preventative maintenance activities on a production/pumping facility or critical water transmission line

  Recommendations for emergency storage volume vary. Appropriate emergency storage is site-specific because it involves balancing risk, costs, and water age. The most often cited recommendations for emergency storage volume are to meet either ADD or MDD conditions for a 24-hour period. In order to minimize water age and chlorine residual decay, SGM will target *an emergency storage volume equal to ADD*.

- *Fire storage* – the volume required to meet the controlling firefighting needs in the area served by a given tank (or tanks). For this water system, SGM met with Mick Woodworth of the Eagle River Fire Protection District (ERFPD) on June 5, 2019. Mr. Woodworth indicated that fire flow needs for Minturn would follow the International Fire Code (IFC) - latest edition; Minturn’s code matches the IFC. For fire storage requirements, target fire flows are multiplied by duration, estimated using Appendix B of the 2017 International Fire Code (IFC). Fire storage volumes assume that only one fire event occurs at a time in the service area of a tank (or tanks).

5.1.3.2 Water Storage Volume Analysis Results and Recommendations – System Wide

Table 15 summarizes the current water storage capacities versus calculated storage needs. **Table 16** provides the same information under anticipated future demand conditions. **Table 17** Fire Flow Required by Zone outlines the fire flow requirements for each tank zone.

As shown in **Table 15**, the storage requirements vary depending on which growth option is used. However, as detailed in section 4.1, the Minturn Tank should be replaced due to structural and leakage concerns.

Table 15 Existing Water Storage Analysis

	Storage Required for Current Conditions				
Tank (Capacity, Gal)	**Emergency (Gal)**	**Equalization (Gal)**	**FireFlow (Gal)**	**Total (Gal)**	**Deficit**
Minturn Tank **(600,000)**	150,000	83,000	270,000	503,000	**0**
Maloit Park Tank **(108,000)**	5,000	6,000	270,000	281,000	**173,000**

Table 16 Future Water Storage Analysis

	Tank (Capacity, Gal)	Emergency (Gal)	Equalization (Gal)	FireFlow (Gal)	Total (Gal)	Deficit
Option 1	Minturn Tank **(600,000)**	198,000	109,000	270,000	577,000	**0**
	Maloit Park Tank **(108,000)**	38,000	22,000	270,000	330,000	**222,000**
Option 2	Minturn Tank **(600,000)**	228,000	126,000	270,000	624,000	**24,000**
	Maloit Park Tank **(108,000)**	89,000	51,000	270,000	410,000	**302,000**

Table 17 Fire Flow Required by Zone

Service Area	Maximum Fire Flow Location	Max. Fire Flow Required (GPM)	Duration (Hours)	Volume (MG)
Town	Entire Service Area	2,250	2	0.27
Maloit Park	Entire Service Area	2,250	2	0.27

5.2 Fire Flow Delivery

5.2.1 Fire Flow Analysis Criteria

Fire flow delivery is the ability of the system to transmit target fire flows under conservative operational and demand conditions. For this evaluation these conditions are:

- Demand condition: MDD
- Minimum tank levels: 5 feet

The recently created water distribution system model was used to predict fire flow delivery throughout the system. Adequate fire flow delivery through firefighting equipment depends on maintaining residual pressure at the local fire hydrant. Furthermore, when large fire flow rates are pulled from the system, pressures drop zone-wide. Maintaining a minimum pressure throughout the distribution system is critical to keep positive pressure and eliminate potential contaminant intrusion. These two considerations lead to the following two pressure criteria, which constrain the maximum available fire flow in a given area:

- Minimum residual pressure at flowing hydrants: 20 PSI
- Minimum pressure elsewhere in the system: 20 PSI

5.2.2 Fire Flow Results and Recommendations

Simulation results indicate that 83% of nodes meet the required fireflow target of 2,250 gpm under current maximum day demand conditions. The percentage decreases for Options 2 and 3, decreasing to around 71%. Critical nodes with the lowest available fireflow are located at the end of Taylor Street, near Cross Creek Road, and throughout the lower portions of Maloit Park. Fireflow deficit in these areas can be mitigated by implementing the following improvements:

- *Taylor Street:* Install a new pipeline under 4th Avenue or 4th Street which ties into the proposed 12" line to Dowd Junction (if the interconnect is built) or extend the existing waterline from Taylor St/Minturn Rd to 4th St (See **Figure 5**). This loop would reduce hydraulic resistance between Minturn's primary storage tank and Taylor street, increasing available fire flow.
- *Cross Creek Road:* Install a PRV station near the intersection of Cross Creek Road and Highway 24 which provides water from the Maloit Park pressure zone via the new Maloit Park Tank.
  - Installing a PRV station would only be beneficial if distribution piping in Maloit Park were upsized or looped to facilitate delivery of fireflow.
  - Installing a PRV near Cross Creek Road could provide a redundant pathway for delivering finished water to the Town Zone. It would possibly reduce the Town's storage requirements by allowing emergency storage to be provided from multiple Tanks.

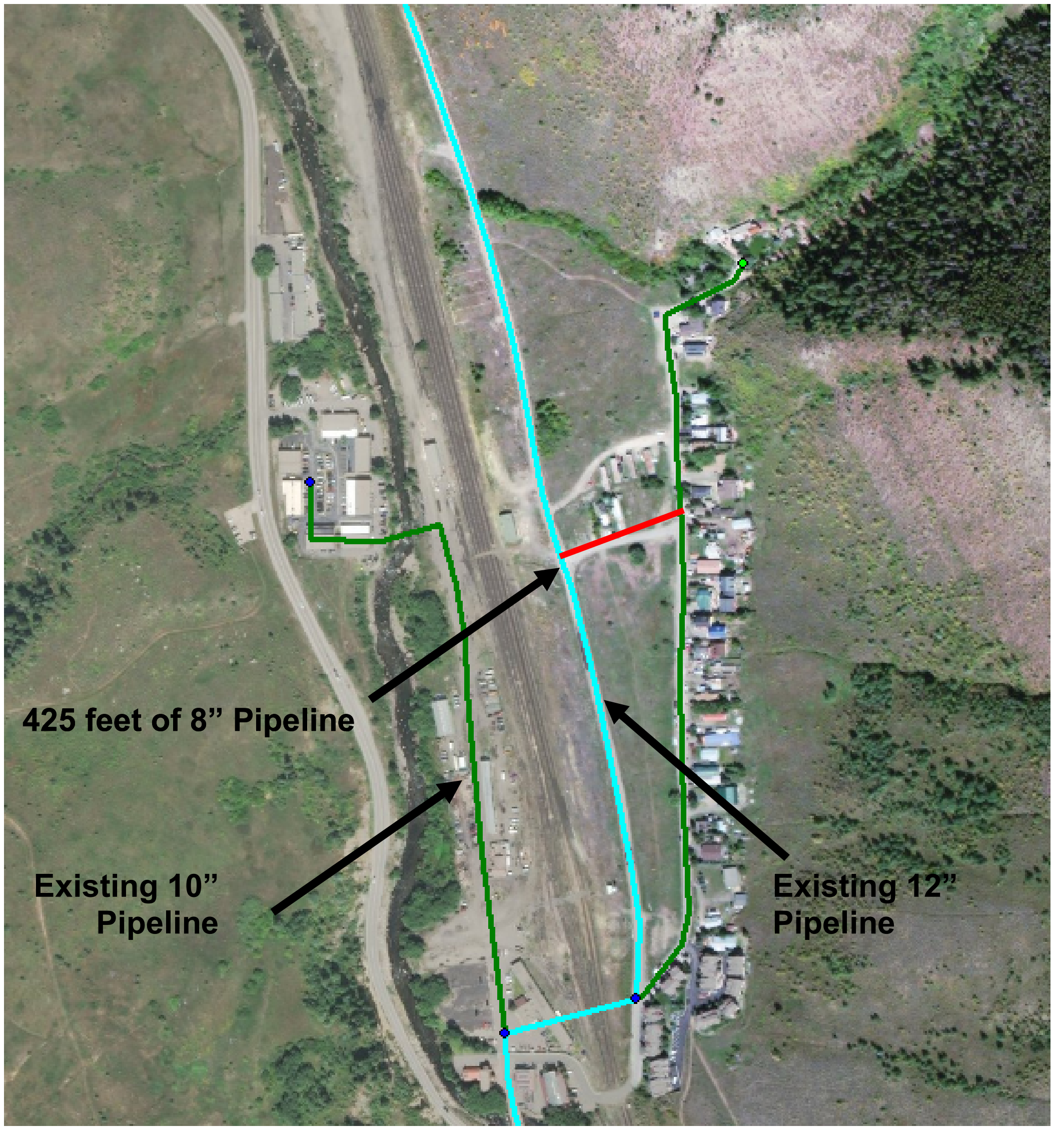


Figure 5 - 4th Avenue Loop Line

5.3 Velocity

5.3.1 Velocity Analysis Criteria

High flow velocity in pipes is undesirable because it (1) increases the potential magnitude of pressure transients, which can increase the risk of contaminant introduction or infrastructure damage (2) increases head loss and required energy consumption and (3) causes stress and wear on fittings and connections, increasing the potential for leaks and main breaks.

Recommended maximum velocity is as follows:

- Maximum day demand conditions: Velocity < 5 FPS (ideal), 7FPS (maximum)
- Peak hour demand conditions: Velocity < 10 FPS

The recently created water distribution system model was used to predict velocity in pipes throughout the system. Velocity analysis was conducted under MDD conditions with pumps running.

5.3.2 Velocity Results and Recommendations

Flow velocities throughout the Town service area and Maloit service area are generally below recommended maximums for MDD and fireflow. The only instance where pipe velcities are outside the maximum reocmmendations are in the Maloit Park service area during fireflow events where they exceed the maximum by approximately 10% which does not impair the ability to delvier the quantity of water necessary druing a fire. Therefore, there are no projects proposed to mitigate velocity concerns.

5.4 Pressure

5.4.1 Pressure Analysis Criteria

Both insufficient and excessively high pressures within the distribution system are undesirable. Low operating pressures provide less protection against backflow, increasing the possibility of system contamination. Low service pressures also can lead to customer complaints, especially regarding domestic service pressure and proper irrigation system function. High pressures increase water use, water loss, energy consumption, buried infrastructure and pump wear, work hazards, and the risk of property damage. The benefits of system design using tight pressure ranges must be balanced against the associated infrastructure costs to create the pressure zone breaks. The appropriate design pressure range for a given system is often site-specific.

Colorado Department of Public Health and Environment (CDPHE)'s 2013 Design Criteria for Potable Water Systems indicate that:

> *"The system must be designed to maintain a minimum pressure of 20 PSI at ground level at all points in the distribution system under all conditions of flow. The normal working pressure in the distribution system must be at least 35 PSI and should be approximately 60 to 80 PSI. Near storage tanks, the water main pressure will be less than the required pressures stated above. The Department expects water systems to mitigate the low pressure around storage tanks and to minimize the amount of distribution main impacted."*

SGM recommends the following normal working pressure range:

Minimum: 20 PSI
Maximum: 120 PSI

5.4.2 Pressure Analysis Results and Recommendations

Modeling results indicate that operating pressures range between **32** and **110** psi under both current and future demand conditions. The only area which fails to meet the minimum recommended pressure criteria of 55 psi is near the intersection of Highway 24 and Cross Creek Road, which is the highest point in the Town service area. Considering that the elevation of this location limits the maximum service pressure to 33 psi, model results do not indicate a supply deficiency. Therefore, the existing distribution system is adequately sized to convey system demands under current and future operating conditions.

5.5 Redundancy

5.5.1 Redundancy Analysis Criteria

A water distribution system design should minimize the likelihood and duration of service interruptions to the extent practicable. The majority of taps should be able to receive water even during planned maintenance activities and unplanned repairs or equipment failures. The Town system was analyzed with consideration given to:

- Piping - Looping and parallel piping networks
- Water storage - Gravity water storage (versus pressure tanks) and ability to take tanks offline for maintenance
- Production - Multiple water production sources

A critical component of system redundancy is having a secondary water source to supply raw water if the primary source – which is Cross Creek is limited. The secondary water source has been identified as the Eagle River Wells as described in Section 3.3 of this report.

5.5.2 Redundancy Analysis Results and Recommendations

Piping –
As with all distribution systems, elimination of all dead-end lines is not feasible. Minimization of dead-end lines, however, should be the goal. The Minturn system generally has a well-looped network outside of the primary transmission mains. However, there are areas that are limited to water delivery by a single main. Those include the following:

- The north end of Town north is fed by a single 12-inch pipe that is exposed and runs across the Eagle River at Bellm Bridge. The pipe is at risk of scour or damage from the Eagle River. It is recommended that the line be replaced – or a parallel line be installed – to mitigate the potential of a failure of this waterline, see **Figure 6**. Waterline can be bored beneath the Eagle River, hung on the existing bridge or installed across the river with an aerial crossing.

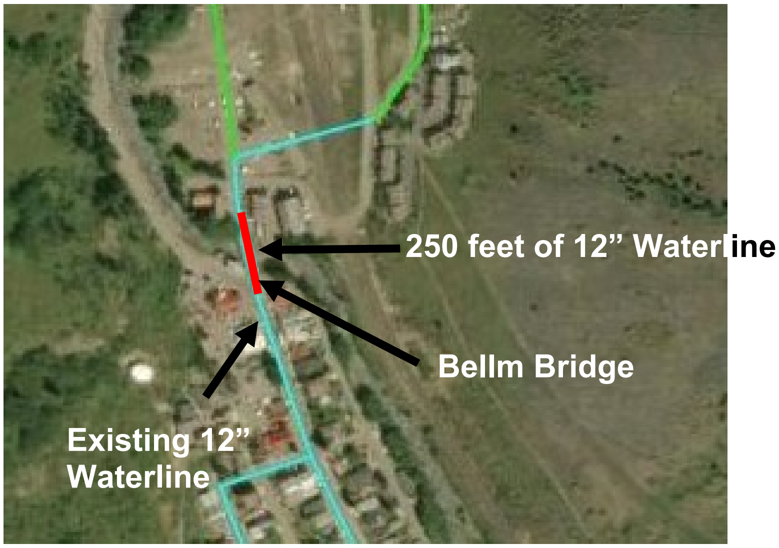


Figure 6 - Bellm Bridge Pipeline

Water Service Redundancy –
The Town and Maloit Park Service Areas are not connected and there needs to be a way to deliver water to either area if the primary feed is compromised. Additionally, water storage tanks should be drained for maintenance occasionally. However, single tank zones that are present in Minturn this can be challenging. SGM recommends:

- Interconnecting the Maloit Service Area and the Town Service area at approximately Cross Creek Drive and Highway 24 at a new PRV/BPS vault and installing a 12-inch line in Cross Creek Road to the Maloit Park service area, see **Figure 7**.
    - Recommend installing a 8-inch PRV with a 2-inch by-pass in parallel.
    - It is recommended that the vault has sufficient space to allow for pump connections to facilitate pumping water between the zones either by installing pumps in the vault or a portable pumping system.

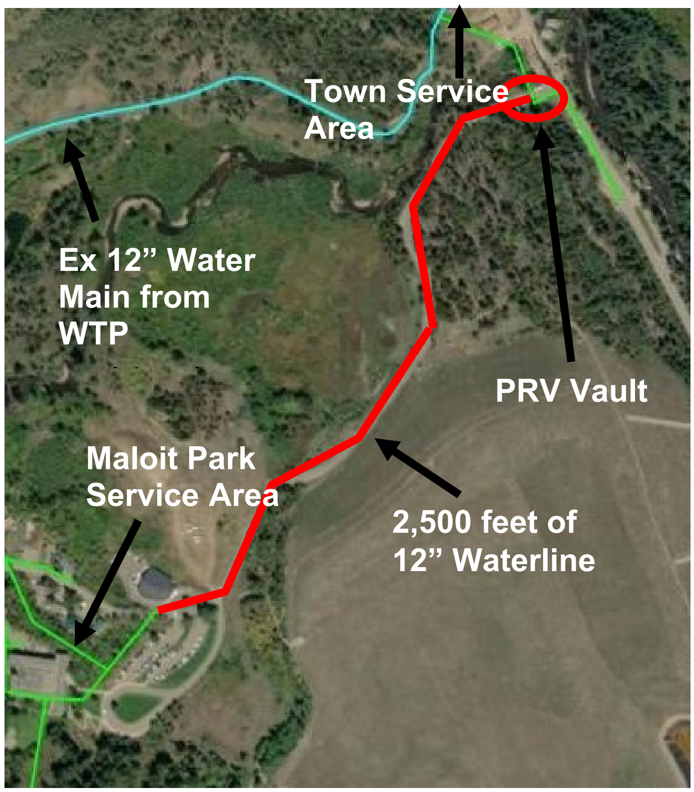


Figure 7 - Town and Maloit Park Service Area Interconnect

5.6 Water Loss Management

Water loss has been a persistent problem for the Town with water loss ranging from 30-60% which is well outside of the typical range of 10-15% for municipalities. While the Town has aggressively tracked and repaired leaks (and recent water loss figures suggests that these efforts have generally been successful), it is likely higher than normal water loss will persist. Generally, leaks have been located and repaired on service lines and not on the water mains. Furthermore, water meters on service lines have not been upgraded or calibrated and might be leaking or recording water used potentially incorrectly leading to a “paper water loss”. The following water loss management projects are recommended:

It is recommended that the Town utilize leak detection equipment to efficiently detect and locate leaks that are not observable from the surface. This will allow Town staff to find and repair leaks that would otherwise go undetected.

It is recommended that the Town initiate a water meter replacement program to upgrade the water meters to current technology.

5.7 Water Main Line Replacement

The majority of the Towns water mains are aging. The Town has not had a pipe replacement plan in place to systematically replace waterlines as they reach the end of their useful life. By delaying the replacement of aging infrastructure, there is risk of line breaks and disruptions to the system.

It is recommended that the Town establish a yearly replacement budget to be used to systematically replace aging pipes. This will help to address water leaks on the mains as new waterlines have very low permissible water loss. Additionally, the corporation stops and service lines to at least the curb stop would be replaced which would address leaks on this section of the system. It is recommended that the Town allocate $250,000 per year to fund the water main replacement plan.

5.8 Water Distribution System Improvements Summary

Table 18 summarizes the distribution system improvements detailed in the previous sections and provides a summary of the water system improvements recommended in this section.

Table 18 Water Distribution System Improvements Summary

Project	Purpose	Cost Est.
Maloit Park Tank	Address storage requirement needs	$1.67M
Minturn Tank	Address leaks and storage requirement needs	$1.55M
Bellm Bridge Waterline Replacement	Provide redundancy to the north part of Town	$570K
Maloit Park and Town Interconnect	Allow water to be moved between service areas	$1.31M
Leak Detection System	Locate leaks	$50K
Water Main Replacement Program	Replace aging watermains	$2.5M
Water Meter Replacement Program	Upgrade aging water meters	$250K

6.0 Recommended Improvements Summary

This chapter summarizes the recommended water system improvements identified in Chapters 2 through 5. The description of the development options are listed below.

- Option 1: Cross Creek Only – Under this option the Town would continue to rely solely on Cross Creek for its water supply.
- Option 2: Cross Creek plus Eagle River Wells – Under this option the Town would continue to utilize Cross Creek water and also develop additional water resources on the Eagle River through a well field. This option includes moderate growth.

Table 19 Recommended Water System Improvements – Option 1

Projects	Category	Description	Cost
		1 TO 3 YEAR TIME HORIZON	
Construct a new Minturn Tank	Tank	Replace existing Minturn Tank with a 600,000 gallon tank	$ 1,600,000
Construct new Maloit Park Tank	Tank	Construct a new 250,000 gallon concrete water tank on the existing tank site. Project would include the demolition of the existing tank.	$ 900,000
Connect Well 4 to existing clearwell	Treatment	Construct approximately 900 feet of 4" pipe from Well 4 to the existing clearwell	$ 230,000
Systematic Waterline Replacement Program	Pipeline	Systematic replacement of the Town's waterlines	$ 2,500,000
Invest/Install leak detection system	O&M	Implement a leak detection system	$ 50,000
Develop a Town GIS system	O&M	Create a comprehensive GIS mapping system of the Town's water and public infrastructure	$ 15,000
Water Meter Replacment Program	O&M	Replace water meters throughout Town	$ 250,000
		3 TO 5 YEAR TIME HORIZON	
Construct new membrane plant at existing plant site designed to treat Cross Creek and Eagle River water	Treatment	Install membranes in a new pre-engineered building at the existing WTP site. New components will include pre-treatment system, booster/feed pumps, membranes, clean-in-place chemical system and compressed air system. The existing clearwell and distribution pumps will remain in service.	$ 4,290,000
Repairs and Modifications to the clearwell	Treatment	Make repairs to the existing clearwell and modifications to piping and controls.	$ 100,000
Raw Water Intake Improvements	Treatment	Install finer screening	$ 25,000
		5 TO 10 YEAR TIME HORIZON	
Connect Maloit Park Service Area to Town Service Area	Pipeline	Construct approximately 2,500 feet of 12" waterline from the Minturn Community Center to the intersection of Highway 24/Cross Creek Road. Project includes the construction of a pressure reducing/sustaining station in a buried vault to include the ability to install booster pumps or connect an electric or diesel powered pump to supply water to either zone.	$ 1,310,000
Replace waterline in Eagle River at Bellm Bridge	Pipeline	Construct approximately 150 feet of 12" waterline across the Eagle River at Bellm Bridge	$ 570,000
			$ 11,840,000
		10 TO 20 YEAR HORIZON	
Loop Taylor Street	Pipeline	Construct approximately 425 feet of 8" pipe from the new 12" Dowd Junction waterline to the existing 8" water line in Taylor St in 4th St.	$ 130,000
			$ 130,000
			$ 11,970,000

Table 20 Recommended Capital Improvements Projects - Option 2

Projects	Category	Description	Cost
1 TO 3 YEAR TIME HORIZON			
Construct a new Minturn Tank	Tank	Replace existing Minturn Tank with a 650,000 gallon tank	$ 1,670,000
Construct new Maloit Park Tank	Tank	Construct a new 250,000 gallon concrete water tank on the existing tank site. Project would include the demolition of the existing tank.	$ 900,000
Connect Well 4 to existing clearwell	Treatment	Construct approximately 900 feet of 4" pipe from Well 4 to the existing clearwell	$ 230,000
Systematic Waterline Replacement Program	Pipeline	Systematic replacement of the Town's waterlines	$ 2,500,000
Invest/Install leak detection system	O&M	Implement a leak detection system	$ 50,000
Develop a Town GIS system	O&M	Create a comprehensive GIS mapping system of the Town's water and public infrastructure	$ 15,000
Water Meter Replacment Program	O&M	Replace water meters throughout Town	$ 250,000
3 TO 5 YEAR TIME HORIZON			
Construct new membrane plant at existing plant site designed to treat Cross Creek and Eagle River water	Treatment	Install membranes in a new pre-engineered building at the existing WTP site. New components will include booster/feed pumps, membranes, clean-in-place chemical system and compressed air system. The existing clearwell and distribution pumps will remain in service.	$ 4,290,000
Construct pretreatment system to pretreat Eagle River water	Treatment	Build concete basins and chemical feed systems to address Eagle River water quality issues.	$ 429,000
Repairs and Modifications to the clearwell	Treatment	Make repairs to the existing clearwell and modifications to piping and controls.	$ 100,000
Raw Water Intake Improvements	Treatment	Install finer screening	$ 25,000
New Well Field and pipeline to connect wells to WTP	Water Supply	Drill 3 new wells at the decreed location of the Eagle River Wells. Includes property acqusition, drilling wells, constructing well building, well pumps and pipeline to the existing WTP site.	$ 5,220,000
5 TO 10 YEAR TIME HORIZON			
Connect Maloit Park Service Area to Town Service Area	Pipeline	Construct approximately 2,500 feet of 12" waterline from the Minturn Community Center to the intersection of Highway 24/Cross Creek Road. Project includes the construction of a pressure reducing/sustaining station in a buried vault to include the ability to install booster pumps or connect an electric or diesel powered pump to supply water to either zone.	$ 1,310,000
Replace waterline in Eagle River at Bellm Bridge	Pipeline	Construct approximately 150 feet of 12" waterline across the Eagle River at Bellm Bridge	$ 570,000
			$ 17,559,000
10 TO 20 YEAR HORIZON			
Loop Taylor Street	Pipeline	Construct approximately 425 feet of 8" pipe from the new 12" Dowd Junction waterline to the existing 8" water line in Taylor St in 4th St.	$ 130,000
			$ 130,000
			$ 17,689,000