WATER TREATMENT

Master Plan Update

City of Helena

AES2

DECEMBER 2023

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Introduction

I. Introduction/Background

The purpose of this Master Plan is to present a summary of the City of Helena's (City's) water supply and treatment facilities and review the condition and capacity of each in association with City's current and projected population demands. Facility information presented in this report was gathered from the City's previous facilities plan, record drawings, or otherwise obtained from City staff. Field investigations of both water treatment facilities were completed with this study.

A. Helena Water System

The majority of the water for the City comes from two sources, the Tenmile Creek and the Missouri River. The Tenmile Water Treatment Plant (TMWTP) is located southwest of the City and has a designed peak treatment capacity of 8.9 million gallons per day (MGD). This treatment facility serves as the primary source of water for the City.

The Missouri River Water Treatment Plant (MRWTP) is located northeast of the City and has an effective treatment capacity of 9 MGD. The MRWTP has two pump systems that deliver finished water directly into the Malben High and Malben Low zones. The MRWTP is primarily used during summer months to supplement capacity from the TMWTP during elevated demand for water.

A smaller percentage of the City's water supply comes from groundwater through the Hale supply system. This system includes the Eureka Well, which has the capacity to produce about 0.55 MGD, but facility rehabilitation is currently in progress to increase this capacity to around 1 MGD. This water source only requires chlorination, so treatment costs are very low, with the primary quality concern associated with the hardness of the water. The capacity of this well represents about a fourth of the City's wintertime demands.

Treated water is fed into the City's water distribution system which consists of over 230 miles of transmission and distribution pipe. A Water Distribution Master Plan was completed in December 2020.

B. Tenmile WTP Background

The TMWTP was constructed in 1989 with the facility being operational in June 1990. The raw water is fed to the facility from the Tenmile Creek Diversion located about 1 mile south of Rimini, MT, into a 18-inch pipeline that generally follows Rimini Road down to the TMWTP. There are pressure break manholes located along the length of the pipeline to manage pressure as the treatment facility is approximately 900 feet lower in elevation. The facility provides direct filtration treatment, with contact adsorption clarifiers ahead of dual media conventional filters.

Treated water is stored in a 6 MG covered clearwell onsite and is gravity fed into a transmission pipeline that supplies water to the City's distribution system.

C. Missouri River WTP Background

The MRWTP was constructed in 1958. The raw water is fed to the facility from the Helena Regulating Reservoir, which is filled with water pumped from the Missouri River. The raw water pipeline is 30-

inches in diameter and generally runs directly to the MRWTP. The facility consists of conventional filtration treatment, with flocculation and sedimentation basins ahead of dual media filters. The MRWTP's treatment capacity correlates with the facilities filtration and pumping capacity.

Treated water is stored in a 1.5 MG at-grade storage clearwell onsite and is pumped into the distribution system. The Malben Low Zone is fed from the Low Zone high service pumps and the Malben High Zone is fed from the High Zone high service pumps.

D. Eureka Well & Pump Station

The Eureka Well pumps chlorinated groundwater into the Hale Tank which serves the Lower and Upper Hale Pressure Zones of the distribution system. Pump station and distribution pipeline modifications are currently in progress to increase well capacity, utilize the water right tied to this source to a greater extent, and improve overall system operational effectiveness.

II. Water Supply and Distribution System Point of Entry

A. Tenmile Water Treatment Plant

1. Watershed Sources & Reservoirs

Tenmile Creek drainage is a compilation of creeks and reservoirs, as shown in Figure 1. Scott Reservoir is filled by Ruby Creek and is the primary storage used in the summer months since the reservoir typically freezes solid in the winter due to its relatively high elevation. The Scott Reservoir discharges back into Ruby Creek, which joins with Banner Creek prior to feeding the Red Mountain Flume headgate, feeding Tenmile Creek prior to the Tenmile Diversion.

Chessman Reservoir is filled by the Red Mountain Flume, which diverts water from Banner Creek, Sallie Belle Creek, Wilson Creek, and several smaller creeks. The flume has a peak flow capacity of 15.5 cubic feet per second (cfs) with a history of water loss issues. To date, the flume section from Banner Creek diversion to the Lyndsay diversion (approximately 1,500 feet) has been piped to decrease water loss. The Chessman Reservoir discharges into Beaver Creek which flows into the raw water supply pipeline via its own diversion. In addition, there are three other creeks - Minniehaha, Moose, and Walker – with independent diversions that allow water to enter the pipeline.

2. Distribution System Point of Entry

After treatment, the water is conveyed to the 6 MG covered clearwell onsite. From there, water enters the existing 36-inch transmission pipeline and is conveyed by gravity to supply the City's distribution system approximately 9 miles northeast of the TMWTP. A section of the transmission pipeline was recently replaced.

B. Missouri River Water Treatment Plant

1. Helena Regulating Reservoir

The Helena Regulating Reservoir was constructed in the 1950's to provide water to Helena Valley Irrigation District. Water within the reservoir is transferred by pumps that receive water from the penstock of Canyon Ferry Dam. An outlet was added to the reservoir to provide raw water supply to the MRWTP in 1960. The outlet feeds the 30-inch transmission pipeline that conveys water by gravity to the pretreatment process at the facility.

2. Distribution System Point of Entry

Treated water is pumped to the 1.5 MGD at-grade clearwell onsite. From there, the two high service pump systems (High Zone and Low Zone) transfer water into the respective Malben distribution zones.

C. Groundwater Sources

1. Eureka Well

The Eureka Well operates year-round. Currently, the Eureka Well facility has two well pumps, one 30HP and one 60HP. The facility's capacity is approximately 0.55 MGD, but improvements are in progress to increase its capacity to about 1 MGD.

2. Orofino Spring

The City also has access to water from the Orofino Spring source but does not use it due to designation as being under the direct influence of surface water. The overall capacity of the spring could be about 0.67 MGD based on available water rights of 725 ac-ft at 13.6 gpm and 730 ac-ft @ 1 cfs (or 462.4 gpm max flow). Appropriate treatment would be required to make use of the Orofino Spring.

3. Current Groundwater Development

The City is proceeding with the development of a groundwater supply in the general vicinity of the MRWTP, including three production wells drilled to date on the property with a probable yield of 1,200 to 1,400 gpm. In addition, the City is planning to drill a test well across the highway as part of planning for three additional wells with similar yield. Overall, the groundwater development objective is to provide at least 3 MGD of water supply capacity. The estimated cost for the groundwater development is provided in Appendix B.

4. Distribution System Point of Entry

After the groundwater is chlorinated at the Eureka Well, the treated water is delivered to the Lower Hale Zone, Upper Hale Zone, and a small pressure zone on West Main Street. The City added a solenoid actuated pressure-reducing valve (PRV) on the Hale Zone to allow the Eureka/Hale Zone to supply water into the Malben Zone, and maximize the ability to utilize this water right.

The addition of groundwater to the MRWTP would likely be directly to the clearwell to allow blending and proper disinfection contact time; therefore, the point of entry to the distribution system would be as described in Paragraph II.B.2 above.

III. Treatment Capacity Evaluation

A. Population Growth/Demand Projection

Based upon population growth and demand projections provided within the Water Distribution Master Plan (WDMP), the peak water use for the City consistently occurs during the month of July. With maximum day demands above 15 MGD and maximum month demands above 12.5 MGD, the peaking factor for the City is generally 2.5 or higher (maximum was 2.8 in 2018).

Utilizing the 0.36% annual population growth provided within the WDMP, the maximum day demand will increase to 15.6 MGD by 2025 and climb to 16.4 MGD by 2040, as shown in Table 1. The recent pandemic has placed significant strain on the housing markets in Montana, and unanticipated developments seeking annexation into the City of Helena have been submitted for review.

Table 1: Helena Population Growth/Demand Projections

Year	# of ERUs	Maximum Day Demand	Additional Demand to the Southeast	Additional Demand to the North
2018	20,448	15.2 MGD	--	--
2025	20,969	15.6 MGD	291,000 gpd	97,000 gpd
2040	22,130	16.4 MGD	938,000 gpd	312,000 gpd

As shown below in Table 2.1, an increase of 750 Equivalent Residential Units (ERUs) across the water system would match the current overall water treatment firm capacity of the City. The anticipated additional 3 MGD capacity of groundwater wells near the MRWTP would increase the ERU growth capacity to 3,850 before additional treatment capacity is needed, as shown in Table 2.2.

Table 2.1: Helena Population Growth – 750 ERUs – Existing Treatment Capacity

Additional ERU's	MDD Demand (MGD)
750	17.3
Treated Water Source (MGD)	
TMWTP	7.2
MRWTP	9.1
Eureka Well	1.0

Current Treatment Firm Capacity w/ 750 additional ERUs

Table 2.2: Helena Population Growth – 3850 ERUs – Treatment Capacity Expansion

Additional ERU's	MDD Demand (MGD)
3,850	20.3
Treated Water Source (MGD)	
TMWTP	7.2
MRWTP	9.1
MRWTP - Wells	3.0
Eureka Well	1.0

Current Treatment Firm Capacity plus 3MGD additional groundwater w/ 3850 additional ERUs

Table 2.3: Helena Population Growth – 10900 ERUs – Treatment Capacity Expansion

Additional ERU's	MDD Demand (MGD)
10,900	27.0
Treated Water Source (MGD)	
TMWTP	7.2
MRWTP	9.1
MRWTP - Expansion	6.7
MRWTP - Wells	3.0
Eureka Well	1.0

Current Treatment Firm Capacity plus 9.7MGD additional source water w/ 10900 additional ERUs

As shown above on Table 2.3, the addition of 9.7 MGD of source water capacity (3MGD of groundwater and 6.7 MGD of surface water) feeding the MRWTP would provide capacity to meet the demands of an additional 10,900 Equivalent Residential Units (ERUs) across the water system.

B. Tenmile & Missouri River Sources

1. Raw Water Supply

The TMWTP raw water supply is solely dependent upon snowpack and other forms of precipitation; therefore, it is highly susceptible to drought, as well as interior impacts to the drainage, such as forest fires, and how they impact the source water.

The MRWTP raw water supply is far more resilient from the perspective that the Helena Regulating Reservoir is filled with water from Canyon Ferry Reservoir on the Missouri River. However, the flow capacity to the facility is limited to 9 MGD based on the water elevation in the reservoir and by the size of the pipeline (30”). An additional pipeline would be necessary to utilize the full potential of the water that is available from the Missouri River. Flow is regulated into the MRWTP by a modulating valve.

2. Water Quality/Treatment

The TMWTP raw water supply by all accounts is a pristine water source. However, as it is direct drainage fed, this water supply is susceptible to flashy turbidity events caused by rainfall or significant and rapid snow melt. The turbidity tends to change more quickly than the treatment facility can respond. Fires in the watershed could potentially create an excessive turbidity load on the treatment system, and the presence of metals caused by mining activities in the watershed has caused discharge permit violations related to the management of TMWTP waste streams.

When compared to the TMWTP, the raw water supply for the MRWTP poses certain challenges. Foremost, the Missouri River water has relatively high concentrations of natural organic matter and related constituents, which has caused complaints from residents due to taste and odor issues, especially for the areas that transition to water from the MRWTP during summer months.

3. Capacity

The TMWTP treatment operational capacity is 8.9 MGD, which is comparable to the City's water rights within the Tenmile Creek Drainage. The MRWTP treatment capacity is 9 MGD, which is predicated by the transfer pumping capacity to the 1.5 MG clearwell. The expected capacity from the Eureka Well following the on-going updates is 1 MGD. The total treated water capacity of all three sources is 18.9 MGD.

4. Facility Infrastructure Age and Condition

The TMWTP has been in operation for about 33 years, and the operations and maintenance staff have done an excellent job keeping the facility in great condition. Most of the wear equipment, such as chemical feed systems, instrumentation, and actuators, have been updated in the past 10 years. The CAC media was last replaced in 2016. The filter underdrains and media are scheduled to be replaced in early 2024.

The original MRWTP facility has been in operation for about 65 years, with the additional pretreatment facility and High Zone pump station being constructed in the past 15 years. Again, the operations and maintenance staff have done an admirable job maintaining the operational condition of this facility, which is more difficult since the facility is only operated during the summer to meet peak demands. Based on an assessment of the facility, the filter media and underdrains appear to be in good working condition. The filter media was last replaced in 2000 and will exceed a typical life cycle because of seasonal operation of the MRWTP. Generally, the main items of concern are the age of the pumps, equipment redundancy within the original facility, and challenges related to operating and maintaining the chemical feed equipment.

C. Eureka Well & Pump Station

1. Summary of Current Upgrade Project

The Eureka Well upgrades currently in progress will increase the well pump horsepower to 75HP each, and this increase will provide an additional 0.45 MGD capacity, bringing the facility's capacity to approximately 1 MGD. In addition, the chemical feed system will be replaced with a positive displacement diaphragm chemical feed pump skid to feed sodium hypochlorite for disinfection.

2. Production Maximization

By increasing the facility's capacity to 1 MGD and adding the PRV station to supply the Malben Zone from the Hale Zone, the City will maximize the water right and greatly improve the functionality of the distribution system.

Tenmile Water Treatment Plant

I. Raw Water Supply

A. Water Rights

The raw water supply from Tenmile Creek is a surface water source used year-round. The City has water rights for 11,721 acre-feet per year (3.82 billion gallons (BG) per year). Tenmile Creek is fed by two mountain reservoirs that have a combined storage capacity of 744 MG – Chessman Reservoir at 550 MG of capacity and Scott Reservoir at 194 MG of capacity.

B. Diversion Structures

The Red Mountain Flume diverts water from Banner, Lyndsay, Sally Belle, and Wilson Creeks to the Chessman Reservoir from April 1 to August 13, or when the creeks come to measure. Sally Belle and Wilson creeks water rights have flow restriction of 2.42 cfs and 2.30 cfs respectively. With that, the City can operate these creek diversions into Red Mountain Flume as they see fit to produce the flow, up to the maximum flume flow of 15.5 cfs. To mitigate water loss issues, about 1,500 feet of the flume has been piped between the Banner diversion to Lyndsay diversion. Runoff from the Beaver Creek drainage also provides water to the Chessman Reservoir. From the reservoir, water flows back into Beaver Creek, which also has two tributaries before reaching the Beaver Creek diversion to the Raw Water Pipeline.

Runoff from the Ruby Creek drainage fills the Scott Reservoir. Water leaves the reservoir through Ruby Creek and is then either captured at the Tenmile Creek diversion, or diverted from Banner Creek through the Red Mountain Flume to Chessman Reservoir, prior to feeding the Raw Water Pipeline.

These reservoirs, along with intakes on Minnehaha, Moose and Walker Creeks, provide flow that is diverted into the Raw Water Pipeline. Per discussion with the City Engineering Team, the City is currently rehabilitating or replacing all of the raw water diversion structures within the Tenmile Creek watershed. An overview of the Tenmile Creek Drainage is shown in Figure 1.

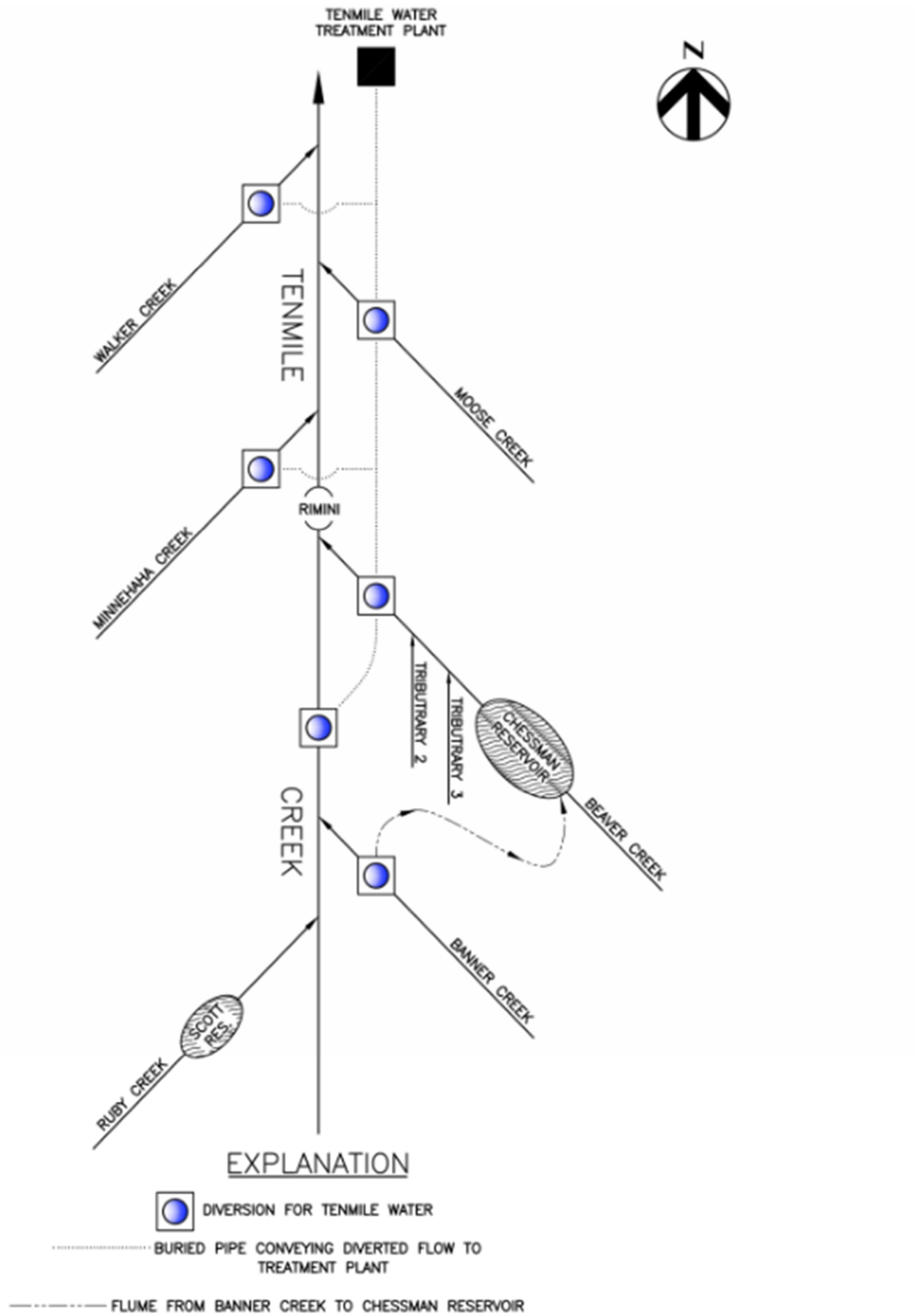


Figure 1: Tenmile Creek Drainage Overview

C. Supply Pipeline

The Raw Water Pipeline to the TMWTP is a buried 18-inch pipe. This pipeline is approximately 100 years old and constructed of concrete. Design capacity of the Tenmile Creek raw water supply is 8.9 MGD, but overflowing occurs at manholes along the Raw Water Pipeline around 8.8 MGD. This system is also subject to freezing during the winter, which limits flow to the TMWTP. The City plans to proceed with an improvements project in the near-term for replacement and upgrade of this system.

II. Water Quality/Treatment

A. Water Quality Concerns

1. Turbidity

The raw water quality entering the TMWTP is pristine for most of the year due to its mountain source; however, this source is susceptible to quality issues during spring runoff. The source is also at risk of water quality deterioration caused by ash generated from potential forest fires in the area. The typical range of seasonal raw water turbidity is presented in Table 3.

Table 3: Helena Tenmile WTP Raw Water Seasonal Turbidity (Typical)

Season	Turbidity (NTU)
Winter	1-5 NTU
Spring	5-50 NTU
Summer	1-5 NTU
Fall	1-5 NTU

As illustrated in Table 3, the runoff from snowmelt and extended periods of rain during the Spring can cause turbidity to increase significantly.

2. Color

Turbidity rise also impacts the color of the raw water entering the TMWTP. Similar spikes in raw water turbidity can occur due to rainfall flushing the organics, or ash generated by forest fires, into the watershed. This raw water variation can lead to treatment concerns and regulatory compliance issues related to turbidity removal.

3. Metals

In addition to susceptibility to turbidity and color spikes, the watershed is also impacted by metal content caused by mining activities in the area which has caused discharge permit violations related to the management of TMWTP waste streams.

B. Pretreatment

1. Existing Pretreatment

The TMWTP is not equipped with any pretreatment between the water plant and the watershed and reservoirs that feed it. Any excess turbidity and color generated from runoff and fire events is sent directly to the plant for treatment. Following the inlet screening process, raw water is dosed with chemical and fed into the Contact Adsorption Clarifiers (CACs) for treatment. The CACs require optimized chemical dosing and consistent feed for ideal treatment operation.

Seasonal fluctuations in raw water quality can negatively impact treatment as shown in the filter performance curves provided in the 2021 Filter Study Report by AE2S which is attached in Appendix D for reference.

The addition of a pretreatment process was suggested to address the turbidity fluctuations in the Filter Analysis Project at TMWTP conducted by AE2S in 2021. Three pretreatment alternatives were identified and evaluated, and the results of the evaluation are summarized in Table 4. The alternatives include a large settling pond between the upper reaches of the watershed and the TMWTP, a flocculation/sedimentation basin directly upstream of the WTP, and a Dissolved/Suspended Air Flotation (DAF/SAF) system upstream of the plant. Detailed documentation and analysis of these potential solutions are provided in the 2021 Filter Study Report by AE2S.

Table 4: Tenmile WTP Pretreatment Alternatives

Pretreatment Alternative	Benefits	Disadvantages
Settling Pond	-Lowest capital cost, City owned land available -Minimal operational energy & cost -Designed to be active full time except during dredging - Provides upstream chemical dosing	-Permitting challenges related to floodplain -Requires a large area to provide sufficient settling -Remote location needed to provide consistent gravitational flow -Regular dredging of sediment - Prevent recycle of backwash water - Limited influence on performance by operators
Flocculation/ Sedimentation Basin	-Controllable treatment based on influent conditions -Operator control and monitoring -Easily bypassed if needed -Increase plant working volume -Provides upstream chemical dosing	-High capital cost -Elevated installation required to maintain gravitational flow - Moderate O&M cost - Allows recycle of backwash water
DAF/SAF System	-Technology ideal to remove high solids content - Provides upstream chemical dosing - Operator control and monitoring - Increase plant working volume	-Highest capital and O&M cost -Elevated installation required to maintain gravitational flow -Requires constant chemical tuning to provide optimal removal of solids and organics - Allows recycle of backwash water

2. Pretreatment Considerations

Several alternatives were evaluated for pretreatment at the TMWTP as shown in Table 4 above. Challenges related to the settling pond include land requirements and potential permitting hurdles. Although settling pond presents the least cost option, with City owned land available up Rimini Road, the remote location and lack of operational control over performance may prevent the ponds from performing well during the most critical periods of runoff. While DAF/SAF treatment provides robust turbidity removal, the option represents the alternative with the highest O&M cost and requires constant chemical feed tuning. As a result, neither of these alternatives are recommended for the TMWTP.

The flocculation/sedimentation basin option provides the most operational flexibility and process control to treat the raw water. Although the capital and O&M costs are substantially higher than settling ponds, the ability to monitor and control the treatment process offers a substantial benefit toward managing filter performance during elevated raw water turbidity, including ash loading from wildfires.

CASE STUDY: Recently, the Red Mountain WTP of Glenwood Springs, Colorado faced the same fire and runoff-based turbidity challenges experienced at the TMWTP. In February 2022, Water Online published an article about how the Red Mountain WTP overcame these issues by implementing plate settlers in a flocculation/sedimentation basin pretreatment process. During run off events, the maximum turbidity would increase significantly compared to the normal maximum of 40-50 NTU. The observed treatment performance exceeded the design basis of a maximum 1 NTU effluent if influent is between 1 and 10 NTU daily average; a maximum 2 NTU effluent if influent is between 10 and 100 NTU daily average; and 98% removal if influent is above 100 NTU and below 200 NTU daily average. Correlating with the TMWTP turbidity data, this type of pretreatment would provide less than 2 NTU turbidity to the filters over 99.8% of the year on average. In addition, the pretreatment volume provided captures short-term turbidity spikes within the process.

The addition of the pretreatment process would also allow the recycle of backwash water to the head of the plant, which is a desired feature expressed by City staff. This would eliminate the need for discharge and the respective permitting requirements. In conjunction, the pretreatment process would provide residence time necessary for chemical optimization to aid in the removal of metals found in the source water.

Although the pretreatment Floc/Sed alternative has a higher capital cost than the pretreatment pond, the utilization of backwash recycle will provide ongoing savings for the TMWTP. Per discussion with plant personnel, the TMWTP discharges approximately 22,000 gallons per day of backwash water. Assuming the majority of the backwash water is recycled, this volumes conserves 24.6 acre-feet of water per year. In addition, if the volume of wasted backwash discharge is required to be produced by the MRWTP, monetary savings can be established based on the cost to produce water at each treatment facility. The TMWTP can produce water at a rate of $0.14/1,000 gallons versus the MRWTP at $0.71/1,000 gallons. Based on a $0.57/1,000 gallon difference between the facilities, recycling the TMWTP backwash could save approximately $4,500 per year.

A potential process layout for a similar facility at the TMWTP is provided below in Figure 2, with a budgetary opinion for probable construction cost of this pretreatment process included in Appendix A.

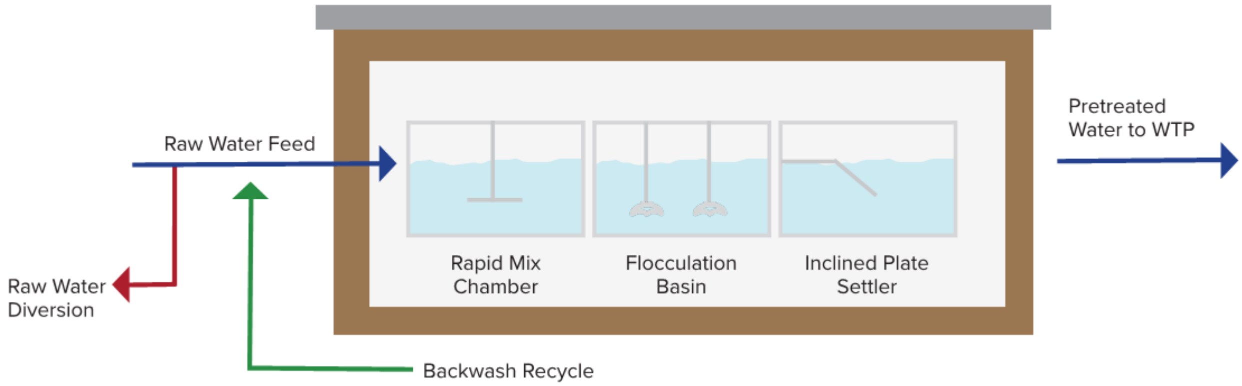


Figure 2: Example Floc/Sed Pretreatment Process

As discussed, the flocculation/sedimentation pretreatment process carries a significant capital cost to construct in comparison to the settling ponds option; however, with the benefits of improving operational control and flexibility, maximizing filter performance, and providing backwash recycle to eliminate discharge permitting and conserve source water, this option is recommended.

C. Filtration

1. Existing Filtration

Filtration is accomplished via four conventional filters downstream of the CACs. Based on the AE2S Filter Evaluation of 2021, the City is proceeding with a project to install new filter underdrains with air scour capability to provide a more effective backwash sequence. Upgrades include underdrain and media replacement in all four filters, blowers and associated air piping installation, and upgrades to treatment instrumentation. The inclusion of air scour as part of the backwash process is anticipated to improve overall filter performance.

The upgrades performed under the 2023-2024 TMWTP Filter Improvements project are expected to provide the City with a resilient filtration system for at least two decades, at which time the media may need replacement. It is recommended that the City continue to evaluate the filter media and performance to maximize the lifespan of the investment, reduce backwash water volume, and extend filter run times.

2. Filtration Improvements

Currently, all four filters are operated simultaneously. In the event that a filter needs to be backwashed, the raw water flow is pushed to the remaining three filters in service. Increasing the number of filters, and overall filter area, would alleviate the need to instantaneously increase filter loading rate to perform backwashes, as well as reduce the overall loading rate per filter in normal operation.

The addition of a pretreatment process would eliminate the need for the existing CACs, which currently struggle during increased and variable turbidity events. The space occupied by the existing CAC tanks could be converted to either membrane filter cassettes or a 4-cell rectangular steel gravity conventional filters to provide increased flexibility and redundancy.

The membrane filter cassettes would utilize the existing CAC tanks as a support structure with extensive piping modifications. Repurposing the tanks allows for simplified construction by placing the cassettes into the existing tanks.

The gravity conventional filter structure would be approximately 49'L x 11'W x 8.5'D. On-site fabrication of this filter is not recommended as it is difficult and expensive for proper quality control. Therefore, pre-assembled filter vessels would need to be rolled into the building using a temporary conveyor system or crane requiring substantial building modifications. A budgetary opinion for probable construction cost of adding membrane filter cassettes to the existing CACs or a gravity conventional filter range from $2.5M to $4.4M. Detailed cost estimated are included in Appendix A. It should be noted that the conventional filter estimate does not include the cost of building modification or temporary conveyor system. A detailed feasibility of installation analysis should be completed if this is the preferred CAC replacement technology.

D. Chemical Feed Systems

1. Existing Chemical Feed Practice

The TMWTP has six separate chemical feed systems:

- Powder Activated Carbon (PAC) – for Total Organic Compound (TOC) removal
- Caustic Soda (NaOH) – for pH modification
- Aluminum Sulfate (Alum) – for primary coagulation
- Cationic Polymer – for coagulation/flocculation aid
- Nonionic Polymer – for filtration aid
- Sodium Hypochlorite (NaOCl) – for disinfection

Each of the chemical feeds above are fed into a rapid mix prior to the CACs, the the exception of NaOCl which can be fed onto the filter bed or into the filter clearwell for disinfection purposes, as well as boosted at the effluent discharge house to maintain disinfectant residual in the distribution system. Except for PAC, all have been upgraded between 2018-2022 by replacing the original pumps with new ProMinent Gamma X diaphragm metering pumps. These pumps are expected to provide a reliable chemical feed system for the next 20 years. The bulk chemical storage tanks are located in the chemical storage room and are original to the plant build in 1991. Although the structural assessment in 2022 found these tanks and their surrounding containment in good condition, it is recommended that these tanks be fully drained and inspected during the next planned plant shutdown event, which will be required for the filter media and underdrain replacement project. The inspection and related repairs, if any, will prevent potential chemical leaks or exposure risks in the future.

2. Chemical Feed Optimization

The addition of the plate settlers for pre-treatment, as recommended above, would impact the treatment process significantly enough that the past chemical feed dosing procedure would be considered obsolete. Pending implementation of pretreatment, the City should consider developing a revised chemical feed strategy as part of the pre-treatment project to properly size and design the chemical feed equipment.

A revised chemical feed optimization strategy is typically performed by chemical sales representative or with assistance from an experienced drinking water engineering consultant. The effort is conducted over the course of six to nine months in order to analyze the coagulation process across a variety of water conditions such as temperature, turbidity, and operating capacity. A budgetary opinion for probable labor cost to develop a chemical feed optimization strategy is included in Appendix A.

E. Pump Systems

The TMWTP currently utilizes two pump systems, the backwash pumps and surface wash pumps. These pumps were installed during construction of the TMWTP.

1. Filter Backwash

The filter improvement project, which is expected to be completed by 2023, will eliminate the need for the surface wash pumps, as they will no longer be needed with the implementation of air scour. The backwash pumps are used to push treated water backwards through the filters for routine media backwash cycles. Although the site inspection did not find any potential operation and maintenance concerns associated with the backwash pumps, the City should consider keeping a shelfed spare or include a backwash pump replacement project in the CIP. Eventual replacement of these pumps, when necessary, would modernize the entire filtration process with the current filter improvement project.

2. Service Pumping

No high service pumping is necessary from the TMWTP due to the hydraulic grade from the facility to the City's distribution system.

F. Disinfection

The Treated Water Clearwell/Reservoir is gravitationally fed from the Filter Effluent Clearwell. The TMWTP currently utilizes HACH CL17 Colorimetric Chlorine Analyzers to monitor disinfection of the treated water. HACH SC200 analyzers will need to be added to the system for the HACH CL17 to interface with the control system. The HACH SC200 analyzer is able to track the pH, oxidation-reduction potential, and dissolved oxygen content of the water. Since this addition is required for control interface, it is recommended to investigate the ProMinent DULCOMETER as this system will integrate with the existing control system and provide more analyzing capability. Furthermore, the ProMinent DULCOMETER will match the manufacturer and service representative of the newly installed chemical feed pumps.

1. Contact Time

Based on the TMWTP operational capacity of 8.9 MGD, the 42,000 gallon interior clearwell, and the 6 MG exterior clearwell, Table 5 provides the worst case level of disinfection with 1 mg/L of free chlorine achieved at the TMWTP. As shown, the level of chemical disinfection provided by the TMWTP is more than adequate.

Table 5: TMWTP Chlorine Contact Time

Tenmile Water Treatment Plant - Helena, MT					
Chlorine Contact Time Calculations					
Clearwell - Circular Tank: Inlet/Outlet Opposite Side					
Storage Volume		6.042	MG		
Baffling Factor		0.1			
Peak Flow		8.9	MGD		
Residual		1.0	mg/L free chlorine		
pH		7.7			
Temp (worst case)		0.5	C		
CT req		12			
Existing Peak Flow		7.5	MGD		
Lowest Volume		3.00	MG		
Formulas:					
Total Detention Time = Lowest Operating Volume/Peak Flow					
		485.3933	**minutes**		
Contact time = Total detention time X Baffling factor					
		48.53933	**minutes**		
Ctcalc = Residual chlorine concentration X Contact time					
		48.53933	**(mg/L)*min**		
Inactivation ratio = Ctcalc/Ctreq					
		4.044944	4 Log Virus =	**16.18**	

a) Storage Capacity

The 6-million-gallon reservoir was constructed in approximately 1931 and protected from the elements with a floating cover. In 2015, the reservoir was completely lined with a synthetic waterproofing material to eliminate leakage. The finished water is metered and feeds the distribution system by gravity. The reservoir provides over eight hours of detention time at peak treatment capacity utilizing 50 percent of the available reservoir volume. No improvements to the storage facilities at the TMWTP site are necessary at this time; however, routine inspections are recommended.

2. Disinfection Residual

The operational target for disinfection residual is 1.0 mg/L free chlorine. The disinfection residual is sampled and monitored by Distribution operators as required by MDEQ. No improvements to the disinfection system at the TMWTP site are necessary at this time.

III. Capacity

A. Treatment Capacity

The current water supply capacity to the TMWTP is 8.9 million gallon per day based on the available water right as discussed in the sections above. Since the water right limits the available water to treat, optimizing the TMWTP's water supply is paramount.

The best way to accomplish this is by better analyzing the drainage storage volumes and diversion flows to maximize the treatment facilities operations based on real-time data. The drainage diversions are being replaced and are currently under a design contract at present. Once this equipment is in place, it is recommended that a water supply optimization study is completed to enhance operations for both treatment facilities.

B. Efficiency Maximization Alternatives

To increase overall efficiency of the TMWTP, a backwash recycle system similar to the recycle process utilized at the MRWTP, is recommended for implementation. The Montana DEQ Surface Water Regulation Summary (May 2010) states:

"The Filter Backwash Recycling Rule went into effect in 2004. This rule is intended to reduce the opportunity for waste-stream recycle practices at treatment plants to adversely affect the performance of the plant. The rule requires systems that recycle spent filter backwash water, thickener supernatant, or liquids from dewatering processes to return the recycle flows through all processes of the system's existing conventional or direct filtration system or at an alternate location approved by the DEQ. This rule only applies to surface water systems that practice conventional or direct filtration and recycle one or more of the specified waste streams."

Further investigation of the EPA's Filter Backwash Recycling Rule indicates two major requirements for the implementation of backwash recycle:

- The backwash recycle needs to be returned to the head of the facility so that the recycle flow goes through the entire treatment process. DEQ/EPA review is required for a different recycle return location.
- Two log (99%) removal of cryptosporidium is required through the treatment process.

The current layout of the TMWTP is considered a direct filtration plant as it omits the sedimentation process, which removes solids from raw water prior to filtration. It is recommended that spent filter backwash be treated prior to recycle in a direct filtration plant as there is no other way to remove solids from the treatment train. Solids loading to the filters will increase over time if the spent backwash recycle is not treated. The recommended filter backwash recycle for a direct filtration plant process flow diagram from the EPA is shown below in Figure 3.

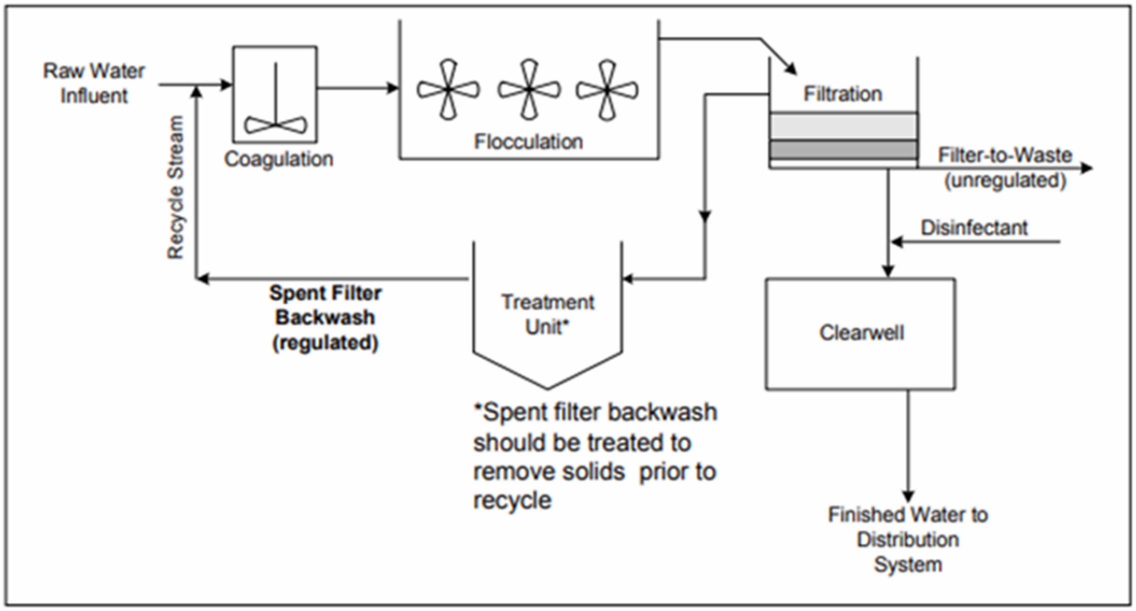


Figure 3: EPA Process Flow Diagram - Direct Filtration with Backwash Recycle

The existing ponds at the TMWTP are expected to provide some level of recycle treatment; however, pond effluent water is expected to be of lower quality than the typical raw water feed except for during a runoff event. Due to the historical CAC operational issues from variable feed water turbidity, it is recommended that spent backwash be treated through an additional process after the existing ponds. Recycling the filter backwash to the head of the pretreatment plate settlers discussed above would provide additional treatment and consistent high quality feed water to the filters. A proposed TMWTP Process Layout with Backwash Recycle is shown in Figure 4.

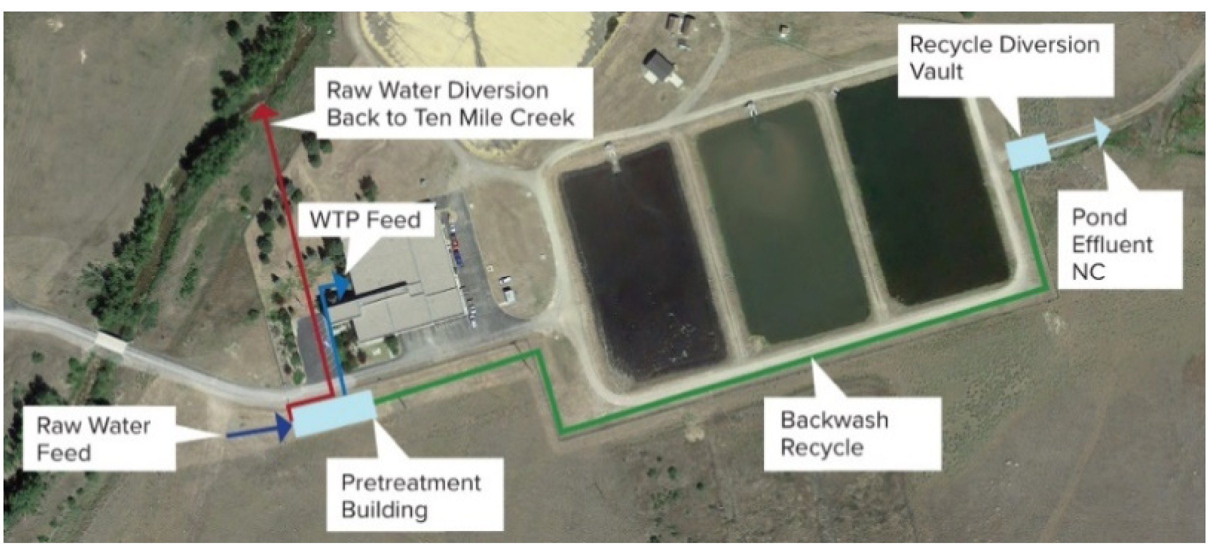


Figure 4: Proposed TMWTP Process Layout with Backwash Recycle

The backwash recycle improvements should be included or considered as a bid alternate with the addition of the pretreatment process. The improvements would provide increased resiliency to forest fire and raw water concerns during runoff, increase the overall plant efficiency, and maximize the use of existing water rights (by conserving the 30K gallons of backwash water used daily on average). There are two options for the infrastructure layout of a backwash recycle concept. First, a pump station could be added to the existing pond but would require a new enclosure and extensive electrical addition to the facility footprint. The second option would be to utilize a buried gravity line that extends from the existing pond effluent to pumps housed in the new pre-treatment building. As the plate settler pretreatment basin will be required to be elevated to maintain gravitational flow, the backwash recycle pumps could be located below the basin. This would incorporate the backwash pumps into the required pretreatment process design. A proposed TMWTP Pretreatment Facility concept with Backwash Recycle is shown in Figure 5.

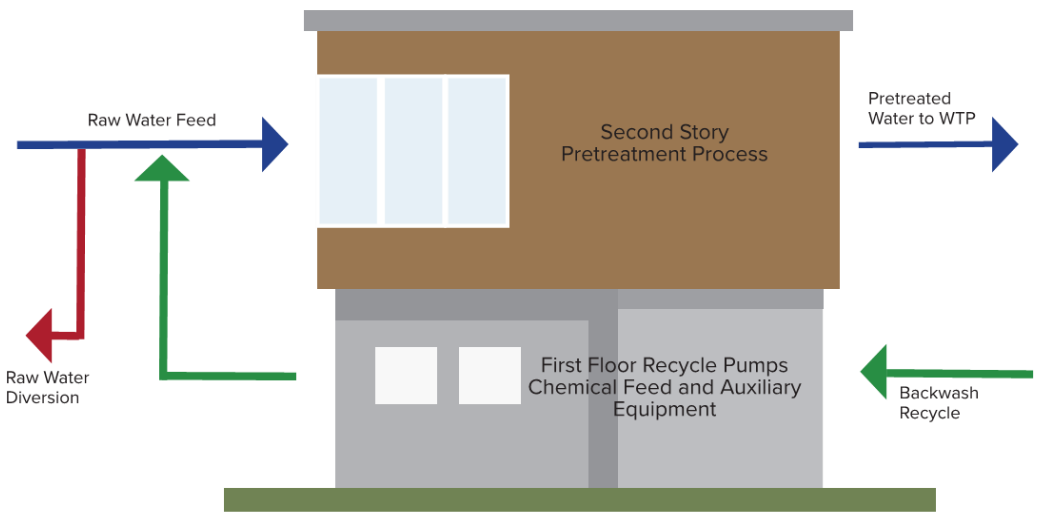


Figure 5: Proposed TMWTP Pretreatment Facility Layout with Backwash Recycle

The estimated construction cost for the addition of the backwash recycle system is $672K, the budgetary opinion for probable construction cost is included in Appendix A.

IV. Facility/Infrastructure Age & Conditions

A. Asset Inventory

Site evaluation walkthroughs were conducted by AE2S at the TMWTP with plant personnel in the Summer of 2022. During these visits, the AE2S team evaluated the overall condition of the structural components of the facility, the process equipment, and electrical gear and developed an asset inventory spreadsheet that is included in Appendix C. This asset inventory provides the age, condition, and general specifications for each piece of process equipment. The following equipment were found to be at or close to approaching their expected operational life:

- Powder Activated Carbon mixing and feed equipment
- CAC Air Scour Blowers
- Filter Backwash Pumps

B. Aging Infrastructure

In addition to building the asset inventory, an overall structural, process, and electrical evaluation was conducted. The findings of this assessment is also provided in Appendix C. No major concerns were identified with the TMWTP structure and electrical conditions; however, the age of the facility is beginning to show as much of the plant is from the original construction in 1991. Although the facility is functioning well, it can be expected that issues will begin to arise in the coming years. It is recommended that adherence to routine and planned maintenance schedules continue, and shelved spares are considered for all crucial equipment to ensure minimal downtime when replacement is deemed necessary.

Missouri River Water Treatment Plant

I. Raw Water Supply

A. Water Rights

Stored water in Canyon Ferry Reservoir on the Missouri River serves as the source of raw water transferred to the Helena Regulating Reservoir, which feeds the MRWTP and is typically used on a seasonal basis to meet summertime demands. The City has a first right Water Purchase Agreement with the Bureau of Reclamation for 11,300 acre-feet of water that was renewed in 2004 and will be up for renewal option in 2045 for 40 additional years. An additional 11,300 acre-feet is available for purchase.

B. Diversion & Storage

Raw water begins its journey to the MRWTP from Canyon Ferry Reservoir 17 miles east of Helena. Two 5,000 horsepower hydro turbine driven pumps, with the combined capacity of 300 cubic feet per second (cfs), located in the Canyon Ferry Pumping Plant convey water to the Regulating Reservoir. Water is pumped through a 2.7 mile long, 7-foot diameter tunnel followed by a canal with a bottom width of 14 feet and average water depth of 5.5 feet. The Regulating Reservoir is approximately 3.5 miles east of the MRWTP and contains two intake structures. A gate structure in the Regulating Reservoir provides the ability to direct flow using valves to the desired intake at an elevation of either 3,789 ft or 3,799 ft. Next, water flows by gravity to the MRWTP through the Raw Water Supply pipeline. Figure 6 shows an approximate route of the existing Raw Water Supply Pipeline to the MRWTP.

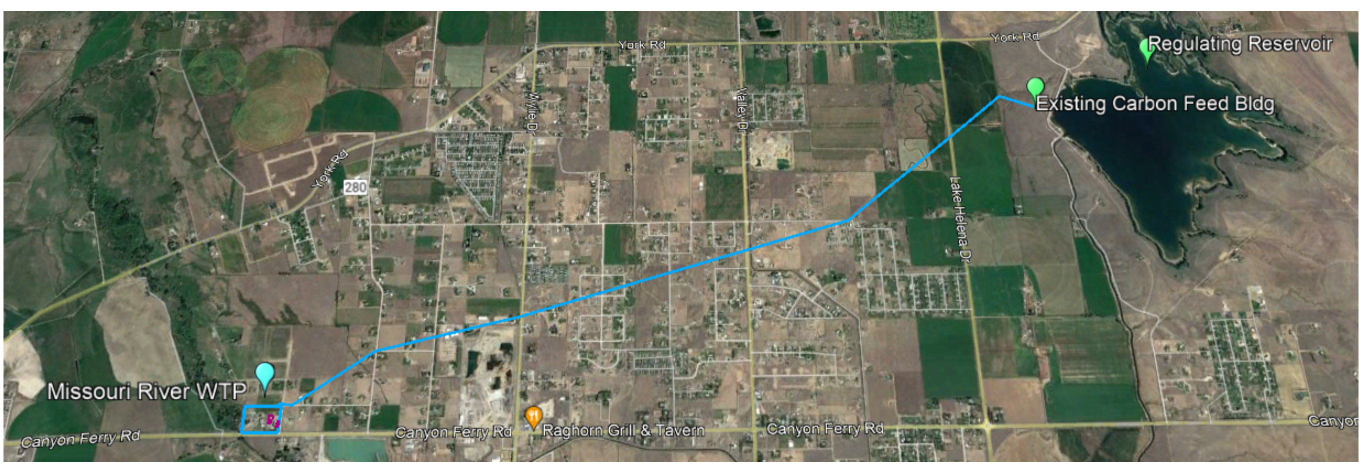


Figure 6: MRWTP Raw Water Supply Pipeline (Existing)

C. Supply Pipeline

The Raw Water Supply pipeline is 3.5 miles of 30-inch diameter, spiral-reinforced steel pipe that is coated in concrete, which was constructed in 1957. Capacity of the pipeline ranges from 9MGD at low water level to a max of 12 MGD. The supply pipe was found to be in excellent condition when it was excavated and inspected in 2016, with no major leaks being reported. The spot excavation provided an indication that the pipeline is likely capable of providing service for several more years. The City could conduct a pipeline condition assessment to ascertain the current state of the pipeline. Options for an assessment range from low, medium, or high-resolution using equipment such as a SmartBall or PipeDiver, which are products available from Pure Techologies. Such assessments typically represent an investment in the range of $100,000 to $500,000 depending on pipeline size, length, and degree of resolution desired. Based on a recent inspection and lack of maintenance requirements, the cost to complete a condition assessment could be used to repair multiple leaks should any be identified in the future.

The pipeline alignment and ability to access the line if repairs are needed is unknown; therefore, the cost of a condition assessment may be better spent on a redundant pipeline. Figure 7 shows two proposed alternatives for new raw water supply pipelines to the MRWTP in relation to the approximate location of the existing pipeline. To meet the additional treatment capacity required for future growth, it is recommended that a new raw water supply pipeline be sized at 36-inch diameter. At this diameter, the pipe material cost will be favorable to install concrete-lined steel, but PVC could also be evaluated given the relatively low operating pressures. The estimated current cost to construct a redundant pipeline is $5.8M.

Figure 7: MRWTP Raw Water Supply Pipelines – Existing and Proposed Alternatives

D. Groundwater Wells

The City may be able to expand source water supply capacity through groundwater well development. Originally, the City held a total combined groundwater water right of 6,000 acre-feet in the Helena Valley. Through a Montana Supreme Court order in 1992 this water right was increased to 7,071 acre-feet. The City is utilizing the Eureka Well at 811.1 ac-ft (805 ac-ft actual) and two additional water rights at Orifino Spring, one for 871 ac-ft and another for 725 ac-ft.

Helena is evaluating the development of additional groundwater water rights and assessing blending of various water sources at the MRWTP. Phase 1 of the test well drilling program has completed the drilling of three production wells near the MRWTP. Phase 2 will consist of three additional test wells at available City sites, such as open space, airport, parks, etc. Phase 1 well testing indicates groundwater access of up to 1,400 gallons per minute is possible, which is equivalent to approximately 2 MGD. Implementation of these groundwater wells will provide the additional water system capacity necessary to address the potential for growth and corresponding demand increase. Furthermore, the groundwater capacity could potentially further mitigate taste and odor concerns of the water produced by MRWTP.

II. Water Quality/Treatment

A. Water Quality Concerns

The main water quality concern at the MRWTP is taste and odor. Customer complaints are more common when the MRWTP initiates operation and customers transition from water treated by the TMWTP to the MRWTP. Typical total organic carbon (TOC) concentrations in the water supply at the MRWTP is 2-6ppm, with the majority being dissolved. Although the water is generally less pristine than the Tenmile source, the water quality is consistent, which allows the MRWTP to operate within a prescribed regime without the need for significant adjustments or modifications. In the case of taste and odor issues, the operations have managed these concerns by implementing the addition of powder activated carbon (PAC) at the rapid mix ahead of pretreatment. Due to the consistency in the raw water source, there are currently no issues meeting turbidity regulations.

B. Pretreatment

The existing pretreatment process at the MRWTP is an improvised rapid mix system for the chemicals fed ahead of the flocculators. Following rapid mix, there are three sedimentation basins with tube settlers. Two of the sedimentation basins are in the original building, and one basin is in a separate building constructed in 2003.

1. Advanced Oxidation

Advanced oxidation could be added to the treatment process to mitigate the taste and odor concerns. Options include ozone, dissolved or suspended air flotation, or contact adsorption clarifiers.

a) Ozone

Two of the existing sedimentation basins have sufficient depth to be converted to ozone chambers. This system would be a side stream injection style, which pumps the ozone stream into the chamber through nozzles. Chambers would be covered with a top vent channel for ozone vacuum capture for destruction. Ozone represents the best option for taste and odor control and provides protection against cyanotoxins. An example Ozone Chamber is shown in Figure 8.

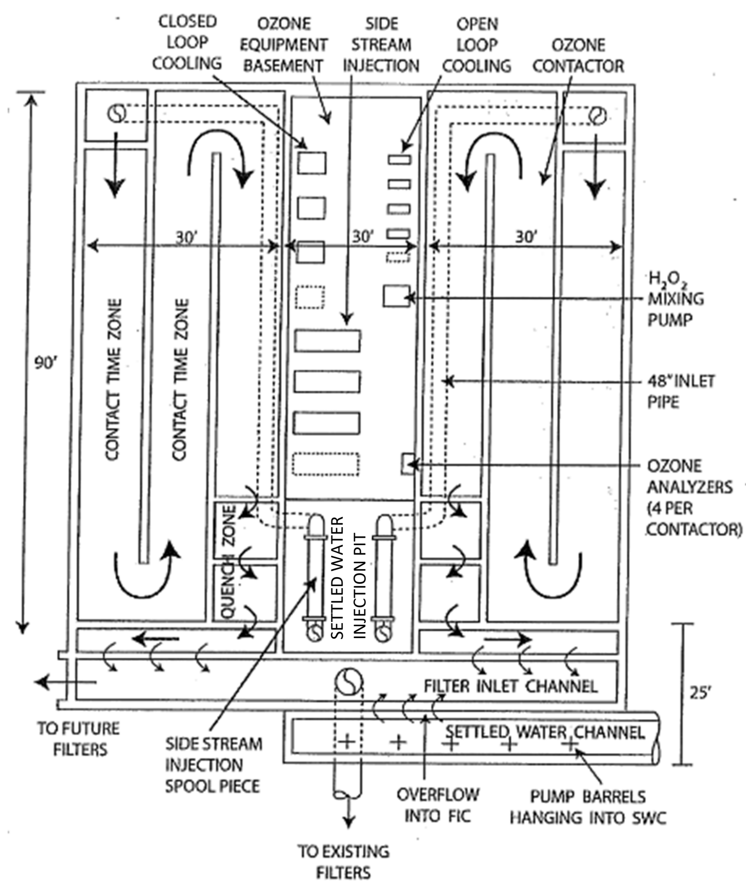


Figure 8: Example Ozone Chamber

b) Dissolved/Suspended Air Flotation

Total Organic Carbon (TOC) at the MRWTP ranges from 2-6 ppm. The suspended organics portion could be treated with either Dissolved Air Flotation (DAF) or Suspended Air Flotation (SAF). Both would need a facility added between the sedimentation and filtration processes.

DAF requires higher energy cost to operate a blower but excels at removal of suspended organics. SAF uses less energy due to chemical addition to generate foam, but there is additional cost associated with the chemical, and there is currently only one supplier of the chemical. SAF is slightly more effective at treating for dissolved organics.

c) Contact Adsorption Clarifiers (CACs)

The Regulating Reservoir ahead of MRWTP lessens the concern for variable water quality. The addition of CACs after the sedimentation basins and ahead of filtration would allow for enhanced control of CACs to utilize chemical capture of organics. Low lift pumps would need to be added post-sedimentation if CAC technology is added due to the existing hydraulic grade line (HGL).

Advanced oxidation at the MRWTP should only be considered if organics related concerns and/or complaints are common, such as disinfection byproduct formation or taste and odor. Since the chemical feed change to introduce PAC into the rapid mix, the City has had minimal complaints. However, if advanced oxidation is determined to be necessary in the future, ozone provides the greatest level of benefit within the WTP's existing footprint and hydraulic profile. Ozone provides the highest level of organics removal, both suspended and dissolved, to mitigate taste and odor issues, lessen disinfection byproduct formation potential, and protect against cyanotoxins.

C. Filtration

The existing filtration system at the MRWTP consists of eight 15'W x18'L x 4.3'D (from top of underdrain to bottom of backwash trough) conventional filters, each with an area of 270 sq-ft. The media and underdrains are in good working condition and air scour is in place.

1. Filter Improvements

a) Biological Filtration

No major improvements were identified for the existing filters. Pending the implementation of ozone for taste and odor control, biological filtration becomes a valid consideration. Conversion of the existing filters to Granular Activated Carbon (GAC) for biological filtration would require modification to the backwash troughs. The backwash troughs would need to move up 12"- 18" to allow for at least 30", with an ideal target of 36" of GAC. Figure 9 shows an example profile of a biological filter.

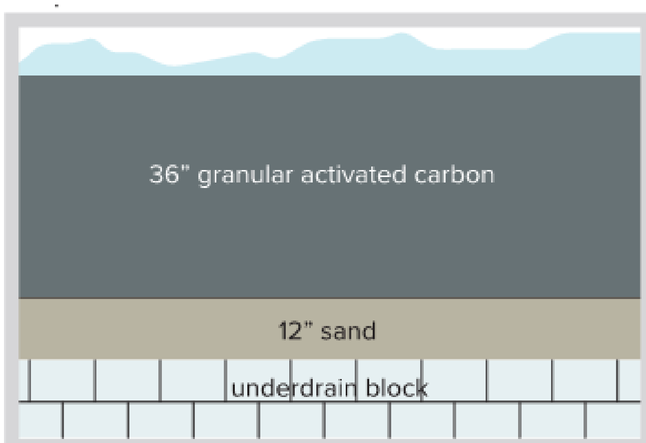


Figure 9: Example Biological Filter Profile

Prior to proceeding with modifications, a pilot of GAC filtration is recommended due to seasonal operation concerns. Biological activity during winter due to cold temperatures and potential lack of nutrients is the main concern. Biologically active filters would operate best if the facility operated year-round.

D. Chemical Feed Systems

1. Existing Chemical Feed Practice

The MRWTP has six separate chemical feed systems:

- Powder Activated Carbon (PAC) – for Total Organic Compound (TOC) removal
- Orthophosphate – as a pipe corrosion inhibitor
- Aluminum Sulfate (Alum) – for primary coagulation
- Cationic Polymer – for coagulation/flocculation aid
- Nonionic Polymer – for filtration aid
- Sodium Hypochlorite (NaOCl) – for disinfection

Each of the treatment chemicals above is fed into the rapid mix prior to the flocculation and sedimentation basins, except for NaOCl and Orthophosphate. NaOCl can be fed directly onto the filter bed or into the sub-filter clearwell for primary disinfection, as well as boosted at the high/low service discharge pumps. The Orthophosphate is added post-disinfection at the high/low service discharge pumps to inhibit corrosion primarily in lead pipes and prevent lead leaching. With the exception of PAC, all have been upgraded between 2018-2022 by replacing the original pumps with new ProMinent Gamma X diaphragm metering pumps. These pumps are expected to provide a reliable chemical feed system for the next 20 years. The bulk chemical storage tanks previously used for Ferric Chloride are in the process of being removed and replaced.

Currently, the major concern with the chemical feed systems at the MRWTP is the transport and storage of chemicals at the facility. The chemical feed systems are primarily housed on the second story of the facility, and there is no automated transport (ie, electric crane/hoist, container lift, etc) provided.

2. Chemical Feed Optimization

The Powder Activated Carbon (PAC) system would benefit from longer retention time ahead of flocculation to adsorb organics. Moving the PAC feed location to the regulating reservoir intake would provide extended retention time and is recommended.

Prior to the City's consideration of moving forward with the addition of advanced oxidation, a pilot may be warranted to optimize the coagulant feed systems to evaluate the TOC removal and effects on taste and odor. This study would focus on organics in conjunction with turbidity removal, using coagulants such as Ferric Chloride (FeCl), Ferric Sulfate (FeSO4), Aluminum Chlorohydrate (ACH), or various blends. The study would be conducted over the course of six to nine months to analyze the coagulation process across a variety of water conditions such as temperature, TOC concentrations, and increased operating capacity. A budgetary opinion for probable labor cost of a pretreatment optimization study is $37.5K, with a detailed breakdown included in Appendix B.

E. Pump Systems

1. Filter Backwash

Filter backwash is a critical operational component in maintaining the effective performance of conventional filters. Currently, the MRWTP has one backwash pump available, with a spare motor on hand. It is highly recommended that a second backwash pump be installed to provide redundancy for this critical process. This spare backwash pump would be plumbed in parallel to the existing backwash pump to provide a simple back-up to the first backwash pump if it were to fail.

2. Service Pumping

The High Zone Service pump station was constructed in 2010 and has a pumping capacity of 7 MGD, with three 600HP pumps. Pumps #1 and #2 each have pumping capacity of 2.6 MGD, with a combined pumping capacity of 4.6 MGD. Pump #3 is capable of pumping 3 MGD, but is not operated in conjunction with the other two pumps due to hydraulic inefficiencies. This pump system serves the municipal area west of the railroad (higher elevation). This area is anticipated to experience growth, and the initial pump station design accounted for expansion to provide increased capacity to meet the additional demand. The Low Zone Service pump station currently has a capacity of 4.5 MGD, with one 150HP and two 300HP pumps. This pump system serves the municipal area east of the railroad (lower elevation). No significant growth is anticipated in this area; however, annexation of existing developments could impose increased demand for water. The pumps within this facility could be modified to provide increased capacity if necessary.

The transfer pump station provides low lift pumping from the clearwell below the filters to the 1.5 MG at grade clearwell onsite. This pump system has a capacity of 9 MGD, with three 125HP pumps capable of pumping 3 MGD each. These pumps would need to be upsized to provide increased capacity if expansion of the MRWTP is necessary.

F. Disinfection

1. Contact Time

Based on the MRWTP peak capacity of 9 MGD, interior clearwell volume of 209,800 gallons, and the 1.5 MG exterior clearwell, Table 6 provides the worst case level of disinfection with 1.2 mg/L of free chlorine achieved at the MRWTP. As shown, the level of chemical disinfection provided by the MRWTP is more than adequate.

Table 6: MRWTP Contact Time

Missouri River Water Treatment Plant - Helena, MT		
Chlorine Contact Time Calculations		
Clearwell - Circular Tank: Inlet/Outlet Same Side		
Storage Volume	1.7098	MG
Baffling Factor	0.1	
Peak Flow	9	MGD
Residual	1.2	mg/L free chlorine
pH	7.7	
Temp (worst case)	0.5	C
CT req	12	
Existing Peak Flow	9	MGD
Lowest Volume	0.85	MG
Formulas:		
Total Detention Time = Lowest Operating Volume/Peak Flow		
	136.78	**minutes**
Contact time = Total detention time X Baffling factor		
	13.68	**minutes**
Ctcalc = Residual chlorine concentration X Contact time		
	16.41	**(mg/L)*min**
Inactivation ratio = Ctcalc/Ctreq		
	1.37	

a) Storage Capacity

The 1.5-million-gallon reservoir at the MRWTP site was constructed in 2010. A 209,800 gallon interior clearwell is also available. The finished water is piped to the High and Low Zone high service pump stations to supply the respective service zones.

The reservoir provides approximately two hours of detention time at peak treatment capacity utilizing 50 percent of the available storage volume. Additional storage capacity would be required if the treatment capacity is increased.

2. Disinfection Residual

The operational target for disinfection residual at the MRWTP is 1.2ppm free chlorine. The disinfection residual is sampled and monitored by Distribution operators as required by MDEQ.

The sodium hypochlorite feed system is designed to feed to three possible locations: the top of the filters, into the interior clear well, or into the header pipe in the high service pump building – downstream of the exterior clearwell. In 2022, the feed piping to the interior clearwell failed. In order to get chemical feed back to the clearwell, operators diverted the feed line that feeds the top of the filters into the interior clearwell. The feed piping was upgraded in 2023 to add two casing pipes from the High Zone Pumpstation to Filter Building to allow future replacement without future excavation. No modifications or improvements were identified for the disinfection system at the MRWTP.

III. Capacity

A. Treatment Capacity

The current treatment capacity of the MRWTP is 9 MGD, with the primary capacity limiting factors being flow capacity through the WTP flow control valve and the plant effluent transfer pump system. The water right available to the City via the contract with the Bureau of Reclamation is currently 11,300 ac-ft, which is equivalent to approximately 10 MGD, 365 days per year, with an additional reserve water right of 11,300 ac-ft available.

B. Seasonal Operation

Currently, the MRWTP is operated as a seasonal "peaking" treatment facility. Generally, the City operates the facility from April through October to provide capacity throughout the peak water demand time of the year.

Some years, the City has needed to adjust the length of operation due to drought conditions and the resulting impact on the Tenmile Creek drainage and storage reservoirs. In conjunction with the available capacity within the Missouri River water contract with the Bureau of Reclamation, expansion of the MRWTP is the most feasible option to provide additional capacity for population growth experienced by the City beyond that being developed from groundwater sources.

C. Capacity Expansion Alternatives

The current treatment capacity (9 MGD) if operated year-round cannot maximize the existing 10 MGD water contract. Treatment expansion by approximately 50% (5 MGD addition) would provide increased capacity and flexibility, address growth and demand concerns, and allow advanced treatment potential to address periphery issues (i.e. taste and odor). Figure 10 provides a proposed layout for the addition of a filtration facility for expanded capacity.

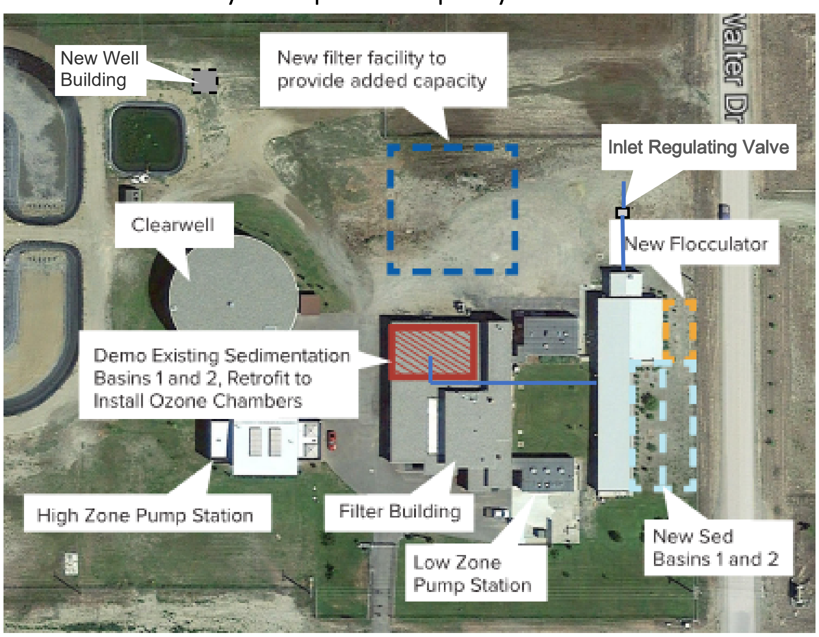


Figure 10: Proposed Facility Modifications for Capacity Expansion

IV. Facility/Infrastructure Age & Conditions

A. Asset Inventory

Site evaluation walkthroughs were conducted by AE2S at the MRWTP with plant personnel in the Summer of 2022. During these visits, the AE2S team evaluated the overall condition of the structural components of the facility, the process equipment, and electrical gear, and developed an asset inventory spreadsheet that is included in Appendix C. This asset inventory provides the age, condition, and general specifications for each piece of process equipment. The following equipment were found to be at or close to approaching their expected operational life:

- Air Scour Blowers
- Sedimentation Basins 1&2 sludge collection systems

B. Aging Infrastructure

As part of the asset inventory evaluation, an overall structural and electrical assessment was conducted over the Summer of 2022. The findings of this assessment are also presented in Appendix C. No major concerns were identified with the MRWTP structure and electrical conditions; however, the age of the facility is beginning to show as much of the facility is circa original construction in 1958. While the newer expanded facilities, such as the High Zone Pumpstation and 1.5 MG clearwell, are in good condition, the original facility will likely develop issues due to the age of the structure and process equipment. It is recommended that maintenance schedules continue and shelved spares are considered for all crucial equipment to ensure minimal downtime upon failure.

Eureka Well Station

I. Raw Water Supply & Quality – Current Capability

A. Water Right

The Eureka Well is a groundwater source of potable water used year-round. The current water right for 811.1 acre-feet per year (805 ac-ft actual) at a rate of 500 gallons per minute (gpm) expires in 2023.

B. Summary of 2022 Improvements

The 2022 improvements to this system will have a targeted capacity of 780 gpm (approximately 1.1 MGD). Main work items include two new 75HP well pumps, new chemicial feed system, distribution connection to the Upper Hale area, pressurized connection to the Hale Tank, decommissioned Reeder's Village Pumpstation and eliminated two pumped pressure zones (Reeder's Village and West Main). These improvements utilize one of the Orifino Spring water rights in conjunction with the water right for the Eureka Well.

C. Further Considerations

Currently, the City has added a PRV station to allow the Hale Zone to provide water into the Malben Zone, waiting on SCADA connection to make it operational. The PRV will help utilize this water more effectively by increasing the area served by the Eureka Well and reduce/eliminate the need for operation of the Reeder's Village booster station.

Summary of Findings

I. Tenmile WTP

- High quality, pristine water source
- Water supply source is highly susceptible to weather extremes (ie, drought, heavy rainfall)
- Gravity flow from source, through treatment, and into distribution results in a highly economical water source
- Limited water supply control or monitoring is provided by existing flow and head gate structures
- CACs cannot handle turbidity or color flashing
- Filter improvements in progress, set to be completed in Spring 2024
- No redundant filtration capacity to maintain constant rate of filtration during backwash operations
- Metals violation on backwash water discharge permit, no backwash recycle in place
- Chemical feed equipment has all been upgraded, except PAC equipment
- Clearwell capacity is meeting prescribed disinfection with free chlorine

II. Missouri River WTP

- Stable water supply with greater supply capacity than existing treatment capacity
- Existing supply pipeline is at maximum capacity and no redundancy is available
- Pumping required to push treated water into Malben High and Low Zones from WTP
  - Expansion is possible to meet growth and increased water demand
- Seasonal operation of WTP to provide for peak demand
- Taste and odor complaints can be an issue; however, effective PAC use has satisfactorily addressed this issue
- Filter media is in good condition, filters are performing very well
- Majority of chemical feed equipment has been upgraded; inconvenient and inefficient systems in place for storing chemicals
- Clearwell capacity is sufficient for treatment capacity up to 11 MGD

III. Eureka Well

- Well pumps and chemical feed equipment improvements are in progress
- Distribution improvements (ie, PRV and pipe connections) are in progress to improve the service area of the wells and improve overall system efficiency

IV. Recommendations

Short-Term Improvements (0-3 Years)

- TMWTP Supply Storage and Drainage Instrumentation and Data Collection (study in progress)
- MRWTP Operations Optimization Plan - based on Tenmile Creek drainage storage capacity/drought mitigation concerns
- MRWTP Groundwater Development – groundwater development is in progress currently, will provide significant source water capacity to the treatment facility
- MRWTP Chemical Feed Storage Addition – for safe and efficient loading/off-loading of chemicals
- TMWTP Pretreament Facility – traditional flocculation/sedimentation process utilizing plate settlers, and optimized chemical feed strategy, will provide volume and pretreatment performance to protect against flashing events and forest fire drainage impacts

- TMWTP Filter Backwash Recycle – recycling backwash water will conserve water supply and mitigate discharge permitting issues
- MRWTP Evaluation of New Raw Water Supply Pipeline Routing – evaluate various pipe materials, sizes, and routing for new redundant supply pipeline
- MRWTP Evaluation of Facility Treatment Upgrades & Expansion – pending groundwater development result, evaluate process and facility layout for new treatment technologies and filter capacity expansion onsite

Table 7: Short-Term Improvements – Cost Estimates

Short-Term Treatment System Improvements					
Priority	Facility	Description	OPCC (Current Yr)	OPCC (Anticipated Yr)	Year
1	TMWTP	Storage/Drainage Instrumentation and Data Collection	Study in Progress		2024
2	MRWTP	Groundwater Development Phase 1	$1,850,000		2024
3	MRWTP	Groundwater Development Phase 2	$7,925,000	$8,125,000	2025
4	MRWTP	Operations Optimization Study to Maximize Ten Mile Creek Capacity	$47,500	$51,063	2025
5	MRWTP	Chemical Feed Storage Addition	$377,000	$405,275	2025
6	TMWTP	Add Pretreatment Facility	$9,120,000	$10,032,000	2026
7	TMWTP	Recycle Filter Backwash	$325,000	$357,500	2026
8	TMWTP	Perform Chemical Feed Optimization	$37,500	$41,250	2026
9	MRWTP	Evaluate New Raw Water Supply Pipeline Routing	$22,500	$25,313	2027
10	MRWTP	Evaluate Facility Upgrade/Expansion Site	$39,500	$44,438	2027

[1]Future costs assume a 2.5% annual inflation rate

Long-Term Improvements (5-20 Years)

- TMWTP Installation of Additional Filtration Capacity – removal of CAC units and utilize footprint to install packaged conventional filters (or ultrafiltration membrane cassettes)
- MRWTP - If Addition of Advance Oxidation is Selected
  - MRWTP Expansion of Flocculation and Sedimentation Basins – expansion of new floc/sed building to add one additional flocculator and two new sedimentation basins
  - MRWTP Modification of old Sedimentation Basins to Ozone Contact Chambers – retrofit the old sedimentation basins into Ozone Contact Chambers, add ozone generation, injection, and destruction equipment to provide advanced oxidation process ahead of filters

    - MRWTP Modification of Conventional Filters to Biological Filters – upgrade filters by removing existing media and replacing with Granular Activated Carbon to provide biological filtration
- MRWTP - If Growth/Water Demands Require Capacity Increase Past 11MGD (including groundwater)
    - MRWTP Increase Clearwell Capacity – construct additional 1.5 MG at grade clearwell to maintain disinfection contact time for additional treatment capacity
    - MRWTP Upgrade Pumping Systems – add/upgrade pumping systems throughout the WTP to match additional treatment/demand capacity

- MRWTP - If Growth/Water Demands Require Capacity Increase Past 9MGD (not including groundwater)
    - MRWTP Construction of New Raw Water Supply Pipeline – based upon findings from evaluation with Short-Term Improvements, install new redundant supply pipeline
    - MRWTP Addition of Filtration Expansion Facility – construct new filtration facility to provide 50% more treatment capacity at the WTP

Table 8: Long-Term Improvements

Long-Term Treatment Improvements					
Priority	Facility	Description	OPCC (Current Yr)	OPCC (Anticipated Yr)	Year
1	TMWTP	Remove CACs/Install Additional Filtration Capacity	$2,060,000	$2,369,000	2028
2	MRWTP	Add New Flocculator and Sedimentation Basins	$3,205,000	$3,765,875	2029
3	MRWTP	Modify old Sed Basins to Ozone Contact	$7,200,000	$8,640,000	2030
4	MRWTP	Modify Filters to Biological Filtration (with GAC)	$725,000	$870,000	2030
5	MRWTP	Construct 36" Raw Water Supply Pipeline	$5,757,500	$7,196,875	2032
6	MRWTP	Add New Filtration Facility	$10,990,000		TBD*
7	MRWTP	Upgrade Pump Systems for Additional Capacity	$1,500,000		TBD*
8	MRWTP	Increase Water Storage for Additional Capacity	$6,500,000		TBD*

[1]Future costs assume a 2.5% annual inflation rate

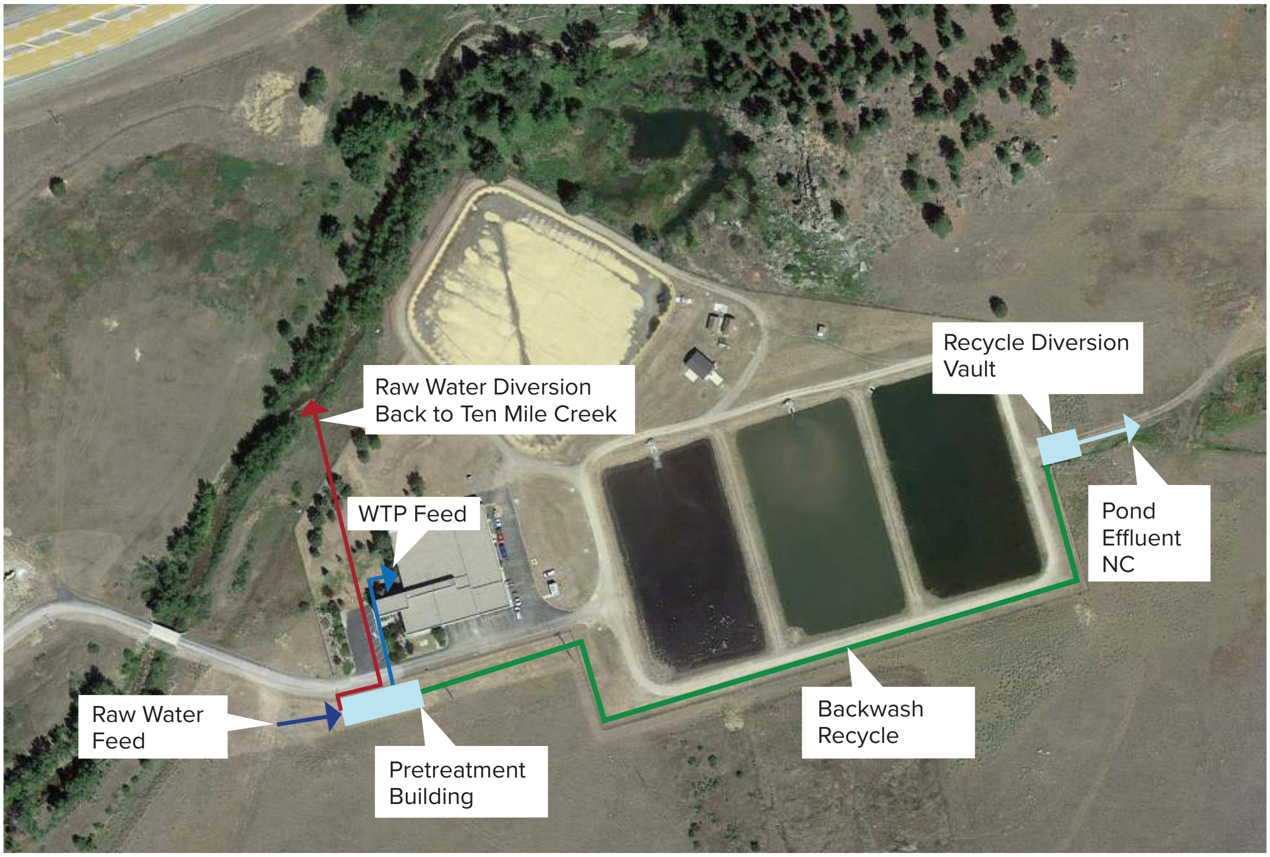
*To Be Determined, based on groundwater supply and future population growth/demand

City of Helena

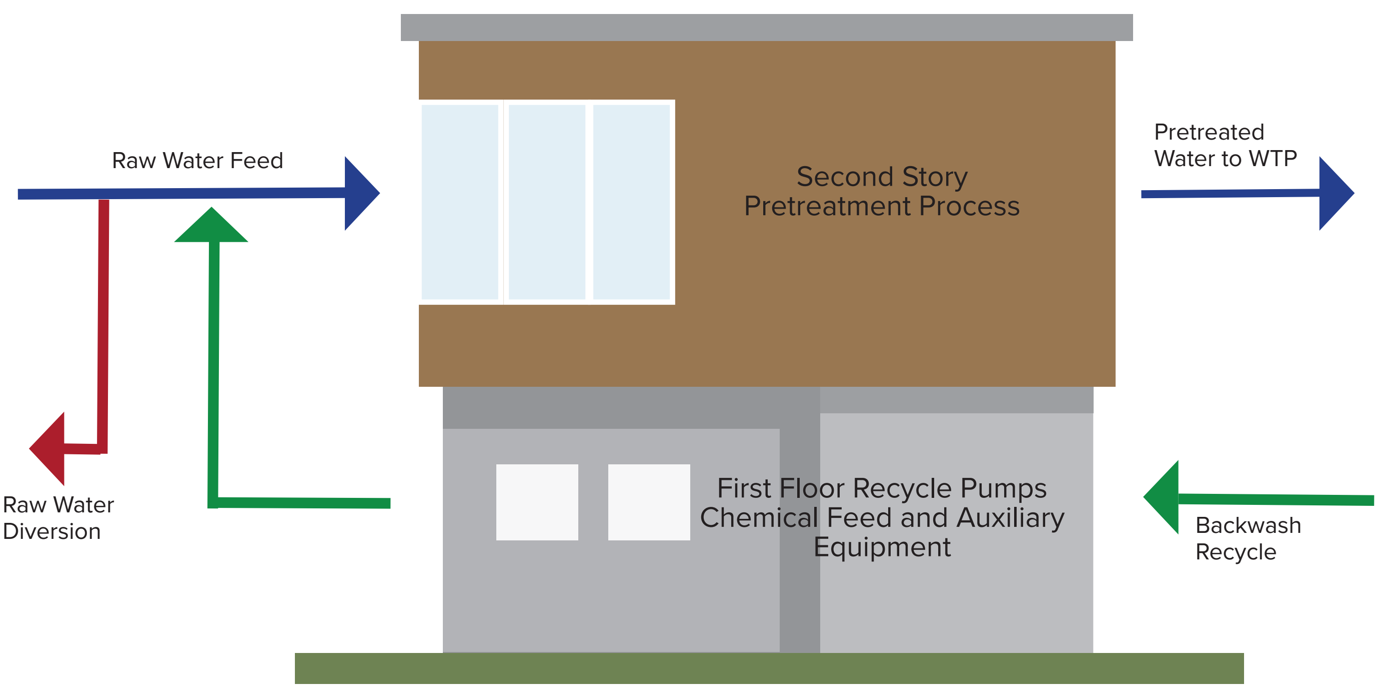
APPENDIX A

TENMILE WTP INFORMATION

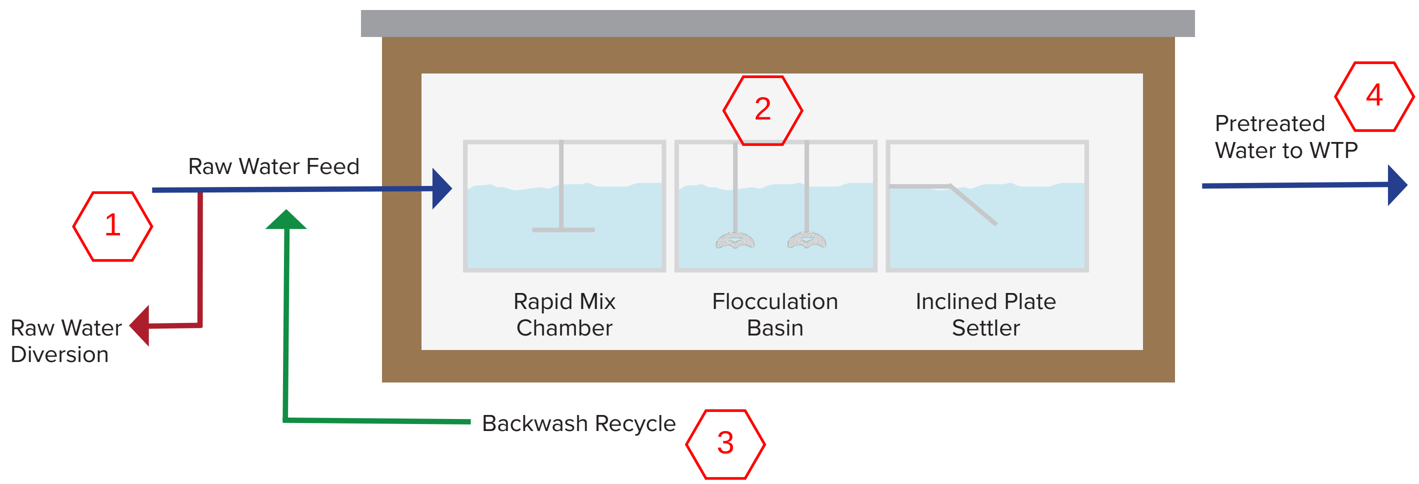
TEN MILE WTP SITE OVERVIEW



Pretreatment Building Side View



Second Story Pretreatment Process



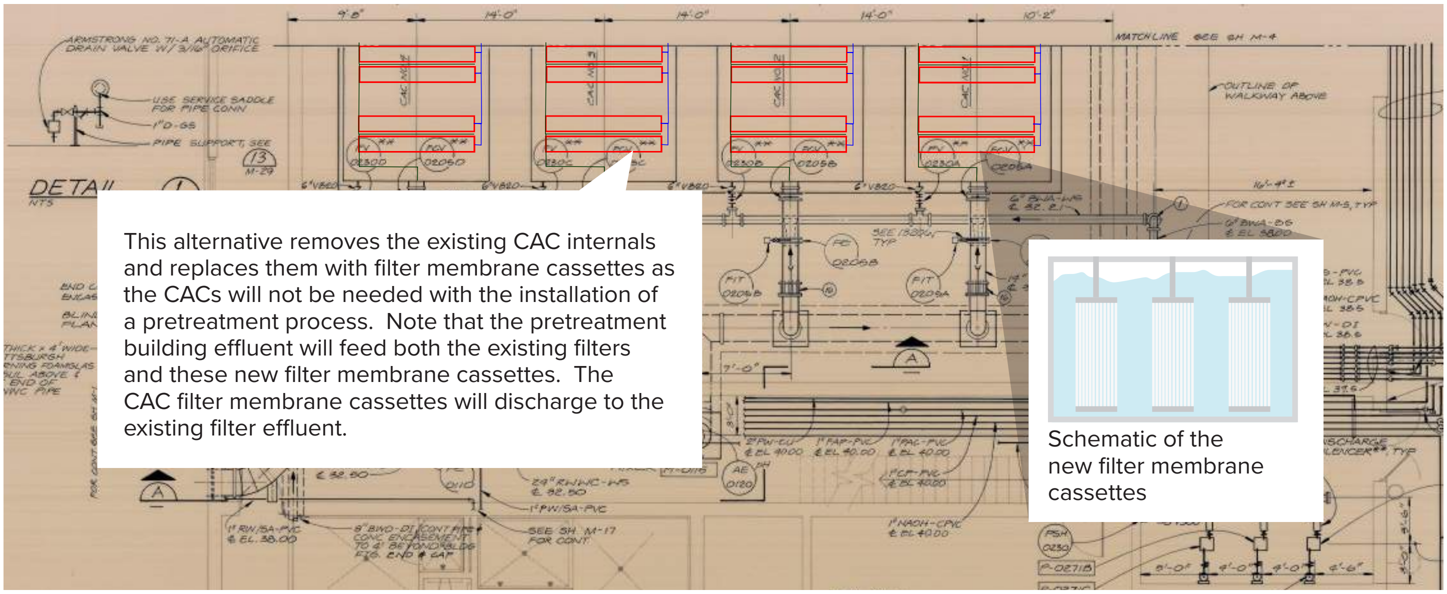
1. Automated raw water feed allows operator flexibility and control of feed rate to the WTP based on raw water quality and treatment processes

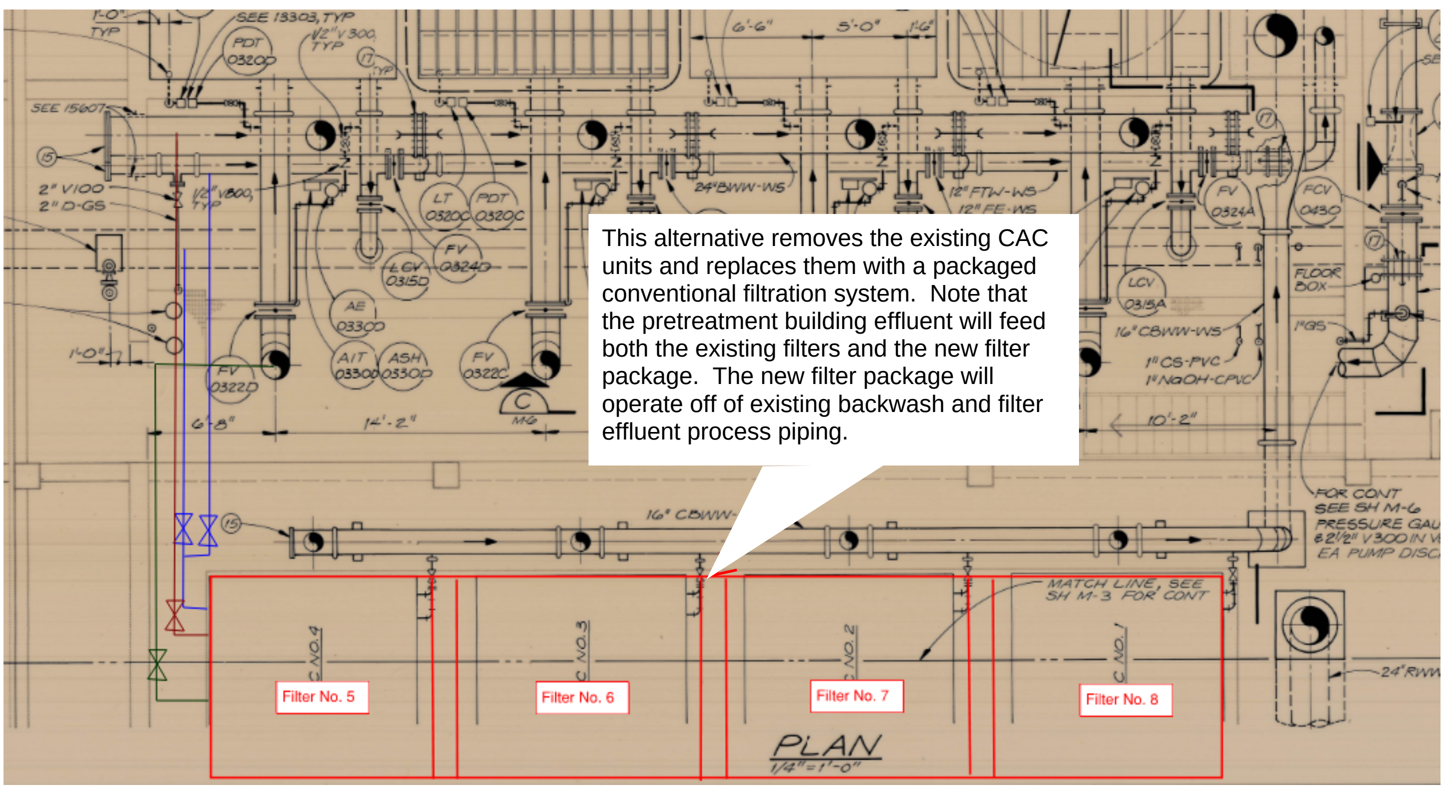
2. Conventional pretreatment process provides maximized turbidity removal in conjunction with volume to mitigate "flashing"

3. Backwash recycle allows backwash effluent to recycle back to pretreatment process to eliminate wasting and the need to discharge permitting

4. Pretreatment effluent discharge matches existing WTP filter feed hydraulic grade line to eliminate need for pumping

CAC Conversion Diagram





Helena Ten Mile WTP
Pre-Treatment Process

January 19, 2023

Preliminary

Budgetary Opinion of Probable Project Construction Cost

No.	Item	QUANTITY	UNIT	UNIT COST	INSTALLED COST	
A.	**General Conditions**					
1.0	**General Conditions**					
1.0	Insurance, Bonds, Mobilization, Travel, Subsistence, Etc. (7%)	1	LS		$ 537,499	
	Subtotal General Conditions					
B.	**Civil/Site**					
1.0	**Improvements**					
1	Excavation & Placement	5000	CY	$ 40.00	$ 200,000.00	
2	Yard piping (raw water pipeline/outlet to plant/sludge blowdown/diversion)	1900	LF	$ 80.00	$ 152,000.00	
3	Yard Piping Fittings	1	LS	$ 10,000.00	$ 10,000.00	
	Subtotal Civil/Site				**$ 362,000.00**	
C.	**Structural**					
1.0	**Improvements**					
1	Cast-in-Place Concrete (140' x 85'; assumed mat foundation)	3000	CY	$ 1,250.00	$ 3,750,000.00	
	Subtotal Structural				**$ 3,750,000.00**	
D.	**Architectural**					
1.0	**Improvements**					
1	CMU Walls (140' x 85')	1	LS	$ 250,000.00	$ 250,000.00	
2	Roofing/ Structural steel (Steel Truss)	1	LS	$ 250,000.00	$ 250,000.00	
	Subtotal Architectural				**$ 500,000.00**	
E.	**Process**					
1.0	**Improvements**					
1	Rapid Mix Unit	1	LS	$ 55,000.00	$ 55,000.00	
2	Dual Stage Flocculators	3	EA	$ 100,000.00	$ 300,000.00	
3	Inclined Plate Settlers, 304SS Supports, FRP Baffles/Launders, Chain & Flight	1	LS	$ 1,050,000.00	$ 1,050,000.00	
4	Chemical Feed (Expand current system)	1	LS	$ 50,000.00	$ 50,000.00	
5	Process Piping	1	LS	$ 60,000.00	$ 60,000.00	
6	Sludge Pumps	2	EA	$ 150,000.00	$ 300,000.00	
	Subtotal Process				**$ 1,815,000.00**	
F.	**Mechanical**					
1.0	**Improvements**					
1	Heating & Ventilation	1	LS	$ 250,000.00	$ 250,000.00	
	Subtotal Mechanical				**$ 250,000.00**	
H.	**Electrical and Instrumentation and Controls**					
1.0	**Improvements**					
1	Electrical w/ I/C (15%)	1	LS	$ 1,001,550.00	$ 1,001,550.00	
	Subtotal Electrical and Instrumentation and Controls				**$ 1,001,550.00**	
	SUBTOTAL CONSTRUCTION COSTS				$ 8,216,048.50	
	Contingencies (15%)				$ 1,232,407.28	
	TOTAL CONSTRUCTION COSTS					**$ 9,448,455.78**
	Non-Construction Costs					
	Design Engineering (6%)				$ 566,907.35	
	Construction Engineering - RPR (10%)				$ 944,845.58	
	Legal/ Admin (5%)				$ 472,423	
	Subtotal Non-Construction Costs					**$ 1,984,175.71**
	TOTAL ESTIMATED COST					**$ 11,433,000**

Helena Ten Mile WTP
CAC Membrane Filter Cassettes

January 19, 2023

Preliminary

Budgetary Opinion of Probable Project Construction Cost

No.	Item	QUANTITY	UNIT	UNIT COST	INSTALLED COST	
A.	**General Conditions**					
1.0	**General Conditions**					
1.0	Insurance, Bonds, Mobilization, Travel, Subsistence, Etc. (7%)	1	LS		$ 205,205	
	Subtotal General Conditions					
B.	**Civil/Site**					
1.0	**Improvements**					
1	CAC Decommisioning and Internals Removal	4	CF	$ 15,000.00	$ 60,000.00	
	Subtotal Civil/Site				**$ 60,000.00**	
C.	**Structural**					
1.0	**Improvements**					
1					$ -	
	Subtotal Structural				**$ -**	
D.	**Architectural**					
1.0	**Improvements**					
1			LS		$ -	
2			LS		$ -	
	Subtotal Architectural				**$ -**	
E.	**Process**					
1.0	**Improvements**					
1	ZeeWeed 1000 Membrane Modules & Cassette System	1	LS	$ 1,700,000.00	$ 1,955,000.00	
2	Piping Modifications	1	LS	$ 150,000.00	$ 150,000.00	
3	Backwash System (Pumps at Existing Surface Wash Pump Location)	1	LS	$ 100,000.00	$ 100,000.00	
4	Existing Tank Modifications	4	EA	$ 25,000.00	$ 100,000.00	
5	Equipment Installation	1	LS	$ 300,000.00	$ 300,000.00	
	Subtotal Process				**$ 2,605,000.00**	
F.	**Mechanical**					
1.0	**Improvements**					
1			LS			
	Subtotal Mechanical				**$ -**	
H.	**Electrical and Instrumentation and Controls**					
1.0	**Improvements**					
1	Electrical w/ I/C (10%)	1	LS	$ 266,500.00	$ 266,500.00	
	Subtotal Electrical and Instrumentation and Controls				**$ 266,500.00**	
	SUBTOTAL CONSTRUCTION COSTS				$ 3,136,705.00	
	Contingencies (15%)				$ 470,505.75	
	TOTAL CONSTRUCTION COSTS					**$ 3,607,210.75**
	Non-Construction Costs					
	Design Engineering (6%)				$ 216,432.65	
	Construction Engineering - RPR (10%)				$ 360,721.08	
	Legal/ Admin (5%)				$ 180,361	
	Subtotal Non-Construction Costs					**$ 757,514.26**
	TOTAL ESTIMATED COST					**$ 4,365,000**

Helena Ten Mile WTP

January 19, 2023

CAC Replacement with Packaged Conventional Filtration

Preliminary

Budgetary Opinion of Probable Project Construction Cost

No.	Item	QUANTITY	UNIT	UNIT COST	INSTALLED COST	
A.	**General Conditions**					
1.0	**General Conditions**					
1.0	Insurance, Bonds, Mobilization, Travel, Subsistence, Etc. (7%)	1	LS		$ 117,194	
	Subtotal General Conditions					
B.	**Civil/Site**					
1.0	**Improvements**					
1	CAC Demo	4	CF	$ 40,000.00	$ 160,000.00	
	Subtotal Civil/Site				**$ 160,000.00**	
C.	**Structural**					
1.0	**Improvements**					
1					$ -	
	Subtotal Structural				**$ -**	
D.	**Architectural**					
1.0	**Improvements**					
1			LS		$ -	
2			LS		$ -	
	Subtotal Architectural				**$ -**	
E.	**Process**					
1.0	**Improvements**					
1	WesTech Rectangular Steel Gravity Filter	1	LS	$ 880,000.00	$ 1,012,000.00	
2	Piping Modifications	1	LS	$ 50,000.00	$ 50,000.00	
3	Backwash System (Pumps at Existing Surface Wash Pump Location)	1	LS	$ 100,000.00	$ 100,000.00	
5	Equipment Installation	1	LS	$ 200,000.00	$ 200,000.00	
	Subtotal Process				**$ 1,362,000.00**	
F.	**Mechanical**					
1.0	**Improvements**					
1			LS			
	Subtotal Mechanical				**$ -**	
H.	**Electrical and Instrumentation and Controls**					
1.0	**Improvements**					
1	Electrical w/ I/C (10%)	1	LS	$ 152,200.00	$ 152,200.00	
	Subtotal Electrical and Instrumentation and Controls				**$ 152,200.00**	
	SUBTOTAL CONSTRUCTION COSTS				$ 1,791,394.00	
	Contingencies (15%)				$ 268,709.10	
	TOTAL CONSTRUCTION COSTS					**$ 2,060,103.10**
	Non-Construction Costs					
	Design Engineering (6%)				$ 123,606.19	
	Construction Engineering - RPR (10%)				$ 206,010.31	
	Legal/ Admin (5%)				$ 103,005	
	Subtotal Non-Construction Costs					**$ 432,621.65**
	TOTAL ESTIMATED COST					**$ 2,493,000**

Helena Ten Mile WTP
Backwash Recycle - Large Suction Line with Pretreatment Building

January 19, 2023

Preliminary

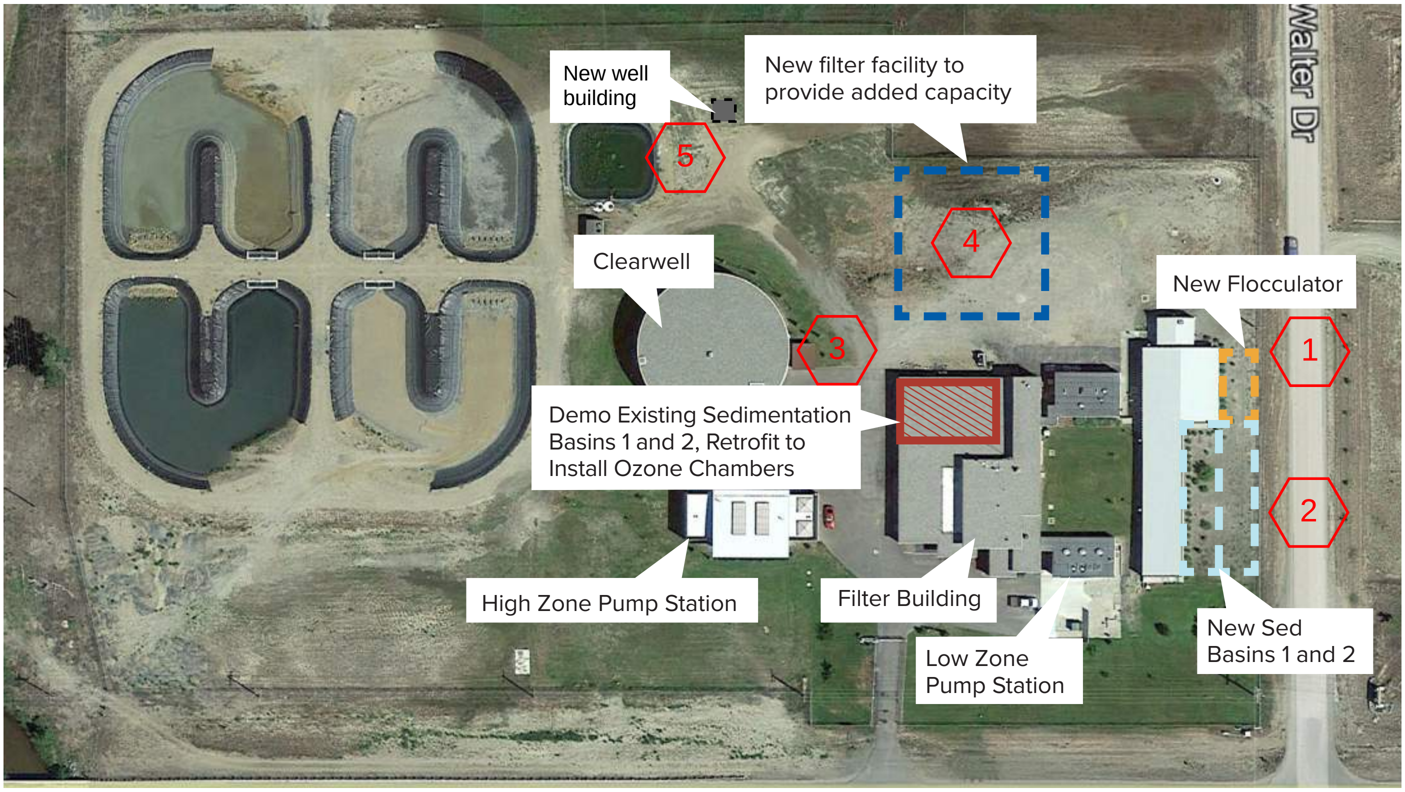
Budgetary Opinion of Probable Project Construction Cost

No.	Item	QUANTITY	UNIT	UNIT COST	INSTALLED COST	
A.	**General Conditions**					
1.0	**General Conditions**					
1.0	Insurance, Bonds, Mobilization, Travel, Subsistence, Etc. (7%)	1	LS		$ 38,238	
	Subtotal General Conditions					
B.	**Civil/Site**					
1.0	**Improvements**					
1	Excavation & Placement	4500	CF	$ 40.00	$ 180,000.00	
2	Yard piping - 16" PVC at 1,500 feet from Pond Effluent to Pretreatment	1500	LF	$ 80.00	$ 120,000.00	
	Subtotal Civil/Site				**$ 300,000.00**	
C.	**Structural**					
1.0	**Improvements**					
1	Pond Effluent Vault	1	LS	$ 25,000.00	$ 25,000.00	
	Subtotal Structural				**$ 25,000.00**	
D.	**Architectural**					
1.0	**Improvements**					
			LS		$ -	
			LS		$ -	
	Subtotal Architectural				**$ -**	
E.	**Process**					
1.0	**Improvements**					
1	Backwash Recycle Pumps	1	LS	$ 100,000.00	$ 100,000.00	
2	Vault Diversion Fittings	1	LS	$ 50,000.00	$ 50,000.00	
	Subtotal Process				**$ 150,000.00**	
F.	**Mechanical**					
1.0	**Improvements**					
			LS			
	Subtotal Mechanical				**$ -**	
H.	**Electrical and Instrumentation and Controls**					
1.0	**Improvements**					
1	Electrical w/ I/C (15%)	1	LS	$ 71,250.00	$ 71,250.00	
	Subtotal Electrical and Instrumentation and Controls				**$ 71,250.00**	
	SUBTOTAL CONSTRUCTION COSTS				$ 584,487.50	
	Contingencies (15%)				$ 87,673.13	
	TOTAL CONSTRUCTION COSTS					**$ 672,160.63**
	Non-Construction Costs					
	Design Engineering (6%)				$ 40,329.64	
	Construction Engineering - RPR (10%)				$ 67,216.06	
	Legal/ Admin (5%)				$ 33,608	
	Subtotal Non-Construction Costs					**$ 141,153.73**
	TOTAL ESTIMATED COST					**$ 813,000**

APPENDIX B

MISSOURI RIVER WTP INFORMATION

Missouri River WTP Overview



1. New rapid mix and additional flocculation required for additional treatment capacity only

2. One new sedimentation basin will replace the existing Sedimentation Basins #1 and #2, additional sedimentation basin required for additional treatment capacity only

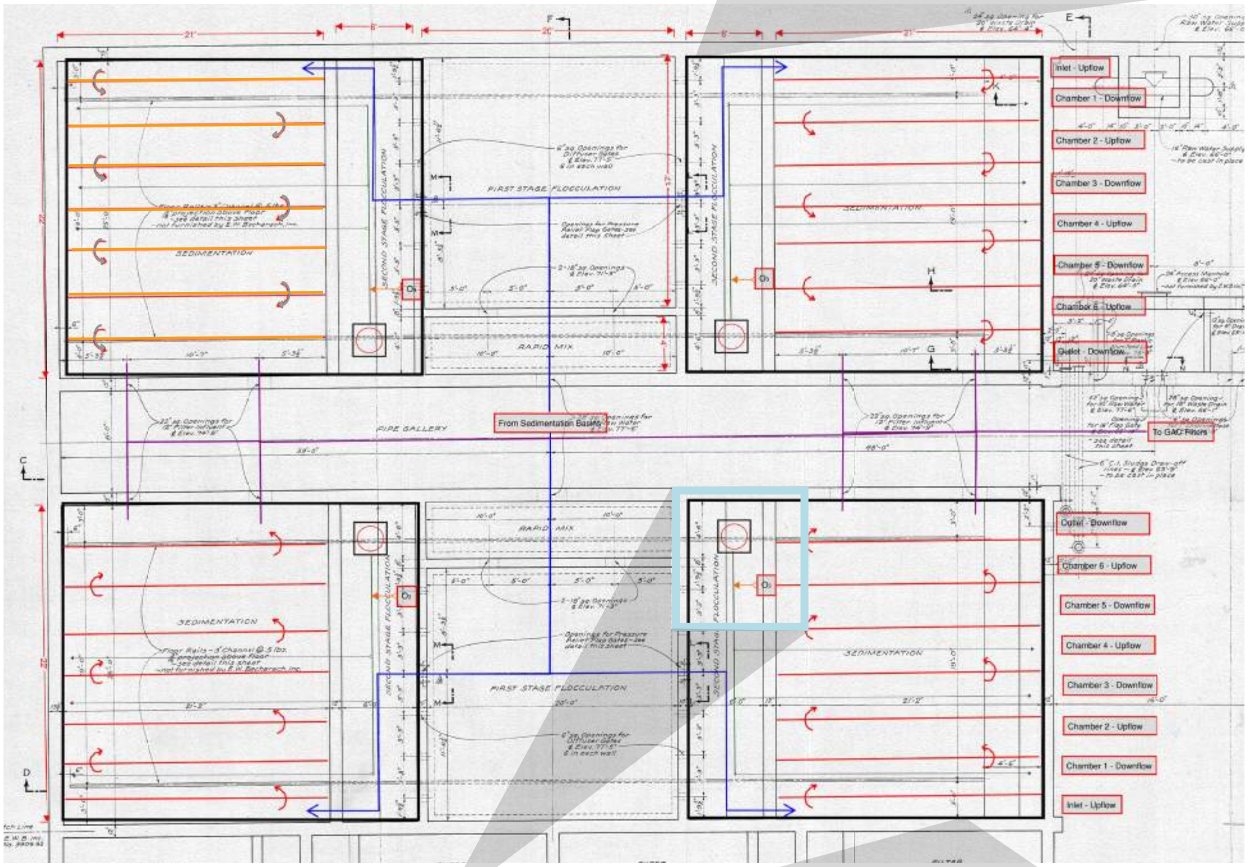
3. Replacement of existing sedimentation basins with advanced oxidation treatment with ozone could be performed to help with taste and odor issues

4. New filter building would provide additional filtration capacity and would be designed to be expanded in the future to replace the existing filter building altogether

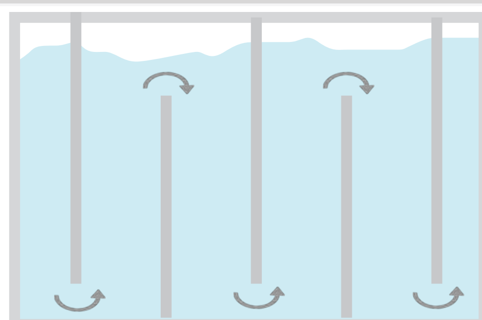
5. New well building will bring groundwater well development into the MRWTP, this additional source water capacity will impact timeframe for necessary treatment capacity upgrades necessary

Sedimentation Basin Conversion Diagram

Ozone chambers will have a concrete lid with a vacuum system to collect excess ozone for deconstruction.

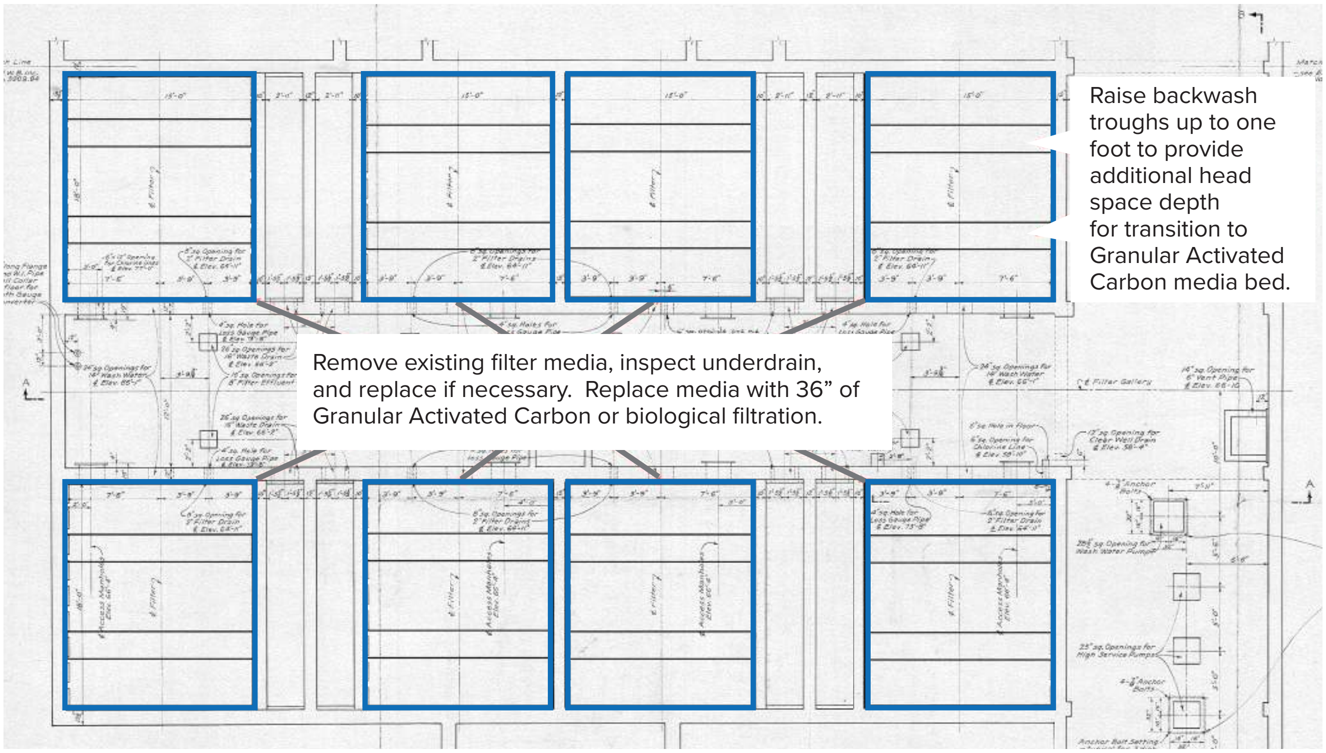


Side stream injection - pumps water from second flocculation stage and ozone is injected prior to flowing through jet nozzles in ozone chamber.

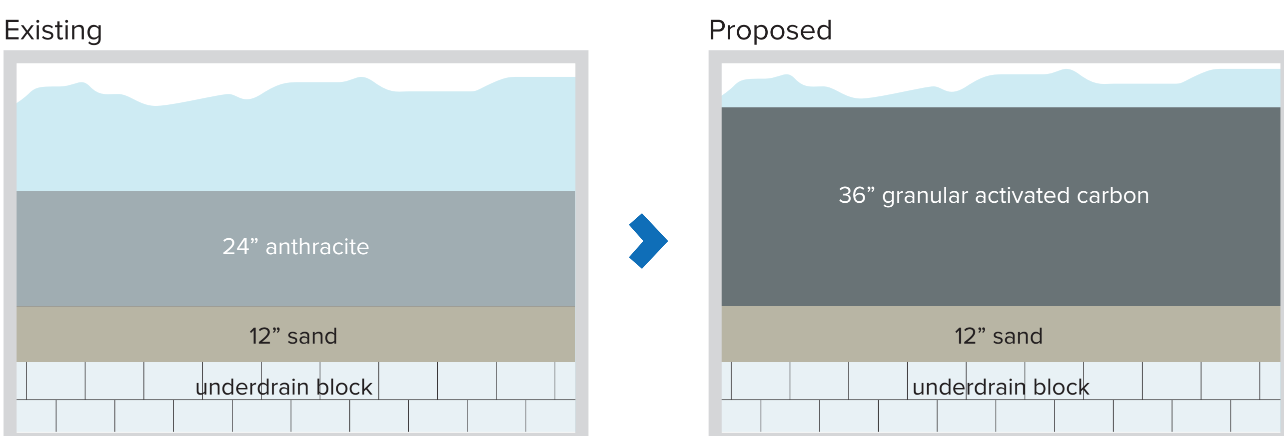


Schematic of the new ozone chamber layout, utilizing side stream injection.

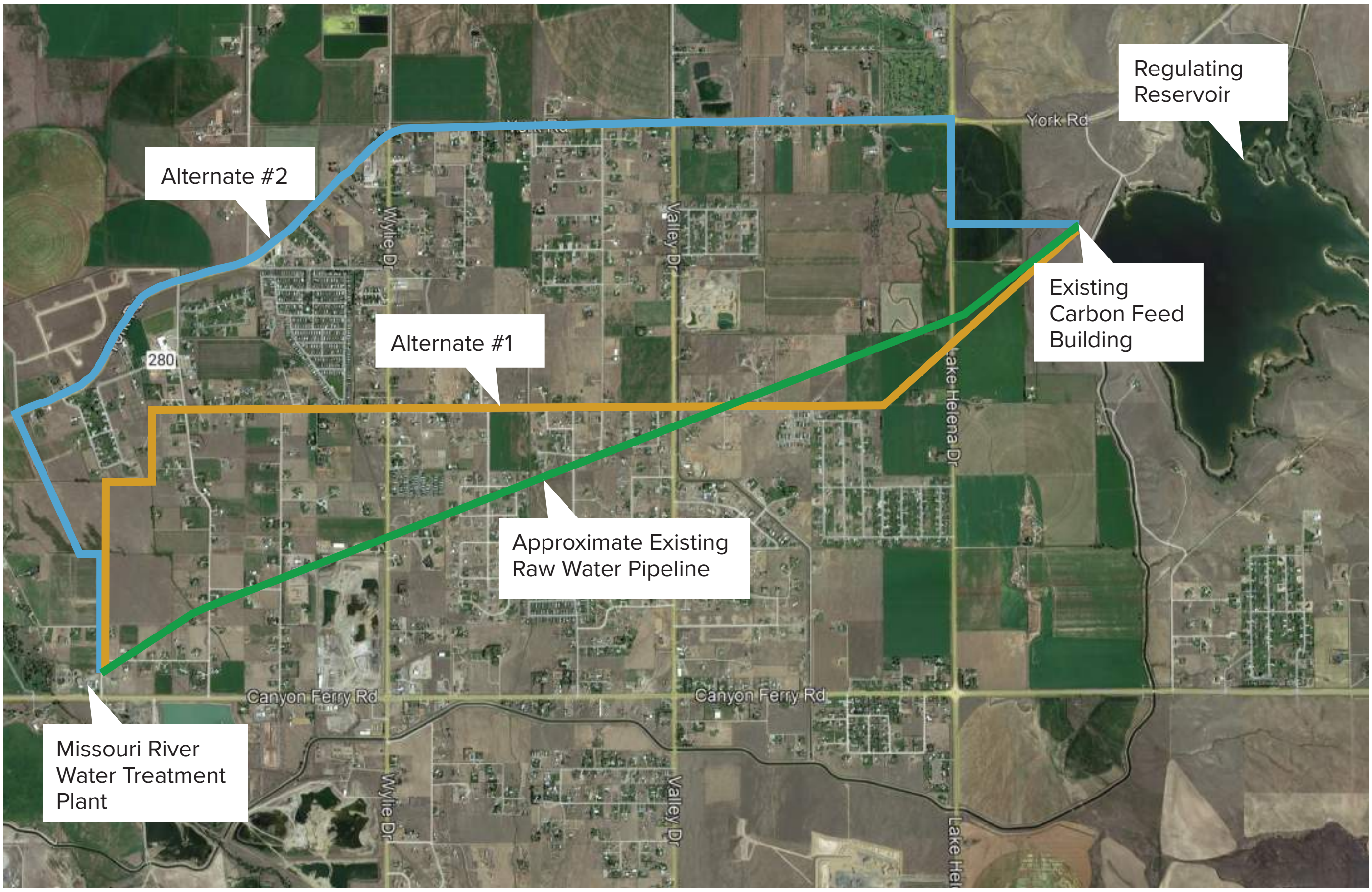
Granular Activated Carbon Conversion Diagram



Filter Basin Schematic



Raw Water Alternatives



Raw Water Alternatives Analysis

Alternate #1: Howard Road

Merits:

- Shorter route by almost one mile
- Lower traffic volume
- Howard Road is mostly gravel

Drawbacks:

- More intersections
- Increased residential impacts
- Potentially crossing existing raw water line

Alternate #2: York Road

Merits:

- Fewer intersections
- Decreased impact to residential areas
- Will not cross the existing raw water line

Drawbacks:

- Longer route by almost one mile
- Higher traffic volume
- York Road is asphalt pavement

Both Alternatives #1 and #2

- Potential overhead powerlines and other utility conflicts
- Provide redundancy
- Limited parcel data on Montana Cadastral

Helena Missouri River WTP
Chemical Feed Addition

January 19, 2023

Preliminary

Budgetary Opinion of Probable Project Construction Cost

No.	Item	QUANTITY	UNIT	UNIT COST	INSTALLED COST	
A.	**General Conditions**					
1.0	**General Conditions**					
1.0	Insurance, Bonds, Mobilization, Travel, Subsistence, Etc. (7%)	1	LS		$ 21,445	
	Subtotal General Conditions					
B.	**Civil/Site**					
1.0	**Improvements**					
1	Excavation & Placement	150	CY	$ 40.00	$ 6,000.00	
	Subtotal Civil/Site				**$ 6,000.00**	
C.	**Structural**					
1.0	**Improvements**					
1	Cast-in-Place Concrete (25' x 25'; assumed mat foundation)	50	CY	$ 1,250.00	$ 62,500.00	
	Subtotal Structural				**$ 62,500.00**	
D.	**Architectural**					
1.0	**Improvements**					
1	Steel Beam Walls (25' x 25')	1	LS	$ 45,000.00	$ 45,000.00	
2	Steel Roofing/Siding	1	LS	$ 30,000.00	$ 30,000.00	
	Subtotal Architectural				**$ 75,000.00**	
E.	**Process**					
1.0	**Improvements**					
1	Chem Feed Piping	1	LS	$ 15,000.00	$ 15,000.00	
2	Secondary Containment Berms	1	EA	$ 10,000.00	$ 10,000.00	
3	Coiling Garage Door	2	LS	$ 20,000.00	$ 40,000.00	
4	Overhead Crane	1	LS	$ 45,000.00	$ 45,000.00	
	Subtotal Process				**$ 110,000.00**	
F.	**Mechanical**					
1.0	**Improvements**					
1	Heating & Ventilation	1	LS	$ 25,000.00	$ 25,000.00	
	Subtotal Mechanical				**$ 25,000.00**	
H.	**Electrical and Instrumentation and Controls**					
1.0	**Improvements**					
1	Electrical w/ I/C (15%)	1	LS	$ 27,850.00	$ 27,850.00	
	Subtotal Electrical and Instrumentation and Controls				**$ 27,850.00**	
	SUBTOTAL CONSTRUCTION COSTS				$ 327,794.50	
	Contingencies (15%)				$ 49,169.18	
	TOTAL CONSTRUCTION COSTS					**$ 376,963.68**
	Non-Construction Costs					
	Design Engineering (6%)				$ 22,617.82	
	Construction Engineering - RPR (10%)				$ 37,696.37	
	Legal/ Admin (5%)				$ 18,848	
	Subtotal Non-Construction Costs					**$ 79,162.37**
	TOTAL ESTIMATED COST					**$ 456,000**

Helena Missouri River WTP
Pretreatment Process

January 19, 2023

Preliminary

Budgetary Opinion of Probable Project Construction Cost

No.	Item	QUANTITY	UNIT	UNIT COST	INSTALLED COST	
A.	**General Conditions**					
1.0	**General Conditions**					
1.0	Insurance, Bonds, Mobilization, Travel, Subsistence, Etc. (7%)	1	LS		$ 182,413	
	Subtotal General Conditions					
B.	**Civil/Site**					
1.0	**Improvements**					
1	Excavation & Placement	1850	CY	$ 40.00	$ 74,000.00	
2	Yard piping (sed basin connections/outlet to plant/sludge blowdown)	250	LF	$ 80.00	$ 20,000.00	
3	Yard Piping Fittings	1	LS	$ 10,000.00	$ 10,000.00	
	Subtotal Civil/Site				**$ 104,000.00**	
C.	**Structural**					
1.0	**Improvements**					
1	Cast-in-Place Concrete (100' x 25'; assumed mat foundation)	400	CY	$ 1,250.00	$ 500,000.00	
	Subtotal Structural				**$ 500,000.00**	
D.	**Architectural**					
1.0	**Improvements**					
1	Steel Beam Walls (100' x 50')	1	LS	$ 125,000.00	$ 125,000.00	
2	Steel Roofing/Siding	1	LS	$ 75,000.00	$ 75,000.00	
	Subtotal Architectural				**$ 200,000.00**	
E.	**Process**					
1.0	**Improvements**					
1	Rapid Mix Unit	1	LS	$ 55,000.00	$ 55,000.00	
2	Dual Stage Flocculators	1	EA	$ 100,000.00	$ 100,000.00	
3	Tube Settlers, 304SS Supports, FRP Baffles/Launders, Chain & Flight	2	LS	$ 600,000.00	$ 1,200,000.00	
4	Process Piping	1	LS	$ 60,000.00	$ 60,000.00	
5	Sludge Pumps	1	EA	$ 75,000.00	$ 75,000.00	
	Subtotal Process				**$ 1,490,000.00**	
F.	**Mechanical**					
1.0	**Improvements**					
1	Heating & Ventilation	1	LS	$ 75,000.00	$ 75,000.00	
	Subtotal Mechanical				**$ 75,000.00**	
H.	**Electrical and Instrumentation and Controls**					
1.0	**Improvements**					
1	Electrical w/ I/C (15%)	1	LS	$ 236,900.00	$ 236,900.00	
	Subtotal Electrical and Instrumentation and Controls				**$ 236,900.00**	
	SUBTOTAL CONSTRUCTION COSTS				$ 2,788,313.00	
	Contingencies (15%)				$ 418,246.95	
	TOTAL CONSTRUCTION COSTS					**$ 3,206,559.95**
	Non-Construction Costs					
	Design Engineering (6%)				$ 192,393.60	
	Construction Engineering - RPR (10%)				$ 320,656.00	
	Legal/ Admin (5%)				$ 160,328	
	Subtotal Non-Construction Costs					**$ 673,377.59**
	TOTAL ESTIMATED COST					**$ 3,880,000**

Helena Missouri River WTP
Ozone Treatment w/ Biological Filtration

January 19, 2023

Preliminary

Budgetary Opinion of Probable Project Construction Cost

No.	Item	QUANTITY	UNIT	UNIT COST	INSTALLED COST	
A.	**General Conditions**					
1.0	**General Conditions**					
1.0	Insurance, Bonds, Mobilization, Travel, Subsistence, Etc. (7%)	1	LS		$ 450,470	
	Subtotal General Conditions					
B.	**Civil/Site**					
1.0	**Improvements**					
1	Sed Basins 1&2 Decommisioning and Internals Removal	2	EA	$ 15,000.00	$ 30,000.00	
2	Conventional Filters - media removal/raise troughs	8	EA	$ 25,000.00	$ 200,000.00	
	Subtotal Civil/Site				**$ 230,000.00**	
C.	**Structural**					
1.0	**Improvements**					
1	Ozone Chambers - Vented Covers	150	CY	$ 1,250.00	$ 187,500.00	
2	Ozone Chambers - Vertical Baffles	28	EA	$ 17,850.00	$ 499,800.00	
	Subtotal Structural				**$ 687,300.00**	
D.	**Architectural**					
1.0	**Improvements**					
1			LS		$ -	
2			LS		$ -	
	Subtotal Architectural				**$ -**	
E.	**Process**					
1.0	**Improvements**					
1	SMO evo Ozone System	1	LS	$ 3,100,000.00	$ 3,565,000.00	
2	Side Stream Injection Pump/Piping Modifications	1	LS	$ 250,000.00	$ 287,500.00	
3	Existing Basin Improvements	4	EA	$ 50,000.00	$ 200,000.00	
4	Biological Filter Media (30"+ Granular Activated Carbon, 12" Fine Sand)	8	EA	$ 65,000.00	$ 520,000.00	
5	Equipment Installation	1	LS	$ 450,000.00	$ 450,000.00	
	Subtotal Process				**$ 5,022,500.00**	
F.	**Mechanical**					
1.0	**Improvements**					
1	Ventilation Improvements	1	LS	$ 50,000.00	$ 50,000.00	
	Subtotal Mechanical				**$ 50,000.00**	
H.	**Electrical and Instrumentation and Controls**					
1.0	**Improvements**					
1	Electrical w/ I/C (10%)	1	LS	$ 445,485.00	$ 445,485.00	
	Subtotal Electrical and Instrumentation and Controls				**$ 445,485.00**	
	SUBTOTAL CONSTRUCTION COSTS				$ 6,885,754.95	
	Contingencies (15%)				$ 1,032,863.24	
	TOTAL CONSTRUCTION COSTS					**$ 7,918,618.19**
	Non-Construction Costs					
	Design Engineering (6%)				$ 475,117.09	
	Construction Engineering - RPR (10%)				$ 791,861.82	
	Legal/ Admin (5%)				$ 395,931	
	Subtotal Non-Construction Costs					**$ 1,662,909.82**
	TOTAL ESTIMATED COST					**$ 9,582,000**

Helena Missouri River WTP
Facility - Filtration Expansion

January 19, 2023

Preliminary

Budgetary Opinion of Probable Project Construction Cost

No.	Item	QUANTITY	UNIT	UNIT COST	INSTALLED COST	
A.	**General Conditions**					
1.0	**General Conditions**					
1.0	Insurance, Bonds, Mobilization, Travel, Subsistence, Etc. (7%)	1	LS		$ 952,648	
	Subtotal General Conditions					
B.	**Civil/Site**					
1.0	**Improvements**					
1	36" Raw Water Supply Pipeline	24500	LF	$ 235.00	$ 5,757,500.00	
2	Excavation/Backfill	2250	CY	$ 45.00	$ 101,250.00	
3	Yard Piping	1	LS	$ 25,000.00	$ 25,000.00	
	Subtotal Civil/Site				**$ 5,883,750.00**	
C.	**Structural**					
1.0	**Improvements**					
1	Cast-in-Place Concrete (80' x 45'; assumed mat foundation)	1100	CY	$ 1,250.00	$ 1,375,000.00	
	Subtotal Structural				**$ 1,375,000.00**	
D.	**Architectural**					
1.0	**Improvements**					
1	Precast Walls (80' x 45')	1	LS	$ 250,000.00	$ 250,000.00	
2	Roofing Membrane/Precast (Double T)	1	LS	$ 275,000.00	$ 275,000.00	
	Subtotal Architectural				**$ 525,000.00**	
E.	**Process**					
1.0	**Improvements**					
1	Biological Gravity Filter	4	LS	$ 480,000.00	$ 2,208,000.00	
2	Process Piping/Valves	1	LS	$ 575,000.00	$ 575,000.00	
3	Backwash/Air Scour Systems	1	LS	$ 650,000.00	$ 650,000.00	
5	Equipment Installation	1	LS	$ 400,000.00	$ 400,000.00	
	Subtotal Process				**$ 3,833,000.00**	
F.	**Mechanical**					
1.0	**Improvements**					
1	Heating and Ventilation	1	LS	$ 250,000.00	$ 250,000.00	
	Subtotal Mechanical				**$ 250,000.00**	
H.	**Electrical and Instrumentation and Controls**					
1.0	**Improvements**					
1	Electrical w/ I/C (15%)	1	LS	$ 1,742,512.50	$ 1,742,512.50	
	Subtotal Electrical and Instrumentation and Controls				**$ 1,742,512.50**	
	SUBTOTAL CONSTRUCTION COSTS				$ 14,561,910.88	
	Contingencies (15%)				$ 2,184,286.63	
	TOTAL CONSTRUCTION COSTS					**$ 16,746,197.51**
	Non-Construction Costs					
	Design Engineering (6%)				$ 1,004,771.85	
	Construction Engineering - RPR (10%)				$ 1,674,619.75	
	Legal/ Admin (5%)				$ 837,310	
	Subtotal Non-Construction Costs					**$ 3,516,701.48**
	TOTAL ESTIMATED COST					**$ 20,263,000**

City of Helena
Groundwater Development Project
Phases 3-5: MRTP PWS Wells
Preliminary Opinion of Probable Cost

ITEM NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	SUBTOTAL	
Construction	**Production Well Drilling**					
101	Production Well Drilling and Testing	0	LS	$ -	$ -	By Others
102	Production Well Pump and Completion	3	LS	$ 125,500	$ 376,500	
103	Well Building	1	LS	$ 510,400	$ 510,400	
104	MRTP Site Piping and CF Road Crossing	1	LS	$ 275,000	$ 275,000	
	Contingency (10%)			10%	$ 116,190	
	Mobilization/Demobilization			3%	$ 34,857	
	General Requirements			5%	$ 58,095	
	Taxes, Bonds Insurance			5%	$ 58,095	
	Subtotal				$ 1,429,137	
	Engineering				$ 407,000	
	Total				$ 1,836,137	

City of Helena
Groundwater Development Project
Phases 3-5: City Wide PWS Wells
Preliminary Opinion of Probable Cost

ITEM NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	SUBTOTAL	
Construction	**Production Well Drilling**					
101	Production Well Drilling and Testing	7	LS	$ 300,000	$ 2,100,000	
102	Production Well Pump and Completion	7	LS	$ 118,250	$ 827,750	
103	Well Buildings	5	LS	$ 510,400	$ 2,552,000	
104	MRTP South Site Piping	1	LS	$ 45,000	$ 45,000	
105	City Wide Wells Site Piping	4	LS	$ 50,000	$ 200,000	
	Contingency (10%)			10%	$ 572,475	
	Mobilization/Demobilization			3%	$ 171,743	
	General Requirements			5%	$ 286,238	
	Taxes, Bonds Insurance			5%	$ 286,238	
	Subtotal				$ 7,041,443	
	Engineering				$ 880,000	
	Total				$ 7,921,443	

APPENDIX C

ASSET INVENTORY

Helena Tenmile Water Treatment Plant

Asset Area	Asset Type	Asset	Manufacturer/Model	Date Installed	Notes
Water Supply Storage	Scott Reservoir	Solar Level			
Water Supply Storage	Scott Reservoir	Flume Flow			
Water Supply Storage	Red Mtn Flume	Banner Cr Diversion			
Water Supply Storage	Red Mtn Flume	Saliie Belle Inlet			
Water Supply Storage	Red Mtn Flume	Wilson Inlet			
Water Supply Storage	Chessman Reservoir	Solar Level			
Water Supply Storage	Chessman Reservoir	Flume Flow			
Water Supply Storage	Tenmile Diversion	Diversion Gate			
Water Supply Storage	Tenmile Diversion	Flume Flow			
Water Supply Storage	Beaver Cr Diversion	Diversion Gate			
Water Supply Storage	Beaver Cr Diversion	Flume Flow			
Water Supply Storage	Minniehaha Cr Diversion	Diverison Gate			
Water Supply Storage	Minniehaha Cr Diversion	Flume Flow			
Water Supply Storage	Moose Cr Diversion	Diverison Gate			
Water Supply Storage	Moose Cr Diversion	Flume Flow			
Water Supply Storage	Walker Cr Diversion	Diverison Gate			
Water Supply Storage	Walker Cr Diversion	Flume Flow			
Water Supply Storage	WTP Raw Water Supply	Screen		1991	
Water Supply Storage	WTP Raw Water Supply	Screen Bio-Flush		1991	
Chemical Feed	Alum/PACl	Storage Tank	9000 gallon FRP	1991	
Chemical Feed	Alum/PACl	Feed Pump	Prominent Gamma X	2021	
Chemical Feed	NaOH	Storage Tank	9000 gallon FRP	1991	
Chemical Feed	NaOH	Feed Pump	Prominent Gamma X	2019	
Chemical Feed	Cationic Polymer (PEC)	Storage Tank	2 - 4200 gallon FRP	1991	
Chemical Feed	Cationic Polymer (PEC)	Feed Pump	Prominent Gamma X	2019	2 to 12 ppm
Chemical Feed	Nonionic Polymer (PEN)	Mixer	Schenk AccuRate	1991	
Chemical Feed	Nonionic Polymer (PEN)	Feed Pump	Prominent Gamma X	2019	
Chemical Feed	PAC	Emulsifier System	Merrick	1991	
Chemical Feed	PAC	Storage Mixing	Merrick	1991	
Chemical Feed	PAC	Feed System	Merrick	1991	50 rpm to sure of dosage
Chemical Feed	NaOCl	Storage Tank	6500 gallon FRP	1991	
Chemical Feed	NaOCl	Feed Pump	Prominent Gamma X	2018	WTP Effluent Feed
Chemical Feed	NaOCl	Feed Pump	Prominent Gamma X	2018	Post-Clearwell Distribution Booster Feed
Contact Adsorption Clarifiers (1-4)	Internal	Buoyant Media	WesTech Trident	2018	
Contact Adsorption Clarifiers (1-4)	Internal	Air Nozzles	WesTech Trident	2018	
Contact Adsorption Clarifiers (1-4)	Internal	Screen	WesTech Trident	1991	
Contact Adsorption Clarifiers (1-4)	AIr Scour	Blower	EG&G Rotron DRS9BM72-ND	1991	20 HP; 1 min air, 12 min air/water, 16 min water
Contact Adsorption Clarifiers (1-4)	AIr Scour	Air Pressure Blowoff	Fisher Governor Co.	1991	Set Pressure = Range is 1.75 to 7 psi
Contact Adsorption Clarifiers (1-4)	Valves	Raw Water Influent	12" Dezurik BFV	1991	
Contact Adsorption Clarifiers (1-4)	Valves	Backwash Influent	same as Raw Water Influent	1991	
Contact Adsorption Clarifiers (1-4)	Valves	Air Scour Inlet Check	6" Valmatic	2021	
Contact Adsorption Clarifiers (1-4)	Valves	Air Scour Inlet Valve	6" Bray BFV	1991	
Contact Adsorption Clarifiers (1-4)	Valves	Backwash Effluent	16" Bray BFV	1991	
Contact Adsorption Clarifiers (1-4)	Valves	CAC Effluent	12" Bray BFV	1991	
Contact Adsorption Clarifiers (1-4)	Instrumentation	DPT/Orifice Flow	Asco Tripoint	1991	
Contact Adsorption Clarifiers (1-4)	Instrumentation	High Pressure Switch	Asco Tripoint	1991	
Contact Adsorption Clarifiers (1-4)	Instrumentation	CAC Effluent Turbidimeter	HACH Surface Scatter 7 sc	2012	
Filters (1-4)	Internal	Filter Media - Anthracite	Leopold	2022 Filter Project	
Filters (1-4)	Internal	Filter Media - Fine Sand	Leopold	2022 Filter Project	

Filters (1-4)	Internal	Filter Media - Support Gravel	to be removed	2022 Filter Project	
Filters (1-4)	Internal	Underdrain	Leopold	2022 Filter Project	
Filters (1-4)	Internal	Surface Wash	to be removed	2022 To Be Removed	
Filters (1-4)	Internal	Backwash Trough	to remain	1991	
Filters (1-4)	Valves	Filter Effluent	Dezurik BFV/Rotork actuator	1991	Actuators 2021-22
Filters (1-4)	Valves	Backwash Influent	Dezurik BFV/Rotork actuator	1991	Actuators 2021-22
Filters (1-4)	Valves	Backwash Effluent	Dezurik BFV/Rotork actuator	1991	Actuators 2021-22
Filters (1-4)	Valves	Filter to Waste	Dezurik BFV/Rotork actuator	1991	Actuators 2021-22
Filters (1-4)	Valves	Filter Influent	Dezurik BFV/Rotork actuator	1991	Actuators 2021-22
Filters (1-4)	Instrumentation	DPT/Orifice Flow	Replaced with Magmeter	New 2022	
Filters (1-4)	Instrumentation	DPT/Head Loss	Rosemount 2088	1991	
Filters (1-4)	Instrumentation	Filter Level	Drexel		
Filters (1-4)	Instrumentation	Combined Filter Effluent Turbidimeter	HACH FilterTrak 660 SC	2018	Laster Nephelometer
Process Pumps	Backwash	Backwash Pump #1	GE - 125HP	1991	880 RPM / 3PH / 460VAC
Process Pumps	Backwash	Backwash Pump #2	GE - 125HP	1991	880 RPM / 3PH / 460VAC
Process Pumps	Surface Wash	Surface Wash Pump #1	Simmons - 25HP	1991	1800 RPM / 3PH / 460 VAC
Process Pumps	Surface Wash	Surface Wash Pump #2	Simmons - 25HP	1991	1800 RPM / 3PH / 460 VAC
Process Pumps	In-Plant Process	Process Pump #1	GE - 15HP	1991	3525 RPM / 3PH / 230/460VAC
Process Pumps	In-Plant Process	Process Pump #2	GE - 15HP	1991	3525 RPM / 3PH / 230/460VAC
Process Pumps	Heat Exchange System	Heat Exchange Pump #1	US Motors - 7.5HP	2013	1735 RPM / 3PH / 230/460VAC
Process Pumps	Heat Exchange System	Heat Exchange Pump #2	US Motors - 7.5HP	2013	1735 RPM / 3PH / 230/460VAC
Treated Water Storage	Clearwell	Floating Lid	6MG	1991	
Treated Water Storage	Clearwell	Structure	45K	1991	

Helena Missouri River Water Treatment Plant

Asset Area	Asset Type	Asset	Manufacturer/Model	Date Installed	Notes
Water Supply Storage	Valves	WTP Inlet Valve		2019	
Clarification	Rapid Mix	Mixing Pump	Ruhrpumpen		US Motors 3HP, 460V
Clarification	Flocculators 1-2	Flocculation Mix	Anco		Baldor 1/4HP, 460V with EuroDrive gearbox
Clarification	Sedimentation 1-2	Sedimentation Screens	Walker Process	1958	Westinghouse 1/2HP with Winsmith gearbox
Clarification	Sedimentation 3	Sedimentation Screens	Link Belt/FMC Corp		Westinghouse Lifeline 1HP with Link Belt 1750 rpm gearbox
Chemical Feed	Alum	Storage Tank	1- 6000 gallon (metal) & 2 - 2500 gallon (poly)	2021	
Chemical Feed	Alum	Feed Pump A	ProMinent S2CB	2019	100-240V, 220W, 28.8 GPH
Chemical Feed	Alum	Feed Pump B	ProMinent S3CB	2019	100-240V, 420W, 132.1 GPH
Chemical Feed	NaOCl	Storage Tank	2 - 3500 gallon poly	2007	
Chemical Feed	NaOCl	Feed Pump	ProMinent S2CB	2019	100-240V, 220W, 28.8 GPH
Chemical Feed	Ortho	Feed Pump	ProMinent S2CB	2019	
Chemical Feed	Cationic Polymer	Storage Tank	Aqua Hawk 7387 - 55 Gallon Drum		
Chemical Feed	Cationic Polymer	Feed Pump	ProMinent S2CB	2019	
Chemical Feed	Nonionic Polymer	Storage Tank	SuperFloc N-300 - 55 Gallon Drum		
Chemical Feed	Nonionic Polymer	Feed Pump	ProMinent S2CB	2019	100-240V, 220W, 39.1 GPH
Chemical Feed	PAC	Emulsifier System	Vibra-Screw	2007	
Chemical Feed	PAC	Storage Mixing	Vibra-Screw	2007	
Chemical Feed	PAC	Feed Pump	Vibra-Screw	2007	
Filters (1-8)	Internal	Filter Media - Anthracite	Leopold	2008	
Filters (1-8)	Internal	Filter Media - Fine Sand	Leopold	2008	
Filters (1-8)	Internal	Filter Media - Support Gravel	Leopold	2008	
Filters (1-8)	Internal	Underdrain	Leopold	2008	w/ Air Scour
Filters (1-8)	Internal	Backwash Trough		1958	
Filters (1-8)	Valves	Filter Effluent	Pratt		Filters 2, 4, & 6 actuators replaced w/ Rotork after flood
Filters (1-8)	Valves	Backwash Influent	Pratt		Filter 2 actuator replaced w/ Rotork after flood
Filters (1-8)	Valves	Backwash Effluent	Pratt		Filters 1,2,3,4,5&6 actuators replaced w/ Rotork after flood
Filters (1-8)	Valves	Filter to Waste	Pratt		Filters 5 & 8 actuators replaced w/ Rotork after flood
Filters (1-8)	Valves	Filter Influent	Pratt		
Filters (1-8)	Valves	Air Scour	Pratt		Filters 1 & 8 actuators replaced w/ Rotork after flood
Filters (1-8)	Instrumentation	DPT/Orifice Flow	Endress + Hauser ProMag	2017	Type 4X/6P
Filters (1-8)	Instrumentation	DPT/Head Loss	Endress + Hauser Cerabar PMP71	2007	
Filters (1-8)	Instrumentation	Filter Flow	Endress + Hauser MADC3919000	2007	ProMag L
Filters (1-8)	Instrumentation	Filter Effluent Turbidimeter	HACH FilterTrak660SC	2007	
Filters (1-8)	Blower	PD Lobe Blower	Gardner Denver Sutorbilt Legend GAGLDPA	1983	2050 Max RPM, Baldor Super-E 50 HP, 460V
Process Pumps	High Pump	High Pump #1	WEIR Floway	2008	3010 GPM @ 600' TDH/Motors replaced in 2016
Process Pumps	High Pump	High Pump #2	WEIR Floway	2008	3010 GPM @ 600' TDH/Motors replaced in 2016
Process Pumps	High Pump	High Pump #3	WEIR Floway	2008	3010 GPM @ 600' TDH/Motors replaced in 2016
Process Pumps	Low Pumps	Low Pump #1	Aurora Verti-Line	1983	V33-70523A Single Stage 2100 GPM w/ US Electrical Motors C1008138 (1775 RPM)
Process Pumps	Low Pumps	Low Pump #2	Aurora Verti-Line	1983	V33-70523B Single Stage 2100 GPM w/ US Electrical Motors C1008138 (1775 RPM)
Process Pumps	Low Pumps	Low Pump #3	Aurora Verti-Line	1983	V33-70525 Single Stage 1000 GPM w/ US Electrical Motors C1008138 (1800 RPM)
Process Pumps	Backwash	Backwash Pump	Goulds DWT	2004	
Process Pumps	Transfer	Transfer Pump #1	GE/Floways	1983	GE 40HP, 460V - 3130 GPM
Process Pumps	Transfer	Transfer Pump #2	GE/Floways	1983	GE 40HP, 460V - 3130 GPM
Process Pumps	Transfer	Transfer Pump #3	GE/Floways	1983	GE 40HP, 460V - 3130 GPM
Treated Water Storage	Clearwell	Structure		2008	1.5MG