HELENA MONTANA

QUEEN CITY OF THE ROCKIES

Helena Water Facilities Plan

CHAPTER 8 – ROLE REVERSAL ANALYSIS

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Switching the source

Joe Bell (It Wolf Photographer)

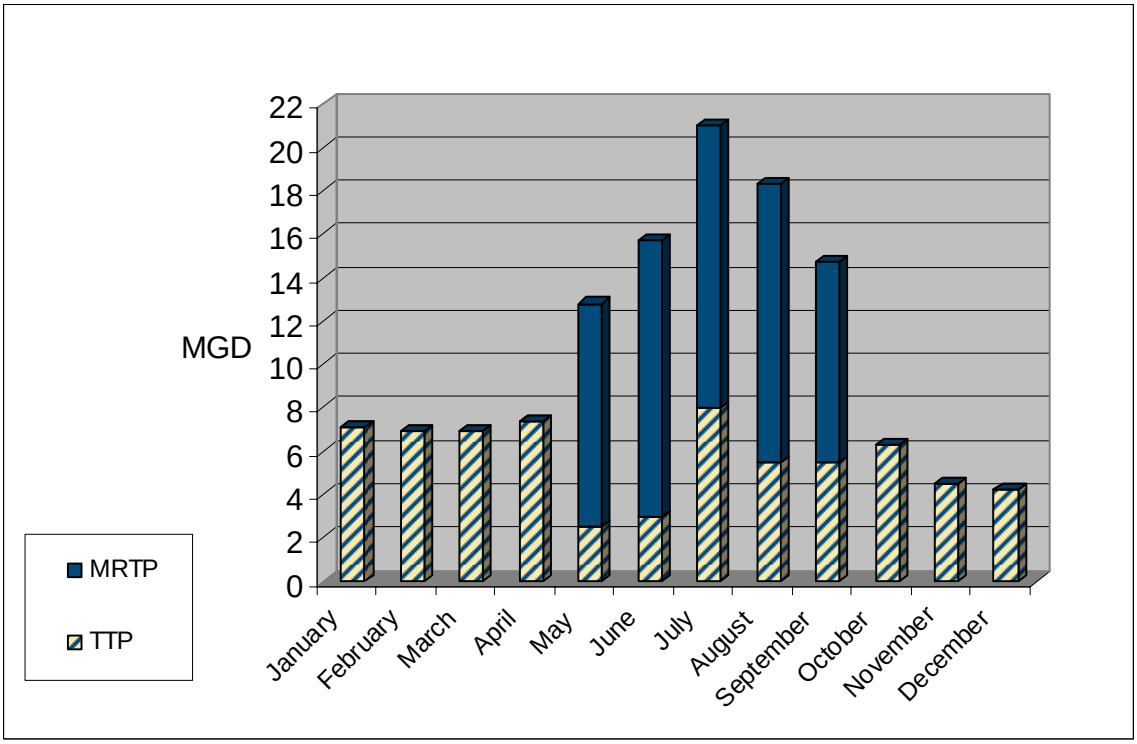
The Tenmile Creek drainage is home to about 150 abandonded gold, lead, zinc and copper mines as work is ongoing to help rehabilitate the land battered by years of mining. One small step in the process is work done each year by the Montana Conservation Corps who spent last week planting thousands of trees along the banks of the creek.

Introduction

The City of Helena currently uses the Missouri River water supply and treatment facilities for peaking purposes in the summer months, while the Tenmile water supply/treatment facilities operate year-round. Figure 8-1 shows the projected monthly flows for 2025, if the current supply and treatment roles were maintained. While this approach has been effective over the last several years, it does have some significant limitations:

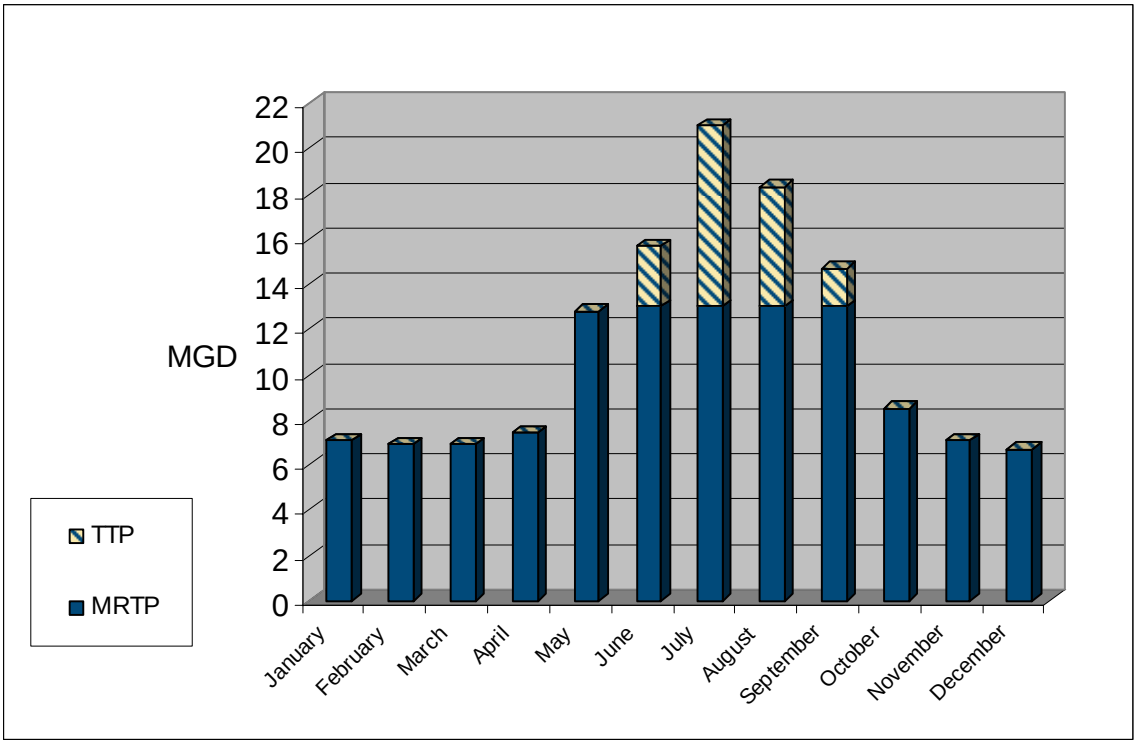
1. Using more flow from the Tenmile system reduces stream flows needed for dilution of the upstream Rimini Superfund site.
2. The City's withdrawals for the Tenmile system dewater the creek in the summer months, affecting the trout fishery downstream of the diversions.
3. The Tenmile system is more susceptible to drought and forest fire negative impacts than the Missouri River system. Continuing to rely on it as a long-term year-round water source may pose some risks.
4. The Tenmile system has significantly less water rights than the Missouri River system, with the firm yield of the watershed potentially compromised during drought conditions.
5. The limited water rights available in the Tenmile system requires that the water from Tenmile be managed carefully to assure water will be available throughout the entire year.
6. The Tenmile facilities are linked by a single pipeline to the City's service area, posing a reliability risk in the event of an unexpected pipeline failure.

Figure 8-1 Projected Monthly Flows at MRTP and TTP for 2025 with Current Roles



As a result, this chapter will review the impacts of reversing the roles of the Tenmile and Missouri River supply and treatment systems. If these roles were reversed, the MRTP would provide water to the City year-round and TTP would operate in the summer months only and potentially at low flows the remainder of the year. Figure 8-2 shows how monthly demands would be met in 2025 if these roles were reversed.

Figure 8-2 Projected Monthly Flows at MRTP and TTP for 2025 with Reversed Roles



The long-term benefits of reversing the supply and treatment roles for the ratepayers, the public and the watersheds are significant. The reversal of roles of the TTP and MRTP has several distinct advantages, the reversal:

1. Increases summer in-stream flows in Tenmile Creek, which is good for the impaired watershed, meets the goals of local watershed groups, and improves the trout fishery.
2. Reduces the City's water supply vulnerability to drought and forest fire effects, taking advantage of the more plentiful supply from the Missouri River source.
3. Provides in-stream flows to Tenmile Creek to dilute heavy metals from historical mine discharges.
4. Builds upon the City's recent successes in pursuing federal funding for much needed improvements to the MRTP to facilitate the role reversal.

To determine whether the City should reverse the roles of the water supplies, the total costs associated with the change needs to be evaluated. Because the Tenmile supply flows to the City by gravity and the Missouri River supply must be pumped, the largest cost associated with reversing the roles is the cost of power. In addition, the City must pay the Bureau of Reclamation (BOR) for water from the Missouri River system. Reversing the roles of the supplies will increase water purchase costs, as water from the Tenmile system is obtained at no cost. No changes in supply or treatment facilities are needed for the reversal, as water is supplied to meet the maximum day demand is the same in either scenario. The raw water

capacity of the Tenmile system and the Missouri River system would be the same for both scenarios.

If the current plant roles were maintained, a total of 1,960 MG of water would be withdrawn from the Tenmile system in 2025, and 1,335 MG would come from the Missouri River system. If the plant roles were reversed, 744 MG would come from the Tenmile system and 2,551 MG would come from the Missouri river system. In the current roles, diversions are limited for Tenmile to 1,960 MG (the reliable hydraulic yield of the Tenmile system) however; in the reversed roles Tenmile would be limited to the available raw water reservoir storage volume of 744 MG (550 MG in Chessman, 194 MG in Scott). Water would be diverted from the creek at the same rate it was being released from the reservoirs, so no instream flow would be removed except in extreme situations. Table 8-1 shows the changes in the total amount of water used from each source for 2025 demands.

Table 8-1 Annual Volume of Water Used in Current Roles and Reversed Roles at 2025 Demands

	Tenmile (MG)	Missouri River (MG)	Total 2025 Demand (MG)
Current Roles	1960	1335	3295
Reversed Roles	744	2551	3295

Cost of Power

The changes in the cost of the power associated with reversing the roles is impacted by several factors; demand charges, use charges and the efficiency of the pumps delivering potable water to the customers. To calculate the increased cost associated with reversing the roles, the following assumptions were made:

- 3.5% annual increase in power costs per year (demand charges and use charges).
- Combined pump and motor efficiency of 60%.
- Average MRTP pumping head of 700 feet.

Table 8-2 shows the average annual cost of power associated with both current and reversed supply roles. The average difference in power costs between current and reversed roles from 2005 to 2025 is $300,000. The difference in cost for each year was devalued to a 2005 present value. The sum of these present values is $2,500,000. These values were calculated assuming no low zone pumping is used at MRTP, which would reduce the power cost differential due to the lower pumping head required. As water demand increases to the north service area, low zone pumping will become more practical, reducing the difference in cost between the two alternatives.

Table 8-2 Average Annual Power Cost for Current Roles and Reversed Roles

	Total Power Cost[1]
Average Difference	$300,000
Sum of 20-year Present Worth of Differences (2005-2025)	$2,500,000

[1] Based on $0.0741/kw-hr and escalated demand charges

Cost of Water

The City pays the BOR raw water delivery charges to provide raw water to the Regulating Reservoir. A 40-year contract with BOR (found in Appendix 3-E) was signed in 2004 for continuation of this program. As shown in Table 8-1, reversing the plant roles requires using an additional 1216 MG of water from the Missouri in 2025 (2551 MG versus 1335 MG). This increase in water usage is well within the available water supply from the Missouri River system. The estimated average annual raw water delivery charges for current roles and reversed roles are shown in Table 8-3.

Table 8-3 Estimated Average Annual Water Right Payments to BOR and HVID for MRTP

	2025 Raw Water Payment*
Average Difference	$100,000
Sum of 20-year Present Worth of Differences (2005-2025)	$1,000,000

* Cost based on $33.09/AF in 2025 using BOR cost escalation methods

The costs shown are based on rates stated in the recently signed contracts. The difference in costs between current roles and reversing roles is $100,000 in Year 2025. The difference in water costs were estimated for each year, and devalued to 2005 dollars. The sum of these present worth values is $1,000,000.

Tenmile Supply

In reversing the supply roles, the City will only divert flows from the Tenmile system that have been captured in its two raw water reservoirs – Chessman and Scott, rather than taking both reservoir and creek flows, as it does currently. The recommendations in Chapter 6 for the Tenmile (adding aeration to Chessman Reservoir, replacing the TTP filter media, and upgrading the TTP disinfection system to meet current codes) remain the same. However, the Tenmile projects all become lower priority if the system becomes a seasonal facility.

Some improvements in the ability to read discharge flows from Chessman and Scott reservoirs would be needed to accurately track reservoir releases. New flume structures with remote read capability would be needed at both Chessman and Scott. In addition, improvements would be needed at the Tenmile and Beaver Creek Diversions to ensure the diversion of stream flows match reservoir releases.

Missouri River Supply

Similar to the Tenmile system, the capital facilities recommended for the Missouri River system remain the same with the role reversal (MRTP clearwell and pump station, MRTP disinfection, MRTP pretreatment, new raw water intake and pump station, and MRTP SCADA system improvements). One possible change required at MRTP with the role reversal is in residuals handling. The residuals ponds currently store and percolate flows effectively in the summertime and water is rarely recycled. With winter operation, the bottom may freeze and percolation capacity could be reduced. As a result, pond overflow may need to be discharged or recycled. The City's NPDES permit to discharge to Prickly Pear via the ponds overflow does not limit flow to the Creek. Depending on how the system responds to the addition of filter-to-waste and to winter operation, a backwash recycle pump

station may be required. Another factor that needs to be considered is the winterization of the MRTP facilities to allow operation in cold weather. All treatment basins in operation will need to be enclosed in buildings to protect from freezing and to allow easy access for operation/maintenance.

Distribution System

The improvements to the distribution system remain the same with reversing the roles of the plants. The projects for paralleling the 20" south of the Airport and the Low Zone pumping at the MRTP become more important with the plant roles reversed. The pipeline will now be used twelve months a year and the additional energy costs associated with the pipe segment at 20-inch will be magnified. Use of the Low Zone pumping will also save energy by pumping directly to the Low Zone instead of pumping from the MRTP to the High Zone and dropping back down to the Low Zone.

Water Age

Reversing the roles will have an effect on water age in the distribution system. The longer the water is in the distribution system the lower the quality of the water. Three scenarios of water age were evaluated for comparison:

1. Current roles, current average day demand and only TTP operating.
2. Reversed roles, current average day demand and TTP operating at 1 MGD.
3. Reversed roles, current average day demand, TTP operating at 1 MGD and a new 12-inch supply line from TTP into Helena.

A scenario including a new 12-inch line, installed in the existing 16-inch line, would allow water from the TTP to reach connections more quickly. At a 1 MGD flow with the existing piping, it would take the water about 1.5 days to reach the main distribution system. If a 12-inch line is used, water age is reduced to 4 hours.

Figures 8-3, 8-4 and 8-5 show water age for the three scenarios. As shown in the Figure 8-3, current roles, the majority of the distribution system water age is less than 48 hours. In Figure 8-4, the roles are reversed and TTP is at 1 MGD. In this scenario the whole west side water age is greater than 48 hours. The southeast portion of town has improved water age as the majority of the water is from MRTP. Figure 8-5 then shows the addition of the 12-inch from TTP. For water age this is the best scenario as most of the system is less than 24 hours and only small pockets have high water age.

Summary

The sum of the present worth costs for differences power and water is $3,500,000. Capital improvement needs are the same in the current supply/treatment roles and reversed roles scenarios.

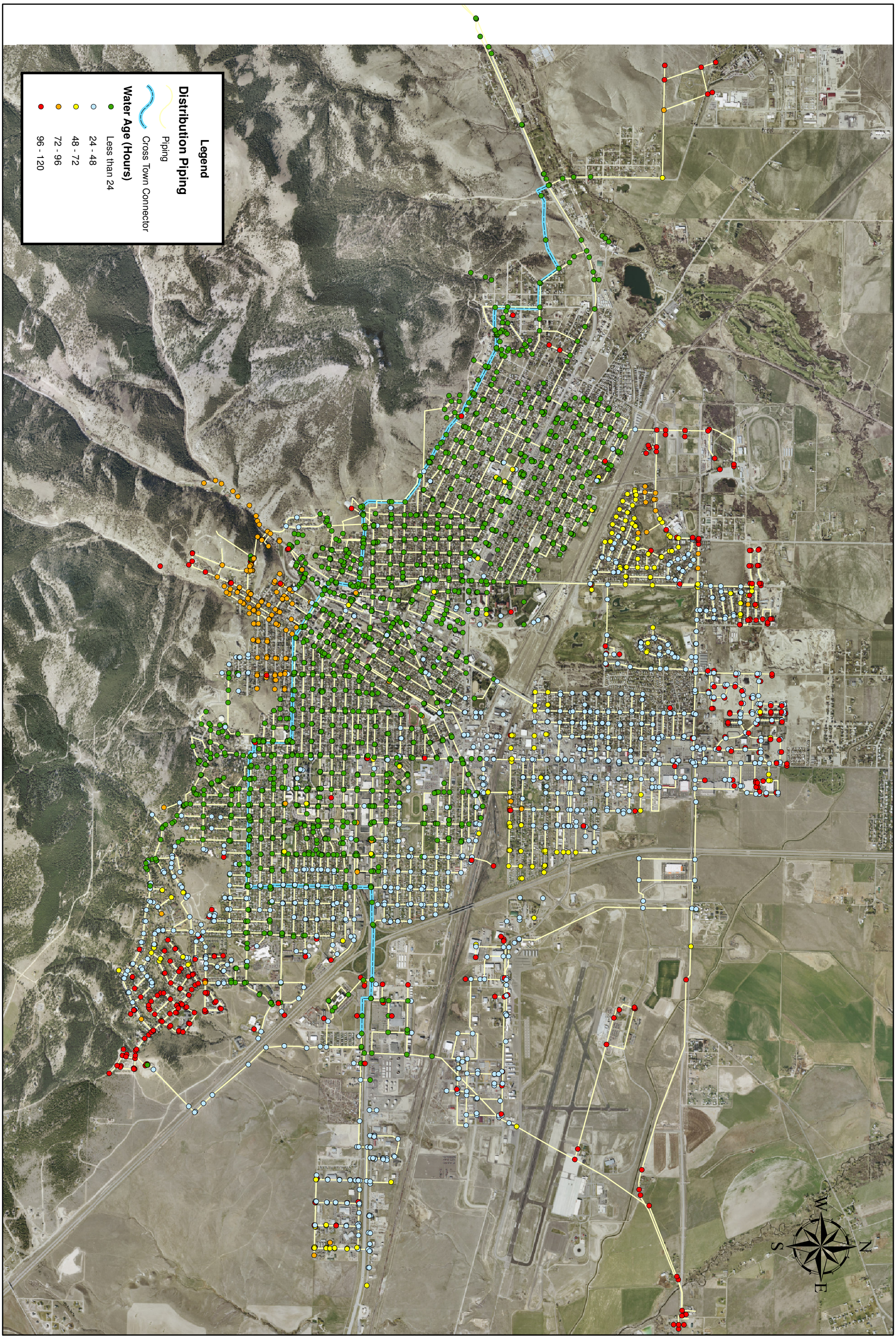


Figure 8-3
Water Age - TTP only
Current Average Day Demand

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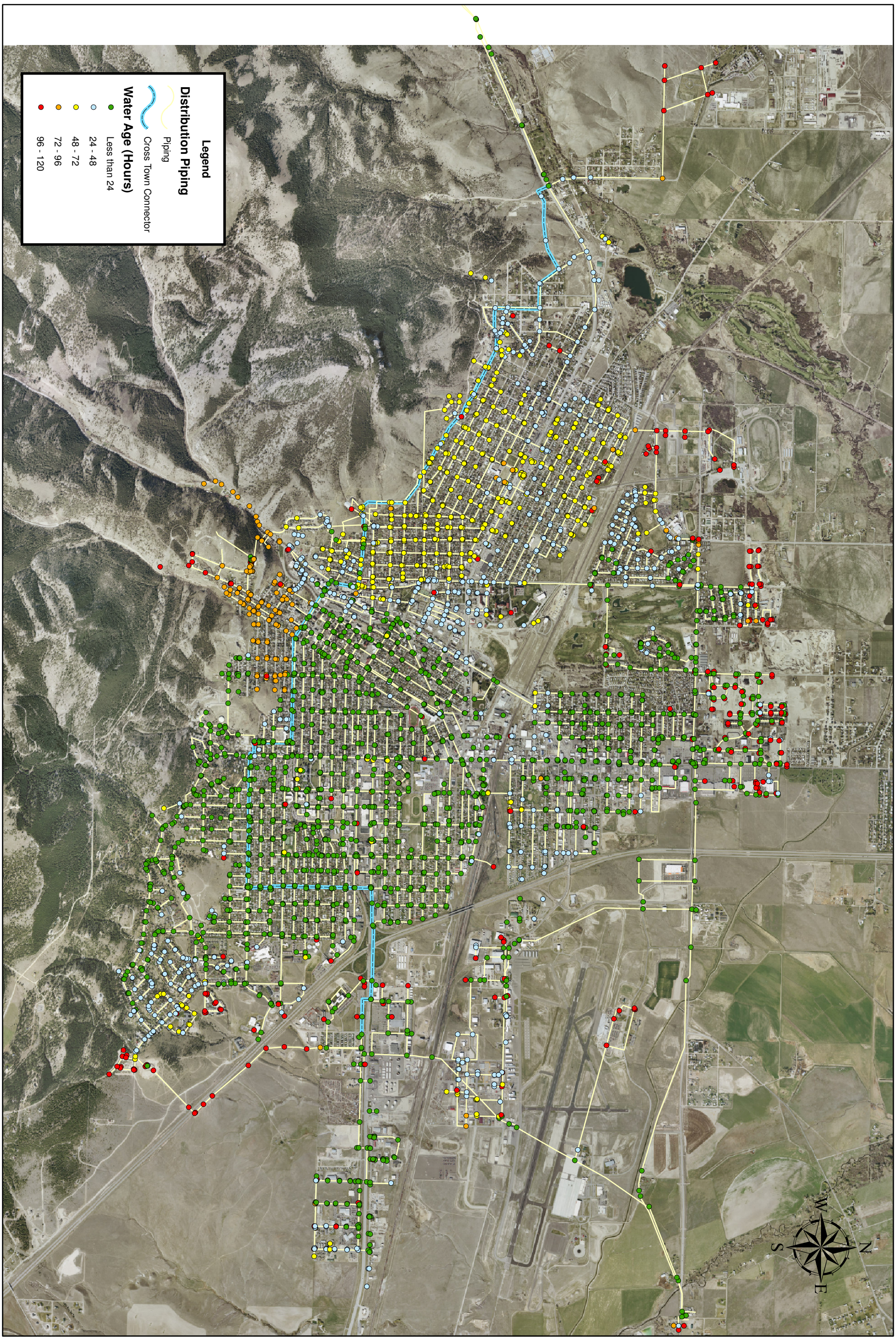

Figure 8-4
Water Age
TTP at 1 MGD (Current Average Day Demand and Existing TTP Supply Piping)

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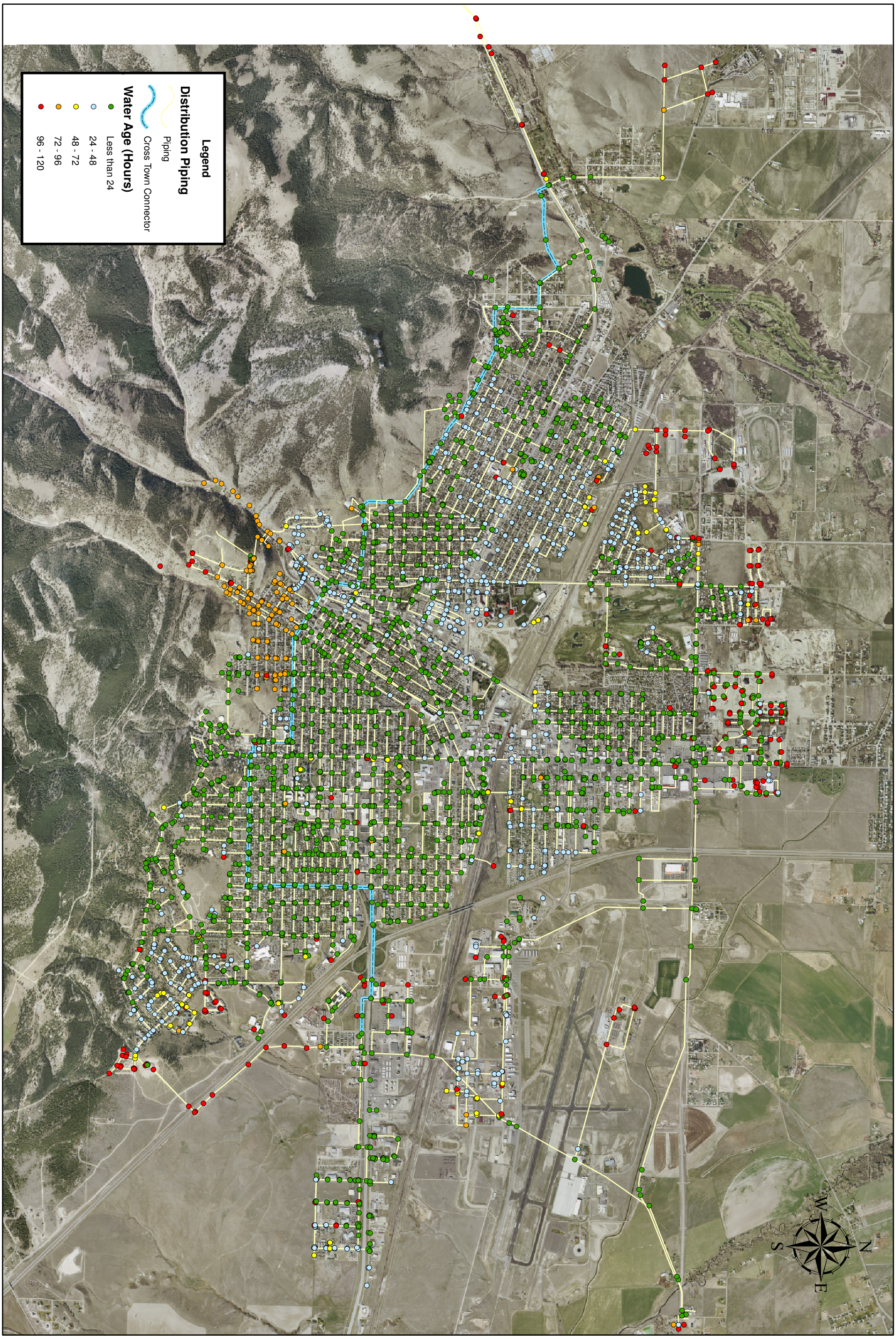

Figure 8-5
Water Age
TTP at 1 MGD (Current Average Day Demand and New 12-inch TTP Supply Piping)

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Evaluation Criteria and Alternative Evaluation

Two water management alternatives have been developed – maintaining the current Tenmile and Missouri River supply/treatment roles and reversing the roles. To differentiate, it is necessary to identify key evaluation criteria to reflect the community and environmental benefits provided by each. Four criteria were established for the comparison. Table 8-4 lists each of the criteria, its weight and the alternatives' score, either a "1" or a "2," with "2" denoting a better rating than "1."

Cost

Cost is clearly a key criterion, since there are many demands on the City's limited financial resources. The total capital cost for implementing both of the alternatives is the same, although priorities and the order in which improvements would be completed differ between alternatives. The incremental present worth operation and maintenance cost increase associated with reversing the roles, compared with current roles, is approximately $3,500,000 ($2,500,000 power, $1,000,000 water).

Environmental Quality

A key objective of water management is to protect both ground and surface water sources. Consideration should therefore be given to how effective each alternative is at protecting the environment. Increasing stream flows in Tenmile Creek improves local environmental quality by providing more dilution flows for the metals associated with the Rimini site. In addition, providing base flows in the stream during the hottest summer months, rather than drying up the creek, provides support for the stream's trout fishery.

Water: Tenmile Creek often dry by August

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money to upgrade the Missouri plant.

"I hesitate to say this, but it was a stretch for us to put the money into enlarging the Chessman Reservoir — but we were supported to do that," said Mike Bishop, EPA remedial project manager. "In a similar fashion, I think it is a stretch to make this investment in the Helena drinking water infrastructure; but in general, it's all consistent with the EPA mission here, so there's some potential to have this work out."

How it flows

The City of Helena has relied on water from the Tenmile Creek basin since the mid 1800s, when an above-ground ditch channeled flows into the Wool-

Joe Ebell *IR Staff Photographer*

A small dead fish lies near the banks of Tenmile Creek. Every year fish have a difficult time surviving as the creek is virtually drained by summer's end.

Public Health

The City Water Department is charged with protecting public health. Both alternatives meet all applicable regulations and codes and ensure the City will continue to protect public health in managing the water in either alternative. Although the Missouri River supply may be subject to seasonal taste and odor problems that must be addressed by treatment, these events are considered manageable and pose no health risk or regulatory concern. However, the Tenmile supply maybe more vulnerable to Giardia and Cryptosporidium contamination during runoff occurrences in the watershed as there is no intervening storage on several of the stream diversions to TTP, that could settle out these pathogens. Reversing the roles eliminates this concern for the TTP.

Drought Risk

The two alternatives respond differently to drought conditions. If the supply roles remain the same, the City will continue to rely on the Tenmile system as the main source of supply. In 1989, and again in 2000, the Tenmile watershed was hit by severe drought. Reservoirs

were roughly only half full, placing more of an emphasis on capturing stream flows for the TTP.

The Missouri River supply draws from a much larger watershed area than Tenmile system, and while it may be impacted by drought, the City's contract with the BOR and the large size of the reservoirs ensures water will be available As a result, the reversed roles alternative scored better for drought risk compared to maintaining current roles.

Fire Risk

The risk of forest fire has been evaluated since it directly affects the City's ability to reliably deliver water to its customers. Because the Missouri River source passes through two reservoirs (Canyon Ferry and the Regulating Reservoir), the risk of fire impacting the water supply is lower than the Tenmile, where the basin is smaller and there is limited storage to settle out runoff material. As a result, the reversed roles alternative also scored better for fire risk compared to current roles.

Summary

Table 8-4 summarizes the evaluation of the two water source management alternatives, their costs, their weight, and their score for each evaluation criteria. Each criterion was given a weight, from which a benefit score was calculated. Public health was given a "2" weight and environmental quality, drought risk and fire risk were given a "1" weight. Then each alternative was evaluated relative to the criteria.

Table 8-4 Alternative Evaluation

	Cost [a]	Drought Risk	Fire Risk	Environmental Impact	Public Health	Total Score	Benefit to Cost Ratio
Weight		1	1	1	2		
Current Roles	$16,000,000	1	1	1	2	5	3.1
Reversed Roles	$19,500,000	2	2	2	2	8	4.1

[a] Total costs do not include distribution system improvements.

Both alternatives received a "2" on public health, as they both equally meet public health requirements. For drought and fire risk, the reversing roles alternative scored a "2" because it has a lower risk. The current roles alternative received a "1" because it has a higher vulnerability. In terms of environmental quality, the reversed roles alternative has a more positive impact and was therefore assigned a "2." Maintaining the current roles alternative is less environmentally friendly and received a "1." Each score was then multiplied by its weight and a total benefit score was given. The benefit score for the current plant roles alternative is "5." The benefit score for reversed roles alternative is "8." The total cost for the current roles alternative is $16,000,000. The total cost for the reversed roles alternative is $19,500,000. Distribution system costs have not been included. The benefit to cost ratio for the current plant role is 3.1. For reversed roles, the benefit to cost ratio is 4.1.

While maintaining the current plant roles has the lowest present worth cost, it has lower environmental and risk benefits. Reversing the plant roles performs better in terms of drought and fire risk and environmental impacts, although at a higher cost.