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2.0 PROJECT PLANNING

The City of Red Lodge was officially established in 1884 but was an area that served the Crow Indians long before the arrival of permanent settlers. The areas' first mine was opened in 1887 by the Rocky Fork Coal Company and served as the backbone of the community until the mid-20th century. In 1943, an underground explosion killing 74 men at the Smith Mine in Bear Creek devastated the community and effectively ended coal mining. Tourism, recreation, and ranching soon replaced mining and continues to be the primary economy for the city.

Over the past 30 years, the local economy has gone through a transition from the dependence on agriculture and mining to more service-oriented, recreation-based businesses with an emphasis on tourism. The City has a 3% Resort Tax that is collected from lodging, retail, bars and restaurants. There are numerous areas available for backpacking, fishing, hiking, hunting, ATV riding, snowmobiling, skiing and other related activities.

Red Lodge is the forty-sixth largest city in Montana and lies 60 miles south of the state's largest city, Billings. Red Lodge is an incorporated city in Carbon County. The business district of Red Lodge includes a variety of services and restaurants for residents and visitors of the area. Carbon County consists of 2,049 square miles of land. The population density is 4.9 persons per square mile compared with 6.8 persons per square mile for the entire State of Montana.

2.1 Location

The City of Red Lodge is located in southcentral Montana in the south-central region of Carbon County, and according to the 2015 Census information, has a population of 2,236. Carbon County is bordered on the north by Yellowstone County and Stillwater County, on the east by Big Horn County, on the south by Park County, Wyoming and on the west by Park County, Montana. Red Lodge is located about 60 miles south of the City of Billings along Montana Highway 212 at the foothills of the Beartooth Mountains. Red Lodge is considered the gateway to Yellowstone National Park via the Beartooth Highway.

Geographically, Red Lodge is located in one of the great landscapes of Montana. The Beartooth Mountains are immediately to the west of town; the Pryor Mountains to the east, and the valley to the north opens up to the Yellowstone River. Rock Creek flows through town providing fishing opportunities, and the Red Lodge Mountain Ski Area is just minutes from downtown and provides a major winter attraction.

The water system's service area is also the City's Corporation limits as shown on the Figure below.

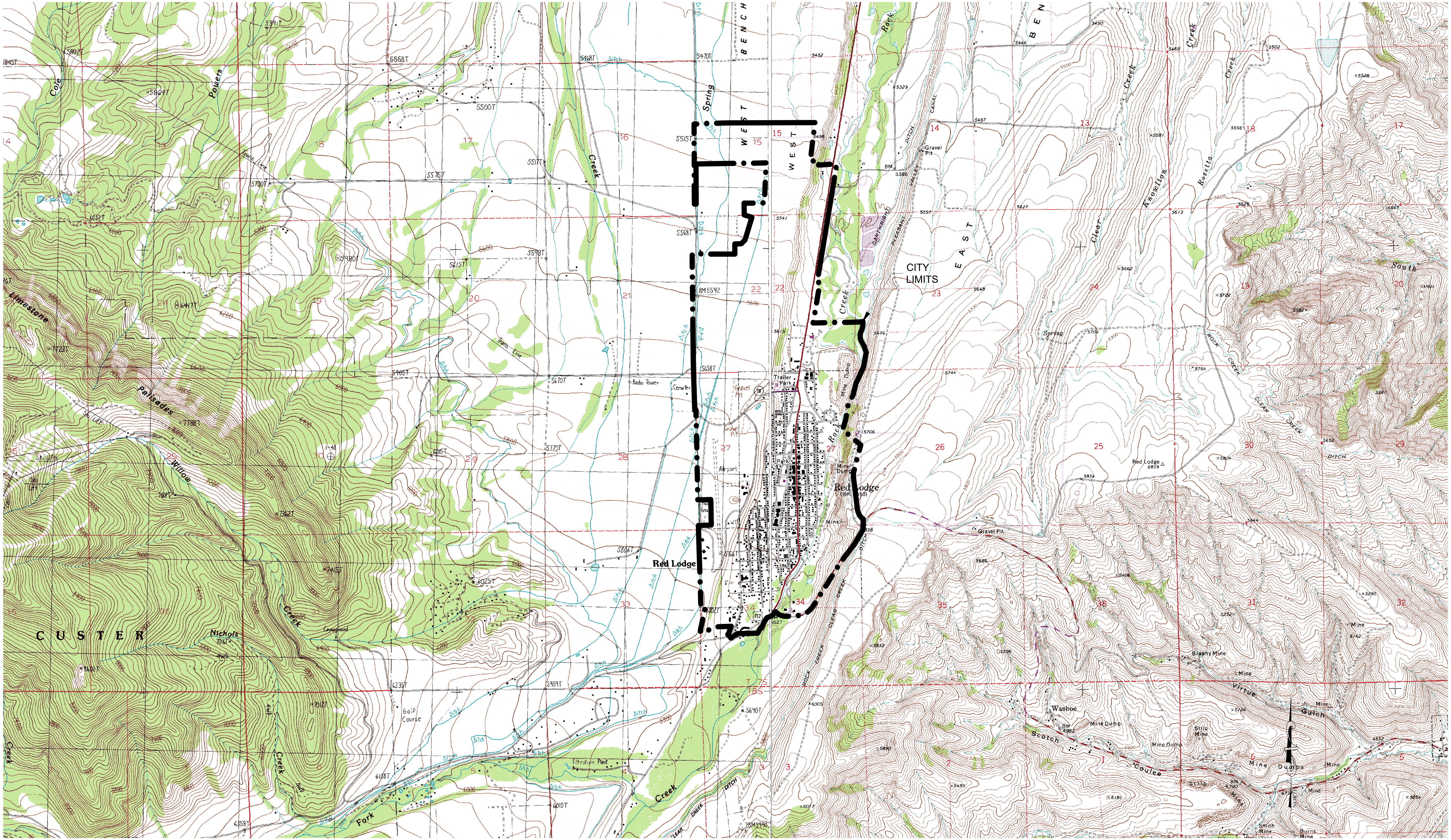

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FIGURE 2:1
CITY OF RED LODGE SERVICE AREA MAP

City of Red Lodge, Montana
2019 Water Preliminary Engineering Report

J:\2-17103 - Red Lodge On-Call 2017\TO 14 - Water PER\CADD 2-17103-14\Sheets\FIGURE 2.1 SERVICE AREA MAP.dwg

2.2 Environmental Resources Present

As part of any potential construction project, the impacts of the project on the surrounding environment should be considered and provisions made to mitigate any negative impacts. The Uniform Application streamlines the process by utilizing a standard procedure called the Uniform Environmental Checklist. The Uniform Environmental Checklist combined with some additional environmental review questions will serve as an Environmental Assessment (EA) for this project. An EA must be completed in order to comply with the Montana Environmental Policy Act (MEPA). A completed EA for the proposed water system improvements in Red Lodge is included in Appendix A.

As part of quantifying the impacts to various environmental resources, the EA process includes sending letters to interested local, state, and federal agencies requesting comments on any potential environmental impacts as a result of potential improvements. A copy of the letters along with responses are included in Appendix A. The following is a list of agencies that were contacted:

- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service
- USDA Natural Resource and Conservation Service
- U.S. Environmental Protection Agency
- U.S. Forest Service
- U.S. Department of Transportation
- Bureau of Land Management
- Bureau of Indian Affairs
- Occupational Safety and Health Administration
- Federal Aviation Administration
- National Park Service
- Montana Department of Commerce, Census and Economic Information Center
- Montana Department of Labor and Industry
- Montana Department of Natural Resources and Conservation
- Montana Department of Environmental Quality
- Montana Department of Transportation
- Montana Nature Resource Conservation
- Montana Department of Fish, Wildlife and Parks
- Montana State Historic Preservation Office
- Montana Natural Heritage Program (via Website Database)
- Carbon County Floodplain Administration

2.2.1 Land Resources

The following is excerpts from the *2015 Red Lodge Growth Policy:*

Strategies for Implementing the Future Land Use Goals –

- *The following regulatory documents should be revised to reflect current laws and goals of this and other referenced documents.*
  - *Subdivision regulations*
  - *Zoning regulations*
  - *Red Lodge Floodplain regulations*
  - *Other City Codes and policies*
- *Infill development should be encouraged as it has proven to be economically and environmentally beneficial. Infill development must be compatible with neighboring uses…*
- *City policy shall discourage sprawling fringe developments*
- *Development site plans shall be evaluated using performance standards that reflect community expectations*
- *The capital facilities planning process shall accommodate the anticipated growth of Red Lodge and the surrounding area.*

- *The City shall actively participate in any process to revise the Carbon County Growth Policy*
- *The Red Lodge Zoning Regulations should address the "perpetual care and maintenance" of landscaping…*
- *The City shall continue to evaluate what protects the night sky within all neighborhoods of Red Lodge*

Municipal Water Distribution System:

The water treatment plant is located southwest of the City. The water treatment plant has adequate capacity to treat the projected demand of 4,140 users by 2026. The water that is delivered to the City is supplied by three wells and is treated with chlorine before it is delivered to two storage reservoirs.

The City should set and adjust user rate fees for the City water system that accurately reflect the costs associated with the collection, treatment and distribution of water to end users. The rates should also include capital reserves for unanticipated expenses as well as capital for planned upgrades to the water treatment and distribution system. Further, the City water system service area should not be expanded to serve areas that are not annexed to or currently within the City Limits of Red Lodge.

Farmland classification, as defined by the NRCS, identifies soils as prime farmland, farmland of statewide importance, farmland of local importance or unique farmland. It identifies the location and extent of the soils that are best suited to food, feed, fiber, forage and oilseed crops. The majority of the soils within the map area of interest are classified as "prime farmland if irrigated" and "Farmland of statewide importance". There are also areas within the AOI that are classified as "Not prime farmland", though these are less prominent than the other two categories. The current land use of the project area will not be affected by the proposed water system upgrades. Because any construction that occurs during this project will be in previously disturbed areas and outside of farming activities, no prime farmland will be disturbed. See Appendix B for a map and table showing the farmland classification of the area soils.

2.2.2 Geology

Located at the foot of the Beartooth mountains, Red Lodge is built upon alluvial terraces along the alluvium channel of Rock Creek. The mountains south and west of town primarily consist of gneissic rock. Geologically, Carbon County contains a wide variety of rocks ranging in age from Precambrian (600 million years) to recent (20,000 years). Bedrock in the area is Precambrian consisting predominantly of granitic gneiss and migmatite.

The elevation of the city is approximately 5,568 feet above sea level. The western portion of town is located on top of a bench that gently slopes to the north. The main portion of town is located on a lower bench and is generally flat and slopes less than 5 percent. The ground surface drains toward the east and north, toward Rock Creek that runs through the eastern portion of the town.

2.2.3 Soil

The NRCS Web Soil Survey was used to generate a map showing the soils in the area around the City of Red Lodge (see Appendix B). The soils found in Red Lodge are primarily composed of gravels, sands, loams, silt, and clays. The predominant soil types identified within the city limits are listed below:

- *Charlos loam, 0 to 2 percent slopes*
- *Charlos loam, 2 to 8 percent slopes*
- *Alluvial land*

Information was obtained describing physical and chemical properties for each soil type. The Natural Resources Conservation Service (NRCS), developed four hydrologic soils groups (A, B, C, and D) to categorize the runoff potential of soils. The NRCS Web Soil Survey provides the following descriptions of the four hydrologic soils groups:

- **Group A.** Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well-drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

- **Group B.** Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well-drained or well-drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

- **Group C.** Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

- **Group D.** Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high-water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

A map illustrating the hydrologic soil group for soils in the Red Lodge area was generated using the NRCS Web Soil Survey, as well as a summary of each soil unit's rating. Both are included in Appendix D. The hydrologic soil groups of the soils in the Red Lodge vicinity are distributed as follows:

Table 2-1 Distribution of Hydrologic Soil Group

Hydrologic Soils Group	Percent of Area
A	<1%
B	83.5%
C	5.6%
D	10.8%

Another important property of the soils that will affect the materials used in the water system is the propensity of the soils to corrode concrete and/or steel. Therefore, each of these properties was analyzed. According to the NRCS,

> " 'Risk of corrosion' [of concrete] pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens concrete. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The concrete in installations that intersect soil

> boundaries or soil layers is more susceptible to corrosion than the concrete in installations that are entirely within one kind of soil or within one soil layer."

81% of the area of interest (AOI) was rated with a "moderate" risk of corrosion to concrete. The remainder of the AOI contains soils classified as a "low" risk of corrosion of concrete. A report listing the risk of corrosion to concrete is included in Appendix D.

The propensity to corrode steel for each of the soils was also evaluated. According to the NRCS,

> " 'Risk of corrosion' [of steel] pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel in installations that are entirely within one kind of soil or within one soil layer."

The majority of the AOI, 93.2%, had a rating of "high" for risk of corrosion. A report listing the risk of corrosion to steel is included in Appendix D.

2.2.4 Climate

The climate in Red Lodge has a humid continental climate per the Koppen climate classification system with annual precipitation rates currently estimated at 21.31 inches. Over 64 percent of the annual precipitation total occurs from March through August. Precipitation can vary significantly from year to year, and location to location within a given year. November through March are the dryer times of the year with average monthly precipitation of 1.15 inches or less. The temperature extremes can range from 10ºF in the winter to 78ºF in the summer, based on monthly averages. The average growing season (consecutive frost-free days) is 100 days. Prevailing winds are from the west at 5-10 mph and gusts up to 20-30 mph are not uncommon.

2.2.5 Biological Resources

The Montana Natural Heritage Program database was queried for information on biological resources. Fauna of the area consists of typical mammalian species found in the intermountain west, including mule deer, whitetail deer, antelope, coyote, rabbit, skunk, weasel, rodents and other species. Common bird species include the black-billed magpie, American robin, Canadian goose, osprey, blackbird, sparrow, warbler, common waterfowl, other raptors, game birds and other species. The nearby Rock Creek holds rainbow, brook trout and brown trout. Reptile and amphibian species prevalent include snakes, lizard, and frogs. In terms of vegetation, the area is typically populated with riparian species and grasses.

The Montana Natural Heritage Program maintains a website with up-to-date lists of Species of Concern across the State of Montana, including species listed as endangered or threatened by the United States Fish and Wildlife Service (USFWS). A review of this information was completed as part of this PER effort and is included in Appendix A. A Species of Concern is a species at risk or potentially at risk as a result of declining population trends, threats to their habitats, and/or restricted distribution. While no statutory or regulatory classification or enforcement is associated with this designation, it helps resource managers make proactive decisions regarding species conservation and data collection priorities.

In the vicinity of Red Lodge (Township 7S, Range 20E), the following species of concern were identified:

- Birds
  - Northern Goshawk
  - Great Blue Heron
  - Veery
  - Greater Sage Grouse
  - Brown Creeper
  - Peregrine Falcon
  - Cassin's Finch
  - Clark's Nutcracker
  - Long-billed Curlew
  - Green-tailed Towhee
  - Brewer's Sparrow

- Reptiles
  - Western Milksnake

- Fish
  - Yellowstone Cutthroat Trout

- Mammals
  - Wolverine
  - Hoary Bat
  - Canada Lynx
  - Grizzly Bear

- Flowering Plants
  - Beautiful Fleabane

- Wood Lily

The U.S. Fish and Wildlife Service was contacted and provided the following statement:

> *"Based on the confined nature and proposed location of this proposed work in an existing developed municipal setting, we do not anticipate its implementation would result in adverse effects to listed, proposed or candidate threatened or endangered species, or listed or proposed critical habitat. Similarly, given the developed nature of the immediate project area containing existing (and proposed) facilities, we do not anticipate substantive negative project-related effects to eagles or other migratory birds. The Service is not aware of any eagle nests within several miles of the proposed project."*

The area was also reviewed for Sage Grouse habitat. Based on a review of the Montana Sage Grouse Habitat Conservation Program Mapper (*https://sagegrouse.mt.gov/projects*), the proposed project area is associated with the city limits, the south half of the city is within the "Exempt Community Boundary" of the City of Red Lodge, and the north half of the city is classified as not mapped in an Executive Order (EO) Area for Sage Grouse Habitat. As such, Sage Grouse are not anticipated to be adversely affected by this work. Following the award of grant funds, and within 12 months of the proposed construction date, the City will consult with the MSGHCP regarding the work.

2.2.6 Water Resources

Water resources are identified to be both groundwater and surface water sources within the project planning area. Groundwater wells and surface water sources are identified by the Natural Resources Information System (NRIS) and the Ground Water Information Center (GWIC).

2.2.6.1 Ground Water

The City of Red Lodge currently obtains its municipal public water supply from groundwater sources. The City has three municipal wells. Two of the three wells (wells 2 and 3), located near the water treatment plant, are allocated a flow rate of 1200 gpm and an annual volume of 968 acre-feet under provisional permit 43D 300011 72. The other well, (Well 1) located in Grant Avenue between 19th Street and 18th Street, is allocated a flow rate of 902 gpm and an annual volume of 1450 acre-feet. From these wells the City has a maximum flow rate stipulated by these claims of 2102 gpm with a maximum annual use of 2352 acre-feet.

The City also has two wells for irrigation. The well in the north eastern portion of town is allocated for sprinkler irrigation of the City's sports complex. This well, under water right 43D 66358 00, is allocated a flow rate of 100 gpm and an annual volume of 97.11 acre feet. The other well is allocated a flow rate of 212 gpm and an annual volume of 26 acre feet under water right 43D 45738 00 for the purpose of irrigation of the cemetery. These wells are not part of the municipal supply system.

2.2.6.2 Surface Water

The City of Red Lodge historically obtained their entire public water supply from surface water. The City's water treatment plant is located near the West Fork of Rock Creek where the City's water had previously been supplied through a diversion in the creek. The treatment plant is no longer in use as the West Fork of Rock Creek has moved away from the intake structure.

The City maintains surface water rights for municipal use through the following water rights; 43D 43377 00 with a flow rate of 2.5 cfs and an annual volume of 1272 acre-feet; 43D 43378 00 with a flow rate of 1.25 cfs and an annual volume of 903 acre-feet; and 43D 45737 00 with a flow rate of 1.6 cfs and an annual volume of 32 acre-feet.

From these water rights the City has a maximum flow rate of 5.35 cfs, and an annual maximum annual use of 2207 acre-feet.

2.2.7 Floodplains

A review of the Federal Emergency Management Agency (FEMA) floodplain maps was completed in the proposed project area. The Flood Insurance Rate Maps (FIRM – 30009C0692D-2012, FIRM – 30009C0711D-2012, and FIRM 30009C0703D-2012) indicates that portions of the City of Red Lodge are within the 100-year floodplain of Rock Creek. As part of the proposed water project, construction activity may be within the 100-year floodplain and portions of the system adjacent to Rock Creek may be within the 500-year floodplain. A more detailed analysis of the project will be completed during the design phase to determine if a Joint Application Permit package is necessary for any of the proposed projects. The floodplain maps for the City of Red Lodge area are provided in Appendix B.

2.2.8 Wetlands

The National Wetlands Inventory maintained by the USFWS was queried for information on wetlands in the proposed construction areas. The Wetlands Mapper utility indicates that wetland areas are present along Rock Creek, but they all appear to be outside of the limits of the proposed water improvements and will not be impacted by the project. A wetland delineation will be performed to document any jurisdictional wetlands at the site vicinity during the design phase of the project to ensure wetlands are not impacted. Wetland maps are included in Appendix B.

2.2.9 Cultural Resources

As part of the environmental review process, the Montana State Historic Preservation Office (SHPO) was contacted and asked to comment on potential impacts to cultural resources in the project area. SHPO provided a response letter indicating that there are previously recorded sites in the Red Lodge area and that cultural resource inventories have been completed for other projects in the area. The letter further stated that *"for all water lines [stormwater] that are within existing roadways we feel there is a low likelihood cultural properties will be impacted as these areas have been previously disturbed. Any water lines [stormwater] that would not be located within an existing roadway, which have not had previous disturbance, for these we would recommend a cultural resource inventory be conducted in order to determine whether or not sites exist and if they will be impacted."* A copy of the response letter is included in Appendix C.

There does not appear to be any potential conflicts with any historic structures within the City. The final design will need to be coordinated to ensure that any historical structures are not adversely impacted or are mitigated properly.

The National Register of Historic Places is the official list of the nation's cultural resources worthy of preservation. Authorized under NHPA, the Register is administered by the National Park Service. Properties on the National Register include districts, sites, buildings, structures, objects that are significant in American history, architecture, archaeology, engineering and culture.

Table 2-2 Red Lodge Properties Listed on the National Register

Resource Name	Address	Date Listed
Hi Bug Historic District	Roughly bounded by W. 3rd St., N. Villard Ave., W. 8th St., and N. Word Ave.	1986-07-23
Red Lodge Commercial Historic District	Roughly Broadway from 8th to 13th Streets.	1983-04-14

Red Lodge Commercial Historic District	S. Broadway between 8th and 15th Streets.	1986-08-28
Yodeler Motel	601 S. Broadway Ave.	2014-03-26
Warila Boarding House and Sauna	20 N. Haggin	1985-10-24
Calvary Episcopal Church	9 N. Villard Ave.	1986-10-23
Red Lodge Brewing Company – Red Lodge Canning Company	904 N. Bonner St.	2007-09-05
Red Lodge Communal Mausoleum	Montana HWY 78	2001-03-21

2.2.10 Socio-economic and Environmental Justice Issues

The City of Red Lodge is not considered a minority of low-income community according to the Department of Commerce based on information from the 2015 American Communities Survey (ACS) and Census and Target Rate 2015 Information from Community Development Division. The median household income for Red Lodge, according to the 2015 ACS, is $42,500.

Red Lodge is considered to have a low and moderate income (LMI) percentage of 37.94%. In order to be eligible for a Community Development Block Grant (CDBG), which is a low-income grant program, a community must have an LMI of at least 51%.

Concerns with the water system are not anticipated to have a disproportionately high adverse effect to minority of low-income sections of the community. The proposed improvements will affect the entire community equally. The improvements will be beneficial to public safety and human health and will not adversely impact the environment.

2.3 Population Trends

Population data for Red Lodge was collected by searching the decennial consensus records on the U.S. Census Bureau website. There has been no known appreciable growth in Red Lodge since the 2010 census was completed. Table 2.1 summarizes the population of the City and County as recorded in decennial censuses by the U.S. Census Bureau. The table also includes the calculated annual growth rate associated with the census populations.

Table 2-3 Population History

Census	Town of Red Lodge	Carbon County

	Population	% Annual Growth	Population	% Annual Growth
1960	2,278	-1.80%	8,317	-2.10%
1970	1,844	-2.09%	7,080	-1.60%
1980	1,896	0.28%	8,099	1.35%
1990	1,979	0.43%	8,080	-0.02%
2000	2,190	1.02%	9,552	1.69%
2010	2,128	-0.29%	10,078	0.54%
2019	2,294	0.84%	10,714	0.68%
Average	2,087	0.03%	8,846	0.44%

Note: 2019 population based on Annual Estimates of the Resident Population from the U.S. Census Bureau, Population Division.

A 20 year design life is typically assumed for major capital improvements, resulting in a design year of 2040 for purposes of the PER. In an effort to be conservative and to more closely match the historical growth of the State, a 1.0% growth was assumed beginning in 2019 through the 20-year design period to the year 2040.

Using these assumptions, Table 2.2 shows the projected population of Red Lodge through the 2040 year design period.

Table 2-4 Population Projections

Year	Town of Red Lodge	
	Assumed Annual Growth Rate	Projected Population
2019	--	2,294
2020	1.0%	2,317
2025	1.0%	2,435
2030	1.0%	2,559
2035	1.0%	2,690
2040	1.0%	2,827

2.4 Community Engagement

Describe the utility's approach used (or proposed for use) to engage the community in the project planning process. The project planning process should help the community develop an understanding of the need for the project, the utility operational service levels required, funding and revenue strategies to meet these requirements, along with other considerations.

3.0 EXISTING FACILITIES

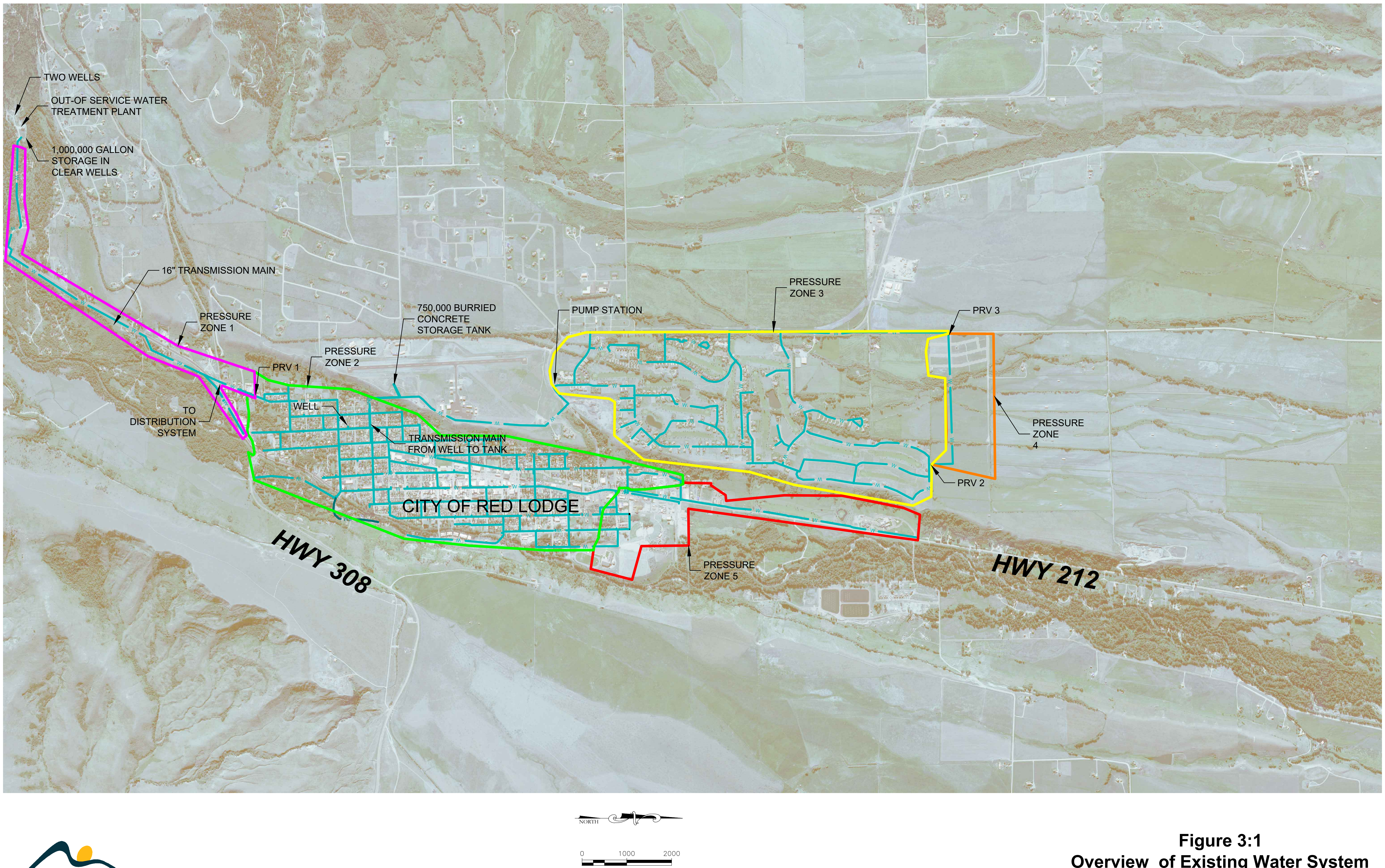
The components within the City of Red Lodge's municipal water system consists of two 500,000 gallon baffled clear wells at the water treatment plant and a 750,000 gallon buried concrete tank located on the West Bench, a 1.4 MGD direct filtration water treatment plant, an intake structure in the West Fork of Rock Creek, three wells, liquid chlorine injection disinfection, one booster station, three pressure relief valves, distribution and transmission mains.

3.1 Location Map

The City's intake structure is approximately 1 ½ miles south west of the City Limits, on Water Works Road. The intake structure has been abandoned as the West Fork of Rock Creek has diverted away from the intake structure. The City's water treatment plant is just east of the intake structure. At the treatment plant is one of the city's two water storage reservoirs. This storage facility is has a total storage of 1,000,000 gallons in clearwells. The other storage facility is a 750,000 gallon underground concrete storage tank which is located on the West Bench near the airport.

The City's water system is composed of 5 pressure zones. Zone 1 is the main from the water treatment plant to the corporate limits near PRV 1 in White Avenue. Zone 2 is the majority of the City. Pressure in Zone 2 is regulated by the water level in the West Bench tank. Zone 3 consists of Country Club Estates. The pressure in Zone 3 is controlled by the booster Station. Zone 4 is the Spires Subdivision loop. The pressure in Zone 4 is regulated by two pressure relief valves. Zone 4 is the northern most portion of the original City. This zone has pressures ranging from 100 to 153 psi. Zone 5 pressure is controlled by the tank on the West Bench.

The City has two wells near the water treatment plant (Wells 2 and 3), and a well in Grant Avenue between 19th Street and 18th Street (Well 1). An overview of the system is provided in Figure 3.1.



J:\2-17103 -- Red Lodge On-Call 2017\TO 14 -- Water PER\CADD 2-17103-14\Sheets\Figure 3.1 Overview of Existing Water System.dwg

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Figure 3:1
Overview of Existing Water System

City of Red Lodge, Montana
2019 Water Preliminary Engineering Report

3.2 History

The most recent preliminary engineering report for the City of Red Lodge was completed in 1994. This PER referenced the 1976 water master plan. The work in the PER mainly consisted of water main replacements. At the time of the report the water treatment plant had already been taken off of the system.

Red Lodge's water treatment plant is a 1.4 MGD conventional filtration plant constructed in 1983. The plant has been taken out of service because the West Fork of Rock Creek has moved away. Currently the City water source is strictly from wells.

The majority of the City's distribution system was initially constructed using cast iron pipe. The original portions of the distribution system were installed as early as the 1910's. Over the years, the City has been chipping away at water line replacements throughout the distribution system.

A summary of water system improvements that have been completed in the last two decades include:

- 1996: 5 blocks of water main were replaced with 8" ductile iron pipe in the alley between Haggin Avenue and Cooper Avenue between 12th Street and 9th Street.
- 1999: Drilled well No. 2 at the water treatment plant
- 1999: 34 blocks of water main were replaced with ductile iron pipe ranging from 6" to 12" diameter. 4 Blocks were replaced in Broadway Avenue from 3rd Street northward; 6 blocks in Cooper and Chambers in between 9th Street and 5th Street;4 blocks on the south end of Haggin Avenue and Platt Avenue; 3 blocks in Hauser Avenue, two of which were between 11th Street and 15th Street and one between 20th Street and 19th Street; 4 blocks in Oaks Avenue and Word Avenue between 17th Street and 13th Street; 6 blocks in Word Avenue and Adams Avenue between 13th Street and 8th Street; 1 block in 13th Street between Grant Avenue and Adams Avenue; 6 Blocks in White Avenue, McGillen Avenue, and 22nd Street.
- 2004: 18 blocks of water main were replaced with ductile iron pipe ranging from 6" to 12" diameter. 4 blocks were replaced in Adams Avenue and Word Avenue between 21st Street and 17th Street; 7 blocks in Word Avenue between 11th Street and 4th Street; 5 blocks in

Hauser Avenue between 7th Street and 1st Street; and 2 blocks in 1st Street from Hauser Avenue to Bonner Avenue.

- 2005: Drilled well No. 3 at the water treatment plant.
- 2009: Construction of new 500,000 gallon storage tank at the water treatment plant. Construction of a 16" ductile iron pipe transmission main from the water treatment plant to the PRV in White Avenue.
- 2012: 14 blocks of water main were replaced with 12" ductile iron pipe as part of the Broadway Avenue water replacement project.
- 2013: Replace Well SCADA controls.
- 2018: Upgrade disinfection system at the water treatment plant well location and the grant well location from gas chlorine to liquid chlorination.
- 2019: 19 blocks of water main were replaced with 8" or 6" pvc as part of the Haggin Avenue water replacement project.

3.3 Condition of Existing Facilities

An overview of the water system components was provided in Section 3.1. This section will provide a detailed analysis of each system component. In addition to the analysis provided herein; the Department of Environmental Quality (DEQ) has also completed regular Sanitary Surveys. The latest Sanitary Survey was conducted in MONTH YEAR. The sanitary survey noted a few Recommendations/Minor Deficiencies but did not note any Major Deficiencies. A copy of the survey is included in Appendix C for reference.

3.3.1 Water Demand

Water sales by month from January 2014 through December 2018 were obtained from the City. A summary of the gallons sold and number of users on the system by category is included in Appendix D

3.3.1.1 Average Day Demand

The City has logged daily water use since November of 2016. Each month they record the gallons used on the lowest use day, the average of the month's day use, and the highest day use. See Appendix D. The average gallons per day demand is determined by averaging each month's average day use from January 2016 through the end of December 2018, which is just under 261,500 gallons per day (or 182 gallons per minute).

It is important to note that this water use is established from the water metered and water use estimated for unmetered use. Since 2014 the City has experienced an average water loss of 47% per month. This water loss can be attributed to leakage in the distribution system and services, water used for firefighting or flushing of hydrants, unknown water users, etc. Water loss will be discussed further as part of the distribution system. However, it is worth noting that 47% water loss is concerningly high. The Environmental Protection Agency (EPA) estimates that average water system losses are 16% and up to 75% of that is recoverable. [vii] (See Big Timber PER reference section). Red Lodge's water loss is nearly triple the EPA estimate.

In order to establish Average Day Demand, the average day used water volume of 261,500 gallons per day was divided by the estimated 2019 population of 2,294 residents, which results in a gallons per capita day usage of 114 gallons per capita day (gpcd). Multiplying the calculated gallons per capita day by the design year population of 2,827 residents results in a design average day demand of 322,300 gallons per day (or 224 gallons per minute) for the analyses in this report.

3.3.1.2 Peak Day Demand

Peak day demands or maximum day demands are important to consider as water usage varies throughout the day in addition to the month and year. The water supply should be sufficient to meet the peak day demands without using stored water. The most important reason to consider peak day demand is to ensure that adequate water supply is available to meet peak day demands without using stored water as required in Circular DEQ-1, Section 3.1.1.a. A peak day peaking factor is typically used to estimate the peak day demands and is defined as the ratio of the peak day demand to the average day demand.

A peaking factor is defined as the ratio of the peak day demand to the average day demand. Throughout the United States, peaking factors range from 2 to 5[1]. However, studies done throughout Montana and the Dakotas indicate peaking factors of 1.8 to 4.0[2,3,4,5]. In general, the smaller the water supply system, the larger the peaking factor, though, metered systems typically see lower peaking factors due to a conscious effort made by the users to conserve water. Also, peak days typically occur during the hottest days of the year when lawn watering is at a maximum.

The City of Red lodge has recorded daily maximum production flows over the last several years. These water production records and a summary spreadsheet are attached in Appendix D. As provided by the Public Works Director, the day with the highest production volume from November 2016, through October 2019 occurred in August 2018 with a volume of 1,118,000 gallons. The average day production volume during this time period is of 476,700 gallons. The peak day factor was established using the produced volumes of the system as daily metered used volumes are not available. The peak day factor was determined to be 2.4.

Multiplying the peak day factor by the design average day demand of 322,300 gallons per day gives a design peak day demand volume of 773,600 gallons per day.

3.3.1.3 Peak Hour Demand

Just as the peak day demand is the day with the highest usage, the peak hour or peak momentary demand represents the hour with the highest usage. Peak hours typically occur in the mornings prior to work and school (when people are taking showers) with a slightly smaller peak occurring in the evening hours after work. Peak hour demands are important to consider when analyzing or designing booster pumps within a system.

Since there is no data available to determine peak hour demands for Red Lodge, a peak hour peaking factor must be estimated. Peak hour peaking factors generally range from 1.6 to 2.0

[1] Salvato, Joseph A. Environmental Engineering and Sanitation. John Wiley and Sons. 1982.

[2] HKM Associates. Fort Totten Area Project Report. 1989.

[3] HKM Associates. Rosebud Sioux Tribe Municipal, Rural and Industrial Water Needs Assessment. 1989.

[4] Morrison-Maierle/CSSA. Final Engineering Report, Mni Wiconi Rural Water Supply Project. 1989.

[5] De Wild Grant Reckert & Associates Company. Engineering Report for Luman-Jones Rural Water System, Mni Wiconi Rural Water Supply Project. 1992.

times the peak day demand. To be conservative, the maximum peaking factor of 2.0 from this range will be used.

The calculated design peak day demand of 773,600 gallons per day equates to 32,240 gallons per hour. Multiplying this by a peak hour factor of 2.0 results in a design peak hour demand of 64,480 gallons per hour.

Because the water for peak hour demand is not needed on a continual basis, any demand above the peak day demand is typically supplied from storage. As will be discussed with the evaluation of the storage, the City has adequate capacity in their storage tank to meet the projected peak hour demands. The actual influence of peak hourly demands on the overall system will be considered in the hydraulic model, though.

Table 3-1 Summary of Existing and Projected Water Demands

YEAR	POPULATION	AVERAGE PER CAPITA DEMAND	AVERAGE DAY DEMAND			MAX DAY PEAKING FACTOR	PEAK DAY DEMAND			PEAK HOUR FACTOR	PEAK HOUR DEMAND
			gpd	gal/yr	gpm		gpd	gph	gpm		gph
2019	2,294	114	261,500	95,447,500	182	2.40	627,600	26,150	440	2	52,300
2020	2,317	114	264,200	96,433,000	183	2.40	634,100	26,430	450	2	52,860
2025	2,435	114	277,600	101,324,000	193	2.40	666,300	27,770	470	2	55,540
2030	2,559	114	291,800	106,507,000	203	2.40	700,400	29,190	490	2	58,380
2035	2,690	114	306,700	111,945,500	213	2.40	736,100	30,680	520	2	61,360
2040	2,827	114	322,300	117,639,500	224	2.40	773,600	32,240	540	2	64,480

3.3.2 Supply

The City gets its municipal water supply from three groundwater wells. Well No. 1, (Grant Avenue Well) was drilled and completed in 1961. Well No. 2 and Well No. 3, located at the water treatment plant, have a joint header. Well No. 2, drilled and completed in 1999, is the higher producing well of the two and as such is the City's primary water supply well. Well No. 3 was drilled and completed in 2005. Currently the City does not use well No. 3 as it is the lowest producer of the three wells. Well logs from the Groundwater Information Center (GWIC) website[6] are included in Appendix E. And Table 3.2 provides a summary of characteristics of each well.

[6] Montana Bureau of Mines and Geology, Groundwater Information Center, https://mbmggwic.mtech.edu/.

Well No. 1 is located under the Pump house in Grant avenue. The well is pumped with a vertical turbine pump. The motor and controls were replaced in 2018. Figure 3.2 below shows the well piping and pump.

Table 3-2 Well Log Information

Characteristic	Units	Well No. 1	Well No. 2	Well No. 3
Completion Date	date	9/17/1961	12/31/1999	11/7/2005
Total Depth	feet	74	67	61
Static Water Level	feet	20	8	13
Screened Interval	feet		40-65	
Pump Test Data				
Rate	gpm	900	1040	500
Drawdown	feet		0	
Duration	hours		20	32

Figure 3.2: Grant Well (Well No. 1)

Wells No. 2 and No. 3 are located approximately 1 ½ miles south of the City near the West Fork of Rock Creek. Both wells are completed with a vented pitless unit and a submersible pump set in the screened interval. Well No. 2 is drilled underneath the well building, well No. 3 is approximately 100 feet west of the well building and is connected to the header in the well building via an 8" ductile iron pipe. Each well at the water plant has a 20 hp franklin electric submersible well pump. The City keeps a spare pump in the well header building. The well manifold connects the two wells' water with an 8" diameter manifold in the building. Figure 3.3 below shows the well header.

Figure 3.3: Water Plant Well Header (Wells 2 and 3)

Only one of Wells No. 2 and No. 3 is operated at a time and the active well must be manually selected. The City currently only uses Well No. 2. at the water treatment plant and Well No. 1 at Grant as the back-up water source.

3.3.2.1 Water Capacity

Paragraph 3.2.1.1.a of Circular DEQ 1 – Standards for Waterworks (DEQ-1) discusses source capacity and states:

> *The total developed ground water source capacity for systems utilizing gravity storage or pumped storage, unless otherwise specified by MDEQ, must equal or exceed the design maximum day demand with the largest producing well out of service.*

As shown in the table, the stabilized pumping rates for the wells are: well 1-900 gpm, well 2-1040 gpm and well 3-500 gpm for a total of 2840 gpm. As shown in Table 3.2 above, the design peak day demand is 960 gpm. These well capacity rates significantly exceed the current and design peak day demands individually, meeting the DEQ requirement for source capacity.

3.3.2.2 Water Quality

Table 3.3 summarizes the most recent water quality testing from the wells in May of 2017.

With respect to primary drinking water standards, Red Lodge's water supply meets the Maximum Contaminant Levels (MCLs) of the Safe Drinking Water Act, and treatment other than disinfection is not required.

Table 3-3 Well Water Quality

Parameter	Units	Well No. 1	Well No. 2	Well No. 3
Sample Date	date	5/16/17		5/16/17
Physical Properties				
pH	std. units	6.9	6.9	7.2
Total Dissolved Solids	mg/L		65	
Inorganics				
Alkalinity, Total as $CaCO_4$	mg/L	55	0.0	
Bicarbonate as HCO_3	mg/L		62	
Carbonate as CO_3	mg/L			
Chloride	mg/L			
Fluoride	mg/L			
Sulfate	mg/L	ND	3.0	ND
Nutrients				
Nitrate + Nitrite (as N)	mg/L	0.39	0.13	ND
Metals				
Antimony	mg/L			
Arsenic	mg/L			
Barium	mg/L	0.023	0.4	
Beryllium	mg/L			
Cadmium	mg/L			
Calcium	mg/L	13	11	
Chromium	mg/L			
Copper	mg/L			
Iron	mg/L	0.01		ND
Lead	mg/L		0.004	
Magnesium	mg/L	4.1	3.0	ND
Manganese	mg/L			
Mercury	mg/L			
Nickel	mg/L			
Potassium	mg/L			
Selenium	mg/L			
Sodium	mg/L	2.8	2.0	
Thallium	mg/L			

Note: "ND" = Not detected. "-" = Parameter Not Analyzed.

3.3.2.3 Water Rights

The City of Red Lodge currently obtains its municipal public water supply from groundwater sources. The City has three municipal wells. Wells 2 and 3, located near the water treatment plant, are allocated a flow rate of 1200 gpm and an annual volume of 968 acre-feet under water provisional permit 43D 300011 72 with a priority date of March 7, 2002. The well 1, located in Grant Avenue between 19th Street and 18th Street, is allocated a flow rate of 902 gpm and an annual volume of 1450 acre-feet. From these wells the City has a maximum flow rate stipulated by these claims of 2102 gpm with a maximum annual use of 2352 acre-feet.

The City also has two wells for irrigation. The well in the north eastern portion of town is allocated for sprinkler irrigation of the City's sports complex. This well, under water right 43D 66358 00, is allocated a flow rate of 100 gpm and an annual volume of 97.11 acre-feet. The other well is allocated a flow rate of 212 gpm and an annual volume of 26 acre-feet under water right 43D 45738 00 for the purpose of irrigation of the cemetery. These wells are not part of the municipal supply system. From these water rights the City has a maximum flow rate of 5.35 cfs, and an annual maximum annual use of 2207 acre-feet. Copies of the City's water rights are included in Appendix E.

The City of Red Lodge historically obtained their entire public water supply from surface water. The City's water treatment plant is located near the West Fork of Rock Creek where the City's water had previously been supplied through a diversion in the creek. The treatment plant is no longer in use as priorities on the West Fork of Rock Creek upstream from the red Lodge Diversion total 39.1 cfs. The second right can only be used when the flow in the creek is greater than 42 cfs. Also, prior to the 1994 Water PER, Rock Creek's flow had moved away from the water treatment plant intake structure.

The City maintains surface water rights for municipal use through the following water rights; 43D 43377 00 with a flow rate of 2.5 cfs and an annual volume of 1272 acre-feet; 43D 43378 00 with a flow rate of 1.25 cfs and an annual volume of 903 acre-feet; and 43D 45737 00 with a flow rate of 1.6 cfs and an annual volume of 32 acre-feet.

3.3.2.4 Water Source Protection

The City updated its Source Water Delineation and Assessment Report in 2003. A copy of the Source Water Protection Plan is included in Appendix F. With the addition of Well 3 in 2005 the report may need updated.

There were no unusual significant source water protection issues raised in the report. The use of a sanitary sewer system, as well as storm sewer system, while favorable for groundwater quality, does present some risk in the event of a leaking sewer. Two of the three underground storage tanks (UTS) in the City have leak histories which are up gradient of well 1 pose a potential risk to that well. There is moderate septic density near well 2. The Town has not yet detected pesticides or herbicides in the water supply.

3.3.3 Treatment

The City has two chlorination disinfection systems, one for the Water produced from Well No. 1 in Grant avenue and the other for the water produced from Wells No. 2 and 3 at the water treatment plant. Water is disinfected prior to entering the distribution system. Chlorine disinfection is applied using liquid sodium hypochlorite solution at 12.5%. A single chemical metering pump (peristaltic) is used to properly dose the well discharge, and there is sufficient supply of disinfectant on-site. Figure 3.4 below exhibits the water treatment plant site.

3.3.3.1 Chlorination

The design flowrates of the wells were determined based upon actual historical usage. The flowrate at the water plant wells (Wells 2 and 3) is 700 gpm, and the flowrate at the Grant Well (well 1) is 550 gpm. The capacity from the well logs shown above is what was tested during well construction but is not consistent with the actual pumps that were installed. Therefore, the pump capacity flow rate was used in the following chlorination calculations. The City switched from gas chlorine disinfection to liquid chlorine injection systems in 2018.

Grant Well (Well No. 1) Chlorination

Well No. 1 is located under the Pump house in Grant avenue. Chlorine is injected in the pump house and the residual chlorine is sampled from the pump house. There are two chemical feed pumps plumbed for redundancy in the chemical feed room. Chemicals are stored in a separate room with an emergency eyewash station. After disinfection is applied to water supplied from the well water is routed through a 10" main directly to the water tower on the west bench. There are no services on this line. This water main is approximately 2,186 feet. Estimated contact volume is 1,192 cubic feet (point of chlorine application to water tower). The sample tap for measuring minimal residual dose is near the chemical injection point. The City Operators keep the measured residual around 2.0 mg/l, however, the actual feed chemical residual may vary. For this reason, the disinfection calculation used a minimum residual dose of 1 mg/l. A minimum residual dose of 1.0 mg/l into a flowrate of 550 gpm (pH 7-9, Temp 0.5°C) gives an actual CT of 16.2, which exceeds the required CT of 12.

Water Plant Wells (Wells No. 2 and No. 3 Chlorination)

After disinfection is applied to water supplied form Wells 2 and 3, it is piped to the two baffled clearwells with a total volume of 1,000,000 gallons. Chlorination is applied to the water in a chlorination room located in the old water treatment plant building, see Figure 3.4 below. The City stores a back-up chemical feed pump in the chlorine contact room. The residual chlorine analyzer is in another building located on the south east corner of the tank and clearwell. After the water passes through the residual chlorine building it enters the 16" ductile iron pipe transmission main. The first metered service on the transmission main is 26 Waterworks Road, which is approximately 1340 feet from the residual chlorine building. The City Operator's run the chemical injection at a residual dose of 1.2 mg/l. A minimum residual dose of 1.2 mg/l into a flowrate of 1040 gpm (pH 7-9, Temp 0.5°C) gives an actual CT of 119, which exceeds the required CT of 12

Figure 3.4: Chlorine Residual Building

3.3.4 Storage

The City's storage consists of two storage locations. The first location is near the water treatment plant, where the majority of the City's storage is contained. At the water treatment plant there is a 500,000 gallon clear well with a baffle creating two equal storage basins which was constructed at the time of the water treatment plant in 1983. The second clearwell at the water treatment plant location holds 500,000 gallons and was constructed in 2009. A photo of the underground clearwell and new storage tank site at the water treatment plant is shown below in Figure 3.5. The second storage location is on the west bench where the City constructed a 750,000 gallon concrete underground storage tank. The City's current total storage is 1,750,000 gallons.

Figure 3.5: Clear Well and Water Plant Underground Storage Tanks

3.3.4.1 Storage Condition

Inspection of the tank and water plant clearwells was completed in July of 2016 as part of the regular maintenance plan. The inspections report three clearwells, two are the 500,00 gallon clearwells and one is a vault which connects the two clearwells. The findings from the inspections are in Appendix K.

The inspection notes are summarized in the table below:

Table 3-4 Storage Tank Inspection Summary

Concrete Condition Found	Clearwell #1	Clearwell #2	Clearwell #3	West Bench Tank
Cracking		Walls, Floor	Walls	
Settling		Walls, Floor		Roof
Honeycomb			Walls	
Pitting				Columns
Spalling	Walls, Floor			
Pop outs	Walls			Columns
Chalking				Walls, columns
Exposed Reinforcement	Walls		Walls	

As part of the City's regular maintenance schedule, the reports recommend that the vents on all the tanks should have a security vent shroud and tank hatches should include a security hatch locking device. The Tank assessments recommend the tanks be cleaned and reassessed every 3 years.

3.3.4.2 Storage Volume

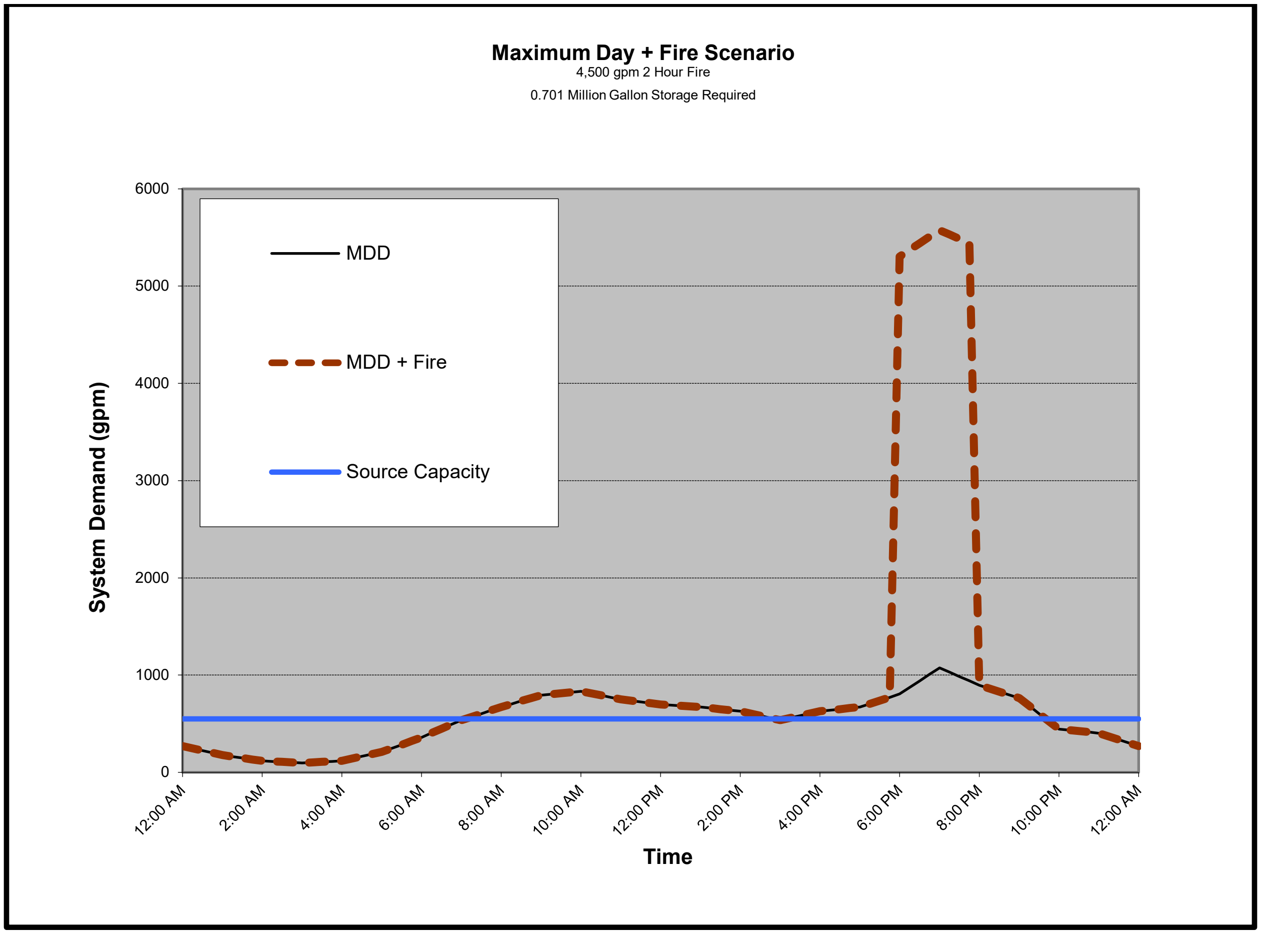
DEQ gives the following two standards for analyzing minimum required storage volume in water system that provide fire protection:

Criteria 1. "*Storage facilities must be sufficient, as determined from engineering studies, to supplement source capacity to satisfy all system demands occurring on the maximum day, plus fie flow demands where fire protection is provided."* (Circular DEQ-1, Paragraph 7.0.1)

Criteria 2. *"The minimum allowable storage must be equal to the average daily demand for a 24-hour period plus fire flow demand where fire protection is provided."* (Circular DEQ-1, Paragraph 7.0.1.b)

Compliance with Criteria 1 is shown by the graph in Figure 3.6. The graph shows that the existing combination of source capacity and storage volume is adequate to provide maximum day demand plus fire flow for a 4,500 gpm 2 hour duration fire. The building with the highest fire demand is the old Cannery building, which is no longer being used. The demand for the cannery is 4,500 gpm. The horizontal line on the graph represents the pump capacity of Well No. 1 (550 gallons per minute), which is less than the capacity of joint header wells No 2 and 3. The required storage volume is equal to the area between the “MDD + Fire” curve and the “Source Capacity” line. The total required storage volume in this scenario is 701,000 gallons. The City’s available storage is 1,750,000 gallons.

Figure 3.6: Storage Analysis Graph



To comply with Criteria 2, the City must be able to supply the future average day water usage (322,300 gallons) and needed fire flow with the source out of commission. Therefore, currently the City’s fire storage is:

Total Storage-Average Day Demand=Fire Storage

1,750,000 gallons – 322,300 gallons=1,427,700 gallons

DEQ Circular 1, Paragraph 7.0.1a. states:

Fire flow requirements recommended by the fire protection agency in which the water system is being developed, or in the absence of such a recommendation, the fire code adopted by the State of Montana, must be satisfied where fire protection is provided.

3.3.5 Pumping Stations

The City has one booster station at the intersection of Highway 78 and Lazy M street which was constructed in the mid 80’s. Water from the west bench tank is piped to the booster station through a 16” ductile iron transmission main. The booster station pumps water to approximately 30% of the City of Red Lodge’s water system service area. The booster station service area, in general, has a lower residential density than the majority of the City, as it includes the golf course. The booster station pumps 21% of the entire system demand.

The control system used to automatically switch pumps to keep use on the pumps equal, however, the control system no longer works, therefore, the City workers must manually cycle the pumps each month. The west pump was replaced in 2019. Figure 3.5 below shows the pump piping inside the booster station building.

Figure 3.7: Booster Station

The pumping station has two 15 hp peerless pumps (model 6 1250A). The 16" main forks into two 8" ductile iron pipes which are piped to the respective pumps to provide redundancy. One pump runs to maintain a pressure of 54 psi. The pumps are adequately sized to convey the design Peak Hour demand. The pressure on the suction end of the pump is controlled by the tank level. During the site visit on November 19, 2019, the pressure was 26 psi.

The Fire Chief noted that the pumps cannot deliver adequate fire flow because of low pressure in the transmission main from the West Bench Tank to the pump station. The water model also showed that the transmission main low pressure limited available fire flow to the booster station service area. The needed residential fire flow is 1,500 gpm, the lowest fire flow available in this service are is 1,161gpm. The majority of intersections available fire flow is less than 1,300 gpm with the exception of the first intersection after the pump which has available fire flow of 1,524 gpm with the peak day demand applied. Another significant fire flow issue which needs addressed in this service area is the golf course club house, which has a needed fire flow of 2,000 gpm, yet the system can only supply 1,292 gpm as a result of the transmission line which feeds the booster station's low pressure.

3.3.6 Distribution System

The distribution system is laid throughout the community in a grid-like manner. Table 3.5 provides a summary of water main types, sizes, and lengths for the system.

Table 3-5 Distribution System Inventory

Pipe Size	Length (ft)				Total (ft)
	Ductile Iron	PVC	Cast iron	Asbestos Cement	
2"	0	0	301	0	301
4"	0	0	3,309	0	3,309
6"	8,571	1,035	5,085	2,794	17,486
8"	83,895	5,707	0	1598	91,200
10"	2,900	0	0	0	2,900
12"	16,596	0	0	0	16,596
14"	2,742	0	0	0	2,742
16"	14,698	0	0	0	14,698
Total	129,401	6,743	8,695	4,392	159,231

Starting in the mid-1990's the City began replacing much of the City's old water mains with ductile iron pipe. Figure 3:8 Water System Inventory map, shown below, illustrates the City's current water distribution system inventory.

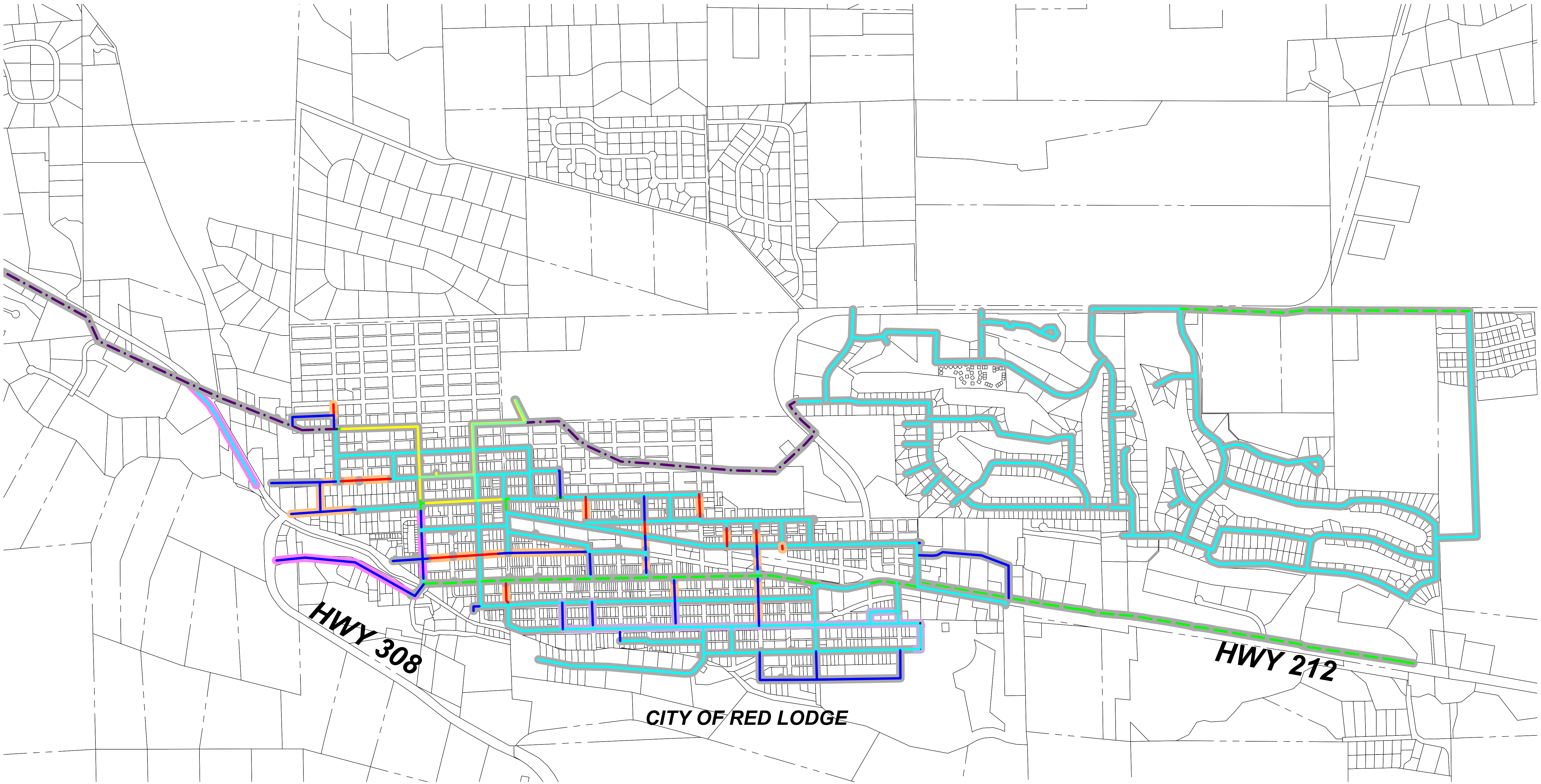
Circular DEQ-1 discusses main size in section 8.2.2. it states that:

> *The minimum size of water main in the distribution system where fire protection is not to be provided should be a minimum of three inches in diameter.*

The City has one known 2-inch water line serving as a water main without fire hydrants in South Kainu. This water line connects to the water main at the intersection of Kainu and Park avenue and continues north where it dead ends near the would-be intersection of 17^{th} Street.

The City loses on average about 79 million gallons a year. As discussed in Section 3.3.1, since 2014 the City has experienced an average water loss of 47%. This water loss can be attributed to leakage in the distribution system and services, water used for firefighting or flushing of hydrants, unknown water users, etc. It is worth noting that 47% water loss is concerningly high. The Environmental Protection Agency (EPA) estimates that average water system losses are 16% and up to 75% of that is recoverable. [vii] (See Big Timber PER reference section). Red Lodge's water loss is nearly triple the EPA estimate.

The City's average day per capita water use is 114 gpcd while the water loss per capita is 94 gpcd. The City must pump, disinfect and distribute 208 gpcd. The water loss which the City experiences is a significant loss caused by old, leaky cast iron mains, leaky valves, leaky water service pipes, unmetered water use and breaks.



SCALE: 1"= 1/4 MILE

WATER MAIN SIZE LEGEND

- 4"
- 6"
- 8"
- 10"
- 12"
- 14"
- 16"

WATER MAIN MATERIAL LEGEND

- ASBESTOS CEMENT
- CAST IRON
- DUCTILE IRON
- PVC

GreatWest engineering®

Figure 3:8
Water System Inventory Map

City of Red Lodge, Montana
2019 Water Preliminary Engineering Report

J:\2-17103 - Red Lodge On-Call 2017\TO 14 - Water PER\CADD 2-17103-14\Sheets\Figure 3.4 PIPE TYPE AND SIZE.dwg

3.3.6.1 Main Breaks and Freezes

During the winter of 2018-2019 the City had over 80 water services freeze, In the winter of 2018-2019 the city had several mains freeze, which the City was unable to thaw without excavation. Several residences were without water for extended periods. The water main in Park Avenue was one of the more extreme cases was the existing 6” water main dead-ends at the intersection of bear Creek Hill and has minimal cover to protect against freezing. The City has also had approximately three main breaks per year for the last several years.

As a comparison, the frequency of repair from several cities and districts around Montana are shown in Table 3-6 Below. It should be notes that the table shows main breaks, not including main freezes. The number of leaks is expected to increase as these mains continue to age.

Table 3-6 Average Water Main Breaks for Cities in Montana

City	Water Main Length (miles)	Ave. Breaks/year	Breaks/Mile/Year
Red Lodge	31	3	0.10
Miles City	63.5	7	0.11
Kalispell	145	12	0.08
Missoula	320	30	0.09
Bozeman	276	6	0.02
Wolf Point	20	2	0.10
*AWWA Standard is 0.15 leaks per mile per year			

3.3.6.2 Cast Iron Mains

Although the City has been working vigilantly over the years to improve the distribution system through both pipeline replacements and new installations, there is still a significant amount of 4 inch and 6 inch cast iron mains located throughout the City that are over 80 years old. The City of Red Lodge has 8,695 feet of cast iron main still in operation. The existing cast iron mains are described below:

1. There are three blocks of cast iron water main in South Hauser Avenue between 13th Street and 17th Street.
2. Two blocks in Grant Avenue between 20th Street and 22nd Street.
3. 4 blocks in 7th Street from Haggin Avenue to Villard Avenue. In 2019 the City replaced the 4” CIP water main in Haggin Avenue with PVC along with 6 side streets. During

construction of the project it was discovered that the main in 7th Street between Haggin Avenue and Broadway Avenue has approximately 600 feet of 6” CIP. It is believed that the old 6” cast iron main in 7th Avenue continues westward to Villard Avenue

4. As well as five block portions which still have cast iron pipe. Scattered throughout the original City as shown “orange” on Figure 3:8 Water System Inventory Map.

The cast iron mains removed from Haggin Avenue in 2019 were found to have pinhole leaks and larger cracks throughout the main. The interior pipe walls were tuberculated. When the main was flushed and excavated the water quality issues caused by these old mains was evident. The water was rust red as shown in Figure 3.9 below which was taken during construction of the Haggin Avenue water main replacement. This Picture shows the condition of the water quality in the City of Red Lodge’s dated cast iron water mains.

Figure 3.9: Cast Iron Water Main

3.3.6.3 Dead End Mains

Section 8.2.4 of Circular DEQ-1 states the following regarding dead ends:

a. To provide increased reliability of the service and reduce headloss dead ends must be minimized by using appropriate tie-ins whenever practical.

b. Where dead-end mains occur, they must be provided with a fire hydrant if flow and pressure are sufficient, or with an approved flushing hydrant or blow-off for flushing purposes.

Although the existing distribution system is, in general, well-looped, it does contain several dead end mains. In addition to significantly stifling fire flows, these dead-ends also present a serious health concern. This is due to the stagnation of water that can occur in the main. As a result, the chlorine residual may decay significantly which produces an environment that permits bacteria to thrive, particularly if it is an aged cast iron main with scaled walls.

In addition to DEQ's comment regarding dead-ends, they cause a particular additional problem in Red Lodge. Red Lodge is a mountain town which has colder winters and much more snowfall than an average City in Montana. The dead ends are more prone to freezing. The dead-ends of concern are:

1. Park Avenue near Bear Creek Hill
2. Kainue Avenue connects to the water distribution system through on 8" crossing under Rock Creek at 9th Street and dead-ends at 15th Street. There is a 2-inch pipe connecting to the main in Park Avenue which serves as a water main to homes on Kainue Avenue from Park Avenue north to 17th Street.
3. In Highway 212 and 8" main tees from the 16" transmission main and dead ends near Adams avenue.
4. Adams Avenue dead ends west of Highway 212.

The primary reason for connecting dead ends is to mitigate a potential threat to public health but to also significantly improves conveyance which subsequently increases fire flows, and prevent freezing, though normally these improvements are localized.

3.3.6.4 Valves

DEQ-1 Section 8.3 states the following in regard to valves:

> *Sufficient valves must be provided on water mains so that inconvenience and sanitary hazards will be minimized during repairs. Valves should be located at not more than 500-foot intervals in commercial districts and at no more than one block or 800 foot intervals in other districts."*

The as-built plans for much of the City's previous water replacement projects show adequate valving, however, over time many of them have been paved over, and the City Publics Works department is finding several of these valves were indeed not installed. As a result, the City has great difficulty in isolation sections of mains during repairs. Many of the older valves on cast iron and asbestos cement mains are also found to be in-operable.

Isolation is also increasing difficult as old mains which were previously thought to be abandoned are being found to still be connected to existing cast iron mains in the distribution system. As they are encountered, the City is abandoning these mains. This is likely a major contributing cause to the City's excessive water loss. During construction of the water main replacement in 10th Street in 2019, there was a 4 inch cast iron main in Platt avenue was found to be live. When the 8" main was constructed the old 4" was not abandoned. This raises concern that there may be other locations in Platt Avenue, and other locations throughout the City, which may have old mains still live. This is a very concerning issue, not only as a result of difficulty isolating water mains, but also the volume of treated water lost to these old mains as well as serious health concern as leaky water mains can raise a variety of water quality risks including a high risk of cross contamination.

3.3.6.5 Water Services

In winter of 2018-2019 the City had over 80 water services freeze. As a result, as water service breaks occur they are replaced with poly service pipe, buried with 7 feet of cover and insulated with rigid foam insulation. Until recently, the water services were replaced with copper pipe, however, corrosion has shown to occur on copper services where the copper meets old cast iron pipe. Many of the copper services and cast iron service pipes are leaking. The City is responsible for water services from the corporation stop to the curb stop, and the homeowner is responsible for the water service from the curb stop to the residence. Apart from service freezes, most of the water system leaks are located at the water service connection, of which, they average repairing about one every month.

3.3.6.6 Fire Hydrants

Section 8.2.2 of Circular DEQ-1 requires:

> *The minimum size of water main for providing fire protection and serving fire hydrants must be six-inches in diameter. Larger size mains will be required if necessary to allow the withdrawal of the required fire flows while maintaining the minimum residual pressure specified in section 8.2.1. [20 psi under all conditions of flow]*

The City has approximately12 blocks of water main that are 4-inch cast iron mains with fire hydrants connected that need to be upsized. The 4" mains with fire hydrants are on shown on Figure 3:8 Water System Inventory Map. Hydraulic water modeling was conducted and will be discussed below, which provided the analysis necessary to determine the recommended size of water main replacements.

3.3.6.7 Pressure Relief Valves

The City has three existing pressure relief valves (PRV). The first PRV is where the 16" diameter transmission main from the water treatment plant enters the Corporate limits of the City on White Avenue. The valve is 6" diameter and reduces the main pressure from approximately 100 psi to approximately 50 psi. The PRV does not include a secondary fire flow PRV, limiting the available fire flow to the City.

The second PRV is located near the golf course at the north end of Diamond C Trail to reduce pressure to the water main loop through the Spires subdivision. The third PRV is on the west end of the Spires subdivision water main loop at the intersection of Lark Spur Road and Willow Creek Road. The Spires PRVs pressure gauges are inaccessible. Pressures of adjacent fire hydrants were measured to determine that the PRVs reduces pressure from 120 psi to 80 psi in the Spires subdivision loop.

The water main in Spires Subdivision continues on to loop down Willow Creek road and Highway 78. Until recently, the City was unaware of the existence of these PRVs.

There is a significant need for additional pressure relief north of the intersection of Robison Lane and Broadway. DEQ-1 Section 7.3.1 requires:

> "*The minimum working pressure in the distribution system should be 35 psi and the normal working pressures should be approximately 60 to 80 psi. When static pressures exceed 100 psi, pressure reducing devices must be provided on mains or as part of the setting on individual service lines in the distribution system*."

The static pressure on the farthest north fire hydrant near the hospital was measured to be 152 psi. Installation of pressure valve(s) will be needed to reduce the pressure of this zone. See the water model figure illustrating the City's pressures below:

3.3.6.8 Hydraulic Model

A new hydraulic water model of the water system was created using the WaterCAD computer modeling software. The size and material of distribution piping used in the model were taken by compiling various project as-builts and mapping of the City of Red Lodge. Four of the City's fire hydrants were tested in November 2019 to assist in calibrating the computer model. For each of the four hydrants tested, pressures were monitored at two other hydrants, one along the line to the hydrant being tested and one further back in the distribution grid. Hazen-Williams roughness coefficients were adjusted as necessary to allow the model to match within 5 psi of field obtained results. Values of the Hazen Williams coefficients assigned to the distribution mains ranged from 100 for cast iron pipe, and 150 for PVC pipe and varied, in general, according to the size and material of pipe. The pump curve for the booster station was modeled by inserting the pump's curve data and making minor adjustment to the pump curve to calibrate the pumps function within the existing configuration. The model is considered to accurately represent the system as it presently exists. A general summary of the water model results are discussed in this section.

Peak Hour Demand Scenario:

The distribution system is considered adequate if the system pressures remain at or above 35 psi during peak demands (DEQ-1, Section 8.2.1). There is one service on the transmission main in between the West Bench Tank and the booster pump which does not meet this DEQ requirement. During Peak hour flow, the pressure at this service is 27 psi. The remaining services have pressures of 45 psi or greater.

Maximum Day Demand plus Fire Flow scenario:

The needed residential fire flow is 1,500 gpm in residential areas according to the City of Red Lodge Fire Chief. The downtown business district fire demand is 3500 gpm for a two hour duration. The Fire Chief reported buildings with specific fire flow demands. This list is attached in Appendix ?. The table below lists the buildings noted as having fire flow demands greater than 1500 gpm, as well as the available fire flow shown in the water model.

Table 3-7 Buildings With Needed Fire Flow Greater Than 1500 gpm

Building Description	Needed Fire Flow (gpm)	Available Fire Flow (gpm)
Red Lodge Country Club	2,000	1,292
Earlywood	2,500	2,676
Cedar Wood Villa	3,500	4,500+
Red Lodge Ales Brewery	1,750	2,900
Red Lodge Inn	2,000	2,150
Red Lodge Fire-EMS	2,500	3,600
Roosevelt School	3,500	4,500+
Cannery Building	4,500	4,500+
Masonic Temple Building	1,750	4,500+
Carbon County News	2,250	4,500+

The fire flow results show fire flow available without reducing zone pressure below 20 psi. Nodes on the water lines near the tanks are omitted from the calculation per DEQ 8.2.1.

The distribution system is considered adequate if the system pressure remain at a minimum of 20 psi under maximum day demand plus fire flow. Available fire flow in Country Club Estates subdivision ranged from 1167 gpm to 1200 gpm. The majority of the original city had fire flows in excess of 3500 gpm, with the exception of dead-end mains and blocks where 4” mains supplied fire hydrants. See the “Available Fire Flow Map” shown below:

The booster station currently only provides available fire flows up to 1200 gpm in Country Club Estates and Spires subdivisions. The City Fire Chief stated that needed fire flows in the City’s residential areas is 1500 gpm. When these fire flows are ran in the model, a zero pressure is given on the 16” transmission main from the west bench tank to the pumping station

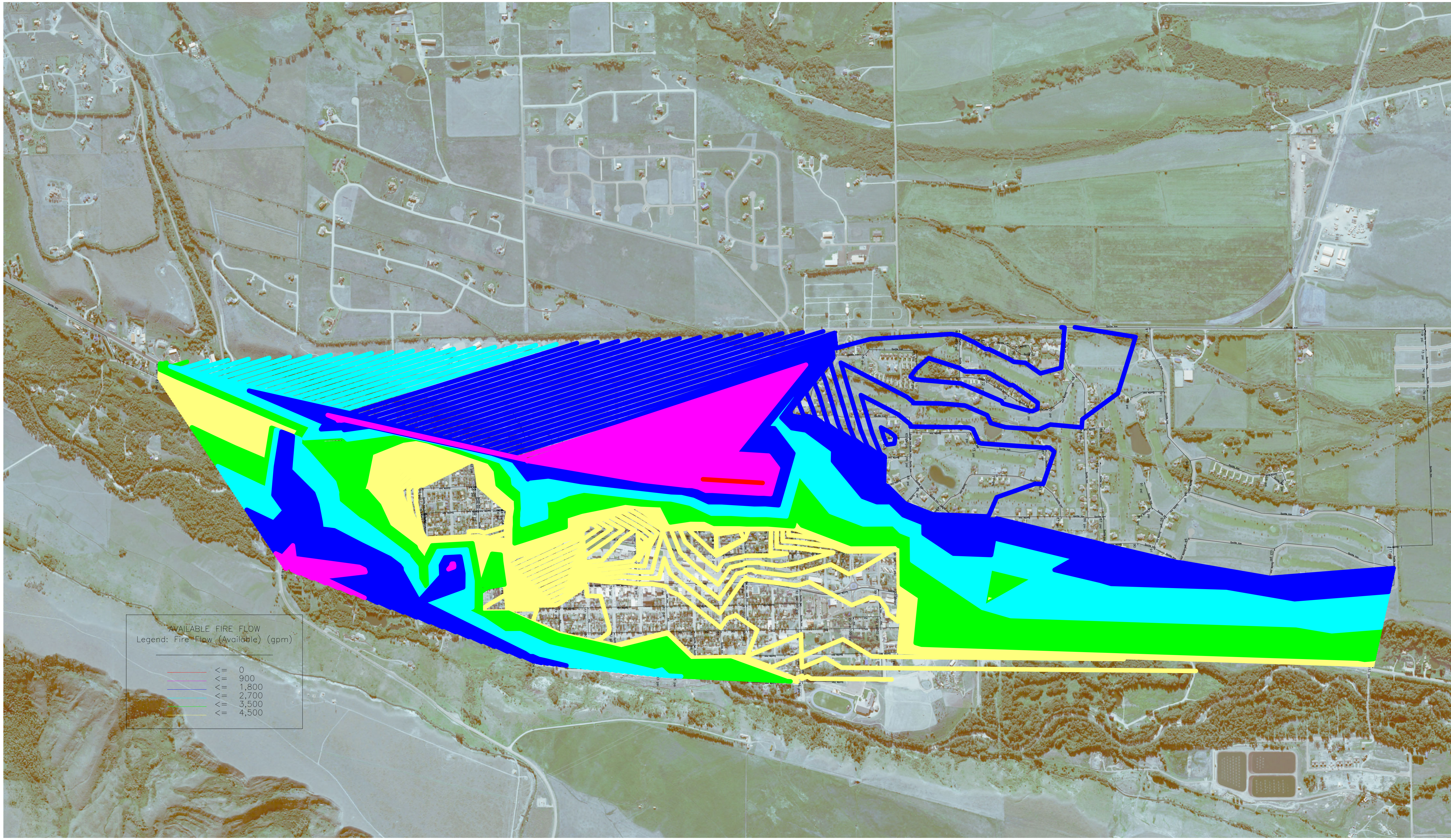


Figure 3:
AVAILABLE FIRE FLOW MAP

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The hydraulic model of the water system also helped to evaluate the adequacy of the system to meet anticipated needed fire flows. Initial computer modeling found that the system provides good fire flows throughout most of the City with the exception of a few areas where capacity and or pressures currently fall short of recommended fire flows. In general, it was determined that capacity is restricted in the areas by aged 4-inch cast iron mains or dead ends. Locations with the most pronounced deficiency are in Figure 3:11 Poor Fire Flow Map below. The concerning areas include:

1. Park Avenue-Park Avenue's water main is a 6" dead end main with fire hydrants. The available fire flow at the dead end is approximately 600 gpm.
2. South Hauser between 17th Street and 19th Street. 17th street to 18th street in Hauser is 4" CIP, and 18th Street to 19th Street may have a live 2" water main. The approximate available fire flow in the intersection of 18th Street of 780 gpm.
3. South Grant Between 22nd Street and 23rd. This section of Grant is 6" cast iron with a dead end in 23rd Street. The available fire flow at the dead end in 23rd Street is approximately 980 gpm.
4. The west of the intersection of 22nd Street and White Avenue there is a section of 4" CIP main which supplies a hydrant. The available fire flow here is approximately 760 gpm
5. Country Club Estates and Spires subdivision. The needed fire flow of 1500 gpm for residential and 2000 gpm for the Golf Course club house, neither of which can be supplied to the subdivisions as the 16" transmission main pressures lower to zero PSI when flows of 1200 gpm are provided to the subdivisions, restricting fire flow availability

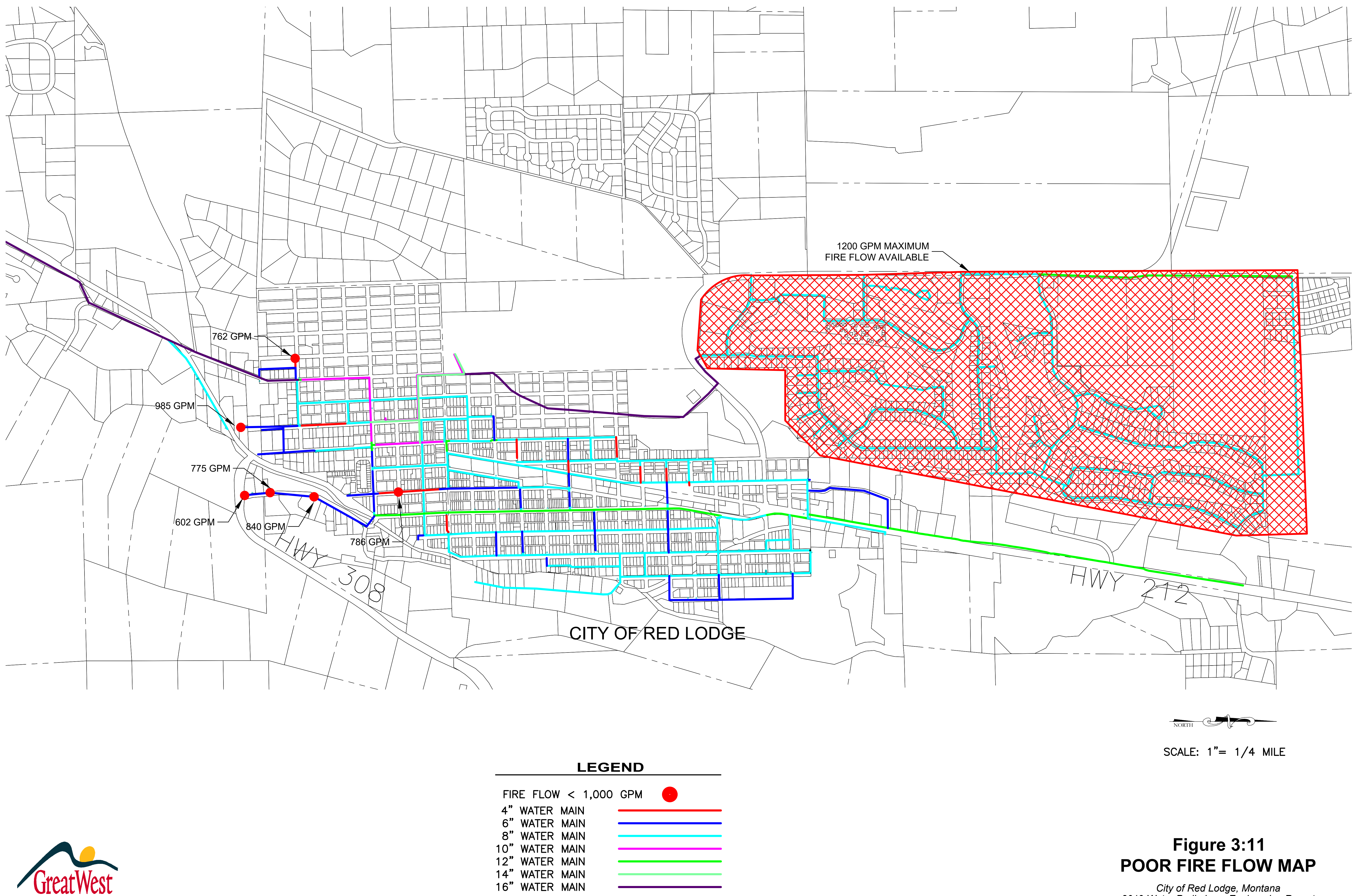

Figure 3:11
POOR FIRE FLOW MAP

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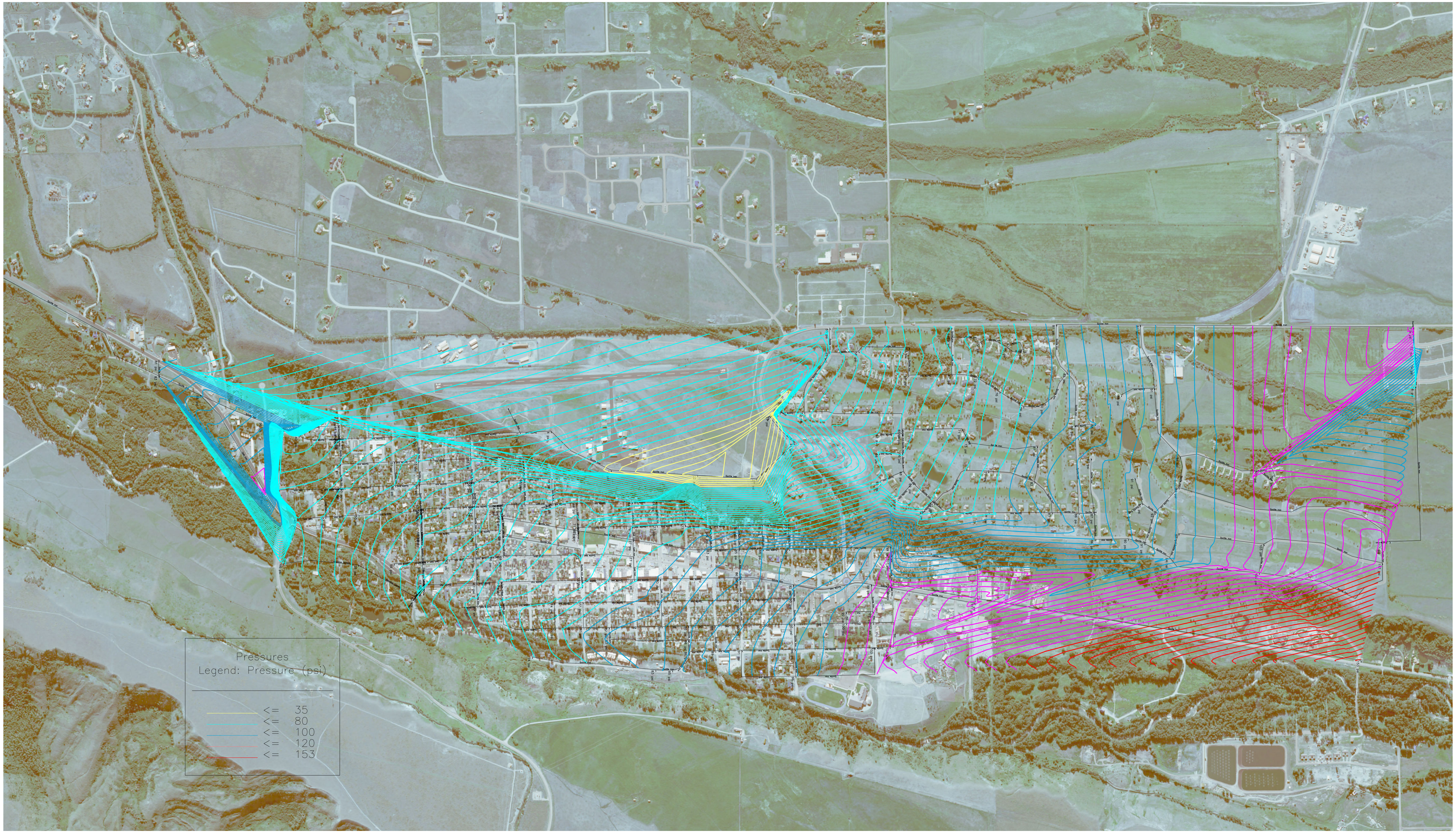
J:\2-17103 - Red Lodge On-Call 2017\TO 14 - Water PER\CADD 2-17103-14\Sheets\Figure 3.7 existing fireflow figure.dwg

The hydraulic model also showed zone 5 has excessive pressures. Zone 5 is the most northern section of the City as shown on Figure 3:1. Pressures in this zone ranged from over 100 psi to 152 psi at the Hospital. As mentioned previously, DEQ-1 requires pressure reducing infrastructure to reduce static pressures above 100 psi. Figure 3:12 System Pressure Map, shown below, illustrates the model's result of the City's water system pressures.

As shown in the figure, the pressures exceed 100 psi in a triangle shaped area east of Bonner from 1st street south east to the intersection of Chambers Avenue and what would be 4th Street. If the City chose to address the pressures in this area, service pressure relief systems could be provided, as the looping would require four main line pressure relief valves.

The model also determined that when the west bench water tower is out of commission and the entirety of the City's water supply is from the water treatment plant storage, PRV 1 in White Avenue is inadequately sized to provide needed fire flows. In this case, the 3500 gpm fire flow needed for the commercial buildings in Broadway Avenue is not met. The available flow is reduced to 2900 gpm.



J:\2-17103 – Red Lodge On-Call 2017\TO 14 – Water PER\CADD 2-17103-14\Water Cad\2-17103-TO14 Red Lodge 2019 Water Model.dwg

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Figure 3:
WATER SYSTEM PRESSURE MAP

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3.4 Operational and Management Practices and Capabilities

The City of Red Lodge Public Works staff does an exceptional job of operating and managing their water system given the limited amount of resources they have and the challenges related to operating a system with portions nearly 100 years old. Some of the operational challenges that were discussed in previous sections include the following:

1. Repairing an excessive amount of water main and service freezes.
2. Excessive amount of service breaks.
3. Dealing with inadequate valve spacing and inoperable valves, making it difficult to isolate portions of the system when breaks occur.
4. Maintaining reasonable pressures in high-pressure zones without proper pressure relief valving.

3.5 Financial Status of any Existing Facilities

Income and expenditures for the water system, including operation and maintenance, are included in the Water Enterprise Fund under the City's accounting system.

3.5.1.1 Expenses and Revenue

The City increased its water rates in August of 2019 to address a shortfall in the water enterprise fund. A copy of the current rates is included in Appendix H. A summary of the expenditures and revenue for the last three fiscal years before the rate increase was enacted is included in Table 3-8, and a complete breakout of the expenses and revenues is included in Appendix H. It should be noted that the intergovernmental revenue from the capital grand have been removed from the summary of fiscal year 2018-2019 to provide a more accurate overview of the City's annual O&M costs for the system.

Table 3-8 Summary of Income and Expenses

Account	FY 16-17	FY 17-18	FY 18-19	Average
Expenses				
430510 Water	$ 395,046.66	$ 476,345.10	$ 589,867.28	$ 487,086.35
Total Expense	$ 395,046.66	$ 476,345.10	$ 589,867.28	$ 487,086.35
Revenue				
33000 Intergovernmental Revenue	$ 1,890.00	$ 1,857.00	$ 2,426.00	$ 2,057.67
340000 Charges for Services	$ 955,728.92	$ 1,099,807.71	$ 1,195,922.87	$ 1,083,819.83
Misc. Revenues			$ 9,075.20	$ 9,075.20
370000 Investments and Royalty Earnings	$ 1,355.35	$ 4,198.43	$ 6,918.98	$ 4,157.59
383000 Resort Tax	$ 100,000.00	$ 100,000.00	$ 201,477.10	$ 133,825.70
Total Revenue	$ 1,058,974.27	$ 1,205,863.14	$ 1,415,820.15	$ 1,226,885.85
Revenue Minus Expenses=Reserves	$ 663,927.61	$ 729,518.04	$ 825,952.87	$ 739,799.51

3.5.1.2 Debt Services

3.5.1.3 Water System Energy Use

Power bills for the City's well pumps, PRV, and booster station from 2019 are summarized in the following three table summarizing electricity usage and costs for each of the three locations. The bills are located in Appendix H.

Table 3-9 2019 Well Power Use and Cost

Month	Electrical Usage at Water Treatment Plant Wells		Electrical Usage at Grant Avenue Well	
	Electricity Usage (kWh)	Electricity Cost	Electricity Usage (kWh)	Electricity Cost
Dec-18	13,760	$ 1,749.39	3,200	$ 739.68
Jan-19	12,520	$ 1,619.34	4,160	$ 819.03
Feb-19	12,420	$ 1,621.91	4,240	$ 870.98
Mar-19	12,260	$ 1,646.60	4,080	$ 858.67
Apr-19	13,580	$ 1,664.52	4,720	$ 880.44
May-19	13,640	$ 1,677.53	4,960	$ 913.10
Jun-19	12,440	$ 1,498.44	2,640	$ 734.18
Jul-19	16,040	$ 1,738.99	1,600	$ 654.04
Aug-19	16,200	$ 1,709.94	2,720	$ 732.10
Sep-19	17,480	$ 1,818.35	2,400	$ 707.39
Oct-19	11,800	$ 1,451.63	2,240	$ 697.66
Nov-19	11,780	$ 1,583.39	3,040	$ 803.70
Annual Total	163,920	$ 19,780.03	40,000	$ 9,410.97
2019 Well Power Usage (kWh)				203,920
2019 Well Power Cost				$ 29,191.00

Table 3-10 2019 Existing PRV Power Use and Cost

Water Electrical Usage at PRV		
Month	Electricity Usage (kWh)	Electricity Cost
Dec-18	674	$ 87.52
Jan-19	700	$ 91.47
Feb-19	736	$ 97.61
Mar-19	765	$ 101.21
Apr-19	684	$ 91.63
May-19	625	$ 85.28
Jun-19	548	$ 75.54
Jul-19	414	$ 58.58
Aug-19	461	$ 64.58
Sep-19	472	$ 65.98
Oct-19	360	$ 52.19
Annual Total	6439	$ 871.59

Table 3-11 2019 Booster Station Power Use and Cost

Water Electrical Usage at Booster Station		
Month	Electricity Usage (kWh)	Electricity Cost
*Nov-18	4548	$ 450.00
Dec-18	2728	$ 314.21
Jan-19	4218	$ 427.28
Feb-19	423	$ 144.23
Mar-19	1353	$ 208.93
Apr-19	5898	$ 566.58
May-19	6104	$ 584.22
Jun-19	4239	$ 454.13
Jul-19	4592	$ 451.36
Aug-19	4113	$ 417.80
Sep-19	4113	$ 415.21
Oct-19	3388	$ 372.96
Annual Total	45717	$ 4,806.91

*Electricity Usage given on Dec 18 Bill, however Bill amount not given. Electricity cost assumed based off of Jul-19 cost with similar usage.

3.5.2 Existing User Rates

Also important to the financial status of the City is the City's ability to meet the "target rate." The target rate is a user rate established by the Montana Department of Commerce (MDOC) for each municipality across the state. The rate is used to determine whether or not a municipality is paying its "fair share" of a project's cost. In order to apply for grant funding from the MDOC, the user rates after completion of the project must meet or exceed the established target rates. According to the 2015 Census, American Community Survey estimates the City of Red Lodge's median household income to be $42,500 with an LMI of 48.97%.

The MDOC has determined, based on surveying communities that have undergone recent upgrades to their water and/or wastewater system, the "fair share" of cost per user after completing a project should be approximately 0.9% of the MDI for wastewater alone, 1.4% of the MHI for water alone, or 2.3% of the MHI for wastewater and water combined.

Thus, the final target rates are calculated in Table 3.9 below:

Table 3-12 Target Rate for Red Lodge

SYSTEM	MHI	%	TARGET RATE ANNUAL	TARGET RATE MONTHLY
MDOC: WATER ONLY	$ 42,500.00	1.4%	$ 594.96	$ 49.58
MDOC: WASTEWATER ONLY	$ 42,500.00	0.9%	$ 382.56	$ 31.88
MDOC: COMBINE TARGET RATE	**$ 42,500.00**	**2.3%**	**$ 977.52**	**$ 81.46**

Since target rates are based upon equivalent dwelling units (EDU's), it is important to calculate the City's rates based upon EDU's. An EDU rate system charges are based on the area of the service size. A 3/4" water service is a typical residential water service and is considered to be 1 EDU. The EDUs for each service line are then calculated based on the area of the service size divided by the area of the 3/4" service size.

Table 3-13 Below presents a summary of the EDU's for the City of Red Lodge.

Table 3-13 Existing EDU's for Red Lodge

Service Size (inches)	EDU's per Service	Residential		Commercial		Total	
		Number	EDU's	Number	EDU's	Number	EDU's
3/4	1.00	1363	1363	129	129	1492	1492
1	1.79	21	38	33	59	54	97
1 1/2	4.00	3	12	11	44	14	56
2	7.14	1	7	10	72	11	79
3	16.00	0	0	1	16	1	16
TOTAL		**1388**	**1420**	**184**	**320**	**1572**	**1740**

The Montana Department of Commerce (MDOC) considers both the water and wastewater rates combined for systems which have both. The current base rates are established at:

- Water: $40.91 base rate (0 to 3,000 gallons) + $ 4.46 per 1,000 gallons (3,001 to 8,000 gallons) + $5.86 per 1,000 gallons (8,001 to 20,000 gallons) + $7.39 per 1,000 gallons (>20,001 gallons)

- Wastewater: $50.27 base rate (0 to 3,000 gallons) + $1.74 per 1,000 gallons (3,001 to 8,000 gallons) + $2.28 per 1,000 gallons (8,001 to 20,000 gallons) + $2.98 per 1,000 gallons (>20,001 gallons)

The average water usage is based on the yearly average day use as discussed in Section 3.3.1. The metered average day use is 261,500 gallons. With 1740 existing EDU's, the average water use is 4,500 gallons per month. Applying this usage to the rate structure, the average water billing rate is $47.60 per month.

Wastewater usage is based upon the average usage over the winter months. Billing reports indicate the average residential sewer usage is just under 3,000 gallons per month. Applying this usage to the rate structure, the average wastewater billing rate is $50.27 per month.

As shown in the Table below. The average combined monthly water and wastewater rate for a residential household (or per EDU) is $97.87 per month, which is 120% of the target rate of $81.46 listed on the MDOC website.

Table 3-14 Current Water and Sewer Rates

System	MDOC Target Rate	Average Existing Rate per EDU
Water Only	$49.58	$47.60
Wastewater Only	$31.88	$50.27
Combined	$81.46	$97.87
Percent of Target Rate	---	120%

3.6 Water/Energy/Waste Audits

The City conducts their own water audits utilizing information from both their production meter as well as their customer meters. This has proven to be a powerful tool for the City personnel to know when there may be a new leak within the system. However, the leaks can be very challenging to find due to the type of soils in the area (leaks don't surface). If the City continues their path to replace older mains, they will also continue to discover leaking service lines and mains and continue to reduce their overall system water loss.

The City has not completed any recent energy or waste audits.

4.0 NEED FOR PROJECT

In addition to identifying deficiencies within a public utility system and developing alternatives to correct those deficiencies, a PER must also discuss the relevant need for the project to help communities prioritize capital projects and manage limited resources and budgets. The following subsections will provide an overview of the system needs.

4.1 Health, Sanitation and Security

Health and safety of the public is by far the largest concern for any community water system. The City of Red Lodge has a few deficiencies within the water system that compromise the health and safety of the public. Lack of fire protection, dead-end mains and old cast iron mains are the largest community concern.

4.1.1 Undersized Mains

The system currently has multiple fire hydrants throughout the City that are served by 4” cast iron mains. This is clearly out of compliance with DEQ standards. Circular DEQ-1 states:

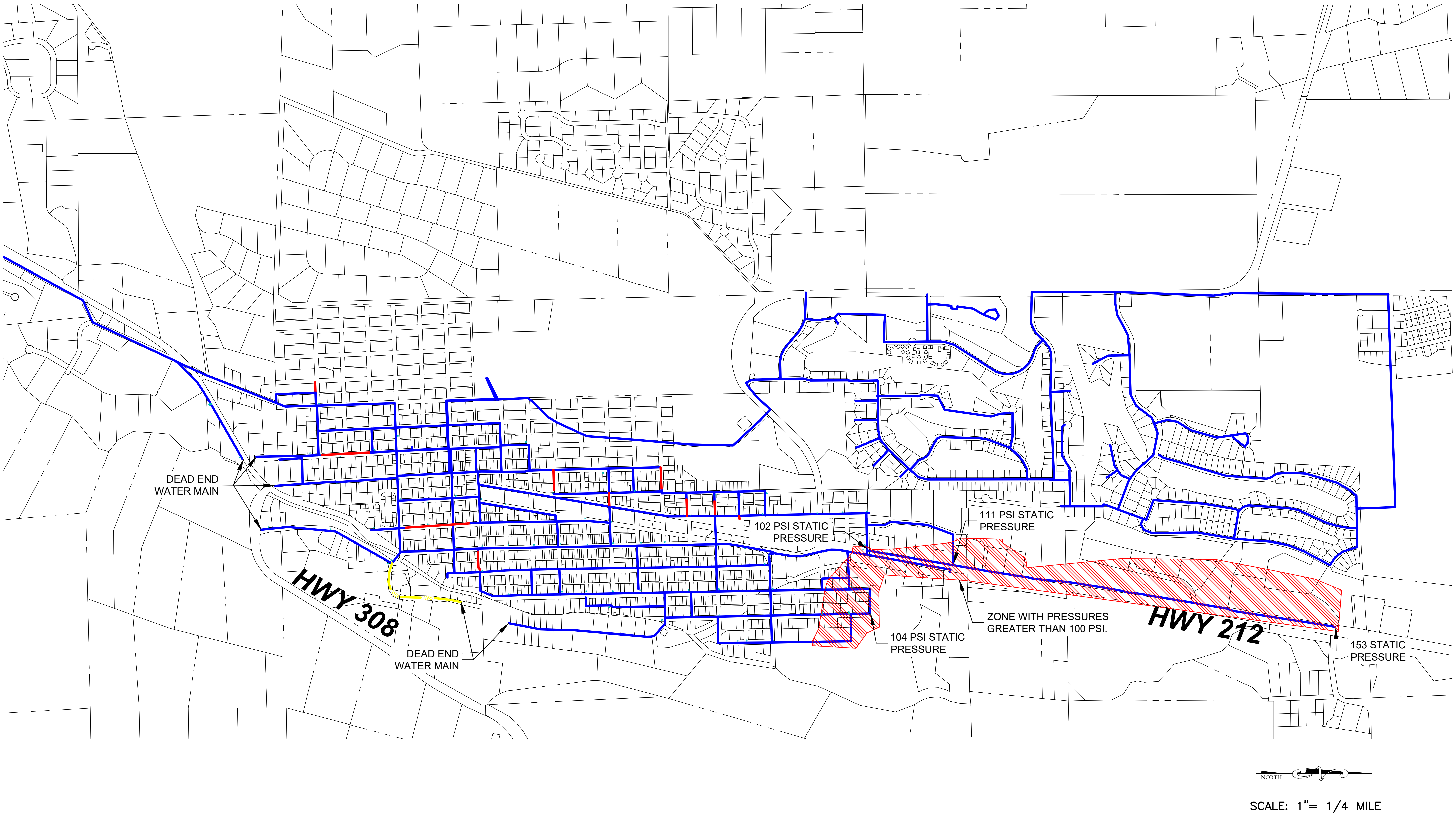
> *The minimum size of water main for providing fire protection and serving fire hydrants must be six inches in diameter.*

The concern here is 4” lines, particularly corroded ones, present a significant restriction on capacity and hence fire protection. This deficiency represents a threat to public safety. Figure 4.1 highlights the 4” water mains within the distribution system that have fire hydrants connected to them.

Circular DEQ-1 discusses main size in section 8.2.2. it states that:

> *The minimum size of water main in the distribution system where fire protection is not to be provided should be a minimum of three inches in diameter.*

The City has one known 2” water line serving as a water main without fire hydrants. This water line connects to the water main at the intersection of Kainu and Park avenue and continues north where it dead ends near the would-be intersection of 17th Street.



J:\2-17103 - Red Lodge On-Call 2017\TO 14 - Water PER\CADD 2-17103-14\Sheets\Figure 4.1 Undersized Mains.dwg

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Figure 4:1
NEED FOR PROJECT MAP

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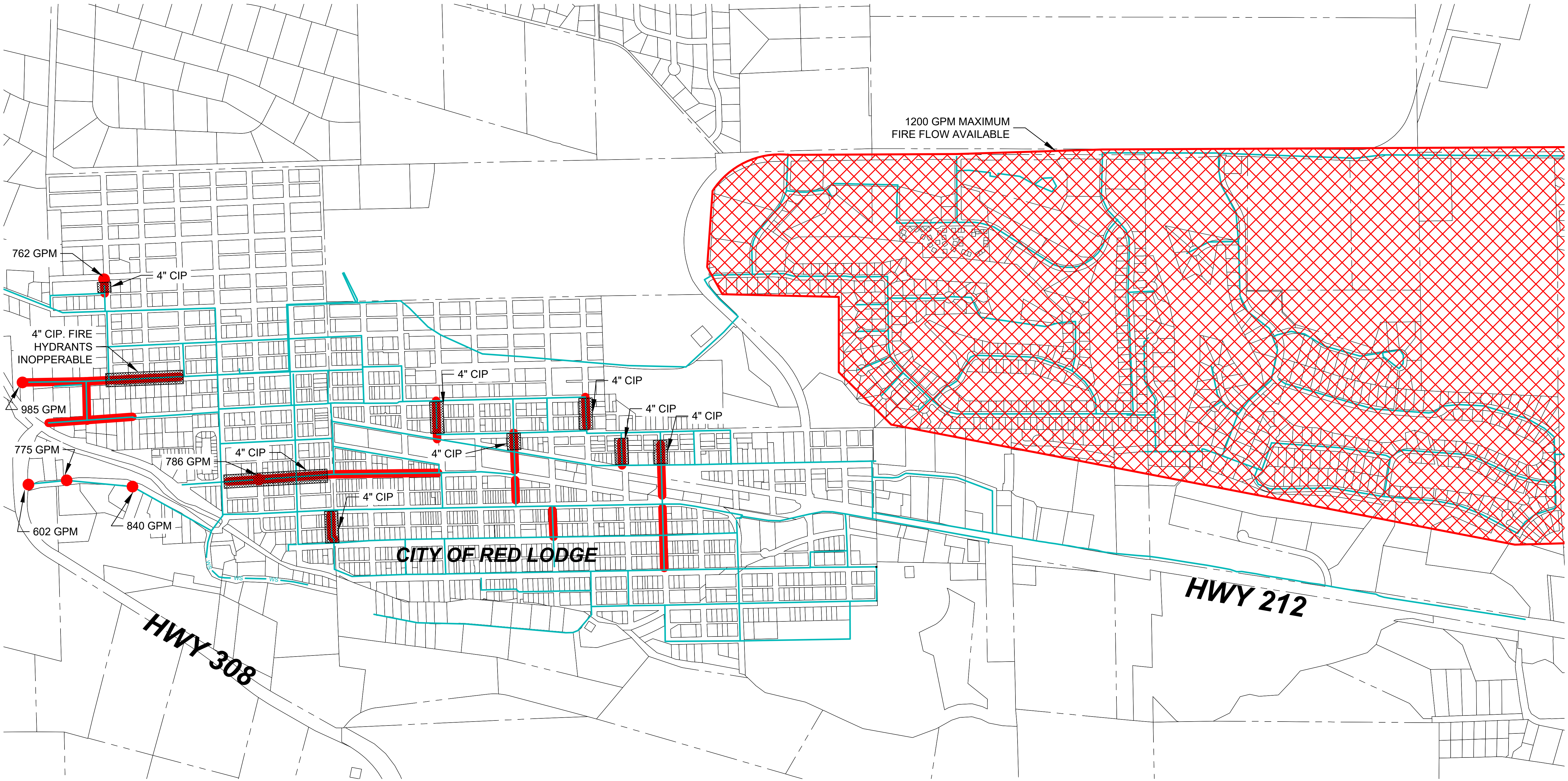
4.1.2 Dead-End Mains

There are several dead end mains in the current distribution system, which in addition to significantly stifling fire flows, also presents a serious health concern. This is due to the stagnation of water that can occur in the main. As a result, the chlorine residual may decay significantly which produces an environment that permits bacteria to thrive, particularly if it is an aged cast iron main with scaled walls. Dead end mains are discussed in Circular DEQ-1 section 8.2.4, in which it is recommended that they be minimized and looped in the system whenever it is feasible to do so.

The City's dead-end mains can be seen in Figure 4.2, and are described below:

1. South of Highway 212, an 8" line dead ends1200 feet north of the intersection of Highway 212 and Ski Run Road.
2. The main in South Adams Avenue dead ends near Beartooth Hideaway Inn.
3. The water main in Park Avenue dead ends at the intersection of Park Avenue and Bear Creek Hill.
4. The 2" water main in the southern portion of Kainu Avenue dead ends at what would be the intersection of 16th Street.
5. The water main in South Adams Avenue dead ends on the west side of the intersection of South Adams Avenue and Highway 212.
6. The water main in Kainu Avenue dead ends at what would be the intersection of Kainu Avenue and 15th Street.



NORTH

SCALE: 1"= 1,000 FT

LEGEND

CAST IRON WATER MAIN

Figure 4:2
CAST IRON WATER MAINS AND INADEQUATE FIRE FLOW

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J:\2-17103 - Red Lodge On-Call 2017\TO 14 - Water PER\CADD 2-17103-14\Sheets\Figure 4.5 CAST IRON WATER MAINS.dwg

4.1.3 System Pressure

There is a significant need for additional pressure relief north of the intersection of Robison Lane and Broadway. DEQ-1 Section 7.3.1 requires:

> "*The minimum working pressure in the distribution system should be 35 psi and the normal working pressures should be approximately 60 to 80 psi. When static pressures exceed 100 psi, pressure reducing devices must be provided on mains or as part of the setting on individual service lines in the distribution system.*"

The static pressure on the farthest north fire hydrant near the hospital was measured to be 152 psi. This is 150% of the recommended maximum system pressure of 100 psi. Installation of pressure relieve valve(s) will be needed to reduce the pressure of this zone. Figure 4.2 shows the main pressures in the high pressure area.

The existing PRV in White Avenue (PRV 1) consists of one 6" PRV without an additional fire flow PRV. In the case where the west bench water tower or grant avenue well is out of commission it is necessary to replace this PRV system with a new PRV vault which would include a normal operation PRV and an additional fire flow PRV. This will increase system resiliency. Currently, in the event that the west bench tower is out of commission the entirety of the historic commercial buildings do not have the needed 3500 gpm fire flow. Addition of a secondary pressure relief valve at PRV 1 will allow the system to supply needed fire flow in the event the west bench tower is out of commission.

4.1.4 Fire Flow

In general, it was determined that capacity is restricted in the areas by aged 4-inch cast iron mains or dead ends. Locations with the most pronounced deficiency are in Figure 4.2 Inadequate Fire flow Map below. The concerning areas include:

1. Park Avenue-Park avenue is a 6” dead end main with fire hydrants. The available fire flow at the dead end is approximately 600 gpm.
2. South Hauser between 17th Street and 19th Street. 17th street to 18th street in Hauser is 4” CIP, and 18th Street to 19th Street may have a live 2” water main. The approximate available fire flow in the intersection of 18th Street of 780 gpm.
3. South Grant Between 22nd Street and 23rd. This section of Grant is 6” cast iron with a dead end in 23rd Street. The available fire flow at the dead end in 23rd Street is approximately 980 gpm.
4. The west of the intersection of 22nd Street and White Avenue there is a section of 4” CIP main which supplies a hydrant. The available fire flow here is approximately 760 gpm

Another concern is fire flow availability provided after the booster station. The booster station currently only provides available fire flows up to 1200 gpm in Country Club Estates and Spires subdivisions. The City Fire Chief stated that needed fire flows in the City’s residential areas is 1500 gpm. When these fire flows are ran in the model, a zero pressure is given on the 16” transmission main from the west bench tank to the pumping station. The low pressure in the transmission main limits the booster station’s ability to provide the needed fire flow to the entirety of Zone 3 as shown on Figure 4.2.

As mentioned in 4.1.3 above, PRV 1 limits needed fire flows in town in the event the west bench tank is out of commission.

4.2 Aging Infrastructure

The City of Red Lodge has been continually working to replace the aging infrastructure within the water system. Despite their efforts, there are still a large number of cast iron mains that are approximately 80 years old. Figure 4.2 identifies the cast iron mains located within the distribution system.

As discussed in Chapter 3, tuberculation is a common problem in cast iron mains. Not only is the inside diameter of the pipe reduced, the roughness is also increased, which causes further hydraulic loss in the pipeline. The age and condition of the pipes results in a very inefficient system. In severe cases such as in Red Lodge, the tuberculation can also lead to pipe leaks. Leaky pipes contribute to not only water loss, but also expose the water distribution system to potential cross contamination.

Since 2014 the City has experienced a 47% water loss, or on average of 79 million gallons a year. the Environmental Protection Agency (EPA) estimates that average water system losses are 16% and up to 75% of that is recoverable. [vii] (See Big Timber PER reference section). Red Lodge's water loss is nearly triple the EPA estimate. This loss is attributed to cold cast iron mains as well as old, leaky services.

Park Avenue and the line in 19th Street between Broadway and Hauser are asbestos cement pipe. Asbestos-cement pipe was used extensively in the mid-1900's in potable water distribution systems, particularly in the western United States. The Chrysotile Institute estimates AC pipe life span at 70 years, but actual service life depends largely on pipe condition and working environment. Over time, AC pipe undergoes gradual degradation in the form of corrosion (i.e. internal calcium leaching due to conveyed water and/or external leaching due to ground water). Such leaching leads to reduction in effective cross section, which results in pipe softening and loss of mechanical strength. These lines experience frequent breaks from freezing in Red Lodge. The AC pipe is also extremely dangerous to live tap. With the City's frequency of service failures, they are frequently exposed to the danger when a new tap is needed.

Although the public works department does not spend an extraordinary amount of resources on repairing leaks on water mains, they do notice continual problems with leakage at the service line connections. Service line leakage is likely a major contributor to overall system water losses, which is very high. It is also worth noting that these leaks are extremely difficult to locate as the water rarely surfaces due to the extremely porous soils in the area.

4.3 Reasonable Growth

Population figures and projections were presented in Section 2.3. The population of the City of Red Lodge is anticipated to grow with a gradual increase through the planning period of 2040 to 2,827 persons.

Water demands were discussed in detail in Section 3.2.1 and were projected over the planning period. All design and planning are based upon the projected demands for an average day demand of 322,300 gpd and a peak demand of 773,600 gpd.

5.0 ALTERNATIVES CONSIDERED

Numerous alternatives exist which would address the identified deficiencies within the City's water system. Because several of the alternatives may not be viable for various reasons, the alternative screening process will be used to discuss the available alternatives and determine which ones are viable for detailed consideration in the alternative analysis in the next Chapter.

5.1 Alternative Screening

5.1.1 Supply Alternatives

No supply deficiencies were identified within the City's water system. Therefore, no other alternatives are necessary.

5.1.2 Treatment Alternatives

No treatment deficiencies were identified within the City's water system. Therefore, no other alternatives are necessary.

5.1.3 Storage Alternatives

The storage deficiencies noted in Chapter 3 consist of standard maintenance repair of the tanks. The City is planning these repairs once a new inspection is completed. No other storage deficiencies were identified with the City's water system. Therefore, no other alternatives are necessary.

5.1.4 Pumping Station Alternatives

The booster station currently only provides available fire flows up to 1200 gpm in Country Club Estates and Spires subdivisions. The City Fire Chief stated that needed fire flows in the City's residential areas is 1500 gpm and 2000 gpm at the Clubhouse. When these fire flows are run in the model, a zero pressure is given on the 16" transmission main from the west bench tank to the pumping station, limiting the flows to the subdivisions. The following alternatives have been identified as possible solutions.

Alternative P-1: No Action. The "No Action" alternative is an attractive alternative for communities since there are no capital costs associated with it. In this case, the No Action alternative has a slightly negative impact on public health and safety in that the needed fire flow of 1500 gpm to the Country Club Estates and Spires Subdivisions is not available as the pumps can only supply 1200 gpm. The system can supply 80% of the needed residential fire flow. The system has adequate flow, pressure, and pump redundancy to supply water in all other cases except the fire flow. Since the system satisfies all other requirements this alternative will be considered further.

Alternative P-2: Update Controls at the booster station. The option of updating controls to allow both pumps to run to provide the fire flows is not viable as the increased flow will cavitate pressures in the transmission main. This option also does not allow for system redundancy, in the event that one of the pumps is down, there wouldn't be a back up pump available to supply needed fire flows. Therefore, this option will not be considered further.

Alternative P-3 Add a fire flow pump to the booster station. The option of adding an additional fire flow pump to the booster station would satisfy the pump redundancy issue, but as with option P-2, this option is not viable as the low pressure in the transmission main limits the available flow to the pumps, therefore this option will not be considered further.

Alternative P-4 Bypass Booster Station. This alternative would interconnect the 16" transmission main from the water treatment plant, prior to PRV 1, to the 16" transmission main between the west bench tank and the booster station and remove the existing booster station. This Alternative will provide the needed fire flow, allow the pressure on the 16" transmission main to increase so that additional services could be installed on the main, and the City will save on maintenance and energy costs of maintaining the booster station. Therefore, this alternative will be considered further.

Alternative P-5 Move Booster Station. This alternative would remove the booster station in its current location and install a new booster station on the 16" transmission main closer to the west bench tank. This Alternative will provide the needed fire flow and allow the pressure on the 16" transmission main to increase so that additional services could be installed on the main. Therefore, this alternative will be considered further.

5.1.5 Distribution System Alternatives

Distribution alternatives that were considered address fire flows, condition of the pipes, and dead end mains. In Addition, to determine the adequacy of the proposed alternatives for the distribution and to provide optimum design the computerized hydraulic model, as discussed in Section 3.3.6 was used to identify the highest priorities within the distribution system and to help evaluate proposed alternatives. The alternatives discussed below were narrowed down from the hydraulic model and considered the options to address the concerns within the distribution system.

Alternative D-1: No Action The "No Action" Alternative is sometimes an attractive alternative for communities since there are no capital costs associated with it. However, in this case, by not completing these improvements, public health and safety will be continuously at risk as a result of lack of fire flow capacity and continued high maintenance, water loss, and inoperable fire hydrants and valves. The town would still need to continue to repair the existing cast iron water main leaks which are draining their resources and exposing the system to various contaminants. By not making any improvements, the system will continue to operate in its current state and deteriorate further. Therefore, the no action alternative is not considered viable and will not be considered further.

Alternative D-2: Park Avenue-and Kainu Avenue Project. This alternate would limit 6 dead ends within the distribution system, replace 6" AC main with 8" pvc and increase fire flows at four of the intersections which currently have less than 900 gpm fire flows. Therefore, this alternative will be considered further.

Alternative D-3 Pressure Relief in Zone 5 and Replace PRV 1. This alternative will install pressure reducing valves to reduce the pressures in Zone 5, which currently are in excess of 150 psi as well as replace the existing PRV in White Avenue, PRV 1, with a new PRV vault which will include a normal operation pressure relief valve as well as an additional fire flow pressure relief valve. This Alternative would increase public health and safety by updating PRV 1 so that adequate fire flows can be conveyed through PRV-

1. The PRV's in Zone 5 would reduce system pressure and reduce water loss in the event of a break by bringing Zone 5's pressure into compliance with DEQ requirements for system pressure. Therefore, this alternative

Alternative D-4 Replace all cast iron mains. This alternative will be analyzed by breaking the pipe replacement into four options, Options A through D. The Options will be prioritized by comparing each option's need for fire flow improvement, pipe diameter to meet DEQ's minimum 6" diameter to supply fire hydrants, and will reduce water loss through and potential contamination by removing all the cast iron mains in the system and replacing them with 8" pvc. Therefore, this alternative will be considered further.

5.2 Pumping Station Alternatives

Section 5.1 discussed various alternatives considered for the distribution system. The following alternatives were considered feasible and will be discussed in detail in this section.

- Alt. P-1 No Action
- Alt. P-4 Bypass Booster Station
- Alt. P-5 Move Booster Station

5.2.1 Alt. P-1 No Action

This option includes keeping the booster station in its current condition. Alt.P-1 is an attractive alternative since there are no capital costs associated with it. In this case, the No Action alternative has a slightly negative impact on public health and safety in that the needed fire flow of 1500 gpm to the Country Club Estates and Spires Subdivisions is not available as the pumps can only supply 1200 gpm. This alternate will maintain the current available fire flow to those subdivision of 80% of the needed fire flow. Currently, the booster station has adequate flow, pressure, and pump redundancy to supply water in all other cases except the fire flow.

Alt. P-1 will keep the static pressure on the 16" transmission main at its current levels. The transmission main in this alterative will not have adequate pressures to meet DEQ's minimum static pressure for services, therefore the 16" main will remain functioning as a transmission main and any future services would require individual booster pumps.

There will be no change to annual O&M, and energy use costs associated with Alt. P-1.

5.2.2 Alt. P-4: Bypass Booster Station

This option includes installation of a 16” main from the water plant transmission main, down White Avenue and connecting to the 16” transmission main in between the west bench tank and the booster station. The 16” transmission main would remain connected to the West Bench tank with a check valve that would open in the event the 16” transmission main from the water treatment plant is out of commission. With Alternate P-4 water would be supplied to the subdivisions from the water plant sources. The fire flows in the subdivision will be increased to above 1600 gpm, and the booster station removed. Installation of a PRV would be required near the existing pumping system. And could potentially be installed in the existing pump house. The City has a need to supply water to the airport, with existing pressures in the 16” line near the airport a booster pump for that service would need to be installed. This Option allows for adequate pressures to serve the airport. Also, fire flows are greatly increased in the 16” main from less than 500 gpm to greater than 2500 gpm. Static Pressures in the main will be increased from a low of 11 psi to just over 70 psi.

A normally closed valve will be installed at the high pressure tie in to prevent excessive pressure loss in the transmission main to the subdivisions in the unlikely event of a break in the transmission main from the water treatment plan transmission main. The valve will automatically open the line to the west bench water tank if the main pressure drops below 10 psi. The valve will be integrated with the City’s existing SCADA system to alarm them of the pressure loss.

Design Criteria

The new main and PRV will be constructed following DEQ-1.

Permitting would involve obtaining DEQ approval of the project plans and specifications. If the project disturbs an area greater than one acre, it would fall under the requirements of the “General Permit for storm Water Discharges Associated with Construction Activity”, which is required by the federal water Pollution Control Act and enforced by DEQ.

Map

The map in Figure 5:1 shows the layout of the proposed system improvements.

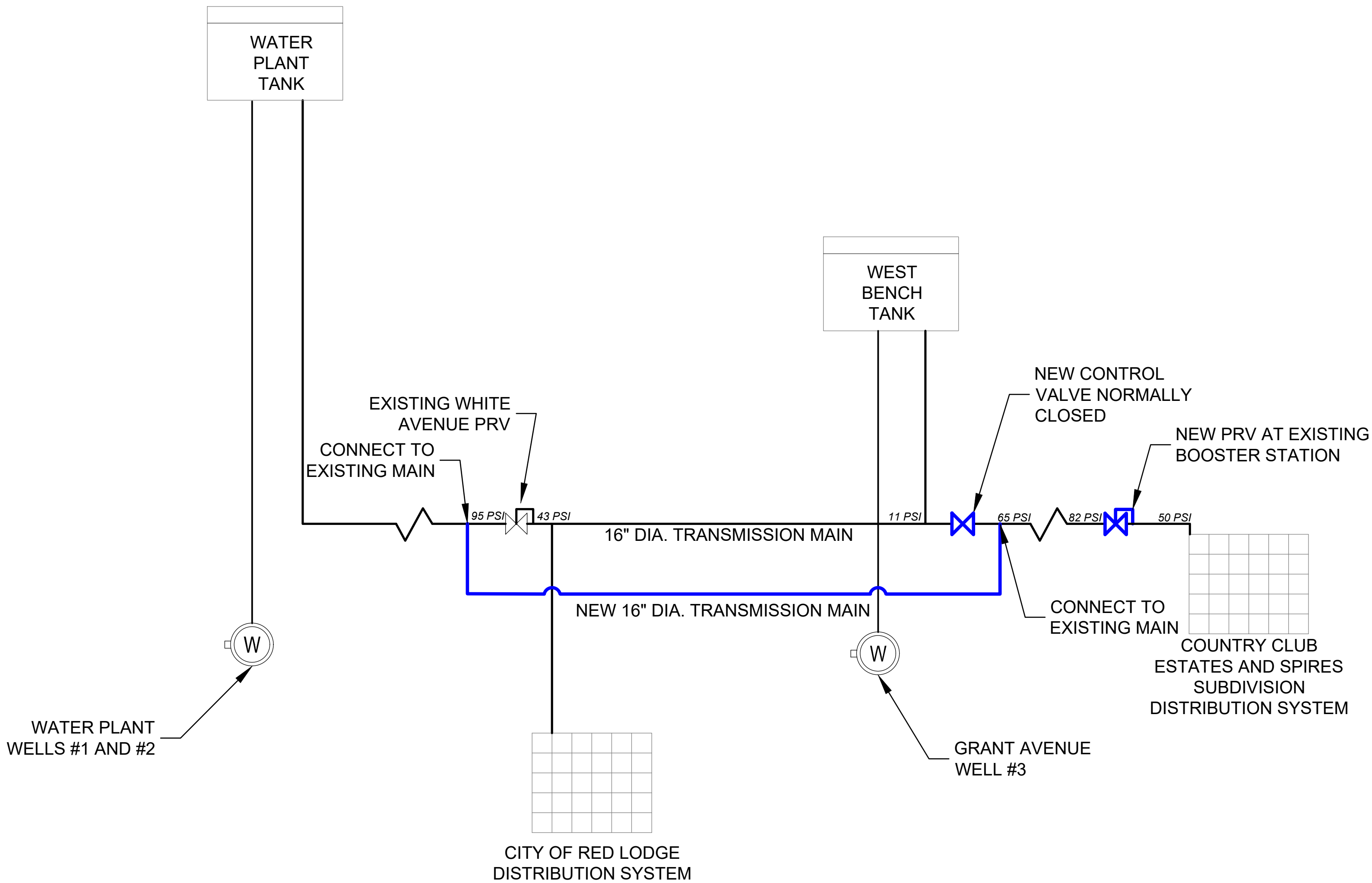

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Figure 5-?
Alt P-4 PROCESS DIAGRAM

City of Red Lodge, Montana
2019 WATER PRELIMINARY ENGINEERING REPORT

J:\2-17103 - Red Lodge On-Call 2017\TO 14 - Water PER\CADD 2-17103-14\Sheets\Figure 5.1 Alternate P2 remove pumps.dwg

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Figure 5:1
Alt. P-4 Bypass Booster Station

City of Red Lodge, Montana
2019 Water Preliminary Engineering Report

Environmental impacts

This alternative will have very few environmental impacts. The new water main, and PRV will be placed within City streets surrounded by already developed lots.

No known floodplains, wetlands, endangered species, historical or archeological properties are anticipated to be disturbed as a result of the project.

Land Requirements

The project will be constructed entirely within City Right-of Way.

Potential Construction Problems

A Geotechnical investigation will need to be completed to ensure the soils are suitable for construction or to determine if any special design requirements will be necessary. Soils within the general vicinity of the City are similar in nature and have been suitable for development. Larger coble may be encountered and may need to be screened from the excavated material prior to backfill. Cost for a geotechnical evaluation are factored into the cost estimate.

The two southernmost blocks in White avenue where the water main will be constructed have existing sanitary sewer and storm sewer. Sewer and water main separation will be maintained per DEQ-1.

Sustainability Considerations

This option will improve the City's energy use by removing the need for pumping. The proposed project will remove the City's only booster station, allowing pressures to be supplied to Country Club Estates, Spires Subdivision, and a water service to the airport without pumping.

Water and Energy Efficiency

This option has a significant positive impact on energy efficiency. The existing pumping station requires a significant amount of power use to operate full time. With this main connection and the removal of the pumps, fire flow and needed pressure will be provided without the use of power needed for the pumps. The PRV can be installed in the existing booster station building. The building will need a power supply for lighting and heating.

Green Infrastructure

This alternate will reduce the City's use of natural resources by removing the power use associated with the current booster station. The City used 45,717 kWh which cost $4,800 in 2019 to power the booster pumps, see Table 3-11. This option will add a PRV in the existing booster station which has an estimated power use similar to the existing PRV in White Avenue which used 6,439 kWh which cost $870 in 2019, See Table 3-10. Therefore, Alt P-4 could potentially reduce the City's energy usage by nearly 40,000 kWh annually, saving the City up to $4,000 annually.

Other

This option increases the City's water distribution system resiliency. Approximately ¼ of residential neighborhood area served by the City's water system has water currently supplied through the booster station. There are redundant pumps in the booster station in case of pump failure, however, the pump station is vulnerable to power-outage. The system currently depends on the booster pumps to normal flows and fire flows. With the proposed improvements, needed fire flow and day demands can be supplied to these residences in the event of a power outage.

The transmission main will have a minimum static pressure of 70 psi, which will allow a service to the airport and potential future water services along Airport Road.

Cost Estimates

Table 5.1 presents an estimated opinion of probable cost for Alternative P-4, and Table 5.2 addresses costs related to operation and maintenance of the improvements. The annual operation and maintenance costs are presented for comparison purposes only of the alternatives.

Table 5-1 Opinion of Probable Cost for Alt. P-4: Bypass Booster Station

OPINION OF PROBABLE COST City of Red Lodge 2020 Water PER Alternate P-4 Bypass Booster Station				
Item	Unit	Quantity	Unit Cost [1]	Total
Connect to Existing Main	EA	2	$8,000	$16,000
Swing Check Valve	EA	1	$15,000	$15,000
Specialty Valve Vault, Piping and Contols	LSM	1	$30,000	$30,000
16"x16" Tee	EA	1	$4,500	$4,500
16" Cap	EA	1	$3,000	$3,000
Abandon Water Main	EA	1	$2,500	$2,500
Under Ground Utility Crossing	EA	80	$500	$40,000
16" PVC Water Main	LF	3,500	$90	$315,000
Flowable Fill	CY	30	$250	$7,500
16" Gate Valve	EA	6	$7,000	$42,000
16" Bend	EA	7	$3,500	$24,500
Remove Pumps	LSM	1	$10,000	$10,000
Install PRV's in Existing Building	LSM	1	$60,000	$60,000
Type A Surface Restoration (Asphalt)	LF	3,000	$60	$180,000
				$750,000
Mobilization		10.00%		$75,000
Traffic Control		2.5%		$2,000
Subtotal 2019 Construction Cost				$827,000
2022 Construction Cost[2]		3.0%	annually	$904,000
Contingency		10.0%		$91,000
Total: D-4 2022 Construction Cost:				$995,000
Geotechnical Investigation				$20,000
Engineering		20.0%		$199,000
Legal and Administrative		2.0%		$20,000
Total: D-3 2022 Capital Cost				**$1,234,000**

[1] Estimated unit costs are based upon estimates from suppliers and bid tabs for similar projects throughout Montana.

[2] The ENR 20 year average Construction Cost Index is +2.94% (as of December 2018). Capital improvement costs are projected to 2020 using 3.0% factor.

Table 5-2 Alternative P-4 Opinion of Probable Annual O&M Costs

PRESENT WORTH ANALYSIS CITY OF RED LODGE 2019 WATER PER Alternative P-4: Bypass Booster Station				
O&M Item	Estimated Cost	Recurrence Interval	Equivalent Annual O&M1	Present Worth2
Distribution System Improvements				$ -
Electrical Costs	($4,000)	1	$ (4,000)	$ (77,534.50)
			$ -	$ -
			$ -	$ -
Total O&M Present Worth			$ (4,000)	$ (77,534)
Capital Cost				$ 1,234,000
Alternative Total Present Worth				$ 1,156,000
Construction Cost Index	3.00%			
Discount Factor	0.30%			

1 Equivalent Annual O&M calculated using the "real" discount rate from the Office of Management and Budget (OMB)

2 Present worth based upon a 20 year life cycle using calculated discount rate.

5.2.3 Alt P-5: Move Booster Station

The booster station's current location limits its ability to provide fire flows to Country Club Estates and Spires subdivision as the 16" transmission main in between the west bench storage tank and the booster station limits flow capacity. When fire flows are modeled, the flows are limited by a zero pressure section in the 16" transmission main. This alternative includes demolition of the existing booster station and construction of a new booster station near the west bench tank on the 16" transmission main to remove the low pressure from the system.

A new 25'x30' concrete masonry unit (CMU) building will be constructed near the existing west bench water tank. A total of 4 pumps will be required, all of which will have VFD's. One pump will be a smaller pump sized to supply the average day demand flow. The second pump will be sized to aid the fist pump during the peak hour demand. The third pump will be the same size as the second and will be installed as a redundant pump. The fourth pump will be sized to supply the needed 2,500 gpm fire flow demand. Controls will be integrated with the City's existing SCADA system.

This booster station will require three-phase power be ran to the new building. A back-up power source will be provided by a generator. The pump head will be sized to add approximately 40 psi of head to the system in order to match the existing system pressure after the current booster station.

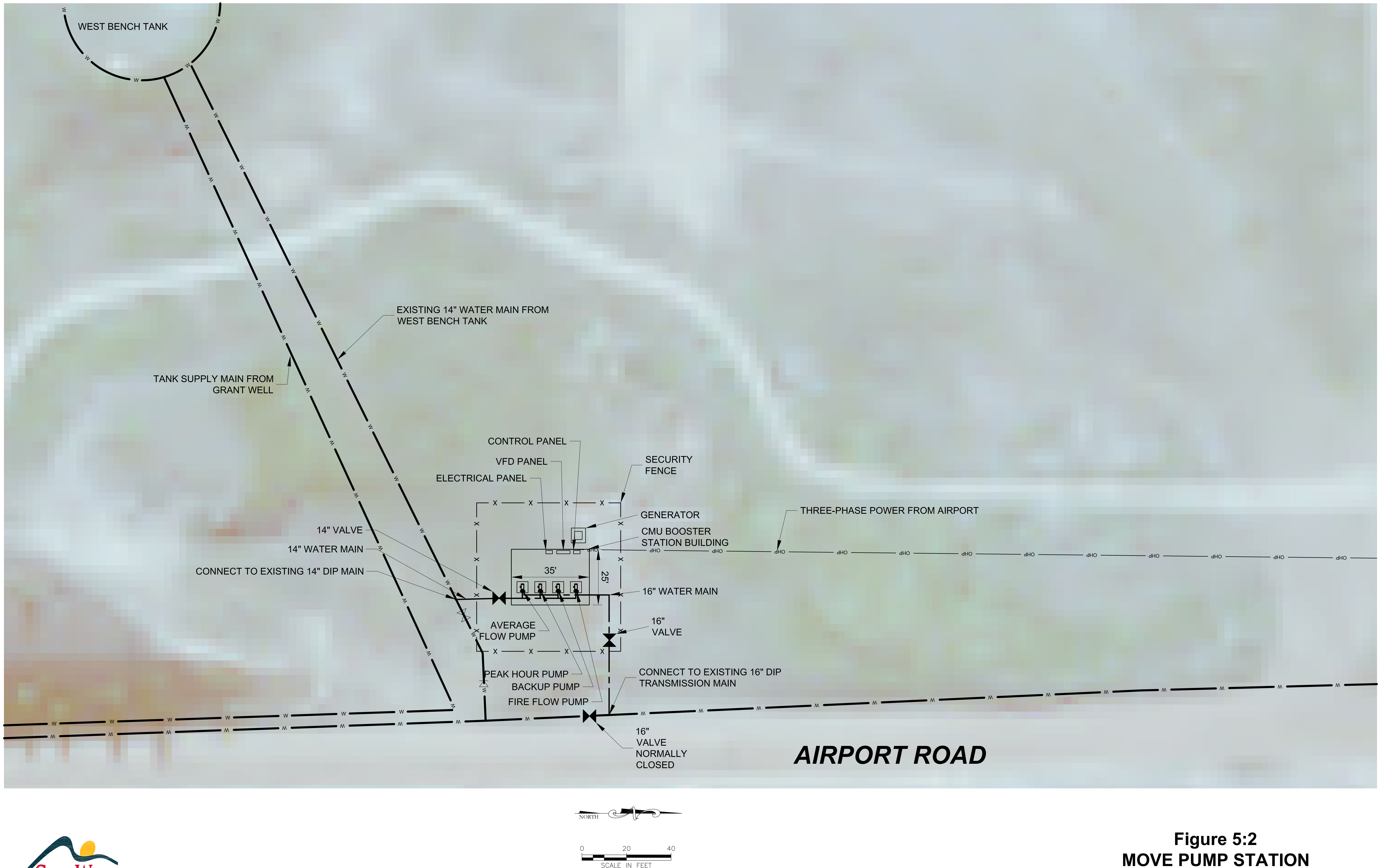
The existing booster station will be demolished and the underground 8” water main piping will be reconnected at the existing booster station. A security fence with a gate will be installed around the perimeter of the building. An access road will be constructed off of Airport Road.

Design Criteria

Permitting would involve obtaining DEQ approval of the project plans and specifications. If the project disturbs an area greater than one acre, it would fall under the requirements of the “General Permit for storm Water Discharges Associated with Construction Activity”, which is required by the federal water Pollution Control Act and enforced by DEQ.

Map

Figure 5.2 below illustrates Alternate P-5 improvements.



J:\2-17103 - Red Lodge On-Call 2017\TO 14 - Water PER\CADD 2-17103-14\Sheets\Figure 5.2 Alt P-4 move pumps.dwg

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Figure 5:2
MOVE PUMP STATION

City of Red Lodge, Montana
2019 Water Preliminary Engineering Report

Environmental Impacts

This alternative will have very few environmental impacts. The new booster station will be located near the existing west bench tank along Airport Road.

No known floodplains, wetlands, endangered species, historical or archeological properties are anticipated to be disturbed as a result of the project.

Land Requirements

The project will be constructed entirely within City Right-of Way and City property.

Potential Construction Problems

A Geotechnical investigation will need to be completed to ensure the soils are suitable for construction or to determine if any special design requirements will be necessary. Soils within the general vicinity of the City are similar in nature and have been suitable for development. Larger coble may be encountered and may need to be screened from the excavated material prior to backfill. Cost for a geotechnical evaluation are factored into the cost estimate.

Sustainability Considerations

Water and Energy Efficiency

This project includes removal of the current booster station and construction of a new booster station. With addition of larger pumps for average flow demand and the fire flow pump, electricity use is likely to increase.

Green Infrastructure

Alternate P-5 will have little impact on green infrastructure. Construction of a new booster station building, access road and piping will be installed on the west side of Airport road near the existing west bench water tower. The existing booster station will be demolished.

Other

Annual operation and maintenance duties of Alternate P-5 will likely similar to the O&M requirements of the existing booster station.

Cost Estimates

Table 5.3 presents an estimated opinion of probable cost for Alternative P-5, and Table 5.4 addresses costs related to operation and maintenance of the improvements. The annual operation and maintenance costs are presented for comparison purposes only of the alternatives.

Table 5-3 Opinion of Probable Cost for Alt. P-5: Move Booster Station

OPINION OF PROBABLE COST City of Red Lodge 2020 Water PER Alternate P-5 Move Booster Station				
Item	Unit	Quantity	Unit Cost [1]	Total
Connect to Existing Main	EA	2	$8,000	$16,000
25x35 CMU Pump Building	LSM	1	$220,000	$220,000
Three Phase Power to Building	LF	1,300	$12	$15,600
16" Water Main	LF	70	$100	$7,000
16" Valve	EA	2	$9,000	$18,000
16"Tee	EA	1	$5,500	$5,500
16" Bend	EA	3	$4,500	$13,500
14" Water Main	LF	40	$95	$3,800
14" Valve	EA	2	$8,000	$16,000
14" Tee	EA	1	$3,500	$3,500
14" Bend	EA	2	$3,000	$6,000
Pumps and Piping	LSM	1	$280,000	$280,000
Controls	LSM	1	$60,000	$60,000
Electrical Panel	LSM	1	$34,000	$34,000
Generator and Automatic Transfer Switch	EA	1	$70,000	$70,000
Building Electrical	LSM	1	$95,000	$95,000
Demolish Existing Pump Building	LSM	1	$35,000	$35,000
Reconnect 8" Water Main at Existing Building	LSM	1	$8,000	$8,000
Gate	EA	1	$2,000	$2,000
Security Fence	LF	260	$25	$6,500
Site Grading and Access Road	LSM	1	$25,000	$25,000
				$941,000
Mobilization		10.00%		$95,000
Traffic Control		2.5%		$3,000
Subtotal 2019 Construction Cost				$1,039,000
2022 Construction Cost[2]		3.0%	annually	$1,135,000
Contingency		10.0%		$114,000
Total: D-5 2022 Construction Cost:				$1,249,000
Geotechnical Investigation				$20,000
Engineering		20.0%		$250,000
Legal and Administrative		2.0%		$25,000
Total: D-5 2022 Capital Cost				**$1,544,000**

[1] Estimated unit costs are based upon estimates from suppliers and bid tabs for similar projects throughout Montana.

[2] The ENR 20 year average Construction Cost Index is +2.94% (as of December 2018). Capital improvement costs are projected to 2020 using 3.0% factor.

Table 5-4 Alternative P-5 Opinion of Probable Annual O&M Costs

PRESENT WORTH ANALYSIS CITY OF RED LODGE 2019 WATER PER Alternative P-5: Move Booster Station				
O&M Item	Estimated Cost	Recurrence Interval	Equivalent Annual O&M1	Present Worth2
Distribution System Improvements				$ -
Electrical Costs	$2,000	1	$ 2,000	$ 34,001.16
			$ -	$ -
			$ -	$ -
Total O&M Present Worth			$ 2,000	$ 34,001
Capital Cost				$ 1,554,000
Alternative Total Present Worth				$ 1,588,000
Construction Cost Index	3.00%			
Inflation (e)	1.50%			
Interest Rate (i)	3.25%			
Discount Factor	1.60%			
1 Equivalent Annual O&M calculated using the "real" discount rate from the Office of Management and Budget (OMB)				
2 Present worth based upon a 20 year life cycle using calculated discount rate.				

5.3 Distribution System Alternatives

Section 5.1 discussed various alternatives considered for the distribution system. The following alternatives were considered feasible and will be discussed in detail in this section:

- Alternative D-2: Park Avenue and Kainu Avenue
- Alt. D-3: Pressure Relief Valve Zone 5 and Replace PRV 1
- Alt. D-4: Replace Cast Iron Mains

5.3.1 Alt. D-2: Park Avenue and Kainu Avenue

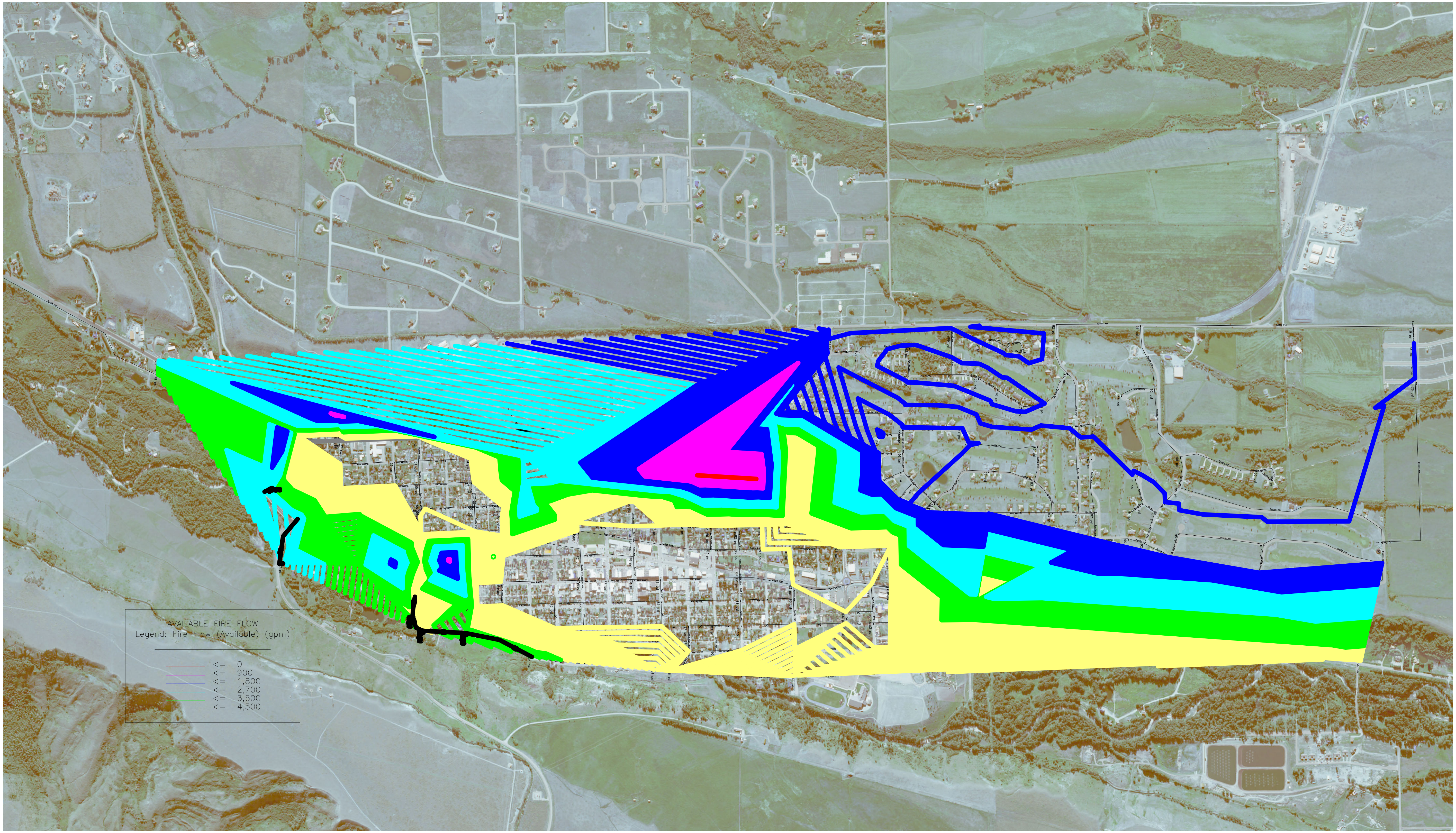
Six dead ends will be eliminated with construction of this project, fire flows will be improved, undersized water mains will be replaced, and fire hydrants will be added. Freezing mains will be reduced by eliminating dead ends increasing water main cover.

The shallow 6" ACP main in Park Avenue will be replaced with an 8" main. The dead end in Park Avenue will be eliminated by continuing new main westward in Bear Creek Hill Road and continuing westward to cross Rock Creek and Broadway Avenue to connect to the existing dead end in South Adams Avenue.

The dead end in South Grant Avenue will cross Highway 212 to connect to the dead end on the water main which runs along the east side of Highway 212. A PRV will be installed at this connection to reduce pressure from the Highway 212 main. The existing static pressures at the eastern main is 100 psi. The PRV will reduce the pressure to approximately 48 psi to match the existing system pressure.

The 2 inch water service on the southern half of Kainu avenue serves several residences. It will be replaced with an 8” main which will extend from Park Avenue to the dead end in the northern section of Kainu near 15th Avenue.

With construction of this project available fire flow on the southeastern quadrant of town will be greatly improved. Figure 5.3 Alternate D-2 Fire Flow Map shown below illustrates the improved fire flow as a result of Alternate D-2.



J:\2-17103 – Red Lodge On-Call 2017\TO 14 – Water PER\CADD 2-17103-14\Water Cad\2-17103-TO14 Red Lodge 2019 Water Model.dwg

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Figure 5:2
Alt. D-2 Fire Flow Map

City of Red Lodge, Montana
2019 Water Preliminary Engineering Report

Design Criteria

The water main improvements will be the replacement of all existing hydrants, hydrant lead lines with auxiliary valves, replacement of all existing gate valves and water services from the main to the curb stops. In addition to the portions of water main being replaced, new mains will be installed to eliminate dead ends. Additional fire hydrants and valves will also be installed to bring the system into compliance with DEQ Circular 1, which were listed in Chapter 3.

Permitting would involve obtaining DEQ approval of the project plans and specifications. If the project disturbs an area greater than one acre, it would fall under the requirements of the "*General Permit for Storm Water Discharges Associated with Construction Activity*", which is required by the Federal *Water Pollution Control Act* and enforced by DEQ.

Other permits could include occupancy permits from the Montana Department of Transportation for all work within State right-of-way.

Map

Alternate D-2 is shown in Figure 5.4 below.

NORTH

0 250 500
SCALE IN FEET

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Figure 5:3
ALTERNATE D-2 PARK AVENUE

City of Red Lodge, Montana
2019 Water Preliminary Engineering Report

J:\2-17103 - Red Lodge On-Call 2017\TO 14 - Water PER\CADD 2-17103-14\Sheets\Figure 5.3 Alternative D-2 Park Ave.dwg

Environmental Impacts

The Kainu connection from 15th Street to 16th Street will be constructed along a graveled road. All other improvements will be constructed in existing City Streets and right of way. A water main will need to be constructed under Rock Creek. In order to cross Rock Creek HDPE water main will be horizontal directional drill (HDD) under both Rock Creek and Broadway Avenue. No Wetlands or environmentally sensitive areas will be disturbed and the AC main will be abandoned.

Land Requirements

In order to connect the southern portion on Kainu Avenue's water main with the Northern portion, one block of right of way or easement may need to be acquired form what would be the intersection of 15th Street to what would be the intersection of 16th Street.

The work within Montana Department of Transportation right-of-way will require occupancy permits.

Potential Construction Problems

Although this project replaces existing mains, there are still several challenges that will need to be addressed during construction. Temporary water will need to be installed to each of the homes affected by the main replacement. Traffic control will need to be established to route traffic around project sites that follows MUTCD standards, especially in the highways.

A Geotechnical investigation will need to be completed to ensure the soils are suitable for construction or to determine if any special design requirements will be necessary. Soils within the general vicinity of the City are similar in nature and have been suitable for development. Larger coble may be encountered and may need to be screened from the excavated material prior to backfill. Cost for a geotechnical evaluation are factored into the cost estimate.

The crossing of Rock Creek and Broadway will need to be directional drilled under the creek and Broadway avenue to the connection in South Adams Avenue. The Broadway crossing at Grant Avenue will be open cut. As this is in MDT right of way, flowable fill backfill will be required.

Sustainability Considerations

The existing distribution system has inadequate cover and six dead ends which cause excessive water main freezes which create frequent breaks. With the project's additional cover and removal of the dead ends, the risk of these breaks caused by freezing will be reduced, thus reducing the City's water loss as well as energy use from the well pumps.

Water and Energy Efficiency

Since the new mains will significantly less breaks and freezes compared to the existing mains, they would require fewer repairs and maintenance and reduced water loss from leaks. Consequently, less energy would be needed for pumping the water from the wells, disinfection, running heavy equipment, transporting materials and flushing the water system.

Green Infrastructure

This alternative would reduce amount of groundwater removed from the aquifer and the amount of energy consumed by the City, thus reducing the City's use of natural resources.

Other

By decreasing the amount of water leaks, the City will also spend less on O&M costs due to decreases in City personnel time, operation of heavy equipment costs, repair parts, and surface repair costs.

Cost Estimates

Table 5.5 presents an estimated opinion of probable cost for Alternative D-2, and Table 5.6 addresses costs related to operation and maintenance of the improvements. The annual operation and maintenance costs are presented for comparison purposes only of the alternatives.

Table 5-5 Opinion of Probable Cost for Alt. D-2: Park Avenue and Kainu Avenue Water Main

OPINION OF PROBABLE COST City of Red Lodge 2020 Water PER Alternate D-2 Park and Kainu Avenue Water Main				
Item	Unit	Quantity	Unit Cost [1]	Total
Connect to Existing Water Main	LSM	5	$10,000	$50,000
Pressure Relief Valve System	LSM	1	$150,000	$150,000
Directional Drill Under Highway and Rock Creek	LF	180	$500	$90,000
8" HDPE Water Main	LF	180	$50	$9,000
14" Steel Casing	LF	80	$350	$28,000
8" Restrained PVC Carrier Pipe	LF	80	$85	$6,800
Flowable Fill in MDT Right-of-Way	CY	45	$60	$2,700
8"x8" Tee	EA	1	$1,000	$1,000
8" PVC Water Main	LF	4,850	$70	$339,500
8" Gate Valve	EA	12	$2,000	$24,000
8"x6" Tee	EA	7	$900	$6,300
6" Fire Hydrant Assembly with Gate Valve	EA	7	$5,800	$40,600
6" PVC Water Main (FH Lead)	LF	130	$65	$8,450
8" Bend	EA	15	$800	$12,000
1" Corporation Stop Assembly	EA	36	$525	$18,900
1" Poly Service Line w/ Insulation	LF	615	$50	$30,750
1" Curb Stop Assembly	EA	36	$600	$21,600
Remove Existing Fire Hydrant	EA	3	$1,000	$3,000
Abandon Existing Main	EA	1	$4,500	$4,500
Underground Utility Crossing	EA	20	$750	$15,000
Exploratory Excavation	HR	10	$175	$1,750
Type A Surface Restoration (Highway)	SY	150	$100	$15,000
Type A Surface Restoration (Asphalt)	SY	6,200	$60	$372,000
Type B Surface Restoration (Aggregate)	SY	1,250	$16	$20,000
Type C Surface Restoration (Grass)	SY	1,100	$12	$13,200
Subtotal: 2019 Direct Construction Cost				$1,285,000

Mobilization, Bonding, Etc.	10.0%		$129,000
Traffic Control	2.5%		$33,000
Total: 2019 Construction Cost			$1,447,000
2022 Construction Cost[2]	3.0%	annually	$1,581,000
Contingency	10.0%		$159,000
Total: 2022 Construction Cost			$1,740,000
Geotechnical Investigation			$20,000
Engineering	20.0%		$348,000
Easement Acquisition			$40,000
Legal and Administrative	2.0%		$35,000
Total: D-2 2022 Capital Cost			**$2,183,000**

[1] Estimated unit costs are based upon estimates from suppliers and bid tabs for similar projects throughout Montana.

[2] The ENR 20 year average Construction Cost Index is +2.94% (as of December 2018). Capital improvement costs are projected to 2020 using 3.0% factor.

Table 5-6 Opinion of Probable Annual O&M Costs Alt. D-2

PRESENT WORTH ANALYSIS
CITY OF RED LODGE 2020 WATER PER
Alternative D-2: Park Avenue and Kainu Avenue Water Main

O&M Item	Estimated Cost	Recurrence Interval	Equivalent Annual O&M1	Present Worth2
Distribution System Improvements				$ -
3 Leak Repairs Per Year	$6,000	1	$ 6,000	$ 116,301.75
			$ -	$ -
			$ -	$ -
Total O&M Present Worth			**$ 6,000**	**$ 116,302**
Capital Cost				$ 2,183,000
Alternative Total Present Worth				**$ 2,299,000**
Construction Cost Index	3.00%			
Discount Factor	0.30%			

1 Equivalent Annual O&M calculated using the "real" discount rate from the Office of Management and Budget (OMB)

2 Present worth based upon a 20 year life cycle using calculated discount rate.

5.3.2 Alt. D-3: Pressure Relief Valve Zone 5 and Replace PRV 1

Alternate D-3 will reduce pressures in Zone 5 as shown Figure 4.3 and includes replacement of the PRV in White Avenue (PRV-1). Pressures in Zone 5 is in excess of 150 psi. In order to reduce pressures west of Broadway Avenue and North of 2nd Street two pressure relieve valves will need to be installed. One in Hauser Avenue between 5th Street and 1st Street and the other in Broadway between 5th Street and 1st Street. This will reduce pressures so that the maximum pressure in the zone is decreased to less than 100 psi. The PRV's will be installed in a vault which will contain one PRV for normal flows, and an additional PRV for fire flows.

There is also a strong need to replace PRV 1. The PRV vault has one 6" pressure relief valve, but no secondary fire flow bypass PRV. The existing vault may be large enough to keep in place, however, it is very likely the space available in the PRV is not enough to install the piping and a new fire flow RPV. For the purpose of this PER, it will be assumed that a new vault is needed.

Design Criteria

The water main improvements will include replacement of one pressure reducing valve vaults in White avenue with a PRV vault sized to properly handle fire flows, as well as addition of two new pressure reducing valve vaults near 2nd Street to reduce pressure to the high pressure zone identified in Chapter 5. Each PRV vault will include the needed PRV(s), vault, piping and needed valving for installation of a complete pressure reducing system. The PRV vaults will be installed to bring the system into compliance with DEQ Circular 1, Section 7.3.1 which requires:

> "*The minimum working pressure in the distribution system should be 35 psi and the normal working pressures should be approximately 60 to 80 psi. When static pressures exceed 100 psi, pressure reducing devices must be provided on mains or as part of the setting on individual service lines in the distribution system."*

Permitting would involve obtaining DEQ approval of the project plans and specifications. If the project disturbs an area greater than one acre, it would fall under the requirements of the "*General Permit for Storm Water Discharges Associated with Construction Activity*", which is required by the Federal *Water Pollution Control Act* and enforced by DEQ.

Other permits could include occupancy permits from the Montana Department of Transportation for all work within State right-of-way.

Map

Alternative D-3 is shown in Figure 5:4 below:

GreatWest engineering

Figure 5:4
ALT. D-3 PRESSURE RELIEF SYSTEM

City of Red Lodge, Montana
2019 Water Preliminary Engineering Report

J:\2-17103 – Red Lodge On-Call 2017\TO 14 – Water PER\CADD 2-17103-14\Sheets\Figure 5.4 Alternative D-3 PRV Valves.dwg

Environmental Impacts

Since construction will take place within improved City streets, there are no anticipated negative environmental impacts associated with this alternative. No wetlands or environmentally sensitive areas will be disturbed.

Land Requirements

The work within Montana Department of Transportation right-of-way near the intersection of Broadway and 2nd Street will require occupancy permit.

All other work in this alternate would be completed within existing City rights-of-way and will not require easement acquisitions.

Potential Construction Problems

A Geotechnical investigation will need to be completed to ensure the soils are suitable for construction or to determine if any special design requirements will be necessary. Soils within the general vicinity of the City are similar in nature and have been suitable for development. Larger coble may be encountered and may need to be screened from the excavated material prior to backfill. Cost for a geotechnical evaluation are factored into the cost estimate.

Isolation of the existing mains may require additional valves be installed. Temporary water will need to be installed to each of the homes and businesses affected by the PRV installation. Isolation of the mains due to non-working valves may create areas that have to be live tapped. Traffic control will need to be established to route traffic around project sites that follows MUTCD standards, especially in the highway where it will impact the business district.

Sustainability Considerations

In the event of a leak in the high pressure zone where pressure can reach over 150 psi, a considerable amount of water loss will occur. This high pressure also increases the likelihood of service breaks, as well as user pluming breaks. Reducing the pressure will reduce break frequency as well as the volume of water loss associated with those breaks.

Water and Energy Efficiency

Since the reduced pressure to the mains will decrease the number of leaks compared to the existing pressures, they would require fewer repairs and maintenance. Consequently, less energy would be needed for pumping the water from the wells, disinfection, running heavy equipment, transporting materials and flushing the water system. Also, in the event of a leak considerably less volume of water will be lost with decreased pressures.

Green Infrastructure

This alternative would reduce amount of groundwater removed from the aquifer and the amount of energy consumed by the City, thus reducing the City's use of natural resources.

Other

By decreasing the amount of water leaks, the City will also spend less on O&M costs due to decreases in City personnel time, operation of heavy equipment costs, repair parts, and surface repair costs. Reducing the pressure will also reduce the risk to breaks within residences and business.

Cost Estimates

Table 5.7 presents an estimated opinion of probable cost for Alternative D-3. The opinion of probable costs assumes that the PRV at Broadway and 2nd Street will be located no further away from the main then 35 feet. Table 5.8 addresses costs related to operation and maintenance of the improvements. The annual operation and maintenance costs are presented for comparison purposes only of the alternatives.

Table 5-7 Opinion of Probable Cost for Alt. D-3: Pressure Reducing Valves

OPINION OF PROBABLE COST City of Red Lodge 2020 Water PER Alternate D-3: Pressure Reducing Valves				
White Avenue PRV Replacement				
Item	Unit	Quantity	Unit Cost [1]	Total
Remove Existing PRV Vault	LSM	1	$10,000	$10,000
New PRV Station	LSM	1	$150,000	$150,000
Connect to Existing Main	EA	2	$10,000	$20,000
16" PVC Water Main	LF	20	$105	$2,100
16" Bend	EA	2	$1,400	$2,800
Type C Surface Restoration (Grass)	SY	100	$12	$1,200
Subtotal: White Avenue PRV Direct Construction Cost				$177,000
2nd Avenue North Pressure Relief System				
Item	Unit	Quantity	Unit Cost [1]	Total
New PRV Station	LSM	2	$150,000	$300,000
Connect to Existing Main	EA	4	$10,000	$40,000
Abandon Existing Main	EA	2	$4,500	$9,000
12" PVC Water Main	LF	70	$100	$7,000
12" Bend	EA	2	$1,200	$2,400
8" PVC Water Main	LF	30	$70	$2,100
8" Bend	EA	2	$800	$1,600
Flowable Fill MDT Right of Way	CY	110	$60	$6,600
Exploratory Excavation	HR	10	$175	$1,750
Type A Restoration (Asphalt-MDT)	SY	47	$100	$4,667
Type A Restoration (Asphalt)	SY	50	$60	$3,000
Type C Surface Restoration (Grass)	SY	100	$12	$1,200
Subtotal: 2nd Ave North PRV Direct Construction Cost				$380,000
White Avenue and 2nd Avenue North PRV Subtotal:				$557,000
Mobilization, Bonding, Etc.		10.0%		$38,000

Traffic Control	2.5%		$10,000
		Total: D-3 2019 Construction Cost:	$985,000
2022 Construction Cost[2]	3.0%	annually	$1,076,000
Contingency	10.0%		$108,000
		Total: D-3 2022 Construction Cost:	$1,184,000
Geotechnical Investigation			$10,000
Engineering	20.0%		$237,000
Easement Acquisition			$40,000
Legal and Administrative	2.0%		$24,000
Total: D-3 2022 Capital Cost			**$1,495,000**

[1] Estimated unit costs are based upon estimates from suppliers and bid tabs for similar projects throughout Montana.

[2] The ENR 20 year average Construction Cost Index is +2.94% (as of December 2018). Capital improvement costs are projected to 2020 using 3.0% factor.

Table 5-8 Operation and Maintenance Cost Alt. D-3: Present Value

PRESENT WORTH ANALYSIS CITY OF RED LODGE 2020 WATER PER Alternative D-3: Pressure Reducing Valves				
O&M Item	**Estimated Cost**	**Recurrence Interval**	**Equivalent Annual O&M1**	**Present Worth2**
Distribution System Improvements				$ -
Leak Repairs	($2,000)	1	$ (2,000)	$ (38,767.25)
Energy Costs	$1,600	1	$ 1,600	$31,013.80
			$ -	$ -
Total O&M Present Worth			**$ (400)**	**$ (7,753)**
Capital Cost				$ 1,495,000
Alternative Total Present Worth				**$ 1,487,000**
Construction Cost Index	3.00%			
Discount Factor	0.30%			

1 Equivalent Annual O&M calculated using the "real" discount rate from the Office of Management and Budget (OMB)

2 Present worth based upon a 20 year life cycle using calculated discount rate.

5.3.3 Alt. D-4: Replace Cast Iron Mains

Due to the condition and age of the cast iron mains in the existing system, this alternate includes replacement of all of the cast iron mains regardless of size. Most mains are 4" and 6" but would be upsized to 8" mains in accordance with the recommendations from the water model. The 8" pipes have a significant hydraulic benefit over 6” pipes and greatly improve fire flows throughout the entire distribution system. The locations of these existing cast iron mains were compiled using as-builts from the City’s projects starting from 1994. Size, type and location of each main should be field verified prior to the design phase.

The method of pipeline replacement is anticipated to be typical open trenching for all the mains. Trenchless technologies such as pipe bursting can be completed on pipelines as small as 4” in diameter. However, costs to burst the smaller diameter pipelines are higher. Pipe bursting would likely also be challenging given the anticipated condition of the existing cast iron mains (high tuberculation). In general, pipeline replacements identified in the alternative are located within street right of way where there is not a major concern with width restrictions.

Within this alternative, there are priorities of replacement based upon condition, size, and fire flow. The cast iron water main replacement will be prioritized by defining 4 Options, Options A through D are defined by areas with CIP grouped together to formulate a reasonable phase of the project. These Options are shown on Figure 5:5 Alt. D-4 Replace Cast Iron Water Mains and are as described below:

Option A

The southernmost phase of this project, Option A, includes replacing CIP in Grant Avenue from 22nd Street to 19th Street, one block of water main behind Frontier Communities between Grant Avenue and Adams Avenue, and Adams Avenue from Broadway to 20th Street. It also includes replacement of a ¼ block of 4” CIP main in the west end of 21st Street.

Option B

Option B includes replacement of 4” CIP in South Hauser Avenue between 19th Street and 13th Street. It is unknown if the water main in South Hauser Avenue from 19th Street to 17th Street is 2” CIP or 4” CIP. For purpose of this report it is assumed the line is 4” CIP. Option B includes replacing 4” CIP in 16th Street between Broadway Avenue and Platt Avenue.

Option C

Option C includes replacing one block of 4” CIP and 2 Blocks of 6” CIP in 11th Street between Word Avenue and Broadway Avenue and replacement of 4” CIP in 13th Street between Adams Avenue and Word Avenue, and one Block of 6” CIP in 10th Street Between Broadway Avenue and Platt Avenue.

Option D

Option D includes replacing 3 blocks of 6" CIP and one block of 4" CIP in 7th Street from Haggin Avenue to Hauser Avenue, one block of 4" CIP in 8th Street from Hauser Avenue to Word Avenue, and one block of 4" CIP in 9th Street from Word Avenue to Adams Avenue.

In order to prioritize the options within alternate D-4 the options were compared by determining which option has low fire flows, inadequate pipe size and leaks as shown in the Table below. The fire flow column has the number of intersections with low fire flows, the leaks column has the number of blocks with leaky pipes, and the diameter column has the number of blocks that do not meet DEQ's minimum requirement of 6".

Table 5-9 Alt. D-4 Option Comparison

Option	Fire Flow	Leaks	Diameter	Score
A	6	7	3	16
B	3	7	4	14
C	-	4	2	6
D	-	6	3	9

As shown in the Comparison table above, Option A is the first priority within Alternate D-4. Option B is the Second Priority, Option D is the third priority and Option C is the last priority. Options A and B both scored considerably higher than Options C and D.

With construction of this project available fire flow on the cast iron mains will meet the needed fire flow demands. Figure 5.3 Alternate D-4 Fire Flow Map shown below illustrates the improved fire flow as a result of Alternate D-4.

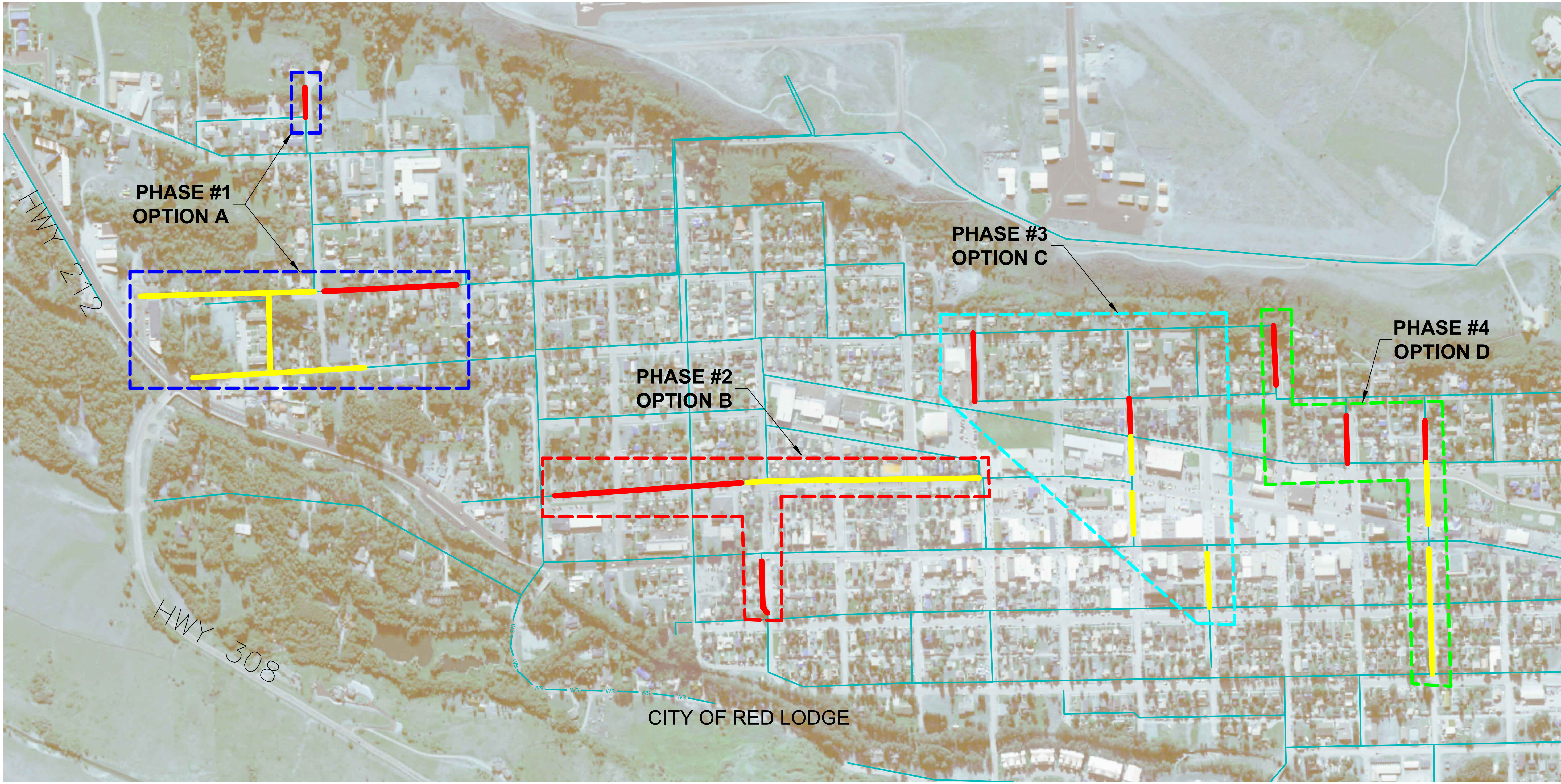
Design Criteria

The water main improvements will be the replacement of all existing hydrants, hydrant lead lines with auxiliary valves, replacement of all existing gate valves and water services from the main to the curb stops. In addition to the portions of water main being replaced, new mains will be installed to eliminate dead ends. Additional fire hydrants and valves will also be installed to bring the system into compliance with DEQ Circular 1, which were listed in Chapter 3.

Permitting would involve obtaining DEQ approval of the project plans and specifications. If the project disturbs an area greater than one acre, it would fall under the requirements of the "*General Permit for Storm Water Discharges Associated with Construction Activity*", which is required by the Federal *Water Pollution Control Act* and enforced by DEQ.

Map

Alternate D-4 is shown in Figure 5.7 below.



LEGEND

REPLACE 4"CAST IRON WATER MAIN WITH 8"

REPLACE 6"CAST IRON WATER MAIN WITH 8"

ALTERNATE D–4: OPTION A

ALTERNATE D–4: OPTION B

ALTERNATE D–4: OPTION C

ALTERNATE D–4: OPTION D

NORTH

SCALE: 1"= 500 FT

GreatWest engineering®

Figure 5:7
ALT D-4 REPLACE CAST IRON WATER MAINS

City of Red Lodge, Montana
2019 Water Preliminary Engineering Report

J:\2-17103 – Red Lodge On-Call 2017\TO 14 – Water PER\CADD 2-17103-14\Sheets\Figure 5.5 CAST IRON WATER MAINS.dwg

Environmental impacts

General environmental conditions were discussed in Section 2.2. Although a significant amount of ground will be disturbed, the pipeline will be located underground and will not have a long-term impact on the environment. In addition, the ground affected by these improvements has been previously disturbed through previous water line installations, construction of streets, and/or construction of buildings. No environmental problems are anticipated.

Land Requirements

The improvement in Alternate D-4 replace existing water mains. The City already owns the land or has an existing easement for the water mains. Most of the City's existing water mains are in alley's or streets, which the City has jurisdiction over. The improvements do not include any work to be conducted within MDT right-of-way.

Potential Construction Problems

Although this project replaces existing mains, there are still several challenges that will need to be addressed during construction. Temporary water will need to be installed to each of the homes affected by the main replacement. Traffic control will need to be established to route traffic around project sites.

A Geotechnical investigation will need to be completed to ensure the soils are suitable for construction or to determine if any special design requirements will be necessary. Soils within the general vicinity of the City are similar in nature and have been suitable for development. Larger coble may be encountered and may need to be screened from the excavated material prior to backfill. Cost for a geotechnical evaluation are factored into the cost estimate.

Sustainability Considerations

The existing cast iron water mains in the distribution system have frequent breaks and have excessive leaks. The City currently has a 47% water loss. Alternate D-4 will replace the remaining cast iron mains with new PVC mains which will be cutting up to 25% of the lost water, reducing energy usage from well pumps.

Water and Energy Efficiency

Since the new mains would not have nearly the number of leaks compared to the existing mains, they would require fewer repairs and maintenance. Consequently, less energy would be needed for pumping water from the wells, disinfection, and running heavy equipment, transporting materials and flushing the water system.

This alternative will reduce energy consumption of the community. Table 3-9 summarizes the energy usage and cost at the well pumps in 2019. Annual electricity used at the wells costs the City nearly $30,000 annually. Estimating a 25% reduction in water lost, thus a 25% reduction in well pump power usage, would mean an annual savings of 50,980 kWh, and potentially $7,000 in energy costs for supplying the water lost per year.

Green Infrastructure

This alternative would reduce the amount of groundwater removed from the aquifer. This City currently loses nearly 79 million gallons of water annually. Alternate D-4 could potentially reduce that leakage by 25%, saving approximately 20 million gallons of water.

Other

By decreasing the amount of water leaks, the City will also spend less on O&M costs due to decreases in City personnel time, operation of heavy equipment costs, repair parts, and surface repair costs. Operability of the distribution system will be improved with valves which will allow the City to more efficiently isolate sections of water main.

Alternate D-4 will increase the distribution system resiliency, as the existing line’s pinhole leaks expose the City to potential contamination into their water system.

Cost Estimates

Tables 5.10 through 5.13 present estimated opinion of probable cost for the Alternative D-4 Options. Table 5.14 shows the total cost of Alternate D-4.

Table 5-10 Opinion of Probable Cost for Alt. D-4: Replace Cast Iron Mains Option A

OPINION OF PROBABLE COST City of Red Lodge 2020 Water PER Alternate D-4 Replace Cast Iron Mains				
Option A				
Item	Unit	Quantity	Unit Cost [1]	Total
Connect to Existing Main	EA	7	$4,500	$31,500
Abandon Water Main	EA	1	$4,500	$4,500
6" PVC Water Main (22nd Street Water Main)	LF	144	$65	$9,360
8" PVC Water Main	LF	2,705	$70	$189,350
6"x6"x6" Tee	EA	1	$900	$900
8"x8"x8" Tee	EA	2	$2,000	$4,000
6" Gate Valve with Valve Box	EA	1	$1,800	$1,800
8" Gate Valve with Valve Box	EA	12	$2,000	$24,000
Fire Hydrant Assembly with Gate Valve	EA	9	$5,800	$52,200
8"x8"x6" Tee	EA	8	$1,500	$12,000
Remove Fire Hydrant Assembly	EA	7	$1,000	$7,000
1" Poly Service with insulation	LF	990	$50	$49,500
1" Curb Stop Assembly	EA	33	$600	$19,800
1" Corporation Stop Assembly	EA	33	$525	$17,325
Type A Surface Restoration (Asphalt)	LF	3,249	$60	$194,940
Underground Utility Crossing	EA	37	$500	$18,500
Flowable Fill	CY	10	$170	$1,700
			Subtotal:	$639,000
2022 Construction Cost[2]		3.0%	annually	$698,000
Contingency		10.0%		$70,000
		Total: D-4 Opt. A 2022 Construction Cost:		$768,000
Geotechnical Investigation				$10,000
Engineering		20.0%		$154,000
Legal and Administrative		2.0%		$16,000
Total: D-4 Option A 2022 Capital Cost				**$948,000**
[1] Estimated unit costs are based upon estimates from suppliers and bid tabs for similar projects throughout Montana.				
[2] The ENR 20 year average Construction Cost Index is +2.94% (as of December 2018). Capital improvement costs are projected to 2020 using 3.0% factor.				

Table 5-11 Opinion of Probable Cost for Alt. D-4: Replace Cast Iron Mains Option B

OPINION OF PROBABLE COST City of Red Lodge 2020 Water PER Alternate D-4 Replace Cast Iron Mains Option B				
Item	Unit	Quantity	Unit Cost [1]	Total
Connect to Existing Main	EA	8	$4,500	$36,000
Abandon Water Main	EA	2	$4,500	$9,000
8" PVC Water Main	LF	2,340	$70	$163,800
8" Cross	EA	1	$2,200	$2,200
8"x8"x8" Tee	EA	1	$2,000	$2,000
8" Bend	EA	1	$800	$800
8" Gate Valve with Valve Box	EA	6	$2,000	$12,000
Fire Hydrant Assembly with Gate Valve	EA	6	$5,800	$34,800
8"x8"x6" Tee	EA	6	$1,500	$9,000
Remove Fire Hydrant Assembly	EA	2	$1,000	$2,000
1" Poly Service with insulation	LF	2,130	$50	$106,500
1" Curb Stop Assembly	EA	71	$600	$42,600
1" Corporation Stop Assembly	EA	71	$525	$37,275
Type A Surface Restoration (Asphalt)	LF	4,140	$60	$248,400
Underground Utility Crossing	EA	35	$500	$17,500
Flowable Fill	CY	15	$170	$2,550
			Subtotal:	$691,000
2022 Construction Cost[2]		3.0%	annually	$755,000
Contingency		10.0%		$76,000
Total: D-4 Opt. B 2022 Construction Cost:				$831,000
Geotechnical Investigation				$10,000
Engineering		20.0%		$167,000
Legal and Administrative		2.0%		$17,000
Total: D-4 Option B 2022 Capital Cost				**$1,025,000**

[1] Estimated unit costs are based upon estimates from suppliers and bid tabs for similar projects throughout M

[2] The ENR 20 year average Construction Cost Index is +2.94% (as of December 2018). Capital improvement costs are projected to 2020 using 3.0% factor.

Table 5-12 Opinion of Probable Cost for Alt. D-4: Replace Cast Iron Mains Option C

OPINION OF PROBABLE COST City of Red Lodge 2020 Water PER Alternate D-4 Replace Cast Iron Mains Option C				
Item	Unit	Quantity	Unit Cost [1]	Total
Connect to Existing Main	EA	15	$4,500	$67,500
8" PVC Water Main	LF	1,400	$70	$98,000
8" Cross	EA	1	$2,200	$2,200
8"x8"x8" Tee	EA	4	$2,000	$8,000
8" Bend	EA	1	$800	$800
8" Gate Valve with Valve Box	EA	9	$2,000	$18,000
Fire Hydrant Assembly with Gate Valve	EA	4	$5,800	$23,200
8"x8"x6" Tee	EA	4	$1,500	$6,000
Remove Fire Hydrant Assembly	EA	1	$1,000	$1,000
1" Poly Service with insulation	LF	450	$50	$22,500
1" Curb Stop Assembly	EA	15	$600	$9,000
1" Corporation Stop Assembly	EA	15	$525	$7,875
Type A Surface Restoration (Asphalt)	LF	1,705	$60	$102,300
Underground Utility Crossing	EA	28	$500	$14,000
Flowable Fill	CY	10	$170	$1,700
			Subtotal:	$383,000
2022 Construction Cost[2]		3.0%	annually	$419,000
Contingency		10.0%		$42,000
Total: D-4 Opt. C 2022 Construction Cost:				$461,000
Geotechnical Investigation				$10,000
Engineering		20.0%		$93,000
Legal and Administrative		2.0%		$10,000
Total: D-4 Option C 2022 Capital Cost				**$574,000**

[1] Estimated unit costs are based upon estimates from suppliers and bid tabs for similar projects throughout M

[2] The ENR 20 year average Construction Cost Index is +2.94% (as of December 2018). Capital improvement costs are projected to 2020 using 3.0% factor.

Table 5-13 Opinion of Probable Cost for Alt. D-4: Replace Cast Iron Mains Option D

OPINION OF PROBABLE COST City of Red Lodge 2020 Water PER Alternate D-4 Replace Cast Iron Mains Option D				
Item	Unit	Quantity	Unit Cost [1]	Total
Connect to Existing Main	EA	14	$4,500	$63,000
8" PVC Water Main	LF	1,655	$70	$115,850
8" Cross	EA	2	$2,200	$4,400
8"x8"x8" Tee	EA	1	$2,000	$2,000
8" Bend	EA	1	$800	$800
8" Gate Valve with Valve Box	EA	7	$2,000	$14,000
Fire Hydrant Assembly with Gate Valve	EA	5	$5,800	$29,000
8"x8"x6" Tee	EA	5	$1,500	$7,500
1" Poly Service with insulation	LF	1,110	$50	$55,500
1" Curb Stop Assembly	EA	37	$600	$22,200
1" Corporation Stop Assembly	EA	37	$525	$19,425
Type A Surface Restoration (Asphalt)	LF	2,765	$60	$165,900
Underground Utility Crossing	EA	40	$500	$20,000
Flowable Fill	CY	10	$170	$1,700
			Subtotal:	$522,000
2022 Construction Cost[2]		3.0%	annually	$570,000
Contingency		10.0%		$57,000
		Total: D-4 Opt. D 2022 Construction Cost:		$627,000
Geotechnical Investigation				$10,000
Engineering		20.0%		$126,000
Legal and Administrative		2.0%		$13,000
Total: D-4 Option D 2022 Capital Cost				**$776,000**

[1] Estimated unit costs are based upon estimates from suppliers and bid tabs for similar projects throughout M

[2] The ENR 20 year average Construction Cost Index is +2.94% (as of December 2018). Capital improvement costs are projected to 2020 using 3.0% factor.

Table 5-14 Summary Table of Opinion of Probable Cost for Alt. D-4

Alternate D-4 Cost Summary Table	
Option A	$948,000
Option B	$1,025,000
Option C	$574,000
Option D	$776,000
Alt. D-4 Total	$3,323,000

Tables 5-15 through Table 5-18 address costs related to operation and maintenance of the Options respective improvements. Table 5-19 presents operation and maintenance of the complete Alternate D-4 project which replaces all existing cast iron water mains.. The annual operation and maintenance costs are presented for comparison purposes only of the alternatives.

Table 5-15 Operation and Maintenance Cost for Alt. D-4 Option A

PRESENT WORTH ANALYSIS CITY OF RED LODGE 2020 WATER PER Alternative D-4: Replace Cast Iron Mains Option A				
O&M Item	**Estimated Cost**	**Recurrence Interval**	**Equivalent Annual O&M1**	**Present Worth2**
Distribution System Improvements				$ -
Leak Repairs	($2,000)	1	$ (2,000)	$ (38,767.25)
Energy Savings	($2,000)	1	$ (2,000)	$ (38,767.25)
			$ -	$ -
Total O&M Present Worth			**$ (4,000)**	**$ (77,534)**
Capital Cost				$ 948,000
Alternative Option Total Present Worth				**$ 870,000**
Construction Cost Index	3.00%			
Discount Factor	0.30%			
1 Equivalent Annual O&M calculated using the "real" discount rate from the Office of Management and Budget (OMB)				
2 Present worth based upon a 20 year life cycle using calculated discount rate.				

Table 5-16 Operation and Maintenance Cost for Alt. D-4 Option B

PRESENT WORTH ANALYSIS CITY OF RED LODGE 2020 WATER PER Alternative D-4: Replace Cast Iron Mains Option B				
O&M Item	**Estimated Cost**	**Recurrence Interval**	**Equivalent Annual O&M1**	**Present Worth2**
Distribution System Improvements				$ -
Leak Repairs	($2,000)	1	$ (2,000)	$ (38,767.25)
Energy Savings	($2,000)	1	$ (2,000)	$ (38,767.25)
			$ -	$ -
Total O&M Present Worth			**$ (4,000)**	**$ (77,534)**
Capital Cost				$ 1,025,000
Alternative Optoin Total Present Worth				**$ 947,000**
Construction Cost Index	3.00%			
Discount Factor	0.30%			
1 Equivalent Annual O&M calculated using the "real" discount rate from the Office of Management and Budget (OMB)				
2 Present worth based upon a 20 year life cycle using calculated discount rate.				

Table 5-17 Operation and Maintenance Cost for Alt. D-4 Option C

PRESENT WORTH ANALYSIS CITY OF RED LODGE 2020 WATER PER Alternative D-4: Replace Cast Iron Mains Option C				
O&M Item	**Estimated Cost**	**Recurrence Interval**	**Equivalent Annual O&M1**	**Present Worth2**
Distribution System Improvements				$ -
Leak Repairs	($2,000)	1	$ (2,000)	$ (38,767.25)
Energy Savings	($1,100)	1	$ (1,100)	$ (21,321.99)
			$ -	$ -
Total O&M Present Worth			**$ (3,100)**	**$ (60,089)**
Capital Cost				$ 776,000
Alternative Option Total Present Worth				**$ 716,000**
Construction Cost Index	3.00%			
Discount Factor	0.30%			
1 Equivalent Annual O&M calculated using the "real" discount rate from the Office of Management and Budget (OMB)				
2 Present worth based upon a 20 year life cycle using calculated discount rate.				

Table 5-18 Operation and Maintenance Cost for Alt. D-4 Option D

PRESENT WORTH ANALYSIS CITY OF RED LODGE 2020 WATER PER Alternative D-4: Replace Cast Iron Mains Option D				
O&M Item	**Estimated Cost**	**Recurrence Interval**	**Equivalent Annual O&M1**	**Present Worth2**
Distribution System Improvements				$ -
Leak Repairs	($2,000)	1	$ (2,000)	$ (38,767.25)
Energy Savings	($1,800)	1	$ (1,800)	$ (34,890.52)
			$ -	$ -
Total O&M Present Worth			**$ (3,800)**	**$ (73,658)**
Capital Cost				$ 776,000
Alternative Option Total Present Worth				**$ 702,000**
Construction Cost Index	3.00%			
Discount Factor	0.30%			
1 Equivalent Annual O&M calculated using the "real" discount rate from the Office of Management and Budget (OMB)				
2 Present worth based upon a 20 year life cycle using calculated discount rate.				

Table 5-19 Operation and Maintenance Cost for Alt. D-4

PRESENT WORTH ANALYSIS CITY OF RED LODGE 2020 WATER PER Alternative D-4: Replace Cast Iron Mains				
O&M Item	**Estimated Cost**	**Recurrence Interval**	**Equivalent Annual O&M1**	**Present Worth2**
Distribution System Improvements				$ -
Leak Repairs	($6,000)	1	$ (6,000)	$ (116,301.75)
Energy Savings	($6,900)	1	$ (6,900)	$ (133,747.01)
			$ -	$ -
Total O&M Present Worth			**$ (12,900)**	**$ (250,049)**
Capital Cost				$ 3,323,000
Alternative Total Present Worth				**$ 3,073,000**
Construction Cost Index	3.00%			
Discount Factor	0.30%			
1 Equivalent Annual O&M calculated using the "real" discount rate from the Office of Management and Budget (OMB)				
2 Present worth based upon a 20 year life cycle using calculated discount rate.				

6.0 SELECTION OF AN ALTERNATIVE

Selection of an alternative is the process by which data from the previous section, "Alternatives Considered" is analyzed in a systematic manner to identify a recommended alternative. The analysis should include consideration of both life cycle costs and non- monetary factors (i.e. triple bottom line analysis: financial, social, and environmental). If water reuse or conservation, energy efficient design, and/or renewable generation of energy components are included in the proposal provide an explanation of their cost effectiveness in this section

Non-Monetary Factors. Non-monetary factors, including social and environmental aspects (e.g. sustainability considerations, operator training requirements, permit issues, community objections, reduction of greenhouse gas emissions, wetland relocation, reliability, operability) should also be considered in determining which alternative is recommended and may be factored into the calculations.

Each of the technically feasible alternatives considered meet the design criteria and applicable regulations identified in the alternative description. This section will examine advantages and disadvantages of each in terms of life cycle costs, operational and maintenance considerations, permitting concerns, social impacts, environmental impacts, and other non-monetary considerations.

6.1 Life Cycle Cost Analysis

A life cycle cost present worth analysis (an engineering economics technique to evaluate present and future costs for comparison of alternatives) should be completed to compare the technically feasible alternatives. Do not leave out alternatives because of anticipated costs; let the life cycle cost analysis show whether an alternative may have an acceptable cost. This analysis should meet the following requirements and should be repeated for each technically feasible alternative. Several analyses may be required of the project has different aspects, such as one analysis for different types of collection systems and another for different types of treatment.

1. *The analysis should convert all costs to present day dollars;*
2. *The planning period to be used is recommended to be 20 years, but may be any period determined reasonable by the engineer and concurred on by the state or federal agency;*

3. *The discount rate to be used should be the "real' discount rate taken from Appendix C of OMB Circular A-94 and found at (www.whitehouse.gov/omb/circulars_a094/a94_appx-c);*

4. *The total capital cost (construction plus non-construction costs) should be included;*

5. *Annual O&M costs should be converted to present day dollars using a uniform series present worth (USPW) calculation;*

6. *The salvage value of the constructed project should be estimated using the anticipated life expectancy of the constructed items using straight line depreciation calculated at the end of the planning period and converted to present day dollars;*

7. *The present worth of the salvage value should be subtracted from the present worth costs;*

8. *The net present value (NPV) is then calculated for each technically feasible alternative as the sum of the capital cost (C) plus the present worth of the uniform series of annual O&M (USPW(O&M)) costs minus the single payment present worth of the salvage value (SPPW(S)):* $NPV = C + USPW\ (O\&M) - SPPW\ (S)$

9. *A table showing the capital cost, annual O&M cost, salvage value, present worth of each of these values, and the NPV should be developed for state or federal agency review. All factors (major and minor components), discount rates, and planning periods used should be shown within the table;*

10. *Short lived asset costs (see Appendix A for examples) should also be included in the life cycle cost analysis if determined appropriate by the consulting engineer or agency. Life cycles of short lived assets should be tailored to the facilities being constructed and be based on generally accepted design life. Different features in the system may have varied life cycles.*

The cost of extensive capital improvements to meet minimum health and safety requirements, applicable regulations, and reduce environmental impacts is a great concern to small communities with limited budgets and resources. At the same time, some alternatives may have a low capital costs but high O&M costs that will put a continual burden on the community. A life cycle cost analysis provides a method to compare the costs of each alternative to one another.

To complete the life cycle cost analysis, the anticipated annual increase to O&M costs and estimated salvage value of any improvements based upon a straight-line depreciation are converted to present day dollars using the "real" discount rate from Appendix C of OMB A-94. The net present value is then calculated for each alternative by adding the estimated capital cost and present worth of the increased O&M and then subtracting the present worth of the calculated salvage value.

Table 6-1 summarizes the life cycle cost analysis for all the alternatives.

Table 6-1 Present Worth Life Cycle Analysis

System Alternatives							
Alternative	Capital Cost	Annual Increase to O&M	Present Worth of O&M Increase	20 year Salvage Value	Present Worth of Salvage	Net Present Value	Criteria Score
P-1	$ -	$ -	$ -	$ -	$ -	$ -	10.0
P-4	$ 1,234,000.00	$ (4,000.00)	$ (77,534.00)	$ 270,800.00	$ 255,000.00	$ 901,466.00	1.4
P-5	$ 1,544,000.00	$ 2,000.00	$ 38,767.00	$ 346,200.00	$ 326,000.00	$ 1,256,767.00	0.0
D-2	$ 2,183,000.00	$ (720.00)	$ (12,190.00)	$ 399,200.00	$ 376,000.00	$ 1,794,810.00	1.2
D-3	$ 1,495,000.00	$ (400.00)	$ (6,800.00)	$ 247,500.00	$ 233,000.00	$ 1,255,200.00	3.2
D-4 Option A	$ 948,000.00	$ (4,000.00)	$ (68,000.00)	$ 191,000.00	$ 180,000.00	$ 700,000.00	6.1
D-4 Option B	$ 1,025,000.00	$ (4,000.00)	$ (68,000.00)	$ 206,800.00	$ 195,000.00	$ 762,000.00	5.7
D-4 Option C	$ 574,000.00	$ (3,100.00)	$ (52,700.00)	$ 98,650.00	$ 93,000.00	$ 428,300.00	8.8
D-4 Option D	$ 776,000.00	$ (3,800.00)	$ (64,600.00)	$ 136,200.00	$ 128,000.00	$ 583,400.00	7.0

6.2 Ranking Criteria

A matrix to compare each alternative objectively against the other will be developed to select the preferred alternative. Each alternative will be given a score ranging from 0 to 10 for a number of criteria, with 0 representing a negative impact and 10 representing the maximum benefit to the community. The alternatives will begin with a score of 5 for each criterion, and then the score will be adjusted up or down relative to the benefit of the particular alternative in relation to the other alternatives.

In addition to scoring each alternative, the criteria themselves with be weighted in relation to one another. Weighting factors ranging from 1 to 10 will be used to give greater importance to items such as cost. This is appropriate, as often times higher investments are made to overcome many other problems such as reliability or to mitigate problems with technical feasibility or environmental concerns.

6.2.1 Life Cycle Costs

The cost of extensive capital improvements to meet minimum health and safety requirements, applicable regulations, and environmental impacts is a great concern to small communities with limited budgets and resources. Life cycle costs also include anticipated increases to ongoing O&M costs.

Accordingly, this criterion will be provided with the maximum weighting factor of 10. This represents over 30% of the total weighting, and Public Opinion is closely tied to cost also, giving the cost for each alternative even more weight.

In addition to providing the maximum emphasis on costs, a method must be utilized to provide an objective comparison of costs for each alternative relative to one another and not just an overall comparison. Given a range of costs for various alternatives, the relative cost of any alternative can be determined using the lowest cost and the highest cost from the range of costs and the following equation.

$$5 \times [(\text{Lowest Cost}) / (\text{Cost}) + (\text{Highest Cost} - \text{Cost}) / (\text{Highest Cost})]$$

For example, if a number of alternatives were compared having costs of $500,000, $1,000,000 and $2,000,000, the above equation would provide scores of 8.8, 5.0, and 1.3, respectively. The utilization of a formula to score the 20 year life cycle costs in the matrix eliminates any subjectivity and provides a consistent, relative comparison of costs.

6.2.2 Operational and Maintenance Considerations

Operation and maintenance is an important issue when considering any large capital improvements within a small community. The costs for O&M associated with the alternatives is included in the 20 year life cycle costs compared under the financial feasibility, but there are other considerations that must be weighed for the O&M associated with each alternative.

The City has limited resources and manpower, and some alternatives may have O&M requirements that drastically tax those limited resources creating deficiencies in other areas. City personnel also have a much more intrinsic knowledge of the system than the average resident or even Council members. Priorities identified by the operators to facilitate the efficient operation of the system must be given some weight.

This criterion will be provided with a weighting factor of 7.

6.2.3 Permitting Issues

Some alternatives may encounter permitting issues that would significantly delay the project and/or result in additional expenses for the community. Consideration for these concerns will be given under this criterion.

This criterion will be provided with a weighting factor of 4.

6.2.4 Social Impacts

Social impacts will be considered in the final alternative selection as a project poorly supported by the community will have a limited chance of success. Efforts such as public hearings are ways to identify public opinion and perceptions. Costs are always a concern with consumers, but the health and safety of their families is just as important.

This criterion will be provided with a weighting factor of 5.

6.2.5 Environmental Impacts

Environmental impacts for each alternative, whether detrimental or beneficial, need to be considered in the final selection of a preferred alternative.

This criterion will be provided with a weighting factor of 5.

6.2.6 Sustainability Considerations

Sustainable utility management practices can greatly benefit a community and result in cost savings. Consideration will be given to alternatives benefitting the sustainability of the utility.

This criterion will be provided with a weighting factor of 4.

6.2.7 Public Health and Safety

Alternatives that do not meet the public health and safety requirements as required by the state and federal governments were eliminated during the Alternative Development. The alternatives retained for the alternative Analysis are designed to meet public health and safety laws, so the scoring for each alternative under this criterion would be expected to be fairly high. However, addressing public health and safety concerns is the main purpose of the entire report, so this category will still be given a higher weighting factor.

This criterion will be provided with a weighting factor of 7.

6.2.8 Land Acquisition

Issues with land acquisition often supersede the black-and-white world of engineering. This ranking category will include the feasibility of acquiring sufficient land in terms of lease, right-of-way, and/or land purchases. Although these are not strict engineering issues, problems with land acquisition can greatly impact a project's overall feasibility and require that land issues be given a very serious consideration.

This criterion will be provided with a weighting factor of 3.

6.3 Scoring of Pumping Station Alternatives

A matrix to compare each alternative objectively against the other will be developed to select the preferred alternate and to develop needed alternative prioritization. Each alternative will be given a score ranging from 1 to 10 for a number or criteria, with 0 representing a negative impact and 10 representing the maximum benefit to the community. The alternatives will begin with a score of 5 for each criterion, and then the score will be adjusted up or down relative to the benefit of that alternative in relation to the other alternatives.

The alternatives that will be discussed and scored under this section include:

- P-1: "No Action" Pumping Alternative
- P-4: "Bypass Booster Station" Pumping Alternative
- P-5: "Move Booster Station" Pumping Alternative

6.3.1 Life Cycle Costs

The scoring for the life cycle cost was calculated using the formula presented in the ranking criteria discussion and is summarized in Table 6-1.

6.3.2 Operational and Maintenance Considerations

Alternative P-1: “No Action” would not result in a significant increase or decrease to current system O&M requirements, so it will be given the base score of 5

Alternative P-4: “Bypass Booster Station” would remove O&M costs associated with the booster station but would introduce slight O&M costs with addition of the PRV system. Overall, there would be a net reduction in O&M costs, so it will be given a score of 8.

Alternative P-5: “Move Booster Station” would increase O&M costs as the proposed booster station would require a higher horsepower pump for fire flows in addition to normal operating pumps, as well as O&M costs associated with a back-up generator. Therefore, it will be given a score of 3.

6.3.3 Permitting Issues

All of the pumping alternatives (P-1, P-4, P-5) would only require routine permitting and DEQ review and approval so they will be given a score of 5 for this criterion.

6.3.4 Social Impacts

Public opinion for system improvements are often based on the maximum benefit received by the community that would increase monthly rates the least. Alternatives P-1, P-4 and P-5 will be scored against each other relative to the life cycle costs. Therefore, the pump alternatives will be given scores of 8, 5, and 1 respectively. The score for alternative P-4 was increased from 2 to a 5 as the City of Red Lodge have shown interest in pursuing ways to reducing the City’s energy use.

6.3.5 Environmental Impacts

Alternative P-1 has no environmental impact and will be given a score of 5 for this criterion.

Alternative P-4 includes construction of new transmission main. The proposed new main will be located on ground that has been disturbed through previous water line installations, construction of streets, and/or construction of buildings. Therefore, this alternative will be given a score of 4 for this criterion

Alternative P-5 will require construction of a new building and site development. Therefore, Alternative P-5 will be given a score of 3 for this criterion.

6.3.6 Sustainability Considerations

Alternative P-1: “No Action” would have a negative impact on the system resiliency and sustainability for a specific neighborhood, as the existing pump station has limited capability to supply needed fire flow, and no redundant power source to supply water to the neighborhood in the event of a power outage. Therefore, Alternative P-1 will be given a score of 2 for this criterion.

Alternative P-4: “Bypass Booster Station” would increase the sustainability and resilience of the system by removing the City’s only booster station. Therefore, Alternative P-4 will be given a score of 8 for this criterion.

Alternative P-5: “Move Booster Station” would increase the resilience of the system. However, it will have increased energy use as the proposed booster station would require a higher horsepower pump for fire flows in addition to normal operating pumps. Alternative P-5 will be given a score of 5.

6.3.7 Public Health and Safety

Alternative P-1 maintains the existing risk to public health and safety as the available fire flow to Country Club Estates and Spires subdivisions will remain limited. Also, without redundant power, the subdivision has a risk of loss of water supply during a power outage at the booster station. Therefore, Alternate P-1 will be given a score of 1 for this criterion.

Alternatives P-4 and P-5 have equal improvements to public health and safety and will be given a score of 7 for this criterion.

6.3.8 Land Acquisition

Alternatives P-1 and P-4 will be constructed within existing City property and right of way. Therefore, these alternatives will be given a rank of 8 for this criterion.

Alternate P-5 may require Land Acquisition for a new booster station location. Therefore, this alternative will be given a rank of 2 for this criterion.

6.4 Scoring of Distribution Alternatives

A matrix to compare each alternative objectively against the other will be developed to select the preferred alternate and to develop needed alternative prioritization. Each alternative will be given a score ranging from 1 to 10 for a number or criteria, with 0 representing a negative impact and 10 representing the maximum benefit to the community. The alternatives will begin with a score of 5 for each criterion, and then the score will be adjusted up or down relative to the benefit of that alternative in relation to the other alternatives.

The alternatives that will be discussed and scored under this section include:

- D-2: “Park Avenue and Kainu Avenue Water Main”
- D-3: “Pressure Relief Zone 5 and Replace PRV 1”
- D-4 Option A: “Replace Cast Iron Pipe” in Location A
- D-4 Option B: “Replace Cast Iron Pipe” in Location B
- D-4 Option C: “Replace Cast Iron Pipe” in Location C
- D-4 Option D: “Replace Cast Iron Pipe” in Location D

6.4.1 Life Cycle Costs

The scoring for the life cycle cost was calculated using the formula presented in the ranking criteria discussion and is summarized in Table 6-1.

6.4.2 Operational and Maintenance Considerations

Alternative D-2: “Park Avenue and Kainu Avenue Water Main” will eliminate the need for the City to repair reoccurring leaks and freezes, typically three per year, in the line, so it will be given a score of 7

Alternative D-3: “Pressure Relief Zone 5 and Replace PRV 1” will reduce O&M costs incurred by the City by reducing water loss from leaks in the high pressure zones. Installation of the PRV’s will also reduce the frequency of breaks by reducing high pressures. Therefore, the PRV’s will be given a score of 6.

All options in D-4 will reduce O&M costs by reducing power usage to produce water lost in the leaks, as well as eliminating the need for repairs. Therefore, all D-4 Options will be given a score of 7

6.4.3 Permitting Issues

Alternative D-2 includes two highway crossings which would require permits from the Montana Department of Transportation. This alternate also includes horizontal drilling under rock creek, therefore there is potential that stream permitting through a Joint Application may be required. Therefore, this alternative will be given a score of 3 for this criterion.

All of the other alternatives (D-3 and all options in D-4) would only require routine permitting and DEQ review and approval so they will be given a score of 5 for this criterion.

6.4.4 Social Impacts

Public opinion for system improvements are often based on the maximum benefit received by the community that would increase monthly rates the least. The various options for Alternative D-4 will be scored against each other relative to the life cycle costs, yet score higher in general as these alternatives have the highest social impact as the City residents are very aware of the need continue replacing water mains. Therefore, Alternate D-4.A and D-4.B are given a score of 7, Alternative D-4.C is given a score of 9, and Alternative D-4.D is given a score of 8.

Alternatives D-2 and D-3 are given a score of 5, as this alternative's life cycle costs are the highest of the distribution projects.

6.4.5 Environmental Impacts

The proposed new water mains will be either bored or installed in areas that have previously been disturbed for utility installation and streets. New hydrants and PRV vaults will be located on ground that has been disturbed through previous water line installations, construction of streets, and/or construction of buildings. Therefore, alternatives D-2, D-3 and all options in D-4 will be given a score of 5.

6.4.6 Sustainability Considerations

Alternative D-2: “Park Avenue and Kainu Avenue Water Main” will eliminate the need for the City to repair reoccurring leaks and freezing. Also, the water main looping provided in this alternative will also increase sustainability throughout a larger area of the City, so it will be given a score of 8.

Alternative D-3: “Pressure Relief Zone 5 and Replace PRV 1” will increase sustainability by reducing system pressures, which will reduce water loss, and allow more fire flow to the City by installation of a PRV sized to allow needed fire flow though. Therefore, Alternative D-3 will be given a score of 9.

All options in D-4 will improve sustainability, however the increased sustainability will be localized to the blocks where the mains will be replaced Therefore, all D-4 Options will be given a score of 6 for this criterion.

6.4.7 Public Health and Safety

Alternative D-2 will improve public health and safety by reducing breaks, freezing, and loss of water supply to the users on the mains being replaced as well as improve water quality and increase available fire flow for a much of the City by eliminating dead end water mains. Therefore this Alternative will be given a score of 9 for this criterion.

Alternative D-3 will improve public health and safety by increasing available fire flow to the City in the event that the west bench water tower is out of commission. Therefore, this alternative will be given a score of 8 for this criterion.

Alternatives D-4.A through D-4.D offer great improvement to public health and safety. The deteriorating water mains pose a risk for cross-contamination, freezing, breaks, and loss of water service to several water users. The improvements in each of Alternative D-4 options will greatly improve these public health and safety concerns for several users in the City. Therefore, all options in Alternative D-4 will be given a score of 7 for this criterion.

6.4.8 Land Acquisition

Alternate D-2 may require Land Acquisition for a utility easement to connect the water mains in Kainu Avenue. Therefore, this alternative will be given a score of 4 for this criterion.

Alternatives D-3 and all options in D-4 will likely not require land acquisition. Therefore, they will be given a score of 8 for this criterion.

6.5 Decision Matrix and Selection of Preferred Alternative

The scores and the weighted scores for each alternative were compiled to provide a comparison using a decision matrix as shown in Table 6.2

Table 6-2 Present Worth Life Cycle Analysis

Alternative	Life Cycle Cost		Operation and Maintenance		Permitting Issues		Social Impacts		Environmental Impacts		Sustainability		Public Health and Safety		Land Acquisition		TOTAL
	Weight:	10	Weight:	7	Weight:	4	Weight:	5	Weight:	5	Weight:	4	Weight:	7	Weight:	3	
	Score	Wtd.	Score	Wtd.	Score	Wtd.	Score	Wtd.	Score	Wtd.	Score	Wtd.	Score	Wtd.	Score	Wtd.	
P-1	10.0	100	5.0	35	5.0	20	8.0	40	5.0	25	2.0	8	1.0	7	8.0	24	**283**
P-4	1.4	14	8.0	56	5.0	20	5.0	25	4.0	20	8.0	32	7.0	49	8.0	24	**264**
P-5	0.0	0	3.0	21	5.0	20	1.0	5	3.0	15	5.0	20	7.0	49	2.0	6	**142**
D-2	1.2	12	7.0	49	3.0	12	5.0	25	5.0	25	8.0	32	9.0	63	4.0	12	**242**
D-3	3.2	32	6.0	42	5.0	20	5.0	25	5.0	25	9.0	36	8.0	56	8.0	24	**284**
D-4.A	6.1	61	7.0	49	5.0	20	7.0	35	5.0	25	6.0	24	7.0	49	8.0	24	**311**
D-4.B	5.7	57	7.0	49	5.0	20	7.0	35	5.0	25	6.0	24	7.0	49	8.0	24	**307**
D-4.C	8.8	88	7.0	49	5.0	20	9.0	45	5.0	25	6.0	24	7.0	49	8.0	24	**348**
D-4.D	7.0	70	7.0	49	5.0	20	8.0	40	5.0	25	6.0	24	7.0	49	8.0	24	**325**

It is important to note that the above scoring and weighting are subjective. Alternatives that score overall within 10 pts of each other may essentially hold the same degree of preference.