Executive Summary

Introduction

Mapleton City is situated on the east side of Utah Valley on a bench between Hobble Creek and Spanish Fork Canyons. The City currently encompasses 8,070.9 acres and is bounded by Springville City on the north, Maple Mountain on the east, Spanish Fork City on the south and the railroad tracks on the west. Approximately 490 acres of additional land are proposed to be annexed into Mapleton City. Since the area is not currently within the boundaries of Mapleton City, it has not been included in this master plan analysis. The present population of Mapleton is estimated at approximately 7,300. Ultimately, the population of the City is projected to reach 25,000-30,000.

Recent growth has placed a great strain on the Mapleton City culinary water system since many residences use culinary water for both their domestic and outdoor irrigation needs. The northwest portion of the city already has a functioning secondary water system. The City is considering the feasibility of expanding the existing secondary water system to supply non-potable water for outdoor sprinkling and irrigation use for the whole city as opposed to developing more wells, springs, treated water, and storage in their culinary system to accommodate both domestic and irrigation needs.

Master Plan Objectives

The objectives of the master plan are to:

1) evaluate the existing secondary water system
2) determine the secondary water system demand and required supply
3) determine the layout and sizing of the secondary water system components
4) determine capital and operations and maintenance costs associated with the secondary water system
5) make recommendations for phasing and implementation of the secondary water system

Evaluation of Existing System

The northwest portion of Mapleton City has an existing secondary water system that was constructed by Ensign-Bickford Company as mitigation for contamination of a portion of the City's culinary aquifer. The system is supplied by three groundwater wells. Water is pumped from the aquifer, treated and conveyed to the system through a large transmission pipeline in Main Street which ranges in size from 18 to 30 inches. Distribution pipes within the system are typically 6 inches. The system is not metered and residents in the service area pay a flat monthly fee when they are connected to the system. Residents are encouraged to water on alternating days. Unfortunately, pressure is often inadequate to properly operate pop-up sprinkling systems and complaints are common.

Future Secondary Demand and Supply

Demand was determined using State of Utah recommended values for outdoor irrigation of 3.96 gallons per minute per irrigated acre. Of the 8,070.9 acres in the city, 1,915.2 acres are on the steep eastern hillsides and will not be developed. An additional 895 acres on the east bench will not be serviced by the secondary water system. These are primarily areas that have not been serviced by Mapleton Irrigation Company and therefore have no water rights attached to the properties. The remaining acreage is considered to be 60% irrigable in the developed condition. The total 24-hour peak day demand for the portions of the city (when completely developed) to be served by the secondary water system is 12,500 gallons per minute.

Water for the secondary water system will be supplied from the three existing groundwater wells, the recently piped Mapleton-Springville canal, Maple Creek and Hobble Creek. In order to avoid spilling excess water from these sources back into Hobble Creek, a storage pond will be an integral part of the secondary water system concept. Existing water rights in Maple Creek and Hobble Creek can be used in the secondary water system by diverting flow from the Creeks into the proposed storage pond and pumping from the pond into the system. According to the Central Utah Water Conservancy District (CUWCD), the current Mapleton Irrigation allotment of water from the Mapleton-Springville canal is 45% of 50 cfs. If the City desires to supply the build-out demand from the wells and pressurized canal pipeline without using Maple Creek and Hobble Creek water, this allotment must be increased to 50%. This can be accomplished if trades are made with Springville to increase their usage of Hobble Creek water, allowing Mapleton more capacity in the pressurized canal pipeline.

Secondary Water Master Plan

Pipe sizing was determined by ensuring that all areas to be serviced had adequate pressure and that velocities in the pipes were reasonable (generally less than 5 feet per second). The overall Secondary Water Master Plan, including pipe sizes determined by the model, is shown on Figure ES-1. The key transmission pipes, which form the backbone of the secondary water system, are located in Main Street and Maple Street. These pipes range in size from 12 to 30 inches in diameter, and connect the system to the existing wells, the proposed storage pond and the Mapleton-Springville canal. Other 12- and 16-inch diameter pipes are strategically located in major streets to ensure adequate water delivery to all portions of the City. Remaining pipes are 8-inch diameter minimum in accordance with current City policy.

Providing secondary water to the entire area to be serviced will require a pumping station at the proposed storage pond in addition to the pressurized Mapleton-Springville canal and the three wells currently being used. This new station will be designed for a total capacity of 18,000 gallons per minute.

Existing or proposed home elevations in Mapleton City to be serviced by the secondary water system range from approximately 4668 feet to 4925 feet. The City has been divided into two pressure zones in order to provide reasonable pressures at all locations to be serviced within the City. Desired pressures are between 40 and 85 psi in each zone. A total of 10 pressure reducing valves (PRV) will be required in various locations throughout the City to control pressures adequately. There are a few limited areas where the system cannot provide the minimum 40 psi pressure desired. These areas will need to have outdoor water provided from the culinary

system, or will need to have booster pumps installed to lift pressures to adequately service these properties at the desired levels.

Since 1998, Mapleton City has required all developers to install dry pipe in their subdivisions that will ultimately be connected to the secondary water system when it becomes available in that area. It is important that this policy be continued so that the infrastructure within the newly developed subdivisions will be in place and the City will not have to bear the burden of these costs.

Storage Facilities

A secondary irrigation storage pond is necessary to allow the system to run efficiently and to prevent water waste. During periods of low usage, excess water will be stored in the pond and can then be used during high demand periods. System storage increases the reliability of the system by ensuring that sufficient water is on hand to meet peak demand conditions, and provides an economic benefit in evening out usage and subsequent costs of supply in a 24-hour period.

It is recommended that residential irrigation be restricted between the hours of 10:00 a.m. and 6:00 p.m. in order to conserve water. To avoid waste, the water in the canal and the water obtained from the wells, Maple Canyon, and Hobble Creek during this period of time must be stored in the pond. A total of 18.4 acre-feet of storage is needed for this purpose. It would also be prudent to maintain a base storage of a full day's usage of 55.2 acre-feet as a buffer in case of system emergencies. Hence, a minimum of 73.6 acre-feet of storage should be provided to meet these conditions.

Mapleton City has acquired a site for a proposed secondary water pond near 200 South and 1600 East. The site was formerly used by the Mapleton Irrigation Company as a pond to provide supplemental and peak use water during low flow periods. The maximum capacity of the pond is proposed to be 98.7 acre-feet, which is sufficient to provide the recommended minimum storage of 73.6 acre-feet.

Cost Estimate

A capital cost estimate has been prepared for implementation of the proposed secondary water system. The cost to design and construct the entire system is estimated to be $19,288,800. This estimate includes piping with shut off valves, pressure reducing valves, single and double lateral connections, water meters and boxes, untreated base gravel and asphalt replacement for pipe trenches, connections to the pressurized canal, and connections to existing pipes in the pressurized irrigation system. For purposes of funding flexibility, the costs to install water meters are listed separately in the construction cost estimates. The cost of the storage pond, including all piping, pumps, and other items to construct the pond, is also included. Costs for facilities in future streets that do not currently exist have not been included in the cost estimates, although these proposed lines have been shown on the Master Plan drawing. All prices are 2010 dollars.

An estimate of operation and maintenance costs has also been prepared and is included this master plan. Annual operation and maintenance costs for the completed build-out system are estimated to be $132,300.00. The maintenance for the existing secondary water system is performed by the same crews that maintain the culinary system. Maintenance of the secondary water system is largely seasonal and is primarily centered for several days or weeks around the time that the system will be charged, and when it will be drained. System maintenance is likely to increase over time as the system ages and more residents are connected to it. At the present time, additional personnel to maintain the secondary water system are not anticipated. When installed, reading of secondary water meters can be done at the same time as the culinary meters are read. The City billing system is already set up to handle the additional billing for secondary water.

Implementation/Phasing

Due to the large cost and scope of the proposed system, it is recommended that the system be constructed in phases. Three phases of approximately equal value are proposed as shown on Figure ES-2. Phasing was determined based on constructing the system in a sequence that would allow for optimal pressures and flows in the system at all stages of construction. Priority was given to areas of the City with higher populations over those with lower populations, in order to serve as many residents as early as possible. The first phase essentially completes the existing irrigation system in the northwest portion of the city, with the exception of installation of water meters; adds supporting infrastructure, including construction of pipes along Maple Street and construction of the storage pond; and includes construction of the system from Maple Street to 400 North, between Main Street and the Mapleton-Springville canal pipeline. The second phase completes the system east of Main Street, including piping, pressure reducing valves, connections to existing dry pipes in the area, and residential connections to the system. The third phase completes the system west of Main Street, including the same items as constructed in the second phase.

Through Section 207 of the Central Utah Project Completion Act, the U.S. Department of Interior provides funding to municipalities and other entities for water conservation projects. Locally, these funds are administered through the Central Utah Water Conservancy District. Mapleton City has been approved by the CUWCD and the Department of Interior for a $5,000,000 grant for Phase I of the Secondary Water system. The grant requires a 35% local match, which can be provided through cash to the project or in-kind constructed facilities. While future funding through the Section 207 program is not guaranteed, the City can apply for additional grants for subsequent phases of the project. However, each approved grant requires a dedication of 1,000 acre-feet of water to the CUWCD.

The State of Utah Division of Water Resources also approves low interest or no interest loans for water conservation projects. Mapleton City is on the waiting list for one of these loans at the present time. Further funding can be investigated through this and similar sources. The project phases presented previously can be modified as necessary to meet funding resources as they become available.

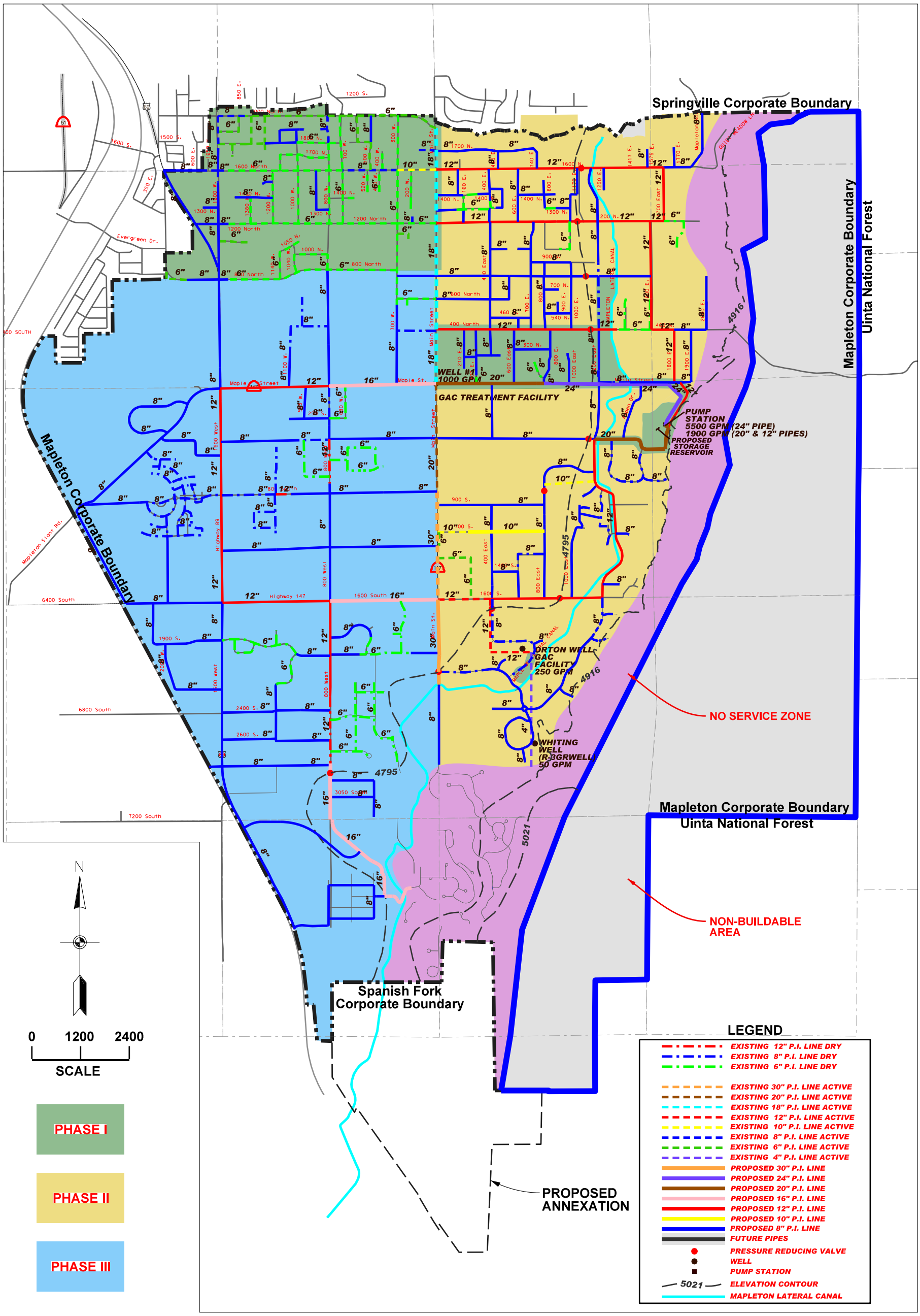

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Figure ES-2

Mapleton City Secondary Water System
Master Plan
Phasing Plan

System Operation

Irrigation Schedule

Mapleton City has pledged to reduce overall water usage 25% by the year 2050. One way to impact water conservation is to restrict irrigation during the hours of maximum evapotranspiration and wind drift. Evapotranspiration is the combination of loss of water by transpiration of the plant and evaporation from plants and soil surfaces. It is the highest during the heat of the day, typically between 10:00 a.m. and 4:00 p.m. This is when the plants are under the greatest stress from high temperatures, solar radiation and lower humidity. Plants respond better to irrigation during less stressful times. Furthermore, water applications from sprinklers are more susceptible to evaporation and wind drift during these times because wind speeds are typically higher. Irrigating during these hours requires a much higher application rate to achieve the same results[1]. Studies in semi-arid and arid regions have shown that water losses during daytime hours can range from 20% to 45% depending on humidity, wind speed and temperature.[2]

Based upon the above factors, it is evident that water can be conserved by restricting irrigation during the hotter portions of the day. Conservation practices will reduce the amount of water that must be supplied by the City and the corresponding costs of supplying that water. Therefore, it is recommended that consideration be given to restricting sprinkler irrigation from the secondary water system between the hours of 10:00 a.m. and 6:00 p.m.

Metering of Secondary Water

Construction of a secondary water system will effectively reduce the demands on the City culinary water system. However, experience has shown that implementation of a secondary water system actually increases overall water usage because users commonly pay a monthly fixed fee for unlimited water use. Since there is no mechanism to restrict water use to what is needed, water waste results. Metering water and billing for its use is an effective way to reduce usage and water waste among residents. A study by Colorado State University showed that unmetered, flat rate users expended approximately 39 percent more water than those who had their water metered.[3] In a study conducted by the Utah Division of Water Resources for Weber, Davis and Tooele Counties, it was determined that when water is unmetered, users generally use 47 percent more than necessary to irrigate their lawns.[4] While there are costs associated with metering, the benefits usually outweigh the costs in reducing the amount of water that the City must acquire and provide.

One challenge in metering secondary water is that conventional water meters do not function well because the metering mechanisms can clog with debris. Either extensive filtration of the water is required or a meter specifically designed for non-potable water must be used. These meters are typically more expensive than conventional culinary water meters. However, there are new meters on the market without moving parts that could prove to be effective in secondary systems. Indications are that these meters could be more cost effective.

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[1] W. Bryan Smith, Clemson University Extension, HGIC 1804 (2008)
[2] Bavi, et al, Journal of Applied Science (2009)
[3] Colorado State University (2003)
[4] Utah Division of Water Resources (2004)

Operation and Maintenance Issues

Since Mapleton City already has a secondary water system functioning in the northwest part of the City, the majority of operation and maintenance issues have already been experienced. However, note should be made of some of these important issues.

Most secondary water systems are drained each year when the irrigation season comes to an end. Draining the system will prevent damage due to freezing of pipes and other facilities. Draining of the storage pond will be required as a condition of receiving project funding from the Central Utah Water Conservancy District through the Federal Section 207 program. This will also permit inspection and completion of repairs or other needed annual maintenance. Laterals to each property should be sloped from the meter box to the main, so that the lateral will also drain when the main is drained.

Water meters can also be susceptible to the influence of frost and freezing. The water meter that is selected for use in the Mapleton City system must be of a type that will be resistant to damage from frost or freezing in the winter when not in use. Even though the system is drained, small amounts of water can remain in and damage the meter. A freeze plate on the meter can be a safeguard against damage from freezing.

Costs associated with reading meters can be reduced with the use of electronic radio meters that can be read without opening the meter box. Mapleton City currently uses this type of meter in the culinary water system. It will be important to have a similar meter in the secondary system.

A certain amount of maintenance will be necessary each spring as the system is charged for summer use. Filters and pumps will need to be maintained and the pond will need to be cleaned. As water is introduced into the pipes, the system must be checked for leaks, primarily in laterals that did not properly drain, and necessary repairs made.

Although most water used in the Mapleton secondary system will be of relatively good quality, it will still carry certain amounts of debris. This will be particularly true of water that may come from Maple Canyon, Hobble Creek or may be stored in the pond. In order to prevent fouling or damage to valves, meters and sprinkler heads, it will be necessary to filter the water. Filtering can be accomplished by every individual property owner through installation of an individual filter, or it can take place prior to the water entering the system. Since much of the water will be taken from the Mapleton-Springville canal in various locations, it will be difficult to filter it before it enters the system. A filter will be installed at the outlet to the storage pond prior to introducing that water in the system, but it may still be desirable for individual property owners to install filters before allowing the water into their sprinkler irrigation system. The main filter at the outlet to the pond will also reduce damage and clogging of the pumps from debris in the water.

Estimated Costs and Project Phasing

A capital cost estimate has been prepared for implementation of the proposed secondary water system. Estimated quantities of materials were computed from available mapping, using the assumptions for the various features as outlined in this report. The estimated costs include piping with shut off valves, pressure reducing valves, single and double lateral connections, water meters and boxes, surface restoration of pipe trenches, connections to the pressurized canal, and connections to existing pipes in the pressurized irrigation system. The cost of the storage pond, including all piping, pumps, and other items to construct the pond, is also included. Costs for facilities in future streets have not been included in the cost estimates, although these proposed lines have been shown on the Master Plan drawing for future reference. All prices are 2010 dollars. An estimate of operation and maintenance costs has also been prepared and is included.

In order to match project construction to potential funding, the overall project has been divided into three projects of approximately equal size. Phasing was determined based on constructing the system in a sequence that would allow for optimal pressures and flows in the system at all stages of construction. Priority was given to areas of the city with higher populations over those with lower populations, in order to serve as many residents as early as possible. Figure 10 shows the recommended phasing areas as discussed in the following sections.

Phase I – Existing System and Additional Supporting Infrastructure

This phase includes adding facilities (pipes and connections) to the existing system in the northwest section of Mapleton City (north of 800 North and between Main Street and Highway 89) where they do not now exist, construction of the storage pond and pump station, construction of pipes in Maple Street that will connect the storage pond to the existing mainline pipe in Main Street, and construction of the portion of the system between Maple Street and 400 North from Main Street east to the Mapleton-Springville Canal. Although they are large cost items, the storage pond and pipes in Maple Street will provide a backbone for the additions to the system that will follow in Phase II. As a result of the heavy infrastructure costs in Phase 1, water meters will not be included in this phase, but will be installed at a future time. Therefore, costs for water meters are shown separately. A cost estimate has been prepared for this project phase and is included in Table 7. The total construction cost to complete this work is estimated to be $6,450,500. An additional $665,000 will be required to install water meters in this portion of the City for a total phase cost of $7,115,500.

Phase II – Completion of System East of Main Street

With the Phase I improvements in place, the next recommended step will be to construct the remaining system to the east of Main Street. This area comprises the most heavily populated portion of Mapleton City. The work will include connections to the Canal at 1600 North, 1200 North, and 1600 South as well as all piping, pressure reducing valves, connections to existing dry pipes in the area, and residential connections to the system in this portion of the City. Water meters and boxes are once again listed separately. The cost to construct this portion of the system is estimated to be $5,671,900. Water meters in this area will cost an additional $935,000.00 for a total cost of $6,606,900. A detailed cost breakdown is presented in Table 8.

Phase III – Completion of System West of Main Street and South of 800 North

The final project phase will include construction of all remaining portions of the system. This will primarily involve the City areas south of 800 North and west of Main Street, as well as all areas west of Highway 89. Table 9 presents the costs associated with construction of these capital improvements. The total estimated construction cost for this phase is $4,966,400. The cost to install water meters in this section of the City will require an additional $600,000 resulting in a total phase cost of $5,566,400. A connection will be made to the Canal on Main Street at approximately 2200 South. Other facilities will include piping, pressure reducing valves as needed in the southern portions of the City and connections to existing dry pipes.

Operation and Maintenance Costs

An estimate of operation and maintenance costs for the overall system is included in Table 10. Maintenance for the existing secondary water system is performed by the same crews that do the maintenance on the culinary system. The secondary water maintenance is largely seasonal and is primarily centered for several days or weeks around the time that the system will be charged, and when it will be drained. At this time additional personnel to maintain the secondary water system are not anticipated. Reading of secondary water meters can be done at the same time as the culinary meters are read. The City billing system is already set up to handle the additional billing for the secondary water.

Operation and maintenance costs were estimated using the capital construction costs. The following factors were applied:

Pipelines and Appurtenances	0.5 percent of construction costs
Storage Pond	1.0 percent of construction costs
Pump Station (Structure)	1.0 percent of construction costs
(Mechanical/Electrical)	3.0 percent of construction costs
Water metered connections	2.0 percent of construction costs

Applying the specified percentages yields an annual operation and maintenance cost of $132,300.00 to support the secondary water system.

Additional System Construction

As identified in the overall Master Plan, pipes are included in streets which do not currently exist, but are shown on the Master Transportation Plan for Mapleton City. These pipes are included in the Secondary Water master plan to give guidance as these areas are eventually developed, but the costs of construction are not included in the cost estimates for the various phases as presented above.

Since 1998, Mapleton City has required all developers to install dry pipe in their subdivisions that will ultimately be connected to the secondary water system when it becomes available in that area. It is important that this policy be continued so that the infrastructure within the newly developed subdivisions will be in place and the City will not have to bear the burden of these costs. While areas that have been approved by the City for development, such as Mapleton Village, have been included in the analysis of the secondary water system, costs for construction of these improvements will be the responsibility of the developer and, hence, have not been included in the phase costs previously presented.

Total Construction Cost and Funding Options

The total construction cost to implement the secondary water master plan, including installation of water meters is summarized as follows:

Phase I Construction Cost	$ 7,115,500.00
Phase II Construction Cost	6,606,900.00
Phase III Construction Cost	5,566,400.00
Total Project Construction Cost	**$ 19,288,800.00**

The value of facilities already in place that can be used as match for grants is as follows:

Phase I Facilities in Place	$ 372,000.00
Value of Property for Storage Pond	1,800,000.00
Phase II Facilities in Place	585,000.00
Phase III Facilities in Place	1,512,000.00
Total Value of Facilities in Place	**$ 4,269,000.00**

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The State of Utah Division of Water Resources also approves low interest or no interest loans for water conservation projects. Mapleton City is on the waiting list for one of these loans at the present time. Further funding can be investigated through this and similar sources. The project phases presented previously can be modified as necessary to meet funding resources as they become available.