WEST JORDAN CITY

DRINKING WATER SYSTEM MASTER PLAN UPDATE

(HAL PROJECT NO.: 089.21.100)

FINAL DRAFT

JUNE 2015

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ENGINEERS

WEST JORDAN CITY

DRINKING WATER SYSTEM MASTER PLAN

(HAL Project No.: 089.21.100)

Project Engineer

June 2015

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GLOSSARY OF TECHNICAL TERMS

Average Daily Flow: The average yearly demand volume expressed in a flow rate.

Average Yearly Demand: The volume of water used during an entire year.

Build-out: When the development density reaches maximum allowed by planned development.

Demand: Required water flow rate or volume.

Distribution System: The network of pipes, valves and appurtenances contained within a water system.

Drinking Water: Water of sufficient quality for human consumption. Also referred to as Culinary or Potable water.

Dynamic Pressure: The pressure exerted by water within the pipelines and other water system appurtenances when water is flowing through the system.

Equivalent Residential Connection: A measure used in comparing water demand from non-residential connections to residential connections.

Fire Flow Requirements: The rate of water delivery required to extinguish a particular fire. Usually it is given in rate of flow (gallons per minute) for a specific period of time (hours).

Head: A measure of the pressure in a distribution system that is exerted by the water. Head represents the height of the free water surface (or pressure reduction valve setting) above any point in the hydraulic system.

Headloss: The amount of pressure lost in a distribution system under dynamic conditions due to the wall roughness and other physical characteristics of pipes in the system.

Peak Day: The day(s) of the year in which a maximum amount of water is used in a 24-hour period.

Peak Day Demand: The average daily flow required to meet the needs imposed on a water system during the peak day(s) of the year.

Peak Instantaneous Demand: The flow required to meet the needs imposed on a water system during maximum flow on a peak day.

Pressure Reducing Valve (PRV): A valve used to reduce excessive pressure in a water distribution system.

Pressure Zone: The area within a distribution system in which water pressure is maintained within specified limits.

Service Area: Typically the area within the boundaries of the entity or entities that participate in the ownership, planning, design, construction, operation and maintenance of a water system.

Static Pressure: The pressure exerted by water within the pipelines and other water system appurtenances when water is not flowing through the system, i.e., during periods of little or no water use.

Storage Reservoir: A facility used to store, contain and protect drinking water until it is needed by the customers of a water system. Also referred to as a Storage Tank.

Transmission Pipeline: A pipeline that transfers water from a source to a reservoir or from a reservoir to a distribution system.

Water Conservation: Planned management of water to prevent waste.

ABBREVIATIONS

ac-ft	acre-feet
DDW	The State of Utah Division of Drinking Water
ERC	Equivalent Residential Connection
GIS	Geographic Information System
gpd	Gallons per Day
gpd/conn	Gallons per Day per Connection
gpm	Gallons per Minute
HAL	Hansen, Allen & Luce, Inc.
JVWCD	Jordan Valley Water Conservancy District
MG	Million Gallons
PRV	Pressure Reducing Valve
psi	Pounds per Square Inch
SCADA	Supervisory Control And Data Acquisition

CHAPTER 1

INTRODUCTION

PURPOSE

The purpose of this master plan is to provide specific direction to West Jordan City for decisions that will be made over the next 5 to 40 years in order to help the City provide adequate water to customers at the most reasonable cost. Recommendations are based on City drinking water demand data and standards established by the Utah Division of Drinking Water (DDW).

SCOPE

The scope of this master plan includes a study of the City's drinking water system and customer water use including: build-out growth projections, source requirements, water rights, storage requirements, distribution system requirements and water quality. From this study of the water system, an implementation plan with recommended improvements has been prepared. The implementation plan includes conceptual-level cost estimates for the recommended improvements.

The conclusions and recommendations of this study are limited by the accuracy of the development projections and other assumptions used in preparing the study. It is expected that the City will review and update this master plan about every 5 years.

BACKGROUND

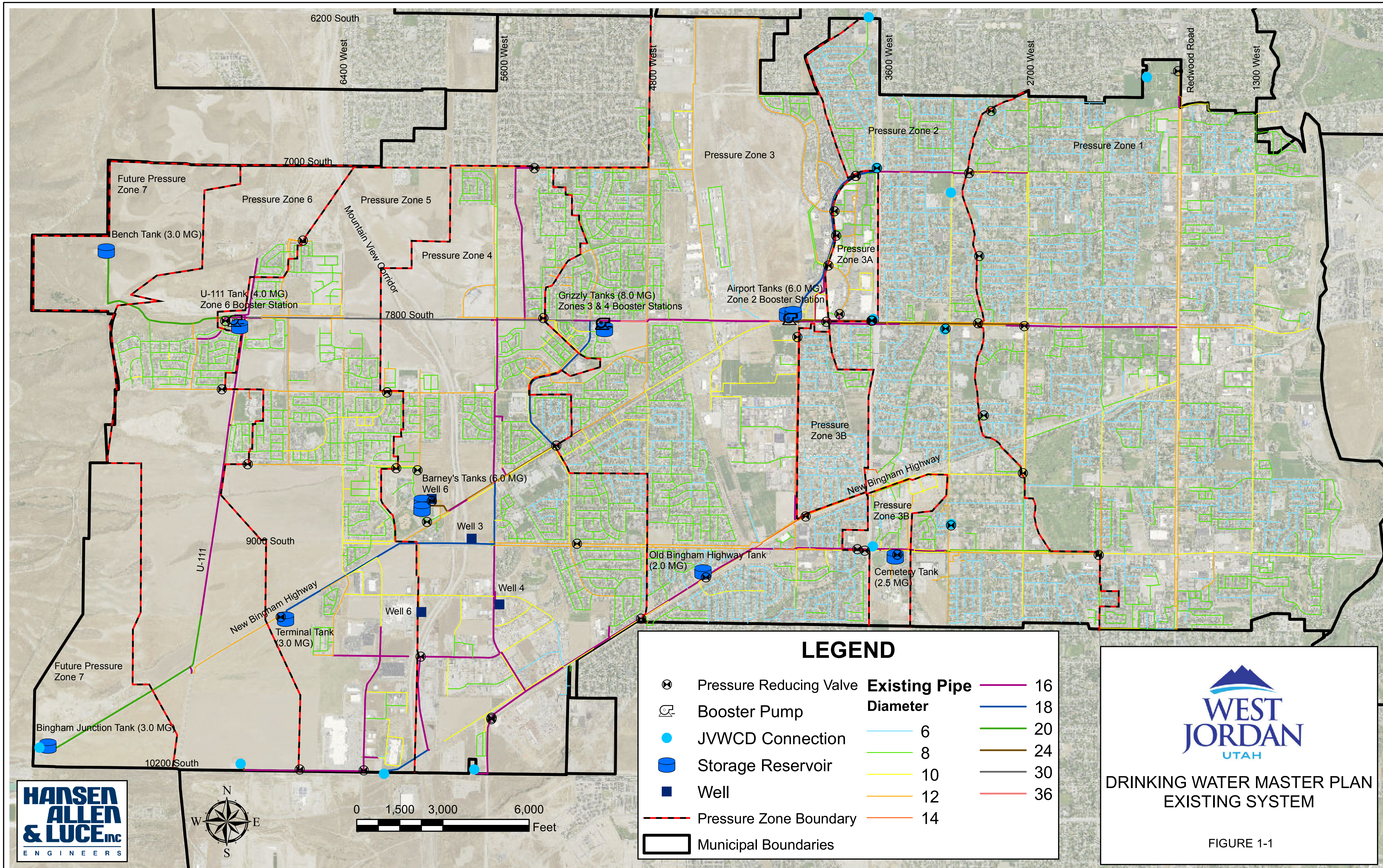
West Jordan City is located in Salt Lake County, Utah and is bounded on the north by West Valley City and Taylorsville City and on the south by South Jordan City. West Jordan is bounded on the east by the Jordan River and stretches westward to the foothills of the Oquirrh Mountains. The general slope of the land in West Jordan is towards the Jordan River on the east side of the City. As of the 2010 census West Jordan was the fourth largest city in Utah with a population of 103,712. The eastern two-thirds of the City is mostly developed, with only scattered pockets of undeveloped land. The western third of the City is largely undeveloped and is the location where most of the future growth will occur.

Figure I-1 illustrates the extent of the West Jordan water system. As shown, the distribution network is divided into six pressure zones with the lowest zone along the east edge of the city and the uppermost zone serving the west side of the City.

WATER SYSTEM MASTER PLANNING APPROACH

The West Jordan water distribution network is made up of a variety of components including pumps, storage facilities, valves, and pipes. The City water system must be capable of responding to daily and seasonal variations in demand while concurrently providing adequate capacity for firefighting and other emergency needs. In order to meet these goals, each of the distribution system components must be designed and operated properly. Furthermore, careful planning is required in order to ensure that the distribution system is capable of meeting the City's needs over the next several decades.

Both present and future needs were evaluated in this master plan. Present water needs were calculated according to Utah Division of Drinking Water (DDW) requirements and compared



DRINKING WATER MASTER PLAN
EXISTING SYSTEM

FIGURE 1-1

with actual water use records obtained from billing records and production data. Future water use projections were calculated by analyzing the existing demands for the various types of land uses present in West Jordan. After determining the unit demand associated with an existing type of land use, the unit demand was applied to undeveloped areas based on the City's future land map (Figure I-2).

In order to facilitate the analysis of the West Jordan water system, a computer model of the system was prepared and analyzed in two parts. First, the performance of existing facilities with present water demands was analyzed. Next, projected future demands were input to the model and the analysis was repeated. Recommendations for system improvements were prepared based on the results of these analyses. In general, this report is organized to follow the outline of the DDW requirements found in section R309-510 of the Utah Administrative Code entitled "Minimum Sizing Requirements", as in effect May 1, 2015.

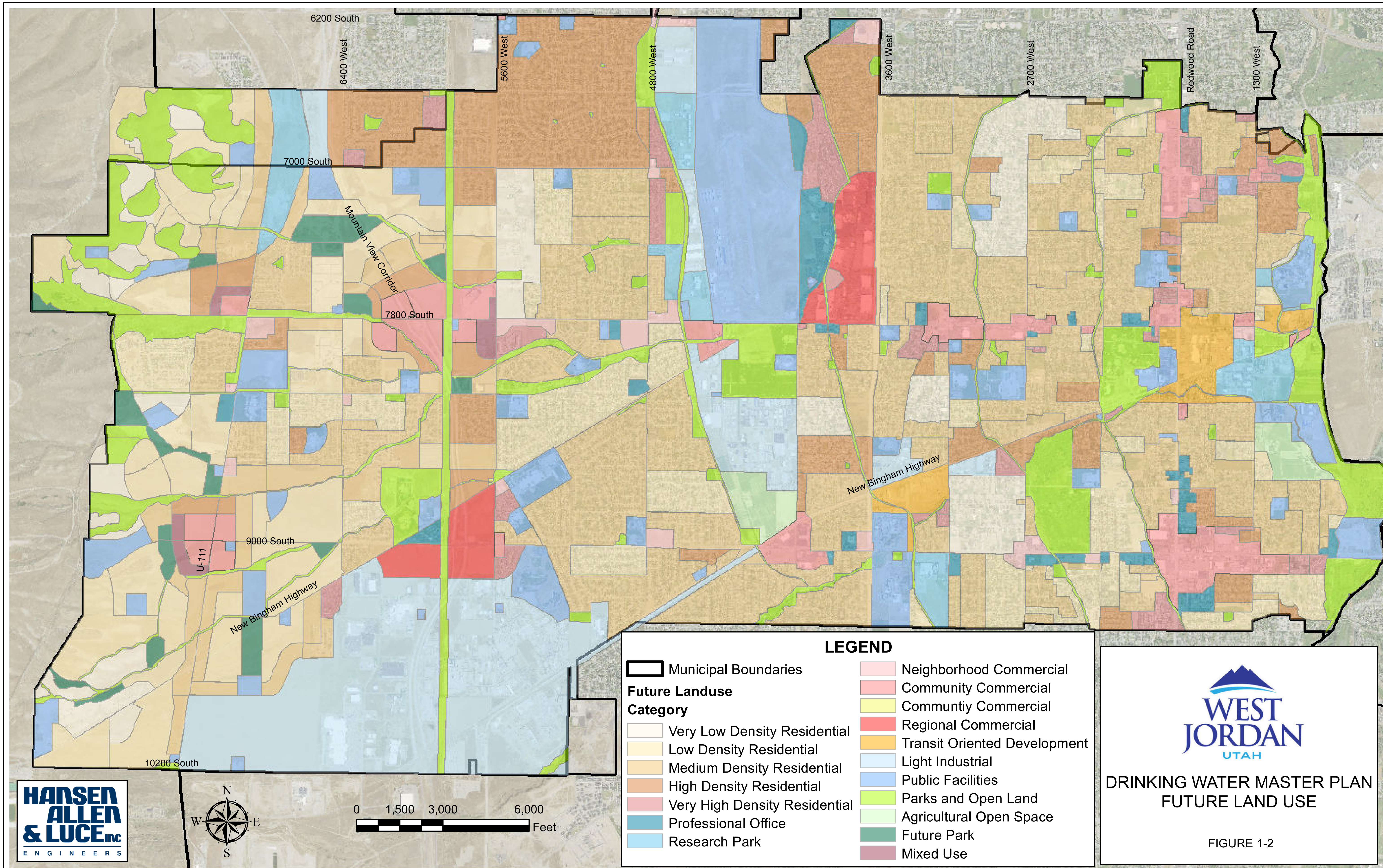
KEY SYSTEM DESIGN CRITERIA AND PERFORMANCE FINDINGS

Summaries of the key water system design criteria and performance findings for the West Jordan drinking water system are included in Table 1-1. The design criteria were used in evaluating system performance and in recommending future water system improvements.

TABLE 1-1
KEY SYSTEM DESIGN CRITERIA

	CRITERIA	2014 EXISTING REQUIREMENTS	ESTIMATED BUILD-OUT REQUIREMENTS
EQUIVALENT RESIDENTIAL CONNECTIONS	Calculated	37,993	62,084
SOURCE			
Peak Day Demand	1,635 gpd/ERC	43,136 gpm	70,489 gpm
Average Yearly Demand	0.7221 acre-ft/ERC	27,433 acre-ft	44,828 acre-ft
STORAGE			
Equalization	817 gallons/ERC	31.2 MG	50.7 MG
Fire Suppression	Total fire flow volume	6.2 MG	7.4 MG
Operational	¼ day pumped volume	11.1 MG	15.1 MG
Total		48.5 MG	73.2 MG
DISTRIBUTION			
Peak Instantaneous	1.5258 x Peak Day Demand	65,818 gpm	107,551 gpm
Minimum Fire Flow	@ 20 psi	1,000 gpm	1,000 gpm
Max Operating Pressure	City Preference	130 psi	130 psi
Min. Operating Pressure	City Preference	50 psi	50 psi

Table 1-2 presents the design flows analyzed for the distribution system modeling.


6200 South
6400 West
5600 West
4800 West
3600 West
2700 West
Redwood Road
1300 West
7000 South
Mountain View Corridor
7800 South
9000 South
U-111
New Bingham Highway
New Bingham Highway
10200 South
LEGEND
Municipal Boundaries
Future Landuse
Category
Very Low Density Residential
Low Density Residential
Medium Density Residential
High Density Residential
Very High Density Residential
Professional Office
Research Park
Neighborhood Commercial
Community Commercial
Communtiy Commercial
Regional Commercial
Transit Oriented Development
Light Industrial
Public Facilities
Parks and Open Land
Agricultural Open Space
Future Park
Mixed Use
N
S
E
W
0 1,500 3,000 6,000
Feet
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DRINKING WATER MASTER PLAN
FUTURE LAND USE
FIGURE 1-2

TABLE 1-2
DESIGN FLOW SUMMARY

DEMAND	DEMAND PER ERC (gpm/ERC)	TOTAL EXISTING DEMAND (gpm)	TOTAL BUILD-OUT DEMAND (gpm)	FLOW RATIO
Average Day	0.4475	17,003	27,784	ADD/ADD = 1.00
Peak Day	1.1354	43,136	70,489	PDD/ADD = 2.53
Peak Instantaneous	1.7324	65,818	107,551	PID/ADD = 3.87

CHAPTER 2

CONNECTIONS

EXISTING CONNECTIONS

According to 2013 connection information reported to the Division of Water Resources, the West Jordan distribution network includes 22,487 connections. Of that total, 20,651 are residential connections while 1,836 connections are nonresidential. An Equivalent Residential Connection (ERC) is a measure used in comparing water demand from non-residential connections to residential connections. The number of ERCs served by the West Jordan drinking water system was calculated in accordance with guidelines provided by R309-110. By definition, each residential connection represents 1 ERC. The average demand per ERC was determined by dividing the total annual residential demand by the total number of residential connections. Using flow data available from the Utah Division of Water Rights, the annual volume of water used by residential customers in 2013 was 11,461 acre-feet. Converting the annual volume to an average flow and dividing by the number of residential connections gives an average demand of 0.344 gpm/ERC (495 gpd/ERC). In order to express non-residential demands in terms of ERCs, each non-residential demand was divided by the average demand per residential connection. The total number of ERCs computed for the West Jordan system was 37,993. The raw data associated with the ERC calculations are included in Appendix A. A per zone breakdown of the ERC distribution is shown in Table 2-1.

TABLE 2-1
EXISTING ERCS

ZONE	ERCs
1	11,090
2	6,927
3	9,200
3a	437
3b	984
4	4,855
5	3,529
6	971
TOTAL	**37,993**

Actual usage was considered in formulating a design flow for modeling the West Jordan drinking water system. Indoor and outdoor demands were determined by reviewing the City's billing data from January 2014 and July 2013. The average demand for January 2014 was 5,885 gpm. Converting the average flow to a daily volume and dividing by the total number of ERCs gives a January demand of 223 gpd/ERC. Similarly, the average demand for July 2014 was 27,914 gpm. Converting the July demand to a daily volume and dividing by the total ERCs gives a July demand of 1,058 gpd/ERC. Since there is no outdoor usage in January, the January demand was used to determine the City's indoor demand. Moreover, it was assumed that the indoor demand would be relatively unchanged between January and July. Based on this assumption the City's outdoor demand was calculated by subtracting the January demand from the July demand. Using this approach, total outdoor demand was calculated to be 22,029 gpm, or 835 gpd/ERC.

The calculated value of outdoor demand was compared against the minimum source guidelines for outdoor demands as defined by R309-510-7 of the Utah Administrative Code. West Jordan is located in zone 4 of the map "Irrigated Crop Consumptive Use Zones and Normal Annual Effective Precipitation". As a result, the peak day demand for irrigation is specified as 3.96 gpm/irrigated acre. To facilitate the comparison with State Standards, the outdoor demand of 835 gpd/ERC was converted to 0.580 gpm/ERC. Dividing 0.580 gpm/ERC by 3.96 gpm/irrigated acre gives a value of 0.1465 irrigated acres per ERC. This was judged to be a reasonable value for West Jordan City where residential lot sizes are commonly about 0.25 acres. Therefore, the flow data indicate that outdoor water usage in West Jordan is about the same as the outdoor usage requirement defined by State Standards.

The overriding objective in defining a design flow for modeling was to develop a demand that is representative of the actual conditions of a peak day demand event. The design flow should have a reasonable degree of conservatism; however, excessively conservative demands can lead to over-sizing facilities and pipelines. In order to incorporate conservatism in the design flow, the indoor demand was assumed to be 400 gpd/ERC, which results in a total indoor demand of 10,554 gpm. The outdoor demands were not augmented, but were left as 835 gpd/ERC so that the total demand for the design flow is 1,235 gpd/ERC. Based on this unit demand, the total of the indoor and outdoor demands was 32,583 gpm. Two sets of data were available for comparison against the design flow. The first was monthly billing data. As noted previously the July 2014 demand was 27,914 gpm. The design flow represents an increase of 4,669 gpm over the July 2013 flow or about17%. In addition to the monthly data, the City also provided production data for the peak day in July 2014. On that day the flow reached 28,896 gpm. Compared to the peak day flow the design flow is 3,687 gpm higher, an increase of about 13%.

This design flow rate indicated in the preceding paragraph is not intended to take the place of the peak day flow of 43,136 gpm as shown in Table 1-1. The peak day source requirement is defined by State Standards and was calculated in accordance with R309-510-7. The required source capacity and fire flow capacity were evaluated based on the peak day flow as outlined by State Standards. The peak day flow is very conservative, almost 50% higher than the actual observed flows. In evaluating other aspects of general system performance, it can be useful to apply a more realistic flow scenario. For example, representative demands are necessary in order to obtain meaningful results when modeling system efficiency and water quality. The per ERC demand associated with the design flow rate (0.858 gpm/ERC) was also used to evaluate the number of build-out ERCs.

CONNECTIONS PROJECTED AT BUILD-OUT

The number of build-out ERCs was determined by starting with the existing ERCs and adding to that number the incremental amount of ERCs associated with future demands. The first step employed in calculating future ERCs was to consider the existing water use for the various types of land uses present within West Jordan. Existing water use values were calculated using the City's future land use map and water billing data. The billing data were distributed within GIS and then the demands associated with the various land use types were analyzed. Table 2-2 presents the observed peak day unit demands by land use type.

Also, for reference, the planned density for each of the residential land uses is shown in Table 2-3. Based on the demands shown in Table 2-2 along with the City's future land use map, future demands, in gpm, were calculated for the currently undeveloped portions of West Jordan. The incremental demand associated with future development was 20,660 gpm. After determining the demands associated with the undeveloped areas, ERCs were calculated by dividing the future demand by 0.858 gpm/ERC (1,235 gpd/ERC). Therefore 24,091 ERCs were added to represent future demands.

TABLE 2-2
FUTURE LAND USE UNIT DEMANDS

Land Use Type	Peak Day Unit Demand (gpm/ac)	Peak Day Unit Demand (gpd/ac)
Very Low Density Residential	1.04	1,500
Low Density Residential	4.05	5,831
Medium Density Residential	3.48	5,012
High Density Residential	3.88	5,582
Research Park	2.92	4,208
Neighborhood Commercial	2.99	4,310
Community Commercial	2.99	4,310
Light Industrial	1.49	2,140
Public Facilities	1.38	1,981
Parks and Open Lands	2.98	4,291
Mixed Use	3.61	5,204

TABLE 2-3
RESIDENTIAL DENSITIES

Density Designation	Current Density Range (dwelling units per acre)
Very Low Density	Up to 2.0
Low Density	1 to 3
Medium Density	3.1 to 5.0
High Density	5.1 to 10
Very High Density	10.1 and up

A per zone breakdown of the build-out ERC distribution is shown in Table 2-4. A comparison between Table 2-1 and Table 2-4 further confirms that the majority of the new growth will be in western portion of the City.

As an additional check, the growth in ERCs was compared against the overall population growth for the City. The current population for West Jordan is estimated to be about 108,000. Using the 2012 Baseline City Population Projections developed by the Utah Governor's Office of Planning & Budget (GOPB 2013), the population of West Jordan City is projected to increase to 180,050 in 2060, an increase of about 67%. The ERC projections are intended to cover the same time frame and increase from 37,993 to 62,048, a gain of about 63%. Therefore, the ERC projections align well with the population projections.

TABLE 2-4
BUILD-OUT ERCS

ZONE	ERC
1	12,636
2	7,254
3	11,007
3a	499
3b	1,706
4	8,843
5	9,817
6	7,180
7	3,142
TOTAL	**62,084**

CHAPTER 3

SOURCES

EXISTING SOURCES

West Jordan currently uses four city-owned wells which provide water to the City's drinking water system. A summary of the wells is provided in Table 3-1.

TABLE 3-1
SUMMARY OF WEST JORDAN WELLS

NAME	ZONE	CAPACITY (gpm)
Well 3	Zone 4	600
Well 4	Zone 4	1,800
Well 5	Zone 3	1,400
Well 6	Zone 4	2,000

Based on these values, the drinking water wells have a total capacity of 5,800 gpm. In addition to the wells, the City maintains connections with Jordan Valley Water Conservancy District (JVWCD) as listed in Table 3-2.

TABLE 3-2
SUMMARY OF JVWCD CONNECTIONS BY ZONE

ZONE	CONNECTION	MAX CAPACITY[1] (gpm)	MAX DAY CONTRACT[2] (gpm)	ANNUAL CONTRACT[3] (acre-feet)
1	6400 S Redwood Rd	1,900	659	13,400
1	7000 S Bangerter Hwy	1,900	1,000	
1	7800 S Bangerter Hwy	11,000	8,000	
1	9000 S Bangerter Hwy	3,200	1,500	
2	Dixie, 3655 West 6500 South	500	400	
2	7100 S 3200 W	1,300	500	
2	7800 S 3200 W	3,300	500	
2	8800 S 3200 W	2,400	600	
3	10200 S 5600 W	3,500	1,500	
4	Deadmans, 6100 West 10200 South	4,600	2,000	
5	6950 West 10200 South	2,100	500	
6	Junction, 8400 West New Bingham Hwy.	2,350	800	

1. Max Capacity is the upper flow rate observed during the period from Jun 30, 2014 to July 6, 2014.
2. Max Day Contract is the maximum daily flow rate specified in the 2011 JVWCD contract and is the maximum average flow rate specified for the connection.
3. Annual Contract is the minimum amount of water the West Jordan has contracted to purchase.

Summing the individual "Max Day Contract" values gives the JVWCD connections a total capacity of 17,959 gpm. However, an additional provision within the JVWCD contract provides a supplementary allocation of water to West Jordan. The provision allows West Jordan to use up to 1,032 gpm of additional water from JVWCD's Zone A connections. All of West Jordan's connections in Zone 1 receive JVWCD Zone A water. Thus the total contract flow available from JVWCD is 18,991 gpm and the total flow available from all sources is 24,791 gpm.

During the Master Plan study, production data for each of the JVWCD meters was provided to HAL for the period from June 30, 2014 to July 6, 2014. The highest values observed during that period were entered into the column with the heading "Max Capacity". Summing the values of "Max Capacity" gives a total of 36,750 gpm. Although the JVWCD contract provides lower flow limits than the observed flows, historically, it has not been a problem for an entity to exceed the maximum daily flow limitations imposed by their contract with JVWCD. However, it should be recognized that problems could arise in the event that JVWCD encountered difficulties in fulfilling their obligations to their customers. Because the "Max Capacity" values reflect what the City has actually been using, these values are used for the remainder of the analysis.

PUMP STATIONS

West Jordan has four pump stations. The West Jordan pump stations are summarized in Table 3-3.

TABLE 3-3
WEST JORDAN PUMP STATIONS

NAME	FROM ZONE	PUMPS	RATED CAPACITY (gpm)
Zone 2 (Airport)	Zone 1	1 x 3000 gpm 3 x 5000 gpm	13,000
Zone 3 (Grizzly)	Zone 2	3 x 2400 gpm	4,800
Zone 4 (Grizzly)	Zone 2	2 x 2500 gpm 2 x 3500 gpm	8,500
Zone 6 (U-111)	Zone 4	1 x 1400 gpm 2 x 3000 gpm	4,400

The pump stations are located in the northern portion of the City and provide a way to move source water up 7800 South to higher pressure zones in that area of the City. The City has JVWCD connections at the higher pressure zones along 10200 South, but no JVWCD connections exist at the upper pressure zones in the northern half of the City.

EXISTING SOURCE REQUIREMENTS

DDW standards require that distribution network water sources must be able to meet the expected water demand for two conditions: peak day demand and average yearly demand. Each of these criteria will be addressed in the following paragraphs. The analysis of the Peak Instantaneous demand has been included within Chapter 5 of this report.

Existing Peak Day Demand

Peak day demand is the water demand on the day of the year with the highest water use and is used to determine the required source capacity under existing and build-out conditions. According to Utah State drinking water standards, the requirement for indoor use is 800 gpd/ERC while the outdoor use requirement is 835 gpd/ERC (based on 0.1465 irrigated acres/ERC). Based on 37,993 ERCs under existing conditions, the total peak day demand source requirement is **43,136 gpm** (1,635 gpd/ERC). A per zone breakdown of the existing source requirements is shown in Table 3-4. "Existing Source Capacity" is the total of the drinking water sources which supply water to the pressure zone. "PRV Flows" summarizes the flow in and out of each zone through PRVs. "In" and "Out" are the flows through the PRVs and "From" and "To" are the origination and destination zones of the flow. Similarly, "Pumped Flows" summarizes the flow in and out of each zone through pump stations. "Remaining Capacity" is the summation of all of the flows into the zone minus all of the flows out of the zone. As a final note, although 715 gpm of "Remaining Capacity" is displayed in Zone 6 with none elsewhere, each of the pressure zones could actually make use of the capacity depending on the settings of PRVs and booster pump stations.

Existing Average Yearly Demand

Water utilities must also be able to supply the average yearly demand. Average yearly demand is the average volume of water used during the course of one year. State Standards require an annual volume of 146,000 gallons per ERC (0.4481 acre-ft/ERC) for indoor use. West Jordan is located in zone 4 of the map "Irrigated Crop Consumptive Use Zones and Normal Annual Effective Precipitation" and therefore has an outdoor use requirement of 1.87 acre-feet per irrigated acre. Based on 37,993 ERCs and 0.1465 irrigated acres per ERC, the average yearly demand requirement for the West Jordan distribution system is **27,433** ac-ft.

BUILD-OUT SOURCE REQUIREMENTS

Water demand is expected to increase as development within the City continues. As with existing water use, future water source needs were evaluated on the basis of peak day demand and average yearly demand. Build-out requirements were calculated in a similar manner as the existing requirements. Each requirement is addressed separately in the following paragraphs.

Build-Out Peak Day Demand

The projected total peak day demand at build-out is **70,489 gpm** (1,635 gpd/ERC x 62,084 ERCs). At build-out, only Zone 1 is projected to have excess source capacity based on existing sources. However, excess capacity from Zone 1 can be pumped to higher Zones. Still, the excess capacity is only enough to fully meet the needs of Zone 2. In all, the projected shortfall in source capacity is 26,639 gpm. Table 3-5 provides a summary of the build-out source requirements for West Jordan City with each column heading as previously defined for Table 3-5.

Build-Out Average Yearly Demand

Assuming an average annual indoor use of 0.4481 acre-ft/ERC, 1.87 acre-ft per irrigated acre for outdoor use, 0.1465 irrigated acres per ERC, and 62,048 ERCs; the projected average yearly demand at build-out is **44,828 ac-ft**. The increase in average yearly demand between existing and build-out conditions is projected to be 17,395 ac-ft. The increased demand will be supplied by increases in the well capacity of City owned sources and by increasing the demands from JVWCD.

TABLE 3-4
EXISTING SOURCE REQUIREMENTS

Zone	ERCs	Zone Demand (gpm)	Existing Source Capacity (gpm)	PRV Flows				Pumped Flows				Remaining Capacity (gpm)
				In (gpm)	From	Out (gpm)	To	In (gpm)	From	Out (gpm)	To	
1	11,090	12,591	18,000	0	NA	0	NA	0	NA	5,409	2	0
2	6,927	7,865	7,500	0	NA	0	NA	5,409	1	5,044 0	3 4	0
3a	437	496	0	496	3	0	NA	0	NA	0	NA	0
3b	984	1,117	0	1,117	3	0	NA	0	NA	0	NA	0
3	9,200	10,445	4,900	2114	4	496 1,117	3a 3b	5,044	2	0	NA	0
4	4855	5,512	9,000	850	5	2,114	3	0	2	2,224	6	0
5	3,529	4,007	2,100	2,757	6	850	4	0	NA	0	NA	0
6	971	1,102	2,350	0	NA	2,757	5	2,224	4	0	NA	715
Sum	37,993	43,136	43,850	7,334	-	7,334	-	12,677	-	12,677	-	715

TABLE 3-5
BUILD-OUT SOURCE REQUIREMENTS

Zone	ERCs	Zone Demand (gpm)	Proposed Source Capacity (gpm)	PRV Flows				Pumped Flows				Remaining Capacity (gpm)
				In (gpm)	From	Out (gpm)	To	In (gpm)	From	Out (gpm)	To	
1	12,636	14,347	27,347	0	NA	0	NA	0	NA	13000	2	0
2	7,254	8,236	8,536	0	NA	0	NA	13,000	1	4,800 8,500	3 4	0
3a	499	567	0	567	4	0	NA	0	NA	0	NA	0
3b	1,706	1,937	0	1,937	4	0	NA	0	NA	0	NA	0
3	11,007	12,497	10,201	0	NA	567 1,937	3a 3b	4,800	2	0	NA	0
4	8,843	10,040	16,490	0	NA	0	NA	8,500	2	4,400 10,550	6 5	0
5	9,817	11,146	0	596	6	0	NA	10,550	4	0	NA	0
6	7,180	8,152	7,915	0	NA	596	5	4,400	4	3,567	7	0
7	3,142	3,567	0	0	NA	0	NA	3,567	6	0	NA	0
Sum	62,084	70,489	70,489	3,100	-	3,100	-	44,817	-	44,817	-	0

SOURCE REDUNDANCY

In addition to meeting the peak day and annual source requirements, it is also recommended that redundancy be incorporated into the drinking water system. The distribution system should have adequate capacity to meet all of the demand objectives with a major source unavailable. Based on the reviewed flow data, the largest source in the West Jordan system is the 7800 S JVWCD connection, with an observed flow of 8,000 gpm. Although that connection provides more flow than the existing remaining capacity, it is still believed that West Jordan has sufficient source redundancy under existing conditions. As the City continues to develop, improvements to the JVWCD connections should be considered so that no single connection is indispensable.

SOURCE RECOMMENDATIONS

As West Jordan City continues to grow, the peak day demand and yearly demand requirements are projected to increase. Under build-out conditions the projected shortfall in peak day source capacity is 26,639 gpm. During the preparation of this master plan, the City has indicated that they plan to increase the number of drinking water wells from four to eight. The assumed locations for the new wells are as follows:

- U-111 Tank Site at 6960 West 7800 South
- Terminal Tank Site at 6600 West Old Bingham Highway
- Ron Wood Park at 6000 West New Bingham Highway
- Barney's Wash area in Zone 5 at about 7400 West 8600 South

These are preliminary locations, but have been included for convenience in the master planning process. Based on the existing West Jordan owned wells, it is believed that the flow from the new wells will average about 1,500 gpm. Accordingly, the total contribution from the new wells would be 6000 gpm. Even with this increase in well capacity, the remaining shortfall would be about 20,600 gpm and would need to be met by increasing the City's flows from JVWCD.

The JVWCD connections in the lower pressure zones should be the first priority for increasing wholesale capacity. In particular, the connections along Bangerter Highway are supplied by JVWCD's 78-inch aqueduct which has excess capacity. The capacity of the connections in the lower zones should be increased in order to allow full utilization of the Zone 1, Zone 2, and Zone 3 pump stations.

JVWCD connections are included in Zone 1 at the following locations:

- 64 & Redwood
- 70 & Bangerter Highway
- 78 & Bangerter Highway
- 90 & Bangerter Highway

In order to meet the build-out needs, the Zone 1 source capacity will need to increase from 18,000 gpm to just under 27,400 gpm. Based on our analysis of the West Jordan model and our understanding of the JVWCD network, West Jordan should be able to access this flow without extensive modifications to their distribution network. Although extensive changes to the network are not expected to be required, it may be necessary to modify the connections themselves in order to allow the increased flows.

Within Zone 2, the JVWCD source capacity will need to be increased from about 7,500 gpm up to about 8,540 gpm. The JVWCD connections that supply West Jordan's Zone 2 are connected to JVWCD's 36-inch pipeline in 3200 West. This modest increase in source capacity is not expected to present any difficulties in either the JVWCD or West Jordan distribution networks. These proposed increases in Zone 1 and Zone 2 capacity will allow the Airport and Grizzly pump stations to operate at their full capacity. Additional Zone 1 and Zone 2 capacity beyond the amounts outlined above could serve as redundant capacity for the lower zones but, due to pump station capacity would be unusable to the higher pressure zones.

Zone 3 capacity will also need to be increased. Under existing conditions, the Zone 3 capacity is 4,900 gpm. Of that total 1,400 gpm is from Well 5 with the remaining 3,500 gpm coming from the 102 South & 5600 West JVWCD connection. In addition to these sources, it is proposed that Well 3 should be transferred to Zone 3 by installing a pipeline to connect the Well with the existing Zone 3 pipeline in New Bingham Highway just east of Mountain View corridor. At build-out, the capacity of the JVWCD connection will need to be increased to just over 8,200 gpm. Increasing the capacity of the connection is expected to require improvements to both the West Jordan and JVWCD distribution systems. An associated West Jordan pipeline project is included later in the master plan in distribution recommendations and the City should coordinate with JVWCD so that the District is aware of the City's future water needs.

As with the previously discussed zones, the capacity in Zone 4 will also need to increase in order to meet build-out demands. The existing source capacity for Zone 4 is 9,000 gpm. Of that total, 4,400 gpm is associated with well sources and 4,600 gpm comes from the JVWCD Deadmans connection. At build-out the well sources will be cut to 3,800 gpm as a result of moving Well 3 to Zone 3. The required source capacity at build-out is projected to be 16,490 gpm, based on a zone demand of 10,040 gpm, a contribution of 8,500 gpm from the Grizzly Zone 4 pump station, and 14,950 gpm being pumped out of Zone 4 up to Zones 5 and 6. Three of the proposed wells are expected to be constructed in Zone 4 and are planned to add a total of 4,500 gpm to the Zone's capacity. In addition, it is proposed that a pipeline should be installed so that the 6950 West 10200 South JVWCD connection can supply water to the Zone 4 Terminal Tank. The 6950 West 10200 South connection has an existing capacity of 2,100 gpm which would bring the total source capacity to 15,000 gpm. In order to meet the build-out source requirements, the capacity of the JVWCD connections would need to be increased by 1,490 gpm.

Zone 5 currently has a source capacity of 2,100 gpm via the 6950 West 10200 South JVWCD connection. For the existing system, Zone 5 receives all additional water from PRV connections with Zone 6. At build-out the Zone 5 demand is projected to increase to 11,146 gpm. Distribution system modeling was performed which showed that pulling all of the Zone 5 water from the Zone 6 tanks caused high headloss through Zone 6. For this reason, it is proposed that storage tanks should be added to Zone 5 along with two booster pump stations. The proposed booster pump stations would be located at the U-111 and Terminal Tank sites and would pump water from Zone 4 to Zone 5. As shown in Table 3-5, the demand in Zone 5 would be met by 596 gpm from Zone 6 PRVs and 10,550 gpm from the proposed pump stations. In addition to reducing pressure fluctuations in the build-out Zone 6, adding pump stations to Zone 4 would also serve to greatly reduce pumping costs. A pump from Zone 4 to Zone 6 must add about 300 feet of head to the pumped water, not including conveyance losses. Pumping directly to Zone 5 only requires about 130 feet of head. Energy savings would be on the order of 50-60%. New storage and pumping facilities would be needed to meet the future Zone 5 demands regardless of whether Zone 5 is served directly or via Zone 6. However, locating the facities in Zone 5 enables the energy savings, while simultaneously reducing the cost for additional transmission. Additional projects that would be required to add the Zone 5 boosters are described in the "Storage" and "Distribution System" chapters of this master plan.

The Zone 6 source capacity will need to be increased from 2,350 gpm to 7,915 gpm at build-out. A new well is projected to be located in Zone 6, so 1,500 gpm of that increase can be attributed to the added well capacity. Therefore, the flow capacity from the JVWCD Zone D Tank will need to be increased by 4,065 gpm to about 6,415 gpm.

The majority of the proposed flow increases at the JVWCD connections will not require extensive projects in order to facilitate the increased flow. In some cases minor changes may be required at the connections, but it is not known which connection will or will not require modification. For that reason, a project has been included for each zone's JVWCD connections within the capital improvements project of this report.

The Zone 2, Zone 3, and Zone 4 pump stations each currently have a vacant bay for an additional pump. Adding the pump at each pump station provides additional flexibility for meeting the build-out demands. Modeling was performed to evaluate whether there is sufficient transmission capacity to increase the flow rate at each of the pump stations. It was found that the Zones 2 and 4 pump stations have adequate transmission capacity, but that the Zone 3 pump station would require a pipeline project in order to avoid excessive flow velocities. The Zone 3 pipeline project is detailed within the "Distribution System" chapter (Project D-12).

In order to ensure that the necessary JVWCD capacity is available to the City, it is recommended that the City communicate regularly with JVWCD so that JVWCD is aware of the City's growth projections and can plan appropriately. The City should also evaluate their JVWCD contract regularly and make adjustments to the contract amounts as needed.

CHAPTER 4

STORAGE

EXISTING STORAGE

The City's current drinking water system includes twelve storage facilities with a total capacity of 37.5 MG. The locations of storage facilities are shown on Figure I-1. Table 4-1 presents a listing of the names and select attributes of the West Jordan water storage tanks.

TABLE 4-1
EXISTING STORAGE TANKS

Name	Type	Diameter (ft)	Volume (MG)	Outlet Level	Emergency Storage Level	Fire Suppression Level	Overflow/ Equalization Level
Airport 4mg	Concrete	184	4.0	4577.0 (0 feet)	NA	4579.3 (2.3 feet)	4597.0 (20.0 feet)
Airport 2mg	Concrete	130	2.0	4577.0 (0 feet)	NA	4579.3 (2.3 feet)	4597.0 (20.0 feet)
Cemetery Tank	Concrete	130	2.5	4567.0 (0 feet)	NA	4576.0 (9.0 feet)	4592.0 (25.0 feet)
Grizzly Tank 1	Concrete	184	4.0	4702.0 (0 feet)	NA	4704.0 (2.0 feet)	4722.0 (20.0 feet)
Grizzly Tank 2	Concrete	184	4.0	4702.0 (0 feet)	NA	4704.0 (2.0 feet)	4722.0 (20.0 feet)
Old Bingham Tank	Concrete	130	2.0	4700.0 (0 feet)	NA	4704.0 (4.0 feet)	4720.0 (20.0 feet)
Barney's 1	Concrete	143	3.0	4885.0 (0 feet)	NA	4889.2 (4.2 feet)	4910.0 (25.0 feet)
Barney's 2	Concrete	143	3.0	4885.0 (0 feet)	NA	4889.2 (4.2 feet)	4910.0 (25.0 feet)
Terminal Tank	Concrete	143	3.0	5029.0 (0 feet)	NA	5030.7 (1.7 feet)	5054.0 (25.0 feet)
U-111 Tank	Concrete	164	4.0	5,024.0 (0 feet)	NA	5030.5 (6.5 feet)	5050.0 (26.0 feet)
Bench Tank	Concrete	146	3.0	5,330.0 (0 feet)	NA	5335.0 (5.0 feet)	5355.0 (25.0 feet)
Bingham Junction	Concrete	146	3.0	5,330.0 (0 feet)	NA	5335.0 (5.0 feet)	5355.0 (25.0 feet)

DDW standards suggest that emergency storage can be considered in the sizing of storage facilities. Emergency storage is intended to provide a safety factor that can be used in the case of unexpectedly high demands, pipeline failures, equipment failures, electrical power outages, water supply contamination, or natural disasters. Based on previous experience, no emergency storage has been recommended because the required equalization storage as set by Utah

R309-510 is generally sufficiently conservative such that additional storage for emergencies is not needed. Accordingly, no tank levels were specified for emergency storage in Table 4-1.

EXISTING STORAGE REQUIREMENTS

According to DDW standards, storage tanks must be able to provide: 1) equalization storage volume to make up the difference between the peak day flow rate and the peak instantaneous; and 2) fire suppression storage volume to supply water for firefighting. Operational storage, although not required by DDW, was included at the request of the City. A summary of the existing storage requirements for the drinking water system is shown in Table 4-2.

TABLE 4-2
EXISTING WATER STORAGE REQUIREMENTS

PRESSURE ZONE	ERCs	REQUIRED STORAGE (MG)				EXISTING STORAGE (MG)	REMAINING (MG)
		Equalization (MG)	Fire Suppression (MG)	Operational (MG)	Total (MG)		
1	11,090	9.1	1.6	4.7	15.4	8.5	-6.9
2	6,927	5.7	1.2	4.8	11.7	10.0	-1.7
3a	437	0.4	0.0	0.0	0.4	0.0	-0.4
3b	984	0.8	0.0	0.0	0.8	0.0	-0.8
3	9,200	7.5	1.0	0.0	8.5	6.0	-2.5
4	4,855	4.0	1.2	1.6	6.8	7.0	0.2
5	3,529	2.9	0.0	0.0	2.9	0.0	-2.9
6	971	0.8	1.2	0.0	2.0	6.0	4.0
TOTAL	**37,993**	**31.2**	**6.2**	**11.1**	**48.5**	**37.5**	**-11.0**

Overall, the City has a deficit of -11.0 MG in drinking water storage capacity. The primary reason for the deficit is the voluntary inclusion of operational storage. Further discussion on operational storage is included below.

Equalization Storage

The need for equalization storage is highest during the irrigation season on days of peak water use. Equalization storage is used to meet peak demands during the time when demand exceeds the capacity of the sources. For West Jordan, the required equalization storage was calculated according to the guidelines outlined by Utah Administrative Code R309-510-8. The existing equalization storage requirement for West Jordan was found to be **31.2 MG,** which is equivalent to 821 gallon/ERC.

Fire Suppression Storage

Fire suppression storage is required for water systems that provide water for firefighting. The West Jordan Fire Department has jurisdiction over the City and the fire flow requirements in this master plan were supplied by the Deputy Fire Chief, Reed Scharman. The contact information for the West Jordan Fire department is as follows:

Phone: 801-260-7300

Address: 7602 South Jordan Landing Blvd.
West Jordan, UT 84048

The minimum fire flow requirement for a building was **1,000 gpm for 2 hours.** Depending on the size of the building and the type of construction, higher flow requirements were assessed based on the International Fire Code and fire department recommendations. The required fire suppression storage for a given zone is determined by the building in the zone with the highest fire flow requirement.

West Jordan Middle School, which is located in Zone 1, was assessed a required flow of **5,500 gpm for 4 hours**. The associated storage volume for that fire suppression flow is 1.3 MG. For all other zones within the City that include a storage facility, the largest fire suppression flow was **4,000 gpm for 4 hours**, corresponding to a volume of 1.0 MG. For a complete listing of the buildings with large fire demands that were provided by the West Jordan Fire Department please refer to Appendix B.

Several of the pressure zones in West Jordan are fairly large and include multiple storage reservoirs. For cases where the storage reservoirs are separated by large distances, a fire demand will pull water preferentially from the tank that is hydraulically closest. For this reason an additional 20% safety factor was added to the fire demand of the zones that include multiple tanks separated by large distances.

In addition, the water system should be managed so that the storage volume dedicated to fire suppression is available to meet fire flow requirements whenever or wherever it is needed. This can be accomplished by designating minimum storage tank water levels that provide reserve storage equal to the required fire suppression storage. Although it is important to utilize equalization storage, typical daily water fluctuations in the tanks should never be allowed below the minimum established levels except during fire or emergency situations. Fire suppression tank levels are included in Table 4-1. As a general rule, the fire suppression level for the tanks of a given zone should be at the same elevation for each tank. For the West Jordan tanks, this guideline generally holds true but with some minor variations. The largest deviation can be seen in comparing the Airport and Cemetery Tanks in Zone 1. The fire suppression level at the Cemetery Tanks is recommended to be 3 feet lower than at the Airport Tanks. The reduced fire suppression elevation is a result of modeling which showed that water elevation at Cemetery Tank, due to the inlet/outlet configuration and other differences was consistently 2 to 3 feet lower than the elevation of the Airport Tank. This is not a system deficiency, and it is not uncommon to see such differences in the water elevations between tanks that are separated by large distances.

Operational Storage

Operational storage is not required by DDW; however, for some systems it can be useful to account for the storage that is needed to operate pump stations. For this master plan, operational storage was included based on the size of the West Jordan pump stations. Past experience suggests that a storage volume equivalent to the pump station operating at its rated capacity for 6 hours (¼ day) is sufficient for operational storage. West Jordan has several relatively large pump stations, and using this leads to a total operational storage volume of **11.1 MG**. The inclusion of operational storage is significant for West Jordan because it is the difference between the system having a small surplus of 0.1 MG of storage versus a deficit of 11.0 MG.

BUILD-OUT STORAGE REQUIREMENTS

The storage volumes required at build-out are based on the same equalization, fire suppression, and operational storage requirements as were calculated for the existing conditions. The build-out equalization storage will be higher than existing conditions because the number of ERCs is projected to increase. Fire suppression volumes are not expected to increase. In reality, the required fire suppression volume will likely be lower at build-out as a result of older buildings being replaced with newer buildings that meet updated building codes. However, because it is not known if or when such upgrades will occur, the existing fire suppression volumes have been carried over to the build-out projections. The City's future storage requirements at build-out are presented in Table 4-3.

TABLE 4-3
BUILD-OUT STORAGE REQUIREMENTS

PRESSURE ZONE	ERCs	REQUIRED STORAGE (MG)				EXISTING STORAGE (MG)	REMAINING (MG)
		Equalization (MG)	Fire Suppression (MG)	Operational (MG)	Total (MG)		
1	12,636	10.3	1.6	4.7	16.6	8.5	-8.1
2	7,254	5.9	1.2	4.8	11.9	10.0	-1.9
3a	499	0.4	0.0	0.0	0.4	0.0	-0.4
3b	1,706	1.4	0.0	0.0	1.4	0.0	-1.4
3	11,007	9.0	1.0	0.0	10.0	6.0	-4.0
4	8,843	7.2	1.2	4.6[1]	13.0	7.0	-6.0
5	9,817	8.0	0.0	0	8.0	0.0	-8.0
6	7,180	5.9	1.2	1.0	8.1	6.0	-2.1
7	3,142	2.6	1.2	0.0	3.8	0.0	-3.8
TOTAL	**62,084**	**50.7**	**7.4**	**15.1**	**73.2**	**37.5**	**-35.7**

1. Of the 4.6 MG of operational storage shown for Zone 4, 3.0 MG is associated with the proposed Zone 5 pump station discussed in the "Source" chapter of this report.

STORAGE RECOMMENDATIONS

Under build-out conditions West Jordan will require an additional 31.9 MG of storage capacity. The City currently has an existing Capital Facilities Plan. Table 4-4 lists the tanks that are currently included in the City's Capital Facilities Plan. If the planned tanks are added to the existing tanks, the build-out storage summary can be updated to appear as shown in Table 4-5.

With the construction of the planned storage tanks there is still a small deficit in the total drinking water storage. The largest deficits are in Zones 1 and 5. The following paragraphs detail the zone by zone recommendations for meeting the storage needs of West Jordan.

Zone 1 is projected to have a shortfall of 5.1 MG under build-out conditions. Contributing factors to the storage shortcoming are the inclusion of operational storage and the relatively large fire suppression flow located in the zone. The existing Zone 1 storage volume is 8.5 MG with 2.5 MG at Cemetery Tank and a total of 6.0 MG between the two existing Airport Tanks.

TABLE 4-4
PLANNED STORAGE TANKS

ZONE	TANK NAME	SIZE (MG)
1	Airport 2	5.0
2	Old Bingham Highway #2	2.0
3	Zone 3 Old Bingham Highway	3.0
4	Terminal 2	3.0
4	U-111 Tank 2	4.0
6	Bingham Junction #2	3.0
6	Bench #2	3.0
7	Zone 7 North	2.0
7	Zone 7 South	2.0
TOTAL	**N/A**	27.0

TABLE 4-5
BUILD-OUT STORAGE SUMMARY

PRESSURE ZONE	TOTAL (MG)	PLANNED STORAGE (MG)	REMAINING (MG)
1	16.6	11.5	-5.1
2	11.9	12.0	0.1
3a	0.4	0.0	-0.4
3b	1.4	0.0	-1.4
3	10.0	9.0	-1.0
4	13.0	14.0	1.0
5	8.0	0.0	-8.0
6	8.1	12.0	3.9
7	3.8	4.0	0.2
TOTAL	**73.2**	**62.5**	**-10.5**

The proposed Airport 2 tank will take the place of the existing 2.0 MG Airport tank and will have a capacity of 4.0 to 5.0 MG for a net gain of 2.0 to 3.0 MG in total capacity. It order to reduce the storage deficit, it is recommended that additional storage be added at the Cemetery Tank site. If 3.0 MG could be added at the Cemetery Tank site, the remaining shortfall for Zone 1 storage would be 2.1 to 4.1 MG. Although it is generally preferred to locate sufficient storage within each zone, it is not required that all Zone 1 storage be directly located within Zone 1.

The planned storage for Zone 2 is adequate and it is recommended that the City should proceed with the construction of the Old Bingham Highway #2 storage as needed. Completing the storage tank will provide all of the build-out storage that is projected to be needed in Zone 2.

Zone 3 also provides water to Zones 3a and 3b via PRV connections. For this reason the total Zone 3 deficiency is effectively 2.8 MG (plus the carryover deficiency from Zone 1). In order to provide the required storage for Zone 3, it is recommended that the size of the planned Zone 3 Old Bingham Highway tank should be increased from 3 MG to 4 MG and that an additional 2 MG Zone 3 tank should be constructed just north of 7800 South and just east of Mountain View Corridor.

There is currently 7 MG of storage located in Zone 4 and the City's current plan is to increase the Zone 4 storage to 14.0 MG. After adding the additional tanks, the City will still have about 1.0 MG of remaining storage capacity in Zone 4. It is therefore recommended that the Zone 4 storage tanks should be constructed as planned.

As detailed within the "Distribution System" chapter of this master plan, it is recommended that a 5a zone be created in order to provide adequate pressures to what is currently the far southwest corner of Zone 4. In order to provide fire storage for the proposed zone, it is recommended that a 2.0 MG storage tank be constructed along 10200 South just to the east of the existing 10200 South JVWCD connection.

Previously, the City has not intended to construct storage that would be directly connected to Zone 5. Instead the City has planned to place all of the Zone 5 storage in Zone 6. The storage analysis indicates that the equalization storage requirement for Zone 5 is 8 MG. Through the use of the network model, it was found that supplying all of the Zone 5 equalization storage from the Zone 6 tanks was not feasible based on the size of the existing transmission lines to the Zone 6 tanks. In addition to increasing the transmission capacity between Zone 4 and 6, supplying Zone 5 by way of Zone 6 would require the construction of additional storage and pump station facilities within Zone 6. Rather than construct the new facilities in Zone 6, which would require upsizing the transmission capacity, it is recommended that the new facilities should be constructed to directly serve Zone 5. Constructing the facilities in Zone 5 would eliminate the need for upsizing the transmission between the Zone 6 pump station and the Zone 6 tanks while also reducing the pumping costs as outlined previously. For these reasons, it is recommended that two 4 MG storage tanks should be constructed within Zone 5. One tank should be located to serve the northern half of the system, while the other should be located to the south. The proposed location of the northern tank is at about 7100 West 7500 South and the proposed location of the southern tank is at about 7300 West New Bingham Highway. This sizing breakdown assumes that fire flow storage would continue to be provided by Zone 6.

The City's current plan calls for an additional 3.0 MG at each of the existing Zone 6 tank locations. This would bring the total Zone 6 storage to 12.0 MG. Based on the analyses performed for this master plan, it is recommended that the additional storage added to Zone 6 should be reduced to 1.0 to 1.5 MG at each of the existing tanks sites. This course of action would reduce the planned Zone 6 storage to a maximum of 9.0 MG. The smaller Zone 6 tanks would still provide a level of redundancy at each of the tank sites while still cutting out some unneeded storage.

No changes are recommended with respect to the City's plan to construct 4.0 MG of storage in Zone 7. Instead, it is recommended that the City proceed as necessitated by growth and construct two Zone 7 tanks, one to the north and the other to the south.

Based on the storage recommendations outlined above, Table 4-5 has been updated and the results are displayed below as Table 4-6.

TABLE 4-6
PROPOSED BUILD-OUT STORAGE

PRESSURE ZONE	TOTAL (MG)	PLANNED STORAGE (MG)	REMAINING (MG)
1	16.6	14.5	-2.1
2	11.9	12.0	0.1
3a	0.4	0.0	-0.4
3b	1.4	0.0	-1.4
3	10.0	12.0	2.0
4	13.0	14.0	1.0
5	8.0	8.0	0.0
6	8.1	9.0	0.9
7	3.8	4.0	0.2
TOTAL	**73.2**	**73.5**	**0.3**

CHAPTER 5

DISTRIBUTION SYSTEM

EXISTING DISTRIBUTION SYSTEM

The distribution system consists of all pipelines, valves, fittings, and other appurtenances used to convey water from the water sources and storage tanks to the water users. The existing water system contains over 450 miles of distribution pipe ranging in size from 4 to 36 inches in diameter. Figure V-1 presents a summary of pipe length by diameter.

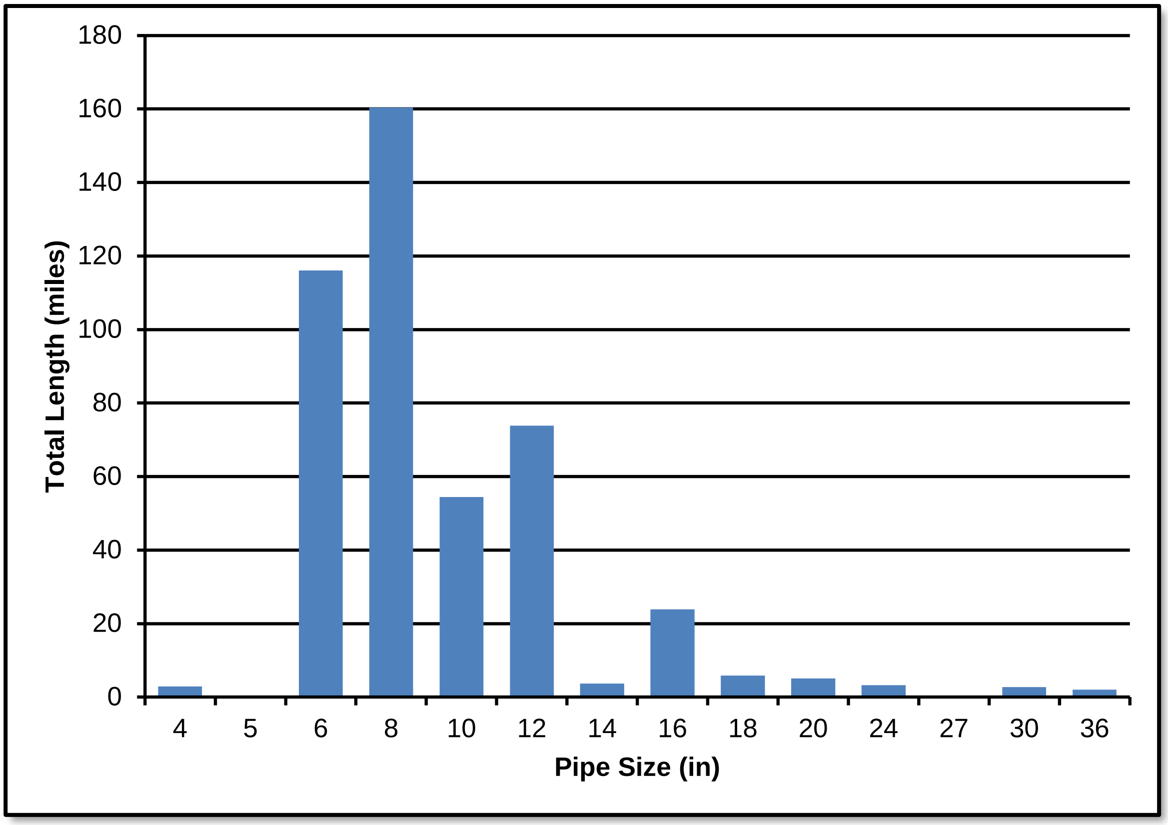


FIGURE 5-1: SUMMARY OF PIPE LENGTH BY DIAMETER

EXISTING DISTRIBUTION SYSTEM REQUIREMENTS

Utah Administrative Code R309-105-9(1) applies to existing systems approved prior to January 1, 2007 and requires that distribution systems be able to maintain 20 psi at all points in the system during normal operating conditions and during conditions of fire flow and peak day demand. R309-105-9(2) adds the following minimum water pressure constraints: (a) 20 psi during conditions of fire flow and fire demand experienced during peak day demand; (b) 30 psi during peak instantaneous demand; and (c) 40 psi during peak day demand. R309 105-9(2) applies to new systems approved after January 1, 2007 and to new areas or subdivisions of existing systems. Much of West Jordan is subject to R309-105-9(1); however, new developments will need to meet the criteria outlined by R309-105-9(2). In addition, West Jordan prefers that the distribution system maintain a minimum of 50 psi at all points in the system under peak instantaneous conditions to avoid customer complaints.

Existing Peak Instantaneous Demand

Peak instantaneous demand is the highest demand on the peak day. The pipes in the distribution system must be large enough to convey the peak instantaneous demand while maintaining a pressure at connections above 50 psi. Using production data, the peak day demand was measured to be 28,896 gpm with a peaking factor of 2.02. Therefore, the measured peak instantaneous flow rate was 58,370 gpm. The peak day average flow as defined by state standards was 43,136 gpm. In establishing the peak instantaneous demand it was necessary to include a degree of conservatism; however direct application of the measured peaking factor to the state standard peak day average flow was judged to result in an excessively conservative peak instantaneous flow. Instead, the peak instantaneous flow was determined by increasing the measured peak day flow by 13% to 32,583 gpm. Applying the peaking factor of 2.02 gave a peak instantaneous flow of **65,818 gpm**. The peaking factor between the state standard peak day demand and the peak instantaneous demand was 1.56.

Existing Peak Day Plus Fire Flow Demand

In accordance with DDW regulations, the distribution system must be capable of delivering fire flow to a specified location within the system while supplying the peak day demand of 43,136, gpm to the entire distribution system and maintaining 20 psi minimum pressure at all delivery points within the distribution system. A minimum fire flow demand of **1,000 gpm** or more is required for all demand nodes in the system. Larger fire flows are required at larger structures throughout the system based on the International Fire Code and recommendations from the West Jordan City Fire Department. As noted previously, West Jordan Middle School was assessed a required flow of **5,500 gpm for 4 hours**, which was the largest requirement in Zone 1. The remaining pressure zones each had a maximum requirement of **4000 gpm for 4 hours**. For a complete listing of the fire flows considered at large buildings refer to Appendix B.

BUILD-OUT DISTRIBUTION SYSTEM REQUIREMENTS

The existing system requirements apply to the projected build-out system. As previously noted, DDW requires the distribution system be able to maintain 20 psi at all points in the system under peak instantaneous conditions and peak day plus fire flow.

Build-Out Peak Instantaneous Demand

The build-out peak day demand for the distribution system is 68,910 gpm. Assuming the same peaking factor of 1.56 gives a value of **107,551 gpm** for the peak instantaneous demand.

Build-Out Peak Day Plus Fire Flow Demand

The build-out peak day plus fire flow scenario was evaluated in a similar manner as compared to the existing peak day plus fire flow scenario. It was assumed that the fire flow requirements would not change between the existing and build-out conditions. Generally, this is a conservative assumption as, over time, older buildings are replaced with newer buildings constructed in accordance with updated building codes.

COMPUTER MODEL

A computer model of the City's water distribution system was developed to analyze the performance of the existing and future distribution system and to prepare solutions for existing facilities that cannot meet the DDW or City criteria for water system pressures. The software used for the model was InfoWater 10.0. InfoWater 10.0 is a computer program that models the hydraulic behavior of piping networks. At the beginning of the master plan study, West Jordan

City provided HAL with the drinking water model that was being maintained by the City. Based on data provided by the City and communication with City personnel, HAL made additional edits to update and calibrate the model.

Computer models were developed for three phases of water system development. The first phase was the development of a model of the existing system (existing model). This model was used for calibration and to identify deficiencies in the existing system. A second model was developed which was used to identify those corrections necessary to improve existing system deficiencies (corrected existing model). The third phase was the development of a future model to indicate those improvements that will be necessary for the projected “build-out” condition (future model).

MODEL COMPONENTS

The two basic elements of the computer model are pipes and nodes. A pipe is described by its inside diameter, overall length, minor friction loss factors, and a roughness value associated with friction head losses. A pipe can include elbows, bends, valves, pumps, and other operational elements. Nodes are the end points of a pipe and they can be categorized as junction nodes or boundary nodes. A junction node is a point where two or more pipes meet, where a change in pipe diameter occurs, or where flow is put in or taken out of the system. A boundary node is a point where the hydraulic grade is known (a reservoir or PRV).

The computer model of the water distribution system is not an exact replica of the actual water system. Pipeline locations used in the model are approximate and every pipeline may not be included in the model, although efforts were made to make the model as complete and accurate as possible. It is not necessary to include all of the distribution system pipes in the model to accurately simulate its performance.

Pipe Network

As indicated previously, the pipe network layout was based upon the model maintained by West Jordan City. During model preparation, accuracy of the new model was verified by reviewing data provided by the City. Updates to the model were made by HAL throughout the master plan study.

Demands

Water demands were located in the model based on billing data from the summer of 2013. The peak monthly demand was determined for each billing address, and then the billing addresses were geocoded in order to link the demands to a physical location. Using GIS, the geocoded demands in gallons per minute were then assigned to the closest model demand node. The peak monthly flows were then scaled in order to convert the monthly flow into a peak day demand flow. The scale factor was based on production data that was provided by the City to HAL and calculations which are included in Appendix A.

Additionally, outdoor demands were isolated from indoor demands within the network model. In order to isolate the demands, billing data were used to identify the indoor and outdoor components of demand for each billing location within the City. It was assumed that water used in January would represent the indoor water use for West Jordan. The outdoor water use was calculated as the difference between the January demands and the July demands at each location. Separate diurnal curves were also applied to the indoor and outdoor water use. Based on SCADA production data provided to HAL a total diurnal demand curve was developed for West Jordan which included all of the water used by water users within the City. Next, a typical indoor only demand curve was obtained using data from a City with separate indoor and secondary watering systems. The indoor demand curve was then subtracted from the total demand curve to find the outdoor demand curve. The non-dimensional diurnal curves for the City are shown in Figure 5-2.

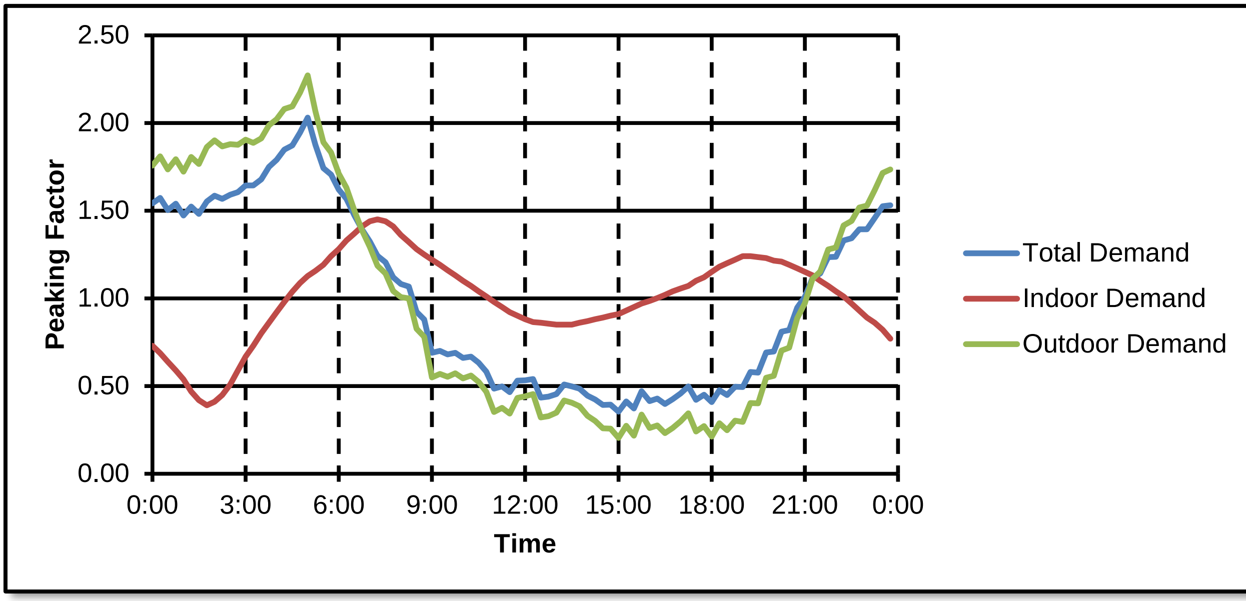


FIGURE 5-2: NON-DIMENSIONAL PEAK DAY DIURNAL CURVES FOR WEST JORDAN

The outdoor demand and the total demand both peak at about 5:00 AM. The indoor demand peaks just after 7:00 AM. The outdoor peak is driven be irrigation, so it is low through mid-day but high through the night while the indoor demand peaks in the mornings and evenings with a minimum at night. The diurnal curves in units of gallons per minute are shown in Figure 5-3.

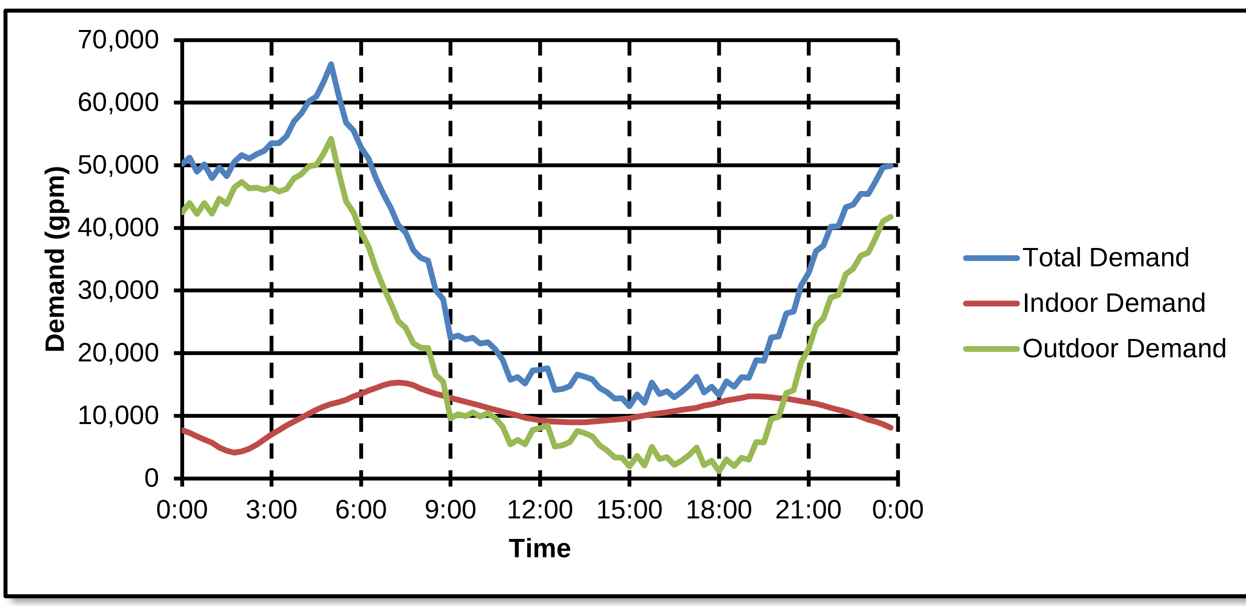


FIGURE 5-3: PEAK DAY DIURNAL CURVES FOR WEST JORDAN

Because of the relatively large size of the outdoor demand compared to the indoor demand the total demand can be seen to generally follow the pattern set by the outdoor demand.

Sources and Storage Tanks

The sources of water in the model are the wells and connections with the JVWCD water system. The levels in the tanks are modeled in the extended period model scenario. The extended period model predicts the levels in the tanks as they fill from sources and empty to meet demand in the system.

MODEL CALIBRATION

A water system computer model should be calibrated before it may be relied on to accurately simulate the performance of the distribution system. Calibration is a comparison of the computer results, field tests, and actual system performance. Field tests are accomplished by performing fire flow tests and pressure tests on the system. When the computer model does not match the field tests within an acceptable level of accuracy, the computer model is adjusted to match field conditions. Calibration is especially useful for identifying pipe sizes that are not correct and PRVs or isolation valves that are not operating as expected. Pipe roughness is an additional characteristic which may also be adjusted during calibration.

The model was calibrated primarily through the use of SCADA data. Source flows and tank levels were provided to HAL and the model was calibrated by adjusting source flows and PRV settings so that the overall behavior of network was reproduced within the model. Calibration results are included in Appendix C. The overall flow patterns in the model matched the observed values very well.

ANALYSIS METHODOLOGY

The InfoWater model was used to analyze the performance of the water system for current and projected future demands under three main operating conditions: low flow (highest pressure) conditions, peak instantaneous conditions, and peak day plus fire flow conditions. Each of these conditions put the water system into a worst-case situation so the performance of the distribution system may be analyzed for compliance with DDW and West Jordan City's requirements. The results of the model for each of the conditions are discussed below.

High Pressure Conditions

Low flow or static conditions are usually the worst case for high pressures in a water distribution system. In the wintertime, water demand during night time hours is very low, tanks are nearly full, and movement of water through the system is minimal. Under these conditions, the water system approaches a static condition and water pressure in the distribution system is dependent only upon the elevation differences and pressure regulating devices. Another condition similar to static condition that can also cause high pressures in the City's water system occurs in the summer when demand is low and pumps are on to fill storage tanks. During times of low demand, the pumps increase the pressure in the system high enough to reverse the flow coming from the tanks. The highest pressures are reached when pumps are on, tanks are almost full, and demand is low. Both of these high pressure conditions were simulated with the model.

Peak Instantaneous Demand Conditions

Peak Instantaneous demand conditions can sometimes be the worst-case scenario for low pressures throughout a water distribution system. The water system reaches peak instantaneous demand conditions during the hottest days of the summer when both indoor and outdoor water use is the highest. The high demand creates high velocities in the distributions pipes which reduces pressure. DDW requires the pipes in the distribution system to be capable of delivering peak instantaneous demand to the entire service area and maintain a minimum pressure of 20 psi at any service connection within the distribution system. Usually, minimum pressures of 20 psi at peak instantaneous demand are too low for customer satisfaction; hence, the City prefers a minimum pressure of 50 psi under this condition.

Peak Day Demand Plus Fire Flow Conditions

Even though peak instantaneous conditions are the worst-case for the lowest pressure and highest demand for the entire system, the peak day plus fire flow is often the worst-case scenario for the lowest pressures for specific locations in the system. This condition occurs when fire hydrants are being used on a day of high water demand. The distribution system must be capable of delivering the required fire flow to the specified location within the system, while supplying the peak day demand to the entire distribution system. In accordance with the recommendations from the West Jordan Fire Department, the required fire flows must be delivered while maintaining 20 psi minimum residual pressure at the delivery point and to all service connections within the distribution system.

Identifying every pipe which is not capable of supplying the required fire flow is beyond the scope of this study. While the computer analysis is useful for providing general indications of the fire flow capacity, it does not calculate the capacity at every fire hydrant, nor does it identify every water line where fire flow capacity is inadequate. The computer analysis checks fire flow capacity at model junction nodes which are generally placed at the intersections of two or more pipes. Fire flow capacity at fire hydrants between model nodes could be less than the computer analysis indicates. For this reason, the computer analysis should not replace physical fire flow tests at fire hydrants as the primary method of determining fire flow capacity.

Peak Day Extended Period

The peak day extended period model was used to model the water system performance over time. An extended period model is actually a static model run multiple times for each time period, like a movie is made up of individual pictures put together. The peak day extended period model includes the peak instantaneous flow at the peak demand period of the day. The peak day extended period model was used to set system conditions for the static models, calibrate zone to zone water transfers, analyze system controls and the performance of the system over time, analyze system recommendations for performance over time, and analyze the water system for optimization recommendations. The peak day extended period model was run for several days with the peak day demand curve repeating every 24 hours such that the model operated in a stable pattern. The model has reached stabilization when the filling and emptying cycles of the tanks repeat in a consistent pattern without running empty. System recommendations for existing conditions and future conditions at build-out were checked with the extended period model to confirm adequacy.

ANALYSIS RESULTS OF THE EXISTING SYSTEM

The model output primarily consists of the computed pressures at nodes and flow rates through pipes. The model also provides additional data related to pipeline flow velocity and head loss to help evaluate the performance of the various components of the distribution system. Results from the model are available on a CD in Appendix D. Due to the large number of pipes and nodes in the model, it is impractical to prepare a figure which illustrates pipe numbers and node numbers. The reader should refer to the CD to review model output.

In general, the observed pressures were well below the City's preferred maximum pressure of 130 psi; however, there are small portions of Zone 3 and Zone 4 where the pressure exceeds 130 psi. In Zone 3 the peak observed pressure was 150 psi in the northeast portion of the zone. The peak pressure in Zone 4 was also about 150 psi and was observed at about 4800 West and 8600 South. An additional high pressure area was observed in the northeast area of Zone 4. In that area pressures reach 142 psi. Solutions for these deficiencies are discussed within the "Distribution System Recommendations" section of this report.

With regard to Peak Instantaneous Demand Conditions, four areas were identified where pressures drop below 50 psi. The first area is located along the western edge of Zone 1 and includes the areas of pressure Zone 1 that are situated to the west of 2700 West. The lowest pressure in Zone 1 was 42 psi. The second low pressure area is along the western boundary of Zone 3, just south of New Bingham Highway. In that area the lowest modeled pressure was 48 psi. The third low pressure area is in the southwest corner of Zone 4. That area is not currently developed; however, pressures were observed to reach about 42 psi. The final low pressure area that was identified was in the northwest corner of Zone 5 at about 7500 South 6630 West in the Maples at Jordan Hill subdivision. The lowest pressures in that region dropped to 42 psi during peak instantaneous flows. Under the existing conditions, all of these low pressure areas are compliant with state standards. However, because the City desires to maintain a minimum pressure of 50 psi, recommendations that address these low pressure areas are included below under the heading "Existing Distribution System Recommendations".

Several fire flow pressure deficiencies were identified by modeling the peak day demand plus fire flow conditions. The majority of the identified shortcomings result from 6-inch diameter pipelines in residential areas. As a result of the undersized pipes, in combination with limited pipe looping, these areas are unable to provide the minimum 1,000 gpm fire flow. There were also two schools which were identified as having insufficient fire suppression flows based on flow requirements provided by the West Jordan Fire Department: West Jordan Elementary School and Westland Elementary School. The location of these fire flow deficiencies and system recommendations to correct the deficiencies are addressed in the "Existing Distribution System Recommendations" section below.

In reviewing the peak day extended model an additional general conclusion was reached. It was observed that some PRVs were set too high to allow full utilization of the equalization storage in the City's storage tanks. Because of the higher PRV settings, rather than using storage from the reservoirs, the City was meeting peak demands in lower zones through PRV flows from higher zones. When that occurs, the City is essentially using the pump station capacity and the equalization storage of upper zones to raise the pressure in lower zones. However, operating the system in this manner results in much higher pumping costs. It is recommended that PRVs should be set to allow the City to maintain adequate pressures while minimizing flow through the PRVs from the upper to lower zones. Recommended PRV settings are included in the section "Existing Distribution System Recommendations" below.

EXISTING DISTRIBUTION SYSTEM RECOMMENDATIONS

Recommendations for improvement projects were based on the modeling, as outlined above, and also guidance provided by West Jordan City personnel. Recommendations have been categorized into the following groups: asbestos-cement pipe projects, fire flow projects, and all other distribution projects.

There are several asbestos-cement pipes currently in use in the West Jordan water distribution system. The City has requested a replacement program for these brittle and old pipes. Table

5-1 lists the projects that have been outlined to replace the asbestos-cement pipes. Locations of these projects are illustrated on Figure V-4 in accordance with the ID number listed in Table 5-1.

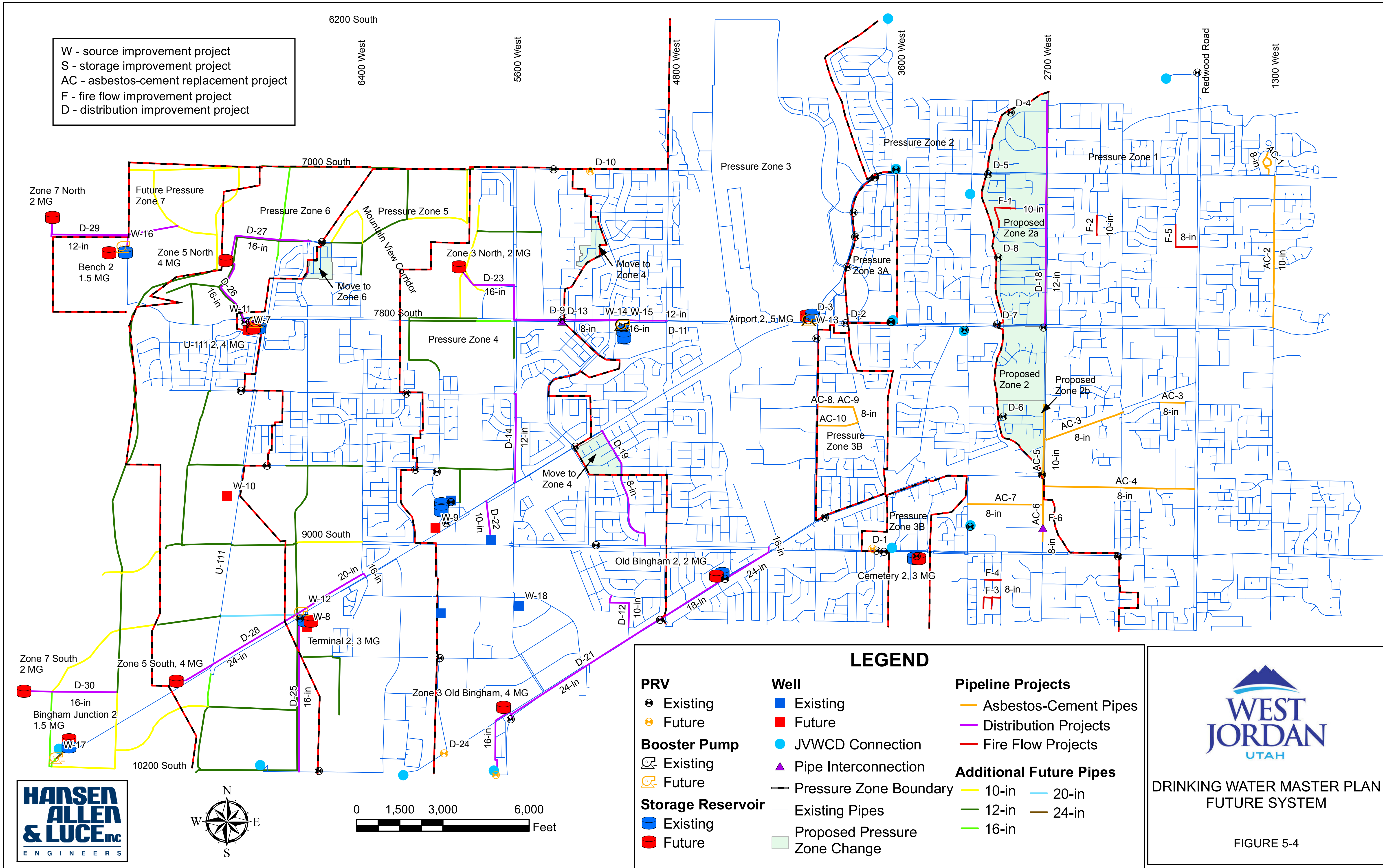
TABLE 5-1
ASBESTOS-CEMENT PIPE REPLACEMENT PROJECTS

ID	PROPOSED SOLUTION
AC-1	Install 1,510 feet of 8-inch pipe in Anderson Way, Flamingo Way, and Kit Circle
AC-2	Install 5,320 feet of 10-inch pipe in 1300 West between 7000 South and 7800 South
AC-3	Install 2,920 feet of 8-inch pipe in Sugar Factory Road between 2200 West and 2700 West
AC-4	Install 5,220 feet of 8-inch pipe in Gardner Lane between Redwood Road and 2700 West
AC-5	Install 2,520 feet of 10-inch pipe in 2700 West between 7800 South and 8600 South
AC-6	Install 2,290 feet of 8-inch pipe in 2700 West between 8600 South and 9000 South
AC-7	Install 2,670 feet of 8-inch pipe in 8750 South between 2700 West and 3200 West
AC-8	Install 1,265 feet of 8-inch pipe in 8250 South between 4000 West and Susan Way
AC-9	Install 565 feet of 8-inch pipe in Susan Way between 8250 South and 8350 South
AC-10	Install 1,450 feet of 8-inch pipe in 8350 South between Susan Way and 4000 West

Table 5-2 lists the projects which address fire flow deficiencies. Locations of these projects are illustrated on Figure V-4 in accordance with the ID number listed in Table 5-2.

TABLE 5-2
FIRE FLOW PROJECTS

ID	PROBLEM	PROPOSED SOLUTION
F-1	Insufficient fire flow at Westland Elementary School	Install 1,440 feet of 10-inch pipe beginning at 7180 South 2870 West and proceeding west around behind Westland Elementary School and then south to 7268 South 2950 West
F-2	Insufficient fire flow at West Jordan Elementary School	Install 690 feet of 10-inch pipe in 2370 West between 7350 South and 7200 South
F-3	Inadequate fire flow to residential area	Install 570 feet of 8-inch pipe in 9240 South between 3000 West and 3090 West, 400 feet of 8-inch pipe in 3090 West between 9240 South and 9300 South, and 400 feet of 8-inch pipe in 3040 West between 9240 South and 9300 South
F-4	Inadequate fire flow to residential area	Install 575 feet of 8-inch pipe in Laytham Way between 3000 West and 3090 West
F-5	Inadequate fire flow to residential area	Install 1,535 feet of 8-inch pipe in Drake Lane between Redwood Road and 1825 West and then north to Executive Drive
F-6	Inadequate fire flow to residential area	Install a new connection at 8870 South 2700 West between the existing 8-inch and 6-inch pipelines



DRINKING WATER MASTER PLAN
FUTURE SYSTEM

FIGURE 5-4

In addition to the projects to replace asbestos-cement pipes and the projects to correct fire flow deficiencies, other projects are needed to replace aging infrastructure, improve redundancy, or to meet other needs within the distribution system. Additional discussion for several of these distribution projects is included below. Project numbers included within the following paragraphs refer to ID numbers in Table 5-3 at the end of this section.

In order to address the low pressures in Zone 1 it is recommended that the areas of Zone 1 west of 2700 West should be segregated into pressure subzones or combined into Zone 2. Specifically, it is recommended that the areas north of 7800 South should be formed into a new Zone 2a, the areas between 7800 South and 8140 South should be added to Zone 2, and the areas south of 8140 South should be formed into a new Zone 2b. The City has already performed much of the work needed to make the boundary change having previously installed new PRVs at 7800 South and 8600 South along 2700 West. In addition, they have also installed a new pipeline on the West side of 2700 West between 7800 South to 8600 South. The City's original plan was to move the entire portion of Zone 1 west of 2700 South into Zone 2; however, due to old pipelines in the area, when the attempt was made to make the transfer there were problems with pipelines breaking. As a result of the lines breaking, the City reverted back to supplying the area west of 2700 West with water at Zone 1 pressure. The new pressure subzones will help to mitigate the large pressure increases caused by moving the entire area to Zone 2. The existing PRVs at 7800 South 3040 West, 7000 South 3100 West, 6400 South 2800 West, 2920 West 7420 South, and 2900 West 8250 South should be refurbished (Projects D-5 to D-9) and used to supply the new Zones.

Zone 2a will receive water from the PRVs at 6400 South 2800 West, 7000 South 3100 West, 2920 West 7420 South, and 7800 South 3040 West. The new Zone will need to be segregated from Zone 1 by closing the pipelines across 2700 West. A new 12-inch pipeline will need to be installed between 6600 South and 7800 South on the west side of 2700 West in order to supply water to Zone 2a. The portion of Zone 1 between 7800 South and 8140 South that will be transferred to Zone 2 will receive water via the existing Zone 2 transmission line in 7800 South. An isolation valve will need to be installed in the existing 10-inch pipeline in 2700 West at about 8140 South in order to segregate this area from Zone 2b. Zone 2b will be supplied water by the PRV at 2900 West 8250 South.

The high pressures in Zone 3 are located in the northeast area of the Zone, just east of the South Valley Regional Airport. Peak pressures reached about 150 psi. The most cost effective way to reduce pressures to the area would be to carve out a smaller pressure sub-zone to serve the high pressure area. The sub-zone could be created by installing PRVs in the 12-inch pipeline in 6200 South on the north side of the airport and in the 18-inch pipeline at about 4000 West 7800 South. In addition to adding these PRVs, a few other supply pipelines would need to be closed. These projects have not been incorporated into the recommendations list, but rather are provided in order to present options for the City.

The high pressures in the northeast area of Zone 4 can be addressed by shifting the pressure zone boundaries. It is recommended that pipelines at 7300 South Grizzly Way and about 5170 West Bridle Creek Drive should be opened to allow water from Zone 3 to serve the area, and pipes at 7520 South Bridle Creek Drive and 5200 West Eclipse Hill Road should be closed.

Project D-19 addresses the low pressure area of Zone 3 and the high pressure area of Zone 4 by adding an additional source of Zone 3 water. By adding the Zone 3 supply pipeline a small portion of Zone 3 can be moved to Zone 4 and a small portion of Zone 4 could be moved to Zone 3. After making the changes, the new pressures in the portion of Zone 4 would range from 115 psi to 125 psi. On the other hand, moving the area currently in Zone 4 to Zone 3 would result in a pressure reduction of about 70 psi. The resulting maximum and minimum pressures for that area are expected to be about 80 psi and 55 psi, respectively. The City's previous drinking water master plan recommended that both boundary changes should be completed; however, as mentioned previously lowering pressures can be difficult. For that reason, moving the Zone 3 area to Zone 4 is a recommended change, but moving the Zone 4 area to Zone 3 should be considered according to City preference. If only the Zone 3 to Zone 4 change is pursued, the entirety of Project D-19 may not be required. Instead only the portion north of 8560 South would be needed.

Similar to several of the previously discussed pressure issues, the low pressures in Zone 5 can be addressed through zone boundary changes. Analysis of the area around 7500 South 6630 West showed that all of Phase 3 of the Maples at Jordan Hills Subdivision should be in Zone 6. The modifications needed to make the boundary change are not expected to be extensive, and would raise the minimum pressures from about 42 psi up to about 90 psi.

Project D-21 is associated with the proposed Zone 3 Old Bingham Highway Tank. In order to utilize the equalization storage of the new tank, additional transmission capacity will be needed along Old Bingham Highway between the tank site and 9000 South. In addition, the capacity of the 102 & 56 JVWCD connection should also be increased along with the transmission lines between the connection and the tank in order to increase the source capacity to Zone 3.

Table 5-3 lists the remaining distribution recommendations that were developed for this master plan. Locations of these projects are illustrated on Figure V-4 in accordance with the ID number listed in Table 5-3.

TABLE 5-3
EXISTING DISTRIBUTION SYSTEM RECOMMENDATIONS

ID	PROBLEM	PROPOSED SOLUTION
D-1	PRV is located in 9000 South and access is difficult and dangerous	Install new 12-inch PRV and vault on the north side of 9000 South at about 3700 West (UDOT Project)
D-2	PRV vault collects water	Rehab PRV at 3850 West 7800 South (State Shops), run power to the vault and install fan and sump pump
D-3	During off peak season, the smallest pump is still larger than needed	Install a VFD on the smallest Zone 2 booster pump by the Airport Tanks at 4070 West 7800 South
D-4	PRV is old and worn	Install a new 6-inch PRV in the existing vault at 6400 South 2800 West (Vault Rehab, Diamond)
D-5	PRV is old and worn	Install a new 12-inch PRV and vault at 7000 South 3100 West (Carter Commons)
D-6	PRV is old and worn	Install a new 6-inch PRV in the existing vault at 2900 West 8250 South (Bluegrass)
D-7	PRV is old and worn	Install a new 8-inch PRV in the existing vault at 7800 South 3040 West (Dill Rental)
D-8	PRV is old and worn	Install a new 6-inch PRV in the existing vault at 2920 West 7420 South, vault needs repair (Cathleen)
D-9	PRV is old and worn	Rehab PRVs and upgrade vault at 5400 West 7800 South (Randy's)

TABLE 5-3 CONTINUED

ID	PROBLEM	PROPOSED SOLUTION
D-10	PRV is old and worn	Install a new 8-inch PRV and vault at 7000 South 5400 West (Shadow Mountain)
D-11	Increase transmission capacity from pump station and complete pipeline in north side of 7800 South	Install 1,590 feet of 8-inch pipeline in 7800 South between 5360 West and 5100 West, 355 feet of 12-inch pipe between 5100 West and 5060 West, 1,175 feet of 16-inch pipe between 5060 West and 4880 West, and 480 feet of 12-inch pipe between 4880 West and 4800 West, and 70 feet of 16-inch pipe across 7800 South at 5060 West
D-12	High water user does not have service redundancy	Install 1,530 feet of 10-inch pipe in the business access road beginning at about 4980 West Old Bingham Highway and from that point north to about 9295 South then west to Winter Berry Drive, then north in Winter Berry Drive to connect to the existing 12-inch pipeline in Wild Acres Drive.
D-13	Elevated flow velocity in existing 30-inch pipeline	Install a new connection between the existing 30-inch pipeline and the existing 16-inch pipeline at about 5490 West 7800 South
D-14	High velocities in Wheatridge Lane Pipes, Lack of redundancy	Install 3,120 feet of 12-inch pipe in 5600 West between New Bingham Highway and 8200 South
D-15	N/A	Improve Old Bingham Reservoir, Terminal Reservoir, U-111 Reservoir, and Barney's Reservoir sites with landscaping
D-16	Lack of indoor storage space for water parts and fittings	Construct a new facility at a location to be determined
D-17	Low pressures in Zone 1	Pressure Zone 1 west of 2700 West should be segregated to form a new Zone 2a and 2b pressure zones.
D-18	Zone 2a Transmission	Install 7,900 feet of 12-inch pipeline in 2700 West between 6600 South and 7800 South
D-19	Low pressures in Zone 3	Pressure Zone 3 & 4 boundary relocation including the installation of 4,605 feet of 8-inch pipe beginning at 4900 West 9000 South and proceeding north to 8900 South 4910 West and in McGinnis Lane between 4910 West and New Bingham Highway.
D-20	Low pressures in Zone 5	Move phase 3 of the Maples at Jordan Hills Subdivision to Zone 6
D-21	Inadequate transmission for proposed Zone 3 Old Bingham Highway Tank	Install 2,435 feet of 16-inch pipe between the existing 102 & 56 JVWCD connection and the proposed Zone 3 Old Bingham Highway Tank. Install 6,300 feet of 24-inch pipe in Old Bingham Highway between 5600 West and 4850 West parallel to the existing pipe, 2,685 feet of 18-inch pipe in Old Bingham Highway between 4850 West and 4470 West parallel to the existing pipe, 1,900 feet of 24-inch pipe in Old Bingham Highway between 4470 West and the intersection with 9000 South parallel to the existing pipe, and 135 feet of 16-inch pipe across 9000 South to connect with the existing 12-inch pipeline on the north side of the street.
D-22	Well 3 relocation	Install 1,500 feet of 10-inch pipeline to connect Well 3 to the existing Zone 3 pipe in New Bingham Highway

Recommended PRV Settings

During the course of analyzing the system the PRV settings were adjusted with the goal of maximizing the usage of equalization storage while minimizing pressure fluctuations and energy costs. Table 5-4 presents the PRV settings which are recommended for the system.

TABLE 5-4
RECOMMENDED PRV SETTINGS

PRV Name	PRV Address	From Zone	To Zone	Elevation (ft)	Setting (psi)
N/A	7800 South 2700 West	2	1	4,454	54
N/A	8600 South 2700 West	2	1	4,476	42
N/A	9000 South 2200 West	2	1	4,446	50
Dill Rental	7800 South 3040 West	2	2a	4,474	68
Carter Commons	7000 South 3100 West	2	2a	4,466	72
Diamond	6400 South 2800 West	2	2a	4,441	83
Cathleen	2920 West 7420 South	2	2a	4,467	71
Bluegrass	2900 West 8250 South	2	2b	4468	70
N/A	7000 South 2700 West	2a	1	4,441	60
Chevron	3760 West 7000 South	3	2	4542	54
State Shops	3850 West 7800 South	3	2	4549	68
Vista West	9000 South 3600 West	3	2	4603	44
Chevron	3760 West 7000 South	3	3A	4542	80
Theater North	7200 South 3800 West	3	3A	4542	80
Theater South	7400 South 3800 West	3	3A	4554	84
Lowe’s	7335 Jordan Landing Blvd	3	3A	4552	87
Mountain America	7700 South 3800 West	3	3A	4548	89
Old Bingham	4000 West Old Bingham Highway	3	3B	4609	65
N/A	7800 South 4000 West	3	3B	4578	70
N/A	9000 South 3600 West	3	3B	4604	70
Glenmore	4800 West Old Bingham Highway	4	3	4773	40

TABLE 5-4 CONTINUED

PRV Name	PRV Address	From Zone	To Zone	Elevation (ft)	Setting (psi)
Library	9000 South 4910 West	4	3	4756	45
Jordan Highlands	5333 West New Bingham Highway	4	3	4770	40
Randy's	5400 West 7800 South	4	3	4767	50
Shadow Mountain	7000 South 5400 West	4	3	4769	40
Oaks	8200 South 6300 West	5	4	4895	45
Sycamores	7025 W 7800 S	6	5	5035	56
Bridgeport	8600 South U-111	6	5	5068	50
Maples	6600 W 7400 S	6	5	5066	40
N/A	7025 W 7800 S	6	5	5035	56
Kraftmaid	7025 W 7800 S	JVWCD	5	5066	60

ANALYSIS RESULTS OF THE BUILD-OUT SYSTEM

The build-out system was analyzed based on the same parameters that were considered for the existing system. Assuming that the existing deficiencies will be addressed as outlined within the previous sections, there was one area within the build-out model where the nodes were not able to meet the City's minimum pressure standard of 50 psi under peak instantaneous conditions. The area that was not able to meet the minimum pressure guidelines was located within the southwest part of Zone 4. Pressures in that area reached about 44 psi. The high pressure standard of 130 psi was met for all areas, as long as the proscribed high pressure solutions were implemented.

No new fire flow pressure deficiencies were identified in the model under build-out conditions. It was assumed that the build-out fire flow requirement would mirror the existing requirements and also that all proposed projects identified to correct existing fire flow deficiencies would be completed. A copy of the build-out model is included on the CD in Appendix D.

BUILD-OUT DISTRIBUTION SYSTEM RECOMMENDATIONS

Table 5-5 lists the build-out distribution recommendations that were developed for this master plan.

The low pressures in the southwest corner of Zone 4 are located in areas that are mostly undeveloped. However, should the City desire to increase the pressures to that area, it can be accomplished by carving out a small Zone 5a in the southwest area of Zone 4. The new Zone 5a could be supplied by the JVWCD Deadmans connection. A PRV would be needed at 9400 South Hawley road. Isolation valves would also need to be closed along Bagley Park Road at about 9400 South and at the intersection with Old Bingham Highway.

TABLE 5-5
BUILD-OUT DISTRIBUTION SYSTEM RECOMMENDATIONS

ID	PROBLEM	PROPOSED SOLUTION
D-23	Transmission is needed for new Zone 3 North Tank	Install 5,250 feet of 16-inch pipe in 7800 South between 5360 West and 5900 West then north to the proposed Zone 3 North Tank site
D-24	Well's Park PRV needs to be replaced	Replace the existing PRV with a new 12-inch PRV and vault just west of Mountain View Corridor along Old Bingham Highway
D-25	Source transmission is needed for Terminal Tank	Install 5,260 feet of 16-inch pipe in the future 6700 West between 10200 South and the Terminal Tanks
D-26	Source transmission is needed for new Zone 5 North Tank	Install 2,575 feet of 16-inch pipeline between the proposed Zone 5 pump station at the U-111 Tanks and the 6950 West 10200 South JVWCD connection
D-27	Outflow transmission is needed for new Zone 5 North Tank	Install 3,540 feet of 16-inch pipeline between the proposed Zone 5 North Tank and 6700 West 7400 South
D-28	Transmission is needed for new Zone 5 South Tank	Install 6,220 feet of 24-inch pipe along New Bingham Highway between 7400 West and 6550 West and 1,370 feet of 20-inch pipe in New Bingham Highway between 6550 West and 6400 West. Install 170 feet of 16-inch pipeline across New Bingham Highway at 6400 West
D-29	Transmission is needed for new Zone 7 North Tank	Install 5,000 feet of 12-inch pipeline between the proposed Zone 7 North Tank and the Zone 7 distribution pipes
D-30	Transmission is needed for new Zone 7 South Tank	Install 3,260 feet of 16-inch pipeline between the proposed Zone 7 South Tank and the Zone 7 distribution pipes
D-31	Upsize reimbursements	This represents money that will be set aside to reimburse developers for required oversizing

The remaining future distribution projects are associated with providing transmission capacity to future storage tanks. It is expected that these projects may change somewhat as compared to current projections depending on the availability of land and other considerations that may affect the final locations of the proposed storage tanks.

Aside from the above recommended projects, additional transmission pipelines are expected to be installed as the City expands to the west. The locations and lengths of these transmission pipelines will vary somewhat depending on the final location of future streets and, for that reason, specific projects have not been included. Instead miscellaneous future pipes larger than 10 inches have been categorized according to size and the lengths of the individual pipelines have been summed with the results shown in Table 5-6. The locations of these pipes are illustrated on Figure V-4.

TABLE 5-6
ADDITIONAL FUTURE PIPES

Pipe Size	Length
10-inch	40,955
12-inch	70,560
16-inch	7,965
20-inch	200
24-inch	1,060

OPTIMIZATION

Three parameters drive the operation of a water system: system performance, water quality, and energy efficiency (Figure V-5). Water systems can be characterized by any degree or combination of these three parameters. One system may perform well but incur high energy costs. Another may be energy efficient but is not sufficiently pressurized during peak demand. Another may perform well hydraulically but fail to meet requirements for chlorine residual. System optimization is the process whereby a distribution network is evaluated in order to identify potential improvements that will allow the network to operate in the region where energy efficiency, system performance, and water quality are balanced.

System optimization was considered throughout the development of this master plan. One of the basic principles used was to limit unnecessary energy losses. Energy losses have a direct impact on energy efficiency and system performance. Moreover, many of the changes which reduce energy losses also promote water circulation, which improves water quality. The following paragraphs describe how optimization was applied in the development of the recommendations included in this master plan.

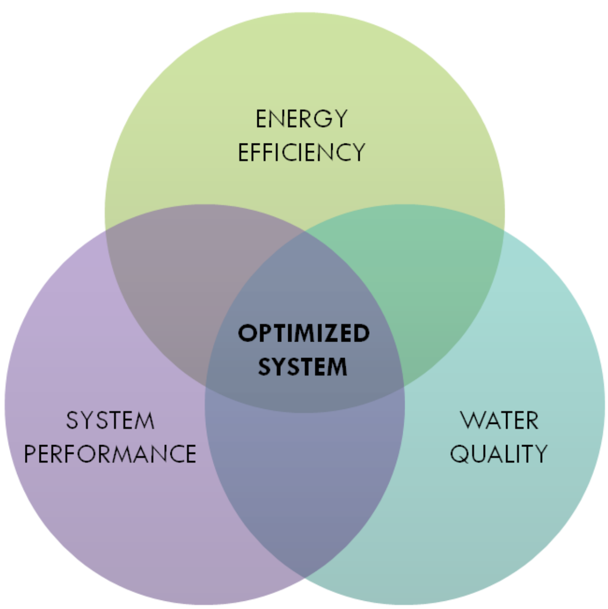


FIGURE V-5: WATER SYSTEM OPTIMIZATION DIAGRAM

The PRV settings are an ideal example of the application of optimization principles. PRVs can provide a useful means of reducing pressure fluctuations in lower zones by allow water to flow during peak flow events. However, setting a PRV too high can have the opposite effect within the upper zone. High PRV flows elevate the flow velocity in the upper zone which in turn increases pressure fluctuations. Furthermore, high PRV settings prevent the equalization storage in tanks from being fully utilized. The solution is to set the PRVs at a level where pressures in the lower zones are protected, but flow through the PRV is limited. The settings included above were chosen to keep daily pressure fluctuations under 10 psi while maintaining a minimum pressure of 50 psi under non-emergency flow conditions.

Another example of using system optimization principles is the recommendation to add Zone 5 storage tanks. In analyzing the system, high pressure fluctuations were observed in Zones 5 and 6. It was found that a primary contributor to the elevated pressure fluctuations was the high demands imposed by Zone 5 due to the lack of Zone 5 storage. The analysis showed that transmission would need to be increased from the Zone 6 pump stations all the way to the Zone 6 Tanks in order to convey the relatively high flows. In order to mitigate the need for the lengthy transmission pipeline, the feasibility of adding Zone 5 storage was explored. Two advantages were readily apparent. First, the transmission pipelines would not need to be as long and, second, pumping costs could be greatly reduced. As mentioned earlier in this report, the difference in head between Zones 4 and 6 is about 300 feet, while the difference between Zones 4 and 5 is about 130 feet. By making some basic assumptions, the potential monthly savings in pumping costs can be estimated. Based on the state standard for peak day source requirements, the build-out peak day demand for Zone 5 that is to be supplied by the booster pumps is 10,300 gpm. However, since state standards include some conservatism, applying a 10% reduction may give a more reasonable estimate for a peak day build-out flow. A further 20% reduction applied to the peak day flow gives a reasonable estimate for a peak month flow. Assuming these reductions gives a peak month flow of 7,400 gpm. Using the aforementioned 300 feet and 130 feet values for head, and assuming a cost of $0.15 kW/hr gives costs of about $67,000 and $29,000, respectively, for the two scenarios. Therefore, under build-out conditions, the potential savings in pumping costs are about $38,000 for a peak usage month.

Reconfiguring Well 3 to pump into Zone 3 is an additional example of a project that promotes energy efficiency. Well three currently pumps to Zone 4. If the water is flowing from Zone 3 down to a lower Zone for use, the extra energy needed to pump the water up to Zone 4 pressure is wasted.

In addition to the projects above, there are a few additional projects that West Jordan should consider. There first would be to supply Zone 2a directly with water from the 7000 South Bangerter JVWCD connection. A review of the connection indicates that it has sufficient pressure to directly supply water to Zone 2a. Under existing conditions, water for the JVWCD connection is reduced to Zone 1 pressure, pumped up to Zone 2 pressure, and then reduced to Zone 2a pressure. Directly supplying water to Zone 2a with eliminate the unnecessary pumping.

Another project which was given cursory consideration involved providing a dedicated pipeline between the JVWCD aqueduct in Bangerter highway to the Airport Tank pump station. The purpose of the pipeline would be to allow water at the JVWCD connection head to be pumped directly to Zone 2 without first going through Zone 1. Presently, the water from the Bangerter Highway JVWCD connections is not at a high enough head to directly enter pressure Zone 2, so it routed down to Zone 1. The water is then pumped back up to Zone 2. In pumping to Zone 2, about 140 feet of head is added. For comparison, if the water was pumped directly from the JVWCD connection head, only 50 feet of head would need to be added. It is estimated that pumping costs could be reduced by more than 60%. The feasibility analysis of this project is beyond the scope of this master plan and for this reason the project has not been included within the recommendations. However, due to the large potential for cost savings, it is recommended that a more complete feasibility analysis should be pursued.

CONTINUED USE OF THE COMPUTER PROGRAM

It is recommended that the City continue updating the model as the water system changes. Below is a list of ways in which the model could help the City with water system management. The computer model can assist City staff in determining:

- Effect on the system if individual facilities are added or taken out of service
- Selection of pipe diameters and location of proposed water mains
- Capacity of the water system to provide fire flows in specific areas
- Water age for water quality monitoring
- Residual chlorine and fluoride levels in the system

The computer model should be maintained for future use. Necessary data required for continued use of the program are:

- The location, length, diameter, pipe material, and ground elevation at each end of each new pipeline constructed
- Changes in water supply location and characteristics
- Location and demand for new large customers
- Changes in chlorine and fluoride dosing rates and procedures

CHAPTER 6

WATER QUALITY

Several water quality parameters were analyzed and compared using the extended-period model. Parameters analyzed included chlorine residual, fluoride, and water age. Each water quality parameter analyzed is discussed in the following sections.

CHLORINE RESIDUAL

While chlorine is an effective disinfectant in controlling many microorganisms in drinking water, it reacts with natural material found in drinking water to form potentially harmful disinfection byproducts (DBPs). Although the risk of becoming ill from microbial pathogens is tens of thousands of times greater than the risk of becoming ill from DBPs, it is enough of a concern that the Environment Protection Agency (EPA) has developed rules to balance the risks between microbial pathogens and DBPs. A drinking water system needs enough chlorine to destroy pathogens but also not produce excessive DBP.

Chlorine residual is the amount of chlorine remaining in a water sample at the time of testing. The model uses a bulk rate coefficient, which was set at –0.2/day for this analysis, to simulate the decay reaction of chlorine. The decay rate was selected based on calibrated water quality models of JVWCD's system and chlorine residual data provided by West Jordan City. The actual decay rate is influenced by the amount of organic material in the water.

The City does not chlorinate water from the wells. The only source of chlorine comes from the wholesale water from JVWCD. The JVWCD connections were defined with a source quality of about 0.8 mg/L based on models of JVWCD's system. Chlorine field test results were compared to modeled values with the results shown in Figure 6-1.

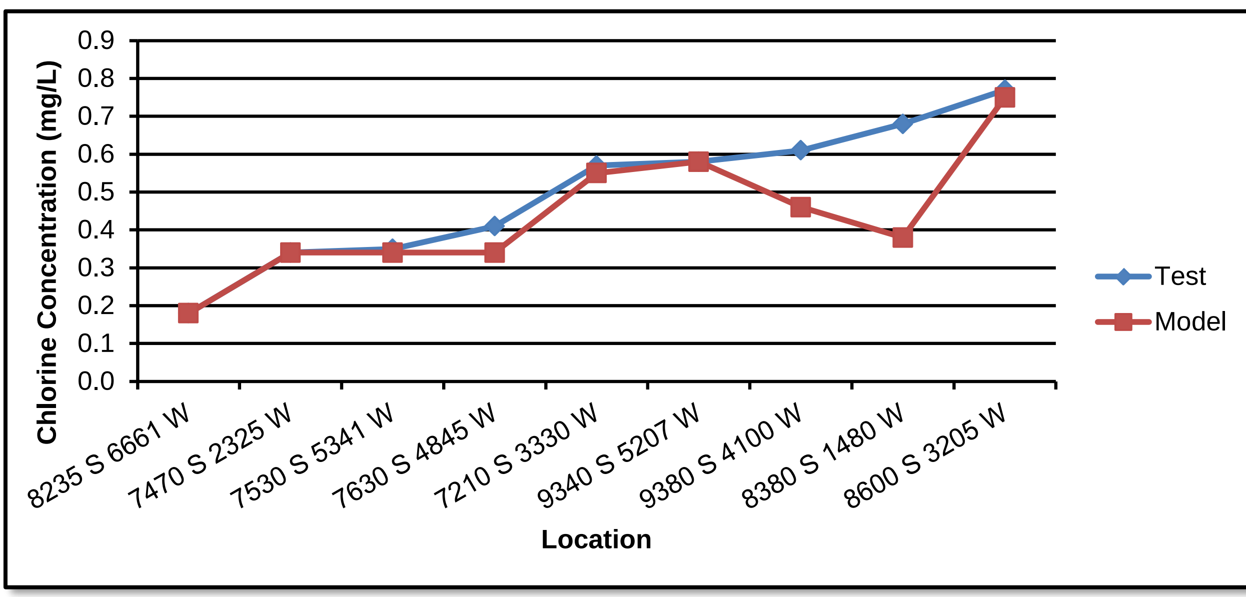


FIGURE 6-1: CHLORINE RESIDUAL FIELD TEST AND MODEL RESULTS

The model values generally agree very well with the test values. The two largest discrepancies between the model and test results at 9380 S 4100 W and 8380 S 1480 W may arise from differences in the operational status of the drinking water wells. As the wells operate, they push unchlorinated water out into the system.

Simulated chlorine residuals after 96 hours of simulation are shown in Figure 6-3. Notice that areas around the wells exhibit low values, depicted in dark blue. The areas near the JVWCD connections have higher chlorine residual. This pattern is also characteristic of fluoride concentrations because chlorine and fluoride are not added to the well water.

FLUORIDE

The extended period model was also used to analyze fluoride concentration over time in the City's drinking water system. Fluoride is a mineral that occurs naturally in most drinking water supplies. Water pumped from the City's wells naturally has about 0.1 to 0.2 parts per million. In the 1940's, it was discovered that residents served by water supplies with just the right amount of fluoride had a significantly reduced amount of dental cavities without serious side effects. Water systems started adding fluoride to the water to get that optimum amount of fluoride. In the year 2000, the residents of Salt Lake County passed a resolution that requires all public water suppliers to add fluoride to the water they deliver. The City does not add fluoride to the well water, but the water from JVWCD has fluoride added to the water. The EPA recommends that water systems add enough fluoride to the water to have a total concentration of 0.7 parts per million without going over.

Fluoride concentration rates for JVWCD sources were set at 0.7 parts per million. Fluoride does not grow or decay, so the model simply calculates resultant concentrations. The model was run long enough for the fluoride concentrations to stabilize which took about three days depending on the water demand. Total fluoride field test results from the City and from the JVWCD hydraulic model were used to calibrate the model with the calibration results shown in Figure 6-2.

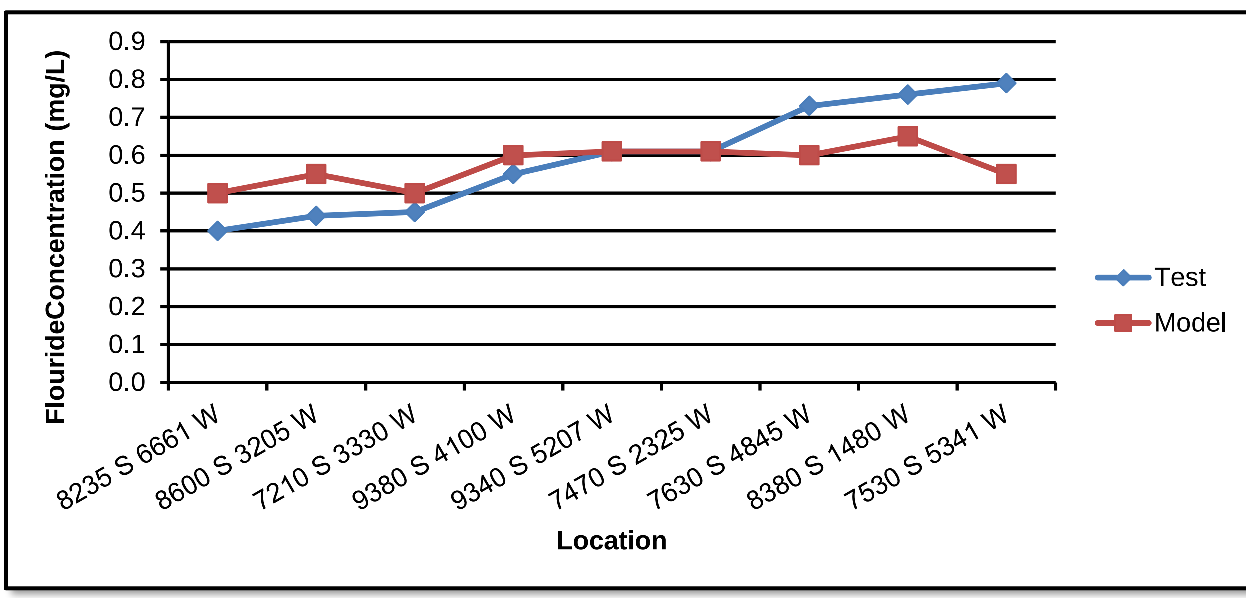


FIGURE 6-2: FLOURIDE CONCENTRATION FIELD TEST AND MODEL RESULTS

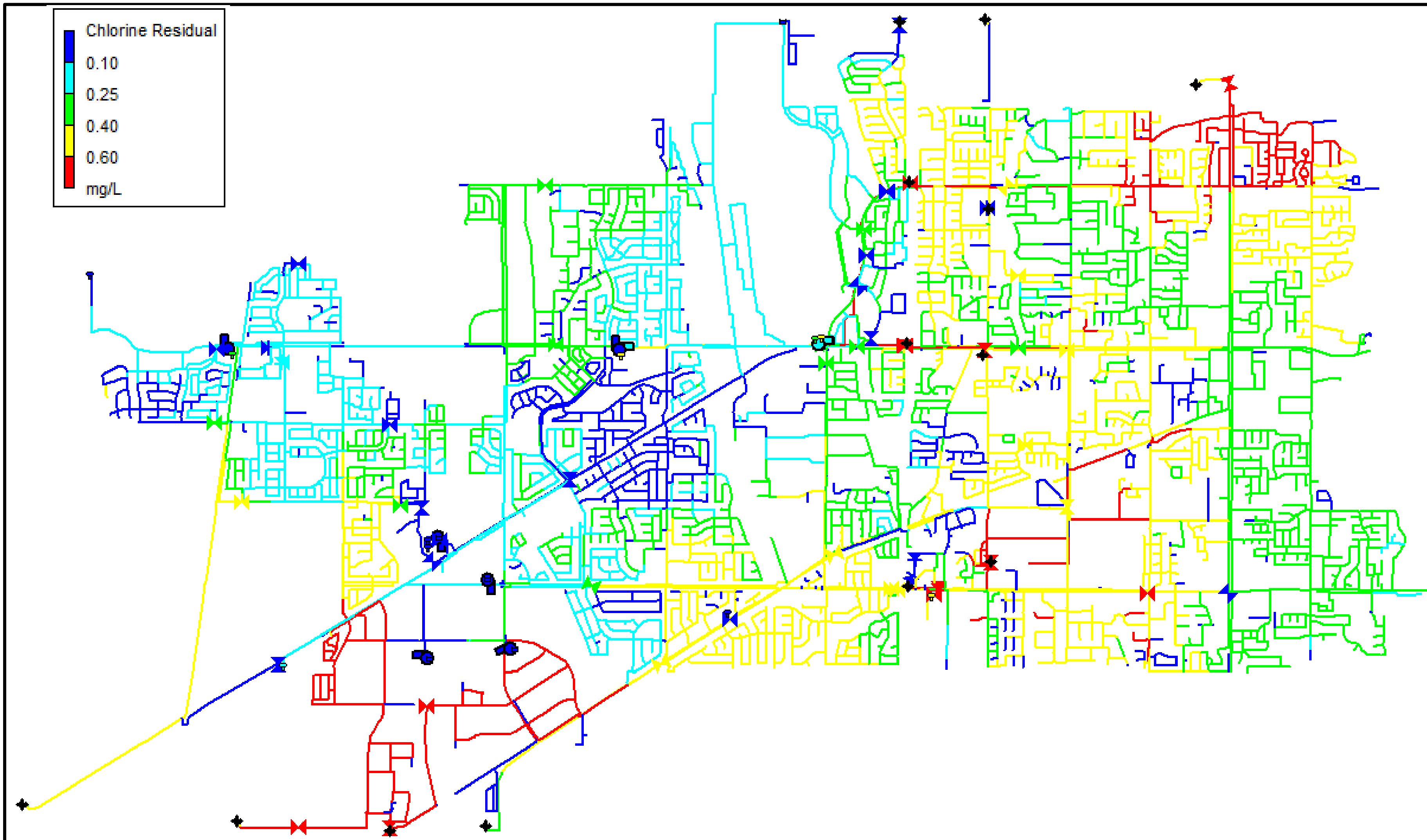


FIGURE 6-3: CHLORINE RESIDUAL AT 72 HOURS

As described regarding chlorine, it is believed that the discrepancies between the model and test concentrations of fluoride are a result of differences in the operational status of the drinking water wells in the model as compared to the drinking water system on the day of the tests. Figure 6-4 presents the results of the fluoride concentration scenario for the Existing Model during a summer scenario.

Fluoride concentrations appear to be even across the City. As to be expected, areas near the wells with no fluoride dosing have lower fluoride concentrations and areas near the JVWCD connections are slightly higher. The areas of red indicating fluoride concentration above 0.7 parts per million in the results are just at or barely above 0.7 parts per million. The only way to eliminate the pockets of lower fluoride concentration is to put fluoride dosing at every well. Overall it appears that the City does well at maintaining the proper fluoride concentration. It is recommended that the City use the model to refine a fluoride concentration plan if necessary to better meet the goals of the City.

WATER AGE

The extended period model was used to predict the areas in the water system that have the highest potential for DBP production. The potential for DBP production is higher in warmer and older water, so a water age model typically follows a similar pattern to where DBP production has the highest potential. Water age was calculated for every location in the system by running the model to simulate several days in the summer scenario. The locations having poor circulation and thus the oldest water are usually also the areas that have the highest potential for DBP production. Figure 6-5 illustrates the results of the water age model scenario at 96 hours using the Summer Existing Model.

Most of the system receives fresh water every three days. It appears that dead end lines have the worst circulation in the model. It is recommended that the District use the water age model to make sure DBP sampling is occurring at the locations with the highest DBP production potential. It is also recommended that the District use the water age model to identify an effective flushing plan.

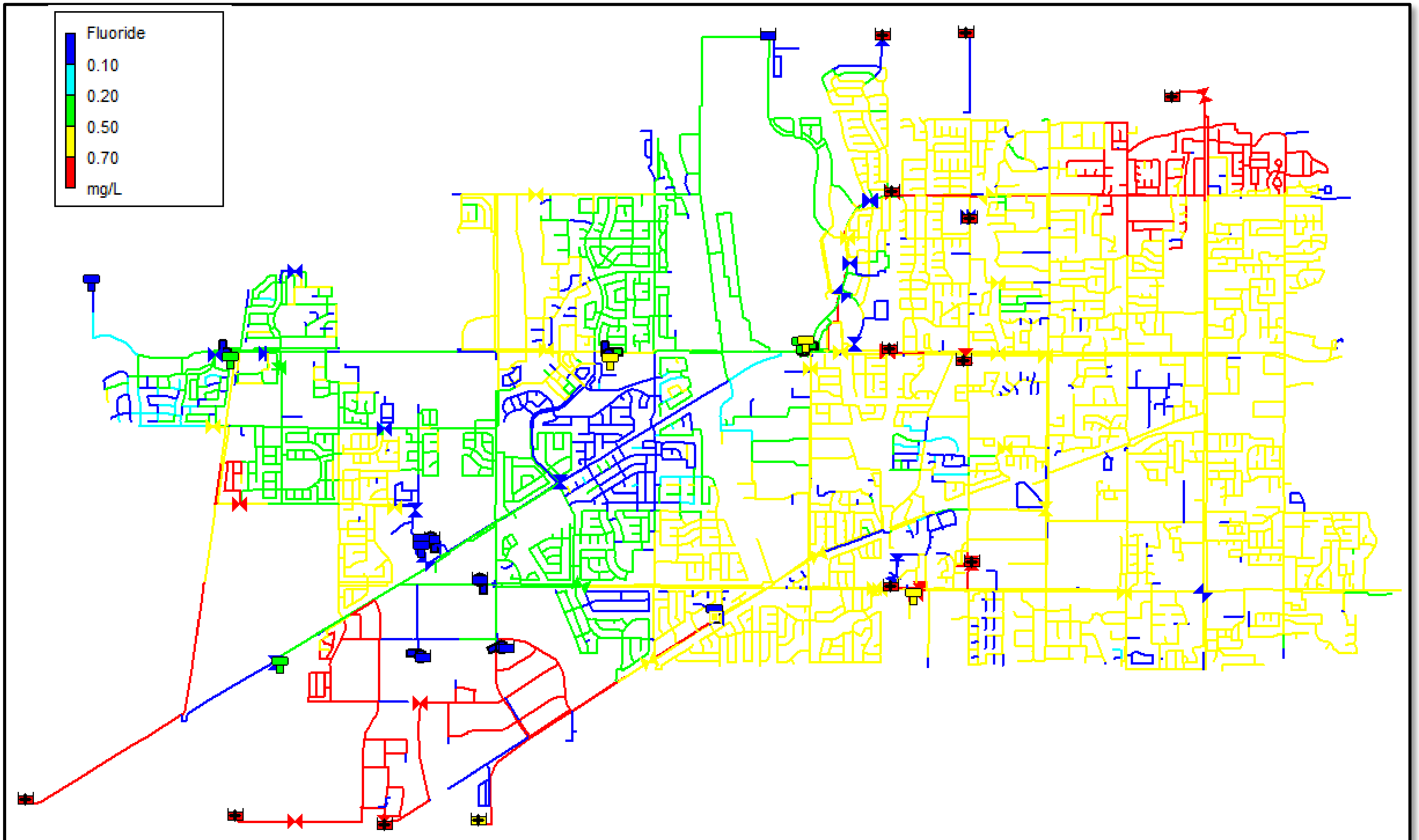


FIGURE 6-4: FLOURIDE AT 72 HOURS

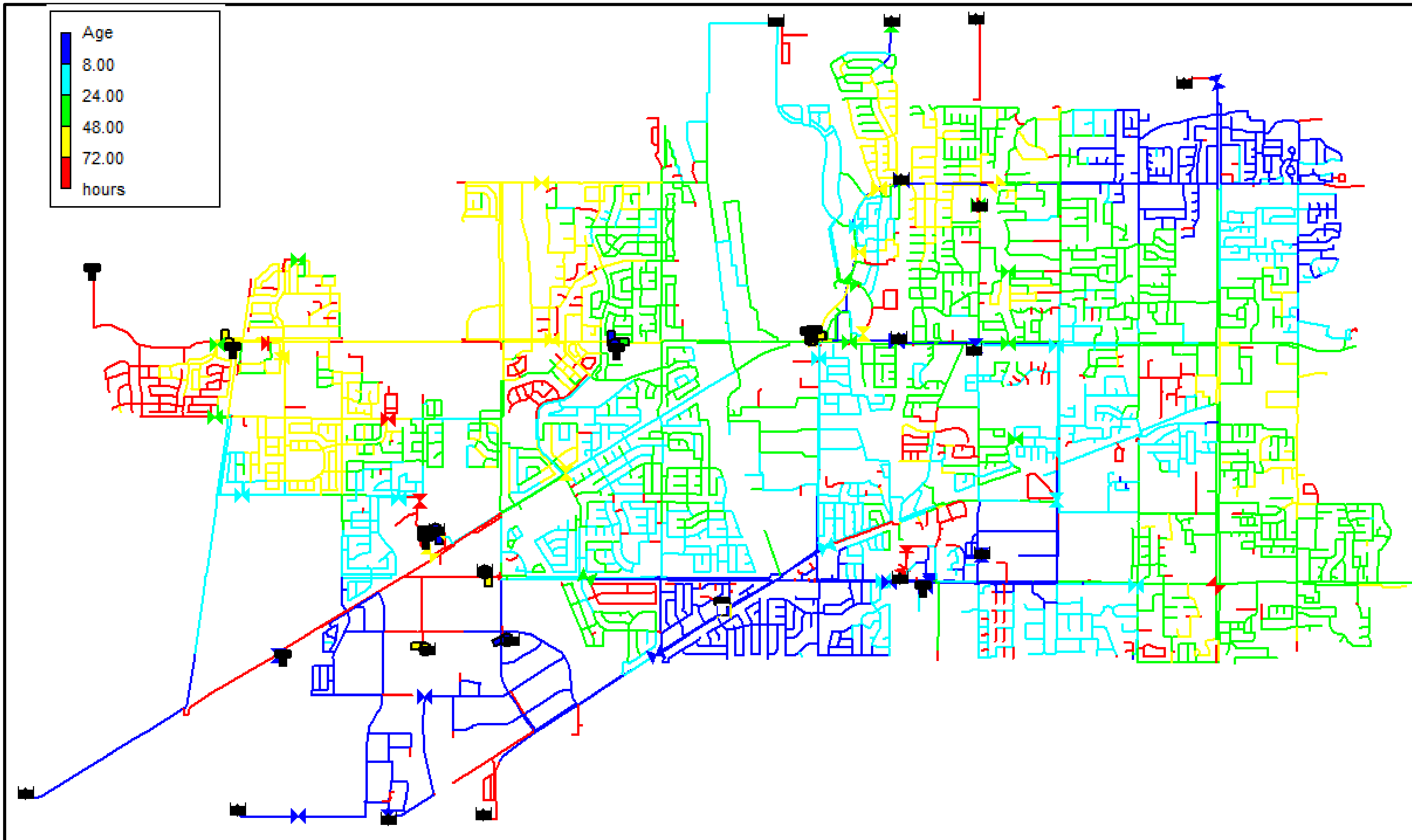


FIGURE 6-5: WATER AGE AT 96 HOURS

CHAPTER 7

SCADA MASTER PLAN

Chapter 7 prepared by Hegerhorst Power Engineering

PURPOSE

The purpose of this SCADA Master Plan is to provide a technical summary of the existing telemetry equipment, evaluation and recommendations for upgrading and replacing existing SCADA equipment, and, for budgeting purposes, provide cost projections for upgrades to the telemetry system. Recommendations on when to upgrade will also be provided.

SCOPE

The scope of the SCADA Master Plan includes a summary of the existing SCADA equipment, both the Master Station and the Remote Telemetry Units (RTU's). It also includes a few paragraphs on new technology, which may be appropriate for the City to consider. Finally, the costs of additional SCADA equipment are provided.

GLOSSARY OF TECHNICAL TERMS

Bandwidth: The rate that data can be transmitted. Higher frequency radios can transmit more data than lower frequency radios.

Central Processing Unit (CPU): A CPU is the electronic circuitry within a computer that carries out the instructions of a computer program by performing the basic arithmetic, logical, control and input/output operations specified by the instructions.

Human-Machine Interface (HMI): The user interface is the space where interactions between humans and machines occur.

Random Access Memory (RAM): RAM is a form of computer data storage.

Remote Telemetry Unit (RTU): A RTU is a microprocessor-controlled electronic device that interfaces objects in the physical world to a distributed control system or SCADA system by transmitting telemetry data to a master system and using messages from the master supervisory system to control connected objects.

Supervisory Control and Data Acquisition (SCADA): Is a system operating with coded signals over communication channels so as to provide control of remote equipment. The control system may be combined with a data acquisition system by adding the use of coded signals over communication channels to acquire information about the status of the remote equipment for display or for recording functions.

Very High Frequency (VHF): Is the International Telecommunications Union designation for radio frequencies in the range between 30 MHz and 300 MHz. VHF propagation characteristics are suited for short-distance terrestrial communication, with a range generally somewhat farther than line-of-site from the transmitter. These radio waves can bend somewhat over the earth.

Ultra High Frequency (UHF): Is the International Telecommunications Union designation for radio frequencies in the range between 300 MHz and 3 Ghz. UHF radio waves propagate mainly by line of sight; they are blocked by hills and large buildings although the transmission through building walls is high enough for indoor reception.

Uninterruptible Power Supply (UPS): An uninterruptible power supply is an electrical apparatus that provides emergency power to a load when the input power source fails.

EXISTING MASTER STATION COMPUTER HARDWARE

The existing Master Station consists of Pentium 3.16 CPU based computers, a uninterruptible power supply, wall mounted 42" operator display, keyboard, mouse and printer.

Computer Dell Precision T5400
- Standard desktop case
- CD/DVD drive(s)
- Operating System: Windows XP
- Processor: 3.16 GHz CPU
- Installed memory (RAM): 3.25 GB
- Hard Drive: 300 GB
- HMI Software: Wonderware v9 (1997)

The Operator display is a ViewSonic wall mounted TV monitor. This has a resolution of 1024 x 768.

EXISTING MASTER STATION COMPUTER SOFTWARE

The operating system for the existing computers is WindowsXP.

MASTER STATION HUMAN MACHINE INTERFACE SOFTWARE

The Human Machine Interface (HMI) software is Wonderware v9. This was originally put in by US Filter in 1997. At that time the license consisted of a development/runtime license. In 2003, West Jordan added SCADAlarm dial out software. In 2004, West Jordan added some Terminal Server runtimes, which allow for remote access on mobile devices. The license for West Jordan City allows for 50,000 points.

EXISTING RADIO TELEMETRY SYSTEM

There are two radio systems presently installed which communicate from the Master Station to the remote sites. These radio systems consist of a transceiver (transmitter/receiver), coaxial antenna cable, and an omnidirectional antenna. One system operates on a frequency of 173 MHz (VHF). The other is operating on 450 MHz (UHF). The City presently does not use any unlicensed data radios.

Data radios operate in a bidirectional pair, transmitter to receiver. The data radio at the master station must be compatible with the remote site. However, one master data radio can be compatible with a host of remote sites.

EXISTING DATA RADIO’S

The City’s system currently is using Datalink serial radios and Siemens SixNet RTU’s. The communications protocol is Modbus ASCII at 2400 baud. The City license and these radios can operate at up to 5 watts (RF transmission rating).

The City has data radios manufactured by CalAmp Integra-TR. The VHF radios are CALAMP Dataradio (Intragra-TR-600) and operate on 173.2625 MHz. The UHF radios are CALAMP Dataradio (DL-3400-510) and operate on 453.9125 MHz.

EXISTING RADIO ANTENNA(S)

The Master Station existing radio antennas are omnidirectional Laird antennas. This means that they deliver the same amount of RF energy in a 360 degree circumference around the antenna. This type of antenna is required for the Master Station to transmit and receive radio signals from anywhere around the City.

The remote sites use directional YAGI antennas. They are Laird Y1505-5 element YAGI antennas. The 173 MHz radios use 11 dBi gain antennas.

EVALUATION OF THE MASTER STATION

Computer Hardware:

The existing hardware is old and outdated. As with almost all computers, newer computer technology performs faster, can access greater memory and is usually considerably less expensive than maintaining aged computer hardware. In many cases, the latest software releases will not operate on the older computers.

For instance, replacing an existing 300 MB hard drive will require ordering a new hard drive with the same bus communications technology as the existing hard drives. Newer hard drives use different and faster bus communications technology; they are considerably larger in capacity for considerably less money.

Computer Operating System:

WindowsXP is a 12 year old operating system. In computer years, it is a very old operating system. Microsoft is no longer supporting or providing upgrades to WindowsXP.

One of the primary limitations of WindowsXP is the amount of memory programs can access. WindowsXP software can access just over 3 MB of RAM memory. To improve software performance, software developers wrote programs that required more RAM memory. For programs with large memory requirements, this caused WindowsXP operating system to page data to and from the hard drive. This slowed down program execution and performance.

Newer 64 bit computer CPU's were developed which allowed more RAM memory access. These computers, of course, required 64 bit operating systems. Software developers then converted their software to take advantage of the 64-bit operating systems. Today's hardware can commonly access several megabits of memory. This resulted in faster, better performing programs.

As with all computer operation systems, they will continue to require upgrading every 7-10 years.

EVALUATION OF EXISTING REMOTE SITES

Figure 7-1 shows the various locations for the monitored remote sites. Blue text represents storage tanks. Red text represents PRV stations. Green text represents Wells. Black text represents JVWCD metering stations. Table 7-1 is a list the SCADA RTU sites with latitude/longitude and I/O information.

West Jordan has a mixture of old and new hardware. This is quite common. As with almost all electronic technology, the few legacy sites with the oldest hardware are either impossible or very expensive to maintain. The replacement cost of older failed hardware is usually considerably more expensive than replacing with newer hardware. Compounding this, some of the older hardware requires older programming software, which no longer is compatible with the newer computer operating systems. So, to reprogram an older piece of equipment, one may need to use an older computer and software.

Another consideration at the remote sites is the field devices. The field devices consist of analog transmitters (level, pressure, flow) and discrete devices (position switches, pressure switches, level switches, etc.). For some analog devices such as flow meters, they are expensive. Typically, if they remain operational, they remain in service. They are only replaced when the repair cost exceeds the replacement cost. For the less expensive devices, upgrading them to newer devices should be considered on a case-by-case basis. They should be considered for replacement around a life span of 20 years, or if their physical condition has deteriorated to where they may become unreliable. Switching devices can usually remain in-service longer than analog devices. They should be inspected at roughly 20 years, and replaced within 30-40 years, depending on their physical condition.

The replacement consideration also applies to the PLC and/or CPU and/or data radios. Devices at remote sites that typically do not get updated (unless they fail) are antennas and coaxial cables.

When a field device fails, it is normal to replace it with the latest technology. Replacement of field devices such as pressure switches or pressure transmitters typically occurs on an as-needed basis, not necessarily when the RTU is upgraded. For remote sites that are receiving significant upgrades, replacing all the devices along with a new RTU would be considered normal. The old removed devices serve as ready spares for replacing failed devices.

Evaluating each and every field device at each remote site is beyond the scope of this Plan, however, the West Jordan SCADA staff are doing this on an on-going basis.

a. Priority Equipment Replacement Considerations - the following locations have hardware that is out-of-date and should be replaced with newer equipment as soon as possible:

    i. Shop - PLC & Radio (D620 system)
    ii. RTU09 - Dannon PRV (D620 system)
    iii. RTU27 - Deadmans meter (D620 system)
    iv. RTU30 - 8800 South 3200 South meter (D620 system)
    v. RTU35 - 7000 South Bangerter meter (D620 system)
    vi. RTU37 - 1700 West 6400 South meter (D620 system)

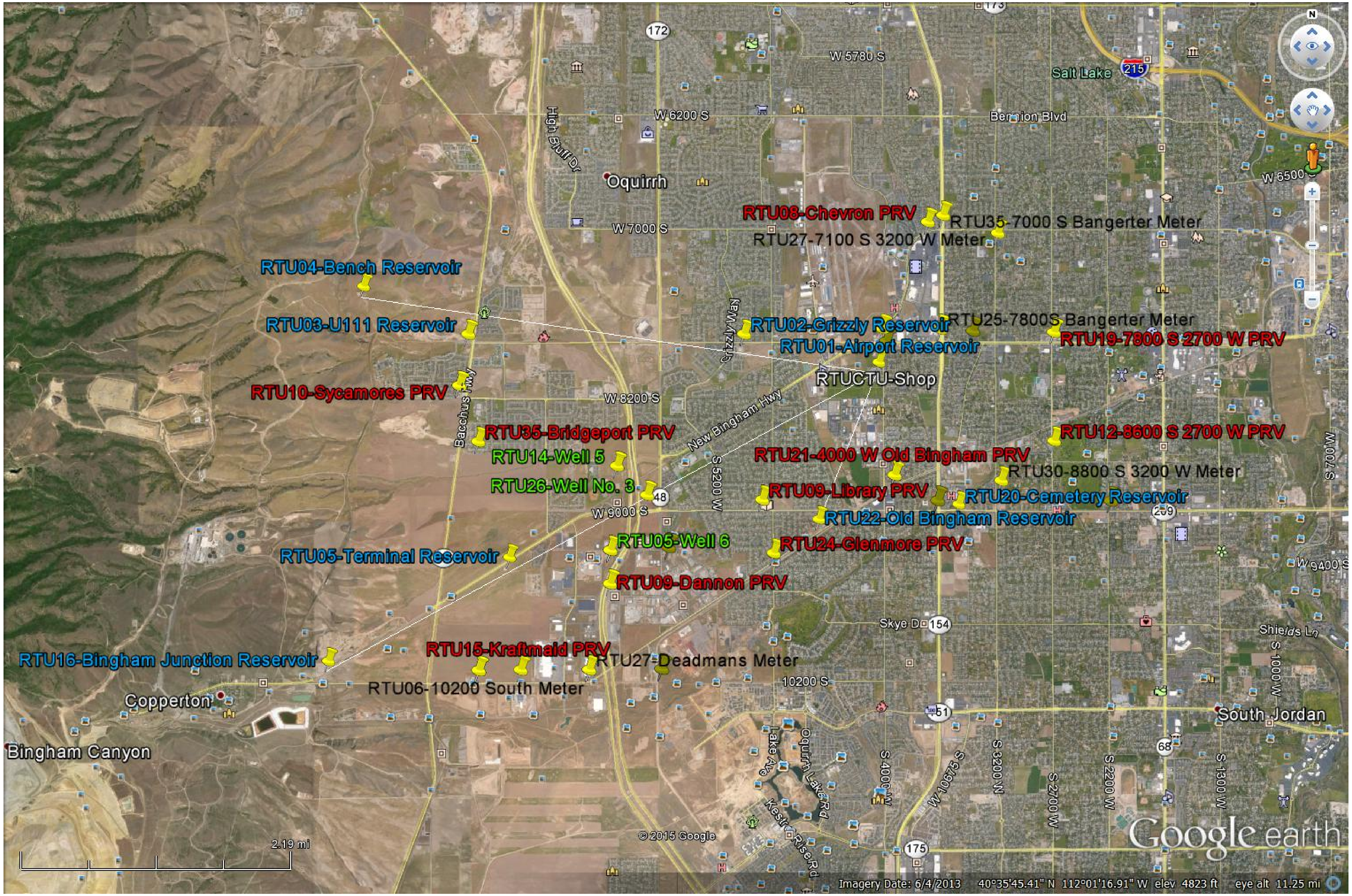


FIGURE 7-1: LOCATIONS FOR THE MONITORED REMOTE SITES

TABLE 7-1
SCHEDULE OF SCADA SITES

D620 RTU No.	LC3000 RTU No.	Location	Type	Latitude	Longitude	Elev (Google Earth)	Radio	Digital Inputs	Digital Outputs	Analog Inputs	Analog Outputs	Other
CTU	CTU	Shop	Shop	40° 36' 20.090" N	111° 59' 15.930" W	4599	VFH	0	0	0	0	2-CTU's at Shop
-	22	Old Bingham Reservoir	Reservoir	40° 35' 07.520" N	111° 59' 52.800" W	4714	VFH	2	2	10	0	2 relays
-	20	Cemetery Reservoir	Reservoir	40° 35' 14.300" N	111° 58' 27.375" W	4591	VFH	2	2	10	0	2 relays
-	1	Airport Reservoir/Booster	Reservoir/Booster	40° 36' 35.248" N	111° 59' 13.972" W	4603	VFH	38	10	12	0	2 relays, & 1)
-	4	Bench Reservoir	Reservoir	40° 36' 54.358" N	112° 04' 27.407" W	5345	VFH	1	0	1	0	
-	2	Grizzly reservoir/Booster	Reservoir/Booster	40° 36' 32.596" N	111° 59' 38.395" W	4721	VFH	77	9	13	3	9 relays
8	-	Terminal Reservoir	Reservoir	40° 34' 50.355" N	112° 03' 00.292" W	5061	UHF	1	0	1	0	
-	3	U-111 Reservoir/Booster	Reservoir/Booster	40° 36' 32.596" N	111° 03' 25.364" W	5056	VFH	54	8	15	3	8 relays
-	26	Well 3	Well	40° 35' 18.313" N	112° 01' 37.349" W	4900	VFH	17	1	6	1	1 relay
-	13	Well 4	Well	40° 34' 54.253" N	112° 01' 24.364" W	4885	VFH	7	2	8	0	1 relay
-	14	Well 5	Well	40° 35' 31.729" N	112° 01' 55.585" W	4908	VFH	8	4	8	0	3 relays
-	5	Well 6	Well	40° 34' 52.995" N	112° 01' 59.592" W	4930	VFH	27	7	10	1	3 relays
-	6	10200 South Meter	Meter	40° 33' 58.115" N	112° 03' 18.916" W	5148	VFH	2	0	2	0	
37	-	1700 West 6400 South Meter	Meter	40° 38' 03.230" N	111° 56' 20.340" W	4426	UHF					out of service
-	7	5600 West 10200 South Meter	Meter	40° 33' 58.339" N	112° 01' 28.569" W	4933	VFH	2	0	5	1	
35	-	7000 South Bangerter Meter	Meter	40° 37' 27.685" N	111° 58' 36.664" W	4522	UHF	2	0	4	0	
-	28	7100 South 3200 West Meter	Meter	40° 37' 19.487" N	111° 58' 03.167" W	5002	VFH	2	2	4	0	2 relays
-	34	7800 South Bangerter Meter	Meter	40° 36' 35.045" N	111° 58' 38.228" W	4534	VFH	4	2	10	4	
-	18	7800 South 3200 West Meter	Meter	40° 36' 33.360" N	111° 58' 03.640" W	4559	VFH	2	2	4	0	2 relays
30	-	8800 South 3200 West meter	Meter	40° 35' 24.700" N	111° 58' 01.416" W	4535	UHF	2	4	6	0	4 relays
27	-	Deadmans Meter	Meter	40° 33' 58.150" N	112° 02' 12.425" W	5002	UHF	2	0	3	0	
-	16	Junction Reservoir	Reservoir	40° 34' 03.311" N	112° 04' 48.511" W	5345	VFH	9	6	5	0	
-	17	2200 West 9000 South	PRV	40° 35' 15.171" N	111° 56' 54.171" W	4446	VFH	2	0	5	0	
-	21	4000 West Old Bingham PRV	PRV	40° 35' 27.341" N	111° 59' 06.708" W	4609	VFH	2	0	5	0	
-	23	4000 West 7900 South PRV	PRV	40° 36' 29.235" N	111° 59' 11.535" W	4578	VFH	2	0	5	0	
-	19	7800 South 2700 west PRV	PRV	40° 36' 33.484" N	111° 57' 28.911" W	4454	VFH	2	0	5	0	
-	12	8600 South 2700 West PRV	PRV	40° 35' 43.047" N	111° 57' 28.875" W	4476	VFH	2	0	5	0	
-	8	Chevron PRV	PRV	40° 37' 24.560" N	111° 58' 46.050" W	4542	VFH	2	4	8	0	4 relays
9	-	Dannon PRV	PRV	40° 34' 37.593" N	112° 01' 59.835" W	4961	UHF	2	4	1	0	4 relays
-	15	Kraftmaid PRV	PRV	40° 33' 58.272" N	112° 02' 53.708" W	5081	VFH	2	0	6	0	
-	9	Library PRV	PRV	40° 35' 16.0370" N	112° 00' 27.453" W	4764	VFH	2	4	6	0	4 relays
-	10	Sycamores PRV	PRV	40° 36' 08.672" N	112° 03' 30.756" W	5071	VFH	2	0	5	0	
-	11	Vista West PRV	PRV	40° 35' 15.580" N	111° 58' 40.385" W	4603	VFH	2	0	10	0	
-	24	Glenmore PRV	PRV	40° 34' 51.470" N	112° 00' 20.570" W	4476	VHF	2	0	6	0	
-	35	Bridgeport PRV	PRV	40° 35' 43.100"N	112° 03' 19.290" W	5071	VHF					

Notes : 1) RS485 to Genset

TELEMETRY SYSTEM OPTIONS

There are multiple transmission network protocol's commonly available for today's SCADA systems. Common protocols include ModbusRTU, serial and Ethernet. There are also multiple methods of transmitting signals from remote sites to the Master Station. These include cellular, master/remote and master/repeater/remote paths. West Jordan utilizes the master/remote method for serial data for the SCADA system.

There are approximately 37 protocol versions. Common ones used in SCADA systems are ModbusRTU, ModbusTCP. Modbus allows communications for up to 247 remote addresses.

Serial Protocol

Serial protocol (known as RS232) has been around for a long time. Serial protocol is limited to one transmitter to one receiver. Serial data is limited and does not permit one-to-many site transmissions. Therefore, for most SCADA systems, this protocol it is quite limiting and not used.

Addressable Serial Protocol

Due to the limitations of strict serial protocol, addressable protocols were developed to allow one master station to address multiple remote sites on the same radio frequency. They are known as RS485 protocols and include ModbusRTU and ModbusTCP. ModbusRTU is a serial protocol, while ModbusTCP is Ethernet based.

Ethernet based protocol considerations

One signal transmission protocol that SCADA systems use is Ethernet based and known as ModbusTCP. The radios are very low power and communicate on license free 902-928 MHz spread spectrum and/or 2.6 GHz frequencies. They require less Radio Frequency (RF) power to transmit data signals. Radio waves from these radios are more negatively affected by objects in their path, such as trees, leaves and buildings. They can however, transmit more data given the same time period as the lower frequency radios and they are less expensive.

ALTERNATIVES AND CONSIDERATIONS

There are several SCADA architecture options available today for telemetry systems. Some are based on the method of transmitting data from the remote sites, such as serial data radio. Within this group are various protocols, such as ModbusPLC, ModbusRTU. These are further segregated into manufacturers, such as Allen-Bradley DH+ protocol, or Profinet. Another common data protocol is Ethernet packets. Typically, these radios are the lower power at either 902-928 MHz or 2.6 GHz spread-spectrum frequency hopping unlicensed radios.

Radio systems only require a transceiver at the Master and the RTU sites. Other forms of data transmission include fiber optic cabling. For Districts or Municipalities that own their own overhead power distribution system, fiber optic data transmission is common. Typically, signal reliability and accuracy is increased with fiber optic systems. However, not all Owners are able to install fiber cabling.

Another form of data transmission is by using cellular data network. The Mission Communications M800 Series RTU can be installed at a remote site, data transmitted via the cellular network and can connect directly to the City's Wonderware HMI via OPC (Open Protocol Communications).

MASTER STATION

Master Station Hardware

For anticipated costs, refer to the Projected Costs section.

CPUs: Most of the computer CPUs manufactured today have adequate computational speed and capability for the HMI software. Since these computers will be dedicated to HMI software, purchasing CPUs with five-cores or smaller will be adequate. Having more CPU capability would not be needed.

RAM: Having at least 16 GB of RAM memory would ensure that the software would not be paging to/from the hard drive, which will ensure excellent speed and performance. RAM memory is relatively inexpensive.

Hard Drive: Computer hard drives of 1 or 2 Terabytes are common and inexpensive. For much faster startup and I/O, solid-state drives are also very reasonably priced.

Case/Power Supply: A full tower chassis lightweight case with adequate air ventilation is also inexpensive. The power supply should match the motherboard and hardware requirements.

Keyboard/Mouse: A wired keyboard and optical mouse with scroll wheel runs $25. Cordless devices are not recommended due to their reliance on batteries. With somewhat infrequent operator use, battery replacement for the keyboard and mouse become a nuisance, and offer minimal convenience.

Master Station Operating System Software

The Master Station Software required to run the HMI software is either WindowsXP or newer, or Windows 2003 Server. With WindowsXP, support is not available. Therefore the most stable platform is Windows7 Professional or Ultimate. As there are dual computers for the master station, each will need its own operating system.

Windows7 was introduced in 2009, and has a very popular base of users. With the advent of touch screen computers, Microsoft introduced Windows8. However, many SCADA computers have not made the transition to Windows8 and are operating on Windows7. It has proven itself as a stable and reliable operating system.

Microsoft just announced that Windows10 will be available soon. For one year, they are offering a free upgrade to Windows7, and 8 registered users. How stable Windows10 will be for SCADA HMI software is unknown at this time.

Master Station Operators HMI Software

Considerable time has gone into developing the various screens that are displayed. Behind these screens are several configuration files that define each Input/Output point in a SCADA system. When new, updated revisions of the HMI software are released, as part of the installation process the software automatically makes the appropriate configuration changes to the software database. Most software is upward compatible to the newer versions. Once converted, they typically are not downward compatible with the older HMI software. Therefore, a significant cost benefit is realized when updating, to keep with the same HMI software.

As with most software products, updating the software should be budgeted to occur roughly every 5-8 years.

To develop new screens or to modify existing screens the HMI software requires a "development license". This software permits building and/or modifying the operator displays, adding new Input/Output points to the HMI database, and/or re-configuring a specific I/O point. Once developed or modified, the screens are saved and either automatically or manually transferred from the primary computer to the backup computer.

Wonderware Development Studio 2014R2 version is the latest HMI configuration software West Jordan requires. The development software and license only needs to be installed on one computer.

By way of information, upgrade pricing is 50% off list prices. The prices are shown in the Projected Costs paragraphs below.

Once the screens and database are developed, both the primary and backup computers will each require a "runtime license" and software. For the present West Jordan remote I/O configuration, the Runtime license for each computer is Wonderware InTouch 2014R2 Runtime. The City is presently licensed for up to 50,000 tags or data points.

MASTER STATION DATA RADIO

The data radios should only need to be replaced if and when the existing radios fail. As the entire SCADA system is dependent on these radios, they are critical to the system operation, but they are easily replaced. Typically, the Master radio is the same as any remote radio of the same frequency.

Data radios today utilize software to configure the radio parameters, such as transmitter power, transmitter frequency, receiver frequency, etc. This software also includes some diagnostic features to aid in troubleshooting transmitter or receiver problems. The radio configuration software is typically loaded on a notebook computer, and operators use the computer to configure and/or diagnose both master and remote data radios.

REMOTE TERMINAL UNITS

RTU Hardware

RTUs consist of several components, such as enclosures, power supplies, terminals, etc. These are readily available from local electrical wholesale supply companies. Maintaining consistency for the other hardware such as the LC3000 CPUs, will ensure standardization. With this standardization, maintaining the existing RTUs will reduce the number of spare components.

RTU Radio Alternatives

A relatively new radio technology from Xetawave offers both serial and Ethernet protocols combined into one radio. These are available for 902-960 MHz unlicensed, 130-232 MHz licensed, 406-512 MHz licensed and 1.3, 1.4 and 2.4 GHz frequencies. These radios also can operate at different transmission speeds, specific to each remote site. So sites further away from the master station may operate on a lower data throughput than sites that are closer to the master. The company also offers radios with up to eight built-in convertible I/O, so for smaller sites, a separate PLC or other processor is not required. Pricing range from $600 for a single serial radio to $1,495 for combined I/O and dual channel capability.

RTU Antennas

Yagi antennas achieve more gain than vertical antennas by concentrating radiation in a single direction. Their reduced gain from the back also helps keep other signals from interfering with normal operation. Front to back ratio is an important characteristic for the Yagi antenna. Yagi's can range from 8 dBi to 14 dBi gain.

When additional signal gain is required, the next antenna configuration is a parabolic antenna. It is the antenna of choice for long range work or in areas of potentially high interference. They do not receive signals from the back, but only operate one direction. A 47" parabolic antenna can achieve up to 18 dBi gain.

Coaxial Cable Losses

An important consideration is the coaxial cable installed in between the radio and the antenna. Various cables offer considerable signal loss, depending on the cable. Table 7-2 summarizes typical coaxial cable losses.

TABLE 7-2
TYPICAL COAXIAL CABLE LOSSES

Cable Type	dB Loss/100Ft at 900 MHz	dB Loss/100Ft at 2.4 GHz
RG58/U	15.8	24.8
RG174/U	27.9	43
LMR195	11.2	18.6
LMR400	3.9	6.6
LMR600	2.5	4.3

Higher quality coaxial cables have lower losses. For sites with communications issues, upgrading the coaxial cable should be considered.

Remote Site Alternatives

Temperature: For remote sites with structures monitoring the building internal temperature may alert operators to failed heating or cooling equipment. Extreme internal temperatures typically lead to equipment failures due to overheating or freezing water. A common method to remotely monitor temperatures is to install a room temperature transmitter as an analog input to the RTU, and then have high/low alarm limit set points in the master station for operators. The local temperature transmitter can also be used to control heating and cooling equipment. Transmitters are generally under $200 plus installation.

Cellular Data Transmission RTU's: When considering replacing hardware at some remote sites, one should consider an alternate telemetry method of using cellular RTU's. For sites with smaller I/O the cellular RTU can handle 8 Digital Inputs, 2 Analog Inputs, 3 Digital Outputs, with some other bells and whistles for around $1,400 per site plus packaging and installation. The cellular air time is included in an annual fee to the cellular RTU company ($350-$575/yr). More sophisticated RTU I/O requirements may be met with cellular RTU's that handle more I/O for around $2,100 per site. The cellular RTU's can communicate directly with the City's Wonderware HMI software via OPC, so there is no obvious change to the operator's screens.

RECOMMENDATIONS

The MS computer hardware is partnered with the Operating System and HMI software. Evaluation of these products should be considered by first selecting the desired HMI software, then reviewing the software developers list of approved and tested computer Operating Systems. Lastly, selecting the most up-to-date computer hardware (CPU, RAM Memory, Hard Drive/Solid State Drive, etc) for the OS and HMI software.

HMI Software

Changing from WonderWare to another HMI software has several distinct disadvantages for the City. The City staff is already familiar with the HMI configuration software, which is used to modify and program the user interface screens. Changing to another HMI software program will require re-training and re-familiarization of how work within the new software. Unless there is a specific reason that WonderWare is or is not performing, keeping the same HMI software will be less expensive for the City in the long run.

The newer versions of WonderWare software require computers with 64 bit operating systems and RAM memory of at least 4 Gigabits.

Computer Operating System

The computer operating system should be based on the proven platform for the HMI software. Wonderware has many installations operating on the Windows7 platform. So, Windows7 Professional is the recommended computer operating system.

Computer Hardware

The computer hardware should also be adequate for the HMI software. For Wonderware v2014R2, the CPU recommendations are most modern CPUs are adequate. They recommend 16GB RAM for the computer. Other hardware considerations are that the new computers have updated motherboards to match the CPU. The case should have redundant cooling fans. CPU water cooling is not required; however, the SCADA computer cases should have at least two case cooling fans. They are inexpensive. They are also typically not monitored, but operators need to occasionally ensure they are operating. A hard drive with at least 1,000 GB is recommended. As the SCADA master computers are not turned off, the reduced time to boot the computer offered by solid-state drives is probably not beneficial.

The existing wall mounted large monitor is adequate. No spare replacement is recommended. A new monitor is readily available from many vendors in the area that are open 24-hours a day, should the wall mounted monitor stop working.

Remote Sites

The existing D620 based RTU's should be upgraded to match the LC3000 based RTUs. This hardware is out-of-date, expensive and difficult to maintain.

Projected Costs

Projected costs for SCADA and/or telemetry systems are segregated into two main areas, the master station and remote sites. The master station costs are sub-divided into hardware and software. Hardware costs are computers, monitors, printers (if used), data radios, un-interruptible power supply. Software costs are for the HMI run-time and development licenses, and any alarm software. Once the license has been purchased and installed, the HMI software then needs to be configured for the city. Configuration is the development of various screens for the SCADA system. For West Jordan, this would be screens showing the water sources, storage, pumping facilities and PRV sites. Other screens are typically developed to provide operator information such as radio communications quality and whether the remote site is on or off line.

One cost benefit to keeping the HMI software as Wonderware, is that most, if not all of the developed operator screens will not need to be re-developed when newer software is installed. Typically, the operator screens are upward compatible with new releases of the HMI software. This saves substantial time/hours re-building screens when the HMI software is periodically updated.

Another cost benefit is most of the configuration data is stored in files similar to software database. Wonderware is upward compatible with newer versions of the software, and will not require re-creating the various configuration parameters for each and every point in the RTU.

The remote sites are mostly hardware costs, as the software is typically replicated from site to site.

Master Station Computer (each):

$275.	i3 CPU w/cooling fan
$160.	i3 motherboard
$120.	16GB RAM (DDR3 SCRM 2400)
$80.	2TB backup hard drive
$100.	256GB SSD (solid state drive)
$125.	tower case/power supply
$860.	Total (assembly not included)

Options:

$175.	22"-24" LED Monitor
$2,200.	**Estimated Budget for two computers**

Software (each):

$200.	Windows7 Professional or Ultimate, 64-bit
$6,380.	Development Studio (HMI development software-one required)
$2,407.	InTouch 2014R2 60KTag w/o I/O RDS (2 rqd)
$2,695.	Win-911/Pro-BT Alarm software

(version upgrades are 50% off list price)

Installation and any configuration efforts not included.

$17,000. **Estimated Budget for software (plus MS Office if desired)**

Optional Software Costs:

$395.	Yearly Operational support WIN-911
22%	Yearly Operational support for HMI software (additional 25% discount when purchased with the upgrade)

Laptop Computer: required to configure and upgrade the remote site radio's and RTU's.

$2,000. **Budget for Laptop**

RTU Costs:

$500.	Enclosure with internal panel
$3,000.	Integra Intra-Link LC3000
$1,200.	Intra-Link OI3000
$500.	Intra-Link MIX24880-E2
$150.	Plus CX5 DC power supply
$200.	Dual Channel Uninterruptible Power Supply (UPS)
$100.	NTRON Network interface
$150.	NTRON Analog Signal Isolator
$2,500.	Calamp Integra Data Radio
$220.	Antenna
$250.	Misc. components (terminals, wire, hardware, etc.)

$8,770. **Estimated total Small RTU Cost**

$11,000. **Estimated Medium RTU Cost**

CHAPTER 8

CAPITAL IMPROVEMENTS PLAN

Throughout the master planning process, the three main components of the City's water system (source, storage, and distribution) were analyzed to determine the system's ability to meet existing demands and also the anticipated future demands at build-out. Each of the system deficiencies identified in the master planning process and described previously in this report were presented in an alternatives workshop with City staff. Possible solutions were discussed for each of the identified system deficiencies as well as possible solutions for maintenance and other system needs not identified in the system analysis. After the workshop, HAL studied the feasibility of the solution alternatives and developed conceptual costs.

One important method of paying for system improvements is through impact fees. Impact fees are collected from new development and should only be used to pay for system improvements related to new development. For this reason it is important to identify which projects are related to resolving existing deficiencies, and which projects are related to providing anticipated future capacity for new development.

PRECISION OF COST ESTIMATES

When considering cost estimates, there are several levels or degrees of precision, depending on the purpose of the estimate and the percentage of detailed design that has been completed. The following levels of precision are typical:

Type of EstimatePrecision
Master Planning±50%
Preliminary Design±30%
Final Design or Bid±10%

For example, at the master planning level (or conceptual or feasibility design level), if a project is estimated to cost $1,000,000, then the precision or reliability of the cost estimate would typically be expected to range between approximately $500,000 and $1,500,000. While this may seem very imprecise, the purpose of master planning is to develop general sizing, location, cost, and scheduling information on a number of individual projects that may be designed and constructed over a period of many years. Master planning also typically includes the selection of common design criteria to help ensure uniformity and compatibility among future individual projects. Details such as the exact capacity of individual projects, the level of redundancy, the location of facilities, the alignment and depth of pipelines, the extent of utility conflicts, the cost of land and easements, the construction methodology, the types of equipment and material to be used, the time of construction, interest and inflation rates, permitting requirements, etc., are typically developed during the more detailed levels of design.

At the preliminary or 10% design level, some of the aforementioned information will have been developed. Major design decisions such as the size of facilities, selection of facility sites, pipeline alignments and depths, and the selection of the types of equipment and material to be used during construction will typically have been made. At this level of design the precision of the cost estimate for a $1,000,000 project would typically be expected to range between approximately $700,000 and $1,300,000.

After the project has been completely designed, and is ready to bid, all design plans and technical specifications will have been completed and nearly all of the significant details about the project should be known. At this level of design, the precision of the cost estimate for the same $1,000,000 project would typically be expected to range between approximately $900,000 and $1,100,000.

SYSTEM IMPROVEMENT PROJECTS

As discussed in previous chapters, several source, storage and distribution system deficiencies were identified during the system analysis. Project descriptions for water system improvements are presented in Chapters 3, 4 and 5 with the location of each project shown in Figure 5-4. Each recommendation includes a conceptual cost estimate for construction.

Unit costs for the construction cost estimates are based on conceptual level engineering. Sources used to estimate construction costs include:

1. "Means Heavy Construction Cost Data, 2015"
2. Price quotes from equipment suppliers
3. Recent construction bids for similar work

All costs are presented in 2015 dollars. Recent price and economic trends indicate that future costs are difficult to predict with certainty. Engineering cost estimates provided in this study should be regarded as conceptual level for use as a planning guide. Only during final design can a definitive and more accurate estimate be provided for each project. A cost estimate calculation for each project is provided in Appendix F and Table 8-1 provides a cost summary for the recommended system improvements.

TABLE 8-1
PROJECT COSTS FOR SYSTEM IMPROVEMENTS

TYPE	ID	RECOMMENDED PROJECT[1]	TOTAL COST	% FUT	FUTURE COST
Source	W-1	Zone 1 JVWCD Connection Improvements	$68,000	100%	$68,000
Source	W-2	Zone 2 JVWCD Connection Improvements	$34,000	100%	$34,000
Source	W-3	Zone 3 JVWCD Connection Improvements	$68,000	100%	$68,000
Source	W-4	Zone 4 JVWCD Connection Improvements	$68,000	100%	$68,000
Source	W-5	Zone 5 JVWCD Connection Improvements	$68,000	100%	$68,000
Source	W-6	Zone 6 JVWCD Connection Improvements	$34,000	100%	$34,000
Source	W-7	New U-111 Well	$1,620,000	100%	$1,620,000
Source	W-8	New Terminal Well	$1,620,000	100%	$1,620,000
Source	W-9	New Ron Wood Park Well	$1,620,000	100%	$1,620,000
Source	W-10	New Barney's Wash Well	$1,620,000	100%	$1,620,000
Source	W-11	New Zone 5 North Booster Station	$1,350,000	100%	$1,350,000
Source	W-12	New Zone 5 South Booster Station	$1,350,000	100%	$1,350,000
Source	W-13	Additional Zone 2 booster pump	$257,000	100%	$257,000
Source	W-14	Additional Zone 3 booster pump	$203,000	100%	$203,000
Source	W-15	Additional Zone 4 booster pump	$257,000	100%	$257,000
Source	W-16	New Zone 7 North Booster Station	$945,000	100%	$945,000
Source	W-17	New Zone 7 South Booster Station	$945,000	100%	$945,000

TABLE 8-1 CONTINUED

TYPE	ID	RECOMMENDED PROJECT[1]	TOTAL COST	% FUT	FUTURE COST
Source	W-18	Well 3 Improvements to allow pumping to Zone 3	$135,000	0%	$0
Source	W-19	Well 4 Improvements	$304,000	100%	$304,000
Source	W-20	Exploratory Wells	$500,000	100%	$500,000
Source	W-21	Water Right Transfer	$25,000	100%	$25,000
Source	W-22	5 Year Master Plan Update	$100,000	100%	$100,000
Storage	S-1	New 5.0 MG Airport Tank	$6,804,000	0%	$0
Storage	S-2	New 3.0 MG Cemetery Tank	$4,050,000	0%	$0
Storage	S-3	New 2.0 MG Old Bingham Highway Zone 2 Tank #2	$2,700,000	15%	$405,000
Storage	S-4	New 4.0 MG Old Bingham Highway Zone 3 Tank	$5,400,000	8%	$405,000
Storage	S-5	New 3.0 MG Terminal Tank #2	$4,050,000	100%	$4,050,000
Storage	S-6	New 4.0 MG U-111 Tank #2	$5,400,000	100%	$5,400,000
Storage	S-7	New 2.0 MG Zone 5a Tank	$2,700,000	100%	$2,700,000
Storage	S-8	New 4.0 MG Zone 5 North Tank	$5,400,000	100%	$5,400,000
Storage	S-9	New 4.0 MG Zone 5 South Tank	$5,400,000	100%	$5,400,000
Storage	S-10	New 1.5 MG Zone 6 North Tank	$2,025,000	100%	$2,025,000
Storage	S-11	New 1.5 MG Zone 6 South Tank	$2,025,000	100%	$2,025,000
Storage	S-12	New 2.0 MG Zone 7 North Tank	$2,700,000	100%	$2,700,000
Storage	S-13	New 2.0 MG Zone 7 South Tank	$2,700,000	100%	$2,700,000
Asb-Cem	AC-1	Install 1,510 feet of 8-inch pipe	$202,000	0%	$0
Asb-Cem	AC-2	Install 5,320 feet of 10-inch pipe	$812,000	0%	$0
Asb-Cem	AC-3	Install 2,920 feet of 8-inch pipe	$390,000	0%	$0
Asb-Cem	AC-4	Install 5,220 feet of 8-inch pipe	$698,000	0%	$0
Asb-Cem	AC-5	Install 2,520 feet of 10-inch pipe	$384,000	0%	$0
Asb-Cem	AC-6	Install 2,290 feet of 8-inch pipe	$306,000	0%	$0
Asb-Cem	AC-7	Install 2,670 feet of 8-inch pipe	$357,000	0%	$0
Asb-Cem	AC-8	Install 1,265 feet of 8-inch pipe	$169,000	0%	$0
Asb-Cem	AC-9	Install 565 feet of 8-inch pipe	$76,000	0%	$0
Asb-Cem	AC-10	Install 1,450 feet of 8-inch pipe	$194,000	0%	$0
Fire flow	F-1	Install 1,440 feet of 10-inch pipe	$220,000	0%	$0
Fire flow	F-2	Install 690 feet of 10-inch pipe	$105,000	0%	$0
Fire flow	F-3	Install 1,370 feet of 8-inch pipe	$182,000	0%	$0
Fire flow	F-4	Install 575 feet of 8-inch pipe	$77,000	0%	$0

TABLE 8-1 CONTINUED

TYPE	ID	RECOMMENDED PROJECT[1]	TOTAL COST	% FUT	FUTURE COST
Fire flow	F-5	Install 1,535 feet of 8-inch pipe	$205,000	0%	$0
Fire flow	F-6	Install a new connection between the existing 8-inch and 6-inch pipelines	$14,000	0%	$0
Distribution	D-1	Install new 12-inch PRV and vault	$203,000	0%	$0
Distribution	D-2	Rehab PRV, run power to the vault and install fan and sump pump	$34,000	0%	$0
Distribution	D-3	Install a VFD on the smallest Zone 2 booster pump	$68,000	0%	$0
Distribution	D-4	Install a new 6-inch PRV in existing vault	$34,000	0%	$0
Distribution	D-5	Install a new 12-inch PRV and vault	$203,000	0%	$0
Distribution	D-6	Install a new 6-inch PRV in existing vault	$34,000	0%	$0
Distribution	D-7	Install a new 8-inch PRV in existing vault	$41,000	0%	$0
Distribution	D-8	Install a new 6-inch PRV in existing vault	$68,000	0%	$0
Distribution	D-9	Install a new 16-inch PRV in existing vault	$95,000	0%	$0
Distribution	D-10	Install a new 8-inch PRV in existing vault	$34,000	0%	$0
Distribution	D-11	Install 1,590 feet of 8-inch pipe, 835 feet of 12-inch pipe, and 1,245 feet of 16-inch pipe	$575,000	63%	$362,250
Distribution	D-12	Install 1,530 feet of 10-inch pipe	$233,000	0%	$0
Distribution	D-13	Install a new connection between the existing 30-inch and 16-inch pipelines	$55,000	0%	$0
Distribution	D-14	Install 3,120 feet of 12-inch pipe	$505,000	0%	$0
Distribution	D-15	Improve Old Bingham Reservoir, Terminal Reservoir, U-111 Reservoir, and Barney's Reservoir sites with landscaping	$405,000	0%	$0
Distribution	D-16	Construct an indoor storage facility for water parts and fittings	$675,000	0%	$0
Distribution	D-17	Segregate a new Zone 2a pressure zone	$68,000	0%	$0
Distribution	D-18	Install 7,900 feet of 12-inch pipeline	1,845,000		
Distribution	D-19	Pressure Zone 3 & 4 boundary relocation including the installation of 4,605 feet of 8-inch pipe	$615,000	0%	$0
Distribution	D-20	Move phase 3 of the Maples at Jordan Hills Subdivision to Zone 6	$54,000	0%	$0
Distribution	D-21	Install 2,435 feet of 16-inch pipe, 6,300 feet of 24-inch pipe, 2,685 feet of 18-inch pipe, 1,900 feet of 24-inch pipe, and 135 feet of 16-inch pipe across 9000 South	$3,376,000	20%	$4,800

TABLE 8-1 CONTINUED

TYPE	ID	RECOMMENDED PROJECT[1]	TOTAL COST	% FUT	FUTURE COST
Distribution	D-22	Install 1,500 feet of 10-inch pipe	$229,000	0%	$0
Distribution	D-23	Install 5,250 feet of 16-inch pipe	$950,000	100%	$950,000
Distribution	D-24	Install a new 12-inch PRV and vault	$203,000	$0	$0
Distribution	D-25	Install 5,260 feet of 16-inch pipe	$952,000	100%	$952,000
Distribution	D-26	Install 2,575 feet of 16-inch pipe	$466,000	100%	$466,000
Distribution	D-27	Install 3,540 feet of 16-inch pipe	$640,000	100%	$640,000
Distribution	D-28	Install 6,220 feet of 24-inch pipe, 1,370 feet of 20-inch pipe, and 170 feet of 16-inch pipe	$2,131,000	100%	$2,131,000
Distribution	D-29	Install 5,000 feet of 12-inch pipe	$810,000	100%	$810,000
Distribution	D-30	Install 3,260 feet of 16-inch pipe	$590,000	100%	$590,000
Distribution	D-31	Upsize reimbursements	$700,000	100%	$700,000
Distribution	D-32	40,955 feet of future 10-inch pipe	$6,248,000	100%	$6,248,000
Distribution	D-33	70,560 feet of future 12-inch pipe	$11,431,000	100%	$11,431,000
Distribution	D-34	7,965 feet of future 16-inch pipe	$1,441,000	100%	$1,441,000
Distribution	D-35	200 feet of future 20-inch pipe	$47,000	100%	$47,000
Distribution	D-36	1,060 feet of future 24-inch pipe	$303,000	100%	$303,000
Total			$105,297,000		$74,012,000

1. See descriptions in the source, storage and distribution system recommendation summaries presented in previous chapters.

All projects with an existing component are recommended to be completed in 0 to 5 years. In general, the highest priority projects are those which address existing deficiencies. Fire flow projects should be considered the first priority, followed by the asbestos-cement pipes and other existing projects.

Projects have also been analyzed in order to determine the percentage of each project which meets future needs. The majority of the projects were either 100% existing of 100% future. In all, four projects were identified with both existing and future components. The methodology used to evaluate the future percentage of each of those projects will be described in the following paragraphs.

Projects S-3 and S-4 are each related to storage. The storage projects were evaluated based on the amount of storage each tank would contribute towards meeting existing storage requirements. For example, Project S-3 is the proposed 2.0 MG Old Bingham Highway Zone 2 Tank #2. Under existing conditions Zone 2 has a storage deficiency of 1.7 MG. Completion of the new tank will eliminate the existing deficiency with an additional 0.3 MG going towards meeting future demands. Dividing 0.3 MG by 2.0 MG gives the percentage attributable to future growth, 15%.

Projects D-11 and D-21 are distribution projects. Project D-11 was originally requested as an 8-inch pipeline in the north side of 7800 South in order to meet the City's standard of dual pipelines on either side of roads with five or more traffic lanes. However, modeling showed that larger pipes would be needed to in the future in order to supply adequate capacity. The future percentage for D-11 was calculated as percentage of the total cost beyond that needed to install the original 8-inch pipeline to meet City standards. The future percentage for Project D-21 was calculated using the modeled flows in the pipe under existing and build-out conditions, and the build-out flow was 20% higher than the existing flow.

FUNDING OPTIONS

Funding options for the recommended projects, in addition to water use fees, could include the following options: general obligation bonds, revenue bonds, State/Federal grants and loans, and impact fees. In reality, the City may need to consider a combination of these funding options. The following discussion describes each of these options.

General Obligation Bonds

This form of debt enables the City to issue general obligation bonds for capital improvements and replacement. General Obligation (G.O.) Bonds would be used for items not typically financed through the Water Revenue Bonds (for example, the purchase of water source to ensure a sufficient water supply for the City's in the future). G.O. bonds are debt instruments backed by the full faith and credit of the City which would be secured by an unconditional pledge of the City to levy assessments, charges or ad valorem taxes necessary to retire the bonds. G.O. bonds are the lowest-cost form of debt financing available to local governments and can be combined with other revenue sources such as specific fees, or special assessment charges to form a dual security through the City's revenue generating authority. These bonds are supported by the City as a whole, so the amount of debt issued for the water system is limited to a fixed percentage of the real market value for taxable property within the City.

Revenue Bonds

This form of debt financing is also available to the City for utility related capital improvements. Unlike G.O. bonds, revenue bonds are not backed by the City as a whole, but constitute a lien against the water service charge revenues of a Water Utility. Revenue bonds present a greater risk to the investor than do G.O. bonds, since repayment of debt depends on an adequate revenue stream, legally defensible rate structure and sound fiscal management by the issuing jurisdiction. Due to this increased risk, revenue bonds generally require a higher interest rate than G.O. bonds, although currently interest rates are at historic lows. This type of debt also has very specific coverage requirements in the form of a reserve fund specifying an amount, usually expressed in terms of average or maximum debt service due in any future year. This debt service is required to be held as a cash reserve for annual debt service payment to the benefit of bondholders. Typically, voter approval is not required when issuing revenue bonds.

State/Federal Grants and Loans

Historically, both local and county governments have experienced significant infrastructure funding support from state and federal government agencies in the form of block grants, direct grants in aid, interagency loans, and general revenue sharing. Federal expenditure pressures and virtual elimination of federal revenue sharing dollars are clear indicators that local government may be left to its own devices regarding infrastructure finance in general. However, state/federal grants and loans should be further investigated as a possible funding source for needed water system improvements.

It is also important to assess likely trends regarding federal / state assistance in infrastructure financing. Future trends indicate that grants will be replaced by loans through a public works revolving fund. Local governments can expect to access these revolving funds or public works trust funds by demonstrating both the need for and the ability to repay the borrowed monies, with interest. As with the revenue bonds discussed earlier, the ability of infrastructure programs to wisely manage their own finances will be a key element in evaluating whether many secondary funding sources, such as federal/state loans, will be available to the City.

Impact Fees

Impact fees can be applied to water related facilities under the Utah Impact Fees Act. The Utah Impacts Fees Act is designed to provide a logical and clear framework for establishing new development assessments. It is also designed to establish the basis for the fee calculation which the City must follow in order to comply with the statute. However, the fundamental objective for the fee structure is the imposition on new development of only those costs associated with providing or expanding water infrastructure to meet the capacity needs created by that specific new development. Also, impact fees cannot be applied retroactively.

REFERENCES

Environmental Protection Agency (EPA). 2006. *Fluoride: Dose-Response Analysis For Non-cancer Effects*. EPA 820-R-10-019. U.S. Environmental Protection Agency, Health and Ecological Criteria Division, Office of Water. Washington, D.C.

Governor's Office of Planning & Budget, 2013.

International Fire Code Institute, Uniform Fire Code, 1997.

State of Utah, Utah Administrative Code.

APPENDIX A
ERC Calculations

HANSEN ALLEN & LUCE inc ENGINEERS	CLIENT West Jordan City	SHEET 1 OF 2	
	PROJECT 2014 DWMP Update	COMPUTED RTC	
	FEATURE ERC Calculations	CHECKED	
	PROJECT NO 089.27.100	DATE 4/11/15	

Water Use and ERC Calculations

Population =	108,000	
Total water use =	21,085	AF
Residential connections =	20,651	
Total Connections =	22,487	
Residential water use =	11,461	AF
Average Residential flow rate =	7,105	gpm
Demand per ERC =	0.34406	gpm/ERC
non resdiential water use =	9,624	AF
non resdiential water use =	5,967	gpm
Summation of ERCs from non-residential demands =	17,342	ERCs
Total ERCs =	37,993	ERCs

Existing Peak day Model Flow Computation

Indoor Calcs

Peak Day Indoor Demand =	400	gallons/day
Total Indoor Demand =	10,554	gpm

Outdoor Calcs

Calculate outdoor demand as July Demand minus December demand
IE assume December demand represents true indoor demand

July 2014 volume =	1.25E+09	gallons
July 2014 average flow =	27,914	gpm
January 2014volume =	2.63E+08	gallons
January 2014 avg. flow =	5,885	gpm
January 2014 Per ERC avg. demand =	0.15489	gpm/ERC
January 2014 daily volume per ERC =	223.038	gal/day
Outdoor demand =	22029	gpm
Outdoor demand =	0.57982	gpm/ERC
State Standards, outdoor demand =	3.96	gpm/irr acre
Irrigated acres/ERC =	0.14642	acres
Total irrigated acreage =	5,563	acres

0.15 irrigated acres/ERC is typical for 1/4 acre lots

Check

Irrigated acres connected to residential ERCs =	3,024	acres
Irrigated acres not connected to residential ERCs =	2,539	acres
Area of parks and open lands =	1,226	acres

assume 75% is irrigated to account for building parking etc.

75% of area of parks and open lands =	919.5	acres

The public facilities zone has an area of 1582 acres of which 736 acres is the airport. Subtracting out the airport and assuming 60% of the remaining is irrigable (schools, landscaping) gives:

Public Facilities acreage =	508	acres
Remaining acreage (total irr. Acreage minus residential minus parks and open space minus public) =	1,112	acres

Remaining acreage is assumed to be associated with landscaping for commercial and industrial areas

Indoor plus outdoor demand

Total demand =	32,583	gpm
Total demand/ERC =	0.8576	gpm/ERC

Analysis of Actual Production Volume

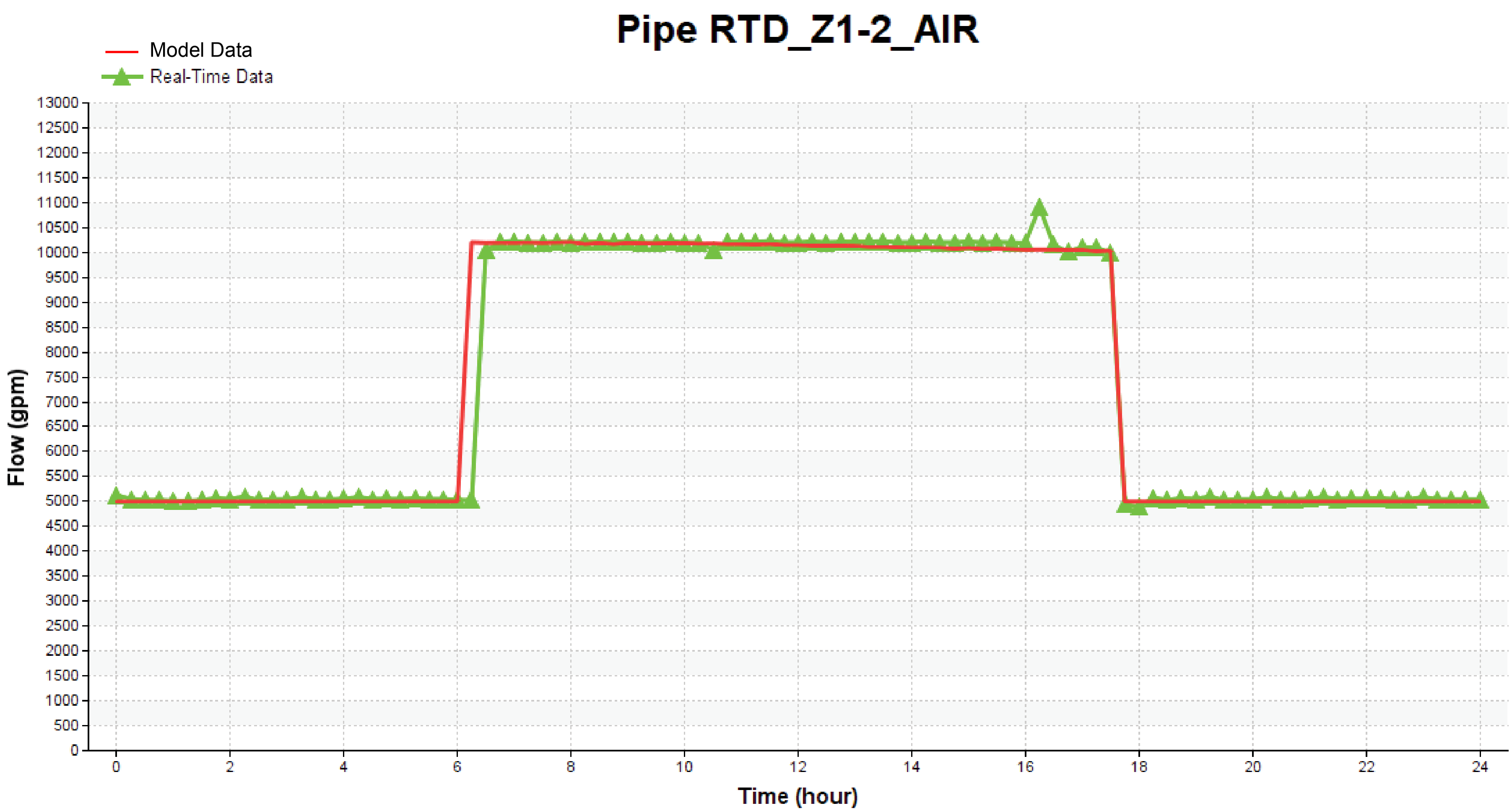
Measured peak day flow from production data =	28,896	gpm
Demand per ERC using production data =	0.76054	gpm/ERC
PD/AD peaking factor =	2.2105	
PI/PD peaking factor from production data =	2.02	
Peak instantaneous flow based on production data =	1.5363	gpm/ERC

APPENDIX B
Large Building Fire Flow Data

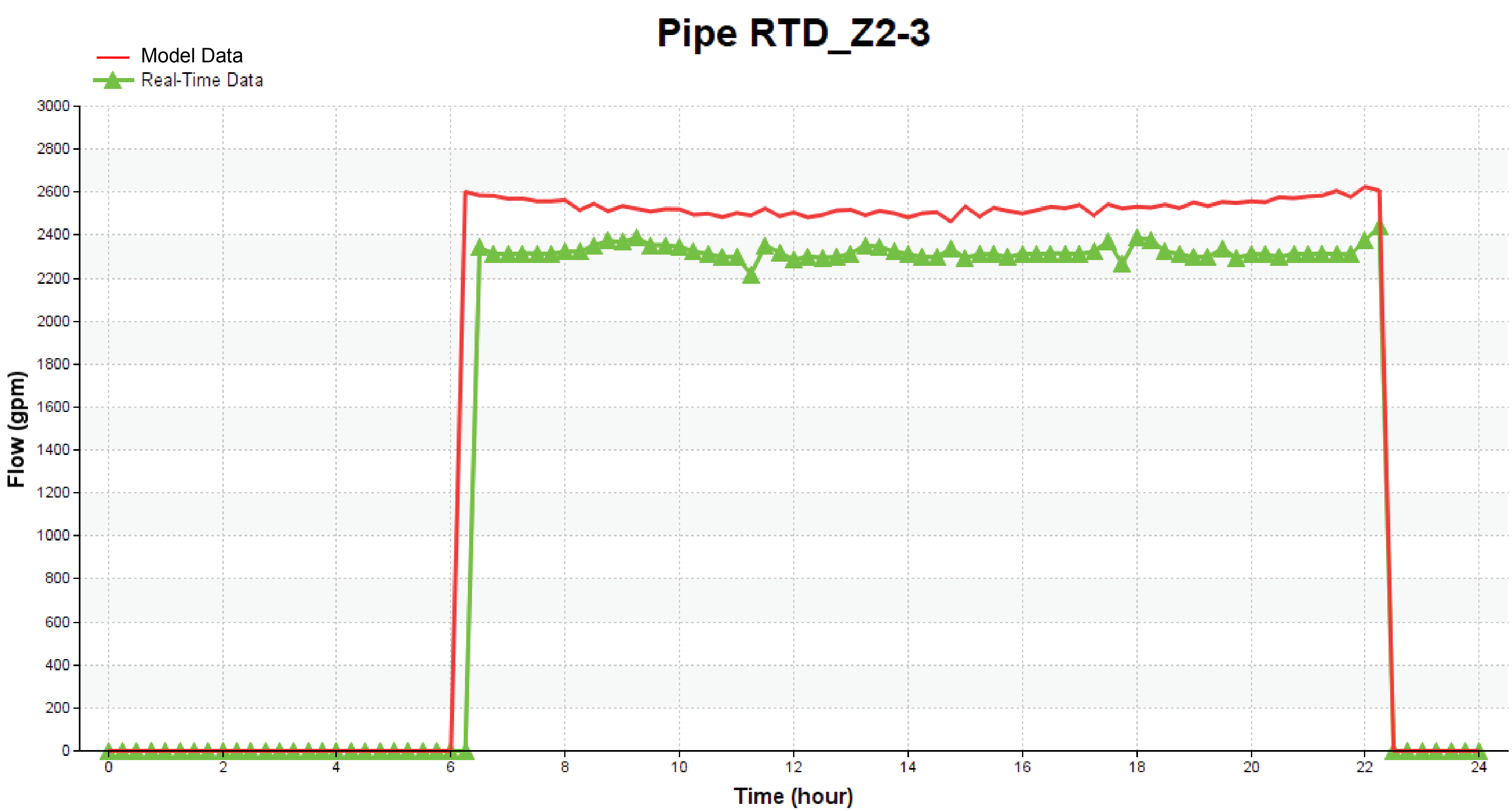
Zone	Building	Address	Flow	Volume
1	Heartland Elementary School	1451 West 7000 South	2,750	0.3
1	Jordan School District Auxiliary Services Building	7905 South Redwood Road	4,000	1.0
1	Lets Play Soccer	1194 West 7800 South	2,250	0.3
1	Majestic Elementary School	7430 South Redwood Road	3,500	0.6
1	Riverside Elementary School	8737 South 1220 West	2,625	0.3
1	Smith's Marketplace - east	1820 West 9000 South	4,000	1.0
1	South Valley School	8400 South Redwood Road	2,250	0.3
1	St. Joseph the Worker	7405 South Redwood Road	2,250	0.3
1	Viridian Library	8030 South 1825 West	3,000	0.5
1	West Jordan Elementary School	7220 South 2370 West	3,250	0.6
1	West Jordan Middle School	7550 South Redwood Road	5,500	1.3
1	Westvale Elementary School	2300 West Gardner Lane	2,625	0.3
2	Beehive Rest Home	8892 South 2700 West	2,000	0.2
2	Columbia Elemetary School	3505 West 7800 South	2,750	0.3
2	Granger Medical Center	3181 West 9000 South	2,500	0.3
2	Joel P. Jensen Middle School	8105 South 3200 West	2,750	0.3
2	Oquirrh Elementary School	7165 South Paddington Road	2,625	0.3
2	Terra Linda Elementary School	8400 South 3400 West	2,500	0.3
2a	West Jordan High School	8136 South 2700 West	4,000	1.0
2a	Westland Elementary School	2925 West 7180 South	2,500	0.3
3	Airport Storage	7508 South Airport Road	2,750	0.3
3	CAO Group	4628 West Skyhawk Drive	2,500	0.3
3	Jordan School District Office	7387 South Campus View Drive	2,250	0.3
3	Jordan School District Tranportation Dome Building	8370 South 4300 West	1,375	0.2
3	Jordan School District Tranportation Main Building	8370 South 4300 West	2,000	0.2
3	Mountain America Credit Union	7167 South Center Park Drive	4,000	1.0
3	Mountain Shadow Elementary School	5255 West 7000 South	2,625	0.3
3	Target	7779 South Jordan Landing Blvd.	4,000	1.0
3a	Jordan Landing	7349 South Plaza Center Drive	3,250	0.6
3a	Jordan Landing Phase IV	7140 South Plaza Center Drive	4,000	1.0
3a	Jordan Landing Phase VI	7181 South Campus View Drive	2,250	0.3
3b	Jordan Applied Tech. Center 1	9301 South 3400 West	2,125	0.3
3b	Jordan Applied Tech. Center 2	9301 South 3400 West	3,125	0.6

3b	Jordan Valley Medical Center Expansion	3580 West 9000 South	2,000	0.2
4	Copper Canyon Elementary School	8917 South Copperwood Drive	2,625	0.3
4	Copper Hills High School	5445 West New Bingham Highway	4,000	1.0
4	Fox Hollow Elementary	6020 West 8200 South	3,125	0.6
4	Hayden Peak Elementary School	5120 West Hayden Peak Drive	2,625	0.3
4	Jordan Hills Elementary School	8892 South 4800 West	2,625	0.3
4	Smith's Marketplace	5710 West 7800 South	4,000	1.0
4	West Hills Middle School	8270 South Grizzly Way	4,000	1.0
5	3rd Dimension	6208 West Dannon Way	4,000	1.0
5	Boeing	10026 South Prosperity Road	4,000	1.0
5	Louis and Company	9826 South Prosperity Road	3,000	0.5
5	Oakcrest Elementary School	8462 South Hilltop Oak Drive	2,750	0.3
5	Oracle America, Inc.	6136 West 10120 South	4,000	1.0
6	LDS Church Sunset Ridge	7528 West Abbotsbury Lane	2,000	0.2
6	Residential House	Sycamores	2,000	0.2
6	Sunset Ridge Middle School	8292 South Skyline Arch Drive	4,000	1.0
none	Falcon Ridge Elementary School	6111 West 7000 South	2,750	0.3

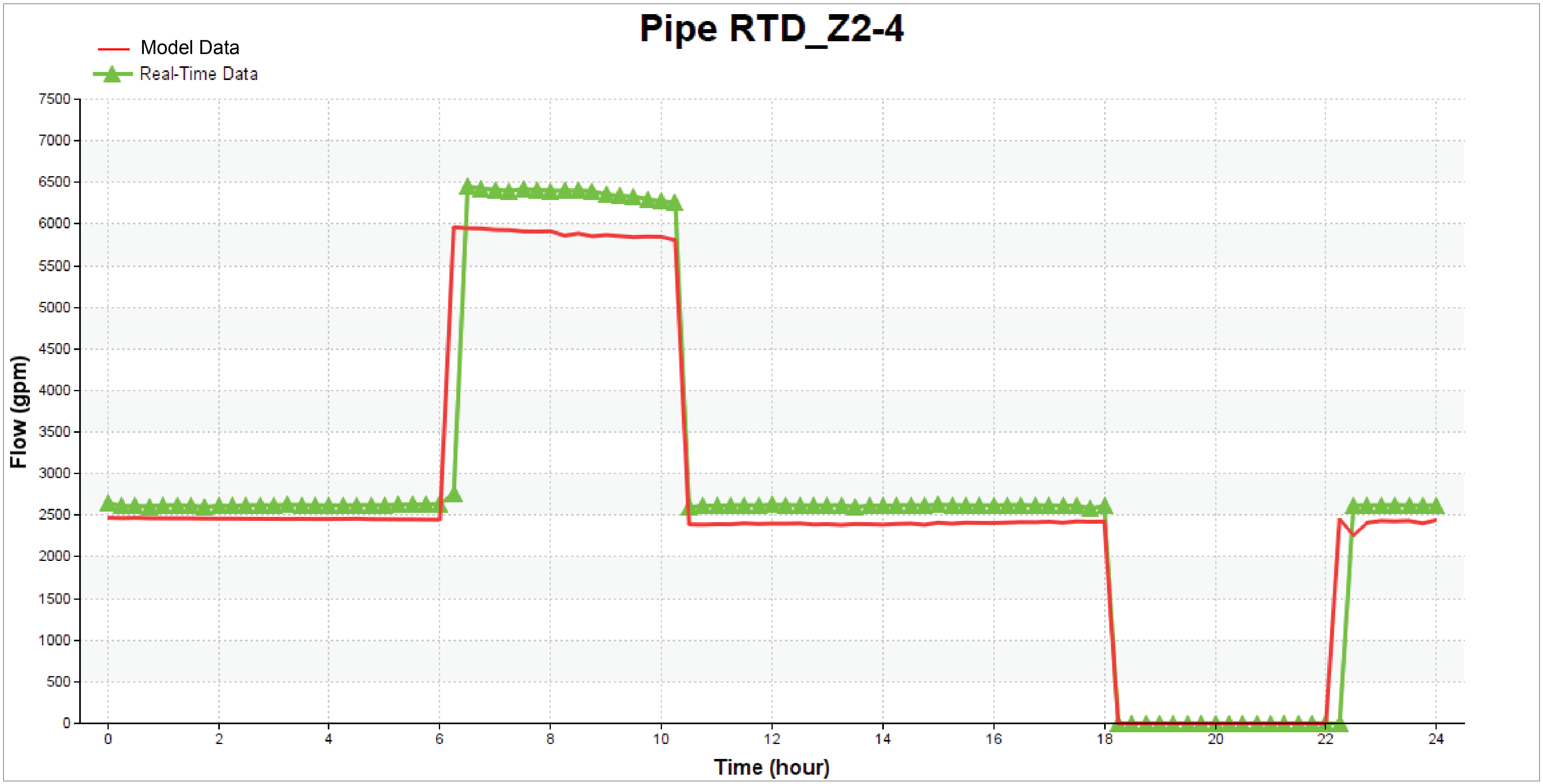
APPENDIX C
Calibration Data



Airport Pump Station

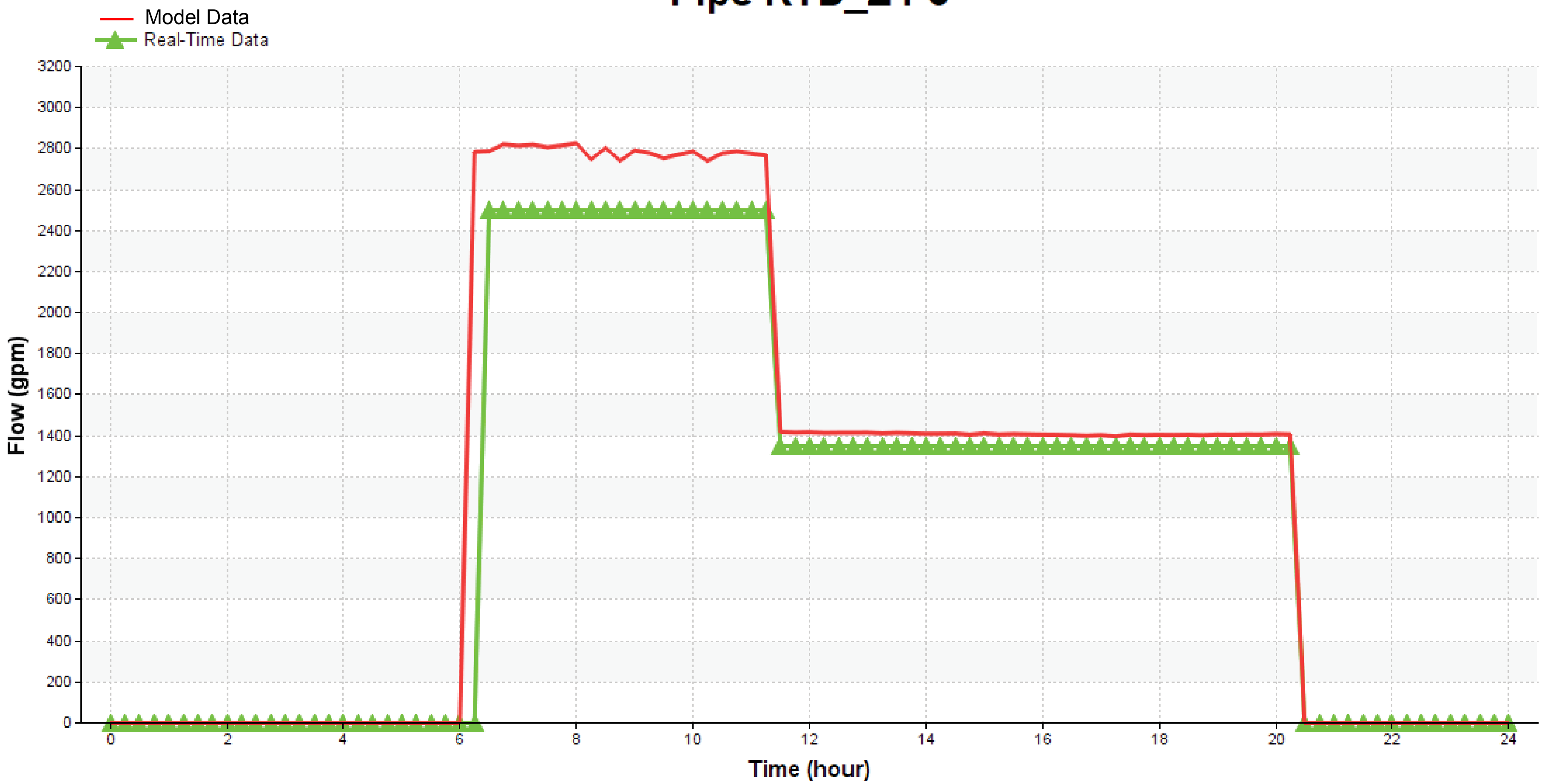


Zone 3 Pump Station



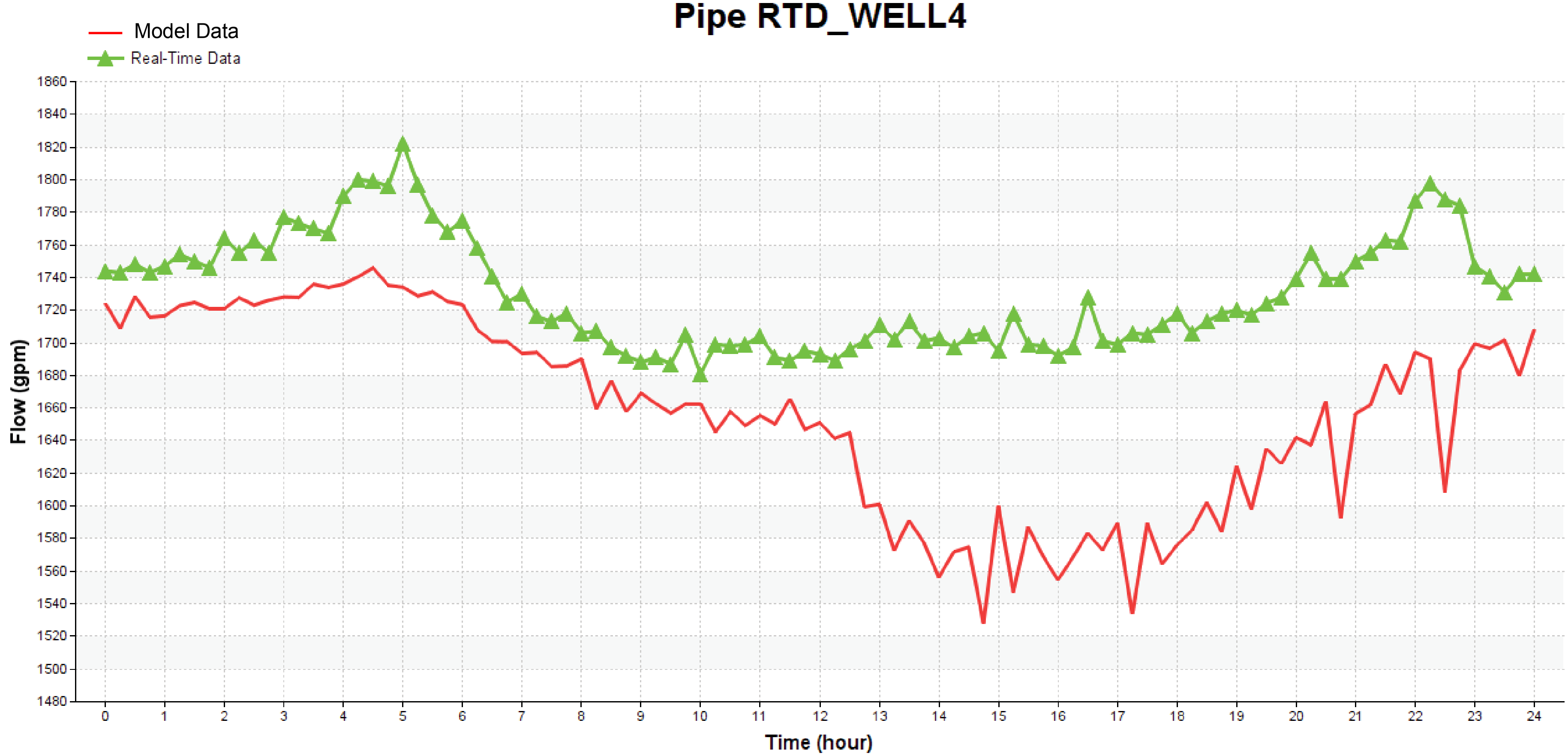
Zone 4 Pump Station

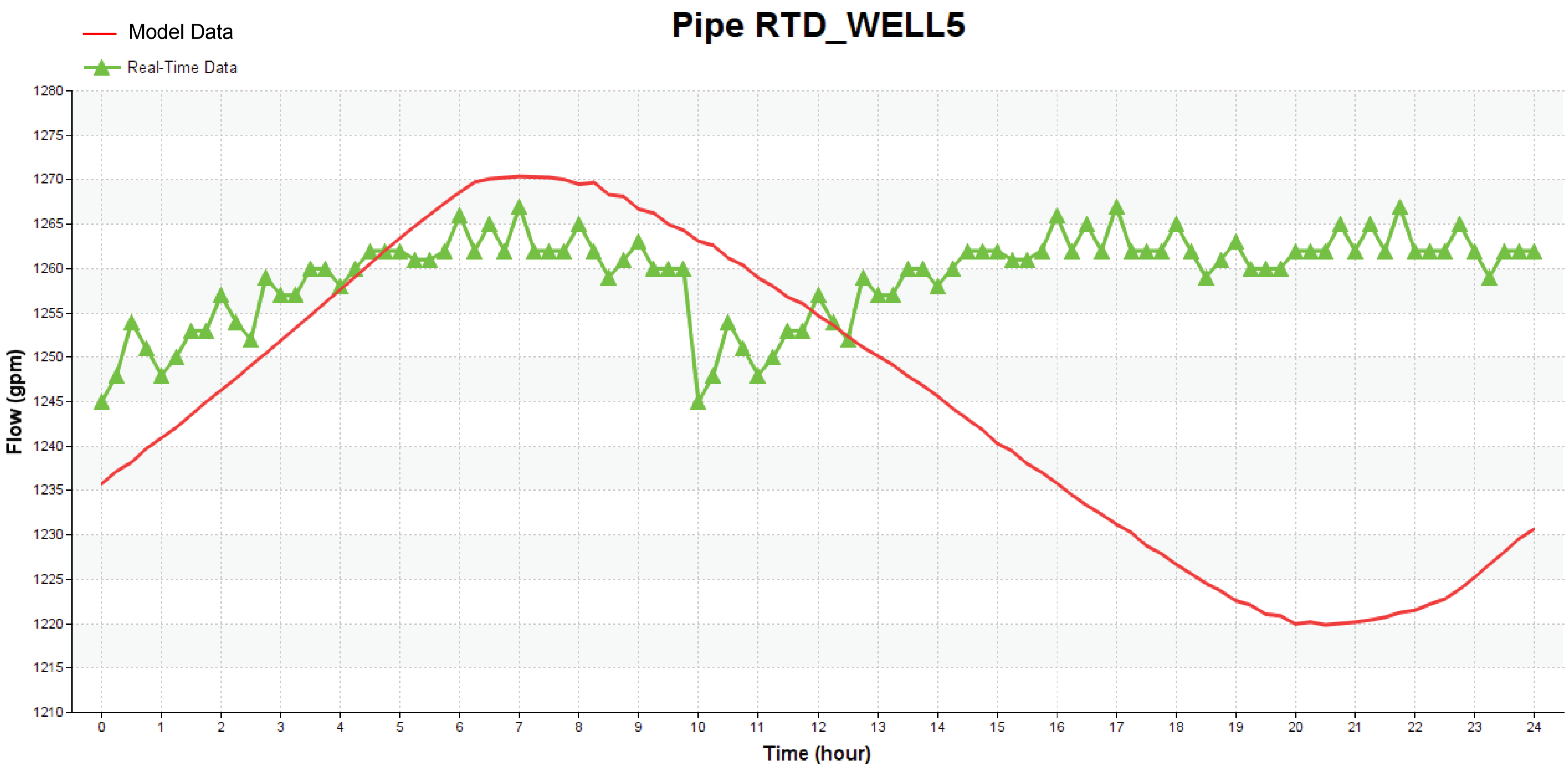
Pipe RTD_Z4-6

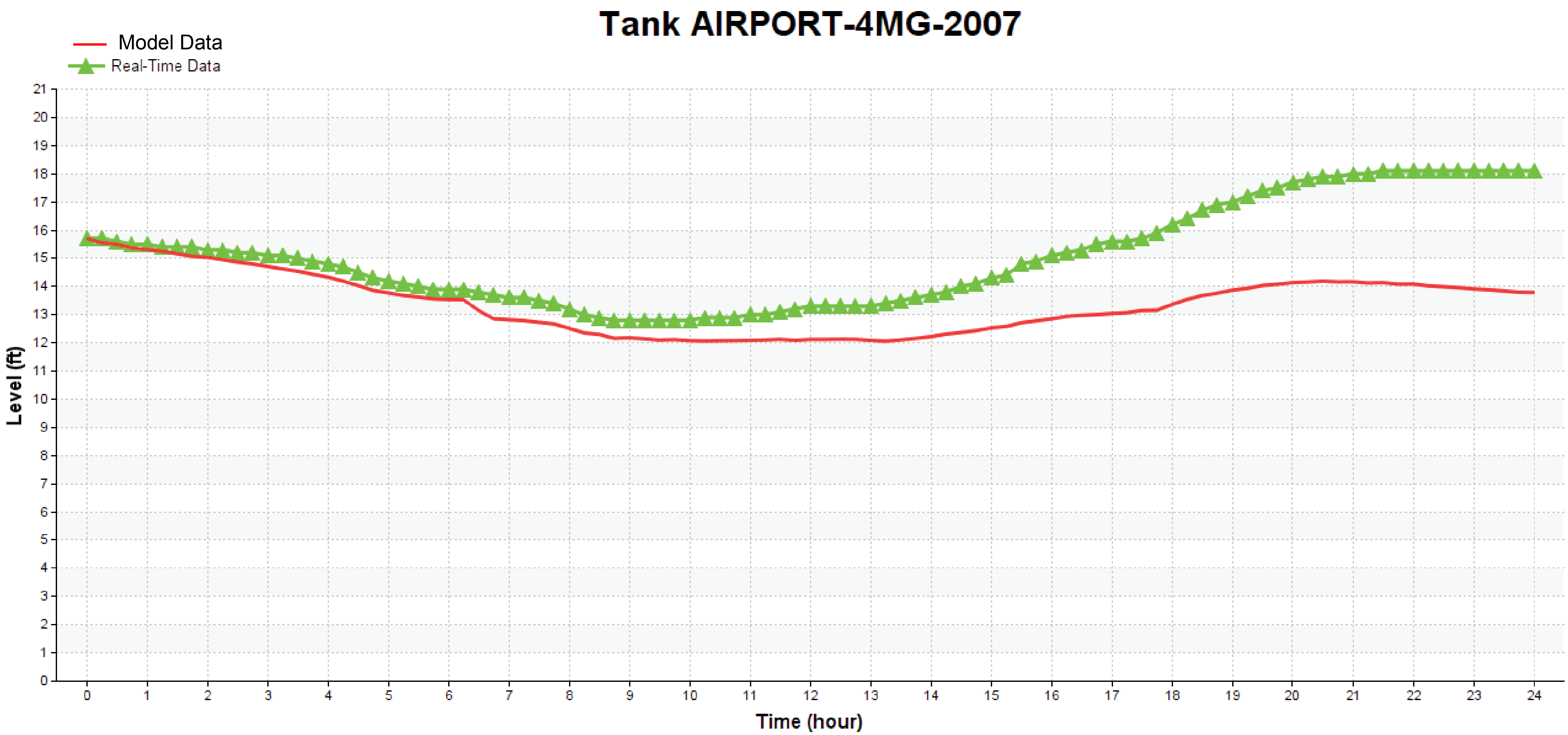


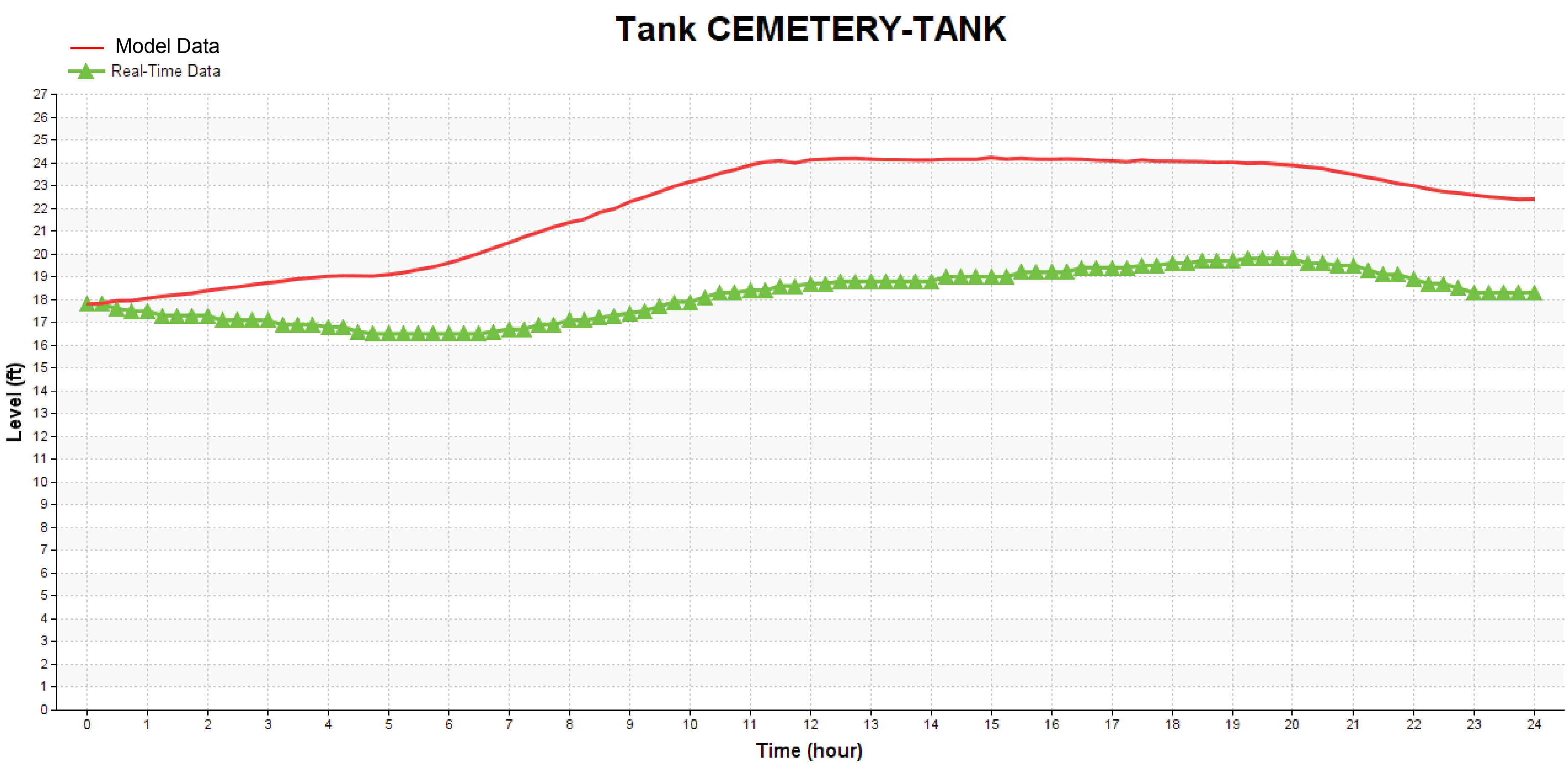
Zone 6 Pump Station

Pipe RTD_WELL4

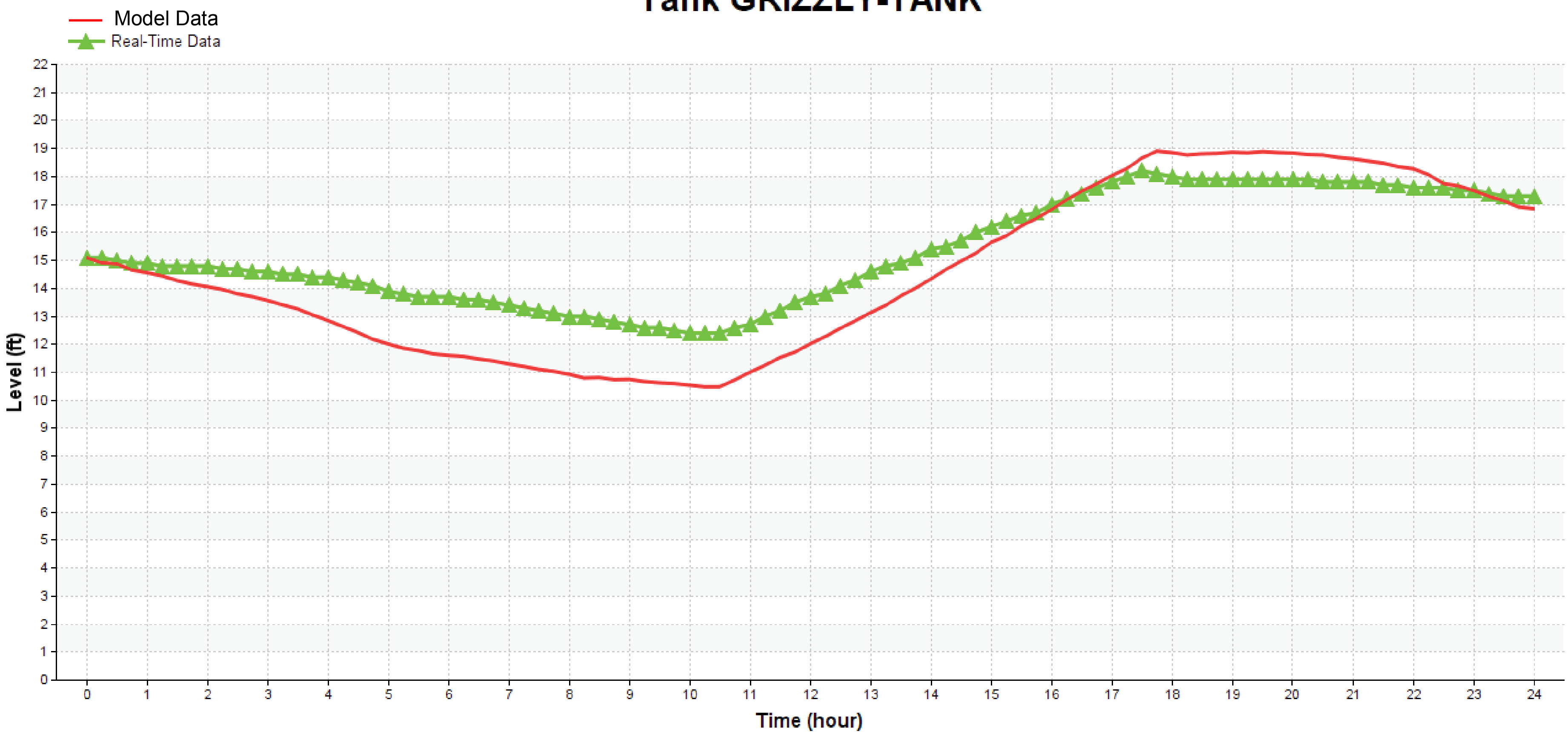


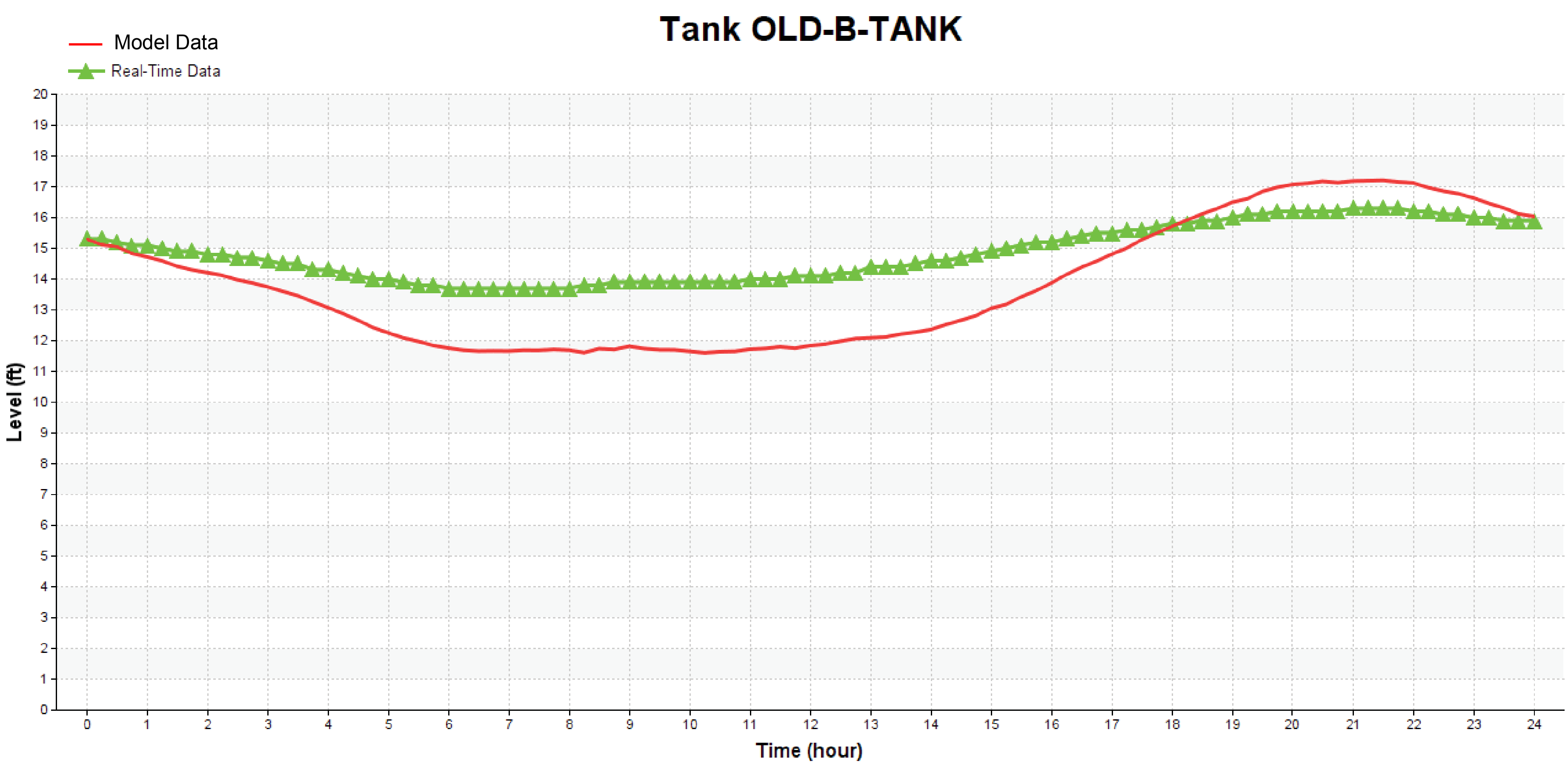

Pipe RTD_WELL5
Model Data
Real-Time Data
Flow (gpm)
1280
1275
1270
1265
1260
1255
1250
1245
1240
1235
1230
1225
1220
1215
1210
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Time (hour)

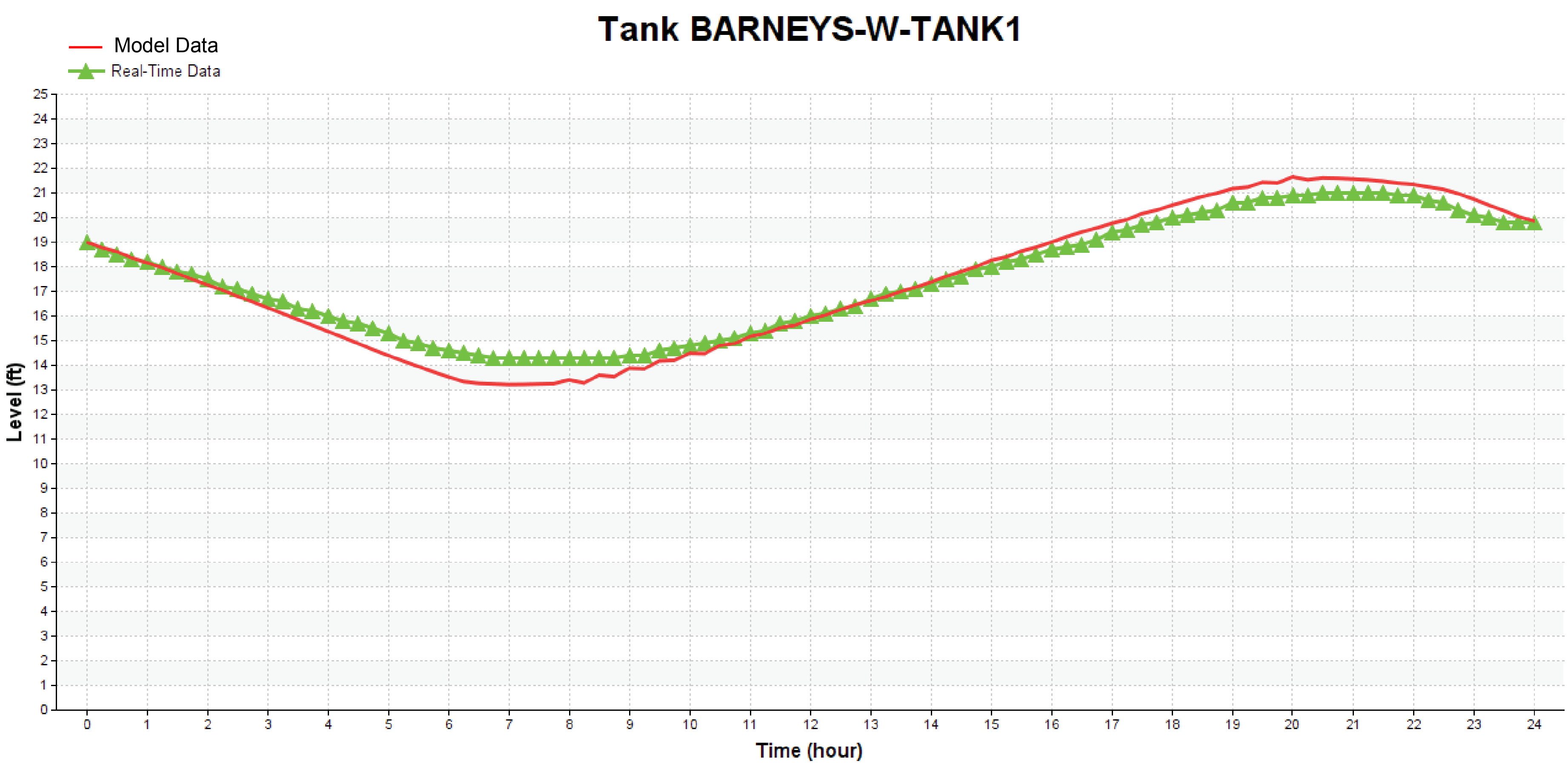

Tank AIRPORT-4MG-2007
Model Data
Real-Time Data
Level (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Time (hour)


Tank CEMETERY-TANK
Model Data
Real-Time Data
Level (ft)
Time (hour)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27

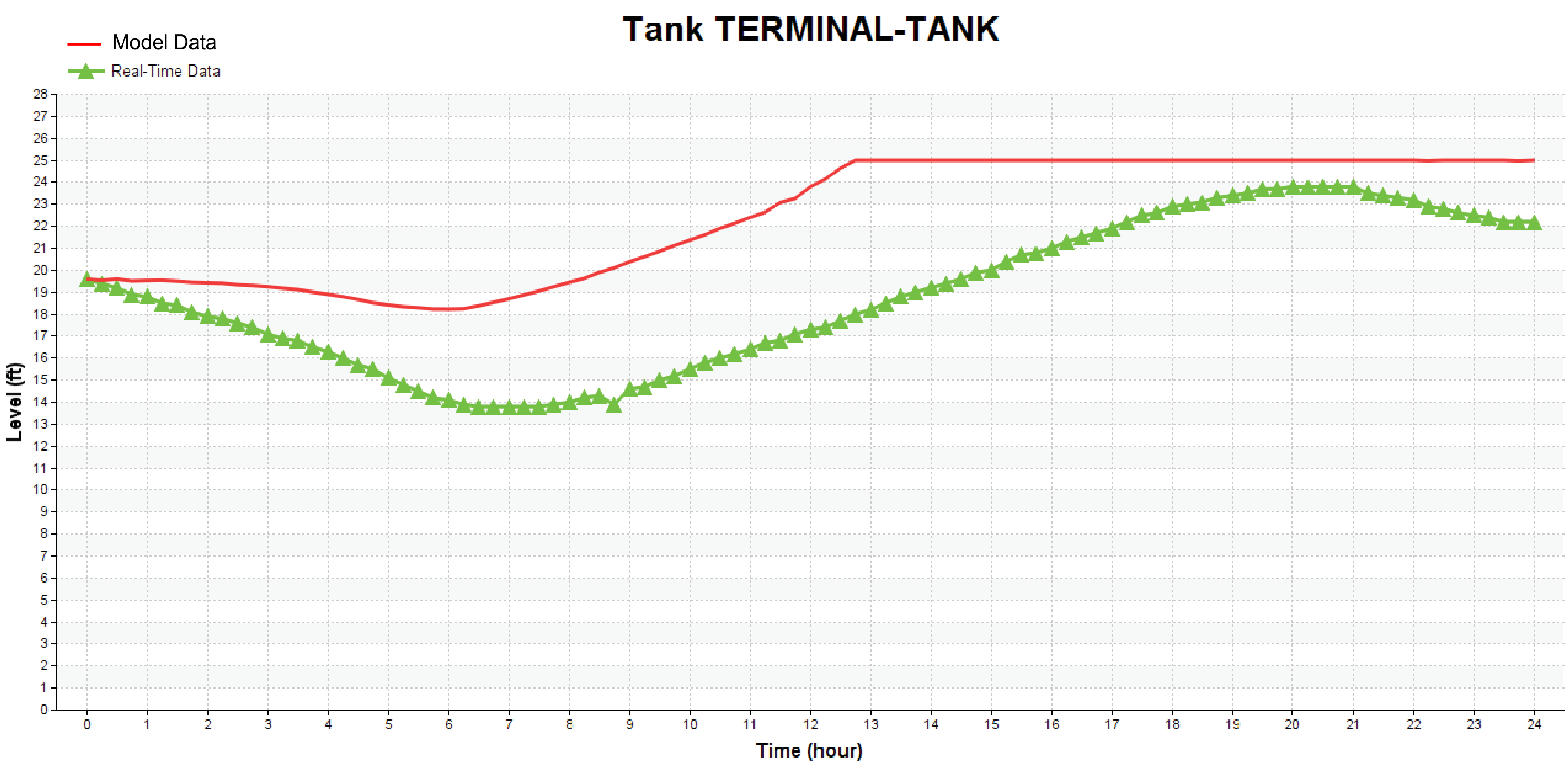
Tank GRIZZLY-TANK

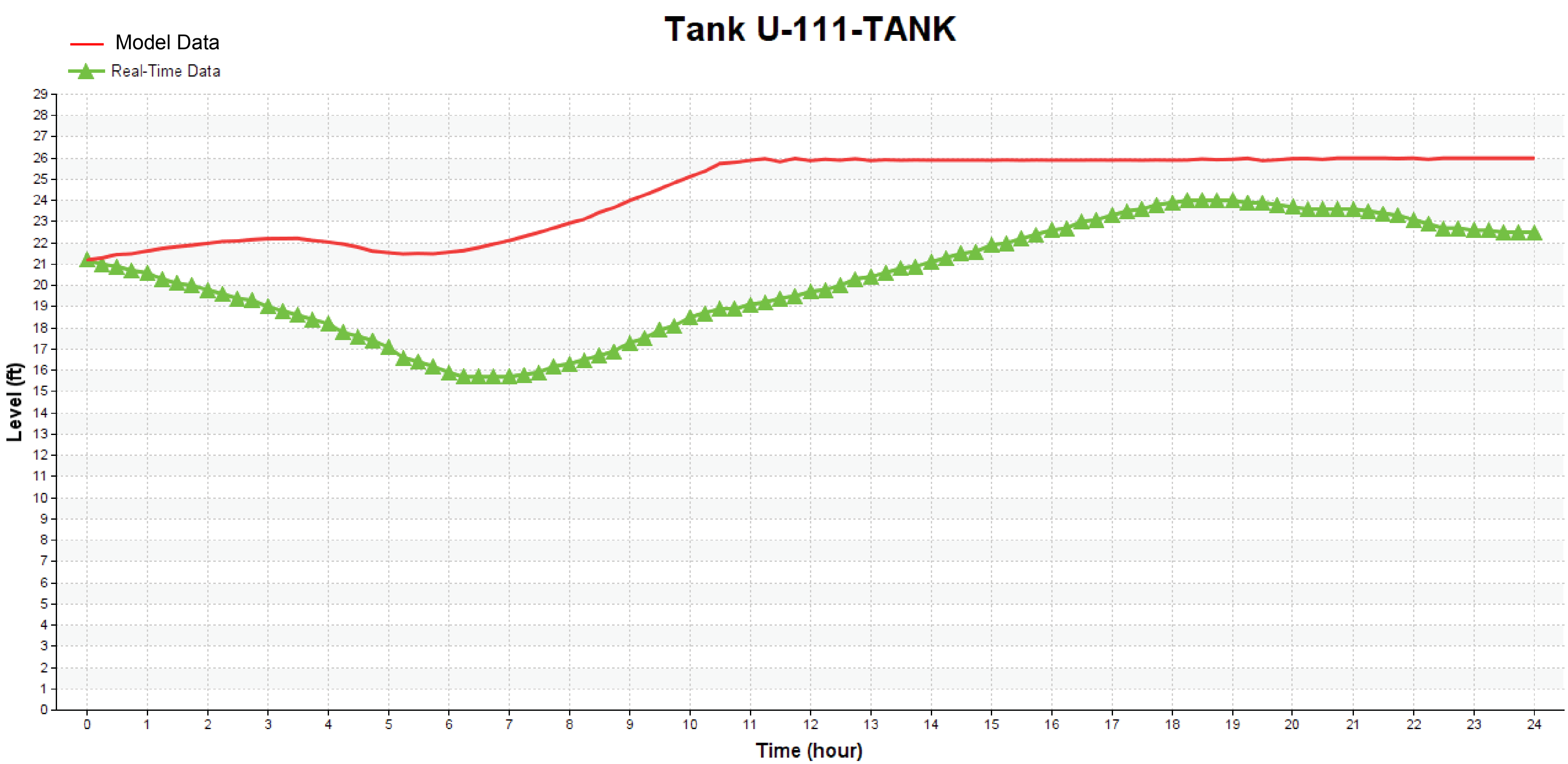



Tank OLD-B-TANK
Model Data
Real-Time Data
Level (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Time (hour)

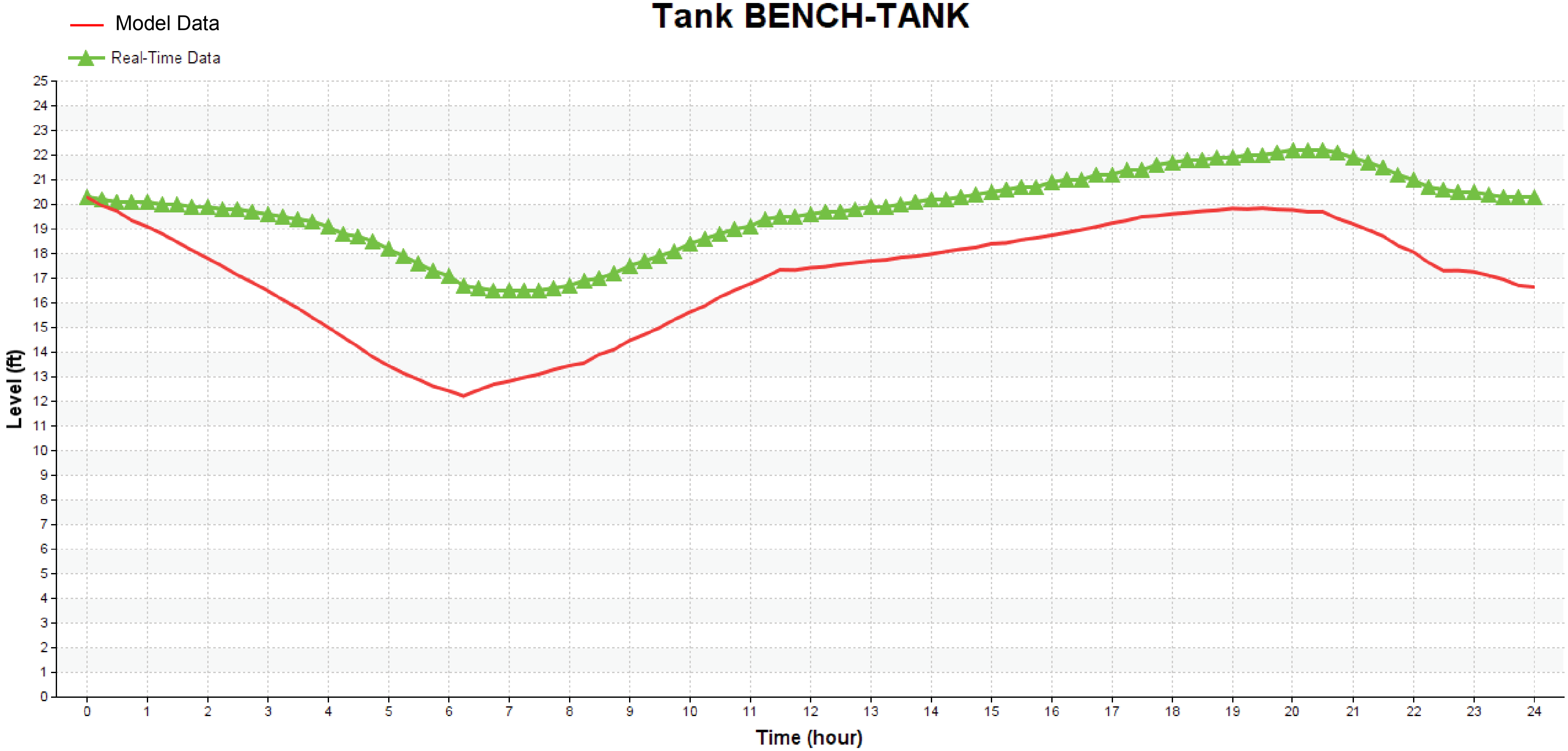


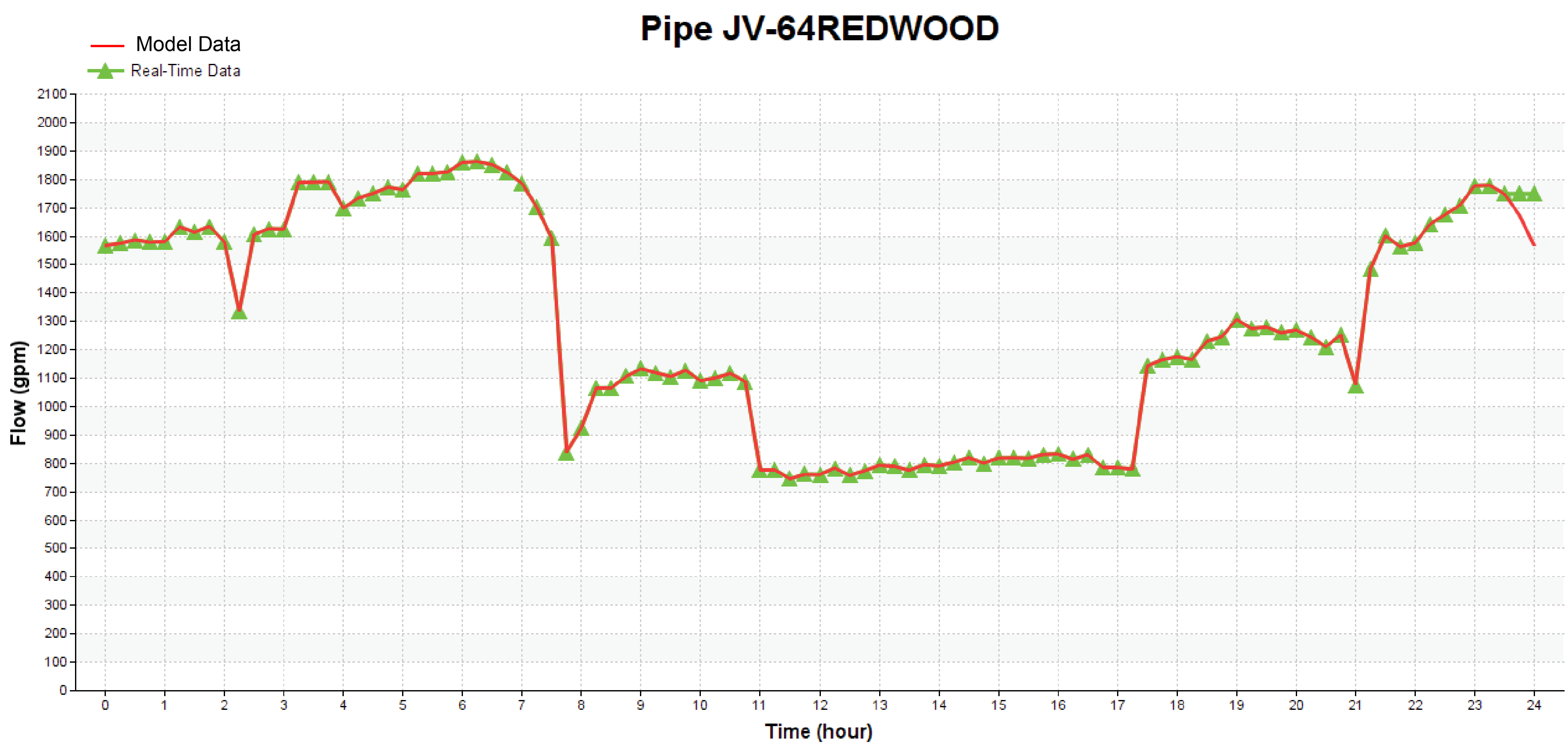
Tank BARNEYS-W-TANK1
Model Data
Real-Time Data
Level (ft)
Time (hour)


Tank TERMINAL-TANK
Model Data
Real-Time Data
Level (ft)
Time (hour)


Tank U-111-TANK
Model Data
Real-Time Data
Level (ft)
Time (hour)

Tank BENCH-TANK




Pipe JV-64REDWOOD
Model Data
Real-Time Data
Flow (gpm)
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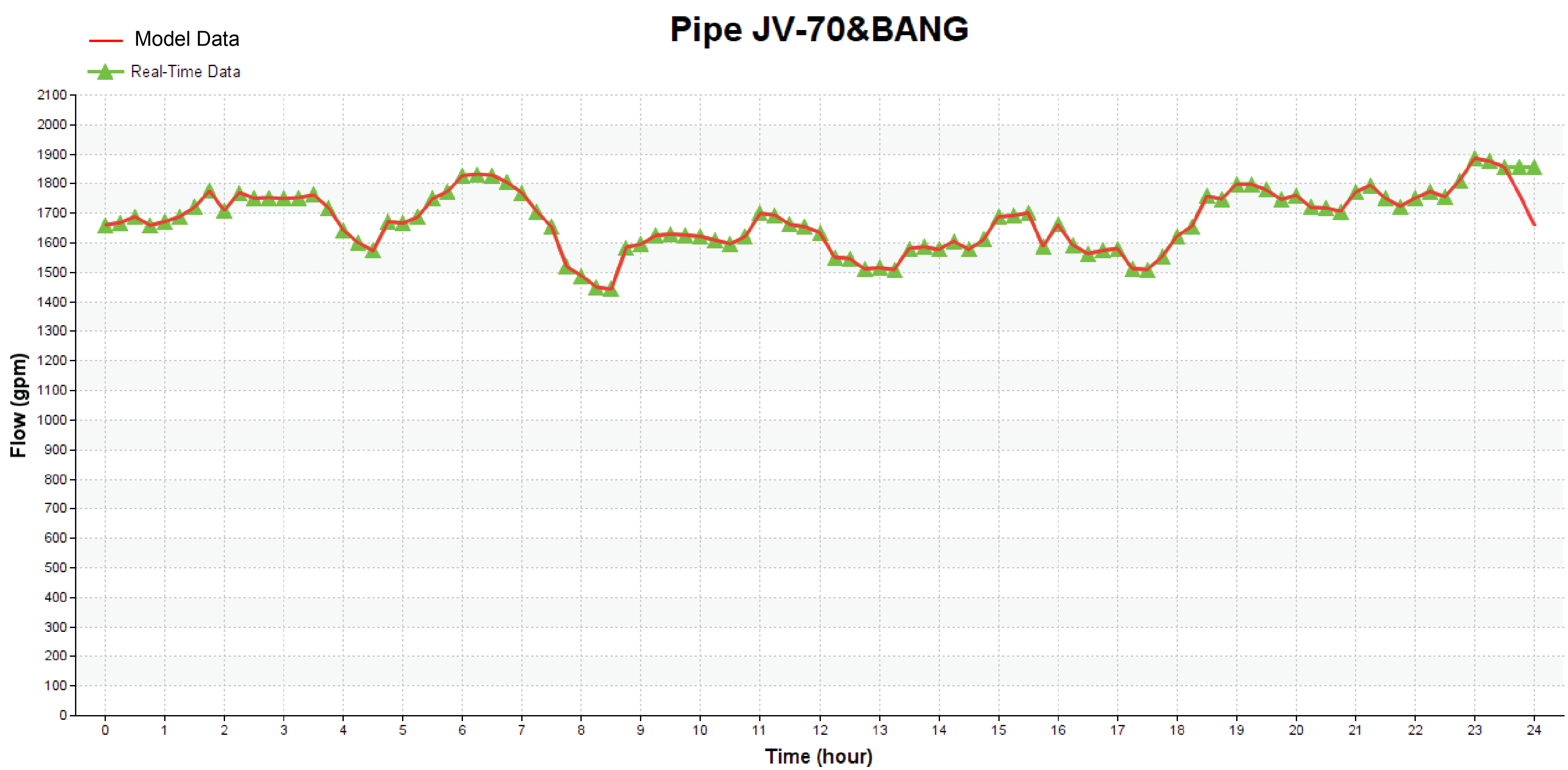
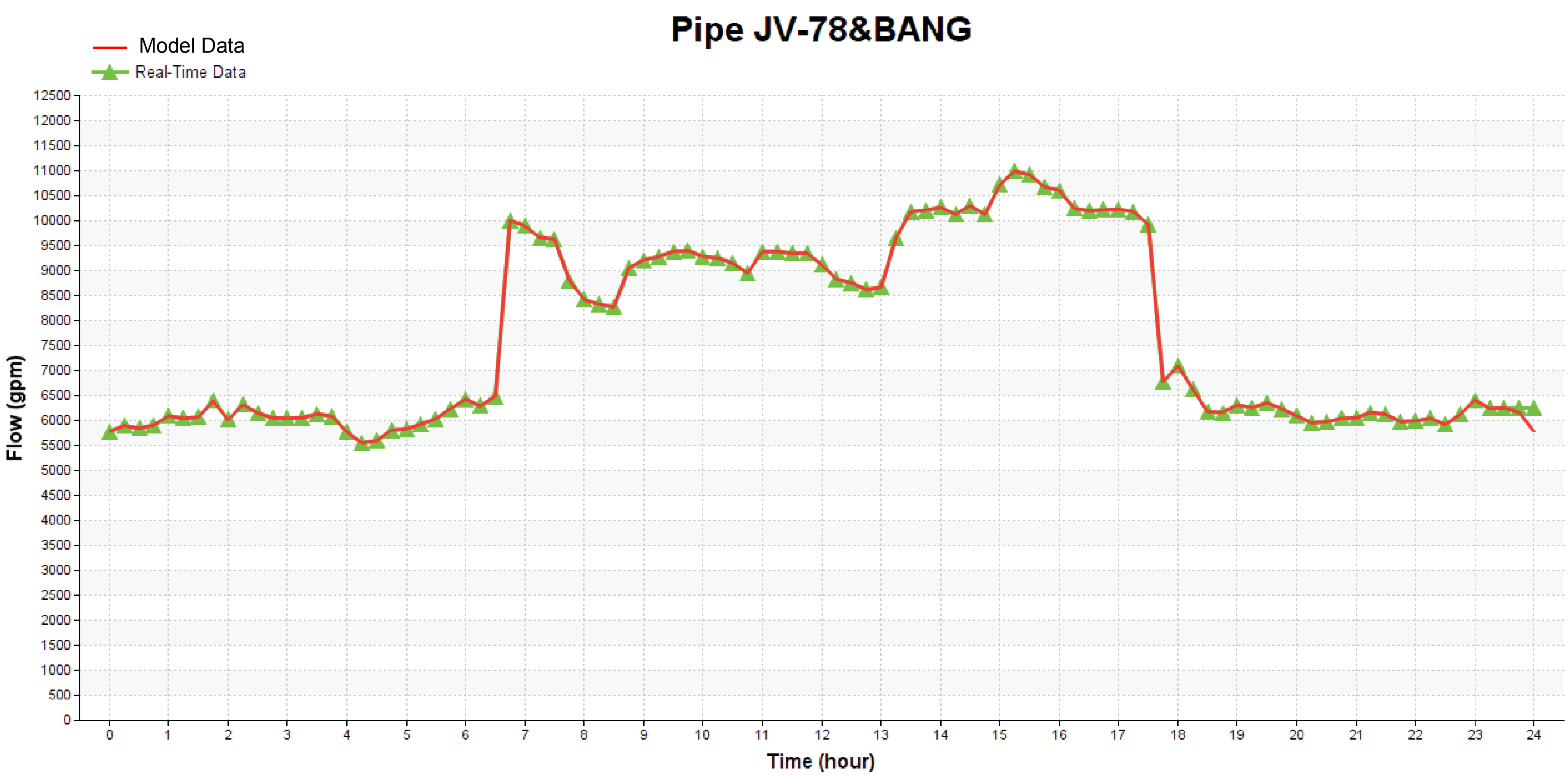
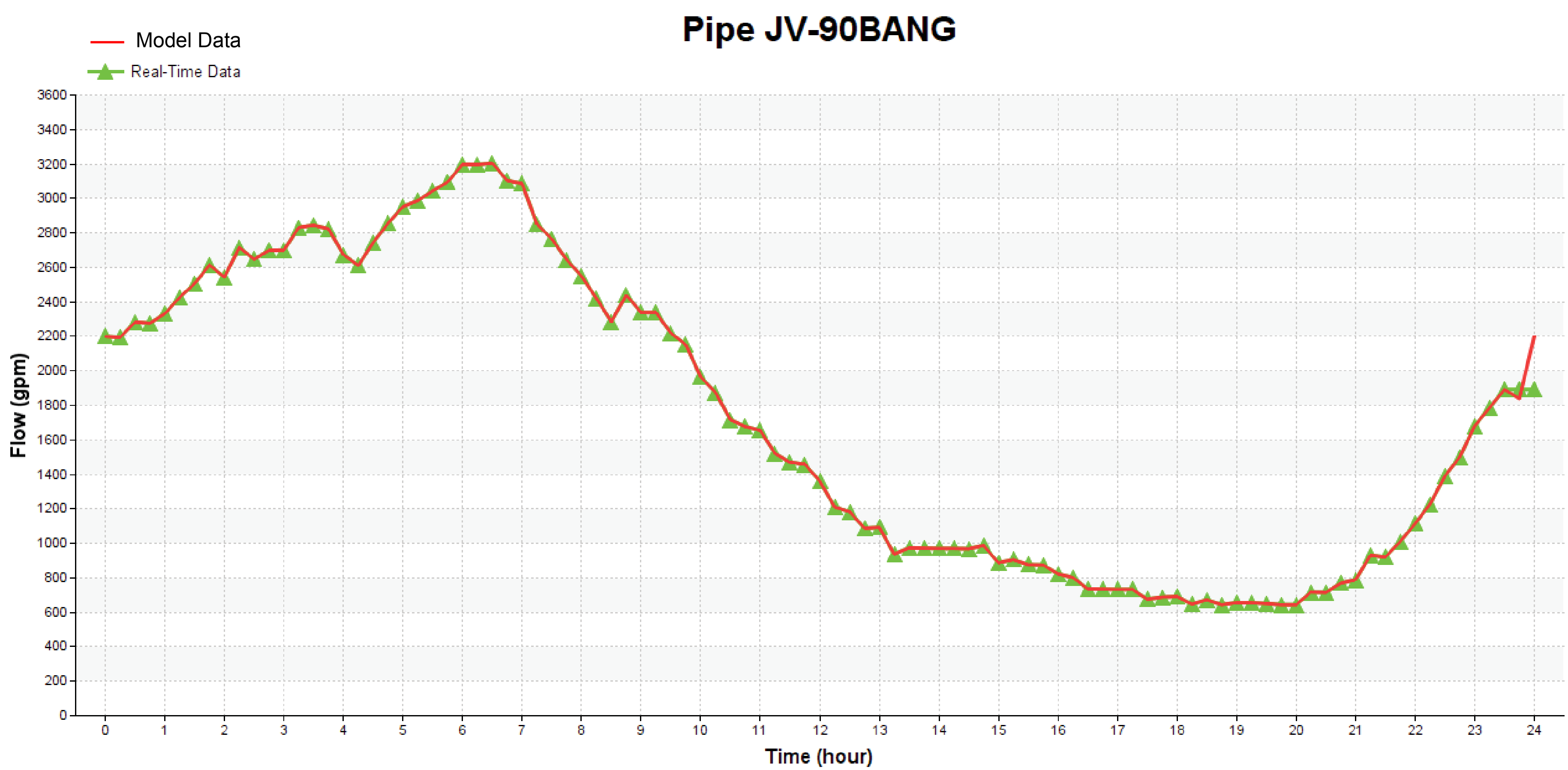
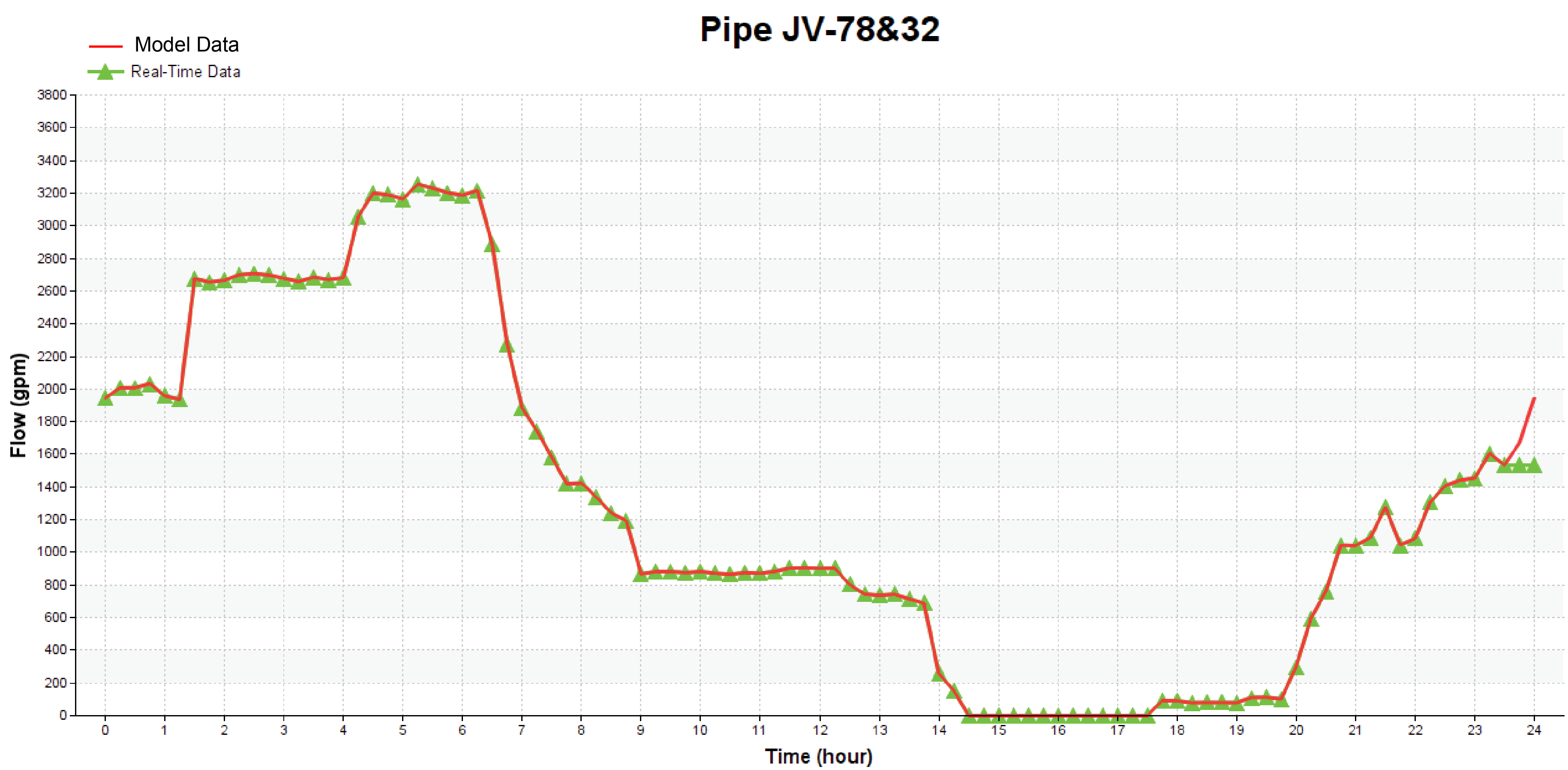
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Time (hour)

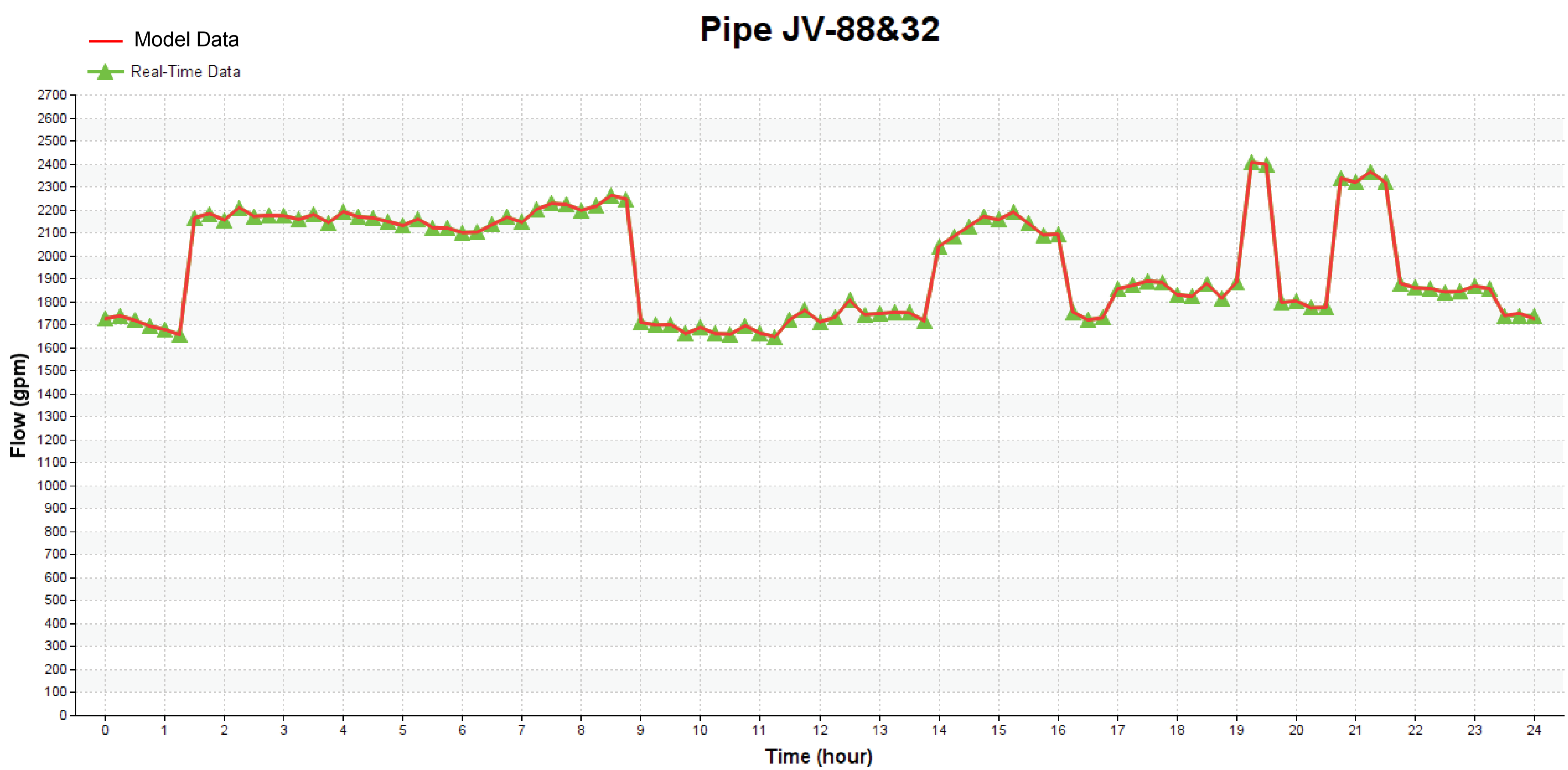

Pipe JV-70&BANG
Model Data
Real-Time Data
Flow (gpm)
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Time (hour)


Pipe JV-78&BANG
Model Data
Real-Time Data
Flow (gpm)
12500
12000
11500
11000
10500
10000
9500
9000
8500
8000
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (hour)



Pipe JV-90BANG
Model Data
Real-Time Data
Flow (gpm)
Time (hour)


Pipe JV-78&32
Model Data
Real-Time Data
Flow (gpm)
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (hour)


Pipe JV-88&32
Model Data
Real-Time Data
Flow (gpm)
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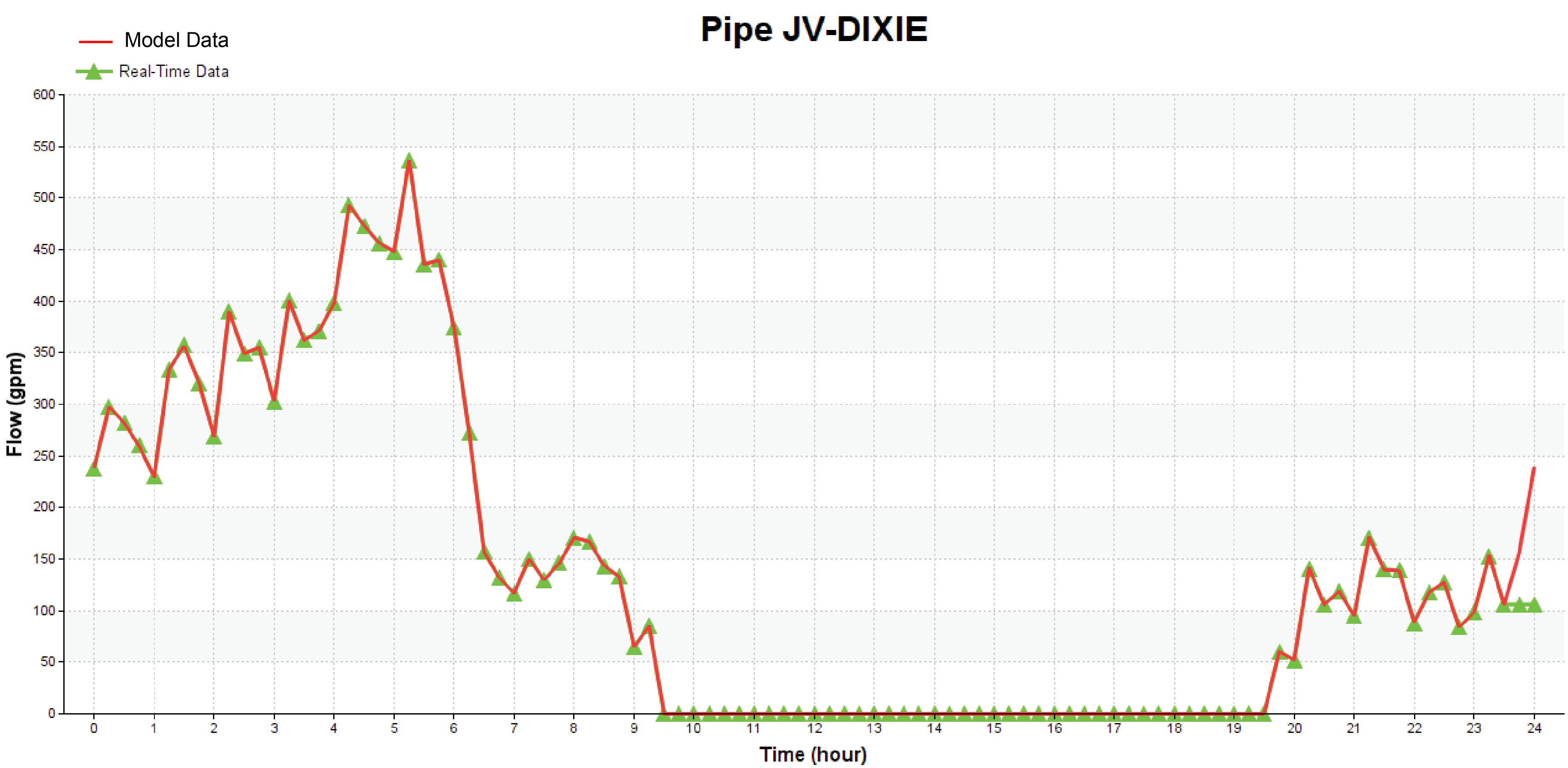
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (hour)


Pipe JV-DIXIE
Model Data
Real-Time Data
Flow (gpm)
600
550
500
450
400
350
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
9
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11
12
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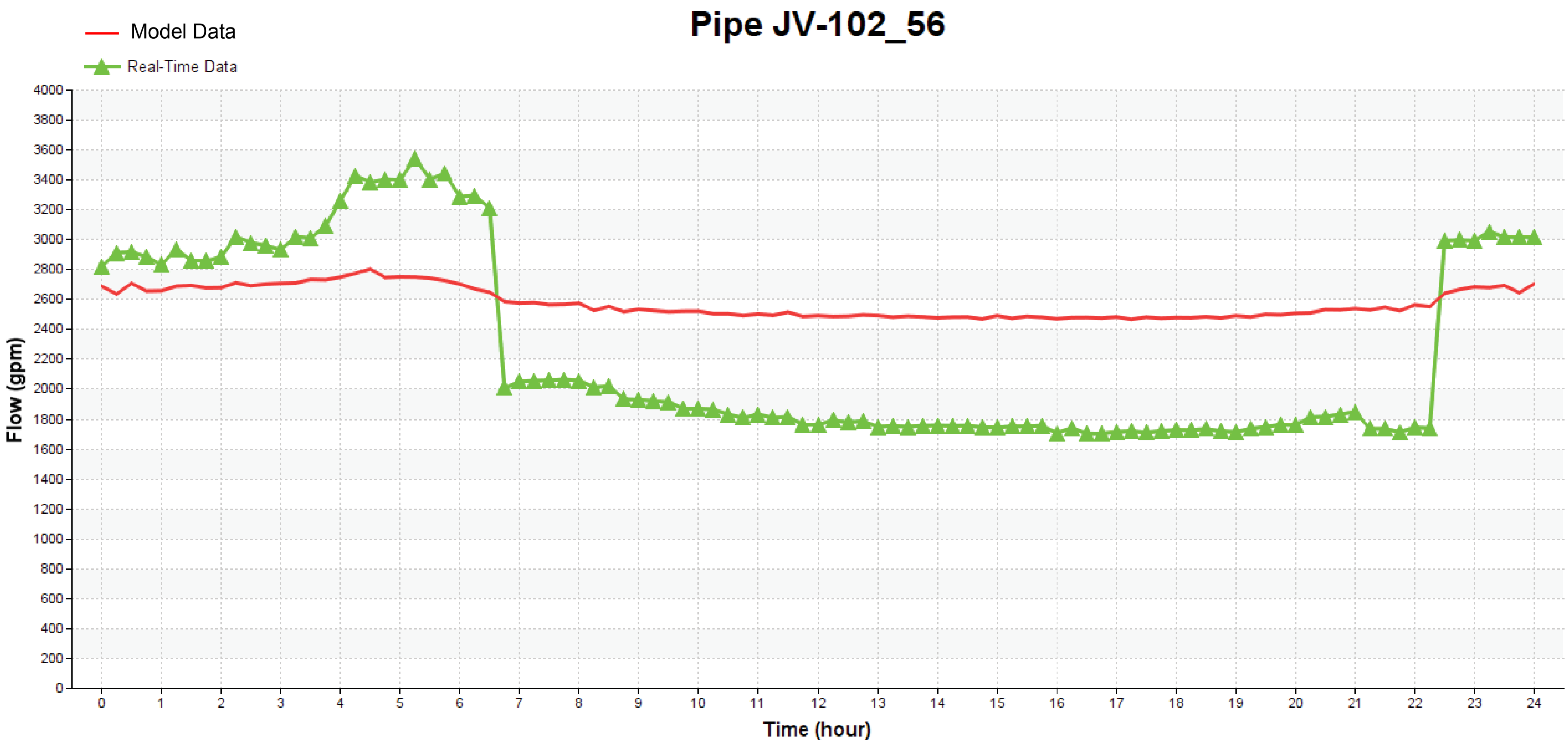
14
15
16
17
18
19
20
21
22
23
24
Time (hour)


Pipe JV-102_56
Model Data
Real-Time Data
Flow (gpm)
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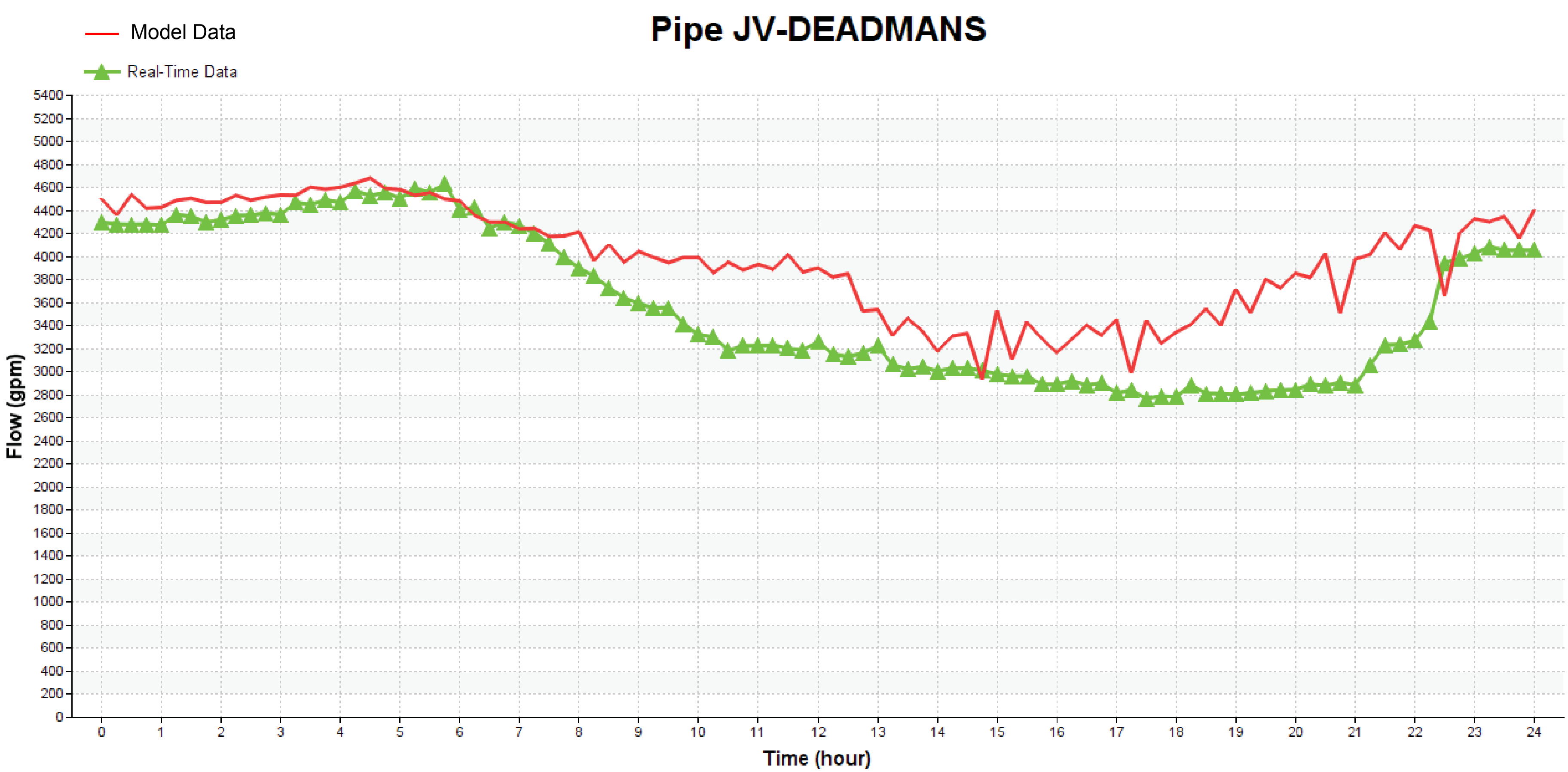
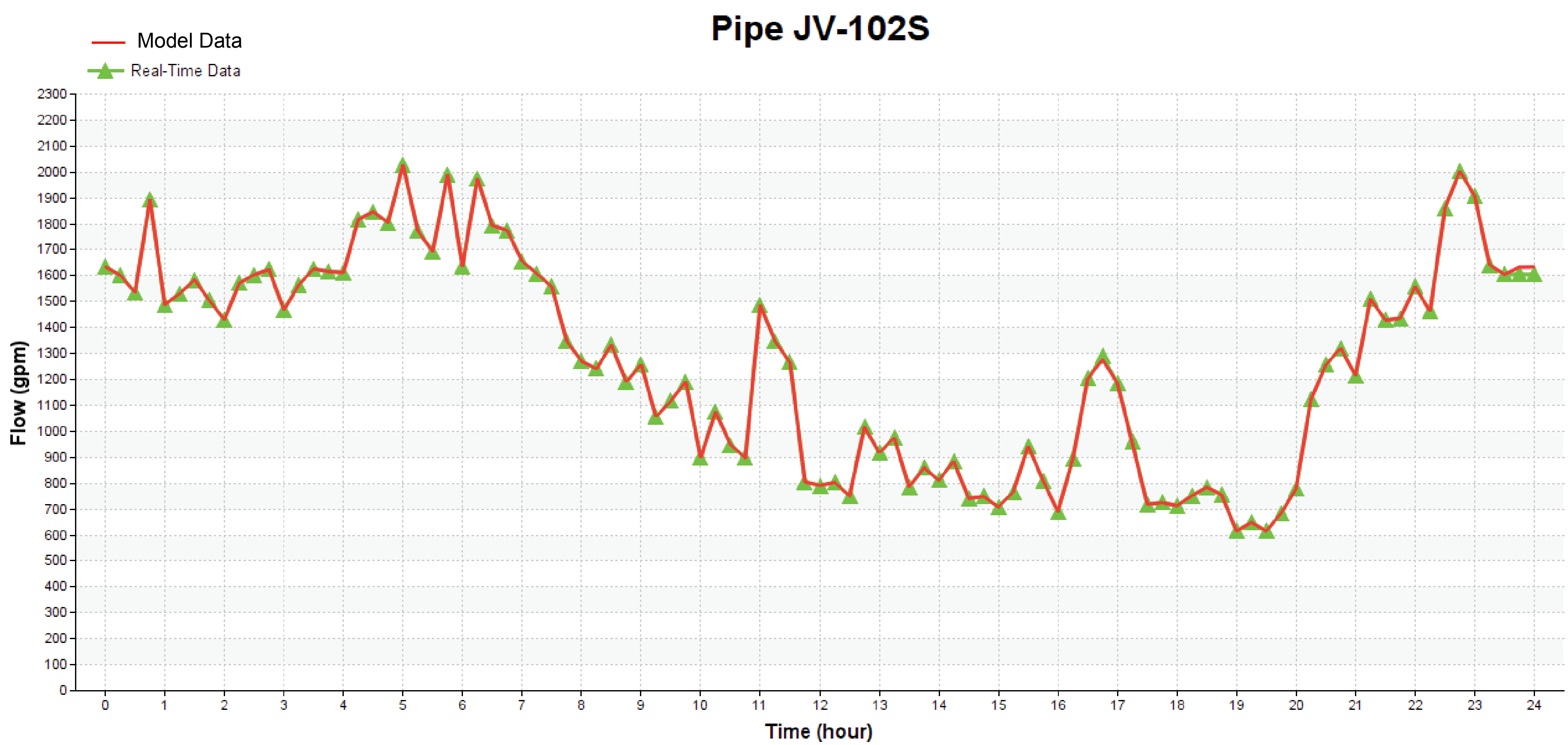
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (hour)


Pipe JV-DEADMANS
Model Data
Real-Time Data
Flow (gpm)
5400
5200
5000
4800
4600
4400
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (hour)


Pipe JV-102S
Model Data
Real-Time Data
Flow (gpm)
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2200
2100
2000
1900
1800
1700
1600
1500
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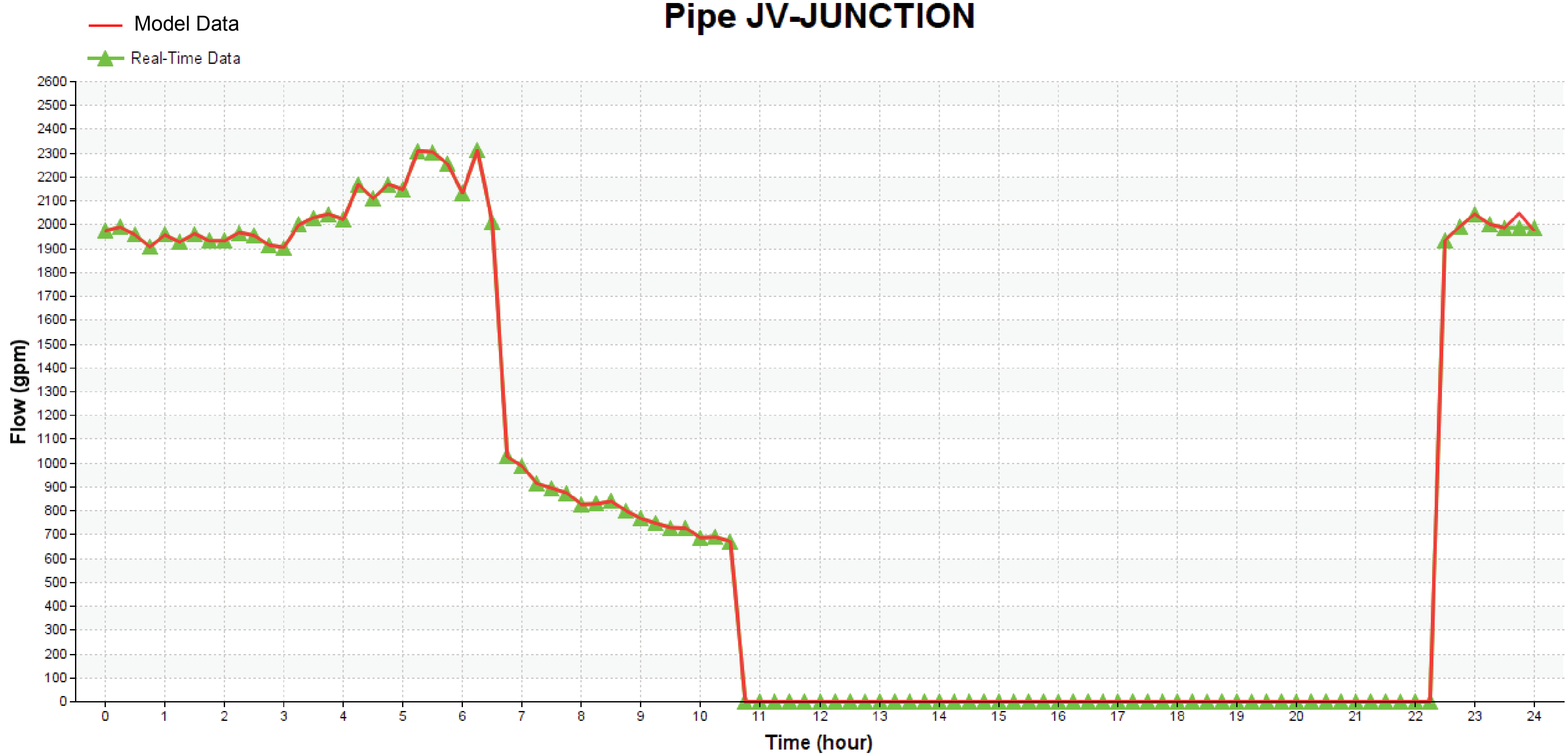
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Time (hour)

Pipe JV-JUNCTION



APPENDIX D
Computer Model Output

SEE DISK

APPENDIX E
Cost Estimate Calculations

PROJECT COST CALCULATIONS

ID	Project Description	UNIT	UNIT TYPE	UNIT COST	COST	Contingency (20%) and Engineering (15%)	TOTAL COST
W-1	Zone 1 JVWCD Connection Improvements	1	ea.	$50,000	$50,000	$17,500	$68,000
W-2	Zone 2 JVWCD Connection Improvements	1	ea.	$25,000	$25,000	$8,750	$34,000
W-3	Zone 3 JVWCD Connection Improvements	1	ea.	$50,000	$50,000	$17,500	$68,000
W-4	Zone 4 JVWCD Connection Improvements	1	ea.	$50,000	$50,000	$17,500	$68,000
W-5	Zone 5 JVWCD Connection Improvements	1	ea.	$50,000	$50,000	$17,500	$68,000
W-6	Zone 6 JVWCD Connection Improvements	1	ea.	$25,000	$25,000	$8,750	$34,000
W-7	New U-111 Well	1	ea.	$1,200,000	$1,200,000	$420,000	$1,620,000
W-8	New Terminal Well	1	ea.	$1,200,000	$1,200,000	$420,000	$1,620,000
W-9	New Ron Wood Park Well	1	ea.	$1,200,000	$1,200,000	$420,000	$1,620,000
W-10	New Barney's Wash Well	1	ea.	$1,200,000	$1,200,000	$420,000	$1,620,000
W-11	New Zone 5 North Booster Station	1	ea.	$1,000,000	$1,000,000	$350,000	$1,350,000
W-12	New Zone 5 South Booster Station	1	ea.	$1,000,000	$1,000,000	$350,000	$1,350,000
W-13	Additional Zone 2 booster pump	1	ea.	$190,000	$190,000	$66,500	$257,000
W-14	Additional Zone 3 booster pump	1	ea.	$150,000	$150,000	$52,500	$203,000
W-15	Additional Zone 4 booster pump	1	ea.	$190,000	$190,000	$66,500	$257,000
W-16	New Zone 7 North Booster Station	1	ea.	$700,000	$700,000	$245,000	$945,000
W-17	New Zone 7 South Booster Station	1	ea.	$700,000	$700,000	$245,000	$945,000
W-18	Well 3 Improvements to allow pumping to Zone 3	1	ea.	100000	$100,000	$35,000	$135,000
W-19	Well 4 Improvements	1	ea.	$225,000	$225,000	$78,750	$304,000
W-20	Exploratory Wells	2	ea.	$185,000	$370,000	$129,500	$500,000
W-21	Water Right Transfer	1	ea.	$18,500	$18,500	$6,475	$25,000
W-22	5 Year Master Plan Update	1	ea.	$74,000	$74,000	$25,900	$100,000
S-1	New 5.0 MG Airport Tank	1	ea.	$5,000,000	$5,000,000	$1,750,000	$6,750,000
	Piping modifications	1	ea.	$40,000	$40,000	$14,000	$54,000
S-2	New 3.0 MG Cemetery Tank	1	ea.	$3,000,000	$3,000,000	$1,050,000	$4,050,000
S-3	New 2.0 MG Old Bingham Highway Zone 2 Tank #2	1	ea.	$2,000,000	$2,000,000	$700,000	$2,700,000
S-4	New 4.0 MG Old Bingham Highway Zone 3 Tank	1	ea.	$4,000,000	$4,000,000	$1,400,000	$5,400,000
S-5	New 3.0 MG Terminal Tank #2	1	ea.	$3,000,000	$3,000,000	$1,050,000	$4,050,000
S-6	New 4.0 MG U-111 Tank #2	1	ea.	$4,000,000	$4,000,000	$1,400,000	$5,400,000
S-7	New 2.0 MG Zone 5a Tank	1	ea.	$2,000,000	$2,000,000	$700,000	$2,700,000
S-8	New 4.0 MG Zone 5 North Tank	1	ea.	$4,000,000	$4,000,000	$1,400,000	$5,400,000
S-9	New 4.0 MG Zone 5 South Tank	1	ea.	$4,000,000	$4,000,000	$1,400,000	$5,400,000
S-10	New 1.5 MG Zone 6 North Tank	1	ea.	$1,500,000	$1,500,000	$525,000	$2,025,000
S-11	New 1.5 MG Zone 6 South Tank	1	ea.	$1,500,000	$1,500,000	$525,000	$2,025,000
S-12	New 2.0 MG Zone 7 North Tank	1	ea.	$2,000,000	$2,000,000	$700,000	$2,700,000
S-13	New 2.0 MG Zone 7 South Tank	1	ea.	$2,000,000	$2,000,000	$700,000	$2,700,000
AC-1	Install 1,510 feet of 8-inch pipe	1,510	foot	$99	$149,490	$52,322	$202,000
AC-2	Install 5,320 feet of 10-inch pipe	5,320	foot	$113	$601,160	$210,406	$812,000
AC-3	Install 2,920 feet of 8-inch pipe	2,920	foot	$99	$289,080	$101,178	$390,000
AC-4	Install 5,220 feet of 8-inch pipe	5,220	foot	$99	$516,780	$180,873	$698,000
AC-5	Install 2,520 feet of 10-inch pipe	2,520	foot	$113	$284,760	$99,666	$384,000
AC-6	Install 2,290 feet of 8-inch pipe	2,290	foot	$99	$226,710	$79,349	$306,000
AC-7	Install 2,670 feet of 8-inch pipe	2,670	foot	$99	$264,330	$92,516	$357,000
AC-8	Install 1,265 feet of 8-inch pipe	1,265	foot	$99	$125,235	$43,832	$169,000
AC-9	Install 565 feet of 8-inch pipe	565	foot	$99	$55,935	$19,577	$76,000
AC-10	Install 1,450 feet of 8-inch pipe	1,450	foot	$99	$143,550	$50,243	$194,000
F-1	1,440 feet of 10-inch pipe	1,440	foot	$113	$162,720	$56,952	$220,000
F-2	690 feet of 10-inch pipe	690	foot	$113	$77,970	$27,290	$105,000
F-3	570 feet of 8-inch pipe	570	foot	$99	$56,430	$19,751	$76,000
	400 feet of 8-inch pipe	400	ea.	$99	$39,600	$13,860	$53,000
	400 feet of 8-inch pipe	400	foot	$99	$39,600	$13,860	$53,000
F-4	575 feet of 8-inch pipe	575	foot	$99	$56,925	$19,924	$77,000
F-5	Install 1,535 feet of 8-inch pipe	1,535	foot	$99	$151,965	$53,188	$205,000
F-6	8-inch interconnection	1	ea.	$10,000	$10,000	$3,500	$14,000
D-1	Install new 12-inch PRV and vault	1	ea.	$150,000	$150,000	$52,500	$203,000
D-2	Rehab PRV, run power to the vault and install fan and sur	1	ea.	$25,000	$25,000	$8,750	$34,000
D-3	Install a VFD on the smallest Zone 2 booster pump	1	ea.	$50,000	$50,000	$17,500	$68,000
D-4	Install a new 6-inch PRV in existing vault	1	ea.	$25,000	$25,000	$8,750	$34,000
D-5	Install a new 12-inch PRV and vault	1	ea.	$150,000	$150,000	$52,500	$203,000
D-6	Install a new 6-inch PRV in existing vault	1	ea.	$25,000	$25,000	$8,750	$34,000
D-7	Install a new 8-inch PRV in existing vault	1	ea.	$30,000	$30,000	$10,500	$41,000
D-8	Install a new 6-inch PRV and repair vault	1	ea.	$50,000	$50,000	$17,500	$68,000
D-9	Install a new 16-inch PRV in existing vault	1	ea.	$70,000	$70,000	$24,500	$95,000
D-10	Install a new 8-inch PRV in existing vault	1	ea.	$25,000	$25,000	$8,750	$34,000
D-11	Install 1,590 feet of 8-inch pipe	1,590	foot	$99	$157,410	$55,094	$213,000
	Install 355 feet of 12-inch pipe	355	foot	$120	$42,600	$14,910	$58,000
	Install 1,175 feet of 16-inch pipe	1,175	foot	$134	$157,450	$55,108	$213,000
	Install 480 feet of 12-inch pipe	480	foot	$120	$57,600	$20,160	$78,000

PROJECT COST CALCULATIONS

	Install 70 feet of 16-inch pipe	70	foot	$134	$9,380	$3,283	$13,000
D-12	Install 1,527 feet of 10-inch pipe	1,527	foot	$113	$172,551	$60,393	$233,000
D-13	New 30-inch Connection	1	ea.	$41,000	$41,000	$14,350	$55,000
D-14	Install 3,120 feet of 12-inch pipe	3,120	foot	$120	$374,400	$131,040	$505,000
D-15	Landscaping at select water sites	4	ea.	$75,000	$300,000	$105,000	$405,000
D-16	Indoor Storage Facility for Water Parts and Fittings	1	ea.	$500,000	$500,000	$175,000	$675,000
D-17	Segregate a new Zone 2a pressure zone	2	ea.	$25,000	$50,000	$17,500	$68,000
D-18	Install 7,900 feet of 12-inch pipe	7,900	foot	$173	$1,366,700	$478,345	$1,845,000
D-19	Install 4,605 feet of 8-inch pipe	4,605	foot	$99	$455,895	$159,563	$615,000
D-20	8-inch pipeline connection changes	4	ea.	$10,000	$40,000	$14,000	$54,000
D-21	Install 2,435 feet of 16-inch pipe	2,435	foot	$134	$326,290	$114,202	$440,000
	Install 6,300 feet of 24-inch pipe	6,300	foot	$212	$1,335,600	$467,460	$1,803,000
	Install 2,685 feet of 18-inch pipe	2,685	foot	$156	$418,860	$146,601	$565,000
	Install 1,900 feet of 24-inch pipe	1,900	foot	$212	$402,800	$140,980	$544,000
	Install 135 feet of 16-inch pipe	135	foot	$134	$18,090	$6,332	$24,000
D-22	Install 1,500 feet of 10-inch pipe	1,500	foot	$113	$169,500	$59,325	$229,000
D-23	Install 5,250 feet of 16-inch pipe	5,250	foot	$134	$703,500	$246,225	$950,000
D-24	Install a new 12-inch PRV and vault	1	ea.	$150,000	$150,000	$52,500	$203,000
D-25	Install 5,260 feet of 16-inch pipe	5,260	foot	$134	$704,840	$246,694	$952,000
D-26	Install 2,575 feet of 16-inch pipe	2,575	foot	$134	$345,050	$120,768	$466,000
D-27	Install 3,540 feet of 16-inch pipe	3,540	foot	$134	$474,360	$166,026	$640,000
D-29	Install 6,220 feet of 24-inch pipe	6,220	foot	$212	$1,318,640	$461,524	$1,780,000
	Install 1,370 feet of 20-inch pipe	1,370	foot	$173	$237,010	$82,954	$320,000
	Install 170 feet of 16-inch pipe	170	foot	$134	$22,780	$7,973	$31,000
D-31	Install 5,000 feet of 12-inch pipe	5,000	foot	$120	$600,000	$210,000	$810,000
D-32	Install 3,260 feet of 16-inch pipe	3,260	foot	$134	$436,840	$152,894	$590,000
D-33	Upsize Reimbursements	1	ea.	$700,000	$700,000	N/A	$700,000
D-34	40,955 feet of future 10-inch pipe	40,955	foot	$113	$4,627,915	$1,619,770	$6,248,000
D-35	70,560 feet of future 12-inch pipe	70,560	foot	$120	$8,467,200	$2,963,520	$11,431,000
D-36	7,965 feet of future 16-inch pipe	7,965	foot	$134	$1,067,310	$373,559	$1,441,000
D-37	200 feet of future 20-inch pipe	200	foot	$173	$34,600	$12,110	$47,000
D-38	1,060 feet of future 24-inch pipe	1,060	foot	$212	$224,720	$78,652	$303,000

TOTAL $105,297,000

APPENDIX F
DDW Report Certification

HYDRAULIC ANALYSIS CERTIFICATION

I hereby certify that the hydraulic modeling analysis for:

____
(Project Name or Description)

____
(Water System Name)

____
(Water System Number)

____
(DDW File Number, If Available)

Meets all requirements as set forth in *R309-511* (*Hydraulic Modeling Rule*) and complies with the provisions thereof, as well as the sizing requirements of *R309-510*, and the minimum water pressures of *R309-105-9*. Where applicable the proposed additions to the distribution system will not cause the pressures at any new or existing connections to be less than those specified in *R309-105-9*. The model is sufficiently calibrated and accurate to represent the conditions within this water system. The velocities in the model are not excessive and are within industry standards. The hydraulic modeling method is *[e.g., use of computer software or hand calculations]*, and the computer software used was *[software name and version]*.

Signature ________________________________ State of Utah P.E. License No.___#####_
[Full Name], P.E.

Date ____

(* This page must be **signed, sealed, and dated** by a professional engineer who oversees the completion of this hydraulic modeling analysis.)

DIVISION OF DRINKING WATER
HYDRAULIC MODELING RULE CHECKLIST

Hydraulic Modeling Rule (R309-511) Applicability

I. Typically, a hydraulic modeling report and a certification of the hydraulic modeling results by a Professional Engineer (PE) are both required as a part of the plan review process for **public drinking water projects** that are for new construction, water system expansions, and new public drinking water systems.

- Hydraulic modeling report and PE certification may NOT be required if:

  - ☐ The water system is a transient system, and R309-550-5(3) does not apply. ***[R309-511-4(1)(a); R309-550-5(3)(b) and (c)];*** or,
  - ☐ The water system is a non-transient non-community water system with system demand less than the requirement in R309-510 and does not provide water for fire suppression. ***[R309-511-4(1)]***.

- Hydraulic modeling report and PE certification are NOT required if the proposed public drinking water project will not result in negative hydraulic impact. ***[R309-511-4(1)(a)(i)(A) through (G)].*** For example:

  - ☐ Addition of new sources.
  - ☐ Re-development of any spring or well source.
  - ☐ Adding disinfection, fluoridation, or other treatment facilities that do not adversely impact flow, pressure or water quality.
  - ☐ A change or addition of any primary coagulant water treatment chemical (excluding filter, flocculent or coagulant aids) when the proposed chemical does not appear on a list of chemicals pre-approved by the Director for a specific treatment facility.
  - ☐ Interior re-coating or re-lining of any raw or drinking water storage tank, or water storage chamber within any treatment facility.
  - ☐ Water main additions with no expansion of service (i.e. looping lines).
  - ☐ The "in-situ" re-lining of any pipeline.
  - ☐ Adding pump station(s) from source or storage upstream of distribution service connections.
  - ☐ Adding transmission lines to storage or sources without adding service connections.
  - ☐ Public drinking water projects that have negligible hydraulic impact as determined by the Director.

- A hydraulic modeling report is not required but a PE certification of the hydraulic analysis of the proposed project is required if:

  - ☐ The water line project is part of a planned phase of a master plan previously approved by the Director. ***[R309-511-4(1)(a)(ii)]***; **or**,
  - ☐ The water system has formally notified the Division of Drinking Water that this water

system maintains and updates a hydraulic model of the system and designates a professional engineer who is responsible for overseeing the hydraulic analysis. ***[R309-511-4(1)(a)(iii)]***.

II. The following are considered **on-going operation and maintenance procedures** ***[R309-500-5(2)]***. Therefore, neither plan review nor hydraulic modeling requirements apply.

- □ Pipeline leak repair.
- □ Replacement of existing deteriorated pipeline where the new pipeline segment is the same size as the old pipeline or the new segment is upgraded to meet the minimum pipeline sizes required by R309-550-5(4) or larger sizes as determined by a hydraulic analysis in accordance with R309-550-5(3).
- □ Tapping existing water mains with corporation stops so as to make connection to new service laterals to individual structures.
- □ Distribution pipeline additions where the pipeline size is the same as the main supplying the addition or the pipeline addition meets the minimum pipeline sizes required by R309-550-5(4) or larger sizes as determined by a hydraulic analysis in accordance with R309-550-5(3), the length is less than 500 feet and contiguous segments of new pipe total less than 1000 feet in any fiscal year.
- □ Entry into a drinking water storage facility for the purposes of inspection, cleaning and maintenance.
- □ Replacement of equipment or pipeline appurtenances with the same type, size and rated capacity (fire hydrants, valves, pressure regulators, meters, service laterals, chemical feeders and booster pumps including deep well pumps).

Minimum Requirements for the Hydraulic Model ***[R309-511-5]***

Are all the following requirements addressed in the hydraulic model?

1. Include at least 80% of the total pipe lengths in the distribution system affected by the proposed project.
2. Account for 100 % of the flow in the distribution system affected by the proposed project. Water demand allocation must account for at least 80% of the flow delivered by the distribution system affected by the proposed project if customer usage in the system is metered.
3. Include all 8-inch diameter and larger pipes. Pipes smaller than 8-inch diameter should also be included if they connect pressure zones, storage facilities, major demand areas, pumps, and control valves, or if they are known or expected to be significant conveyers of water such as fire suppression demand.
4. Include all pipes serving areas at higher elevations, dead ends, remote areas of a distribution system, and areas with known under-sized pipelines.
5. Include all storage facilities and accompanying controls or settings applied to govern the open/closed status of the facility that reflect standard operations.
6. If applicable, include all pump stations, drivers (constant or variable speed), and accompanying controls or settings applied to govern their on/off/speed status that reflect various operating conditions and drivers.
7. Include all control valves or other system features that could significantly affect the flow

of water through the distribution system (i.e. interconnections with other systems, pressure reducing valves between pressure zones) reflecting various operating conditions.

8. Impose peak day and peak instantaneous demands to the water system's facilities.
9. The model has been calibrated to adequately represent the actual field conditions using field measurements and observations.
10. Account for fire suppression flow and duration if fire hydrants are connected to the distribution system or if the fire suppression requirements are specified by the fire authority.
11. Account for outdoor use, such as irrigation, if the drinking water system supplies water for outdoor use.

Certification Elements *[R309-511-6]*

Does the Professional Engineer's certification address the following elements?

1. The hydraulic model meets the minimum requirements in R309-511-5.
2. The demand requirements specified in Rules R309-510 and -511 have been used to evaluate various operating conditions of the public drinking water system.
3. The hydraulic model predicts that new construction will not result in any service connection within the new expansion area not meeting the minimum distribution system pressures as specified in R309-105-9.
4. The hydraulic model predicts that new construction will not decrease the pressures within the existing water system to such that the minimum distribution system pressures as specified in R309-105-9 are not met.
5. The calibration methodology is described and the model is sufficiently accurate to represent conditions likely to be experienced in the water delivery system.
6. Identify the hydraulic modeling method. If computer software was used, identify the software name and version.
7. The certification is signed, dated, and stamped by a registered Professional Engineer, licensed to practice in the State of Utah.
8. The velocities in the model are not excessive and are within industry standards.

For community public water systems:

- □ Has the water system management certified that they have received a copy of input and output data for the hydraulic model with the simulation showing the worst case results in terms of water system pressure and flow?

Hydraulic Model Design Elements Report *[R309-511-7]*

Does the Hydraulic Model Design Elements Report include the following elements?

1. If the public drinking water system provides water for outdoor use, the report must describe the criteria used to estimate this demand.
2. The total number of connections served by the water system including existing connections and anticipated new connections served by the water system after completion of the construction of the project.

3. The total number of equivalent residential connections (ERC) including both existing connections as well as anticipated new connections associated with the project.
4. Provide the following information:
    - methodology used for calculating demand and allocating it to the model;
    - a summary of pipe length by diameter;
    - a hydraulic schematic of the distribution piping showing pressure zones, general pipe connectivity between facilities and pressure zones, storage, elevation and sources; and,
    - values of friction coefficients used in the hydraulic model according to pipe material and condition in the system.
5. A statement stating either "yes fire hydrants exist or will exist within the system" or "there are no fire hydrants connected to the system and there is no plan to add fire hydrants with this project." Identify the local fire authority's name, address, and contact information, as well as the fire flow quantity and duration if required.
6. The locations of the lowest pressures within the distribution system, and areas identified by the hydraulic model as not meeting each scenario of the minimum pressure requirements in R309-105-9.
7. Calibration method and quantitative summary of the calibration results (i.e., comparison tables, graphs).

Additional Requirements for "Hydraulic Model Design Elements and System Capacity and Expansion Report" ***[R309-511-7; R309-511-8; R309-110-4 "Master Plan" Definition]***

For a <u>regional or system-wide</u> hydraulic analysis, instead of a "Hydraulic Model Design Elements Report," a "Hydraulic Model Design Elements and System Capacity and Expansion Report" is often required. A Hydraulic Model Design Elements and System Capacity and Expansion Report typically include the following elements in addition to the seven items listed above.

1. A listing of sources including source name, source type for both existing and additional sources needed for system expansion, minimum reliable flow of the source in gpm, status of the water right, and the water right limit.
2. A listing of storage facilities including storage tank name, the type of material, the diameter, the total volume in gallons, the elevation of the overflow, the lowest level of the equalization volume, the fire suppression volume, and the emergency volume or the outlet.
3. A listing of pump stations including pump station name and pumping capacity in gpm.
4. A listing of the pipe sizes with their associated pipe materials and, if readily available, the approximate length of pipe in each size and material category.
5. A schematic of the distribution piping showing node points, elevations, length and size of lines, pressure zones, demands, and coefficients used for the hydraulic analysis.
6. A listing by customer type along with an assessment of their associated number of ERCs.
7. The number of future connections along with their associated ERC value that the public drinking water system is committed to serve, but has not yet physically connected to the infrastructure.

8. A description of the nature and extent of the area currently served by the water system and a plan of action to control addition of new service connections or expansion of the public drinking water system to serve new development(s). The plan shall include current number of service connections and water usage as well as land use projections and forecasts of future water usage.
9. A hydraulic analysis of the existing distribution system along with any proposed distribution system expansion already identified.
10. A description of potential alternatives to manage system growth, including interconnections with other existing public drinking water systems, developer responsibilities and requirements, water rights issues, source and storage capacity issues and distribution issues.