PRESSURIZED IRRIGATION SYSTEM MASTER PLAN

(HAL Project No.: 314.04.100)

FINAL REPORT

January 2009

HANSEN ALLEN & LUCE inc
ENGINEERS

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January 2009

ACKNOWLEDGMENTS

Successful completion of this study was made possible by the cooperation and assistance of many individuals, including the Mayor of Highland City, Highland City Council, and Highland City Staff as shown below. We sincerely appreciate the cooperation and assistance provided by these individuals.

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GLOSSARY

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 or volume.

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

Drinking Water - Water used for human consumption.

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

Head - A measure of the pressure in a distribution system that is exerted by the water. Head indicates 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.

Irrigated Acreage (Acres) - The area of land that is irrigated in acres.

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 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 demands 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.

Irrigation Water - Water used solely for outdoor watering. Not for human consumption.

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.

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
blvd	boulevard
cfs	cubic feet per second (ft^3/s)
CUP	Central Utah Project or Central Utah Water Conservancy District
E	East
ft	foot or feet
GIS	Geographic Information System
gpm	gallons per minute
HAL	Hansen, Allen & Luce, Inc.
Hwy	highway
ID #	identification number
in	inches
irr	irrigation
N	North
NW	Northwest
psi	pounds per square inch
RR	railroad
S	South
VFD	variable frequency drive
W	West
w/	with

CHAPTER 1

INTRODUCTION

BACKGROUND

Highland City (City) provides irrigation water to its residents through an existing pressurized irrigation system. This service is a great benefit to the residents as the service provides an adequate quantity and quality of water for outdoor use. The pressurized irrigation service has also reduced demand on the public drinking water system, allowing an efficient use of the higher quality drinking water for indoor use.

While the pressurized irrigation system continues to provide adequate service to most areas of the community, increased water demands due to growth are beginning to affect the reliability of the system in certain areas of the City. During times of high demand, water pressures in some areas of the City have decreased significantly. In other areas of the City, water pressures remain higher than the preferred maximums.

In order to accommodate the increased demand on the pressurized irrigation system, and in order to estimate the related infrastructure cost, the Highland City Council commissioned the development of a master plan. Highland City desired that the master plan evaluate the existing system and recommend necessary changes. Highland City also desired that the master plan predict infrastructure needs once the City density met a maximum under the current zoning.

AUTHORIZATION

In December 2006, Highland City selected Hansen, Allen & Luce, Inc. (HAL) to assist in completing the pressurized irrigation master plan. Development of the master plan was completed under the direction of, and in cooperation with, Highland City staff.

WORK PLAN

The work plan for the pressurized irrigation system master plan included the following:

1. Coordination with Highland City.
2. Create an inventory of the existing pressurized irrigation infrastructure based upon existing information.
3. Estimate existing demands on the system, estimate the needed existing water storage volume, predict future demands on the system, and predict the needed future water storage volume.
4. Create computerized hydraulic models of the existing and projected future water distribution systems. Identify potential problems along with solutions to those problems.
5. Prepare a capital improvements plan which includes cost estimates, population projections and implementation schedules.
6. Evaluate the Highland Glen Park Pond for possible storage use.
7. Prepare a pressurized irrigation master plan document and make a presentation to Highland City.

SERVICE AREA

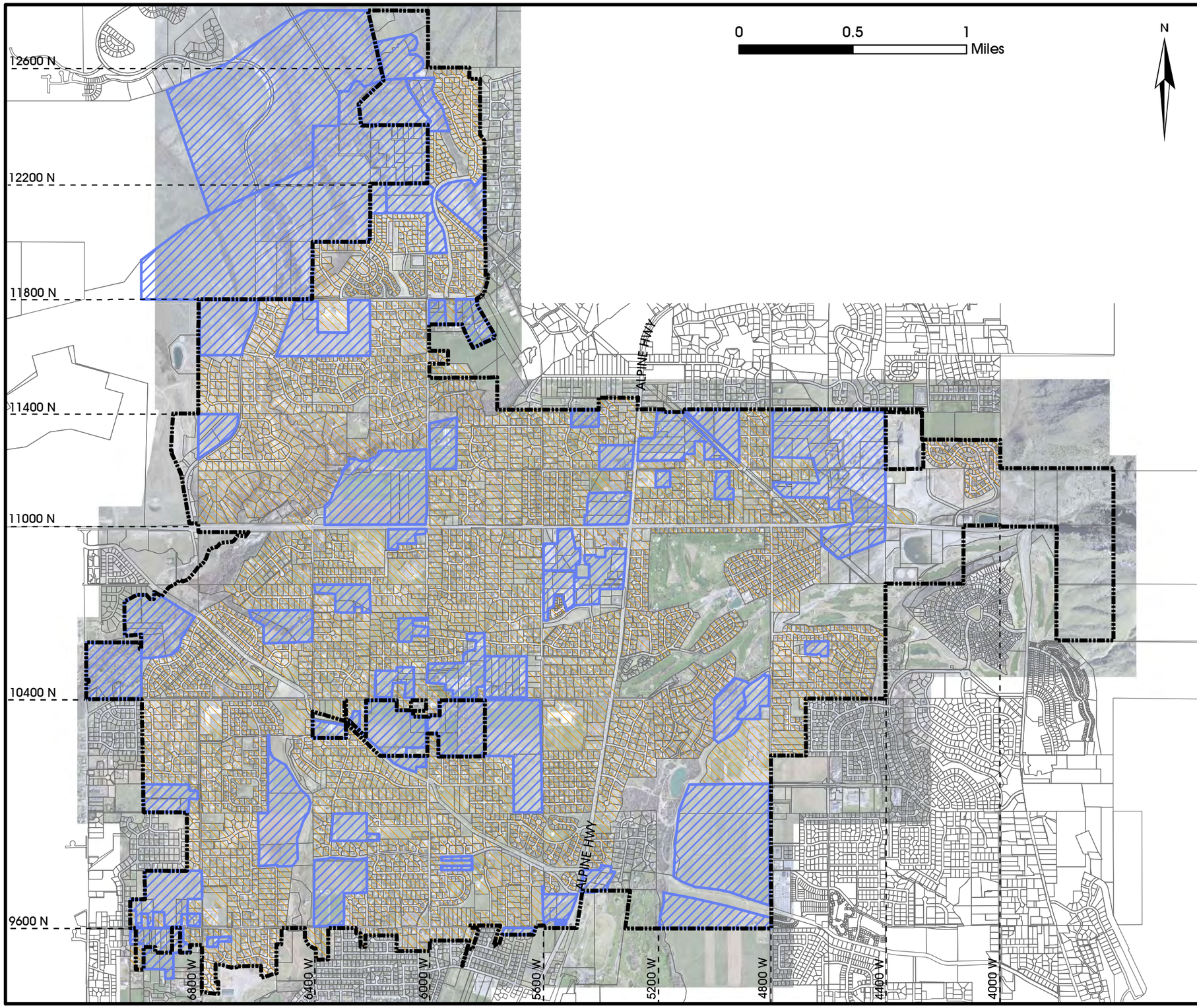
A service area was established for the pressurized irrigation master plan. For the existing system, the service area was identified to be the corporate limit of Highland City with the exception of the Alpine Country Club and the Pheasant Hollow Subdivisions. These developments provide their own irrigation system and will not be connected to Highland City's pressure irrigation system. There are also several areas throughout Highland City that have not yet been developed that are not currently served by the pressure irrigation system. For the future system, the service area was expanded to include areas for which annexation into Highland City appeared likely and all areas within the current City boundaries that are expected to be developed. Areas that are expected to be annexed include unincorporated islands in the middle of the City and an area northwest of the City from about 6000 West to about 7000 West and from about 11800 North to about 12800 North. The areas to be served by the existing and future pressure irrigation systems are shown on Figure 1-1.

DESIGN CRITERIA

The evaluation of existing and future conditions of the pressurized irrigation system were based upon the design criteria provided in Table 1-1.

TABLE 1-1
DESIGN CRITERIA

CRITERIA	VALUE OR ASSUMPTION
Planning Period	Build-out
Land Use	Zoning - Provided by Highland City
Peak Day Demand	5.29 gpm / irrigated acre
Peak Instantaneous Demand	12.74 gpm / irrigated acre
Min. Storage	2,528 gallons / irrigated acre
Min. New Pipe Dia.	8-inch dia.
Min. New Pipe Pressure Rating	200 psi
Roughness Coefficient	Hazen-Williams C = 130
Maximum Water Pressure	Static or Dynamic Pressure at Point of Connection = 120 psi
Minimum Water Pressure	Static or Dynamic Pressure at Point of Connection = 50 psi
Maximum Pressure Change	Static or Dynamic Pressure at Point of Connection = 30 psi



PRESSURIZED IRRIGATION SYSTEM MASTER PLAN

EXISTING AND FUTURE SERVICE AREAS

LEGEND

- Existing Service Areas
- Future Service Areas
- Highland City Boundary

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FIGURE
1-1

CHAPTER 2

EXISTING PRESSURIZED IRRIGATION SYSTEM

EXISTING SYSTEM DESCRIPTION

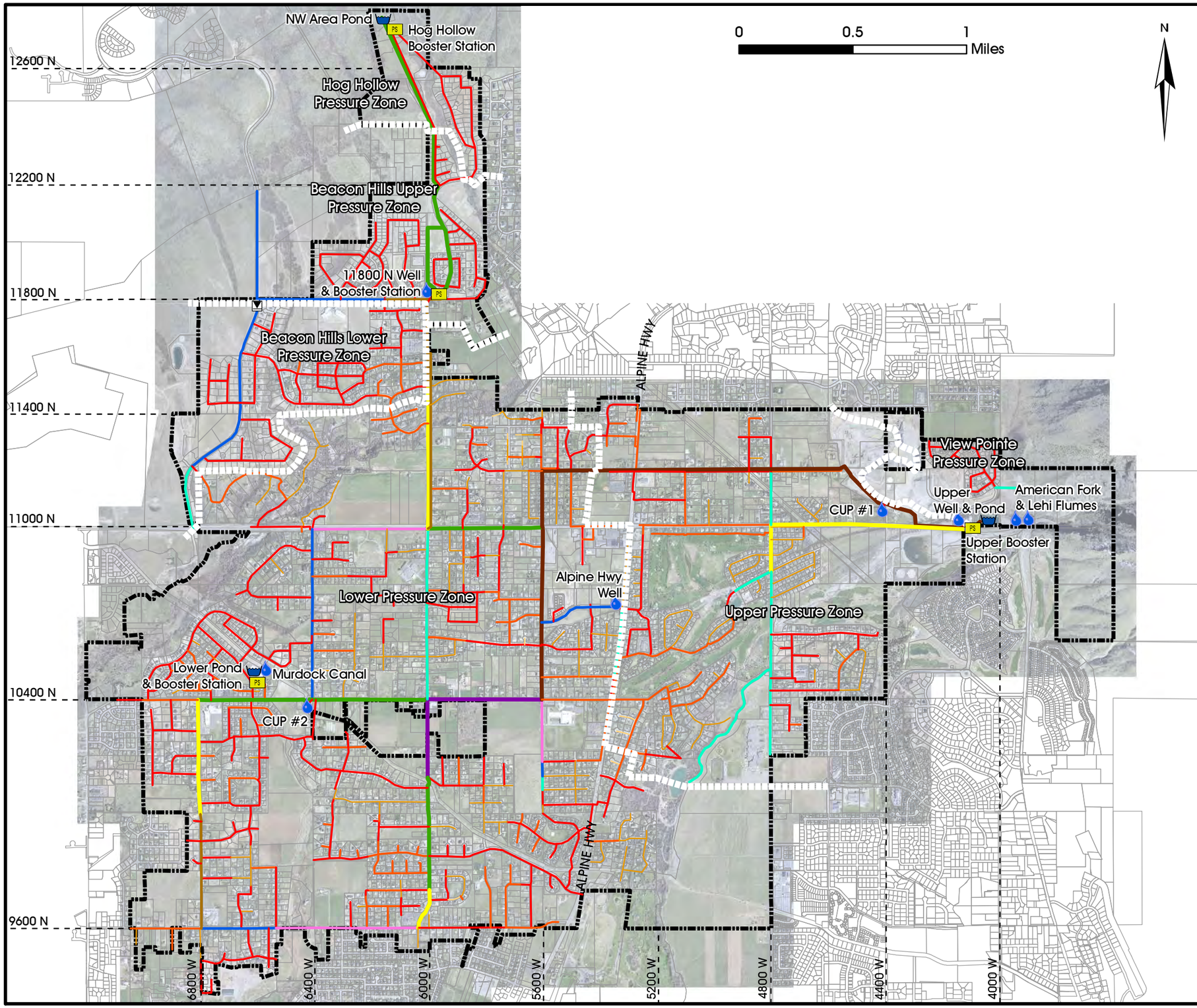
Construction on Highland City's pressurized irrigation system began in 1997 to provide secondary water for irrigation of landscaped areas and gardens. The system extends throughout the developed areas within the corporate boundaries of the City. The existing pressurized irrigation system is shown on Figure 2-1. A schematic representation of the system is shown on Figure 2-2. Sources of irrigation water include three surface water diversions, three underground water wells, and two connections to the Central Utah Project (CUP) wholesale system. There are currently three storage ponds and four booster stations. The distribution system is divided into six pressure zones and consists of approximately 86 miles of pipelines ranging in diameter from 2 inches to 30 inches.

SOURCES

Highland City currently receives secondary water from eight sources. Table 2-1 summarizes the approximate production capacity for each source. Flow records and background information for each source are included in Appendix A.

TABLE 2-1
EXISTING PRESSURIZED IRRIGATION SOURCES

SOURCE	DESCRIPTION	APPROXIMATE CAPACITY (GPM)
American Fork Canyon - American Fork Flume	2-foot parshall flume diversion from American Fork River to the Upper Pond.	3,000 (August) to 7,500 (June)
American Fork Canyon - Lehi Flume	3-foot parshall flume on diversion from American Fork River to the Upper Pond.	800 (August) to 4,000 (June)
Upper Pond Well	12-inch well (640 ft deep) pumping into 30-inch diameter transmission line from upper pond to lower pressure zone.	1,160
11800 North Well	24-inch well (1,000 ft deep) pumping into the lower pressure zone (in same building as the 11800 North booster pumps).	1,600
10700 North Alpine Highway Well	16-inch well (500 ft deep) pumping into the lower pressure zone.	1,670
CUP Connection No. 1	PRV and meter station from high pressure CUP system to 30-inch transmission line to the lower pressure zone.	1,800 gpm (Usage agreement) (Currently diverting 3,590 gpm in exchange for Murdock Canal diversion)
CUP Connection No. 2	PRV and meter station from high pressure CUP system to the lower pressure zone.	3,590
Murdock Canal	Diversion from Murdock Canal to the lower pond with a booster station directly into the lower pressure zone. **CURRENTLY NOT IN USE**.	3,900
	TOTAL:	**17,520 (August) to 25,220 (June)**



PRESSURIZED IRRIGATION SYSTEM MASTER PLAN

EXISTING PRESSURIZED IRRIGATION SYSTEM

LEGEND

- PRV Stations
- Storage Ponds
- Sources
- Booster Stations
- Highland City Boundary
- Pressure Zone Boundary

Pressure Irrigation Pipelines

- 2-inch
- 3-inch
- 4-inch
- 6-inch
- 8-inch
- 10-inch
- 12-inch
- 14-inch
- 16-inch
- 18-inch
- 20-inch
- 24-inch
- 30-inch

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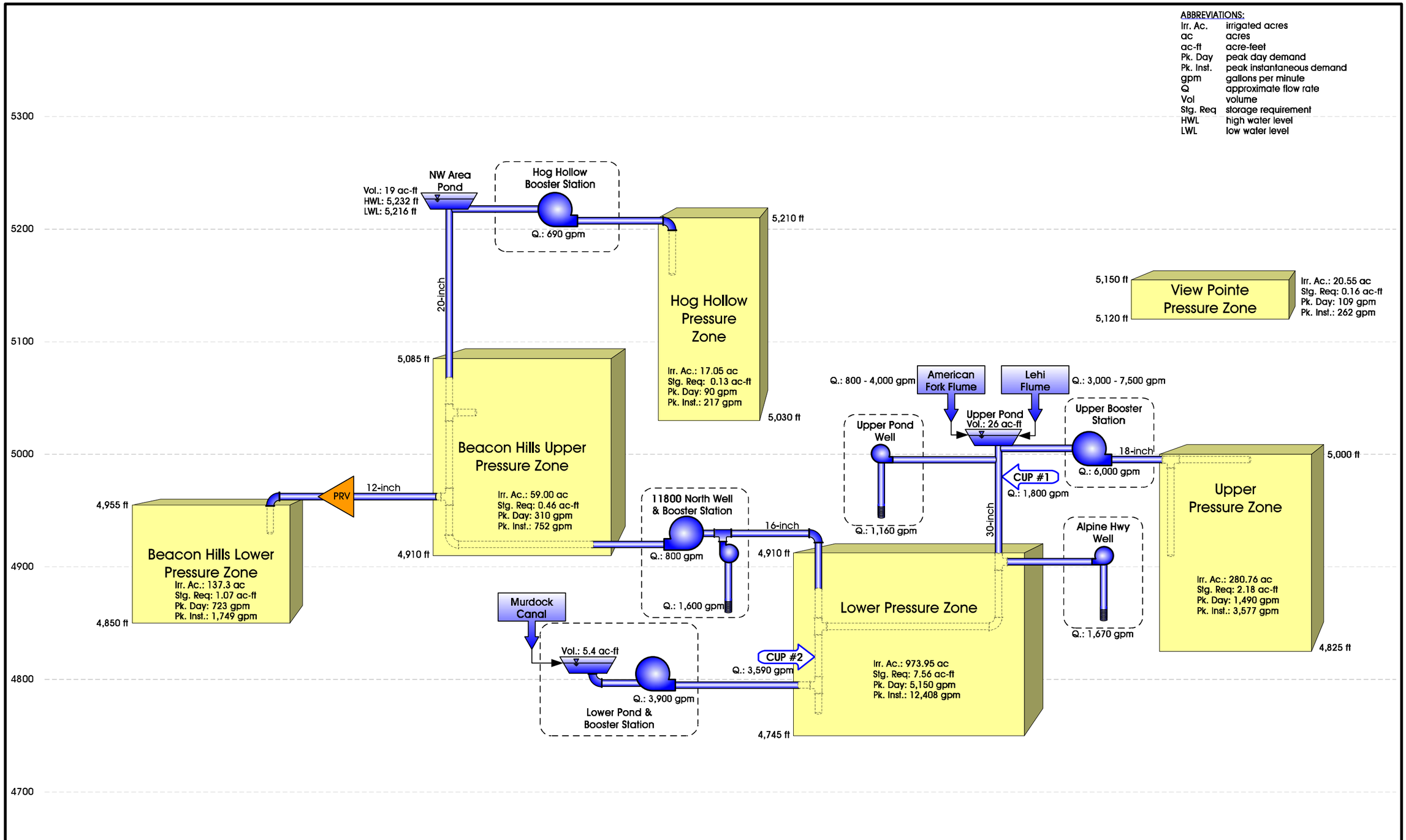
FIGURE

2-1



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HIGHLAND CITY
PRESSURE IRRIGATION SYSTEM MASTER PLAN

EXISTING SYSTEM SCHEMATIC DIAGRAM

FIGURE 2-2

STORAGE PONDS

Highland City currently operates three storage ponds for the pressure irrigation system. These storage reservoirs are described in Table 2-2.

TABLE 2-2
EXISTING STORAGE PONDS

STORAGE POND	DESCRIPTION	STORAGE CAPACITY (AC-FT)
Upper Pond (Mouth of American Fork Canyon)	Located at about 4000 West 11000 North. Serves the Lower Pressure Zone through a 30-inch transmission pipeline. Also serves the Upper Pressure Zone through the Upper Booster Station.	26
Lower Pond (Canterbury North)	Located at about 6600 West 10500 North. Serves the lower pressure zone through the Lower Booster Station.	5.4
Northwest (NW) Area Pond (Beacon Hills)	Located at about 6100 West 12700 North. Serves the Beacon Hills Upper and Lower Pressure Zones through a 20-inch transmission pipeline. Also serves the Hog Hollow Pressure Zone through the Hog Hollow Booster Station.	19
	TOTAL:	**50.4**

DISTRIBUTION SYSTEM

The existing distribution system is divided into six pressure zones with the goal to maintain system pressures within a range of 50 psi to 120 psi. The locations of these pressure zones are shown on Figure 2-1 and a description for each is included in Table 2-3.

TABLE 2-3
EXISTING PRESSURE ZONES

PRESSURE ZONE	DESCRIPTION	APPROXIMATE ELEVATION RANGE (FEET)
View Pointe Pressure Zone	Includes the View Pointe Subdivision located north of 11000 North and east of about 4400 West. This area is not served by the pressure irrigation system because there are no sources currently available at this location and elevation. Pressure irrigation in this area is provided by the Highland City drinking water system.	5,120 - 5,150
Upper Pressure Zone	Includes the area generally east of Alpine Hwy and north of about 10100 North.	4,825 - 5,000
Lower Pressure Zone	Includes the area generally west of Alpine Hwy and south of Dry Creek. This zone serves the largest area of the City.	4,745 - 4,910
Beacon Hills Lower Pressure Zone	Includes the area generally north of Dry Creek and south of 11800 North.	4,850 - 4,955
Beacon Hills Upper Pressure Zone	Includes the area generally north of 11800 North and south of about 12200 North.	4,910 - 5,085
Hog Hollow Pressure Zone	Includes the Hog Hollow area north of about 12200 North that cannot be served by gravity from the NW Area Pond.	5,030 - 5,210

Due to the locations and elevations of the existing ponds and sources relative to the pressure zones, four booster stations have been constructed to set pressures in the distribution system. These booster stations are described in Table 2-4.

TABLE 2-4
EXISTING BOOSTER STATIONS

BOOSTER STATION	DESCRIPTION	STATION CAPACITY (GPM)*
Upper Booster Station (Mouth of Canyon)	Pumps from the Upper Pond to the Upper Pressure Zone through an 18-inch pipeline. Pumps have a variable frequency drive (VFD) to pump on demand and regulate pressures in the Upper Pressure Zone.	6,000
Lower Booster Station (Canterbury North)	Pumps from the Lower Pond directly into the Lower Pressure Zone. Pumps are manually operated in an on or off condition.	3,900
11800 North Booster Station (Dry Creek Booster)	Pumps from a 16-inch diameter pipeline from the Lower Pressure Zone to the NW Area Pond through a 20-inch diameter pipeline. Pumps have a VFD to pump on demand.	800
Hog Hollow Booster Station	Pumps from the NW Area Pond to the Hog Hollow Pressure Zone. Pumps have a VFD to pump on demand and regulate pressures in the Hog Hollow Pressure Zone.	690

*Values shown in Table 2-4 are total booster pumping capacity and have not been reduced to provide redundancy, except for the Hog Hollow Booster Station which has an additional 345 gpm pump. During maintenance, flow capacities will be reduced from the shown values.

CHAPTER 3
DEMAND CALCULATIONS

Pressure irrigation demands in Highland City were estimated based on current land use, future zoning, and the percentage of the land that is irrigated for each zone type. State of Utah standards (R309-510) for minimum sizing for outdoor water use were applied to the existing and estimated future irrigated acreage along with an additional peaking factor for current watering trends.

PLANNING PERIOD AND ZONING

Rather than selecting a planning period (20 years, 30 years, etc.), Highland City staff selected a build-out development condition for the master planning effort. This approach eliminates consideration of time. Build-out was defined by the zoning proposed in the Highland City General Plan Update prepared by Landmark Design in 2007 (See Appendix B).

The build-out planning area for Highland City's pressure irrigation system includes areas that are not currently within the City boundaries but are expected to be annexed by the City. These areas are shown on Figure 1-1. Areas within the current City boundaries that are not currently served by the pressure irrigation system are also shown on Figure 1-1.

IRRIGATED ACREAGE

The irrigated acreage for existing residential parcels was estimated based on the portion of the land that is irrigated for typical parcels within each residential land use zone using the City's existing aerial photography. For residential land use zone R-1-40, land use zones were further divided into small, medium, and large lot sizes for determination of typical irrigated acreage per lot. A summary of the average irrigated acreage per lot for each residential land use type is included in Table 3-1. For all other existing land use types, the irrigated acreage was determined by measurement of the irrigated acreage using the City's existing aerial photography.

TABLE 3-1
RESIDENTIAL IRRIGATED ACREAGE BY LAND USE

RESIDENTIAL LAND USE		TYPICAL IRRIGATED ACREAGE PER LOT
R-1-20		0.22
Non-Conforming R-1-20		0.20
R-1-40	Small Lots (< 0.4 acres)	0.15
	Medium Lots (0.4 - 0.7 acres)	0.27
	Large Lots (> 0.7 acres)	0.70
Conditional Use R-1-40	Tamarack Drive Area	0.49
	Oakview Drive Area	0.33
	4500 West 10400 North & 5300 West 9900 North Areas	0.27

Irrigated acreage for areas that are currently developing, and for which a development plan has been submitted, was determined using the same methodology as for existing areas based

on the submitted development plan. In areas where no development plan exists, typical percentages of total irrigated land area were used for each respective land use zone.

Irrigated areas were also estimated for specific water users identified by Highland City for using water from the pressurized irrigation system for agricultural use. Additionally, irrigated areas were estimated for portions of Highland City which are currently being served by the American Fork Irrigation Company, but which may be served by the Highland City pressurized irrigation system in the near future. Aerial photography was used to estimate irrigated acreage for these areas.

Table 3-2 summarizes the total irrigated acreage for each pressure zone for the existing and future pressure irrigation system. This information has also been included on the existing and future system schematic diagrams (Figures 2-2 and 6-2, respectively).

TABLE 3-2
ESTIMATED IRRIGATED ACREAGE BY PRESSURE ZONE

PRESSURE ZONE	ESTIMATED IRRIGATED ACREAGE	
	EXISTING	FUTURE
View Pointe Pressure Zone	20.55	20.55
Upper Pressure Zone	280.76	472.03
Lower Pressure Zone	973.95	1374.03
Beacon Hills Lower Pressure Zone	137.31	247.47
Beacon Hills Upper Pressure Zone	59.00	228.23
Hog Hollow Pressure Zone	17.05	43.63
Northwest (NW) Area Upper Pressure Zone	N/A	71.26
Northwest (NW) Area Lower Pressure Zone	N/A	106.88
TOTALS:	**1484**	**2560**

UNIT DEMANDS

Highland City is located within consumptive use Zone 3, as defined by the State of Utah standards for outdoor water use. These standards are described in R309-510 of the Utah Administrative Code (UAC) as shown in Table 3-3. In the summer of 2006, flow measurements in 10 to 15 minute increments for all of the City's pressurized irrigation sources were evaluated to determine the peak instantaneous flow for the City. Based on this data, and the number of existing acres irrigated by the system, it was determined that the unit peak instantaneous flow rate in the City is about 12.74 gpm per irrigated acre. This is 1.88 times the state requirement for peak instantaneous conditions. Other Utah cities have also experienced increased peaking which is partly due to current conservation campaigns requesting residents to water at night and the convenience of setting automated sprinkling systems during non-waking hours.

Predictions for peak day demand are also provided. These predictions are based upon information included in the report *Consumptive Use of Irrigated Crops in Utah. Research Report 145. Utah State University. 1994.* Employing a consumptive use of 5.22 inches, as reported for the Pleasant Grove Station for July, and assuming an irrigation efficiency of 60% with no

additional precipitation, a net peak day demand prediction of 5.29 gpm/irrigated acre was calculated. This value is greater than the minimum peak day demand standard of 3.39 gpm/irrigated acre required by the Utah Administrative Code (R309). Therefore, the greater value of 5.29 gpm/irrigated acre was used in predicting peak day values.

TABLE 3-3
UNIT OUTDOOR WATERING DEMANDS

DEMAND CATEGORY	STATE REQUIREMENT	HIGHLAND CITY REQUIREMENT
Annual Average Demand (ac-ft / irrigated acre)	1.66	1.66
Peak Day Demand (gpm / irrigated acre)	3.39	5.29
Peak Instantaneous Demand (gpm / irrigated acre)	6.78	12.74
Storage Volume (gallons / irrigated acre)	2,528	2,528

CHAPTER 4
SOURCE REQUIREMENTS

PEAK DAY DEMANDS

The source requirement for the pressurized irrigation system is equal to the peak day demand on the system. The existing and future peak day demands for each pressure zone were calculated based on the irrigated acreage and peak day requirement per irrigated acre included in Tables 3-2 and 3-3. Table 4-1 compares the peak day demand (source requirement) for each pressure zone in the existing and future system to the existing source supply.

TABLE 4-1
ESTIMATED PEAK DAY DEMAND BY PRESSURE ZONE

PRESSURE ZONE	PEAK DAY DEMAND (GPM)		SOURCE SUPPLY (GPM)
	EXISTING	FUTURE	
View Pointe Pressure Zone	109	109	(Provided by Drinking Water System)
Upper Pressure Zone	1,490	2,500	17,520 (August) to 25,220 (June)
Lower Pressure Zone	5,150	7,270	
Beacon Hills Lower Pressure Zone	725	1,305	
Beacon Hills Upper Pressure Zone	310	1,205	
Hog Hollow Pressure Zone	90	230	
NW Area Upper Pressure Zone	N/A	380	
NW Area Lower Pressure Zone	N/A	565	
TOTALS:	**7,874**	**13,564**	**17,520 - 25,220**

SOURCE EVALUATION AND RECOMMENDATIONS

Existing pressurized irrigation sources for Highland City have been summarized in Table 2-1 and are shown on Figures 2-1 and 2-2. Comparison of the total source capacity in the system with the total peak day demand reveals that Highland City has sufficient total source capacity for build-out conditions. However, all of these sources initially enter the system in the Lower Pressure Zone. Therefore, source requirements for all of the other pressure zones must be satisfied by booster stations. An evaluation of existing booster stations is included in the distribution system analysis in Chapter 6.

The View Pointe pressure zone is located north of the Upper Pond and is significantly higher in elevation. This pressure zone is disconnected from the pressure irrigation system and does not have a source of irrigation water. The irrigation demands are currently served by the City's drinking water system. One option for providing irrigation water to the View Pointe subdivision is to install a booster station and pipeline from the Upper Pond to the subdivision. However, because of the small size of the subdivision, Highland City decided that the expense of a booster station and pipeline was too great for the benefit it would provide. Therefore, outdoor watering needs of the View Pointe subdivision will continue to be served by the drinking water system.

CHAPTER 5
STORAGE REQUIREMENTS

STORAGE DEMANDS

The existing and future storage demands for each pressure zone were calculated based on the irrigated acreage and the storage requirement per irrigated acre included in Tables 3-2 and 3-3. Table 5-1 compares the storage demand for each pressure zone in the existing and future system to the existing storage capacity. As is illustrated in Figure 2-2, the Upper Pond provides storage for both the Upper and the Lower pressure zones. Similarly, the NW Area Pond provides storage for the Beacon Hills Upper and Lower Pressure Zones, the Hog Hollow Pressure Zone , and the future NW Area Upper and Lower Pressure Zones. The Lower Pond provides storage for the Lower Pressure Zone only.

TABLE 5-1
STORAGE DEMAND BY PRESSURE ZONE

PRESSURE ZONE	STORAGE DEMAND (AC-FT)		STORAGE CAPACITY (AC-FT)
	EXISTING	FUTURE	
View Pointe Pressure Zone	0.16	0.16	0.77 ac-ft (250,000 gal Drinking Water System tank)
Upper Pressure Zone	2.18	3.66	26.0 - Upper Pond 5.4 - Lower Pond
Lower Pressure Zone	7.56	10.66	
Sub Total:	**9.7**	**14.3**	**31.4**
Beacon Hills Lower Pressure Zone	1.07	1.92	19.0 - NW Area Pond
Beacon Hills Upper Pressure Zone	0.46	1.77	
Hog Hollow Pressure Zone	0.13	0.34	
NW Area Upper Pressure Zone	N/A	0.55	
NW Area Lower Pressure Zone	N/A	0.83	
Sub Total:	**1.7**	**5.4**	**19.0**
TOTALS:	**11.4**	**19.7**	**50.4**

STORAGE EVALUATION AND RECOMMENDATIONS

Existing storage ponds in the pressurized irrigation system are summarized in Table 2-2. Comparison of the existing storage capacity to the storage demands reveals that Highland City has sufficient storage capacity in the system for build-out conditions.

The View Pointe subdivision is not connected to the pressure irrigation system. Storage for irrigation demands is provided by the 250,000 gallon tank connected to the drinking water system. As discussed in Chapter 4, this subdivision will continue to be served by the drinking water system. It should be noted, however, that the storage tank supporting this development is smaller than would be typically provided for this size of subdivision, when considering both indoor and outdoor service. The estimated storage needed is 285,000 gallons. It is recommended that Highland City closely monitor water use, tank performance and irrigated

area developed for the View Point Subdivision to determine whether and when additional storage capacity is needed.

HIGHLAND GLEN PARK POND EVALUATION

Highland City authorized Hansen, Allen & Luce, Inc. (HAL) to evaluate the Highland Glen Park Pond as a potential water storage location for the pressurized irrigation system. HAL reviewed available data which describe the location, size and features of the pond. The evaluation found that Highland City has adequate storage volume in the existing storage facilities. Therefore, additional storage at the Highland Glen Park Pond site would potentially be of benefit only if the existing ponds were unable to provide storage due to a lack of transmission or pumping capacity and if the Highland Glen Park Pond were able to economically fill the need.

Also, in order to utilize the Highland Glen Park Pond, at a minimum the following would be needed: 1) an additional source of water to the pond, 2) Inlet and outlet structures at the poind, 3) a booster pump station. It also may be necessary to provide a waterproofing liner to portions of the pond bank.

A lack of transmission capacity for the area near the Highland Glen Park Ponds was identified. However, the evaluation found that a new connection between the Highland City pressurized irrigation system and the Central Utah Water Conservancy District (CUWCD) transmission pipeline along 4800 West (Capital Improvement Project No. 12) would serve as an adequate source. This project provides a needed source of water in the area, but requires less infrastructure than would be required at the pond and could take advantage of existing pressure in the CUWCD line. Therefore, additional storage is not recommended at the Highland Glen Park Pond location.

CHAPTER 6
DISTRIBUTION SYSTEM REQUIREMENTS

The pressurized irrigation distribution system was evaluated by its ability to convey water under peak instantaneous demands. Highland City desires to maintain system pressures between 50 psi and 120 psi. Evaluation of the distribution system required development of a hydraulic model of the existing and future pressure irrigation systems. This chapter documents the development of the model. Solutions to the identified deficiencies in the existing and future distribution systems are also provided.

PEAK INSTANTANEOUS DEMANDS

The existing and future peak instantaneous demands for each pressure zone were calculated from the irrigated acreage and the peak instantaneous requirement per irrigated acre included in Tables 3-2 and 3-3. Table 6-1 identifies the peak instantaneous demands for each pressure zone.

TABLE 6-1
ESTIMATED PEAK INSTANTANEOUS DEMAND BY PRESSURE ZONE

PRESSURE ZONE	ESTIMATED PEAK INSTANTANEOUS DEMAND (GPM)	
	EXISTING	FUTURE
View Pointe Pressure Zone	262*	262*
Upper Pressure Zone	3,577	6,014
Lower Pressure Zone	12,408	17,505
Beacon Hills Lower Pressure Zone	1,749	3,153
Beacon Hills Upper Pressure Zone	752	2,908
Hog Hollow Pressure Zone	217	556
NW Area Upper Pressure Zone	N/A	908
NW Area Upper Pressure Zone	N/A	1,362
ROUNDED TOTALS:	**18,700**	**32,400**

* View Pointe peak instantaneous demands are not included in the total because this pressure zone is served by the drinking water system.

DISTRIBUTION SYSTEM MODELING

The hydraulic model of the distribution system was developed by HAL using Haestead Methods' CyberNet software. The primary elements of the model are pipes and nodes. The pipe elements store physical attributes of the actual pipeline such as length, diameter, and roughness. Variables such as flow, velocity, and headloss are calculated on these elements. Node elements serve as point locations where two pipe elements are joined and store point information such as elevation and demand. The system head or pressure is computed at each node in the model. Other model elements used in the computer model include reservoirs, pumps, and valves which simulate the effect of these features upon the network of pipes and nodes. Model input and output data are provided in Appendix C.

Highland City CAD drawings of the existing distribution system pipelines served as the primary basis for generating the pipe network in the computer model. Additional information was provided by system operators during master plan meetings. Node elevations were estimated based on the City's 2-foot interval surface contours. Demands were assigned to model nodes based on the irrigated acreage computed for City parcels in proximity to the demand nodes. Demands and irrigated acreage were calculated for each parcel based on the zoning and unit demands included in Chapter 3.

Three steady state modeling scenarios were developed to evaluate the distribution system under existing and future demands. These scenarios include the calibration scenario, the existing system scenario, and the future system scenario.

DISTRIBUTION SYSTEM CALIBRATION

The calibration scenario was developed to determine the validity of the assumptions made during development of the computer model. Highland City placed system pressure monitors at five locations throughout the system and monitored these locations along with all sources of water entering the system for a three week period from September 27 through October 16, 2006. The time of the peak flow on October 1, 2006 at about 5:00 a.m. was chosen as the conditions for the steady state calibration. This time was chosen because it was a peak demand period within the available data.

Demands were spread among the demand nodes in the existing system model to match the quantity of source water entering the system. Flows and settings at booster stations were also set to match the observed conditions. Table 6-2 compares the measured system pressures under these conditions with the pressures computed by the calibration scenario model.

TABLE 6-2
CALIBRATION RESULTS

PRESSURE MONITORING LOCATIONS			OBSERVED PRESSURE (PSI)	MODELED PRESSURE (PSI)	PRESSURE DIFFERENCE (PSI)
ID #	LOCATION	PRESSURE ZONE			
1	10950 N. Alpine Hwy	Upper Pressure Zone	74.3	78.8	-4.5
2	10290 N. 4730 W.	Upper Pressure Zone	100.1	97.2	2.9
3	6350 W. 10670 N.	Lower Pressure Zone	78.5	80.4	-1.9
4	5250 W. 10100 N.	Lower Pressure Zone	79.2	82.7	-3.5
5	5900 W. 12200 N.	Beacon Hills Upper Pressure Zone	63.5	64.6	-1.1

The difference between the observed and the modeled pressures were within 5 psi at all locations. This was considered an adequate level of agreement for the purposes of this study. Possible reasons for the slight differences include imprecision in placement of the demands for the calibration scenario, partially closed valves in the system, and discrepancies in the way pumps, reservoirs, or valves were simulated in the model.

EXISTING DISTRIBUTION SYSTEM EVALUATION

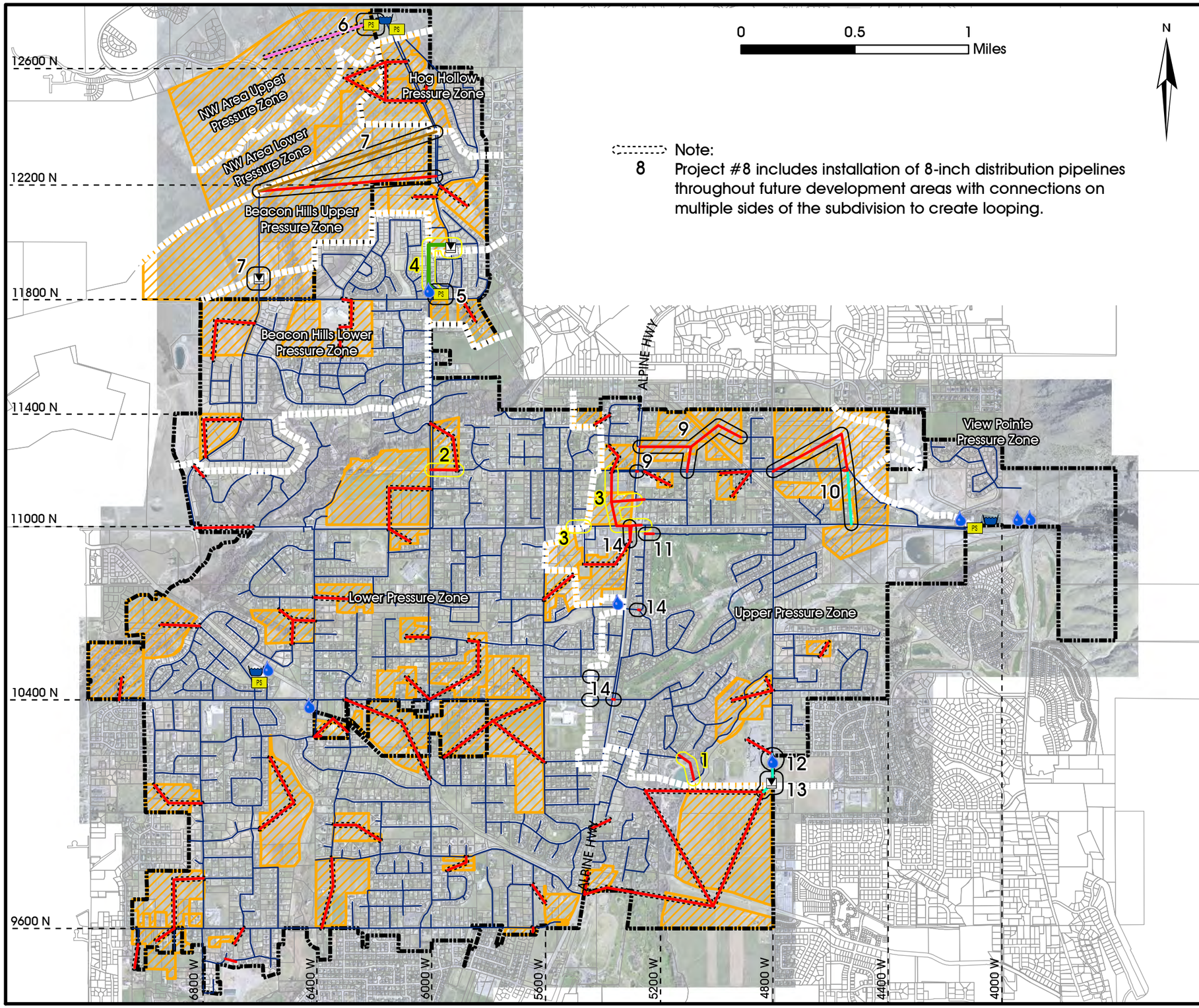
The existing system scenario was developed to evaluate the existing distribution system for deficiencies. This scenario was developed by imposing the existing peak instantaneous demands from Table 6-1 on the calibration model with the existing system sources operating as they would during the peak demands in the summer time. An area of the distribution system was considered to be deficient if the system pressure was less than about 50 psi or greater than about 120 psi. Areas where system pressures dropped by greater than 30 psi from low flow conditions to peak instantaneous conditions were also considered to be deficient because automated sprinkler systems may not function as designed over large pressure fluctuations.

Figure D1, which provides predicted pressure contours has been prepared. The predicted contours are based upon the system peak instantaneous model results and provide a guide of existing system pressures. While the contours are expected to be generally correct, there may be isolated areas within the existing distribution system which vary from the pressures shown. Figure D1 is provided in Appendix D.

Performance of booster stations was also evaluated in the distribution system analysis for pressure zones that are completely dependent upon booster stations for their source of water. This included the Upper Pressure Zone, the Hog Hollow Pressure Zone, the Beacon Hills Upper and Lower Pressure Zones, and the NW Area Upper and Lower Pressure Zones. Each booster station was evaluated based on peak instantaneous demand unless it pumped into a storage pond in which case it was evaluated based on peak day demands. Table 6-3 summarizes the capacities of booster stations relative to the existing and future peak instantaneous or peak day demands. This comparison reveals that most of the existing booster stations have sufficient capacity for existing conditions. However, the 11800 North Booster Station does not currently have adequate capacity to meet the peak day demand and needs to be upgraded. A new booster station (NW Area Booster Station) will be required for the NW Area Upper and Lower Pressure Zones in the future.

TABLE 6-3
BOOSTER STATION EVALUATION

BOOSTER STATION	PRESSURE ZONES SERVED	CAPACITY (GPM)	CRITICAL DEMAND (GPM)	
			EXISTING	FUTURE
Upper Booster Station	Upper Pressure Zone	6,000	Peak Instantaneous	
			3,577	6,014
11800 North Booster Station	Beacon Hills Upper, Beacon Hills Lower, Hog Hollow, and NW Area Upper & Lower Pressure Zones	800	Peak Day	
			1,125	3,700
Hog Hollow Booster Station	Hog Hollow Pressure Zone	690	Peak Instantaneous	
			217	556
NW Area Booster Station (Future)	NW Area Upper Pressure Zone NW Area Lower Pressure Zone (Future)	N/A	Peak Instantaneous	
			N/A	2,270



PRESSURIZED IRRIGATION SYSTEM MASTER PLAN

FUTURE PRESSURIZED IRRIGATION SYSTEM AND CAPITAL IMPROVEMENTS

LEGEND

- PRV Stations
- Storage Ponds
- Sources
- Booster Stations
- Highland City Boundary
- Pressure Zone Boundary
- Future Development Areas

Capital Improvements Projects (with Project ID #)

- Existing Solutions
- Future Solutions

Future Pipelines*

- 8-inch
- 10-inch
- 12-inch
- 14-inch
- 16-inch
- 20-inch

* Locations of pipelines in future development areas are conceptual and will vary based on how development occurs.

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FIGURE 6-1

BOOSTER STATION REDUNDANCY

It is recommended that Highland City evaluate the need, level and types of booster station redundancy desired in the pressurized irrigation system. The level of redundancy refers to a booster station's ability to continue providing service during conditionals of mechanical failure or unanticipated demand. With no redundancy, a pump station will be unable to meet full demand during a mechanical failure. Types of redundancy may include: multiple pump stations with excess capacity serving the same area, an additional pump within a pump station that can be activate during a failure, or stocking key components which can be installed within a short time period after a failure.

The booster station capacities provided in Table 6-3 are for total pumping capacity (except for the Hog Hollow Booster Station which has an additional 345 gpm pump beyond the value shown). No redundancy has been included in the table. The Upper Booster Station currently has no redundancy for peak instantaneous conditions. Capital Facilities Project No. 12 will add a measure of redundancy with addition of 1,800 gpm through an additional connection. Highland City may wish to evaluate whether additional redundancy is desired at this location. The 11800 North Booster Station (Dry Creek Booster Station) currently has no spare pumping capacity, although the Northwest Area Pond does provide a storage reserve for the area served by the booster station. The Lower Booster Station currently isn't being used, and therefore, provides redundancy for the Lower Pressure Zone.

Table 6-4 includes a description of the identified deficiencies in the existing distribution system. Solutions to the deficiencies are also included in this table and are also shown on Figure 6-1 by identification number.

TABLE 6-4
EXISTING DISTRIBUTION SYSTEM DEFICIENCIES

ID #	LOCATION	PROBLEM DESCRIPTION	RECOMMENDED SOLUTION
1	4900 W to 5300 W & 10200 N to 11000 N	Limited distribution capacity through 6-inch dia. pipelines to the southwest portion of the Upper Pressure Zone results in pressure losses of up to 54 psi during existing peak instantaneous conditions.	Install a new 8-inch dia. pipeline from the end of the recently installed 10-inch pipeline at about 10100 N 5100 W to the existing 8-inch pipeline just north of the pond in the park.
2	11000 N 5750 W to 11350 N 5835 W	Limited distribution capacity through one 4-inch dia. pipeline to this neighborhood in the Lower Pressure Zone results in pressures as low as 40 psi during existing peak instantaneous conditions.	Install a new 8-inch distribution pipeline along 11250 N from the 18-inch pipeline along 6000 W to the end of the 8-inch pipeline at about 5900 W.

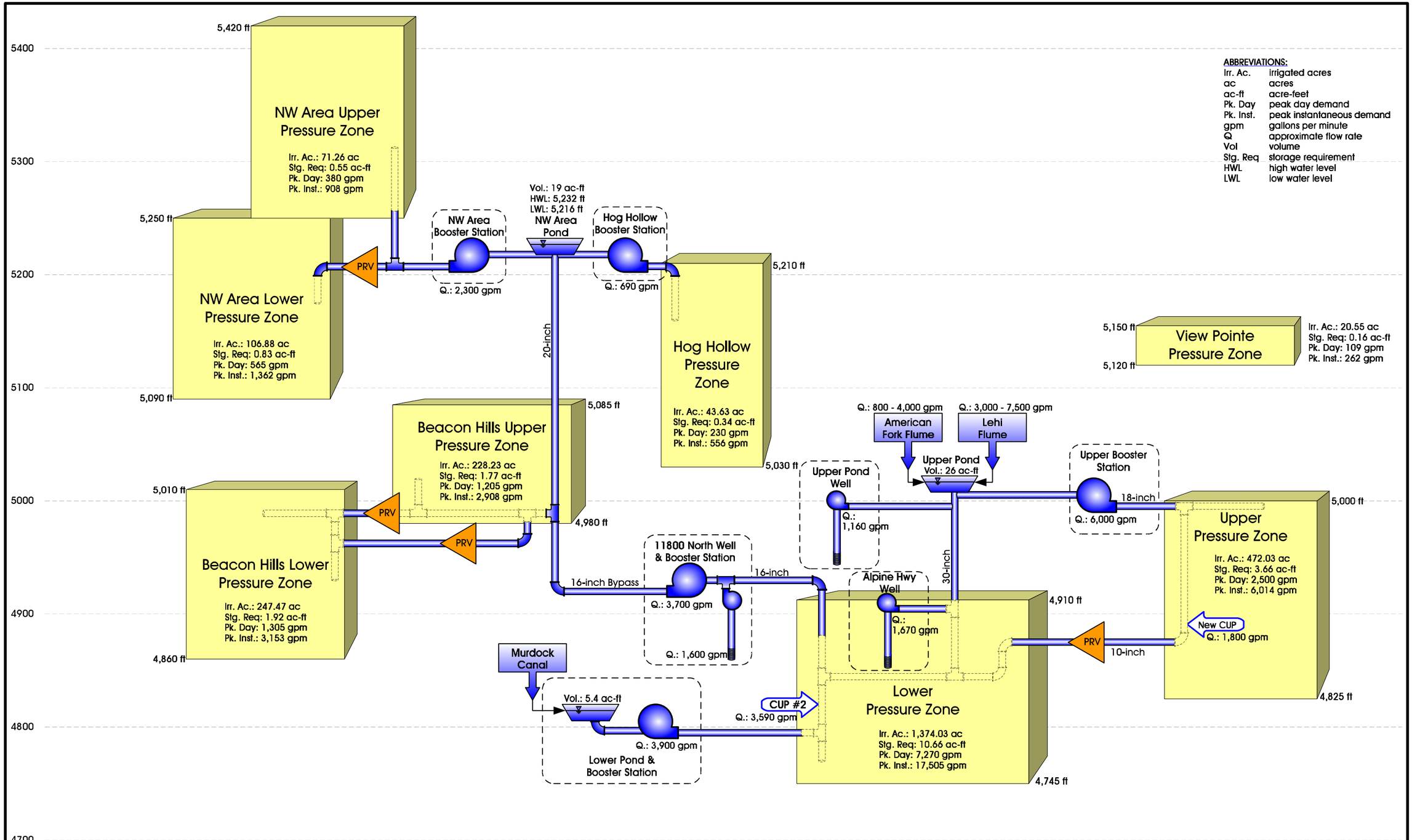
TABLE 6-4 Continued

ID #	LOCATION	PROBLEM DESCRIPTION	RECOMMENDED SOLUTION
3	5300 W to 5500 W & 10900 N to 11000 N	Area located at the top of the pressure zone and distribution capacity in the long 6-inch dia. pipeline limits pressures to about 45 psi during existing peak instantaneous conditions.	When adjacent undeveloped areas to the northeast develop, require development to connect to the 6-inch dia. pipeline along 11000 N at about 5350 W and also to the upper pressure zone pipelines to the northeast. Move this area into the upper pressure zone by closing the 6-inch pipeline at about 5500 W 11000 N.
4	11800 N to 12000 N	Current boundary between the Beacon Hills Upper and Lower Pressure Zones results in pressures exceeding 120 psi in this area of the Beacon Hills Upper Pressure Zone.	Adjust pressure zone boundary by doing the following: • Install a 16-inch dia. transmission line from the 11800 N Booster Station north along the utility corridor to Chamberry Way and then east to the intersection of Beacon Hill Blvd and Century Heights Dr and connect to existing 20-inch pipeline at this location. • Install new PRV on the existing 20-inch dia. pipeline just south of Century Heights Dr on Beacon Hill Blvd. • Remove existing PRV on the 12-inch dia. pipeline at about 11780 N Highland Blvd. • Open/close zone valves.
5	Beacon Hills, NW Area, and Hog Hollow Pressure Zones	Future peak day demand in these pressure zones is greater than the capacity of the 11800 North Booster Station.	• Expand the 11800 North Booster Station to a future capacity of at least 3,700 gpm.

FUTURE DISTRIBUTION SYSTEM EVALUATION

The future system scenario was developed to evaluate the performance of the existing distribution system with future peak instantaneous demands from Table 6-1 imposed on the system. The peak instantaneous demand for each undeveloped area within the proposed future service area was applied to a new node at the highest elevation within the undeveloped area. No attempt was made to identify actual final pipeline locations through these undeveloped areas in the computer model. Instead, conceptual pipelines were placed in the model from nodes on the larger existing pipelines adjacent to each undeveloped area to the new node for that area. Undeveloped areas along with their new nodes and conceptual pipelines are shown on Figure 6-1.

Figure D2, which provides predicted future pressure contours, has been prepared. The predicted contours are based upon the system peak instantaneous model results and provide a guide of future system pressures. While the contours are expected to be generally correct,



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HIGHLAND CITY
PRESSURE IRRIGATION SYSTEM MASTER PLAN

FUTURE SYSTEM SCHEMATIC DIAGRAM

FIGURE 6-2

there may be isolated areas within the future distribution system which vary from the pressures shown. Figure D2 is provided in Appendix D.

The future system scenario model was used to identify deficiencies in the system under future peak instantaneous conditions. Table 6-5 includes a description of the identified deficiencies in the future system along with proposed solutions for each deficiency. Proposed solutions are also identified on Figure 6-1 by the identification number included in Table 6-5. Figure 6-2 is a schematic representation of the future pressurized irrigation system after implementation of the proposed solutions in Tables 6-4 and 6-5.

TABLE 6-5
FUTURE DISTRIBUTION SYSTEM DEFICIENCIES

ID #	LOCATION	PROBLEM DESCRIPTION	RECOMMENDED SOLUTION
6	NW Area Upper Pressure Zone & NW Area Lower Pressure Zone	Elevations are too high and demands are too large in these pressure zones to be served by the existing Hog Hollow Booster Station.	• Install a new booster station (NW Area Booster Station) with the capacity to serve future peak instantaneous demands for these pressure zones (at least 2,300 gpm). • This facility is developer funded.
7	Beacon Hills Upper Pressure Zone	No transmission or distribution pipelines exist in this undeveloped area.	• When this area develops, install 16-inch distribution pipeline from the existing 20-inch transmission pipeline along Beacon Hills Blvd and connect to the existing 12-inch pipeline along Highland Blvd. • Install a PRV on the 12-inch pipeline at about 11850 N Highland Blvd.
8	Undeveloped Areas throughout the City	No distribution pipelines exist in undeveloped areas.	• Install 8-inch distribution pipelines throughout areas as they develop. Connect to existing pipelines on multiple sides of the subdivision to create looping throughout each area to be developed.
9	11000 N to 11400 N & 5200 W to 5400 W	Friction losses through non-looped pipelines to this area results in pressures below 50 psi during future peak instantaneous conditions.	• Connect 8-inch diameter pipelines across Alpine Hwy along 11200 N. • When the area north of 11200 N between 4900 W and Alpine Hwy develops, require looping throughout subdivision with 8-inch pipelines.
10	11000 N to 11400 N & 4400 W to 4800 W	Limited distribution capacity to this area results in pressures below 50 psi during future peak instantaneous conditions.	• Provide looping throughout new development in this area with 8-inch pipelines. • Require 12-inch pipeline from 18-inch pipeline at about 4500 W 11000 N to 4500 W 11200 N.

TABLE 6-5 Continued

ID #	LOCATION	PROBLEM DESCRIPTION	RECOMMENDED SOLUTION
11	5250 W from 10700 N to 11000 N	Limited distribution capacity through 6-inch distribution line along 11000 N results in excessive pressure losses in this area.	• Connect the 6-inch pipeline that runs along the back of homes on the south side of 11000 N to the existing pipeline at 10970 N 5250 W.
12	Upper Pressure Zone	Velocities in 18-inch pipeline from the Upper Booster Station to about 4800 W 11000 N during future peak instantaneous conditions result in significant pressure losses throughout the zone.	• Negotiate a new connection to the CUP transmission line into the Upper Pressure Zone at about 10150 N 4800 W. This new connection would be a replacement for the CUP #1 connection which is recommended to be discontinued in Project #14. A booster station (1,800 gpm capacity) will also be required to pump into the upper pressure zone from this CUP connection.
13	9600 N to 10100 N and 4800 W to 5300 W	Transmission lines in the Lower Pressure Zone to the west of this area do not have sufficient capacity to serve this area.	• Install 10-inch pipeline from Upper Pressure Zone along 4800 W with a pressure reducing valve station to reduce pressures to match the Lower Pressure Zone. • Need new CUP connection at 10150 N 4800 W recommended in Project #12.
14	Northeast area of Lower Pressure Zone	Pressures during future peak instantaneous conditions drop below 50 psi. High velocities in the 30-inch pipeline from the Upper Pond result in large pressure losses. Areas in the Lower Pressure Zone on the west side of Alpine Hwy are too high in elevation to be effectively served by the Lower Pressure Zone.	• Discontinue use of the CUP #1 connection and begin using the Murdock Canal source. Move the pressure zone boundary between the Upper and Lower Pressure Zones to the west about 2 blocks by doing the following: • Loop through undeveloped area from 11000 N to 11200 N and from Alpine Hwy to 5400 W (See problem #3). • Close 6-inch pipeline at about 5500 W 11000 N (See problem #3). • Connect 6-inch pipeline on 11000 N just west of Alpine Hwy to 10-inch pipeline on Alpine Hwy at about 10950 N. • Close 6-inch pipelines on 10400 N and 10500 N at about 5450 W. • Connect 6-inch and 8-inch pipes across Alpine Hwy at 10400 N. • Connect 8-inch pipes at 5150 W 10700 N.

ADDITIONAL RECOMMENDATIONS

In addition to the recommended improvements otherwise provided, we recommend that the City consider the following:

- Smart Irrigation Controllers: These devices monitor weather conditions continuously and adjust irrigation sprinkling based upon need. The smart controllers may receive data from an on-site weather station, or may receive weather data from data providers via the phone or internet. Many water providers have established incentive programs to assist water users with start-up costs. Smart Irrigation Controllers may help reduce water consumption through conservations.

- Water Meters: Currently, Highland City does not meter irrigation water use. Water users do not have a financial incentive to limit water use to their needs. The use of water meters may increase water conservation.

CHAPTER 7

CAPITAL IMPROVEMENTS PLAN

Meetings were held with Highland City personnel to confirm the feasibility of the proposed solutions to the identified deficiencies in Chapters 4 - 6. Alternative solutions that were not preferred by Highland City have not been presented. This chapter addresses the estimated project costs for the preferred solutions.

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 Estimate	Precision
Master Planning	-50% to +100%
Preliminary Design	-30% to +60%
Final Design or Bid	-10% to +20%

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 $2,000,000. 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 $1,600,000.

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 $1,200,000.

ESTIMATED CONSTRUCTION COSTS

Estimated construction costs for the pressurized irrigation pipe lines include valves, fittings, roadway repair, and curb and gutter replacement. Estimated construction costs for booster stations include complete construction of a new station except where a pumping station is to be upgraded.

Unit costs for the construction cost estimates are based on conceptual level engineering. Unit construction costs were estimated based on construction cost indices, communication with material suppliers, and HAL experience with similar construction. All costs are presented in 2008 dollars. Recent price and economic trends indicate that future costs are difficult to predict with certainty. Cost estimates given in this study should be regarded as conceptual level as appropriate for use as a planning guide. Only during final design can a definitive and more accurate estimate be provided. A detailed cost estimate of each project and unit pipe cost tables are provided in Appendix E.

Total capital improvements costs for each project include an additional 20% for contingency and 15% for engineering. The 15% engineering assumption is valid for large projects with costs greater than about $200,000 or $300,000. If small projects are engineered individually, the engineering cost may be higher than 15% of the project cost.

CAPITAL IMPROVEMENTS PLAN

Table 7-1 describes the preferred solution for each identified distribution system problem. Identification numbers (ID #) in Table 7-1 correspond to problem ID numbers in Tables 6-4 and 6-5. Estimated construction costs are also included in these tables. Figure 6-1 shows the location of each project by ID number. Existing and future costs listed in Table 7-1 represent the costs applicable to existing development versus costs applicable to future development.

The cost estimates are budget level and reflect current pricing. They include mobilization, engineering and contingency. They do not include costs associated with acquisition of property or right-of-way, legal fees or administration. Actual cost may vary.

TABLE 7-1
CAPITAL IMPROVEMENTS PLAN

ID #	LOCATION	PROBLEM DESCRIPTION	PREFERRED SOLUTION*	COST (2008 U.S. DOLLARS)		
				EXISTING	FUTURE	TOTAL
1	4900 W to 5300 W & 10200 N to 11000 N	Pressure losses in Upper Pressure Zone up to 54 psi	New 8" pipe from about 10100 N 5100 W to the existing pipe in City park just north of the pond.	$139,100	$0	$139,100
2	11000 N 5750 W to 11350 N 5835 W	Pressures below 50 psi	New 8" pipe along 11250 N from 5900 W to 6000 W	$84,100	$0	$84,100
3	5300 W to 5500 W & 10900 N to 11000 N	Pressures below 50 psi at top of pressure zone	New 8" pipe along 11000 N from 5300 W to 5400 W. New pipes in development to be installed by developer. Closure of pipe at 5500 W 11000 N by City staff.	$182,900	$0	$182,900

TABLE 7-1 Continued

ID #	LOCATION	PROBLEM DESCRIPTION	PREFERRED SOLUTION*	COST (2008 U.S. DOLLARS)		
				EXISTING	FUTURE	TOTAL
4	11800 N to 12000 N	Pressure Zone boundary results in pressures above 120 psi	New 20-inch transmission pipeline from 11800 N Booster Station to intersection of Beacon Hills Blvd and Century Heights Dr and new PRV station just south of this intersection. Removal of PRV station and opening and closing of valves by City staff.	$626,100	$0	$626,100
5	Beacon Hills, NW Area, and Hog Hollow Pressure Zones	Future demand exceeds 11800 N Booster Station capacity	Expand the capacity of the 11800 N Booster Station to at least 3,700 gpm.	$0	$543,400	$543,400
6	NW Area Pressure Zones	Area too high to be served by existing pond or booster station.	Install new NW Area Booster Station with a capacity of about 2100 gpm including VFD.	NW Area Booster Station to be paid for by the developer.		
7	Beacon Hills Upper Pressure Zone	No distribution facilities throughout area to be annexed.	New 16-inch pipe through new development to existing 12-inch pipe on Highland Blvd. New PRV station at 11850 N Highland Blvd. City to pay incremental upsize cost to increase from 8-inch to 16-inch pipe.	$0	$576,000	$576,000
8	Undeveloped Areas throughout the City	No distribution facilities exist in undeveloped areas.	Developers to install 8-inch pipelines throughout new developments.	8-inch pipelines to be paid for by developers.		
9	11000 N to 11400 N & 5200 W to 5400 W	Future pressures below 50 psi.	Connect 8-inch pipes across Alpine Hwy at 11200 N. Developers to install 8-inch pipelines throughout new developments to provide looping.	$0	$115,200	$115,200
10	11000 N to 11400 N & 4400 W to 4800 W	Future pressures below 50 psi.	New 12-inch pipeline from 11000 N to 11200 N at about 4500 W. City to pay upsize cost from 8-inch to 12-inch. Developers to install 8-inch pipelines throughout new developments to provide looping.	$0	$61,600	$61,600
11	5250 W from 10700 N to 11000 N	Limited distribution capacity to area causes excessive pressure losses.	New 8-inch pipe from about 5200 W 10970 N to about 5250 W 10970 N.	$0	$28,100	$28,100

TABLE 7-1 Continued

ID #	LOCATION	PROBLEM DESCRIPTION	PREFERRED SOLUTION*	COST (2008 U.S. DOLLARS)		
				EXISTING	FUTURE	TOTAL
12	Upper Pressure Zone	Velocities in 18-inch transmission line along 11000 N result in excessive pressure losses throughout the pressure zone.	New CUP connection at about 10150 N 4800 W. Discontinue use of CUP #1 connection. Install new booster station to pump into the upper pressure zone.	$0	$871,200	$871,200
13	9600 N to 10100 N and 4800 W to 5300 W	Transmission lines in Lower Pressure Zone to this area do not have sufficient capacity.	New PRV station at 10100 N 4800 W with a 10-inch pipeline along 4800 W to serve into the new development. City to pay incremental upsize cost from 8-inch to 10-inch. Project #12 is needed prior to implementation of this solution.	$0	$237,700	$237,700
14	Northeast area of Lower Pressure Zone	Pressures in upper portions of the pressure zone below 50 psi due to high velocities in 30" transmission line from the Upper Pond.	New 8-inch pipe from 11000 N to existing 10-inch pipe at about 10950 N Alpine Hwy. Connect 6-inch and 8-inch pipes across Alpine Hwy at 10400 N. Connect 8-inch pipes at 5150 W 10700 N. Close valves at 5450 W on 10400 N and 10500 N. Discontinue use of CUP #1 connection and use new connection in Problem #12. Implement solution for Problem #3. Developers to install 8-inch pipes throughout new developments to provide looping.	$0	$195,200	$195,200
			TOTALS:	1,032,200	2,628,400	3,660,600

* Pipe sizes are approximate and are for planning purposes only. Further study is required for final design.

PRIORITY ORDER OF CAPITAL FACILITY PROJECTS

A recommended order of completion has been developed for capital facility projects. Projects have been divided among three tiers. Tier 1 includes projects which will correct existing deficiencies. Tier 2 includes projects whose timing depends on additional growth. Tier 3 includes projects which are recommended to be completed as the underlying parcels develop. Significant portions of Tier 3 projects will be funded by development. It is anticipated that Highland City will complete Tier 1 projects before Tier 2 projects. Tier 3 projects will be completed as development occurs. It is recommended that Highland City periodically review the recommended capital facility projects and project schedules in comparison with system needs. Changes should be made as necessary. A list of projects is provided in Table 7-2.

TABLE 7-2
PRIORITY ORDER OF CAPITAL FACILITY PROJECTS

TIER	INCLUDED PROJECTS
1	1, 2, 3, 4, 5
2	10, 11, 12, 13, 14
3	6, 7, 8, 9

APPENDIX A

SOURCE FLOW RECORDS AND BACKGROUND INFORMATION

HANSEN ALLEN & LUCE inc
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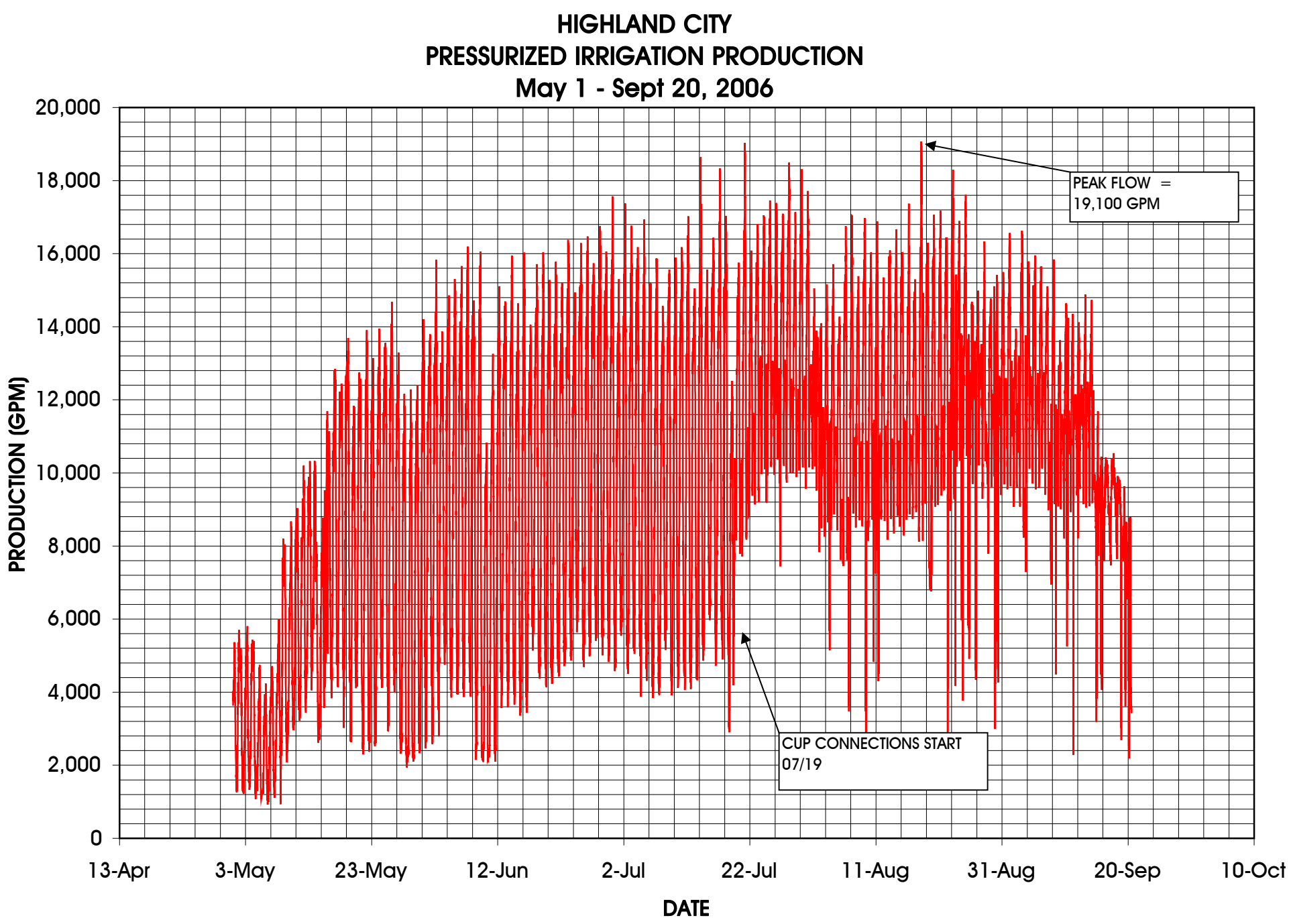
HIGHLAND CITY
PRESSURIZED IRRIGATION PRODUCTION
May 1 - Sept 20, 2006
PRODUCTION (GPM)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
13-Apr
3-May
23-May
12-Jun
2-Jul
22-Jul
11-Aug
31-Aug
20-Sep
10-Oct
DATE
PEAK FLOW =
19,100 GPM
CUP CONNECTIONS START
07/19

4/15/06		20	.25	0	.5	—	—	—	—	—
4/16/06		24	.35	0	.9					

Date	Time	Pond	Weir	AF Flume	Lehi Flume	Booster GPM	Booster 10K	Tank GPM	Tank 10K	Pump	
4-17-06	8:40	24				730	65385	0	16104	#2	
4-18-06	7:00	24	.42	0	.9	754	65482	0	16104	#2	
4-19-06	14:00	24	0	0	0	712	65635	0	16104	#2	
4-20-06	7:30	23	.20	0	0	740	65697	0	16104	#2	
4/21/06	12:50	24 GOING OVER	.58	0	1.15	800	65834	0	16104	#1	CLEANED LEHI FLUME
4/22/06	15:45	24	.68	0	1.15	1151	65991	2067	16111	#1	
4/23/06	18:45	24	.92	0	1.15	949	66150	0	16128	#1	
4/24/06	9:25	24	.64	0	1.1	807	66236	0	16136	#1	
4-25/06											
4-26/06	8:30	24	.68	0	1.1	944	66491	1115	16146	#1	
4/27/06	18:00	24	.68	0	1.1	1120	66696	0	16162	#1	
4/28/06	11:15	24	.80	0	1.1	1015	66829	0	16180	#1	
4/29/06	14:20	20	.80	0	1.0	1530	67028	3136	16216	#1	
4/30/06	08:52	15	.80	1.0	1.0	0	67119	2820	16260	#1	
5/1/06	17:10	22	.80	0	1.0	0	67119	2706	16311	#1	
5/2/06	11:26	18	.80	0	.06 to 1.2	0	67119	1649	16358	#1	
5-3-06	08:05	22	.80	.09	1.1	0	67119	4162	16400	#1 #2	
5-4-06	16:30	23	.90	.09	1.1	0	67119	1496	16460	#1 #2	
5-5-06	17:42	24	.80	.09	1.1	0	67119	1557	16490	#1 #2	
5-6-06	17:39	24	.90	.09	1.1	0	67119	1187	16519	#1 #2	
5-7-06	10:47	24	.70	.08	1.1	0	67119	1881	16555	#1 #2	
5-8-06	08:00	24	.80	.08	1.1	1949	67100	4042	16597	#1 #2	
5/9/06	12:25	24 OVER	.90	.9	1.2	1700	67458	4095	16668	#1 #2	BOTH 80%.
5/11/06	07:45	-1 20	1.0	.9	1.15	2043	67836	4905	16755	#1 & 2	CLEANED FLUMES
5/12/06	14:35	24 GOING OVER	1.05	.85	1.1	1266	68176	2480	16833	1 & 2 @	78% FLUMES OK
5/13/06	14:05	24 GOING OVER	1.10	.85	1.05	1854	68477	3544	16902	1 & 2 @	79% " "
5/14/06	21:15	19.4	.90	.9	1.10	0 PLUGGED	68642	5554	16998	1 & 2 @	81%. CLEANED FLUMES/BA
5/15/06	10:45	17	.9	.88	1.2	1380	68645	3331	17053	#1 & 2	

NO 5/10/06

Date	Time	Pond	Weir	AF Flume	Lehi Flume	Booster GPM	Booster 10K	Tank GPM	Tank 10K	Pump	
5/16/06	20:30	24	1.2	.9	1.1	2258	69064	6869	17154	#2 #3	
5/17/06	17:35	21	1.10	1.0	1.1	2080	69365	2509	17240	#2 #3	
5/18/06	07:04	20	1.10	.90	1.1	2922	69601	7482	17301	#2 #3	
5/19/06	08:48	16	1.0	1.2	1.1	2780	70011	5569	17399	#2 #3	
5/20/06	13:08	20	1.3	1.0	1.1	1986	70384	1716	17461	#2 #3	
5/21/06	10:10	13	1.0	1.4	1.1	725	70676	2674	17536	No Pumps	
5/21/06	12:25	16	1.0	1.4	1.1	884	70686	1898	17539	#2 #3	
5/22/06	07:39	21				3179	70968	7752	17607	#2 #3	
5/23/06											
5/24/06	9:15	17	.8	1.1	.8	2681	71686	3854	17771	#2 #3	
5/25/06	10:30	21	.	1.1	.8	2164	72082	2360	17848	#2 #3	
5/26/06	12:00	20	1.0	1.3	.8	1785	72492	2299	17933	#2 #3	
5/27/06	11:30	22	1.0	1.3	.8	2103	72844	1437	18000	#2 #3	
5/28/06	8:00	22	1.0	1.3	.8	1980	73220	1880	18020	#2 #3	
5/29/06	10:00	20	1.0	1.3	.8	1628	73417	0	18110	#2 #3	
5/30/06	8:00	20	.9	1.4	.8	2529	73698	5702	18158	#2 #3	
5-31-06	16:51	24	1.0	1.3	.8	1663	74135	1245	18257	#2 #3	
6-1-06	07:54	22	1.10	1.3	.9	2982	74399	6968	18317	#2 #3	
6-2-06	15:33	23.5	1.0	1.2	.8	1600	74879	0	18405	#2 #3	
6-3-06	16:38	Full	1.30	1.2	.8	1843	75263	2902	18481	#2 #3	
6-4-06	16:21	20	1.0	1.3	.8	1614	75633	1734	18573	#2 #3	
6-5-06	07:57	19	1.0	1.3	.8	3135	75898	7938	18645	#2 #3	
6/6/06	11:25	22	1.15	1.2	.9	1791	76341	2700	18750	#2 #3	CLEANED FLUMES AF WAS @ .8
6-7-06	09:49	20	1.15	1.3	.9	2449	76690	4317	18888	#2 #3	
6/8/06	07:50	21	1.2	1.3	.9	2995	77038	7059	18905	#2 #3 @ 80%	FLUMES PRETTY GOOD
WELL 379 6/9/06	12:20	22	1.15	1.3	.88	1260	77436	0	18983	#2 #3 @ 74%	CLEANED FLUMES
379 6/10/06	14:30	24	0.95	1.2	.8	1201	77726	0	19018	#2 #3 @ 72%	FLUMES OK
379 6/11/06	20:45	24	1.2	1.25	.8	2235	78100	4257	19081	#2 #3 78%	CLEANED FLUMES
378 6/12/06	22:50	21	1.0	1.2	1.0	3024	78525	9415	19183	#2 #3	CLEANED FLUME
378 6/13/06	08:51	19	1.0	1.2	1.0	2541	78723	6467	19241	#2 #3	

Date	Time	Pond	Weir	AF Flume	Lehi Flume	Booster GPM	Booster 10K	Tank GPM	Tank 10K	Pump	Well Level
5/14/2006	7:30	19	1.10	1.2	1.0	3648	79085	8628	19328	#1#2#3	378
5/15/2006	7:47	20	1.10	1.6	.80	3120	79461	7337	19428	#1#2#3	378
5/16/2006	07:00	19	1.10	1.6	.80	3561	79809	9908	19575	#1#2#3	377
5/17/2006	08:30	20	1.0	1.6	.80	2666	80183	6693	19611	#1#2#3	377
5/18/2006	12:38	20	1.10	1.6	.80	1992	80638	3177	19727	#1#2#3	377
5/19/2006	12:00	18	.96	1.6	.80	1885	81013	3464	19827	#1#2#3	377
5/20/2006	17:20	24	1.0	1.6	.80	1702	81443	3154	19935	#1#2#3	377
5/21/2006	17:35	24	1.0	1.4	.80	1978	81820	3954	20037	#1-2-3	377
5/22/2006	16:30	19	1.1	1.6	.80	1722	82201	2780	20143	#1#2#3	377
5/23/2006	8:00	19	1.1	1.6	.80	3754	82504	6534	20226	#1#2#3	377
5/24/2006	20:30	22	1.1	1.6	.80	3088	83074	8418	20370	#1#2#3	377
5/25/2006	17:15	24	1.1	1.6	.80	1682	83418	3613	20470	#1#2#3	378
5/26/2006	08:14	19	1.10	1.6	.90	3715	83699	9350	20558	#1#2#3	378
5/27/2006	16:25	23	1.10	1.6	.90	1636	84206	3740	20694	#1#2#3	379
5/28/2006	08:45	18	1.10	1.6	.90	3465	84526	8576	20786	#1#2#3	379
5/29/2006	08:00	18.5	1.0	1.6	.80	3424	~~8500~~ 84923	9100	20896	#1#2#3	379
5/30/2006	13:42	19	1.20	1.7	.90	1685	85423	3043	21026	#1#2#3	379
5/31/2006	16:46	24	1.20	1.7	.90	1642	85827	4184	21141	#1-2-3	379
6/1/2006	17:18	23	1.10	1.6	.90	1803	86222	3666	21255	#1-2-3	380
7/3→ 6/2/2006	14:30	19	1.10	1.6	.90	1632	86582	3826	21365	#1-2-3	380
6/3/2006	/										
6/4/2006											
6/5/2006											
6/6/2006											
6/7/2006											
6/8/2006											
6/9/2006											
6/10/2006											
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6/15/2006											
6/16/2006											
6/17/2006											
6/18/2006											
6/19/2006											
6/20/2006											
6/21/2006											
6/22/2006											
6/23/2006											
6/24/2006											

8/8/06 18.00 22 .80 .93 .33 2010 100770 2046 23978 #2987 236.2 MG 39

Date	Time	Pond	Weir	AF Flume	Lehi Flume	Booster GPM	Booster 10K	Tank GPM	Tank 10K	Pump	Well Level	
6/25/2006												
6/26/2006												
6/27/2006												
6/28/2006												
6/29/2006												
6/30/2006												
7/1/2006												
7/2/2006												
7/3/2006												
7/4/2006	10:00	18.5	1.1	1.6	.9	2352	86935	5760	21473	#1 #2 #3	380	
7/5/2006	17:30	20	.96	1.6	.9	1975	87409	3636	21583	1 2 3	380	
7/6/2006	20:20	23	1.1	1.6	.9	2208	87813	6412	21714	1,2,3@80%	380	
7/7/2006	11:20	21	1.0	1.6	.9	1687	88078	3655	21801	1,2,3@78%	380	
7/8/2006	23:20	19	.90	1.5	.85 WAS .5	3148	88584	9980	21946	1,2,3@80%	381	
7/9/2006	21:20	19	.95	1.5	.9	2511	88905	7547	22044	1,2,3@78%	381	
7/10/2006	10:02	14	1.10	1.6	1.1	2266	89146	5471	22119	#1,2,3,	381	
7/11/2006	17:02	24	1.0	1.5	1.1	1676	89630	3213	22239	#1,2,3,	381	
7/12/2006	08:50	19	1.0	1.5	1.0	3196	89943	7948	22331	#1,2,3	381	
7/13/2006	07:24	19	1.0	1.5	1.0	3456	90321	9888	22425	#1,2,	383	
7/14/2006	14:15	22	1.0	1.5	1.1	2019	90846	3358	22555	#1	383	
7/15/2006	11:55	21	1.0	1.5	1.1	2423	91238	4912	22657	#1 #2	383	
7/16/2006	12:03	20	1.0	1.5	1.1	2177	91670	3893	22781	#1	383	
7/17/2006	10:04	18	.9	1.4	.9	2922	92074	7178	22889	#1 #2	384	
7/18/2006	08:10	13	.9	1.5	.9	3398	92479	9559	22996	#1 #2	385	
7/19/2006	11:30	16	.9	1.4	.40	2529	92875	1989	23075	#1 #2	395	1129.5 GPM 230.26 MG
7/20/2006	8:00	19	.85	.75	.40	3429	93162	3741	23108	#1 #2	396	1128.7 GPM 231.67 MG
7/21/2006	9:30	13	.85	.75	.40	2825	93634	0	23167	#1 #2	386	
7/22/2006	9:00	14	.85	.75	.40	2997	94052	0	23203	#1 #2	397	1147.5 232.89
7/23/2006	9:23	11	.80	.93	.38	2943	94502	0	23248	#1 #2	397	1158 234.77
7/24/2006	09:06	17	.70	.90	.40	3053	94903	0	23294	#1 #2	398	
7/25/2006	07:47	17	.78	.90	3.5	3352	95302	2991	23341	#1 #2	358	235.51
7/26/2006	12:30	19	.70	.82	.33	1775	95793	3281	23390	#1	389	
7/27/2006	17:30	24	.70	.82	.33	2093	96266	2892	23448	#1	389	
7/28/2006	10:39	17	.70	.83	.33	2594	96614	1168	23485	#1 #2	389	
7/29/2006	10:10	16	.70	.83	3.5	2895	97029	1143	23525	#1 #2	390	
7/30/2006	14:55	17	.70	.83	.35	1559	97530	3004	23585	#1	390	
7/31/2006	17:30	20	.68	.83	.35	1633	97944	2981	23636	#1	391	235 GPM
8/1/2006	8:00	19	.72	.83	.35	2556	98190	1506	23654	#1 #2	391	
8/2/2006	16:40	24	.70	.85	.33	1267	98566	3615	23714	#1	391	
8/3/2006	17:30	24	.70	.85	.33	1517	98887	3356	23759	#1	391	
8/4/2006	16:55	24	.80	.85	.33	1440	99247	3400	23801	#1	391	
8/5/2006	19:55	24	.80	.85	.33	2487	99652	0	23839	#1 #7	391	
8/6/06	20:00	20	.80	.93	.33	1784	100036	0	23889	#1	392	
8/7/06	07:45	14	.80	.93	.33	3263	[illegible]	4495	23923	#1 #7	[illegible]	

Date	Time	Pond	Weir	AF Flume	Lehi Flume	Booster GPM	Booster 10K	Tank GPM	Tank 10K	Pump	Well Level	
8/6/2006	08:00	20	.80	.93	.33	1784	100036	0	23887	1	392	
8/7/2006	7:45	14	.80	.93	.33	3263	100262	4495	23923	1 & 2	392	
8/8/2006	18:00	22	.80	.93	.33	2010	100770	2046	23978	#1@98%	393	236.3MG
8/9/2006	17:25	21.5	.78	.93	.32	1864	101165	2250	24022	#1@99%	393	236.3MG
8/10/2006	18:15	22	.78	.96	.31	1881	101554	2290	24070	#1@97%	393	
8/11/2006	17:05	21	.78	.93	.30	1670	101940	2222	24115	#1@94%	393	
8/12/2006	20:25	24 GOING OVER	.75	.93	.30	2006	102365	0	24156	#1 & #2@67%	394	
8/13/2006	20:50	24 GOING OVER	.75	.93	.30	2260	102736	0	24204	#1 & #2@24%	394	
8/14/2006	17:20	20	.70	.93	.30	1778	103072	2382	24246	#1	394	
8/15/2006	16:00	20	.70	.93	.30	1587	103420	2650	24268	#1	394	
8/16/2006	16:00	20	.70	.93	.30	1627	103849	2935	24336	#1	394	
8/17/2006	11:00	15	.70	.93	.30	1762	104405	2350	24387	#1 #2	394	
8/18/2006	11:00	15	.70	.93	.30	2115	104580	0	24437	#1 #2	394	
8/19/2006	19:40	17	.70	.93	.30	2324	105084	2634	24480	#1 #2	396	
8/20/2006	19:00	19	.70	.93	.30	2309	105476	1002	24525	#1 #2	406	
8/21/2006	08:00	14	.70	.90	.30	3695	105734	2085	24554	#1 #2	407	
8/22/2006	07:32	18	.70	.90	.30	3373	106161	3707	24598	#1 #2	407	
8/23/2006	08:57	14	.60	.90	.30	3165	106611	3377	24656	#1 #2	397	
8/24/2006	16:24	19	.55	.70	.30	1857	107083	3544	24711	#1	398	
8/25/2006	17:52	16	.53	.70	.30	1897	107451	2781	24750	#1	398	
8/26/2006	09:11	20	.55	.70	.30	1990	107748	1182	24783	#1 #2	399	
8/27/2006	09:09	21	.52	.70	.30	2144	108067	2253	24824	#1 #2	399	
8/28/2006	17:40	24	.52	.68	.29	1869	108478	2585	24882	#1@96%	399	NEED TO CHECK WELL & LOG ON WELL LOG.
8/29/2006	17:30	22	.62	.68	.29	1800	108838	2935	24922	#1	399	
8/30/2006	14:30	24	.51	.67	.29							
8/31/2006	15:00	23	.51	.67	.29							
9/1/2006	11:25	18.8	.50	.59	.27	1584	109860	2390	25041	#1@91%	400	SET FLUMES
9/2/2006	15:40	22	.50	.59	.27	1619	110233	2110	25082	#1@89%	400	
9/3/2006	21:40	18.8	.50	.59	.27	2667	110656	0	25130	#1 & #2 @85%	401	CUP FILTER STICKING
9/4/2006	07:45	13	.49	.59	.27	3399	110859	1442	25150	#1 & #2 @94%	411	RUNNING
9/5/2006	17:30	20	.50	.59	.30	1654	111345	3675	25211	#1	402	
9/6/2006	16:30	19	.49	.59	.29	1565	111703	3828	25251	#1	402	
9/7/2006	18:00	19	.49	.59	.29	0	112013	1543	25289	#1	402	
9/8/2006	13:15	17	.49	.60	.28	600	112253	4501	25319	#1	402	Running
9/9/2006	07:30	18	.50	.60	.29	2280	112470	0	25347	#1	402	
9/10/2006	12:15	18	.50	.60	.30	612	112758	4166	25395	#1	402	
9/11/2006	12:40	21	.50	.60	.30	688	113014	3868	25431	#1	403	
9/12/2006	17:40	22										
9/13/2006	17:40	24	.50	.60	.30	1546	113642	3356	25523	#1	403	
9/14/2006	7:00	18	.46	.60	.30	2580	113857	2090	25542	#1	404	
9/15/2006	11:00	24	.46	.60	.30	702	114127	3425	25578	#1	404	
9/16/2006	11:00	24	.46	.60	.30	0	114275	4090	25616	#1	404	

Date	Time	Pond	Weir	AF Flume	Lehi Flume	Booster GPM	Booster 10K	Tank GPM	Tank 10K	Pump	Well Level
9/17/2006	9:00	24	46	.6	.30	660	114399	3129	25646	#1	403
9/18/2006	1900	24	.46	.60	.30	788	114563	2540	25705	#1	403
9/19/2006	10:55	24	.46	60	30	742	114718	2574	25714	#1	403
9/20/2006	08:55	24	50	60	30	919	114896	2762	25733	#1	403
9/21/2006	12:44	24	50	60	30	239	105033	1537	25754	#1	403
9/22/2006	10:19	24	50	60	30	484	115154	1507	25769	#1	403
9/23/2006	11:37	24	50	60	30	316	115267	1401	25781	#1	403
9/24/2006	18:06	24	.46	58	28	476	115368	1346	25794	#1	403
9/25/2006	17:05	24	.46	.55	.25	650	115490	0	25796	#1 @76%	403
9/26/2006	17:42	24	.46	.55	.25	848	115659	0	25807	#1	403
9/27/2006	17:53	20	.46	.55	.25	617	115848	0	25830	#1	403
9/28/2006	17:20	16	.45	.52	.25	586	116022	1530	25861	#1 @77%	404
9/29/2006	07:15	9.5	.45	.52	.25	1580	116175	1607	25895	#1 @77%	417 *
9/30/2006	07:30	14.8	.45	.52	.25	1680	116206	1710	25918	#1 #2	417
10/1/2006	22:25	22.5	.45	.52	.25	1705	116630	0	25941	#1 @89%	404
10/2/2006	08:00	20	.45	.52	.25	1811	116747	1124	25951	#1 @90%	404
10/3/2006	16:30	24	.45	1.6	.25	0	116913	2927	25983	#1	404
10/4/2006	7:24	24	.45	1.6	.25	1467	117012	0	25996	#1	404
10/5/2006	12:42	19	.45	0	.25	315	117161	0	26016	#1	404
10/6/2006	11:05	16	.45	1.4	.25	315	117268	0	26030	#1	405
10/7/2006	08:53	18	.60	0	.25	475	117334	0	26035	#1	405
10/8/2006	09:19	18	.55	.50	.25	0	117400	0	26044	#1	405
10/9/2006	08:30	19	.55	.50	.20	542	117459	0	26052	#1	405
10/10/2006	17:18	23	.50	.30	.20	342	117644	0	26064	#1	405
10/11/2006	14:39	22	.50	.30	.20	926	117718	0	26073	#1	405
10/12/2006	15:20	23	.50	.30	.20	430	117775	0	26077	#1	405
10/13/2006	19:50	21	.50	.30	.20	856	117848	0	26080	#1	405
10/14/2006	11:14	18	.50	.50	.20	594	117949	0	26092	#1	405
10/15/2006	17:40	18	.50	.60	.1	519	118077	0	26103	#1	405
10/16/2006											
10/17/2006											
10/18/2006											
10/19/2006											
10/20/2006											
10/21/2006											
10/22/2006											
10/23/2006											
10/24/2006											
10/25/2006											
10/26/2006											
10/27/2006											
10/28/2006											

Ryan called 4 of from Cam shut off OFF

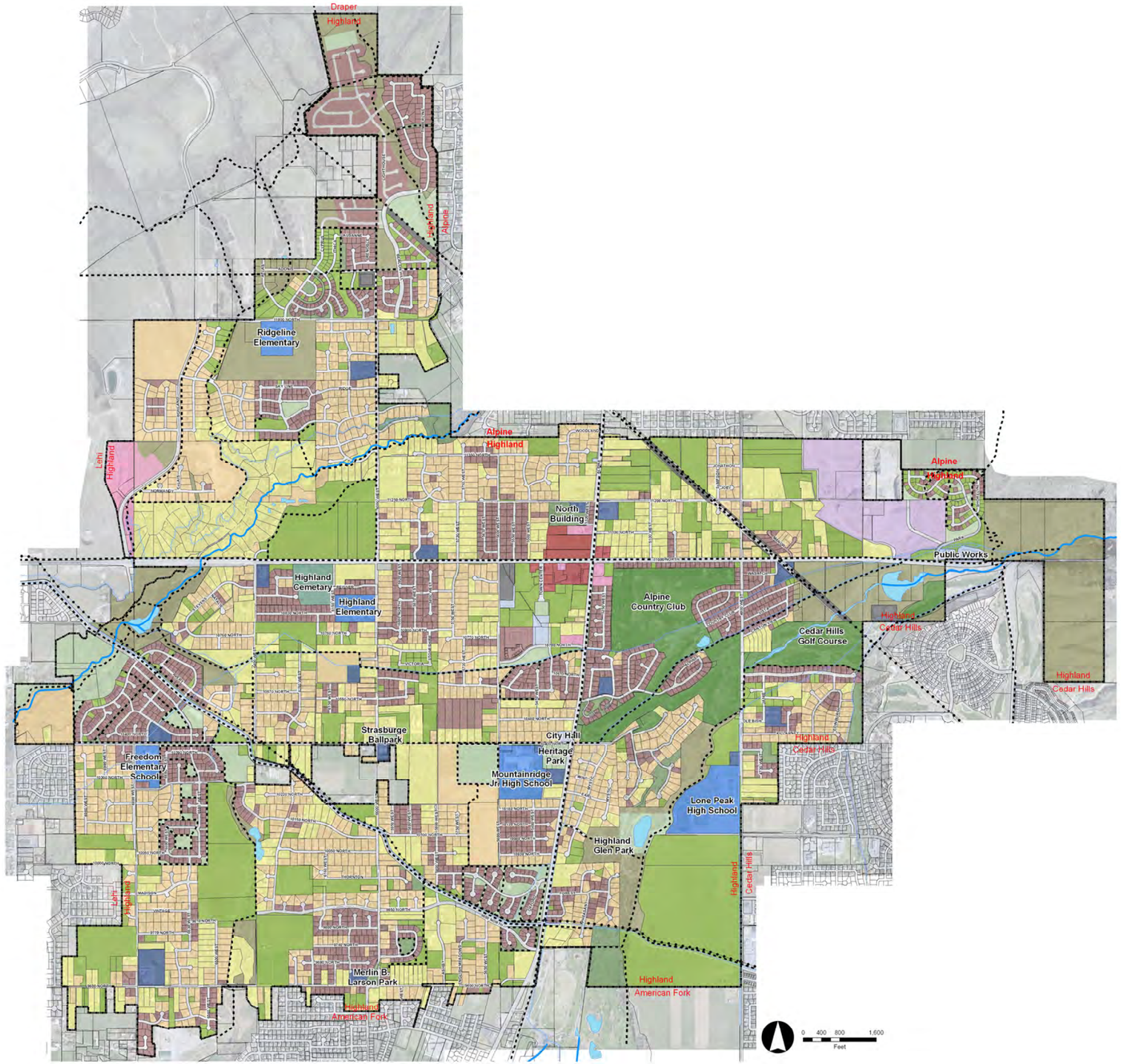
* 20 shut off AF

3:00 PM on the 7 opened A

APPENDIX B

HIGHLAND CITY ZONING

HANSEN ALLEN & LUCE inc
ENGINEERS



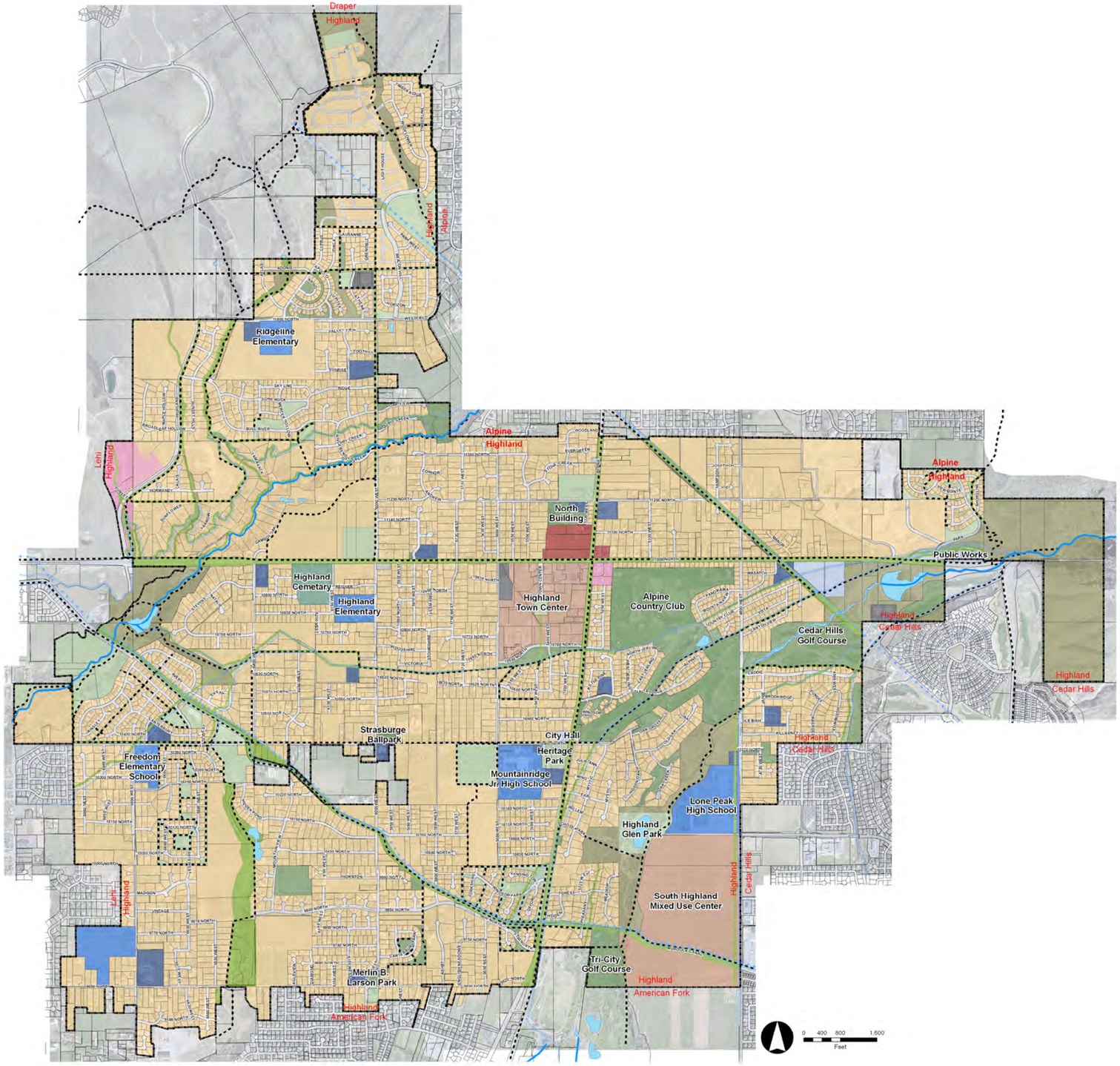
MAP 2-1
EXISTING LAND USE

Land Use

- Residential 1+ acres
- Residential 0.5 to 1 acres
- Residential 0 to 0.5 acres
- Commercial
- Office
- Public
- School
- Religious
- Agriculture/Vacant
- Public Park
- Private Park
- Open Space/Undeveloped
- Golf Course
- Industrial
- Cemetary
- Utility
- **Parcels**
- Waterbody
- Trails
- City Boundary
- Stream or River
- Canal or Ditch
- Pipeline or Aquaduct

Highland City General Plan Update

Adopted



MAP 2-3
FUTURE LAND USE

Land Use

- Low-Density Residential
- Mixed Use Development
- Commercial
- Office
- Institutional
- School
- Religious
- Open Space
- Highland City Public Park
- Trail Corridor & Greenway
- Private Recreation & Mini Park
- Cemetery
- Utility
- Waterbody
- Parcels
- Stream or River
- Canal or Ditch
- Pipeline or Aquaduct
- Trails
- City Boundary

Highland City General Plan Update

Adopted

APPENDIX C

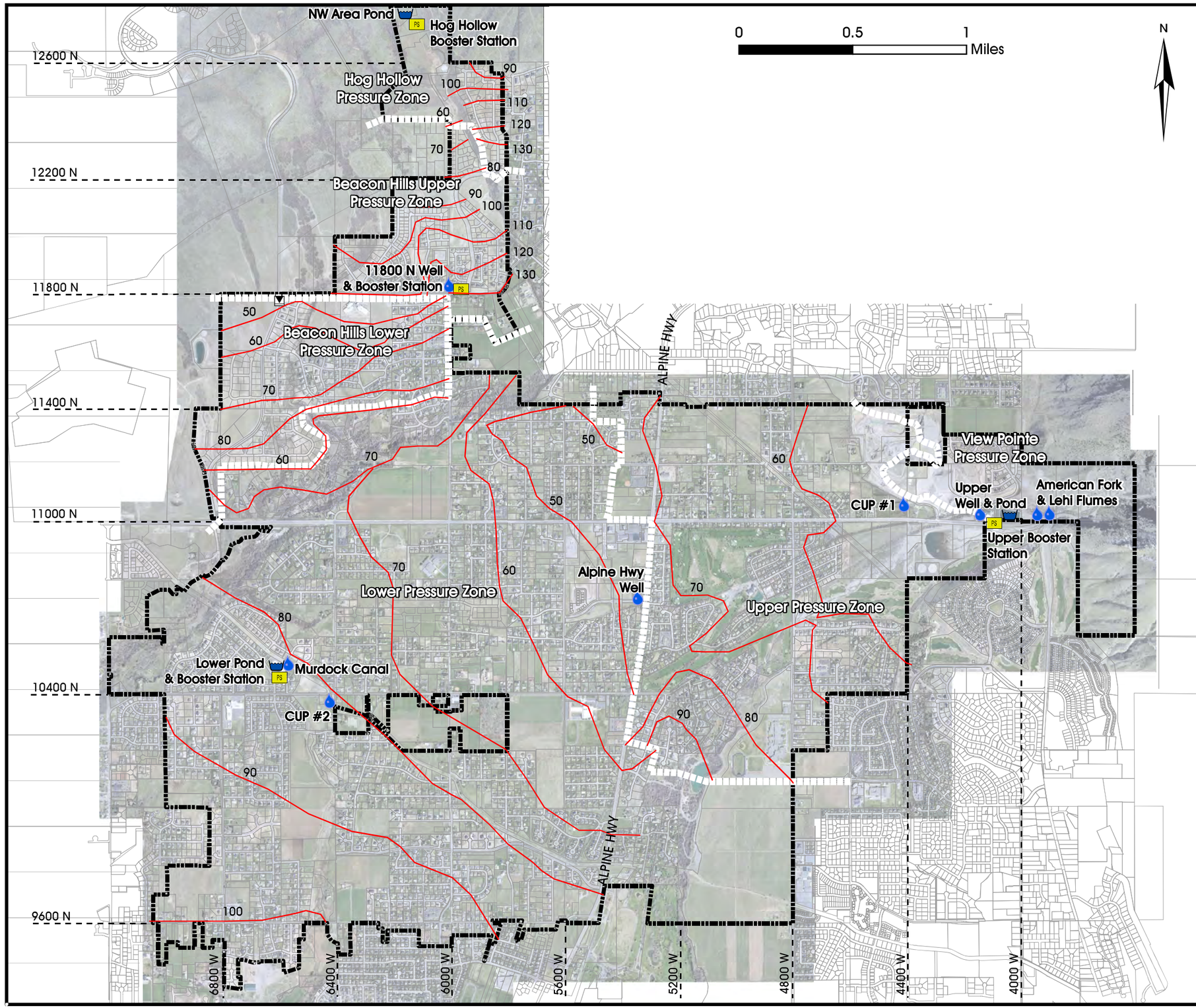
MODEL DATA

HANSEN ALLEN & LUCE inc
ENGINEERS

APPENDIX D

PRESSURE CONTOUR MAPPING

HANSEN ALLEN & LUCE inc
ENGINEERS



PRESSURIZED IRRIGATION SYSTEM MASTER PLAN

EXISTING PRESSURIZED IRRIGATION SYSTEM

PREDICTED PRESSURE CONTOURS (PSI)

LEGEND

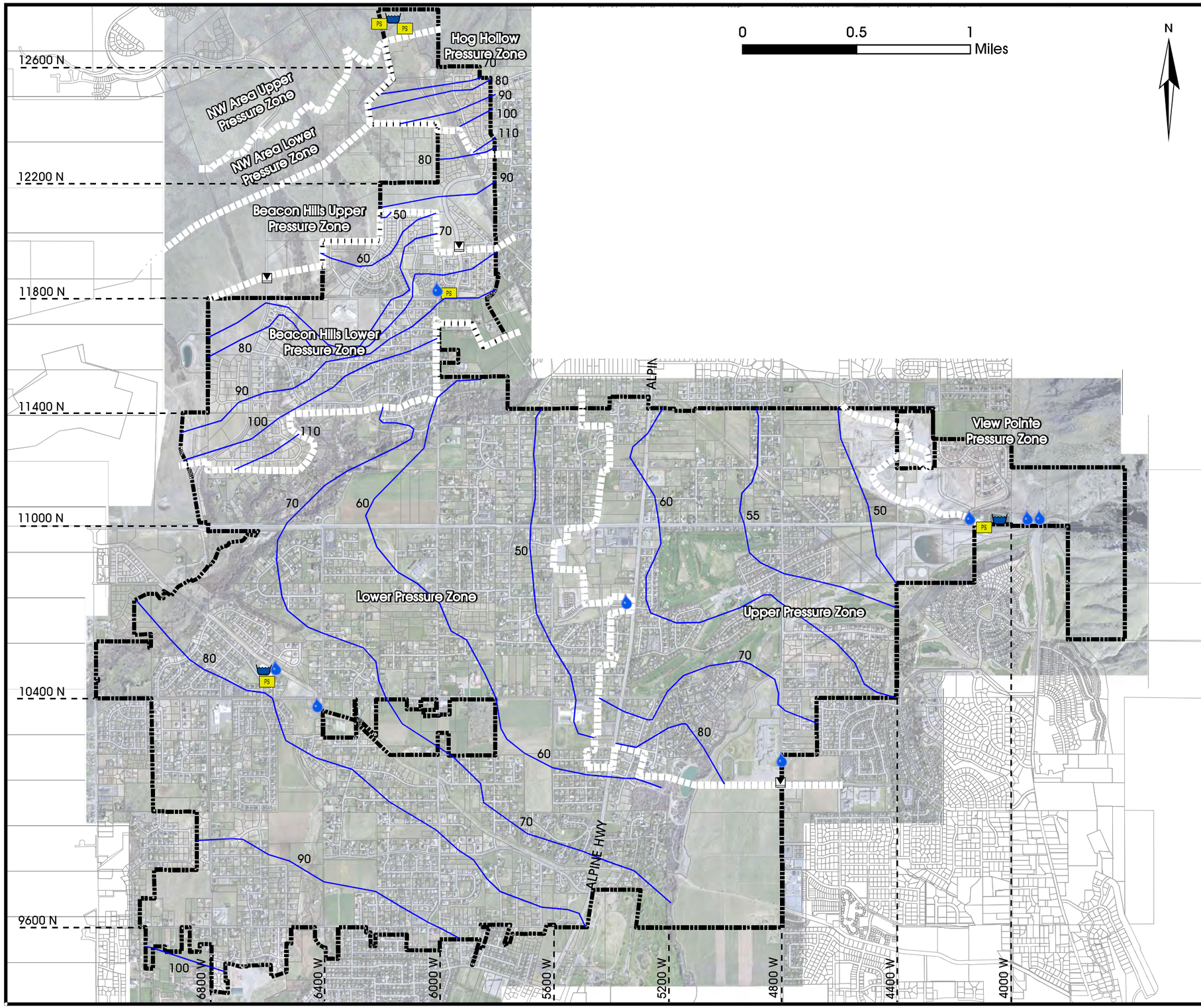
- PRV Stations
- Storage Ponds
- Sources
- Booster Stations
- Highland City Boundary
- Pressure Zone Boundary
- 50 Existing Pressure Contour (psi)

NOTE: PRESSURES SHOWN ARE FOR THE EXISTING PEAK INSTANTANEOUS DEMAND MODEL. SOME AREAS MAY VARY FROM VALUES SHOWN.

HANSEN ALLEN & LUCE inc ENGINEERS

FIGURE

D-1



PRESSURIZED IRRIGATION SYSTEM MASTER PLAN

FUTURE PRESSURIZED IRRIGATION SYSTEM

PREDICTED PRESSURE CONTOURS (PSI)

LEGEND

- PRV Stations
- Storage Ponds
- Sources
- Booster Stations
- Highland City Boundary
- Pressure Zone Boundary
- 50 Future Pressure Contour (psi)

NOTE: PRESSURES SHOWN ARE FOR THE PEAK INSTANTANEOUS DEMAND MODEL & ASSUME COMPLETION OF PLANNED CAPITAL FACILITIES.

HANSEN ALLEN & LUCE inc ENGINEERS

FIGURE

D-2

APPENDIX E

COST DATA

HANSEN ALLEN & LUCE inc
ENGINEERS

TABLE E-1
Highland City Pressurized Irrigation Master Plan Project Costs

		Size			Quantity		Unit	Construction	15% Engineering &	Total Cost	% Existing	Existing Cost	Future Cost	Notes
ID #	Description	Existing	Proposed	unit		unit	Cost	Cost	20% Contingency					
1	New 8" pipe along 10100 N		8	inch	740	ft	$63	$46,620						Mostly out of street (through park)
	Crossing American Fork River		16	inch	100	ft	$430	$42,975						Assume boring with 16-inch casing
	Total w/ 10% Mobilization & 5% Testing:							$103,000	$36,100	$139,100	100%	$139,100	$0	
2	New 8-inch pipe along 11250 N		8	inch	630	ft	$86	$54,180						In street
	Total w/ 10% Mobilization & 5% Testing:							$62,300	$21,800	$84,100	100%	$84,100	$0	
3	New 8" pipe along 11000 N		8	inch	620	ft	$86	$53,320						In street
	New 8" pipes through new development		8	inch	1980	ft	$0	$0						Paid for by developers
	Crossing Alpine Hwy along 11000 N		16	inch	150	ft	$430	$64,463						Assume boring with 16-inch casing
	Close valve on 6" pipe at about 5500 W 11000 N				1	ea	$0	$0						Valve closure by City staff
	Total w/ 10% Mobilization & 5% Testing:							$135,500	$47,400	$182,900	100%	$182,900	$0	
4	New 20" transmission pipe		20	inch	1710	ft	$173	$295,830						Possibly in street (could be out of street??)
	New PRV Station on existing 20" line		16	inch	1	ea	$107,438	$107,438						
	Decommission existing PRV on Highland Blvd				1	ea	$0	$0						PRV decommissioned by City staff
	Open/Close zone valves to separate zones				1	ea	$0	$0						Valve operation by City staff
	Total w/ 10% Mobilization & 5% Testing:							$463,800	$162,300	$626,100	100%	$626,100	$0	
5	Expand 11800 N Booster Station Capacity to 2500 gpm				1	ea	$350,000	$350,000						new pumps and VFD
	Total w/ 10% Mobilization & 5% Testing:							$402,500	$140,900	$543,400	0%	$0	$543,400	
6	Install new NW Area Booster Station (2100 gpm w/ VFD)				1	ea	$0	$0						Paid for by developers
	Total w/ 10% Mobilization & 5% Testing:							$0	$0	$0	0%	$0	$0	
7	New 16" pipe through Beacon Hills Upper Pressure Zone		16	inch	5100	ft	$58	$295,800						Developer to install pipeline - incremental cost to upsize from 8"
	New PRV Station at about 11850 N Highland Blvd		10	inch	1	ea	$75,207	$75,207						Construct new PRV on existing 12-inch line
	Total w/ 10% Mobilization & 5% Testing:							$426,700	$149,300	$576,000	0%	$0	$576,000	
8	New 8" pipes through new developments		8	inch	90000	ft	$0	$0						Paid for by developers
	Total w/ 10% Mobilization & 5% Testing:							$0	$0	$0	0%	$0	$0	
9	New 8" pipe crossing Alpine Hwy at 11200 N		16	inch	150	ft	$494	$74,132						Assume boring with 16-inch casing & 8-inch pipe through casing
	New 8" pipes through development		8	inch	3250	ft	$0	$0						Paid for by developers
	Total w/ 10% Mobilization & 5% Testing:							$85,300	$29,900	$115,200	0%	$0	$115,200	
10	New 10" pipe from 11000 N to 11200 N		10	inch	1240	ft	$32	$39,680						Developer to install pipeline - incremental cost to upsize from 8"
	New 8" pipes through development		8	inch	3000	ft	$0	$0						Paid for by developers
	Total w/ 10% Mobilization & 5% Testing:							$45,600	$16,000	$61,600	0%	$0	$61,600	
11	New 8" pipe at about 10970 N 5250 W		8	inch	210	ft	$86	$18,060						In street
	Total w/ 10% Mobilization & 5% Testing:							$20,800	$7,300	$28,100	0%	$0	$28,100	
12	New CUP connection at 10150 N 4800 W		1800	gpm	1	ea	$161,157	$161,157						
	New booster station		1800	gpm	1	ea	$400,000	$400,000						May not be needed immediately. Will be needed eventually.
	Total w/ 10% Mobilization & 5% Testing:							$645,300	$225,900	$871,200	0%	$0	$871,200	
13	PRV station on 10" line at 10100 N 4800 W		8	inch	1	ea	$59,091	$59,091						
	new 10" pipe to new development south of 10100 N		10	inch	1000	ft	$94	$94,000						In street
	New CUP connection (see Project #12)				1	ea	$0	$0						Included in Project #12
	Total w/ 10% Mobilization & 5% Testing:							$176,100	$61,600	$237,700	0%	$0	$237,700	
14	Discontinue use of CUP #1 connection				1	ea	$0	$0						Connection decommissioned by City staff
	Loop through undeveloped area & close pipe (See Proj #3)				1	ea	$0	$0						Included in Project #3
	New 8" pipe connecting from 10900 N to 11000 N Alpine Hwy		8	inch	400	ft	$86	$34,400						In street
	Connect 6" & 8" pipes across Alpine Hwy at 10400 N		16	inch	150	ft	$494	$74,132						Assume boring with 16-inch casing & 8-inch pipe through casing
	Connect 8" pipes at about 5150 W 10700 N		8	inch	200	ft	$86	$17,200						In street
	Close 6" pipes on 10400 N & 10500 N at about 5450 W				1	ea	$0	$0						Pipe closures by City staff
	Total w/ 10% Mobilization & 5% Testing:							$144,600	$50,600	$195,200	0%	$0	$195,200	
							Totals	**$2,711,500**	**$949,100**	**$3,660,600**		**$1,032,200**	**$2,628,400**	

TABLE E-2
Unit Pipe Costs
314.04.100

Pipe Size	Dec 2008 Adjusted Costs In Street	Dec 2008 Adjusted Costs Out of Street
8	$86	$63
10	$94	$72
12	$118	$93
14	$130	$108
16	$144	$122
18	$159	$137
20	$173	$151
24	$202	$180
30	$235	$209
36	$315	$248