Town of Oro Valley Water Utility 2018 Potable Water Master Plan (System AZ0410-164)

Oro Valley, Arizona

August 2018

Prepared by HDR
for the Town of Oro Valley Water Utility

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Introduction

This 2018 Potable Water Master Plan (the Master Plan) is intended to provide a 10-year planning horizon road map for the Town of Oro Valley Water Utility (TOVWU). The Master Plan details the hydraulic model evaluation undertaken as part of this study, identifies distribution system improvements, and outlines an Infrastructure Improvement Plan (IIP). A key component of hydraulic model evaluation was the spatial distribution of the customer demands based on Geographic Information Systems (GIS) meter records.

Another key element of the Master Plan is the expansion of Central Arizona Project (CAP) water deliveries through the future Northwest Recharge, Recovery, and Delivery System (NWRRDS), beginning in 2024. The expansion of CAP water deliveries will be used to meet future growth demands and offset well pumping to preserve groundwater.

The key objectives of the Master Plan are to:

- Establish a limit for TOVWU's groundwater production to no more than 5,000 acre-feet per year (AFY);
- Create a road map for delivering additional CAP water into the existing service area to achieve the Town of Oro Valley's (the Town) stated groundwater production limit;
- Blend CAP water with existing groundwater supplies to achieve the Town's water quality goals; and
- Develop a 10-year plan for TOVWU to meet current and future demands and prepare a phased, prioritized IIP to achieve these objectives.

TOVWU retained HDR to prepare the Master Plan. The scope of work required to accomplish the Master Plan objectives included the following:

1. Data collection and review;
2. Current and future demand analysis;
3. Hydraulic model development;
4. Existing and future system analyses;
5. IIP development and prioritization; and
6. Master Plan report preparation.

Existing System Review

HDR used the 2006 *Potable Water Master Plan* and the 2011 *CAP Water Distribution and Delivery Study* as reference documents for the development of the Master Plan. Data provided by the Town for the purposes of developing the Master Plan included, but were not limited to, the following:

- Distribution system data;
- Meter account and water use data;
- Operations data;
- Planning and zoning data; and
- Hydrant flow test data.

The existing water distribution system consists of approximately 366 miles of public water mains ranging from 4 to 16-inches in diameter, per the asset inventory included in the Town of Oro Valley Water Utility Commission 2018 Annual Report. In addition, there are 13 storage reservoirs and 24 pump stations within the system.

TOVWU uses a combination of groundwater and CAP water wheeled through the Tucson Water distribution system to meet its potable water demands within its main service area. In 2017, the TOVWU main service area potable water production consisted of 5,069 acre-feet of groundwater (73 percent of total production) and 1,842 acre-feet of CAP water (27 percent of total production). In 2019, TOVWU intends to expand its CAP water deliveries by an additional 240 acre-feet. By 2024, after the completion of the NWRRDS project, TOVWU will have the capacity to deliver an additional 4,000 AFY of CAP water into the main service area at the La Cañada Reservoir, Tangerine Road, and Lambert Lane locations. The estimated CAP water delivery schedule is provided in Table ES-1.

Table ES-1. CAP Water Delivery Locations

Location	Flows (AFY)			
	2017	2018	2019–2023	2024+
Vista del Sol (Naranja Reservoir)	1,572	1,572	1,572–1,772*	—
Calle Buena Vista	270	270	270	320*
Oracle Road and Hardy Road	—	—	240–480*	480*
La Cañada Reservoir	—	—	—	1,600**
Tangerine Road	—	—	—	1,600**
Lambert Lane	—	—	—	800**
Total	**1,842**	**1,842**	**2,082–2,522**	**4,800**

* Values for future CAP water deliveries were estimated based on model results. Further discussion of NWRRDS can be found in Section 6.4.

** Represents maximum annual delivery volumes of future CAP water utilizing NWRRDS.

Current and Future Demands

Existing demands were based on the meter account data from June 2017. The spatial distribution of future demands were derived based on growth projections provided by the Town's Planning Department, as shown in Figure ES-1. Growth projections were categorized as follows:

- "Tier 1" – development in 0-5 years (from 2018 thru 2023)
- "Tier 2" – development in 5-10 years (from 2023 thru 2028)
- "Tier 3" – development in 10+ years (from 2028 thru 2033)

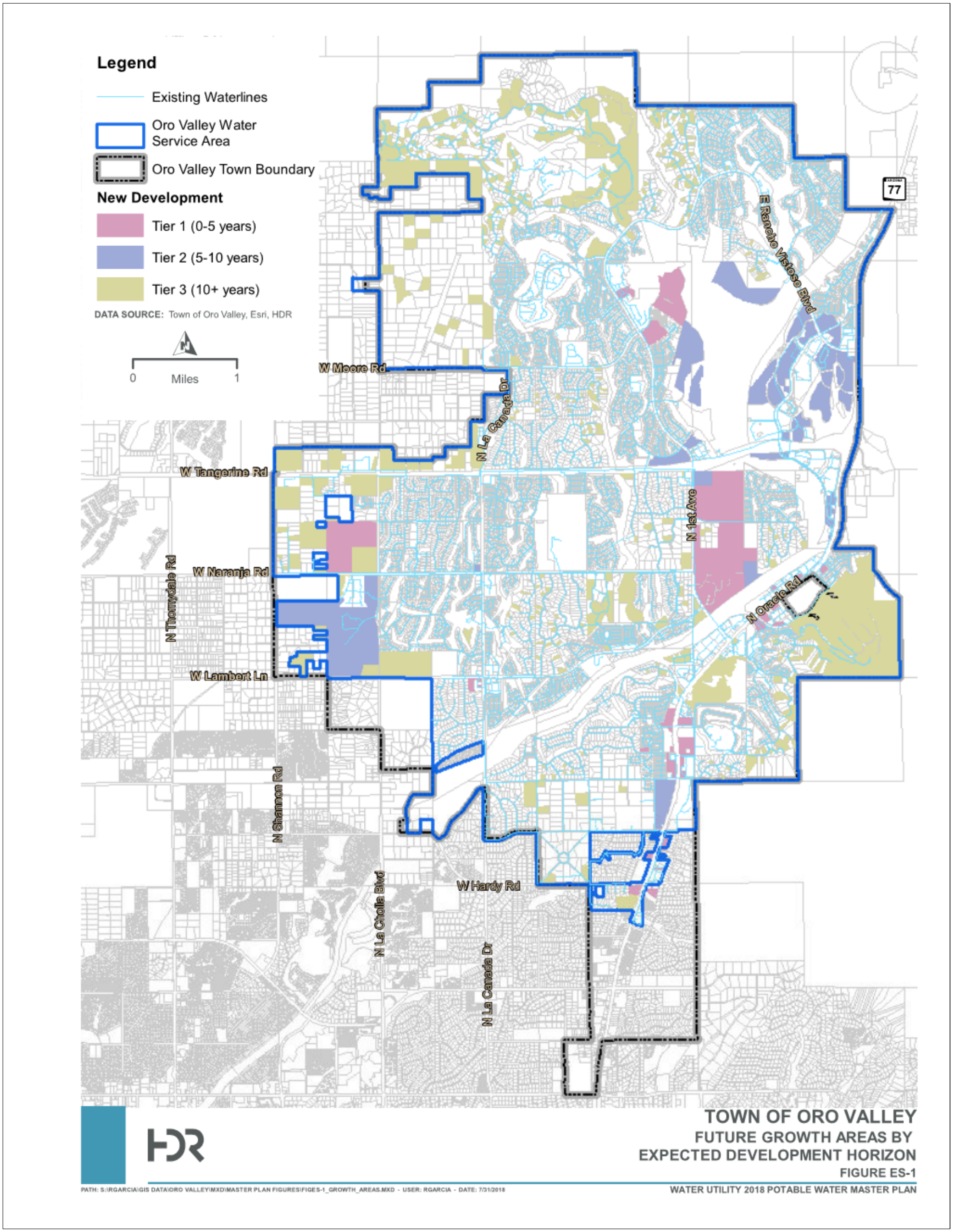
Key water demand metrics that were considered included:

- Average Day Demand (ADD): The ADD is the total water used during the year divided by 365 days per year. The ADD is used primarily to determine the adequacy of the water system to deliver the total amount of water needed during the year. The ADD is the basis for estimating the maximum day and maximum hour demands.
- ADD, Peak Month (ADD-PM): The ADD-PM corresponds the total demand from June 2017 divided by 30 days per year. This metric is used to evaluate available storage against the ADEQ minimum storage requirements.
- Peak Day Demand (PDD): The PDD is the maximum recorded daily demand, representing the single highest system demand for a given year. The water supply must be capable of supplying and transmitting enough water to meet the PDD. Fire flow analysis is based on supplying 1,000 gpm to all nodes during PDD conditions.
- Peak Hour Demand (PHD): The PHD is the water demand during the hour with the highest system demands. Typically, the distribution system must be capable of conveying water to customers at the PHD and at the minimum pressure of 20 pounds per square inch (psi), although the TOVWU's target delivery pressure is 35 psi. The PHD was used to evaluate distribution system pressure, velocities, and head loss in addition to storage equalization needs.

Table ES-2. Key System Demands, Future Modeling Scenarios

Model Simulation	Existing Demand (gallons/day)	Future Demand (gallons/day)		
		0–5 years	5–10 years	10+ years
Average Day Demand	5,591,000	5,862,000	6,125,000	6,446,000
Peak Day Demand	9,256,000	9,705,000	10,140,000	10,672,000
Peak Hour Demand	12,915,000	13,541,000	14,149,000	14,890,000

Figure ES-1. Future Growth Area



Hydraulic Model Development

The water distribution system was evaluated using the network analysis program, WaterGEMS® by Bentley. The Town furnished a working version of the hydraulic model, prepared as part of the 2011 *CAP Water Distribution and Delivery Study* and updated by TOVWU since then to include new development and infrastructure improvement projects. All reservoirs, pumps, and pressure relief valves (PRVs) in the system were verified and updated in the model with their required attributes. Reservoir dimensions and elevations (ground and overflow) and pump characteristics including pump curves were verified using information from TOVWU.

Current demands were spatially allocated to the model to reflect the actual distribution of customer demands and future demands were allocated based on the spatial growth projections provided by the Planning Department. Operational set-points were provided by TOVWU. Demand points were assigned to the model to simulate the NWRRDS delivery points. The delivery set-points were established as constant flows within the model and do not vary throughout the 24-hour diurnal simulation period.

Hydraulic model performance was validated by comparing model output to supervisory control and data acquisition (SCADA) records obtained from TOVWU. With only relatively minor adjustments, the model produced good system-wide results and provides a reliable analysis tool to plan for the future of the water system.

Existing and Future System Analysis

The purpose of the existing and future system analysis is to find system improvements that can then be corrected. The hydraulic model was run under PDD conditions, which is an industry standard for evaluating stress within a hydraulic system including storage capacity, fire flow, system pressures, and pipe head loss.

Existing System Analysis Results

HDR analyzed TOVWU's available storage and pumping capacity to determine whether both were consistent with Town policies, including:

- Maintaining minimum storage equivalent to ADD-PM minus well capacity with the largest production well out of service;
- Adequate pumping capacity and storage volume to supply commercial fire flows during ADD conditions, assumed to be 2500 gpm for 2 hours; and
- Adequate pumping capacity to supply 1,000 gpm residential fire flow for one hour during PDD conditions with a minimum residual pressure of 20 psi and a target delivery pressure of 35 psi.

The storage capacity evaluation shows that on a system-wide basis, there is approximately 3.46 million gallons (MG) of excess storage capacity. There were three individual areas which, when evaluated on a zone by zone basis, had a combined storage shortfall of approximately 1.3 MG, which indicates that storage is not sufficiently distributed across the system. However, given the system-wide excess storage capacity and surplus booster station capacity to move water between zones, no additional storage is warranted at this time but should be considered in the future to accommodate growth.

HDR evaluated daily average and minimum operating pressures across the distribution system and found that average pressures were all within the acceptable range of 40 – 87 psi. Low pressures of less than 40 psi were observed during PDD conditions at two locations, namely the Woodburne E-Zone to F1-Zone booster station, and the northeast portion of the G1 pressure zone.

Fire flow simulations were conducted at 457 model nodes within the distribution system. All fire flow simulations were performed under steady-state, PDD conditions as is typical modeling practice to analyze for potential fire flow improvements in the distribution system. HDR identified seven small fire flow improvement areas.

The hydraulic model simulation results indicate that the existing distribution system has adequate storage, well supply, and pumping capacity to meet PDD demands. The overall system performs well under PDD and PHD conditions, with only a small number of improvements observed. The few improvements noted were primarily related to insufficient fire flow due to small diameter pipes, undersized or insufficient number of PRVs, and undersized booster pumps serving small pressure zone areas at higher elevations where there is no fire flow storage.

Future System Sizing and Requirements

HDR evaluated storage and pumping capacity for the future growth scenarios. The storage evaluation indicates that on a system-wide basis there continues to be a storage surplus. However, there is a spatial disparity in storage, with some interconnected pressure areas showing storage needs. Areas with storage improvements include:

i. Naranja/Deer Run, Glover, and El Conquistador interconnected pressure areas (pressure zones B, C, and D): the storage shortfall in this combined area is 1,090,000 gallons.

ii. Water Plant 13 (pressure zone F1): the storage shortfall is 300,000 gallons.

iii. Water Plant 14 (pressure zones G, H, and I): the storage shortfall in this combined area is 760,000 gallons.

The future system pumping capacity results do not vary significantly from the existing system results, though there is a slight decline in excess fire flow capacity due to increases in ADD. HDR identified insufficient transmission capacity between the eastern portion of zone F2 and western portions of zone F1. The increasing transmission capacity between pressure zones F1 and F2 would improve delivery capacity to zone G1 and would reduce the cost of pushing water supply to zone F2 from Water Plant 4 and the C-Zone wells as the distribution system is currently operated.

Well supply capacity was evaluated under future conditions to determine whether there was sufficient supply to meet future PDD. The analysis indicates that under future conditions the Town will need two additional wells to sustain the same ratio of groundwater supply to demand to meet PDD demands through Tier 3 growth in the event there is a disruption to their CAP water deliveries.

Northwest Recharge, Recovery and Delivery System

The NWRRDS is a partnership between the Town, Metropolitan Domestic Water Improvement District, and the Town of Marana that will recover CAP water that has been stored in the Marana area for future potable distribution. The stored CAP water will be extracted using three recovery wells, transported to a shared forebay and booster station site located at Lambert Lane west of Twin Peaks Road, and from there, each water utility will boost their allocation to their service area. The projected timeline for the NWRRDS is design from 2018-2022, construction from 2020-2023, and it is intended to be fully operational by 2024.

The existing system will be modified to deliver CAP water into three new locations, one at Lambert Lane east of Shannon Road, the second at Tangerine Road east of Shannon Road, and the third at the La Cañada storage reservoir.

With the integration of NWRRDS supplies to the TOVWU main system, the hydraulic model results indicate that TOVWU's groundwater pumping could be reduced from 5,069 AFY currently to 2,300 AFY by Tier 3, after which time groundwater pumping will begin to rise again due to growth. However, under all planning scenarios the total groundwater pumping remains under the Town's target of 5,000 AFY.

IIP Development

With input from TOVWU, HDR provided budgetary level cost estimates based on IIP records from previous TOVWU projects. The costs presented include three types of infrastructure improvements:

1. Existing system improvement projects. These projects are for the existing potable water system and will be financed from the utility's Operating Fund using revenue from water sales and groundwater preservation fees (Existing System Projects).
2. Expansion-related improvement projects. These projects will meet the demands of future growth and will be financed with the utility's Potable Water System Development Impact Fees (PWSDIF).
3. The NWRRDS project is split between two demand classifications that will benefit from the project. A portion of the project (40%) will meet the demands of existing customers and will be financed from the utility's Operating Fund using the Existing Systems Projects revenue detailed above. The remainder of the project (60%) will meet the demands of future growth and will be financed with the utility's Alternative Water Resources Development Impact Fee (AWRDIF).

Table ES-3 identifies the cost split for the three types of projects: Existing System, PWSDIF, and AWRDIF.

Table ES-3. IIP Funding Cost Split

Improvement Type	IIP Funding Cost Split	
	Existing Customer	Growth-Related
Existing System Improvement Projects	100%	0%
PWSDIF-Related Projects	0%	100%
AWRDIF-Related Projects	40%	60%

HDR identified nine improvement projects to address existing distribution system improvements, six projects to address growth-related improvements, and two projects to accommodate future NWRRDS deliveries. The costs associated with these improvement projects are shown in Table ES-4, segregated by tier, and shown in Figure ES-2. Improvements designated by "E" refers to existing system projects, "P" refers to PWSDIF-related projects, and "A" refers to alternative water improvement projects to accommodate NWRRDS deliveries.

Recommendations

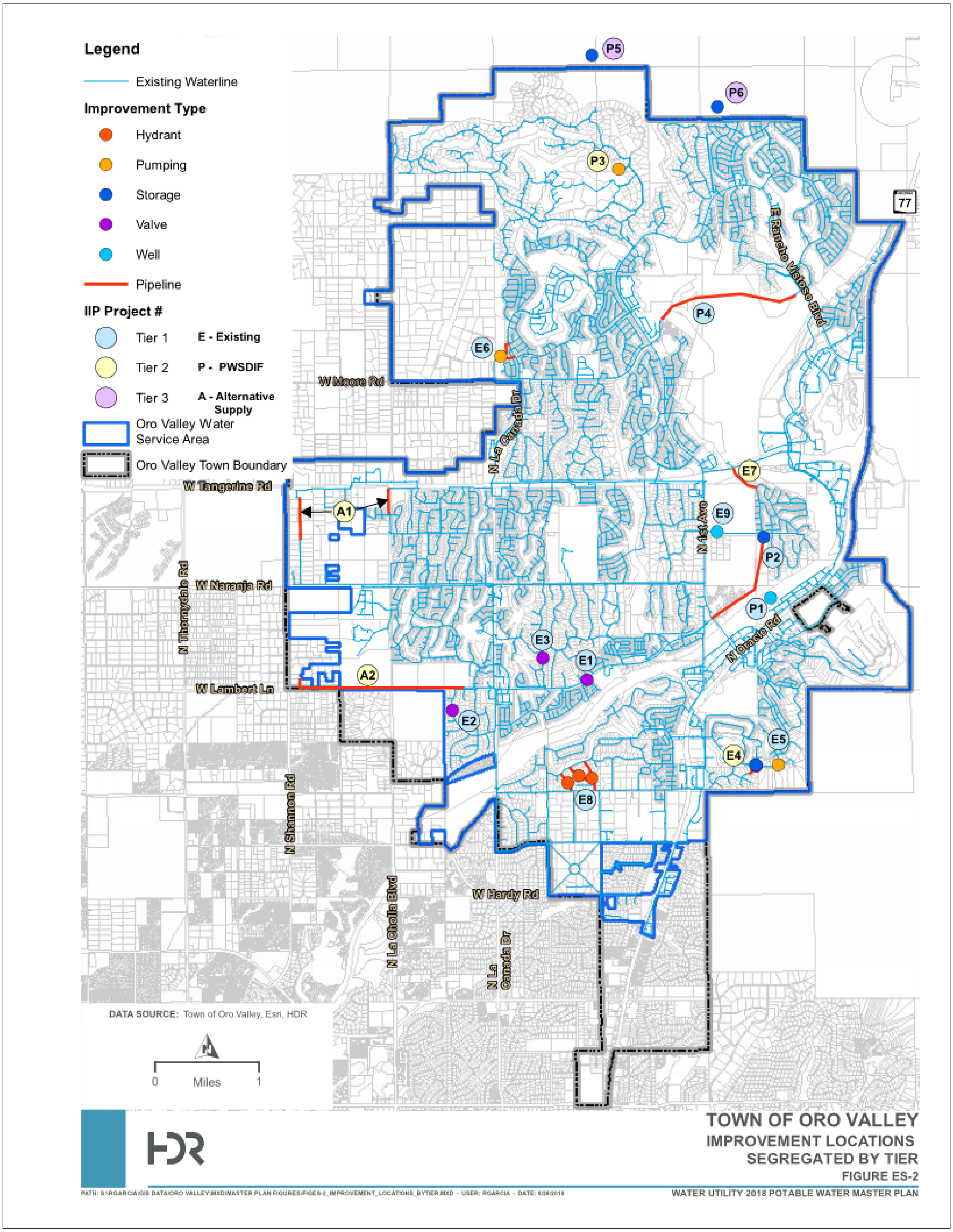
The TOVWU distribution system performs at a high level of service, meeting the demands of existing customers while also providing operational flexibility and resiliency due to redundancy in water supply, storage, and pumping capacity. Through previous master planning efforts, TOVWU has proactively implemented projects that are consistent with future growth and the anticipated integration of CAP water deliveries. In this regard, the existing distribution system pipe network has been adequately sized to meet current and future demands, and TOVWU is well positioned to accommodate future growth and CAP water deliveries through the NWRRDS system with only minimal upgrades to the distribution system. HDR identified a small number of infrastructure projects that will improve the distribution system under future growth conditions.

The transition to NWRRDS will result in a significant change in the bulk transmission of water across the distribution system. However, the available interconnectivity and booster capacity between pressure zones supports this transition with only a few infrastructure improvements. HDR recommends that TOVWU implement a flushing program ahead of the NWRRDS transition in those areas identified in this report where changes in pipe flow direction are anticipated.

Table ES-4. Summary of IIP Costs by Tier

Phase	Improvement	Description	Total Cost
Tier 1 (2018 – 2023)	E-1	4-inch PRV on Corbett Lane	**$70,000**
	E-2	6-inch PRV on Rancho Sonora Drive	**$70,000**
	E-3	6-inch PRV on Stargazer Drive	**$70,000**
	E-5	Booster Pump at Crimson Canyon Booster Station	**$250,000**
	E-6	E-F Booster Station at La Cañada Reservoir	**$600,000**
	E-8	Oro Valley Estates Main Replacement and New Hydrants	**$750,000**
	E-9	Nakoma Sky D-Zone Well	**$1,500,000**
	P-1	Steam Pump D-Zone Well	**$1,500,000**
	P-2	Palisades C-Zone Storage Tank and Pipeline	**$4,250,000**
	P-4	Moore Road F-Zone Interconnect Pipeline	**$750,000**
		Tier 1 Sub-Total	**$9,810,000**
Phase	**Improvement**	**Description**	**Total Cost**
Tier 2 (2023 – 2028)	E-4	4-inch PRV and 6-inch Pipeline at La Reserve	**$100,000**
	E-7	Palisades Neighborhood Pipeline Redundancy	**$550,000**
	P-3	Water Plant 14 Booster Capacity Expansion	**$250,000**
	A-1	NWRRDS Interconnect to Tangerine Road	**$450,000**
	A-2	NWRRDS Interconnect to Lambert Lane	**$850,000**
		Tier 2 Sub-Total	**$2,200,000**
Tier 3 (2028 – 2033)	P-5	Pressure Zone G, H, and I Storage Expansion	**$4,000,000**
	P-6	Pressure Zone G Storage Expansion	**$8,000,000**
		Tier 3 Sub-Total	**$12,000,000**
		Tier 1-3 Total	**$24,010,000**

Figure ES-2. Proposed Infrastructure Improvements, by Tier



1. Introduction

This 2018 Potable Water Master Plan (the Master Plan) is intended to provide a 10-year planning horizon road map for the Town of Oro Valley Water Utility (TOVWU). The Master Plan outlines infrastructure improvements that will benefit existing customers as well as future growth. The Master Plan details the hydraulic model evaluation undertaken as part of this study, identifies distribution system improvements, and outlines an Infrastructure Improvement Plan (IIP). A key component of hydraulic model evaluation was the spatial distribution of the customer demands based on Geographic Information Systems (GIS) meter records. This availability of GIS meter data provided TOVWU their first opportunity to spatially allocate demands, allowing for a more accurate simulation of the distribution system.

Another key element of the Master Plan is the expansion of Central Arizona Project (CAP) water deliveries through the future Northwest Recharge, Recovery, and Delivery System (NWRRDS). By 2024, after the completion of the NWRRDS project, TOVWU will have the capacity to deliver an additional 4,000 acre-feet per year (AFY) of CAP water into the main service area at the La Cañada Reservoir, Tangerine Road, and Lambert Lane locations. The expansion of CAP water deliveries will be used to offset well pumping, reduce reliance on groundwater, and increase aquifer storage as a future resource.

1.1 Background

Water utilities must continuously plan to address system needs and challenges, such as system growth, aging infrastructure, and the need for a well-planned and efficient infrastructure improvement plan. TOVWU completed their last master plan in 2006 which provided a timeline of recommended system improvements, many of which have been implemented over the last 12 years. Beginning in 2012, TOVWU began delivering a portion of their CAP water allocation through the Tucson Water distribution system and, in 2024, TOVWU will significantly expand their CAP water deliveries through the NWRRDS. The transition from majority well supply to a more balanced well and CAP water supply will require a significant change in the way the distribution system is operated and how water is delivered across the system. Due to these changes, TOVWU retained HDR to prepare the Master Plan to identify infrastructure improvements that will accommodate these future changes in supply and operation.

The major components of the Master Plan include the consideration and evaluation of the following:

- **Demand Evaluation:** HDR used GIS meter data to establish existing customer demands and a map of phased future growth areas for estimating future demands.
- **Distribution System Analysis**: HDR updated TOVWU's WaterGEMS® hydraulic model and used the model to perform diurnal and multi-day simulations to evaluate the existing distribution system infrastructure, operations, and water quality and analyze the capacity of these systems to meet present and future demands.

- **IIP Development and Prioritization**: HDR used the results from the distribution system analysis to prioritize and develop costs for distribution system improvements.

1.2 Project Objectives

The primary goal of the Master Plan is to provide an IIP to meet the Town of Oro Valley's (the Town) current and future water demands, while reducing the community's reliance on groundwater. Beginning in 2024, the NWRRDS will enable the Town and their northwest area partners to recover CAP water that has been stored in the Marana area for future potable distribution and convey this water to the TOVWU main service area. The key objectives of this project are to:

- Establish a limit for TOVWU's groundwater production to no more than 5,000 AFY.
- Create a road map for CAP water deliveries into the existing service area to achieve the Town's stated groundwater production limit.
- Blend CAP water deliveries with existing groundwater supplies to achieve the Town's water quality goals.
- Develop a 10-year plan for TOVWU to meet current and future demands and prepare a phased, prioritized IIP to achieve these objectives.

1.3 Scope of Work

The scope of work required to accomplish the Master Plan objectives included the following:

1. Project management and kick-off meeting:
   a. Provide monthly invoices and progress reports.
   b. Provide draft and final kick-off meeting agenda.
   c. Provide draft and final kick-off meeting minutes.
2. Data collection and review:
   a. Collect and review all pertinent data, reports, and operational set points.
3. Current and future demand analysis:
   a. Determine current and future average, peak, and minimum day consumption.
   b. Determine future growth/demand projections, distributed across TOVWU's service area on both a spatial and temporal basis.
   c. Provide a draft and final technical memorandum.
4. Hydraulic model development:
   a. Update model to capture expansion of the potable water distribution system.
   b. Allocate reviewed system demands and diurnal curves.
   c. Validate model performance by comparing predicted model results with observed reservoir levels and system pressures.

5. Existing and future system analyses:
   a. Evaluate adequacy of existing pipe, pump, and storage network.
   b. Complete fire flow evaluation during maximum day conditions.
   c. Evaluate system capacity for peak hour of average day demand scenario.
   d. Evaluate system water age for the minimum week conditions.
6. IIP development and prioritization:
   a. Develop a 10-year IIP.
7. Master Plan report preparation:
   a. Develop and submit draft report.
   b. Develop and submit final report.

2. Water Utility Management and Policies

2.1 Town of Oro Valley Water Utility Management

The TOVWU is composed of customer service, water conservation, engineering and planning, water production, meter operations, water distribution, water quality, and backflow prevention. An organization chart is shown in Figure 2-1. The responsibilities for each division are listed below.

Customer Service

- Monthly billing and payment collection and processing;
- Opening new accounts and closing existing accounts; and
- Responds to questions related to billing, opening/closing accounts, and high water use concerns.

Water Conservation

- Educates and informs customers on water conservation;
- Proactively monitors continuous water use on a daily basis;
- Notifies customers of suspected leaks to save water and money; and
- Performs customer water audits to help reduce water usage.

Engineering and Planning

- Plans and manages design, construction, and inspection of all new water infrastructure;
- Provides engineering support to the Water Operations Group;
- Manages and maintains the GIS database for all existing water system infrastructure; and
- Manages design and construction of infrastructure improvement projects.

Water Production

- Provides 24 hours per day, 365 days per year on-call response to water system problems;
- Operation and maintenance of the wells, booster station pumps, metering stations, reservoirs, and water mains on two potable water systems and the reclaimed water distribution system;
- Performs routine mechanical and electrical maintenance at 47 productions sites;
- Upholds operational balance for CAP water deliveries to the potable system, maintains 23 disinfection injection pumps and disinfection residuals at injection points on the potable and reclaimed water distribution systems; and

- Conducts annual groundwater level survey and prepares report of static water levels in all wells.

Meter Operations

- Monitors and maintains the Advanced Metering Infrastructure (AMI) system;
- Troubleshoots complex metering problems and technical issues within the AMI system using analytical and critical thinking skills;
- Develops solutions to solve water use issues impacting customers using AMI network software, Meter Data Management software, field collection and meter reading hardware, GIS software, and data collection software;
- Installing, programming, maintaining, repairing, and troubleshooting of residential, commercial, and irrigation meters and electronic equipment; and
- Performing preventive maintenance and commercial meter testing.

Water Distribution

- Provides 24 hours per day, 365 days per year on-call response to water system problems;
- Maintains and replaces water mains, valves, fire hydrants, pressure reducing valves, drain valve assemblies, air release valves, and service lines under the preventative maintenance program;
- Updates system mapping, installs new assets, performs erosion repairs, asphalt paving, and system flushing;
- Provides direct, professional customer contact responses in regards to water quality and pressure or flow related issues; and
- Preforms blue-stake locating services for underground pipelines and facilities.

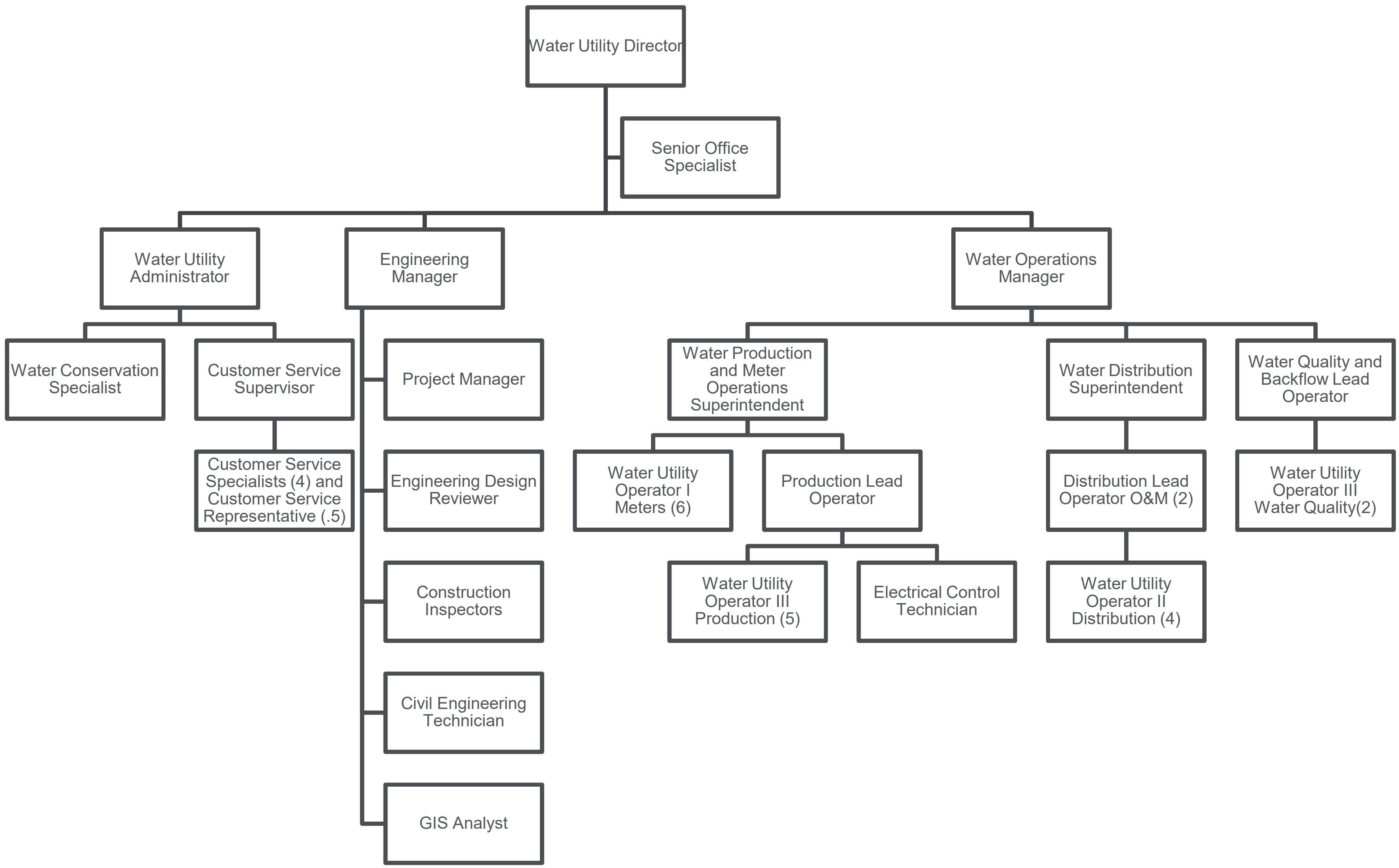
Water Quality

- Collects water samples from potable water points of entry and reclaimed water system;
- Ensures full compliance of state and federal standards and regulations by working closely with the Arizona Department of Environmental Quality (ADEQ); and
- Responds to customer questions with respect to water quality issues.

Backflow Prevention

- Protects the water supply from contaminants that could be introduced into the distribution system through backflow, back siphoning, or back pressure from customer's plumbing systems or internal processes.
- Operates in accordance with the Town of Oro Valley Ordinance (O) 07-21, ADEQ Administrative Code, Section R18-4-B115, the International Plumbing Code, and the guidelines of the University of Southern California Foundation for Cross Connection Control and Hydraulic Research.

Figure 2-1. TOVWU Organization Chart



2.2 Summary of Town's Water Policies and Codes

The Town adopted Water Policies on October 23, 1996 that were amended on June 17, 2015, Resolution No. (R) 15-49. These policies are regulated through the Town's Water Code, with several key codes summarized below:

- *Article 15-13, Water System Capacity Requirements, Oversizing, Refunds for Oversized Capacity*: The developer installs the ultimate-sized water main at their cost. The Town refunds the oversizing cost of the transmission main by reimbursing the developer for the material cost difference between what was required to deliver water to the subject property and what was required to enhance the water system for future growth.

  Improvements identified by the Master Plan have been divided into two primary components: 1) the existing system upgrade requirements, and 2) water system improvements for growth and expansion. The first category of water system improvements defined by the Master Plan includes the specific facility requirements to bring the existing water system into compliance with the Town's Water Policies and Water Code. The second category of water system improvements includes water system expansion for system growth and water system service area expansion. The policy of the TOVWU is that future growth pay for itself. All costs of the new facilities, which are required for new system development, will be paid for by the future development that it benefits.

- *Article 15.15-9, Reclaimed Water*: This code stipulates the requirements for providing reclaimed water to existing and new users irrigating two or more acres of turf. The TOVWU uses reclaimed water to serve most golf courses within the service area boundary. The exceptions to this are the Oro Valley Country Club Golf Course that is not served by the TOVWU water system, and the 9-hole course at El Conquistador that is still served with potable water. Several large turf users within the TOVWU service area, such as Naranja Park and the Painted Sky School, have also converted to reclaimed water irrigation.

- *Article 15-16, Service Obligations of the Town, Interruptions*: This article establishes several key water service criteria:
  - *15-16-1, Level of Service*: The TOVWU shall make reasonable efforts to supply a satisfactory and continuous level of service to its customers. Additionally, the TOVWU will make reasonable efforts to comply with fire protection services. OVWU has adopted a number of standard practices to comply with this code:
    - The TOVWU uses looped water transmission and distribution systems where possible for the water main grid system and for individual subdivisions. Looping with appropriate valving at specific intervals is used to isolate smaller sections of main during breakages and reduce the number of residences out of service.
    - The TOVWU policy requires backup generators at booster stations providing pressure service to areas not connected to a floating storage system. TOVWU maintains centrally located, portable backup generators to fulfill this requirement, and all booster stations have connection points for the portable

generators. There are a minimum of two portable backup generators of adequate size to handle the largest facility and be available to water utility personnel to respond if needed during emergency situations.

- The TOVWU has a fully integrated supervisory control and data acquisition (SCADA) system that provides system monitoring and controls, as well as site security monitoring features for early intrusion detection. The TOVWU continuously maintains and upgrades its automated telemetry controls system.
- The TOVWU has a maintenance and system-exercising program to provide regularly scheduled maintenance on control valves, pumping units, motors, and other critical components of the water distribution system.
- Resolution No. (R) 09-20 authorizes the Intergovernmental Agreement (IGA) between the Town and the Golder Ranch Fire District for fire protection services. The Town's adopted code for fire protection is an amended version of the 2012 International Fire Code, which stipulates a residential fire flow of 1,000 gallons per minute (gpm) over a flow duration of one hour for structures less than 3,600 square feet, and refers to Table B105.1 of the Fire Code for commercial structures and residential structures larger than 3,600 square feet. The required residual pressure during fire flow plus Peak Day Demand (PDD) conditions is 20 pounds per square inch (psi). For the purposes of this Master Plan, the assumed required fire flow rate at all locations throughout the distribution network is 1,000 gpm over a one hour duration. For commercial and larger residential structures, the Master Plan evaluation assumed a fire-flow criteria of 2,500 gpm over a two hour period.

- *15-16-4, Minimum Delivery Pressures*: The TOVWU shall maintain a minimum standard delivery pressure of 20 psi to customers, however the Town's goal is to maintain a minimum static pressure of 30-40 psi and a maximum static pressure of 80 psi at all service connections. In accordance with this article, the TOVWU design goal is to maintain a static pressure of at least 35 psi at the meter during PDD conditions. For the upper pressure limit, it is noted that the TOVWU water system includes zone boundaries located at approximately 100-105 foot intervals. At these intervals, typical static pressure fluctuations will vary from approximately 40 psi at the top of the zone to 87 psi at the bottom of the zone. In foothills areas where unusually steep terrain or areas where highly variable elevations occur, zone boundaries may be allowed to be spaced at approximately 155 foot intervals. Under these conditions, static water pressures may be allowed to approach 120 psi if needed for effective operation within the water transmission system. In these cases the TOVWU shall require appropriate pressure reducing facilities to be installed to protect the TOVWU infrastructure and individual services.
- *15-16-5, Construction Standards*: The TOVWU shall construct all facilities in accordance with the guidelines established by the Arizona Department of Environmental Quality (ADEQ) and the Town's standards. State and Federal statutes are described in Section 2.3 of this report.

- *Article 15-18, Water Conservation*: This code stipulates levels of potable water conservation during water shortage which prioritizes potable demands to be served by the TOVWU. The public will be notified if a shortage occurs and there are restrictions in effect.

2.3 Federal and State Regulations

Federal Safe Drinking Water Act

The U.S. Environmental Protection Agency (EPA) has established regulations for water quality in potable water supply and distribution systems based on the requirements of the Safe Drinking Water Act (SDWA). The SDWA requires that selected contaminants be monitored by water utilities based on EPA established, legally enforceable, maximum contaminant levels (MCLs). The EPA has delegated authority for the management of water quality to ADEQ. The TOVWU uses wellhead chlorination to meet the SDWA disinfection requirements, and maintains adequate residual chlorine concentrations throughout the water system.

Federal Public Health Security and Bioterrorism Preparedness and Response Act

The TOVWU has prepared a vulnerability assessment and emergency response plan per the Public Health Security and Bioterrorism Preparedness and Response Act (PHSBPRA) under the SDWA requirements for water systems serving over 3,300 persons.

Arizona Department of Environmental Quality

ADEQ is responsible for ensuring the health and safety of public water supplies. ADEQ provides a number of standards and guidelines to ensure safe and reliable water quality. Their operational requirements include, drinking water quality requirements, pressure requirements, regulatory storage requirements, backflow requirements, Emergency Operating Plan (EOP), and the Clean Water Act (CWA). The Arizona Department of Health Services published two key bulletins related to the design and construction standards for water distribution systems in Arizona:

- Bulletin 8: Disinfection of Water Systems; and
- Bulletin 10: Guidelines for the Construction of Water Systems.

The Arizona Administration Code (AAC) Title 18, Chapter 5 regulates community water systems in the state, and Rule 18-5-503 regulates minimum storage requirements. Per R18-5-503, the minimum storage capacity requirement for the Town is Average Day Demand (ADD) of the peak month, reduced by the amount of the total daily well production capacity minus the production from the largest producing well.

Arizona Department of Water Resources

The Arizona Department of Water Resources (ADWR) is the agency responsible for the Groundwater Management Code, Active Management Areas (AMA), conservation requirements, Assured Water Supply (AWS), and Groundwater Rights in AMAs regulations for the State of Arizona's water supply.

3. Existing System Review

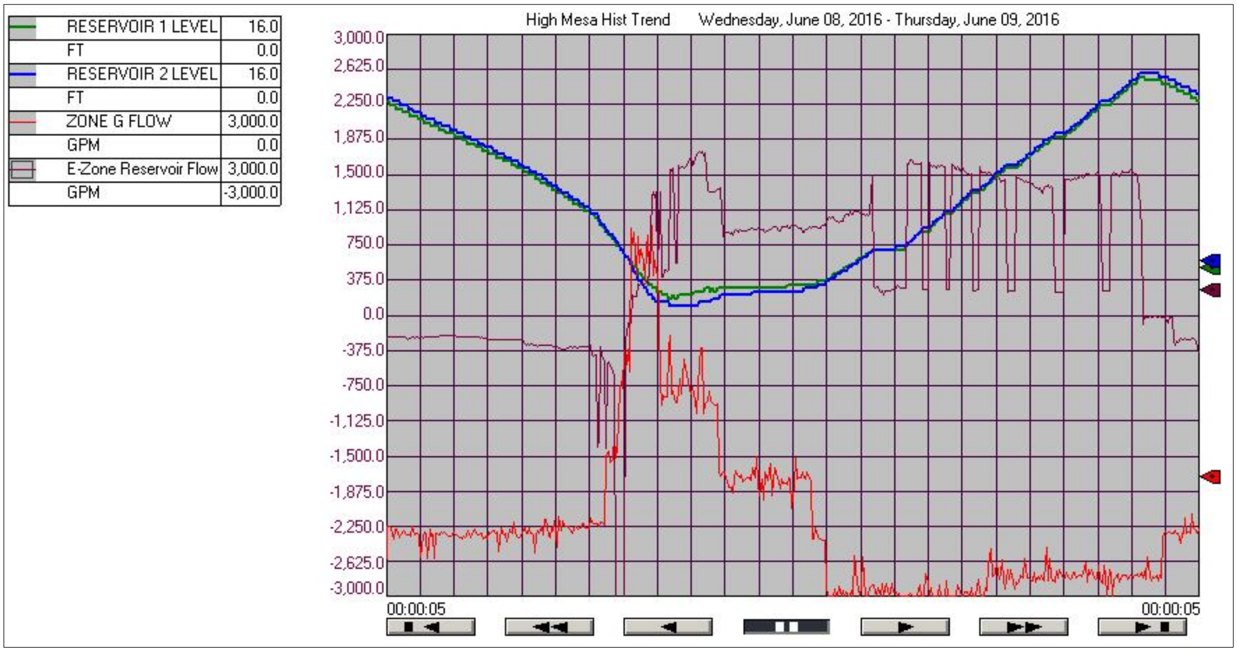
3.1 Data Collection

The 2006 *Potable Water Master Plan* and the 2011 *CAP Water Distribution and Delivery Study* were used as reference documents for this study. Data provided by the Town for the purposes of developing the Master Plan included, but were not limited to, the following:

- Distribution system data:
  - Valve maps (PDF format).
  - GIS maps:
    - System boundary and pressure zone maps;
    - Pipe information, including length, diameter, and material;
    - Tank locations, including dimensions, elevations, and storage volume;
    - Booster stations;
    - Groundwater well locations;
    - Pressure reducing valve (PRV) locations and sizes;
    - Meter size, location, and customer account number.
- Water use data:
  - Daily Reservoir and System Production Reports, July 2015 thru July 2017; and
  - Meter account and water usage data, June 2017.
- Operations data: HDR met with the Operations Division on September 14, 2017, to collect SCADA screen shots from June 2016 for each reservoir and booster to validate the model
- Planning and zoning data:
  - Population projections and future growth areas from the Planning Department.
  - GIS zoning and land use maps
- Hydrant flow test data: Following initial model simulation results and identification of potential fire flow problem areas, HDR conducted hydrant tests at the following locations on January 5, 2018:
    - Star Gazer Drive and Star Gazer Place;
    - Pomegranate Drive and Pomegranate Lane;
    - Rancho Sonora and Placito Salton;
    - Mountain Ridge Drive and Fair Mountain Drive; and
    - Calle Buena Vista and Bangalor Drive.

  See Appendix A for the hydrant testing field notes and photographs.

Figure 3-1. SCADA Screenshots Collected From Operations Division



3.2 Supply and Demand

Service Area Boundary

The service area boundary for the main TOVWU system extends from Shannon Road on the west to Catalina State Park on the east. On the south, TOVWU is bounded by Magee Road and on the north by State Land, as shown in Figure 3-2.

Water Supply

TOVWU delivers a combination of groundwater and CAP water wheeled through the Tucson Water distribution system to meet its potable water demands within its main service area. In 2017, the TOVWU main service area potable water production consisted of 5,069 acre-feet of groundwater (73 percent of total production) and 1,842 acre-feet of CAP water (27 percent of total production).

Wells

There are 17 active wells within the TOVWU main service area, with a total approximate pumping capacity of 12.5 million gallons per day (MGD). The total pumping capacity with the largest well (Well C5) out of service is 10.8 MGD. The well demand fluctuates daily, but typical well demand during average day conditions is approximately 4 MGD, and during peak day conditions typically increases to approximately 8 MGD. All of the wells are permitted by ADWR as recovery wells, which allows the Town to use recharge credits to offset its annual replenishment obligations as determined by the state's Assured Water Supply (AWS) rules. A summary of the groundwater wells is provided in Table 3-1. As part of the hydraulic model simulations, HDR tracked the total annual groundwater production rate over the 15+ year planning horizon and the results are provided in Section 6 of the Master Plan report.

Figure 3-2. Service Area Boundary

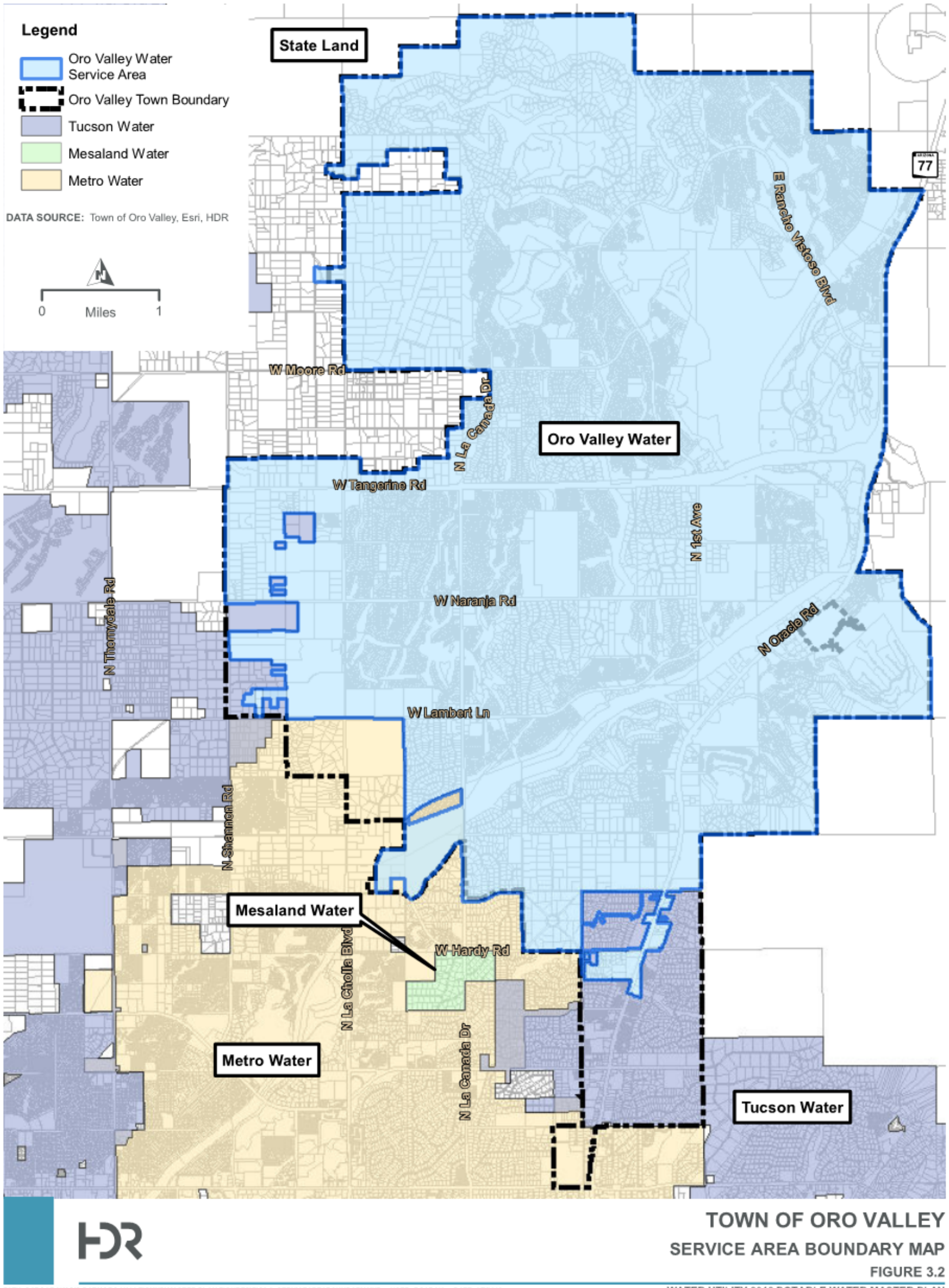


Table 3-1. Well Facilities and Capacities

Well	Flow (gpm)	ADWR Permit Designation
C5	1,199	Recovery
E6B	939	Recovery
C6	774	Recovery
C9	733	Recovery
E7B	736	Recovery
E5B	669	Recovery
D9	733	Recovery
E1B	589	Recovery
E2	508	Recovery
D1	400	Recovery
F1	310	Recovery
D7	318	Recovery
D8	229	Recovery
C4	216	Recovery
C8	204	Recovery
D6	195	Recovery
E3	145	Recovery

CAP Water Supply

In 2017 CAP water was wheeled through the Tucson Water distribution system and delivered to the TOVWU main system at two locations:

1. Vista del Sol (Naranja Reservoir): 1,572 AFY.
2. Calle Buena Vista: 270 AFY.

In 2018, TOVWU intends to expand its CAP water deliveries through the Tucson Water distribution system by adding a third delivery point:

3. Oracle Road and Hardy Road: 240-480 AFY.

In 2021, TOVWU intends to expand its recovered CAP water deliveries at Vista del Sol (Naranja Reservoir) by an additional 200 acre-feet, increasing deliveries at this location to approximately 1,772 AFY.

By 2024, after the completion of the NWRRDS project, TOVWU will have the capacity to deliver an additional 4,000 AFY of CAP water into the main service area at the La Cañada Reservoir, Tangerine Road, and Lambert Lane locations, which have tentatively been identified as the Oro Valley's primary delivery locations. At this point, TOVWU would cease taking deliveries at the Vista del Sol location, which would be preserved as an inactive, but redundant, water supply point. The existing and proposed CAP water delivery locations are shown in Figure 3-3. The estimated CAP water delivery schedule is provided in Table 3-2.

Table 3-2. CAP Water Delivery Locations

Location	Flows (AFY)			
	2017	**2018**	**2019–2023**	**2024+**
Vista del Sol (Naranja Reservoir)	1,572	1,572	1,572–1,772*	—
Calle Buena Vista	270	270	270	320*
Oracle Road and Hardy Road	—	—	240–480*	480*
La Cañada Reservoir	—	—	—	1,600**
Tangerine Road	—	—	—	1,600**
Lambert Lane	—	—	—	800**
Total	**1,842**	**1,842**	**2,082–2,522**	**4,800**

* Values for future CAP water deliveries were estimated based on model results. Further discussion of NWRRDS can be found in Section 6.4.
** Represents maximum annual delivery volumes of future CAP water utilizing NWRRDS.

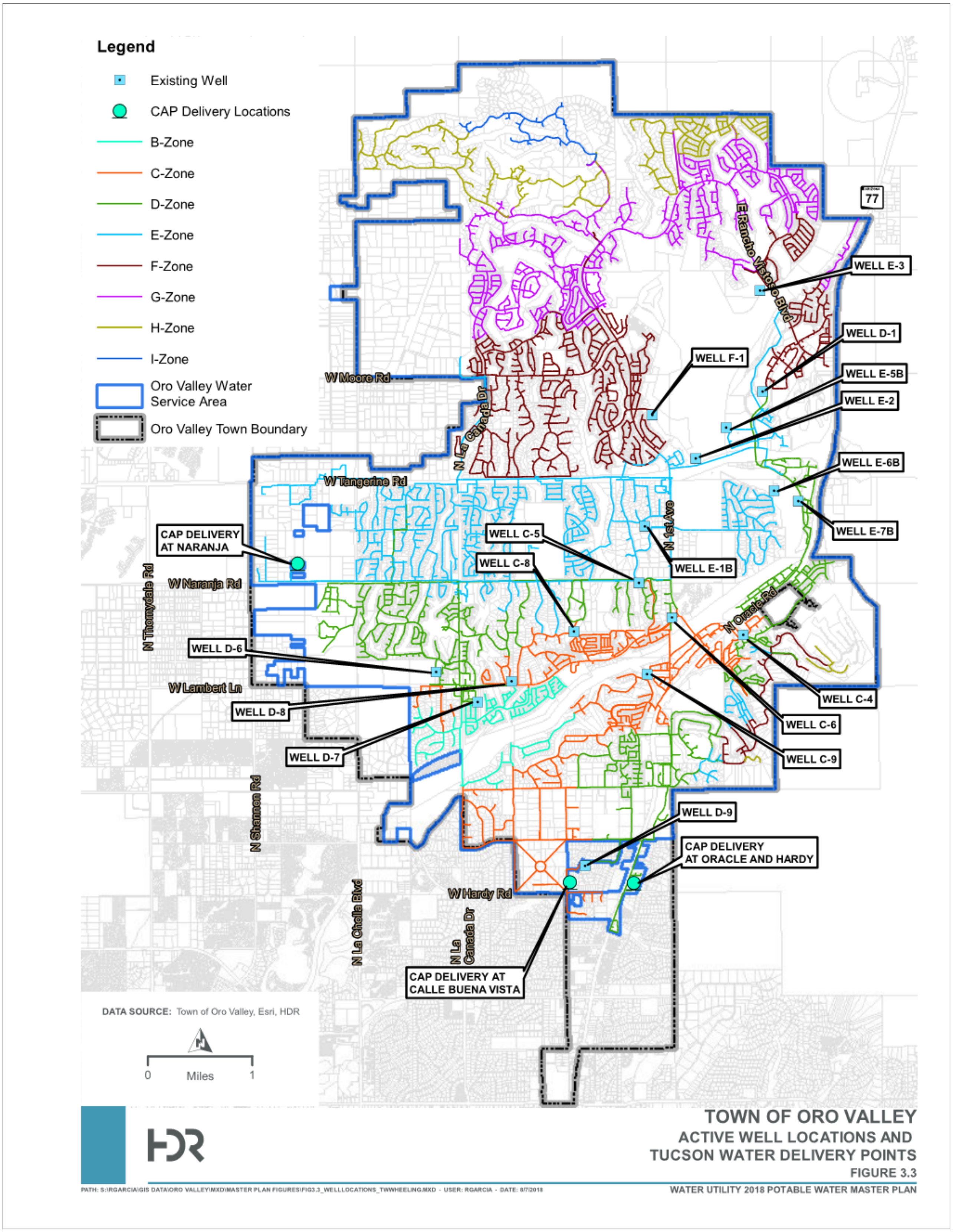
Water Demands

Existing water demands were obtained from existing customer accounts for June 2017, the last available month of billing data prior to the master planning effort. GIS data provided by the Town provided the locations of customer meters so that demands could be applied spatially to the nearest junction in the model.

Water demand varies by time, and there are diurnal as well as seasonal variations. Water use is typically low during overnight hours and increases in the morning and evening corresponding to daily activities, especially in residential areas. During summer months, water use typically increases as compared to winter months. Water use also varies from year to year, depending on factors such as precipitation and temperature. In the assessment of the water system needs, the key water usage rates that were considered included:

- **Average Day Demand (ADD)**. The ADD is the total water used during the year divided by 365 days per year. The ADD is used primarily to determine the adequacy of the water system to deliver the total amount of water needed during the year. It is also used as the common basis for developing peak demand projections. The ADD is the basis for estimating the maximum day and maximum hour demands.
- **ADD, Peak Month (ADD-PM)**. The ADD-PM corresponds the total demand from June 2017 divided by 30 days per year. This metric is used to evaluate available storage against the ADEQ minimum storage requirements.

Figure 3-3. Well Locations and Tucson Water Delivery Points



- **Peak Day Demand (PDD)**. The PDD is the maximum recorded daily demand, representing the single highest system demand for a given year. The water supply must be capable of supplying and transmitting enough water to meet the PDD. Fire flow analysis is based on supplying 1,000 gpm to all nodes during PDD conditions.
- **Peak Hour Demand (PHD)**. The PHD is the water demand during the hour with the highest system demands. Typically, the distribution system must be capable of conveying water to customers at the PHD at a minimum pressure of 20 psi, although the TOVWU's target delivery pressure is 35 psi. The PHD was used to evaluate distribution system pressure, velocities, and head loss in addition to storage equalization needs. Typically, system storage is used to make up the difference between the PHD and PDD.

Peaking Factors

The Daily Reservoir and System Production Reports provided totalized volumes of groundwater well production, CAP water deliveries, and change in total reservoir volume in 30 minute increments over the course of each day, by which the historical PDD conditions can be determined. These data were used to calculate the PHD conditions using a peaking factor analysis. Table 3-3 summarizes the total production, per-capita demand, ADD, PDD, and PHD from July 2015 through August 2017. Diurnal curves were prepared for peak day conditions based on June 8, 2016 records, and are presented in Appendix B. The ratios of peak day to average day demands (PDD:ADD) and peak hour to average day demands (PHD:ADD) are provided in Table 3-4.

Table 3-3. Key System Demands, Future Modeling Scenarios

Model Simulation	Existing Demand (gallons/day)	Future Demand (gallons/day)		
		0–5 years	5–10 years	10+ years
Average Day Demand (ADD)	5,591,000	5,862,000	6,125,000	6,446,000
ADD, Peak Month (ADD-PM)	7,375,500	7,723,300	8,060,000	8,471,400
Peak Day Demand (PDD)	9,256,000	9,705,000	10,140,000	10,672,000
Peak Hour Demand (PHD)	12,915,000	13,541,000	14,149,000	14,890,000

Table 3-4. Peaking Factor Summary

Peaking Factor	2015 Data
ADD-PM:ADD	1.32
PDD:ADD	1.66
PHD:ADD	2.31

3.3 Existing Water System Review

Based on GIS information provided by TOVWU, the existing water distribution system consists of approximately 366 miles of public water mains ranging from 4 to 16 inches in diameter. In addition, there are 13 storage reservoirs and 24 pump stations within the system. The distribution system is monitored by a SCADA system.

Pipe Network

The pipe network evaluated during this study includes both transmission and distribution waterlines. Existing GIS data were provided by the Town for the Master Plan including pipe, pump, and reservoir information required by the hydraulic model. There are approximately 10,019 system and service valves, and 2,291 hydrants located in the pipe network. As is typical in master planning studies, the hydrants, service valves, and system valves were not included in the hydraulic model. Pipes can be closed in the model rather than valves isolated. Fire hydrants did not all have their laterals within the GIS and instead were modeled at the closest model junction. HDR included 25 PRVs in the hydraulic model.

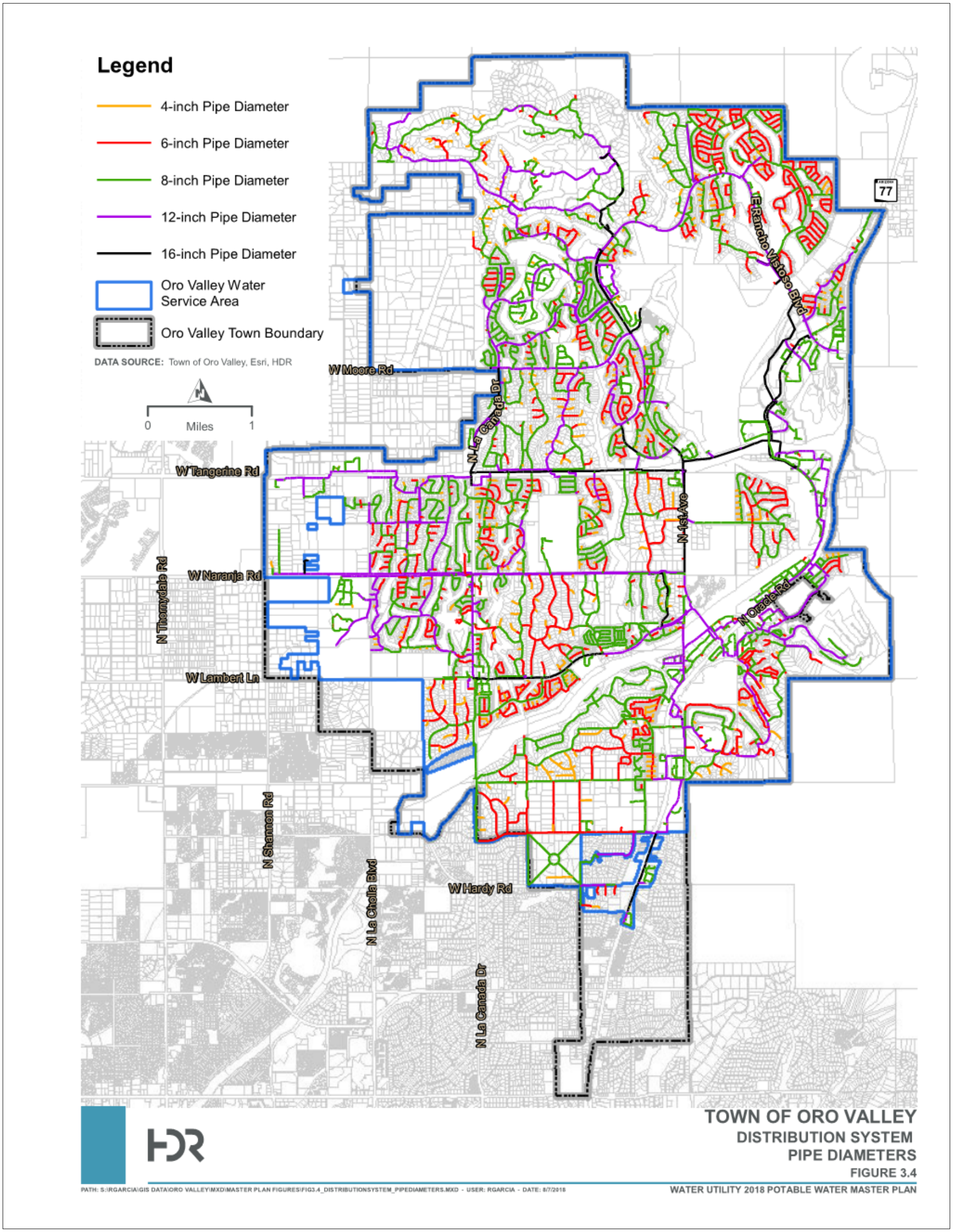
Of the 366 miles listed in the asset inventory included in the Town of Oro Valley Water Utility Commission 2018 Annual Report, only 320 miles were included in the Town's GIS database, ranging in size from 4-inches to 16-inches. The pipe materials and diameters are shown in Figure 3-4 and summarized in Table 3-5. As shown in Table 3-5, the majority of the distribution network is comprised of polyvinyl chloride (PVC) pipe, which makes up approximately 68-percent of the system. Approximately 22-percent is comprised of asbestos cement (AC) and the remaining 10-percent is ductile iron (DI).

Table 3-5. Summary of Pipe Materials and Diameters

Diameter (in)	Length (mi)[1]				
	PVC	AC	DI	Sub-Total	% of Total
4	13.9	7.0	0.4	21.3	6.6
6	41.3	29.3	0.8	71.4	22.3
8	118.5	17.7	9.8	146.0	45.6
12	38.2	14.1	12.7	65.0	20.3
16	5.3	3.5	7.7	16.5	5.2
Sub-Total	217.2	71.6	31.4	**Total = 320.2**	
% of Total	67.8	22.4	9.8		

[1] Lengths were obtained from GIS pipe database and differ from the total pipe lengths reported in the Asset Inventory included in the Town of Oro Valley Water Utility Commission 2018 Annual Report.

Figure 3-4. Distribution System, Showing Pipe Diameters



Pressure Zones

The Town has 24 pressure zones to accommodate a ground elevation range of approximately 2,450-ft (Zone B1) to 3,350-ft (Zone I1) as shown in Figure 3-5. The majority of pressure zones are gravity floated off of storage reservoirs and supplied with a combination of wells, booster stations, and PRVs. A small number of pressure zones at higher elevations have no associated storage and operate solely from booster station supply. For the purposes of evaluating the adequacy of storage and pumping capacity, the pressure zones were consolidated into 10 hydraulically interconnected pressure areas based on the high water levels and storage reservoirs that serve those areas, as summarized in Table 3-6 and shown in Figure 3-6.

Table 3-6. Pressure Zones and Interconnected Pressure Areas[1]

Pressure Zone	Interconnected Pressure Area
B1	Naranja/Deer Run
C2	
C1	Glover
C4	
D1	
D5	El Conquistador
D6	Water Plant 4/Allied Signal/Big Wash
E1	High Mesa/La Cañada
F1	Water Plant 13
D4	Water Plant 16
E2	
E3	
E4	
E5	
F3	
H3	
H4	
F2	Water Plant 14
G1	
G2	
G3	
H2	
I1	
H1	Water Plant 15

[1] Refer to Figure 3-6 and 3-7 for locations.

Figure 3-5. Pressure Zones

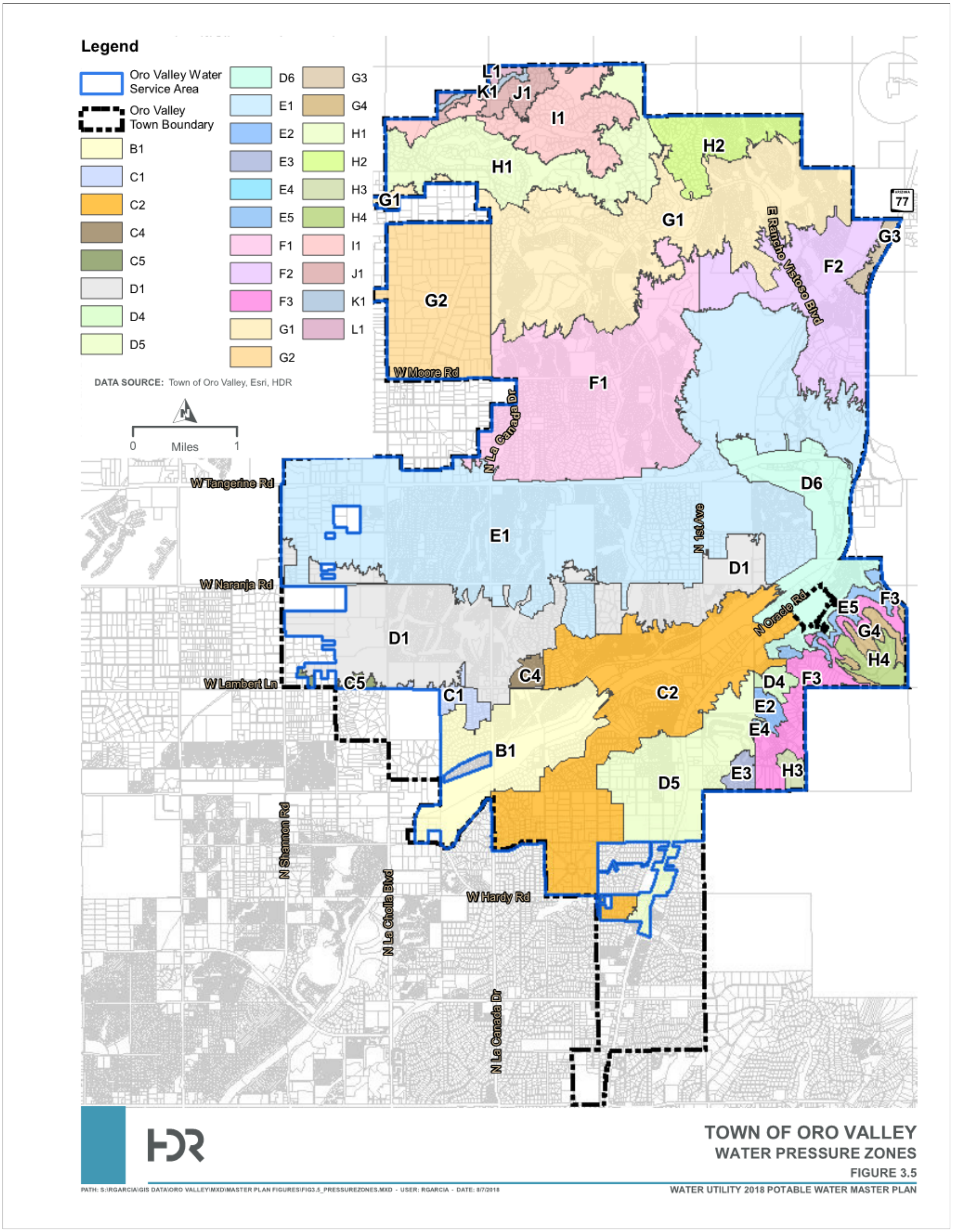
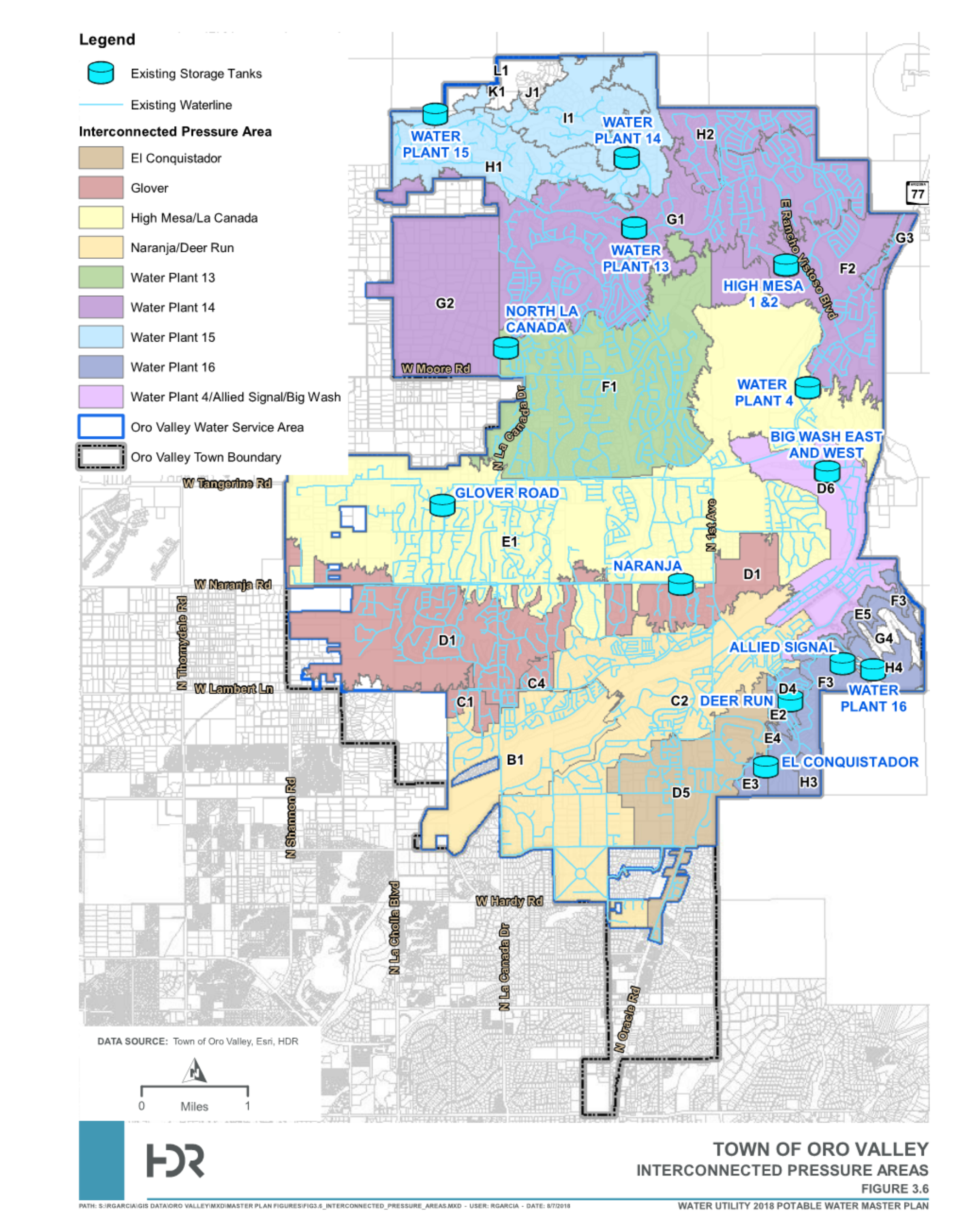


Figure 3-6. Interconnected Pressure Areas



Storage, Booster Stations, and PRVs

The Town is served by 13 storage reservoirs, as summarized in Table 3-7. A total of 10.45 million gallons (MG) of storage is provided in the distribution system. The Town has 24 booster stations. The booster stations are listed in Table 3-8 and identify the pressure zone(s) that they serve. The locations of storage reservoirs and booster stations are shown in Figure 3-7.

Additionally, the Town maintains 29 total PRVs, 25 of which are provided as distribution supply points to lower-elevation areas, four of which specifically accommodate fire flow. The PRV locations are summarized in Table 3-9.

Table 3-7. Storage Facilities and Capacities

Storage Reservoir	Pressure Zone	Nominal Capacity (gallons)	Working Capacity (gallons)
Naranja	B1	500,000	485,000
Deer Run	C2	500,000	507,000
Glover	D1	500,000	508,000
El Conquistador	D5	300,000	292,000
Allied Signal	D6	500,000	507,000
Water Plant 4	D6	600,000	582,000
Big Wash[1]	D6	450,000	410,000
La Cañada	E1	3,000,000	2,553,000
High Mesa	E1	1,300,000	1,230,000
Water Plant 13	F1	1,000,000	1,160,000
Water Plant 16	F3	500,000	563,000
Water Plant 14	G1	800,000	778,000
Water Plant 15	H1	500,000	565,000
	System Total	**10,450,000**	**10,140,000**

[1] Big Wash storage serves as wet well volume for the Big Wash Booster Station and does not provide gravity or equalization storage to Zone D6.

Table 3-8. Pumping Facilities and Capacities

Pump Station	Zone Boundary	Flow (gpm)
Lambert Lane	B1-Zone to C3-Zone	1,200
Naranja	C2-Zone to D1-Zone	1,400
	C2-Zone to E1-Zone	2,200
Sheraton	C2-Zone to D5-Zone	1,150
Copper Creek	D1-Zone to E1-Zone	1,140
El Conquistador	D5-Zone to F3-Zone	1,360
Water Plant 4	D6-Zone to F2-Zone	2,000
Big Wash	E-Zone to D6-Zone	2,000
	E-Zone to E1-Zone	2,800
Tangerine	E-Zone to E1-Zone	960
High Mesa	E1-Zone to F2-Zone	2,000
Woodburne	E1-Zone to F1-Zone	1,700
Rancho del Oro	E1-Zone to F1-Zone	2,000
High Mesa	E1-Zone to G1-Zone	2,400
Woodshade	F1-Zone to G1-Zone	2,000
Big View	F2-Zone to G3-Zone	1,500
Crimson Canyon	F3-Zone to H3-Zone	150
Pusch Ridge	F3-Zone to H4-Zone	1,500
Rancho Vistoso	G1-Zone to H2-Zone	1,000
Sun City	G1-Zone to H2-Zone	950
Water Plant 14	G1-Zone to H1-Zone	2,500
	G1-Zone to I1-Zone	1,200

Figure 3-7. Storage and Booster Station Locations

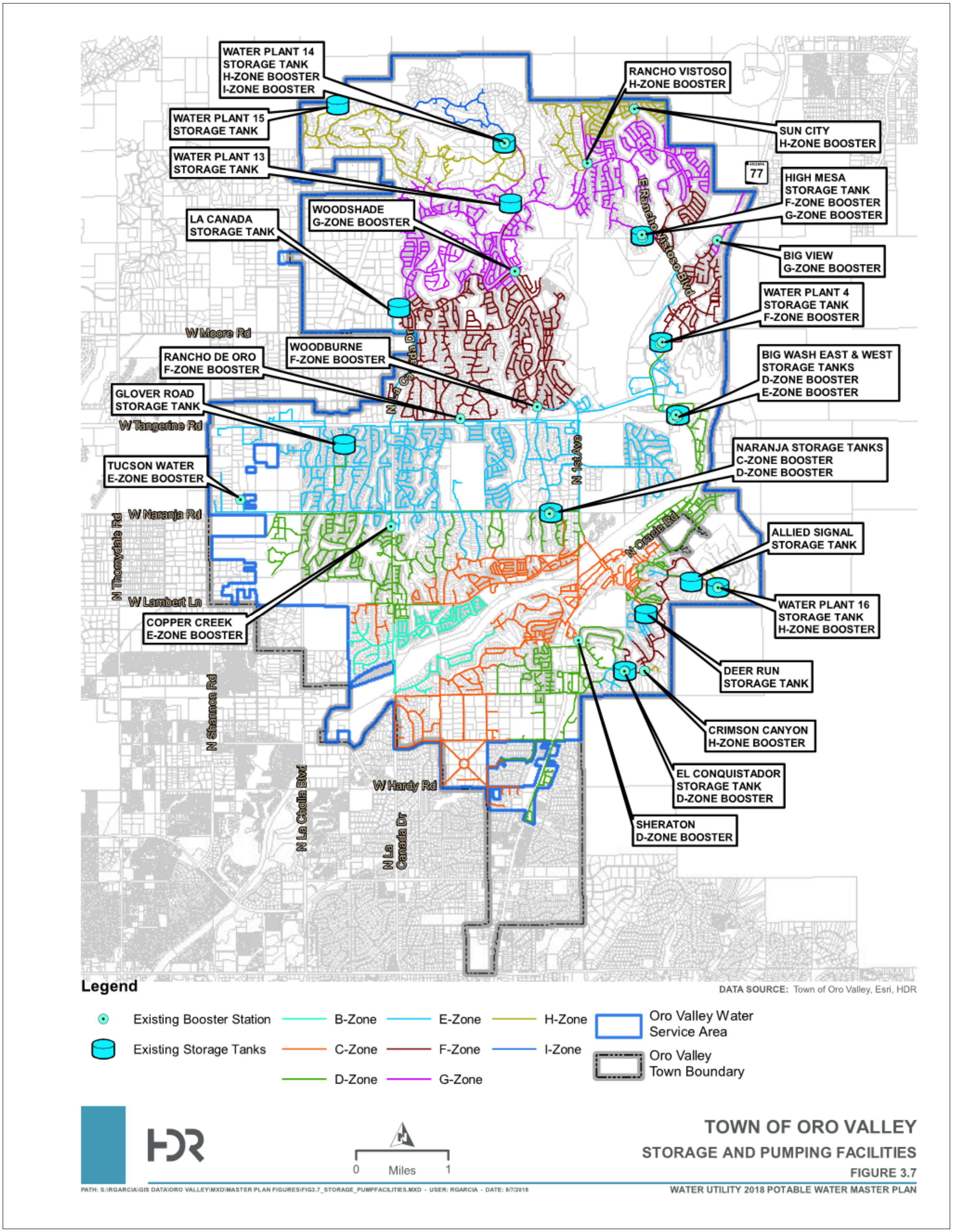


Table 3-9. PRV Locations and Zone Boundaries

PRV Name	Size	Location	Zone Boundary
PRV-001	4-inch	Del Webb	G-Zone to F-Zone
PRV-002	8-inch	Lambert and 1st Avenue	Fire Flow
PRV-004	4-inch	Naranja and Poinsettia	E-Zone to D-Zone
PRV-006A	6-inch	Lambert and Hacienda	D-Zone to C-Zone
PRV-006B	4-inch	Lambert and Hacienda	D-Zone to C-Zone
PRV-007	8-inch	La Cañada and Linda Vista	Fire Flow
PRV-008	8-inch	La Cañada	D-Zone to C-Zone
PRV-010	4-inch	Lambert and Congressional	D-Zone to C-Zone
PRV-011A	4-inch	Calle Loma Linda	C-Zone to B-Zone
PRV-011B	2-inch	Calle Loma Linda	C-Zone to B-Zone
PRV-012A	6-inch	Golf View Drive	C-Zone to B-Zone
PRV-012B	4-inch	Golf View Drive	C-Zone to B-Zone
PRV-013A	6-inch	Desert Sky	C-Zone to B-Zone
PRV-013B	4-inch	Desert Sky	C-Zone to B-Zone
PRV-014	4-inch	Linda Vista and Korte	D-Zone to C-Zone
PRV-015	4-inch	Canyon del Oro High School	D-Zone to C-Zone
PRV-016A	8-inch	Well D9	Fire Flow
PRV-016B	4-inch	Well D9	C-Zone to C-Zone
PRV-017A	4-inch	El Con Reservoir	F-Zone to E-Zone
PRV-017B	2-inch	El Con Reservoir	F-Zone to E-Zone
PRV-018	4-inch	El Con	F-Zone to D-Zone
PRV-019A	4-inch	Bighorn Butte	F-Zone to E-Zone
PRV-019B	2-inch	Bighorn Butte	F-Zone to E-Zone
PRV-020	4-inch	Alder Springs	F-Zone to E-Zone
PRV-024	4-inch	Buck Ridge	F-Zone to E-Zone
PRV-025	6-inch	Cliff Dweller	Fire Flow
PRV-026	4-inch	Well D8	D-Zone to C-Zone
PRV-027A	6-inch	Lambert and Rancho Sonora	D-Zone to C-Zone
PRV-027B	4-inch	Lambert and Rancho Sonora	D-Zone to C-Zone

4. Future Demands and Growth Areas

The objectives for the demand analysis were to document system-wide water production (wells and renewable supplies) data, customer accounts demand and mapping data, daily demand patterns, locations and timelines for future growth, and spatial distribution of existing and future demand. Based on the growth projections and historical water usage trends, demand projections were developed through 2033. The demand projections serve as the basis for the hydraulic analysis and identification of improvement areas. HDR prepared a Current and Future Demand Analysis Technical Memorandum that is provided in Appendix B.

The Town's Planning Department provided a full-size (24-inch x 36-inch) hard copy plot of the Town boundary that graphically identified future growth areas, identified by individual lots, as shown in Figure 4-1. These plots were colored by land-use type (e.g. commercial, residential, and multi-family) and are labeled as follows:

- "Tier 1" – development in 0-5 years (from 2018 thru 2023)
- "Tier 2" – development in 5-10 years (from 2023 thru 2028)
- "Tier 3" – development in 10+ years (from 2028 thru 2033)

The Planning Department plots were used as the basis for estimating the spatial distribution of future demands and polygons were created within GIS to represent the growth areas. Demands were estimated based on the number of units and their corresponding meter size, as outlined in Appendix B. Future demands were presented per pressure zone, as shown in Table 4-1. To assign these demands to the hydraulic model, the demands within each zone were spatially distributed based on the size of the growth area polygon and assigned to the junction nearest to the centroid of the polygons. The future growth area polygons are shown in Figure 4-2.

Note that the demands presented in Table 4-1 are not average day demands, but specifically represent June 2017 demands. For the purposes of modeling, the demands in each pressure zone were escalated or de-escalated to match the modeling scenario. For example, when modeling average day or peak day demand conditions, the demands at all nodes were multiplied uniformly to adjust from June 2017 demands to the modeling scenario.

Figure 4-1. Future Growth Area Map from Planning Department

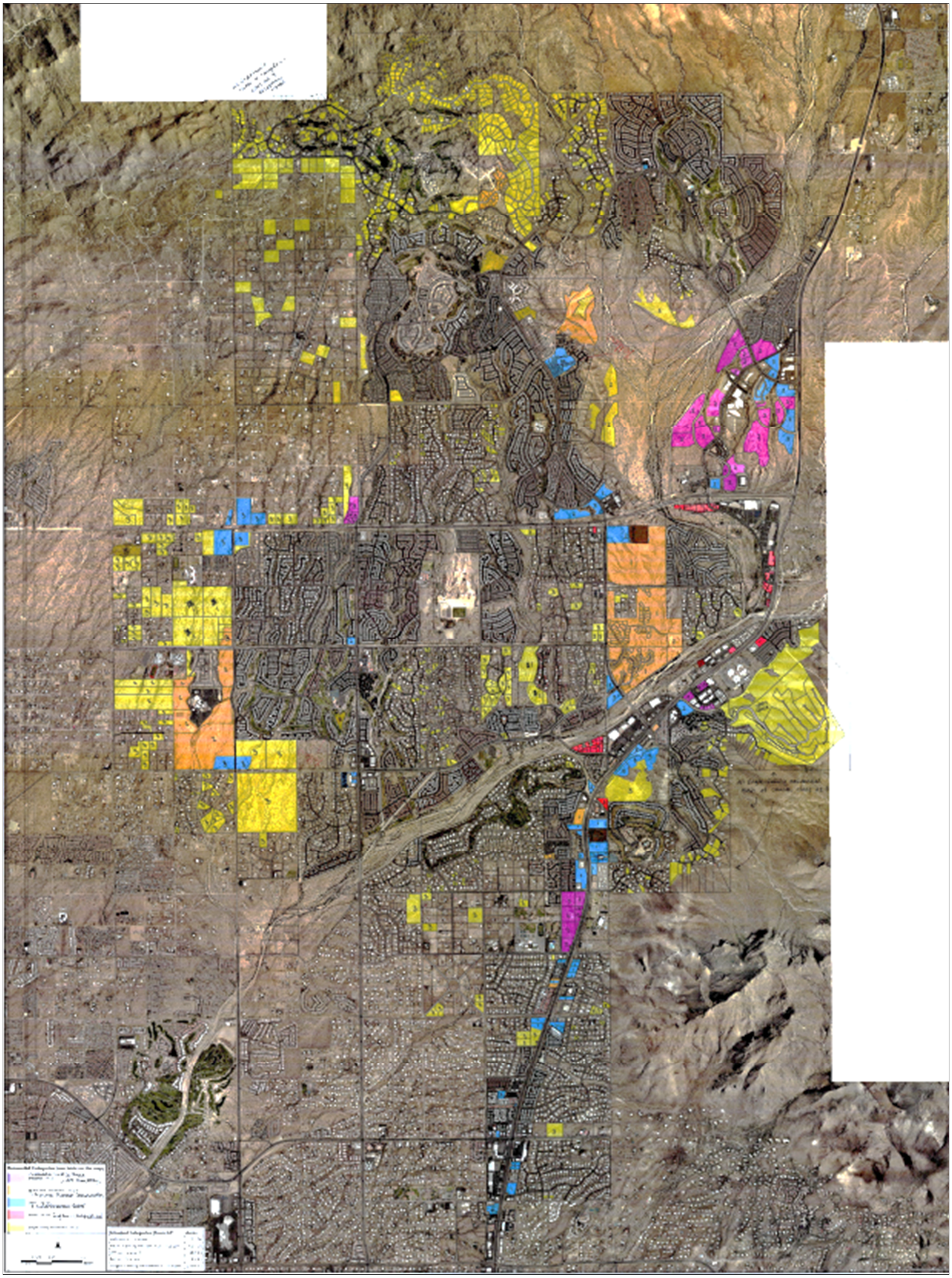
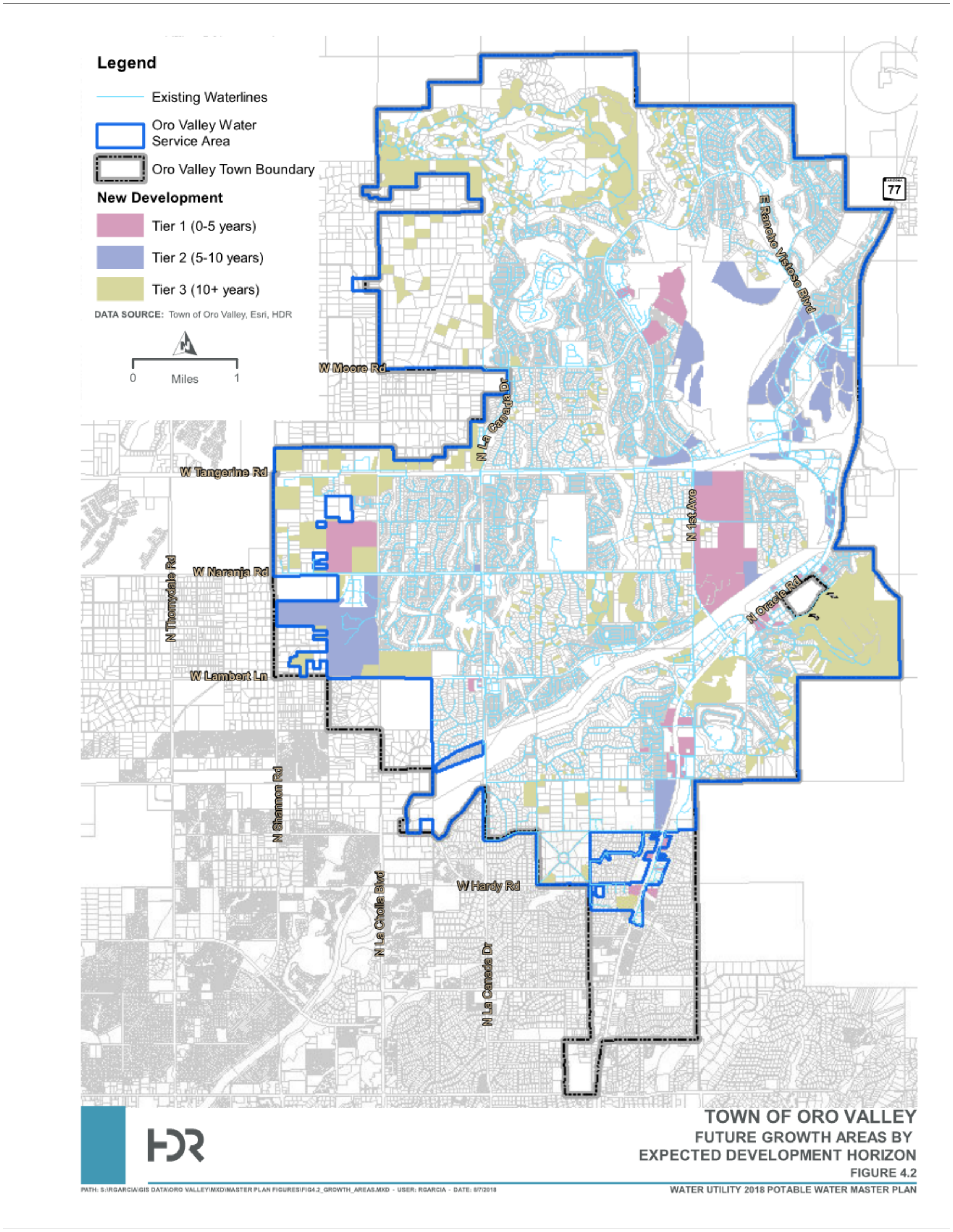


Table 4-1. Projected Average Demands Per Zone (Based on Projections of June 2017 Demands)[2]

Planning Zone	Existing Demand (gallons/day)	Future Demand (gallons/day)		
		0–5 years	5–10 years	10+ years
B1	382,500	0	0	0
C1	40,600	0	0	13,100
C2	859,200	17,000	24,300	27,200
C4	36,400	0	0	0
D1	709,400	17,700	44,200	30,000
D4	34,900	0	0	0
D5	572,000	41,500	13,600	11,800
D6	239,200	0	0	0
E1	1,576,000	172,700	216,900	92,400
E2	40,900	0	0	0
E3	27,300	0	0	0
E4	222,100	0	0	0
E5	3,300	0	0	0
F1	393,200	98,900	0	26,900
F2	249,500	0	37,700	0
F3	65,600	0	0	6,800
G1	805,100	0	0	70,000
G2	92,700	0	0	10,000
G3	42,000	0	0	0
H1	48,600	0	0	74,600
H2	128,600	0	0	15,900
H3	6,900	0	0	0
H4	1,100	0	0	0
I1	6,500	0	0	32,700
Potable Supplement to Reclaimed	791,900	0	0	0
Total	**7,375,500**	**347,800**	**336,700**	**411,400**
	Grand total	**7,723,300**	**8,060,000**	**8,471,400**

[2] This data is provided for informational purposes only and was not utilized for hydraulic modeling associated with the Master Plan.

Figure 4-2. Future Growth Area, by Expected Development Tier



5. Hydraulic Model Development

This section discusses the development and validation of the hydraulic computer model for evaluation of the distribution system for existing and future conditions. The physical characteristics of the water distribution system in the hydraulic model include ground elevations, reservoir and tank elevations, pump and valve characteristics and settings, and pipe diameter, length, and interior roughness.

The water distribution system was evaluated using the network analysis program, WaterGEMS® by Bentley. The Town furnished a working version of the hydraulic model, prepared as part of the 2011 *CAP Water Distribution and Delivery Study* and updated by TOVWU since then to include new development and infrastructure improvement projects. TOVWU also furnished up-to-date GIS maps of the distribution system which were used as the basis for updating the hydraulic model. For the purposes of this study, all existing pipes and junctions to be evaluated were assumed to be accurately represented in the GIS.

5.1 Network and Facilities

Diameters, materials, and lengths were added to the model from GIS. The GIS pipe network included water mains ranging from 4 to 16-inches in diameter, but pipes smaller than 4-inches were not included in the hydraulic model except where designated as private mains. The hydraulic model is close to what is referred to as an “all-pipes model” since it represents most of the pipes within the source GIS.

HDR compared the pipe network from the hydraulic model to the GIS maps and found a relatively small number of pipe segments, likely from development projects completed after 2011, missing in the model. These missing pipe segments were added to the model. The following tasks were completed to construct the model with new pipes and nodes:

- Add active existing pipes from the GIS data to the model;
- Remove orphan pipes or those pipes not attached to any nodes;
- Remove orphan nodes or those nodes not attached to any pipes;
- Insert new nodes at pipe ends where nodes previously did not exist;
- Complete connectivity to create “from node” and “to node” data for all pipes;
- Split pipes as necessary into smaller sections to provide connectivity to all nodes; and
- Interpolate elevation data for all nodes based on contours.

All reservoirs, pumps, and PRVs in the system were verified and updated in the model with their required attributes. Reservoir dimensions and elevations (ground and overflow) and pump characteristics including pump curves were verified using information from TOVWU. The ground elevations for the reservoirs, pump stations, and PRVs were obtained from plans or interpolated from contours.

The distribution system model was run using Hazen-Williams' Energy Loss Equation for pressurized pipes to calculate total head loss in each pipe.

5.2 Demand Allocation

Current demands were allocated in the model based on the spatial location of customer meter records, with average day demands assigned for each customer assigned to the nearest node in the model. Future demands were allocated as described in Section 4, and were based on the locations of future growth polygons as provided by the Town's Planning Department.

5.3 Operational Settings

Operational set-points were provided by TOVWU. Most booster stations are dependent on storage reservoir levels and start and stop points for each booster were provided by TOVWU. A few booster stations supply higher elevation pressure zones where there are no storage reservoirs. At these locations, the booster station pump set-points are based on discharge pressure, also provided by TOVWU. All wells are dependent on storage reservoir levels and with known set-points unique to each well pump.

La Cañada and High Mesa storage reservoirs both support the demand in pressure zone E1. The SCADA system has a control algorithm for the fill valve at High Mesa so that both reservoirs fill and drain on the same cycle. This operational control stabilizes pressures within pressure zone E1 and prevents High Mesa from reaching full capacity while La Cañada is still only partially full.

In addition to the pump/well pump settings and the E1 reservoir controls, demand points were assigned to the model to simulate the NWRRDS delivery points. The delivery set-points were established as constant flows within the model and do not vary throughout the extended period simulations.

5.4 Model Validation

Model validation was completed to provide a baseline model from which to build subsequent demand scenarios. Model validation is the process of examining results compared with available field data to determine whether the model predictions seem reasonable under the modeled conditions for its intended use. The model was validated by comparing model output to SCADA records obtained from TOVWU. The following general procedures were used to validate the model for existing PDD conditions (June 9, 2016).

- Compare modeled reservoir levels and pump station pressures and flows with SCADA data.
- Adjust pump and reservoir model inputs as needed. Slight changes were iteratively made until the results closely resembled the SCADA data provided.

With only relatively minor adjustments, the model produced good system-wide results and provides a reliable analysis tool to plan for the future of the water system. The model validation results for levels, flows and pressures were compared with recorded data, as presented in Figures 5-1 and 5-2. These exhibits are examples showing hydraulic model results superimposed above captured SCADA screenshots for reservoir levels and booster flows. The red dashed lines on the figures indicate the model results and demonstrate the hydraulic model was able to track actual system performance.

Figure 5-1. Model Validation for La Cañada Reservoir

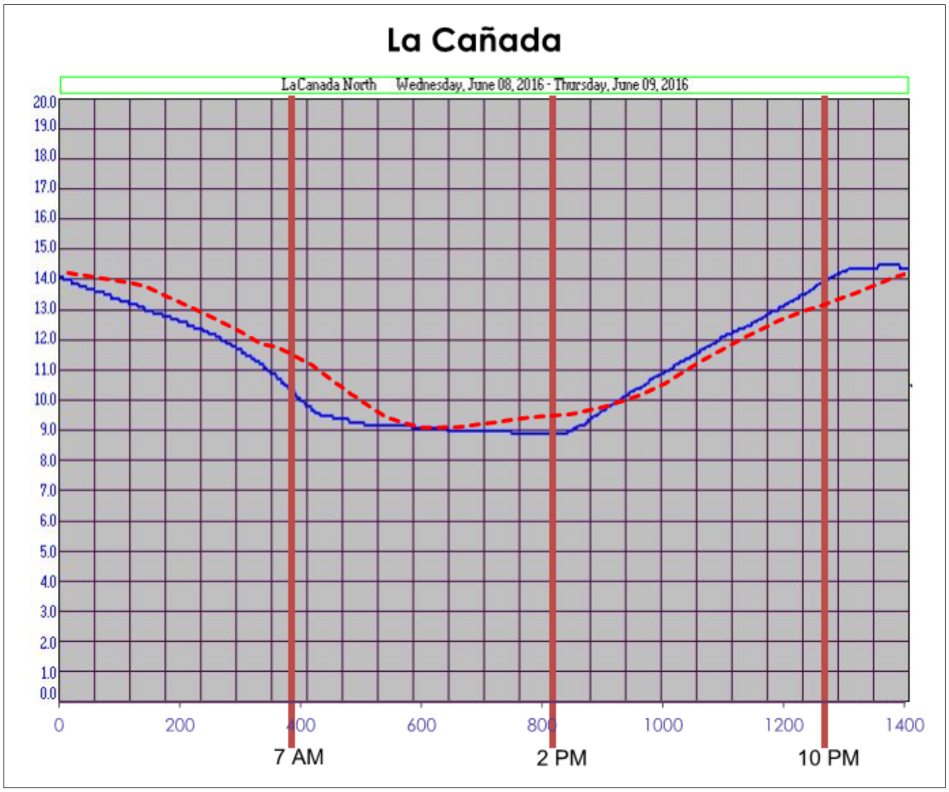
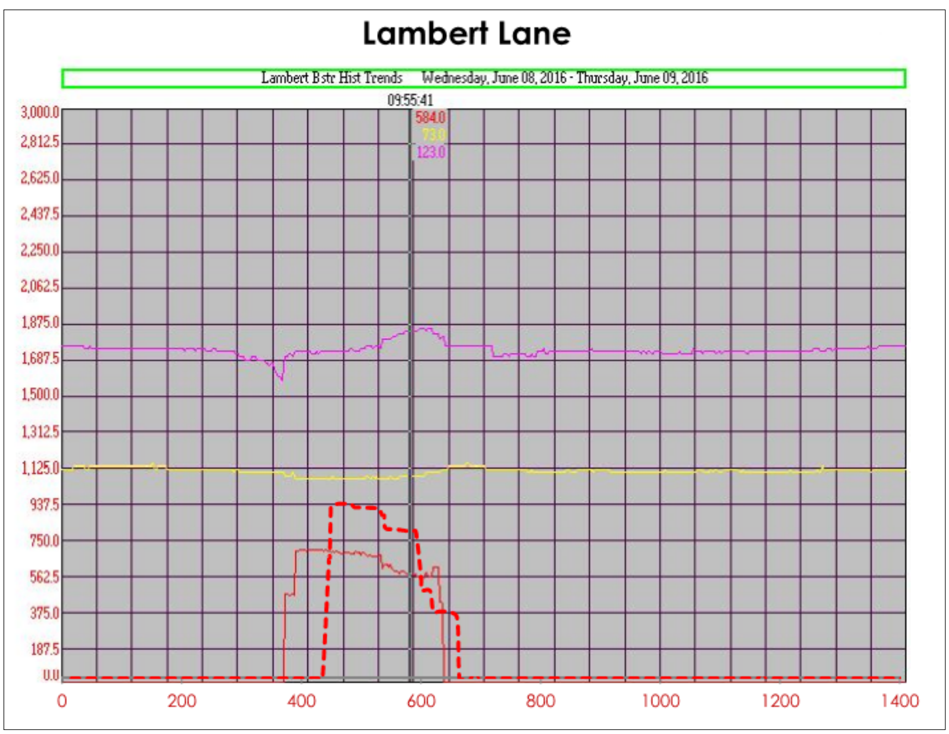


Figure 5-2. Model Validation for Lambert Lane Booster Station



6. Existing and Future System Analysis

The validated hydraulic model was run under PDD conditions for an extended period simulation (EPS) over multiple days using a recurring 24-hour diurnal cycle, which allowed the distribution system model to stabilize. Running a hydraulic model under PDD conditions is a common industry method for evaluating stress within a hydraulic system including storage capacity, fire flow, system pressures, and pipe head loss. The diurnal curve used as part of the EPS simulations also imposes a PHD condition upon the distribution system to further evaluate system performance.

The purpose of the existing and future system analysis is to find system improvements that can then be corrected. Strategies for identifying improvements include increasing system reliability through looping and increased transmission capacity, adding storage and pumping capacity, changing well/pump set-points, and changing PRV set-points. Alternative improvements were investigated to identify those most effective in correcting existing system improvements and meeting future system needs.

6.1 Evaluation Criteria

HDR used the following criteria to evaluate the existing and future distribution systems:

i. Firm well supply capacity should be greater than PDD;

ii. Storage capacity should be greater than ADD minus firm well capacity;

iii. Fire flow supply capacity should exceed:

   a. 1,000 gpm for one hour under PDD conditions at all model nodes and with minimum 20 psi residual pressure.

   b. 2,500 gpm for two hours under ADD conditions in all interconnected pressure zones. This criteria is a conservative assumption for required commercial pumping capacity in small, residential communities with light industry.

iv. Delivery pressure should be between 40 – 87 psi during PDD conditions;

v. Pipe head loss should not exceed 4-feet per 1,000-feet of pipe; and

vi. Pipe velocity should not exceed 10 feet per second (fps) under PPD conditions. Pipe improvements were sized using a target velocity of 3 – 5 fps.

6.2 Existing System Analysis

Well Supply Capacity

As outlined in Section 3.2, the available well pumping is approximately 12.5 MGD, or 8,700 gpm. Without the largest well (Well C5) in service, the “firm” well capacity would be 7,600 gpm, which exceeds the existing PDD of 6,400 gpm. On a system-wide basis, the existing well capacity is sufficient to meet PDD and no additional well capacity is required to help meet existing demands.

Storage and Pumping Capacity

Using the distributed demands for existing customers, HDR analyzed TOVWU's available storage and pumping capacity to determine whether both were consistent with Town policies and State regulations, including:

- Maintaining minimum storage equivalent to ADD-PM minus well capacity with the largest production well out of service;
- Adequate pumping capacity and storage volume to supply 2,500 gpm commercial fire flows for 2 hours during ADD conditions; and
- Adequate pumping capacity to supply 1,000 gpm residential fire flow for one hour during PDD conditions with a minimum residual pressure of 20 psi.

The TOVWU has total storage capacity of 10,450,000 gallons as compared to current ADD-PM demand of 7,375,000 gallons. Per State regulations, the minimum storage requirements should equal ADD-PM minus the firm well pumping capacity. For the TOWVU, the total available storage exceeds ADD-PM without accounting for firm well capacity. However, it should be noted the State regulations are guidelines for minimum storage requirements, and are not an indicator of recommended storage requirements.

The TOVWU has historically used a criteria of target operating storage equal to 1.25 times ADD which is more conservative, and provides TOVWU the flexibility to move water between multiple pressure zones. The ADD target storage volumes within each interconnected pressure area were compared with the available storage, as presented in Table 6-1. The storage capacity evaluation shows that on a system-wide basis, there is approximately 3.0 million gallons of excess storage capacity. There were three interconnected pressure areas in the B, C and D pressure zones that had a combined storage shortfall of approximately 670,000 gallons, which indicates that additional storage may be required to meet TOVWU's target storage. Zone F1, served by Water Plant 13, has a 120,000 gallon shortfall, and the adjacent pressure zones F, G, H, and I, which are served by Water Plant 14, have a storage shortfall of 450,000 gallons that will become greater in the future given the planned growth in that area. Given the system-wide excess storage capacity and surplus booster station capacity to move water between zones, no additional storage is warranted at this time. However, with continued growth in these affected pressure zones, the storage shortfall will increase in the future and additional storage capacity may be warranted at that time.

Fire flow pumping capacity was conservatively evaluated in each interconnected pressure area by assuming a commercial fire flow of 2,500 gpm. Fire flow capacity may be satisfied using a combination of both storage volume and pumping capacity. The results are shown in Table 6-2 and demonstrate that only pressure zone D5 has a commercial fire flow shortfall. The fire flow capacity of pressure zone D5 is 1,800 gpm which is still greater than the typical commercial fire flow requirement of 1,500 gpm.

Pressure zones supplied exclusively by booster stations, i.e. no storage capacity, were evaluated individually to determine whether the booster stations were adequately sized to supply PDD plus residential fire flow requirements. The pressure zones served exclusively by booster stations are all located at higher elevations in residential areas, so the required fire flow is assumed to be 1,000 gpm. The results are presented in Table 6-3 and demonstrate that pressure zone H3 is significantly below the minimum residential fire flow due to the limited size of the booster stations serving this zone.

Table 6-1. Storage Capacity Evaluation

Pressure Zone	Interconnected Pressure Area	ADD (gallons/day)	Target Storage (gallon/day)	Available Storage (gallons)	Storage Surplus/ (Shortfall) (gallons/day))
C2	Naranja/Deer Run	650,000	810,000	1,000,000	(180,000)
B1		290,000	360,000		
D1	Glover	540,000	670,000	500,000	(250,000)
C1		31,000	38,000		
C4		28,000	35,000		
D5	El Conquistador	430,000	540,000	300,000	(240,000)
D6	Water Plant 4/Allied Signal/Big Wash	180,000	230,000	1,550,000	1,320,000
E1	High Mesa/La Cañada	1,190,000	1,490,000	4,300,000	2,810,000
F1	Water Plant 13	900,000	1,120,000	1,000,000	(120,000)
F3	Water Plant 16	50,000	62,000	500,000	130,000
E2		31,000	39,000		
E3		21,000	26,000		
E4		170,000	210,000		
E5		2,500	3,100		
H3		5,200	6,500		
H4		800	1,000		
D4		26,000	33,000		
F2	Water Plant 14	190,000	240,000	800,000	(450,000)
G1		610,000	760,000		
G2		70,000	88,000		
G3		32,000	40,000		
H2		97,000	120,000		
I1		4,900	6,200		
H1	Water Plant 15	37,000	46,000	500,000	450,000
		Totals	**6,990,000**	**10,450,000**	**3,460,000**

Table 6-2. Fire Flow Capacity Evaluation – Pressure Zones With Storage

Pressure Zone	Interconnected Pressure Area	ADD Storage Surplus/ (Shortfall) (gallons)	Well + Booster Supply (gpm)	Fire Flow Requirement (gallons)	Fire Flow Surplus/ (Shortfall) (gallons)
C2 B1	Naranja/Deer Run	(180,000)	2,800	300,000	34,000
D1 C1 C4	Glover	(250,000)	3,300	300,000	98,000
D5	El Conquistador	(240,000)	1,800	300,000	(83,000)
D6	Water Plant 4/Allied Signal/Big Wash	1,320,000	2,000	300,000	1,260,000
E1	High Mesa/La Cañada	2,810,000	7,800	300,000	3,450,000
F1	Water Plant 13	(120,000)	4,000	300,000	180,000
F3 E2 E3 E4 E5 D4	Water Plant 16	130,000	3,800	300,000	280,000
G1 G2	Water Plant 14	(450,000)	4,400	300,000	230,000
H1	Water Plant 15	450,000	2,500	300,000	450,000

Table 6-3. Fire Flow Capacity Evaluation – Pressure Zones Without Storage

Pressure Zone	PDD (gpm)	Pumping Capacity (gpm)	PDD Pumping Surplus (gpm)	Fire Flow Requirement (gpm)	Fire Flow Surplus/ (Shortfall) (gpm)
F2	217	2,000	1,783	1,000	783
G3	37	1,500	1,463	1,000	463
H2	110	1,950	1,838	1,000	838
H3	6	150	144	1,000	(856)
H4	1	1,500	1,499	1,000	499
I1	6	1,200	1,194	1,000	194

Fire Flow Model Simulations

The Storage and Pumping Capacity analysis, as just described, evaluated fire flow on a volumetric basis. A separate fire flow analysis was conducted using the EPS distribution model which has analytical tools to evaluate the hydraulic capability of the network to deliver fire flows. All fire flow simulations were performed under steady-state, PDD conditions which is an industry standard for performing fire flow simulations.

Fire flow analyses provide further insight into system performance by placing a large demand at a model node and simulating the residual pressure and available flow at that model node. Fire flow simulations were conducted for 457 nodes within the distribution system. For the purposes of this study, rather than identifying needed fire flow for existing buildings on individual parcels, the model evaluated the residential fire flow requirement of 1,000 gpm in all areas.

The model simulations validated the fire flow improvement identified in the Storage and Pumping Capacity evaluation (i.e. Zone H3), and also identified some additional fire flow problem areas. Fire flow improvement areas included:

1. B1 pressure zone located near Corbett Lane, due to insufficient fire flow through the existing PRV feed between the C2 and B1 pressure zones.
2. B1 pressure zone located on Rancho Sonora Drive, due to insufficient fire flow through the existing PRV feed between the C1 and B1 pressure zones.
3. C2 pressure zone located on Calle El Milagro, Bangalor Drive, and Calle Buena Vista in the Oro Valley Estates, located north of Linda Vista Boulevard, due to small diameter pipes feeding this area.
4. C4 pressure zone located on Stargazer Drive, due to insufficient fire flow through the existing PRV between the D1 and C4 pressure zones.
5. E1 pressure zone located in the Palisades neighborhood, due to an undersized pipe feeding this area and lack of looping.
6. E3 pressure zone located at La Reserve near the El Con storage reservoir, due to small diameter pipes feeding this area.
7. H3 pressure zone, due to insufficient pumping capacity at the Crimson Canyon booster station.

Pressure Evaluation

HDR evaluated daily average and minimum operating pressures across the distribution system. Daily average pressures were all within the acceptable range of 40 – 87 psi. Low pressures of less than 40 psi were observed during PDD conditions in the following locations:

i. Low suction pressures at the Woodburne E-Zone to F1-Zone booster station, located in pressure zone E1 north of Tangerine Road and west of Rancho Vistoso Boulevard, caused pump errors within the hydraulic model. This suggests that the low pressures may be causing pump cavitation. TOVWU has indicated that they have taken the Woodburne booster station off line due to performance issues and low pressures, which further validates the hydraulic model's ability to correctly simulate existing conditions. TOVWU is considering abandoning the Woodburne booster station and constructing a new E-Zone to F1-Zone booster station at the La Cañada storage reservoir.

ii. The northeast portion of the G1 pressure zone, primarily caused by high head loss in the transmission and distribution mains within the zone. The single 12-inch connection between the east and west portions of zone G1 is acting as a bottleneck, limiting the ability of the Water Plant 14 reservoir, located in the east portion of the zone, to sustain acceptable pressures in the west portion of the zone. Pressures in the west portion of pressure zone G1 may be increased by adding a dedicated storage reservoir serving that area, or by increasing the transmission capacity between the east and west portions of the zone. The 2006 *Potable Water Master Plan* included recommendations for the 2.0 MG Tortolita Storage Reservoir to be installed on the west portion of zone G1, but requires land to the north that may be acquired in the future as part of the Arroyo Grande Annexation. Without the annexation, there is no available land at sufficient elevation to install a new storage reservoir. Additionally, the cost of adding transmission capacity along Rancho Vistoso Boulevard would also be expensive, if installed only for the purposes of increasing minimum pressures in a small portion of zone G1. It is recommended that the Town monitor pressures in this area; however, no improvements are required at this time.

Transmission and Distribution Main Capacity

The base model result had a maximum observed velocity under PDD conditions of 7.59 fps, with no pipes having flow velocities above 10 fps. However, HDR identified multiple small sections of pipelines that had relatively high velocities and head loss under PDD conditions, but there were only three significant lengths that appeared to be problematic. These pipes were identified as having a total head loss in excess of 4-feet per 1,000-feet of pipe. This is a standard modeling metric for identifying pipes that are burning excessive head, sometimes at the expense of higher pumping pressures. In some situations, it may be more cost beneficial to replace these pipe segments compared to continued high pumping costs.

The three pipe locations included:

1. 12-inch pipe along Rancho Vistoso Boulevard connecting the east and west portions of pressure zone G1, as discussed in the Pressure Evaluation.
2. 8-inch pipe along Linda Vista Boulevard, west of Oracle Road.
3. 8-inch pipe along Palisades Road, east of First Avenue.

All three pipe segments flow under gravity conditions, and are not resulting in excessive pumping costs at any booster station or well sites. However, modeling results discussed in the Fire Flow Simulation and Pressure Evaluation sections indicate that all three pipe segments are associated with adjacent problem areas, probably exacerbated by the high head loss in these pipe sections.

At this time, HDR is not recommending the replacement or upsizing of these pipe segments. Instead, for the 12-inch pipe segment along Rancho Vistoso Boulevard, HDR recommends periodic monitoring of pressures in the northeast corner of pressure zone G1. For the 8-inch pipe along Linda Vista Boulevard, HDR recommends upsizing several of the 4-inch lines and adding hydrants within the neighborhoods served as a more cost effective means for improving fire flows. Similarly, for the 8-inch pipe along Palisades Road, HDR recommends adding looping to the Palisades neighborhood as a more cost effective means for improving fire flows.

Summary of Existing System Improvements

The hydraulic model simulation results indicate that the TOVWU system has adequate well supply, storage, pumping, and transmission capacity to meet PDD demands. The overall system performs well under PDD and PHD conditions, with only a small number of improvements observed. The few improvements noted were primarily related to insufficient fire flow due to small diameter pipes, undersized or insufficient number of PRVs, and undersized booster station pumps serving small pressure zone areas at higher elevations where there is no fire flow storage. A summary of the noted existing system improvements is provided below.

<u>Storage Shortfall:</u>

1. Pressure zones B, C, and D pressure zones have a combined storage shortfall of 670,000 gallons.
2. Pressure zone F1 has storage shortfall of 120,000 gallons.
3. Pressure zones F, G, H, and I have a combined storage shortfall of 650,000 gallons.

<u>Insufficient Pumping Capacity:</u>

4. H3 pressure zone has a pumping shortfall of 1,360 gpm.

<u>High Velocity/Head Loss and Low Pressure:</u>

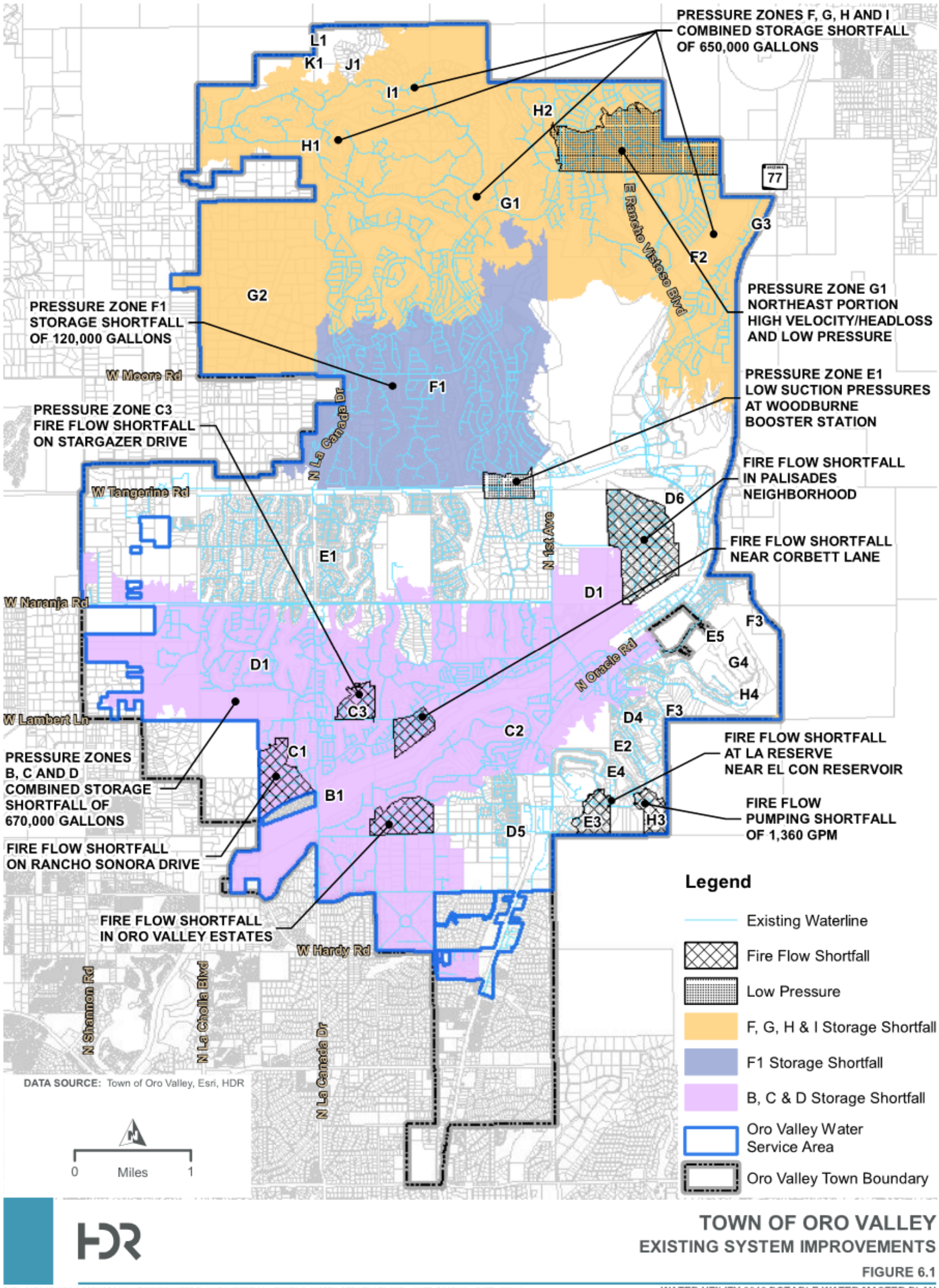
5. E1 pressure zone, Woodburne booster station.
6. G1 pressure zone, northeast portion of zone.

<u>Fire Flow Shortfall:</u>

7. B1 pressure zone located near Corbett Lane.
8. B1 pressure zone located on Rancho Sonora Drive.
9. C2 pressure zone in the Oro Valley Estates.
10. C4 pressure zone located on Stargazer Drive.
11. E1 pressure zone located in the Palisades neighborhood.
12. E3 pressure zone located at La Reserve near the El Con storage reservoir.

See Figure 6-1 for locations of the improvement areas.

Figure 6-1. Existing Improvements



6.3 Future System Sizing and Requirements

The future system includes new development areas and growth-related demands as discussed in Section 4. Additionally, the future system model includes NWRRDS delivery points and increasing amounts of delivered CAP water.

Well Supply Capacity

Based on current operations, TOVWU's preference is to retain their current ratio of well supply to PDD (approximately 1.18:1), as this provides them redundancy and flexibility to move water into lower and upper zones while maintaining their target storage levels. Well supply capacity was evaluated under future conditions to determine whether there was sufficient supply to meet future PDD. System-wide PDD under future conditions was compared to total and firm well pumping capacity in Table 6-4. The comparison shows that if all wells were to continue providing their current capacity, the total well supply capacity would continue to decline over time, with a 1,390 gpm shortfall by the end of Tier 3. To retain the current ratio of well supply to demand, additional well supply capacity would be required. To accommodate future growth, two new wells will be required. The proposed Nakoma Sky Well (Well D-10) will provide water supply for the Glover interconnected zone, and proposed Steam Pump Well (Well D-11) will provide water supply to the Water Plant 4/Allied Signal/Big Wash interconnected pressure zone.

Table 6-4. System Firm Well Capacity and Peak Day Demand

Planning Horizon	PDD (gpm)	Target Firm Well Pumping Capacity (gpm)	Firm Well Pumping Capacity Surplus/(Shortfall)
Existing	6,400	7,600	0
Tier 1	6,900	8,140	(540)
Tier 2	7,200	8,500	(900)
Tier 3	7,700	9,090	(1,390)

Storage and Fire Flow Capacity

HDR evaluated storage and pumping capacity for the future growth scenarios. The analysis is similar to that conducted for existing system, as reported in Table 6-1, except that the analysis used future ADDs. Table 6-5 shows the storage capacity surplus/shortfall in each interconnected pressure area by tier.

Table 6-5. Future Storage Capacity Evaluation

Interconnected Pressure Area	Tier 1	Tier 2	Tier 3
Naranja/Deer Run	(220,000)	(290,000)	(360,000)
Glover	(290,000)	(310,000)	(410,000)
El Conquistador	(290,000)	(290,000)	(320,000)
Water Plant 4/Allied Signal/Big Wash	1,320,000	1,310,000	1,300,000
High Mesa/La Cañada	2,540,000	2,430,000	2,390,000
Water Plant 13	(120,000)	(200,000)	(300,000)
Water Plant 14	(460,000)	(590,000)	(760,000)
Water Plant 15	450,000	450,000	360,000
Water Plant 16	120,000	90,000	60,000
Totals	**3,050,000**	**2,600,000**	**1,960,000**

The storage evaluation indicates that on a system-wide basis there continues to be a storage surplus. However, there is a spatial disparity in storage, with some interconnected pressure areas showing a storage shortfall. The areas with storage improvements are the same areas identified as part of the existing system analysis, namely:

i. Naranja/Deer Run, Glover, and El Conquistador interconnected pressure areas (pressure zones B, C, and D): the existing storage shortfall in this combined area will increase from 670,000 gallons to 1,090,000 gallons Tier 3.

ii. Water Plant 13 (pressure zone F1): the existing storage shortfall will increase from 120,000 gallons to 300,000 gallons by Tier 3.

iii. Water Plant 14 (pressure zones F, G, H, and I): the existing storage shortfall in this combined area will increase from 450,000 gallons to 760,000 gallons by Tier 3.

The future pumping capacity analysis is similar to that conducted for existing system, as reported in Table 6-2, except that the analysis used future ADDs. Table 6-6 shows the pumping capacity surplus/shortfall in each interconnected pressure area by tier.

Table 6-6. Future Fire Flow Capacity Evaluation – Pressure Zones With Storage

Interconnected Pressure Area	Tier 1	Tier 2	Tier 3
Naranja/Deer Run	30,000	30,000	30,000
Glover	98,000	98,000	98,000
El Conquistador	(83,000)	(83,000)	(83,000)
Water Plant 4/Allied Signal/Big Wash	1,290,000	1,270,000	1,260,000
High Mesa/La Cañada	3,180,000	3,070,000	3,030,000
Water Plant 13	180,000	180,000	180,000
Water Plant 14	230,000	230,000	230,000
Water Plant 15	450,000	450,000	360,000
Water Plant 16	270,000	250,000	220,000

The pumping capacity results do not vary significantly from the existing system results, though there is a slight decline in excess fire flow capacity due to increases in ADD. With the exception of the El Conquistador area, all interconnected pressure areas have fire flow capacity well above the required fire flow requirements. As previously discussed, the El Conquistador fire flow capacity of 1,800 gpm is still greater than the typical commercial fire flow requirement of 1,500 gpm.

Fire Flow Model Simulations

Using the model simulation procedure outlined in Section 6.2, no additional fire flow improvement areas were identified.

Pressure Evaluation

Using the model simulation procedure outlined in Section 6.2, no additional pressure improvement areas were identified.

Transmission and Distribution Main Capacity

The model simulation for Tiers 1, 2, and 3 returned maximum observed velocities of 6.55, 6.52, and 6.49 fps, respectively. The maximum velocity of existing conditions through Tiers 1-3 were reduced based on adding recommended PRVs to areas previously served by a single PRV. HDR identified insufficient transmission capacity between the eastern F2-Zone and western portions of F1-Zone. Currently, pressure zones F1 and F2 are isolated from one another, and the lack of interconnectivity requires flows to the northeast portion of the distribution system, i.e. pressure zone G1, be pumped from pressure zones F1 and F2, though TOVWU preferentially supplies G1 from the west (pressure zone F1). However, given the lack of sufficient transmission capacity along Rancho Vistoso Boulevard, pressure zone G1 experiences low pressures. By increasing transmission capacity between pressure zones F1 and F2 that would improve delivery capacity to zone G1 and would reduce the cost of pushing water supply to zone F2 from Water Plant 4 and the C-Zone wells as the distribution system is currently operated.

TOVWU has previously planned to interconnect the F1 and F2 zones through the construction of the Moore Road F-Zone interconnect pipeline. Various portions of that pipeline have been constructed over the years, but the pipeline is not yet complete. The hydraulic modeling results from this study underscore the importance of completing the Moore Road pipeline in the Tier 1 time frame given the Tier 2 growth projections in the F2 zone.

6.4 Northwest Recharge, Recovery and Delivery System

The NWRRDS is a partnership between the Town, Metropolitan Domestic Water Improvement District and the Town of Marana that will recover CAP water that has been stored in the Marana area for future potable distribution. The stored CAP water will be extracted using three recovery wells, transported to a shared forebay and booster station site located at Lambert Lane west of Twin Peaks Road, and from there, each water utility will boost their allocation to their service area. The projected timeline for the NWRRDS is design from 2018-2022, construction from 2020-2023 and it is intended to be fully operational by 2024.

TOVWU has identified approximately 20 separate NWRRDS projects that are anticipated to being in fiscal year (FY) 2018-2019 and continue through completion in 2024. The infrastructure improvements associated with TOVWU's portion of the NWRRDS project were provided by TOVWU and are summarized in Section 7 of this report. The Master Plan does include identifying infrastructure to integrate the NWRRDS deliveries into the distribution system.

Planned Improvements and Integration

The existing system will be modified to integrate CAP water deliveries into three new locations, one at Lambert Lane east of Shannon Road, the second at Tangerine Road east of Shannon Road, and the third at the La Cañada storage reservoir. Table 6-7 shows the approximate flow at each of the new locations based on the model results. In order to accommodate NWRRDS water into the existing system, improvements must be made. These improvements include an "E to C" PRV at Naranja Reservoir, an interconnect at Tangerine Road, and an interconnect at Lambert Lane. Figure 6-2 shows the existing CAP water delivery locations and the future CAP water delivery locations.

The integration of NWRRDS supply into the distribution system would occur during Tier 2 growth. To simulate the NWRRDS supply, HDR created steady state supply points at the three connection points, and inserted two sets of pipeline improvements within the model to facilitate the connections:

i. 8-inch and 12-inch pipelines on Shannon Road and La Cholla Boulevard to provide looping and distribution capacity at the Tangerine Road E-Zone connection point.

ii. 8-inch pipeline along Lambert Road from Shannon Road east to La Cañada Boulevard to provide a connection to the D-Zone.

HDR's Tier 2 hydraulic model simulations indicated that without any changes to the model, NWRRDS deliveries into the distribution system would result in overfilling the La Cañada storage reservoir. However, this situation was easily mitigated through modifying well pumping though a combination of turning off wells and changing the well set-points.

The reductions in well pumping due to NWRRDS under average day conditions are provided in Table 6-8. These results indicate that TOVWU's groundwater pumping could be reduced from 5,069 AFY currently to 2,300 AFY by Tier 3, after which time groundwater pumping will begin to rise again due to growth. However, under all planning scenarios the total groundwater pumping remains under the Town's target of 5,000 AFY.

Table 6-7. Future CAP Water Delivery Locations

Location	Flow (AFY)
La Cañada Reservoir	1,600
Tangerine Road	1,600
Lambert Lane	800
Total	**4,000**

Table 6-8. System Pumping Capacity with Peak Day Demand

Planning Horizon	ADD (AFY)	CAP Deliveries (AFY)	Well Supply (AFY)
Existing	6,260	1,842	5,069
Tier 1	6,710	2,205	4,510
Tier 2	7,050	4,800	2,300
Tier 3	7,520	4,800	2,760

Pipe Flow Direction and Flushing Program

HDR performed a pipe direction flow analysis as part of the EPS water quality simulations to identify which pipes had a change in flow direction due to the implementation of NWRRDS and anticipated change in flow patterns across the distribution system. The changes in flow patterns are due to higher volumes of water supply at the NWRRDS delivery locations, and reducing pumping from the groundwater wells. The analysis was performed for the change from Tier 1 to Tier 2 conditions after NWRRDS is complete. Figure 6-3 demonstrates areas of the system where change in pipe flow direction is expected. HDR recommends implementing a flushing program for the piping indicated in the Figure 6-3 to avoid water quality complaints by customers when the changes to the system are implemented.

Figure 6-2. CAP Delivery Points

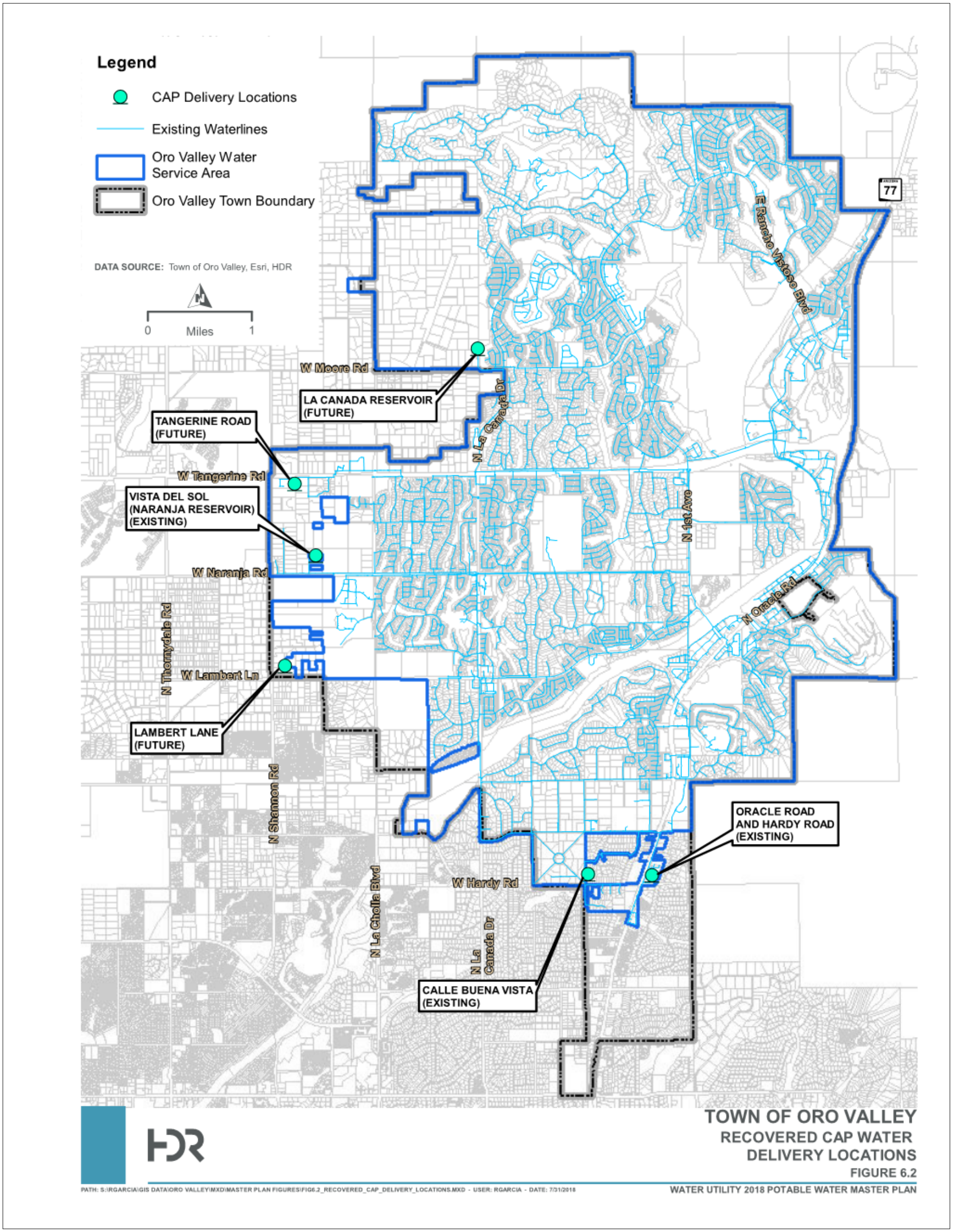
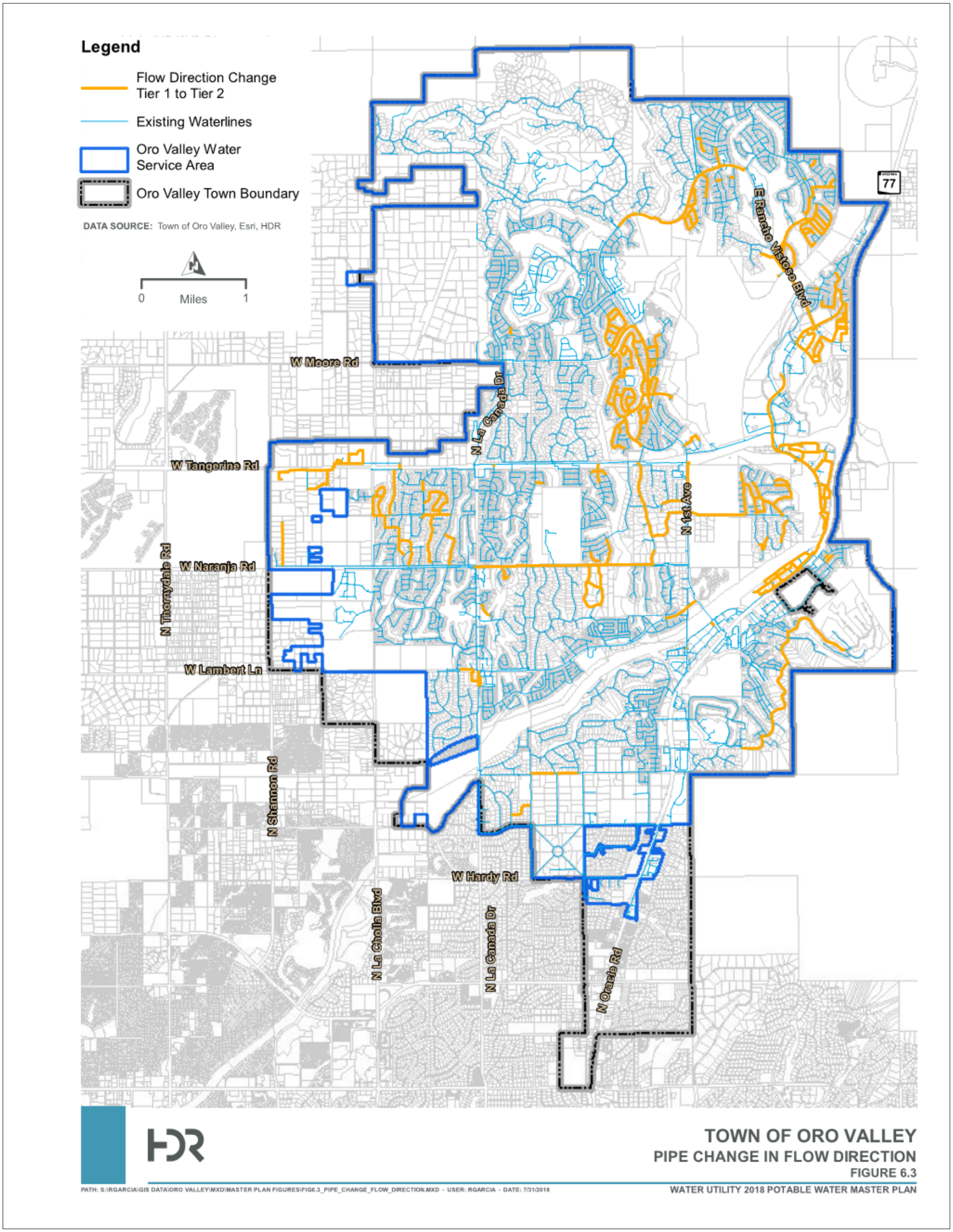


Figure 6-3. Pipe Change in Flow Direction



7. IIP Development

This section provides a more detailed description of specific infrastructure improvements and cost estimates required to address existing and future growth related improvements.

The objectives of this section are as follows:

- Summarize improvements to address existing system improvements;
- Summarize improvements to address Tier 1, 2, and 3 growth-related improvements;
- Summarize improvements to address NWRRDS integration;
- Summarize future improvements outside the Tier 3 planning horizon; and
- Provide cost estimates for the identified improvements.

7.1 Cost Projection Assumptions and Criteria

HDR provided budgetary level cost estimates based on IIP records from previous TOVWU projects. In 2015, TOVWU completed an IIP Cost Evaluation study that identified unit costs based on bid tabulations from 12 projects, which provided a large array of improvement costs. For the Master Plan, HDR used the unit costs from the IIP Cost Evaluation, adjusted by 2.5-percent annual inflation, as the basis for estimating budgetary-level infrastructure costs. HDR met and presented the infrastructure costs to TOVWU staff, who compared these costs to their projections, and the costs were adjusted based on a joint HDR/TOVWU review. The costs presented in Section 7.3 and in Tables 7.2 and 7.3 (Items 20 and 21 only) reflect the HDR/TOVWU derived costs. NWRRDS costs presented in Table 7.3 (Items 1 – 19) were prepared by TOVWU without HDR input.

7.2 Cost Allocations

The costs presented include three types of infrastructure improvements:

1. Existing system improvement projects. These projects are for the existing potable water system and will be financed from the utility's Operating Fund using revenue from water sales and groundwater preservation fees (Existing System Projects).
2. Expansion-related improvement projects. These projects will meet the demands of future growth and will be financed with the utility's PWSDIF.
3. The NWRRDS project is split between two demand classifications that will benefit from the project. A portion of the project (40%) will meet the demands of existing customers and will be financed from the utility's Operating Fund using the Existing Systems Projects. The remainder of the project (60%) will meet the demands of future growth and will be financed with the utility's AWRDIF, which is paid by new development for renewable water supply and infrastructure attributed to new growth.

   The partnered projects and independent TOVWU projects to support the NWRRDS were not evaluated as part of this project. HDR received costs from TOVWU which are summarized in the IIP cost tabulations (see Tables 7-2, 7-3, and 7-4), but the scope of those projects are not included in the project descriptions. HDR evaluated the distribution system improvements to receive NWRRDS supplies.

Table 7-1 identifies the IIP funding cost split for three types of improvement projects: Existing System, PWSDIF, and AWRDIF. Each of the water supply elements is discussed in more detail in the subsequent sections.

Table 7-1. IIP Funding Cost Split

	IIP Funding Cost Split	
Improvement Type	**Existing Customer**	**Growth-Related**
Existing Improvement Projects	100%	0%
PWSDIF-Related Projects	0%	100%
AWRDIF-Related Projects	40%	60%

7.3 Phased IIP Projects

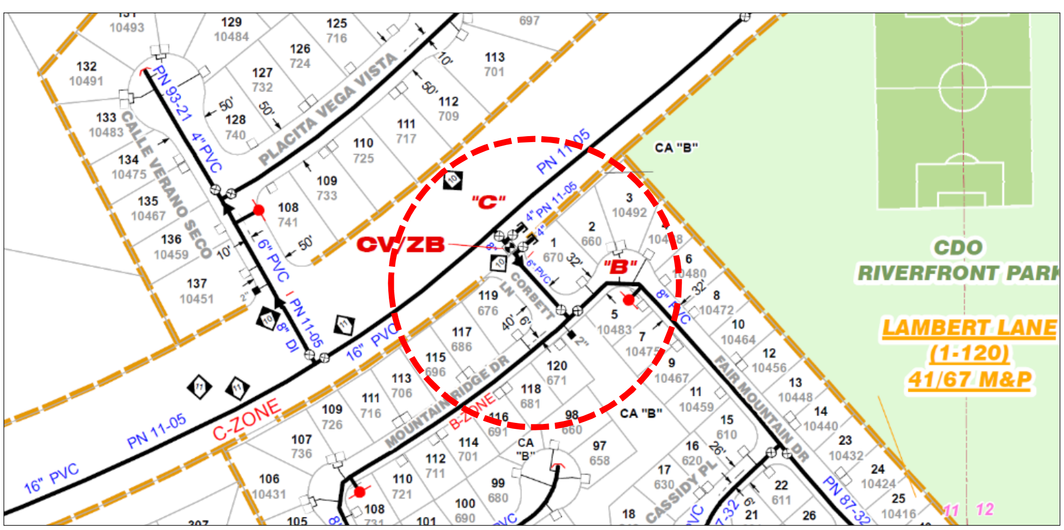
Description of Existing System Improvement IIP Projects

Improvement E-1: Pressure Zone B1 Fire Flow

There is observed low available fire flow northwest of the B1 pressure zone due to a single PRV feed to this area. The proposed 4-inch PRV between the C2 and B1 pressure zones, located on Corbett Lane, would add redundancy and increase the fire flow capacity.

Cost: $70,000

Figure 7-1. Improvement E-1: Pressure Zone B1 Fire Flow

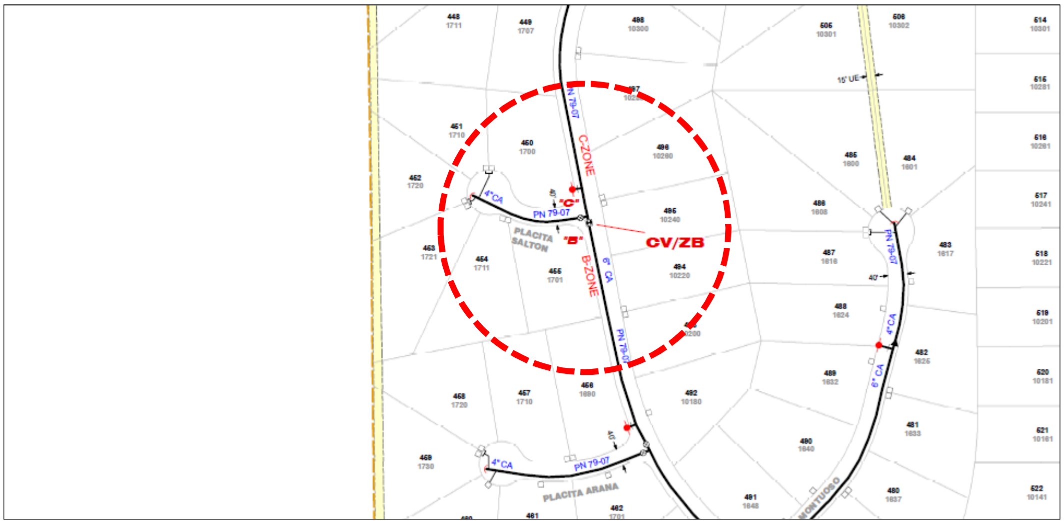


Improvement E-2: Pressure Zone C1 Fire Flow

There is limited available fire flow in the C1 pressure zone due to a single PRV feed to this area as well as insufficient distribution system looping. The proposed 6-inch PRV and redundant line between the C1 and B1 pressure zones, located on Rancho Sonora Drive, would add redundancy and fire flow to the area.

Cost: $70,000

Figure 7-2. Improvement E-2: Pressure Zone C1 Fire Flow

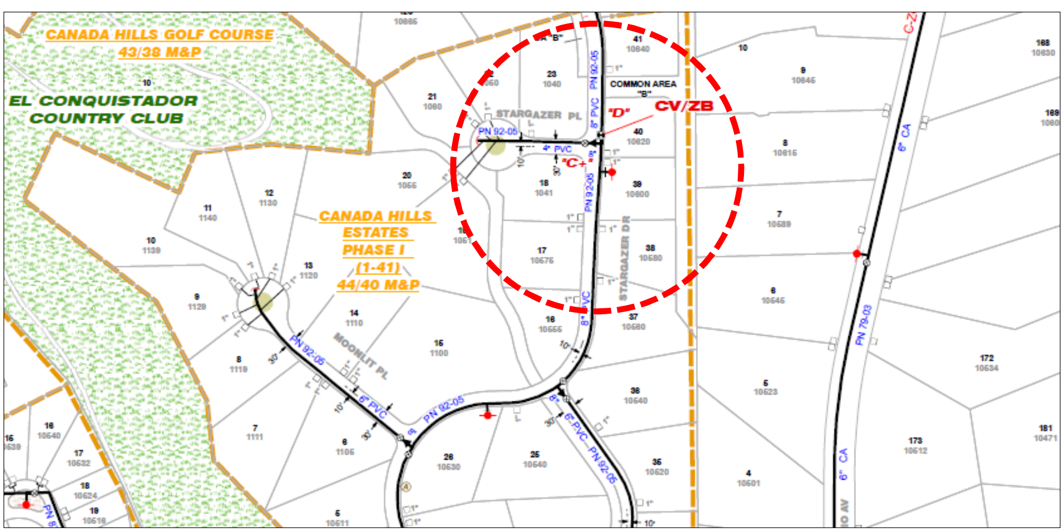


Improvement E-3: Pressure Zone C4 Fire Flow

There is observed low available fire flow in the C4 pressure zone due to a single PRV feed to this area as well as insufficient distribution system looping. The proposed 6-inch PRV between the D1 and C4 pressure zones, located on Stargazer Drive, would add redundancy and fire flow to the area.

Cost: $70,000

Figure 7-3. Improvement E-3: Pressure Zone C4 Fire Flow

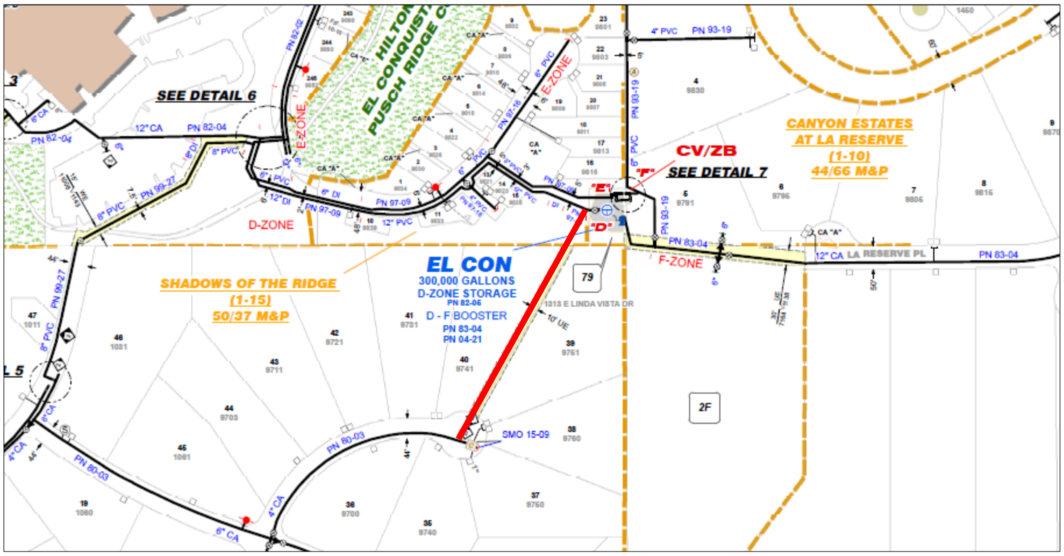


Improvement E-4: Pressure Zone I1 Fire Flow

There is low available fire flow in the E3 pressure zone due to a single PRV feed to this area as well as insufficient distribution system looping. The proposed 4-inch PRV and redundant 6-inch PVC C900 line in the E3 pressure zone, located at La Reserve near the El Conquistador storage reservoir, would add redundancy and fire flow to the area.

Cost: $100,000

Figure 7-4. Improvement E-4: Pressure Zone I1 Fire Flow

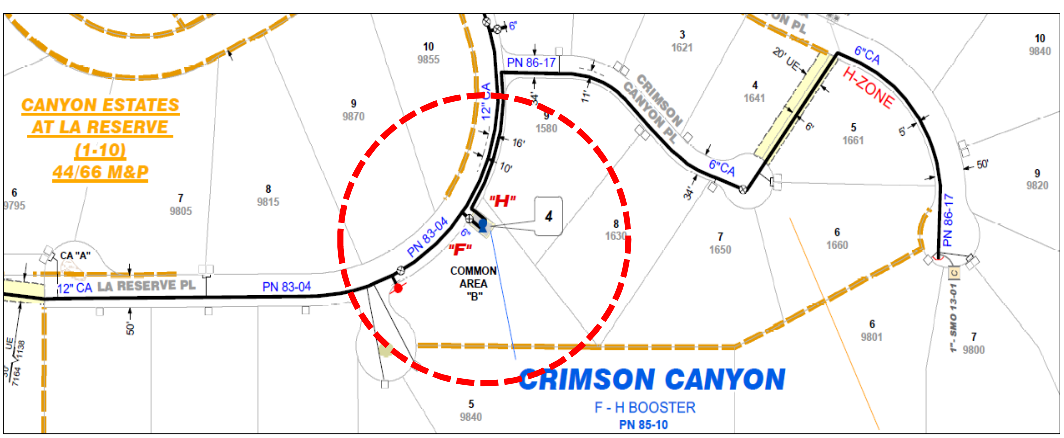


Improvement E-5: Pressure Zone H3 Fire Flow

The current booster station is unable to meet the required capacity of 1,000 gpm for a duration of 2 hours. The proposed 1,000 gpm booster station pump and appurtenances in the H3 pressure zone, located in the Crimson Canyon Booster Station at La Reserve, would increase pump capacity to the existing booster station.

Cost: $250,000

Figure 7-5. Improvement E-5: Pressure Zone H3 Fire Flow

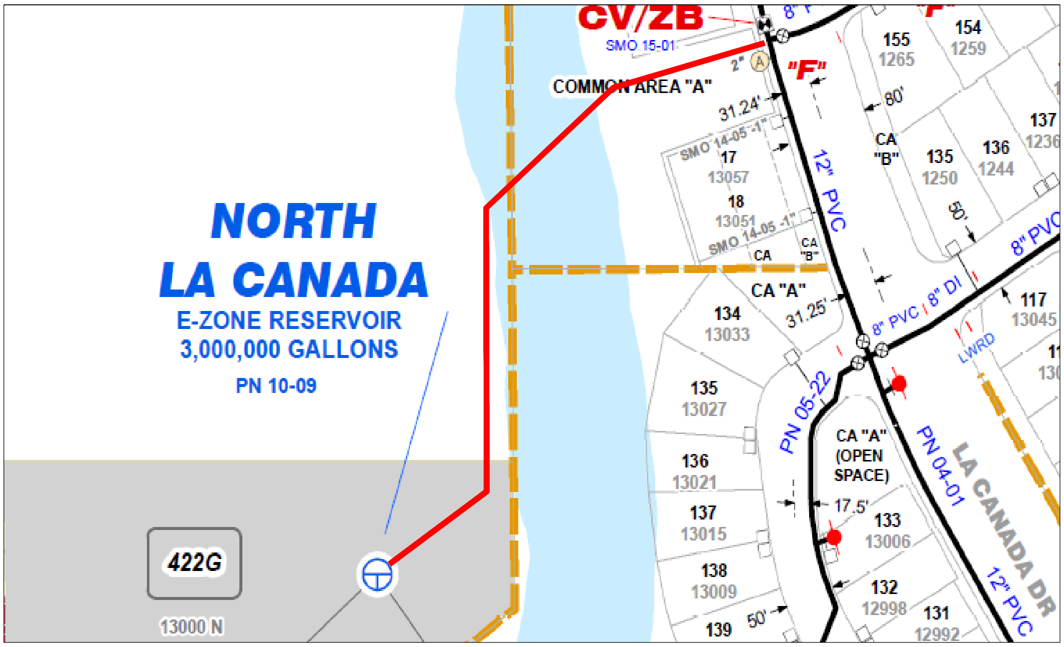


Improvement E-6: Zone E-F Booster Station at La Cañada

The Woodburne E-F booster station experiences lows suction pressures and is no longer in operation. A proposed 2,000 gpm booster station and 12-inch PVC C900 in pressure zone F1, located at the La Cañada storage reservoir, would replace the Woodburne Booster Station.

Cost: $600,000

Figure 7-6. Improvement E-6: Zone E-F Booster Station at La Cañada

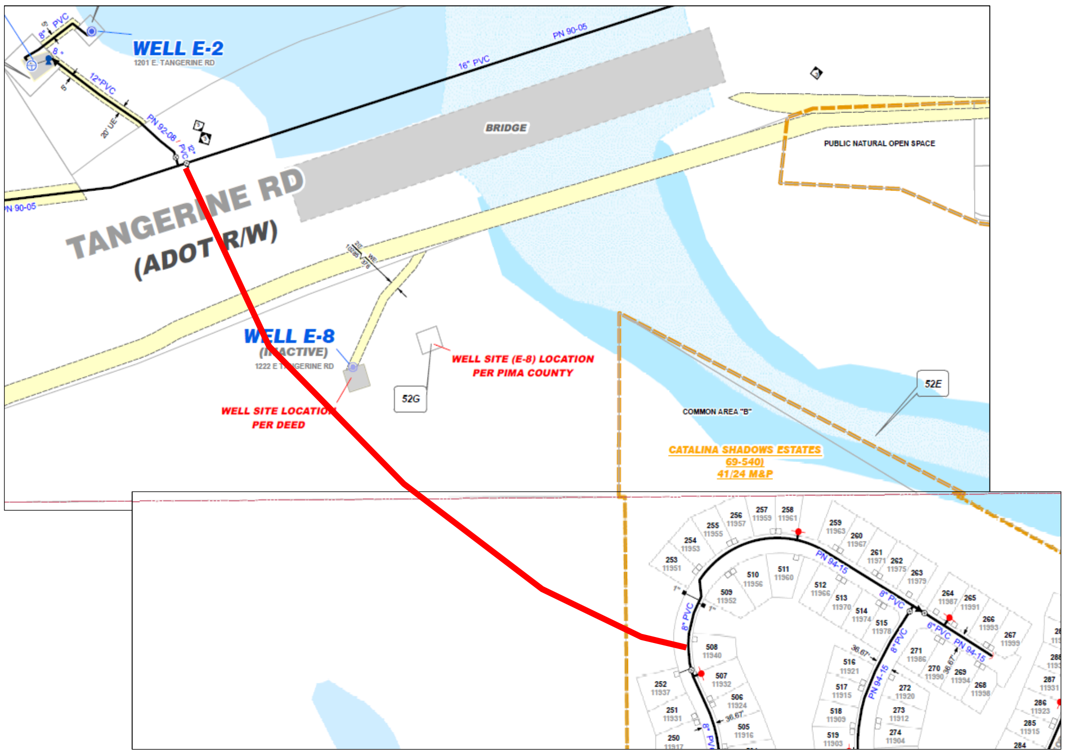


Improvement E-7: Palisades Fire Flow

The single main to the Palisades neighborhood in pressure zone E1 limits fire flow to the area with no redundancy or distribution looping to this area. The proposed 8-inch PVC C900 pipeline, located from Tangerine Road to Labyrinth Drive, would add a redundant connection to the Palisades Neighborhood.

Cost: $550,000

Figure 7-7. Improvement E-7: Palisades Fire Flow

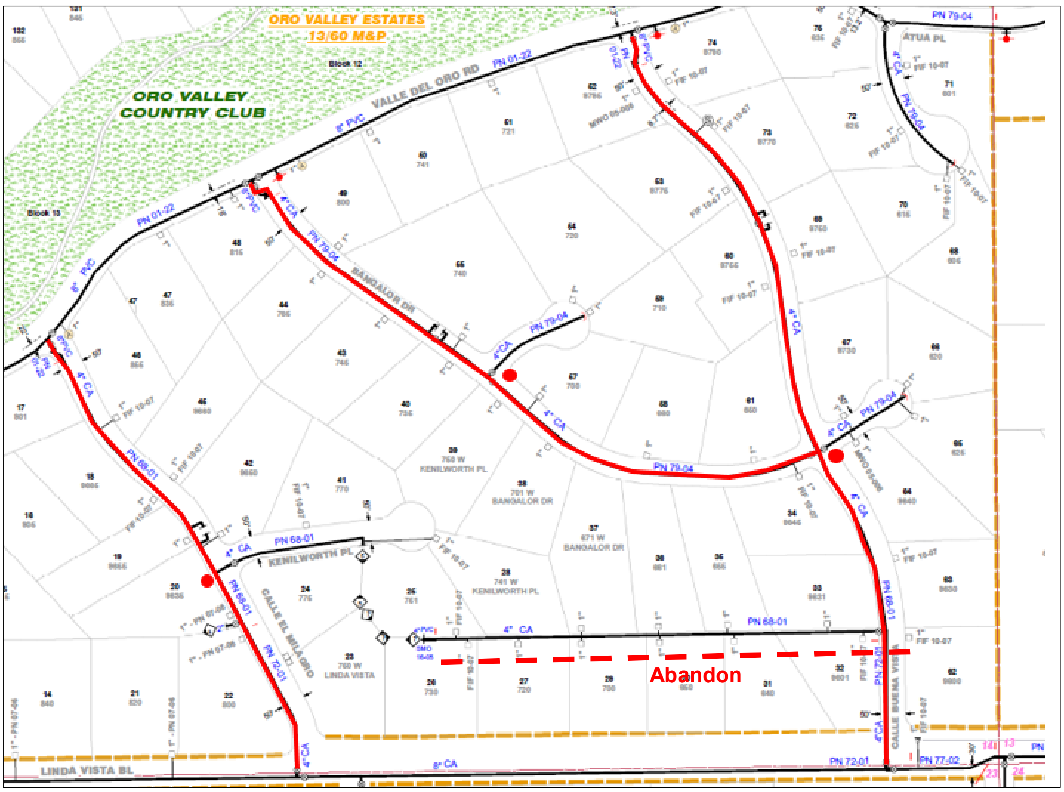


Improvement E-8: Oro Valley Estates Fire Flow

There is insufficient fire flow in Oro Valley Estates north of Linda Vista Boulevard due to of undersized lines and inadequate number of fire hydrants. The proposed upsizing of the existing mains from 4-inch to 8-inch C900 and installation of three additional hydrants, located on Calle El Milagro, Bangalor Drive, and Calle Buena Vista in the Oro Valley Estates, would add increased fire flow and hydrant availability to the neighborhood. Additionally, to coincide with these improvements, the existing 4-inch asbestos cement pipe would be abandoned in favor of new customer connection points coming from the proposed lines.

Cost: $750,000

Figure 7-8. Improvement E-8: Oro Valley Estates Fire Flow

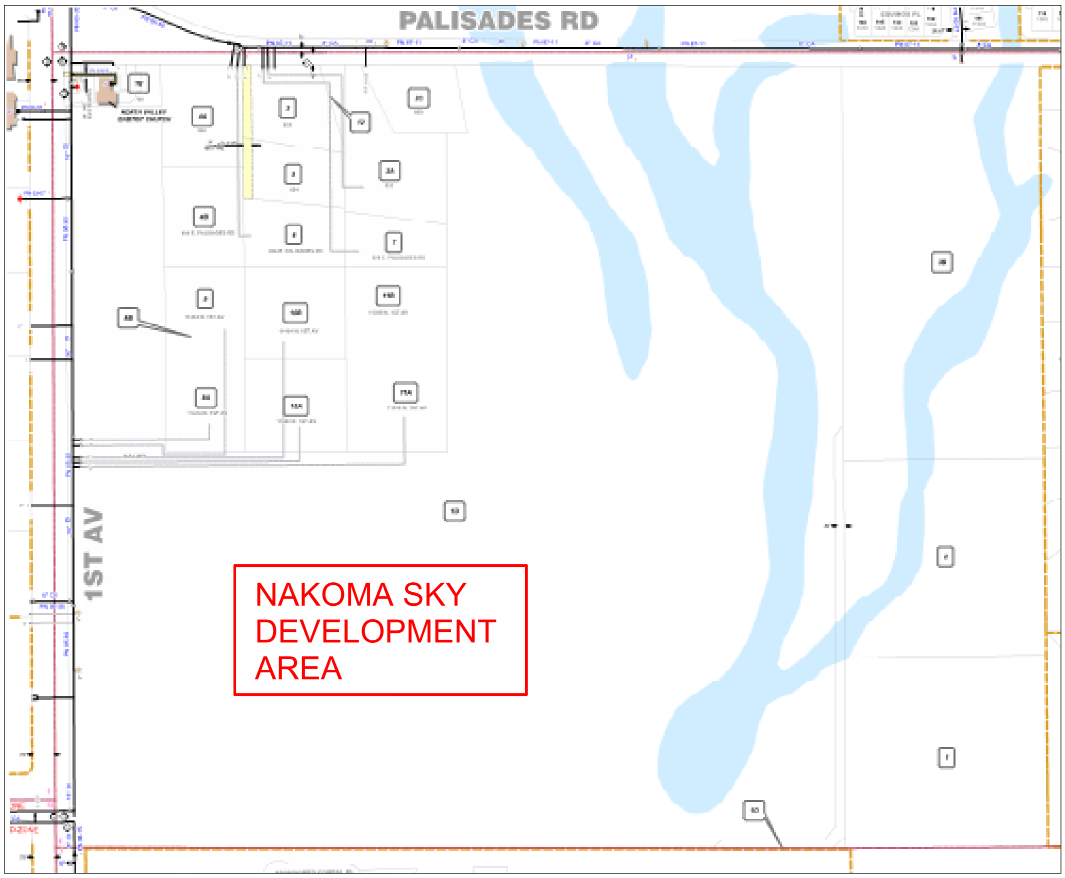


Improvement E-9: Nakoma Sky D-Zone Well (Well D-10)

The proposed Nakoma Sky well would provide water supply to accommodate ongoing development growth in the Glover interconnected pressure area. The new well will be located in the Nakoma Sky development, would supply pressure zone D1.

Cost: $1,500,000

Figure 7-9. Improvement E-9: Nakoma Sky D-Zone Well



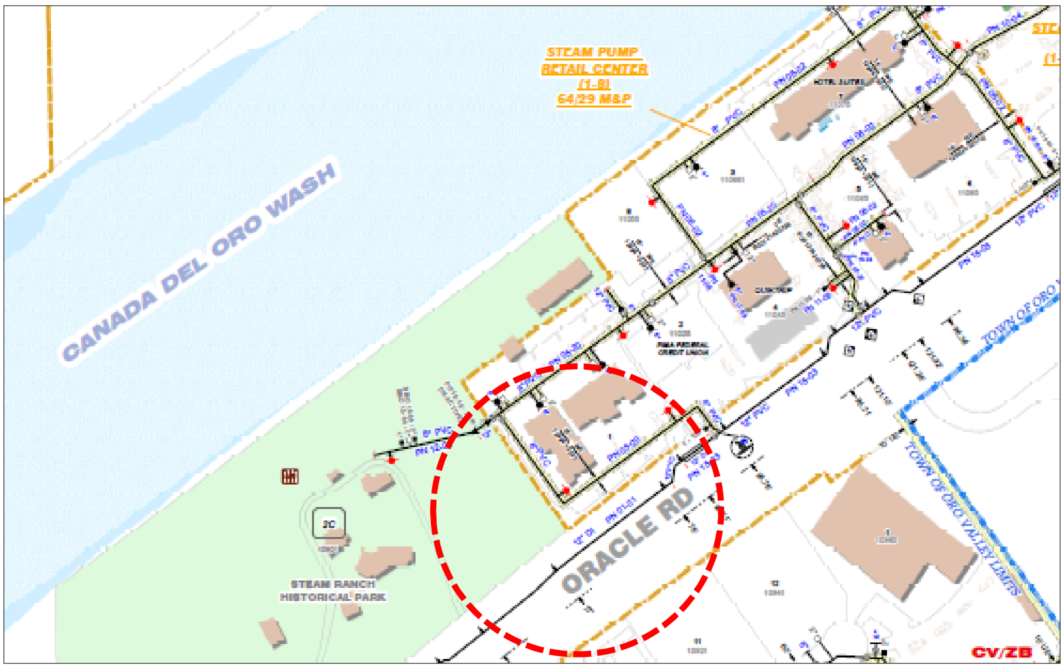
Description of Growth Related IIP Projects

Improvement G-1: Steam Pump D-Zone Well (Well D-11)

Steam Pump well, to be located at the historic Steam Pump Ranch, would provide water supply to meet future growth in zone D6, which is the Water Plant 4/Allied Signal/Big Wash interconnected pressure area.

Cost: $1,500,000

Figure 7-10. Improvement G-1: Steam Pump D-Zone Well

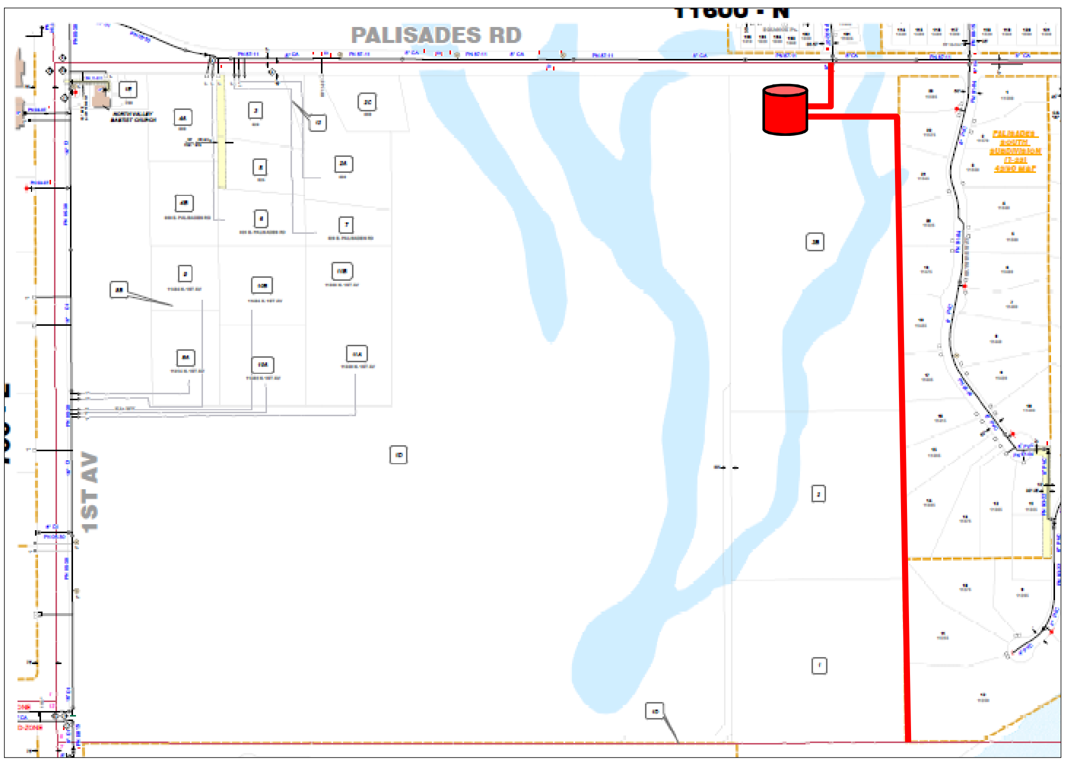


Improvement G-2: Palisades Storage Tank, Pipeline, and C-E Booster Station

There is a lack of available reservoir sites in the B1, C2, and C3 pressure zones that are currently served by the Naranja, Deer Run, Glover, and El Conquistador storage reservoirs. The Palisades storage reservoir would supplement the combined storage of these areas to achieve a volume equal or greater to the recommended 125 percent of ADD. The proposed 1 MG Palisades storage tank and 16-inch PVC C900 transmission main, located in the Palisades Subdivision, would directly supply pressure zone C, with a C-E booster station.

Cost: $4,250,000

Figure 7-11. Palisades Storage Tank, Pipeline, and C-E Booster Station

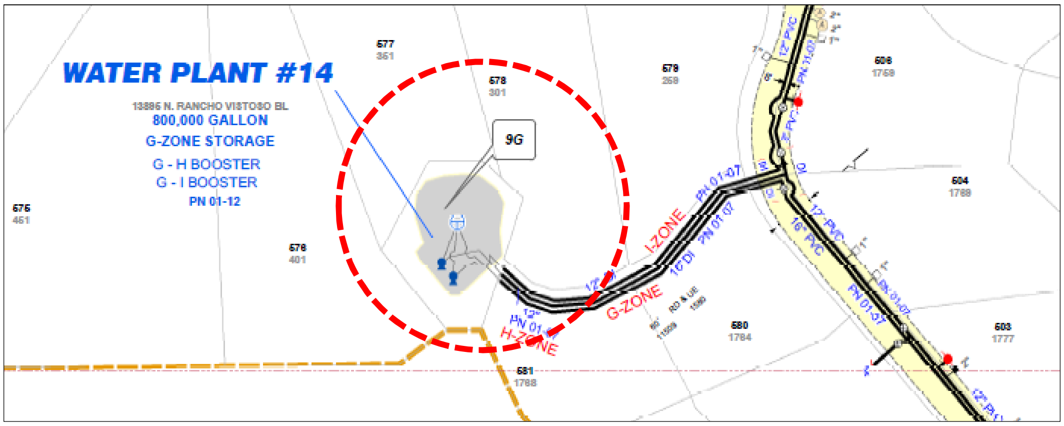


Improvement G-3: Pressure Zone I1 Fire Flow

The fire flow in pressure Zone I1 is below 1,000 gpm due to both lack of sufficient pumping capacity and an undersized 8-inch distribution main that supplies the zone. Two additional pumps at the G-I booster station located at Water Plant 14 would increase pump capacity by 500 gpm.

Cost: $250,000

Figure 7-12. Improvement G-3: Pressure Zone I1 Fire Flow

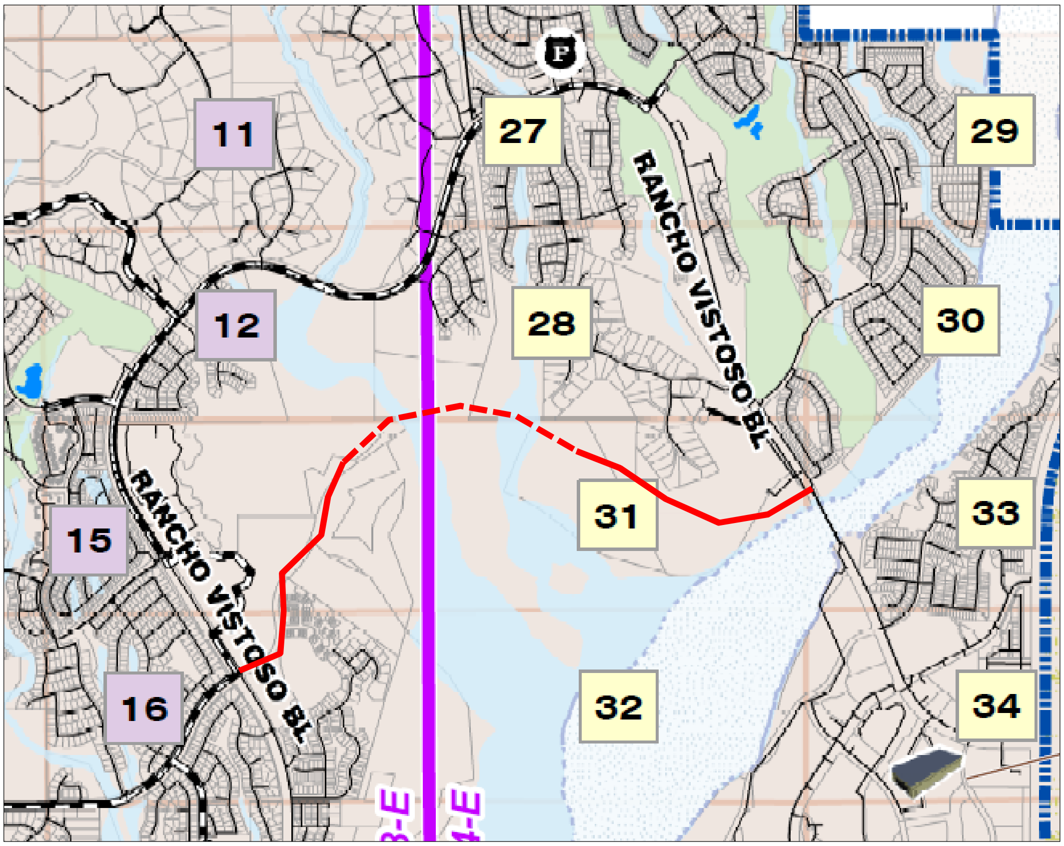


Improvement G-4: Moore Road F-Zone Interconnect Pipeline

The total storage for the system is less than the recommended 125 percent of ADD. The proposed 16-inch C900 interconnect, located along Moore Road, will improve flow through the zone but insufficient storage. Portions of the pipeline have already been constructed, and approximately one mile remains to be completed.

Cost: $750,000

Figure 7-13. Improvement G-4: Moore Road F-Zone Interconnect Pipeline



Improvement G-5: Pressure Zone G, H, and I Storage Expansion

The total storage for pressure zones G1, G2, H2, and I1 is less than 125 percent of ADD and 0.5 MG additional storage is recommended. There is no available space at Water Plant 14 to accommodate a new storage reservoir. The proposed G-1 booster station pumps located at Water Plant 14 would supply a 0.5 MG storage reservoir located within the future Arroyo Grande Annexation at a future location to be determined.

Cost: $4,000,000

Improvement G-6: Pressure Zone G Storage Expansion

The northeast portion of pressure zone G2 has low pressure due to limited transmission capacity from Water Plant 14. Additionally, the available storage at Water Plant 14 does not provide 125 percent of ADD to its service area. The proposed new 2 MG storage tank and 16-inch DIP pipeline located at the future Arroyo Grande Annexation, at a future location to be determined, would increase storage capacity and improve pressures to the northeast portion of pressure zone G2.

Cost: $8,000,000

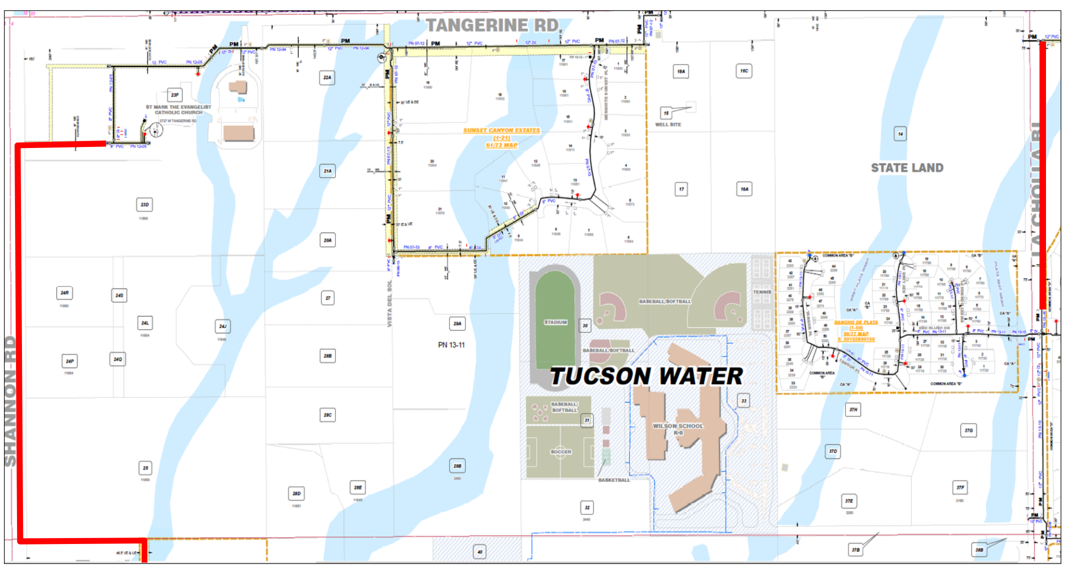
Distribution System Improvements to Receive NWRRDS Supplies

Improvement F-1: NWRRDS Interconnection to Tangerine Road

The NWRRDS will connect to the TOVWU distribution system at Tangerine Road. Additional transmission capacity and looping near the connection point will improve the transmission capacity within the vicinity of the connection point. New 8-inch and 12-inch PVC C900 transmission mains are recommended, located on Shannon Road and La Cholla Boulevard.

Cost: $450,000

Figure 7-14. NWRRDS Interconnection to Tangerine Road

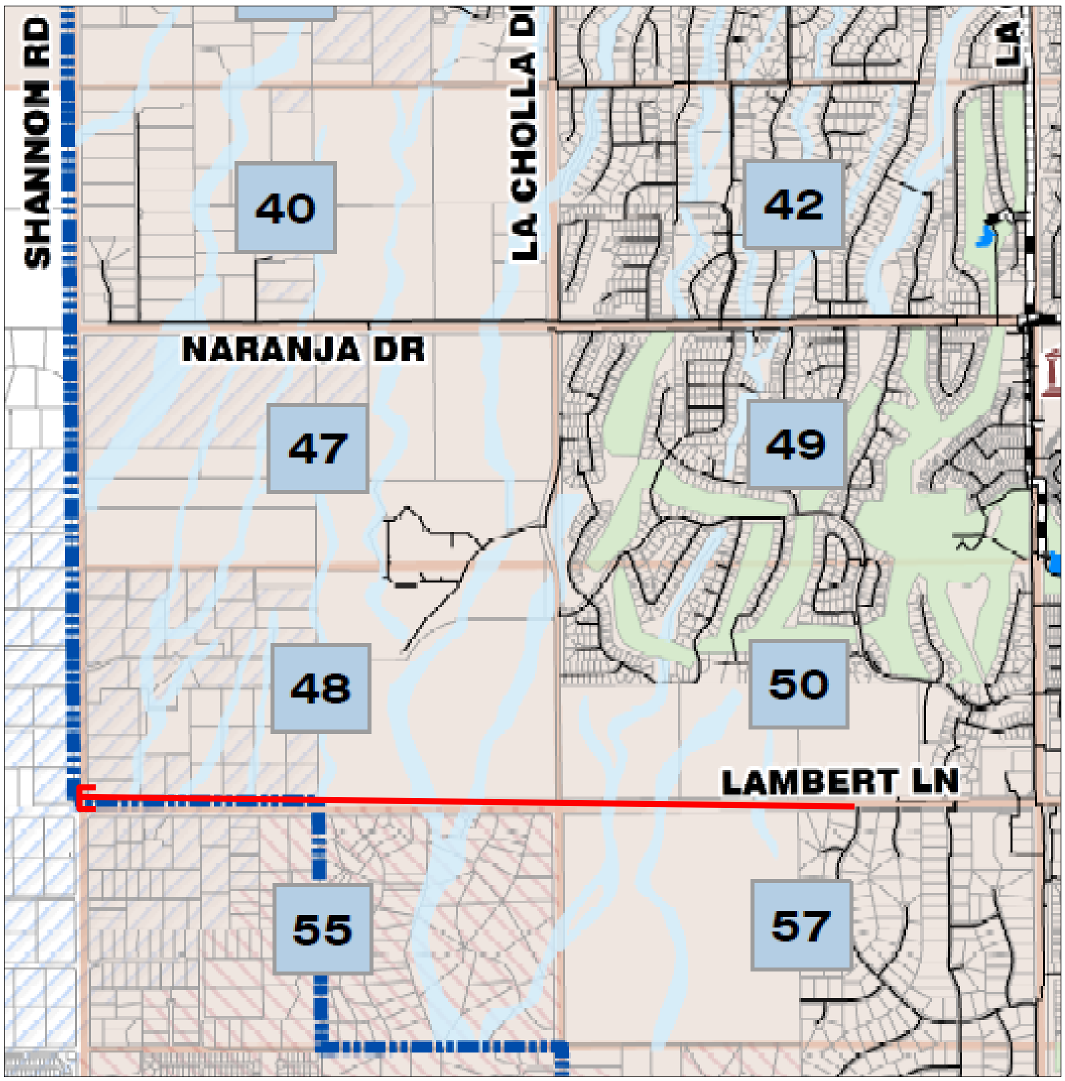


Improvement F-2: NWRRDS Interconnection to Lambert Lane

The NWRRDS will connect to the TOVWU distribution system at Lambert Lane. A transmission pipeline from the connection point will convey water to pressure zone D. A new 8-inch PVC C900 transmission main is recommended, located on Lambert Road from Shannon Road and La Cañada Boulevard.

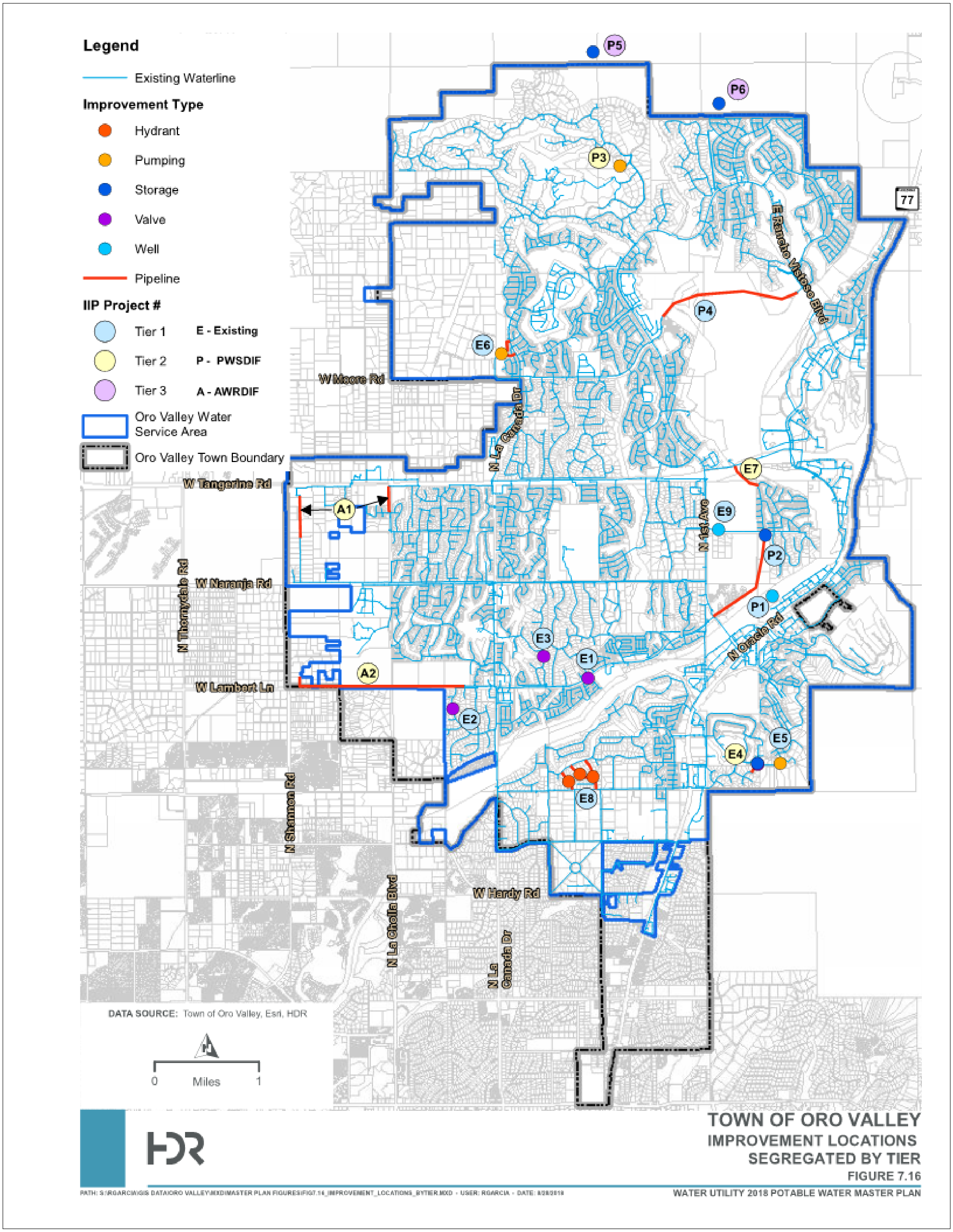
Cost: $850,000

Figure 7-15. NWRRDS Interconnection to Lambert Lane



Improvements E-1 thru E-9, G-1 thru G-6, and F-1 and F-2, are shown in Figure 7-16.

Figure 7-16. Proposed Infrastructure Improvements, by Tier



Summary of IIP Costs

Table 7-2. Summary of IIP Costs by Tier

Phase	Improvement	Description	Total Cost
Tier 1	E-1	4-inch PRV on Corbett Lane	**$70,000**
	E-2	6-inch PRV on Rancho Sonora Drive	**$70,000**
	E-3	6-inch PRV on Stargazer Drive	**$70,000**
	E-5	Booster Pump at Crimson Canyon Booster Station	**$250,000**
	E-6	E-F Booster Station at La Cañada Reservoir	**$600,000**
	E-8	Oro Valley Estates Main Replacement and New Hydrants	**$750,000**
	E-9	Nakoma Sky D-Zone Well	**$1,500,000**
	G-1	Steam Pump D-Zone Well	**$1,500,000**
	G-2	Palisades C-Zone Storage Tank and Pipeline	**$4,250,000**
	G-4	Moore Road F-Zone Interconnect Pipeline	**$750,000**
		Tier 1 Sub-Total	**$9,810,000**
Tier 2	E-4	4-inch PRV and 6-inch Pipeline at La Reserve	**$100,000**
	E-7	Palisades Neighborhood Pipeline Redundancy	**$550,000**
	G-3	Water Plant 14 Booster Capacity Expansion	**$250,000**
	F-1	NWRRDS Interconnect to Tangerine Road	**$450,000**
	F-2	NWRRDS Interconnect to Lambert Lane	**$850,000**
		Tier 2 Sub-Total	**$2,200,000**
Tier 3	G-5	Pressure Zone G, H, and I Storage Expansion	**$4,000,000**
	G-6	Pressure Zone G Storage Expansion	**$8,000,000**
		Tier 3 Sub-Total	**$12,000,000**
		Tier 1-3 Total	**$24,010,000**

7.4 NWRRDS Cost Projections

Table 7-3. NWRRDS Cost By Projects

Project No.	Project Name	NWRRDS OVWU Total Cost
	NWRRDS (Partnered Projects)	
1	Program Management Support Services	**$1,750,000**
2	Well Improvement Analysis and Recovery Permits	**$100,000**
3	Well Drilling and Testing	**$585,000**
4	Construction Permitting, Drilling, Development, and Testing	**$1,950,000**
5	Well Equipping Design and Site Improvements	**$975,000**
6	Pipeline Design (Recovered Water and Transmission)	**$1,101,154**
7	Pipeline Construction	**$4,404,616**
8	NWRRDS Forebay Design	**$165,385**
9	NWRRDS Forebay Reservoir Construction	**$660,386**
	Sub-Total for NWRRDS Project Numbers 1-9	**$11,691,541**
	NWRRDS (Independent Projects)	
10	Pipeline Route Study and Preliminary Design (9.68 Miles)	**$200,000**
11	Shannon Road Forebay Reservoir and Booster Station Property Acquisition	**$200,000**
12	Pipeline Easement Acquisition (9.68 Miles)	**$750,000**
13	Pipeline Design (9.68 Miles of 16-inch DIP)	**$1,400,000**
14	NWRRDS Forebay Reservoir Booster Station Design	**$100,000**
15	Shannon Road Forebay Reservoir and Booster Station Design	**$300,000**
16	Booster Station Construction at NWRRDS Forebay Reservoir	**$500,000**
17	Shannon Road Forebay Reservoir Construction	**$1,400,000**

Project No.	Project Name	NWRRDS OVWU Total Cost
18	Booster Station Construction at Shannon Road Forebay Reservoir	**$500,000**
19	Pipeline Construction from Booster Station at NWRRDS to La Cañada Reservoir	**$9,800,000**
	Sub-Total for NWRRDS project numbers 10-19	**$15,150,000**
	Total for All NWRRDS Project 1-19	**$26,841,541**
	Internal System Improvement to Convey NWRRDS Water in OVWU System	
20	NWRRDS Interconnection to Tangerine Road	**$450,000**
21	NWRRDS Interconnection to Lambert Lane	**$850,000**
	Sub-Total for NWRRDS Project Numbers 20-21	**$1,300,000**
	Total for All NWRRDS Project 1-21	**$28,141,541**

7.5 Cost Summary

Table 7-4. Cost Summary of All Projects

Project No.	Project Description	Cost Split		Tier 1 (0-5 Years)					Tier 2 (5-10 Years)					Tier 3 (10+ Years)
		Existing Customers	Growth Related	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	2025-2026	2026-2027	2027-2028	2028+
	Existing Improvement Projects - HDR Identified													
E-1	4-inch PRV on Corbett Lane	100%	0%	$70,000										
E-2	6-inch PRV on Rancho Sonora Drive	100%	0%			$70,000								
E-3	6-inch PRV on Stargazer Drive	100%	0%				$70,000							
E-4	4-inch PRV and 6-inch Pipeline at La Reserve	100%	0%							$100,000				
E-5	Booster Pump at Crimson Canyon Booster Station	100%	0%				$250,000							
E-6	E-F Booster Station at La Cañada Reservoir	100%	0%		$100,000	$500,000								
E-7	Palisades Neighborhood Pipeline Redundancy	100%	0%							$550,000				
E-8	Oro Valley Estates Main Replacement and New Hydrants	100%	0%			$250,000	$250,000	$250,000						
E-9	Nakoma Sky D-Zone Well	100%	0%	$1,500,000										
	Growth Related Projects - HDR Identified													
G-1	Steam Pump D-Zone Well	0%	100%	$700,000	$800,000									
G-2	Palisades C-Zone Storage Tank and Pipeline	0%	100%		$500,000	$300,000	$1,450,000	$2,000,000						
G-3	Water Plant 14 Booster Capacity Expansion	0%	100%							$250,000				
G-4	Moore Road F-Zone Interconnect	0%	100%			$750,000								
G-5	Pressure Zone G, H, and I Storage Expansion	0%	100%											$4,000,000
G-6	Pressure Zone G Storage Expansion	0%	100%											$8,000,000
	NWRRDS (Partnered Projects)													
1	Program Management Support Services	40%	60%	$400,000										
		40%	60%		$110,000									
		40%	60%			$480,000								
		40%	60%				$740,000							
		40%	60%					$20,000						
			Sub-Totals	**$2,670,000**	**$1,510,000**	**$2,350,000**	**$2,760,000**	**$2,270,000**	**$0**	**$900,000**	**$0**	**$0**	**$0**	**$12,000,000**

Project No.	Project Description	Cost Split		Tier 1 (0-5 Years)					Tier 2 (5-10 Years)					Tier 3 (10+ Years)
		Existing Customers	Growth Related	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	2025-2026	2026-2027	2027-2028	2028+
2	Well Improvement Analysis and Recovery Permits	40%	60%		$100,000									
3	Well Drilling and Testing	40%	60%			$585,000								
4	Construction Permitting, Drilling, Development, and Testing	40%	60%					$1,950,000						
5	Well Equipping Design and Site Improvements	40%	60%					$975,000						
6	Pipeline Design (Recovered Water and Transmission)	40%	60%		$1,101,154									
7	Pipeline Construction	40%	60%				$2,202,308	$2,202,308						
8	NWRRDS Forebay Design	40%	60%		$165,385									
9	NWRRDS Forebay Reservoir Construction	40%	60%				$330,193	$330,193						
	NWRRDS (Independent Projects)													
10	Pipeline Route Study and Preliminary Design (9.68 Miles)	40%	60%	$200,000										
11	Shannon Road Forebay Reservoir and Booster Station Property Acquisition	40%	60%		$200,000									
12	Pipeline Easement Acquisition (9.68 Miles)	40%	60%		$750,000									
13	Pipeline Design (9.68 Miles of 16-inch DIP)	40%	60%		$1,400,000									
14	NWRRDS Forebay Reservoir Booster Station Design	40%	60%		$100,000									
15	Shannon Road Forebay Reservoir and Booster Station Design	40%	60%			$300,000								
16	Booster Station Construction at NWRRDS Forebay Reservoir	40%	60%				$500,000							
17	Shannon Road Forebay Reservoir Construction	40%	60%					$700,000	$700,000					
18	Booster Station Construction at Shannon Road Forebay Reservoir	40%	60%					$250,000	$250,000					
19	Pipeline Construction from Booster Station at NWRRDS to La Cañada Reservoir	40%	60%						$9,800,000					
	Internal System Improvement to Convey NWRRDS Water in OVWU System													
20	NWRRDS Interconnect to Tangerine Road	40%	60%						$450,000					
21	NWRRDS Interconnect to Lambert Lane	40%	60%						$850,000					
			Totals	**$2,870,000**	**$5,326,539**	**$3,235,000**	**$5,792,501**	**$8,677,501**	**$12,050,000**	**$900,000**	**$0**	**$0**	**$0**	**$12,000,000**

8. Recommendations

The TOVWU distribution system performs at a high level of service, meeting the demands of existing customers while also providing operational flexibility and resiliency due to redundancy in water supply, storage, and pumping capacity. Hydraulic model analysis found only minor improvements related to fire flow capacity in a few, small areas. Through previous master planning efforts, TOVWU has proactively implemented projects that are consistent with future growth and the anticipated integration of CAP water deliveries. In this regard, the existing distribution system pipe network has been adequately sized to meet current and future demands, and TOVWU is well positioned to accommodate future growth and CAP water deliveries through the NWRRDS system with only minimal upgrades to the distribution system. HDR identified a small number of infrastructure projects that will improve the distribution system under future growth conditions.

8.1 Summary of Improvements

HDR identified nine improvement projects for the existing distribution system totaling $3.96M in expenditures over the next seven years. Seven of the existing system improvements are related to fire flow, and four of these projects only require the installation of PRV stations. The relocation of the existing E-F booster station from Woodburne to the La Cañada storage reservoir is the most significant existing system improvement due to low available suction pressures in the upper E pressure zone. Other existing system improvements include upsizing pipes and adding hydrants in Oro Valley Estates where the original pipe network was undersized, and completing the Nakoma Sky well as part of an ongoing residential development project.

HDR identified four growth related improvement projects totaling $6.75M in expenditures, also over the next seven years. These projects include a combination of storage, pumping, and pipe transmission capacity, as well as a new well (Steam Pump) to meet future growth demands in the D6 pressure zone area. Two additional growth related projects were also identified 15+ years into the future for increased storage capacity in the northern G and I zones, contingent on the Arroyo Grande Annexation.

TOVWU has identified 19 projects supporting the NWRRDS project. HDR did not evaluate these projects as part of this study, but did investigate modifications to the TOVWU distribution system to integrate the NWRRDS deliveries. HDR identified two pipeline projects totaling $1.30M that would be required to accommodate NWRRDS direct connection points to the D and E pressure zones.

8.2 NWRRDS Integration

The NWRRDS program will deliver 4,000 AFY of CAP water to the TOVWU distribution system beginning in 2024. Required modifications to integrate NWRRDS into the distribution system include two pipeline projects to provide direct connection points to the D and E pressure zones, as well as operational changes to reduce groundwater well pumping. The operational changes related to reducing well supply include both retiring existing wells and changing the well start/stop set-points to reduce the daily supply volume from individual wells. The anticipated reduction in total groundwater well supply is approximately 2,000 AFY by 2024. After NWRRDS is integrated, the total well supply will drop to less than 2,300 AFY which is well below the Town's policy limitation of 5,000 AFY maximum groundwater extractions.

The transition to NWRRDS from current groundwater wells plus CAP water deliveries from the Tucson Water distribution system will result in a significant change in the bulk transmission of water across the distribution system. The existing system supply is well dominated, with the majority of wells located at lower elevations in the C and D pressure zones along the Canyon del Oro wash corridor, generally in the southeast quadrant of the distribution system. Given the locations of the existing wells, water supply is pumped from the C and D zones into the higher pressure zones. Following NWRRDS integration, bulk water supply will originate in the D and E pressure zones along the western half of the distribution system. The available interconnectivity and booster capacity between pressure zones supports the transition from current well supply to NWRRDS supply with only a few infrastructure improvements, although there will be a significant shift in flow patterns. HDR recommends that TOVWU implement a flushing program ahead of the NWRRDS transition in those areas identified in this report where changes in pipe flow direction are anticipated.

Appendix A. Hydrant Testing Field Notes and Photographs

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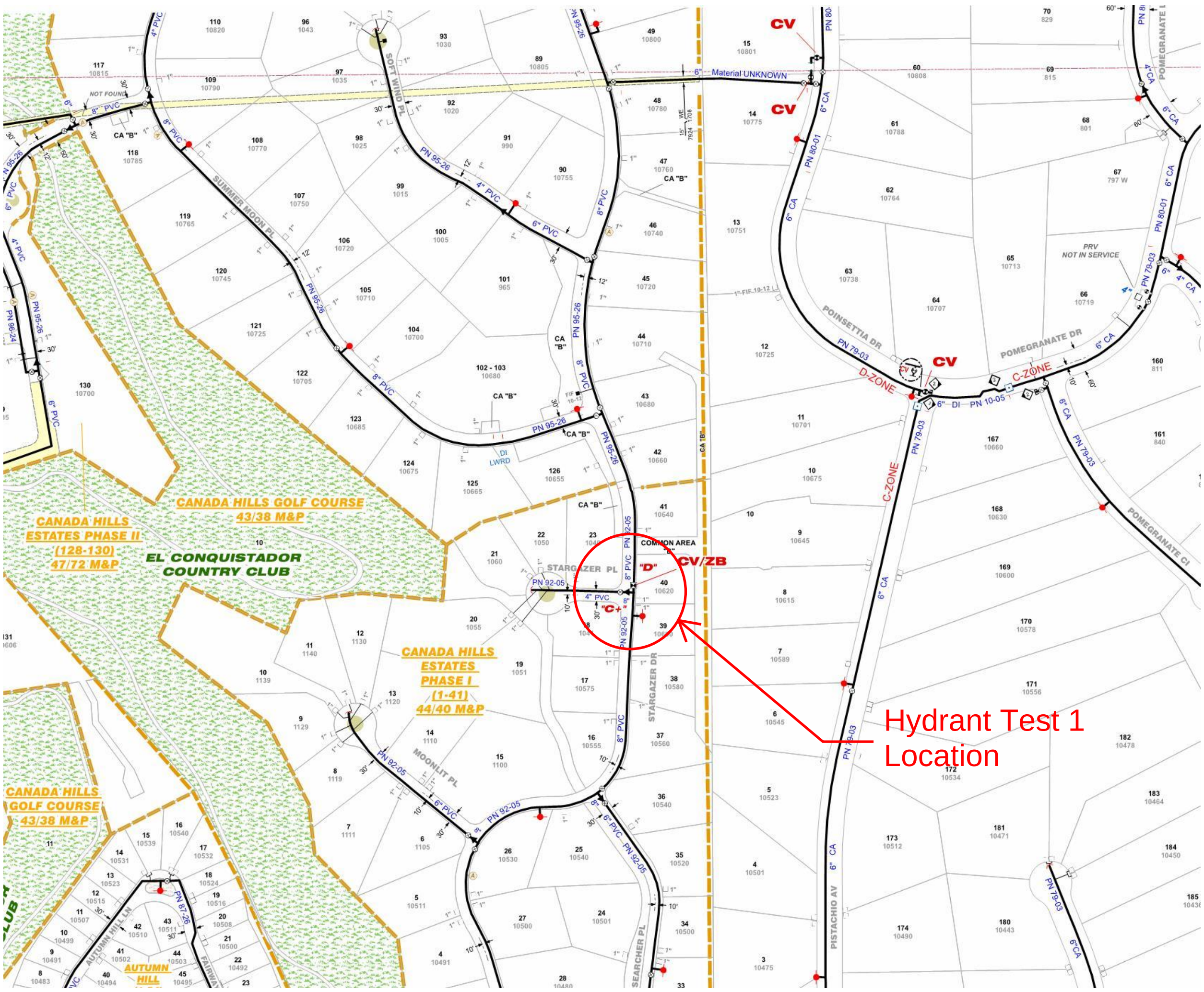
Hydrant Test 1

Stargazer Drive and Stargazer Place



DAILY FIELD REPORT

PROJECT NAME: Oro Valley	**DATE:** 1/5/2018	**DAY:** Friday	**REPORT NO:** ELANSEY's_iPad-20
PROJECT OWNER: OVWU			
	TEMPERATURE:		
HDR PROJECT NO:	**PRECIPITATION:**		
CONTRACTOR: OVWU/HDR	**CONDITIONS:**		

SAFETY CONCERNS/ GENERAL NOTES:
Test #1

Star gazer dr and stargazer pl (1)
Static 58psi
26152 initial flow meter reading
26159 final flow meter reading
700 gallons

Secondary hydrant to the south (2)
Static 61psi

Start time 848
(2)
At 20 sec 55 psi
Up to 65 psi at 35 sec
Stable at 60 at 1min
Stable at 60 at 2 min
(1)
Stable at 49 psi whole time

End test at 2 min 15sec when system stable

Checking flow meter accuracy started at 750gpm and dropped and stable at 530gpm
Golder marked green.

Golders markings
0-499 red
500-999 orange
1000-1499 green
1500+ blue

Green

WORK PERFORMED/ OBSERVATIONS:

SPECIAL INSPECTIONS:

PROJECT OWNER REPRESENTATIVE

NAME:	**TITLE:**
SIGNATURE:	**DATE:**

DAILY FIELD REPORT

PHOTOS

Star gazer dr and star gazer pl

58 psi static

2615.2 initial flow meter reading.

PROJECT OWNER REPRESENTATIVE

NAME:	**TITLE:**
SIGNATURE:	**DATE:**

DAILY FIELD REPORT

Nearest house to secondary hydrant 10540

Secondary hydrant

PROJECT OWNER REPRESENTATIVE

NAME:	**TITLE:**
SIGNATURE:	**DATE:**

DAILY FIELD REPORT

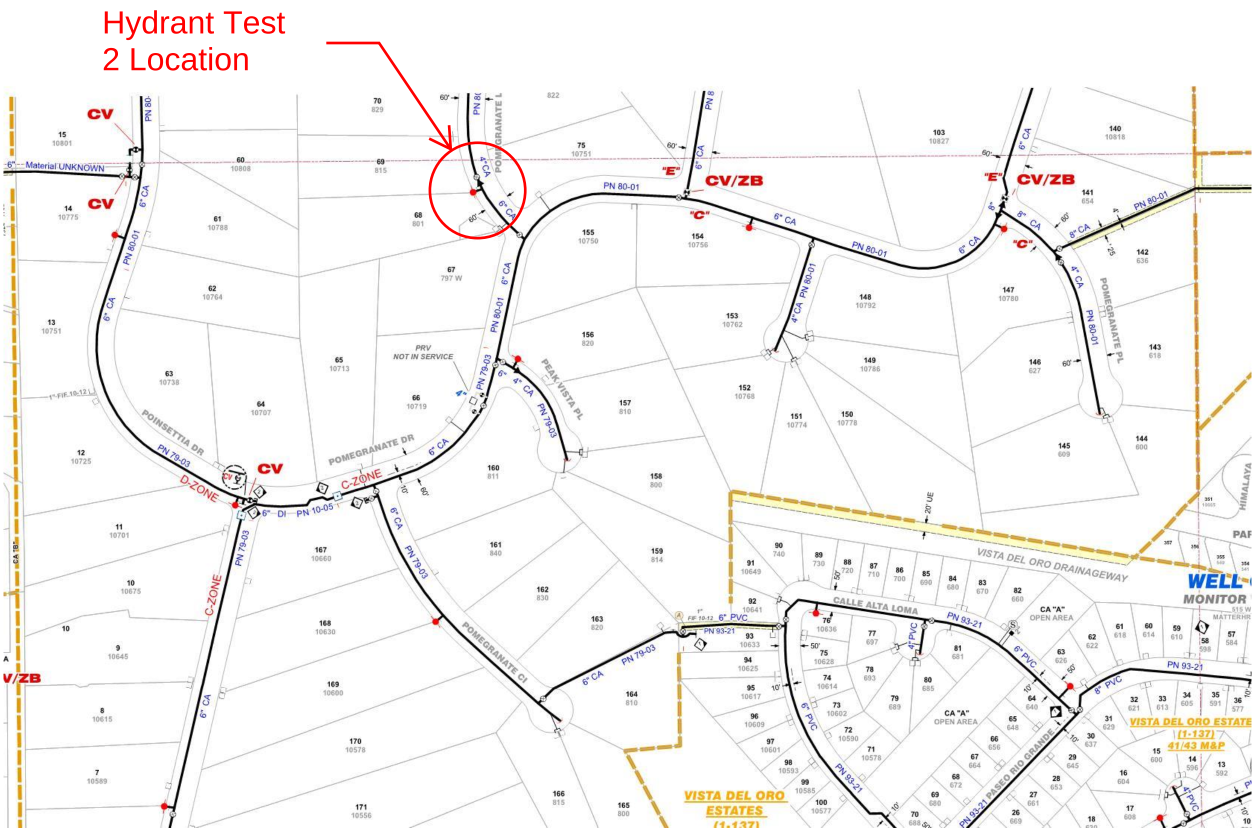
Static 61psi

PROJECT OWNER REPRESENTATIVE

NAME:	**TITLE:**
SIGNATURE:	**DATE:**

Hydrant Test 2

POMEGRANATE DRIVE AND POMEGRANATE LANE



DAILY FIELD REPORT

PROJECT NAME: OVWU	**DATE:** 1/5/2018	**DAY:** Friday	**REPORT NO:** ELANSEY’s_iPad-21
PROJECT OWNER: OVWU			
	TEMPERATURE:		
HDR PROJECT NO:	**PRECIPITATION:**		
CONTRACTOR: OVWU/HDR	**CONDITIONS:**		

SAFETY CONCERNS/ GENERAL NOTES:
Test #2
Pomegranate drive and pomegranate lane

WORK PERFORMED/ OBSERVATIONS:
Hydrant (1) pomegranate dr and pomegranate pl
Static pressure 38psi

Hydrant (2) pomegranate dr and peak vista pl
Static pressure 57 psi

953 start
Jumpy at 50/55 psi
End 957
Stabilized at 54/55psi (2)

(1)
635gpm stable entire time
Stabilized at 31psi

Used Pinot tube 2 in that comes off a 90deg bend from 2.5in hydrant for gpm

SPECIAL INSPECTIONS:

NOTES:

PROJECT OWNER REPRESENTATIVE

NAME: **TITLE:**

SIGNATURE: **DATE:**

DAILY FIELD REPORT

PHOTOS

Next to house 801

PROJECT OWNER REPRESENTATIVE

NAME:	**TITLE:**
SIGNATURE:	**DATE:**

DAILY FIELD REPORT

Pomegranate dr and peak visit pl
hydrant 2
Next to house 820

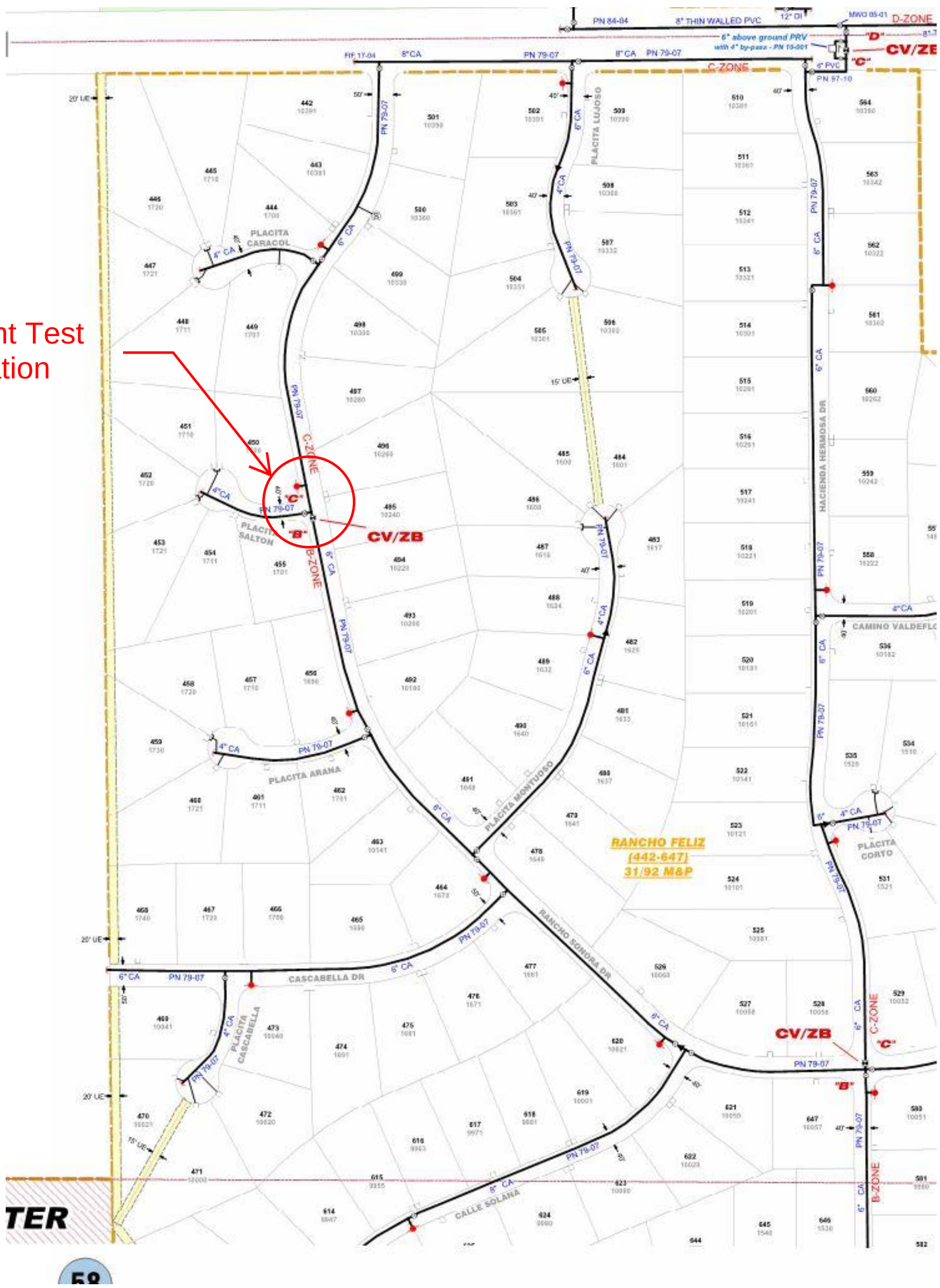
PROJECT OWNER REPRESENTATIVE

NAME:	**TITLE:**
SIGNATURE:	**DATE:**

Hydrant Test 3

RANCHO SONORA AND PLACITA SALTON

Hydrant Test 3 Location



DAILY FIELD REPORT

PROJECT NAME: OVWU	**DATE:** 1/5/2018	**DAY:** Friday	**REPORT NO:** ELANSEY's_iPad-22
PROJECT OWNER:			
	TEMPERATURE:		
HDR PROJECT NO:	**PRECIPITATION:**		
CONTRACTOR: OVWU/HDR	**CONDITIONS:**		

SAFETY CONCERNS/ GENERAL NOTES:
Hydrant (1) corner of rancho Sonora and placito salton
Static 87psi

Hydrant (2) placita caracol and rancho Sonora
Static 68psi

(2)
Started 1026
Dropped to 30 then recovered just above 50psi jumpy from 55-75psi
Began to stabilize at 60-65psi at 1029 but then got jumpy again

(1)
Jumpy between 70-80psi
Stable at 960 gpm

End test at 1034. Bringing a third person to come and check the PRV settings during pumping, will restart a test soon.

Starting test to verify prv settings at 1051
Only the 6 inch PRV is opening, the 4 inch PRV is not, Joe will change the settings so that both open when demand is seen. This will increase fire flow to this area.

WORK PERFORMED/ OBSERVATIONS:
Stacked setup
6”prv with4” prv parallel set up
Set 5 psi apart

Prv across rancho sonora

SPECIAL INSPECTIONS:

NOTES:

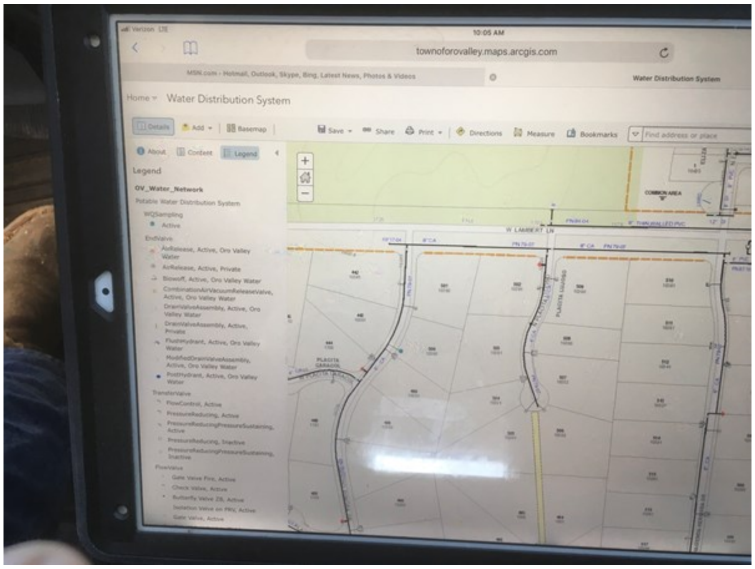
PROJECT OWNER REPRESENTATIVE

NAME: **TITLE:**

SIGNATURE: **DATE:**

DAILY FIELD REPORT

PHOTOS



New prv north of lambert west of ranch Sonora set 60psi has increased pressure in d to c drop, just below lambert system pressure to approximately 80psi

PROJECT OWNER REPRESENTATIVE

NAME:	**TITLE:**
SIGNATURE:	**DATE:**

Hydrant 2 for pressure test
Higher upstream because blow hydrant is in lower zone, valve connecting zones is closed

PROJECT OWNER REPRESENTATIVE

NAME:	**TITLE:**
SIGNATURE:	**DATE:**

DAILY FIELD REPORT

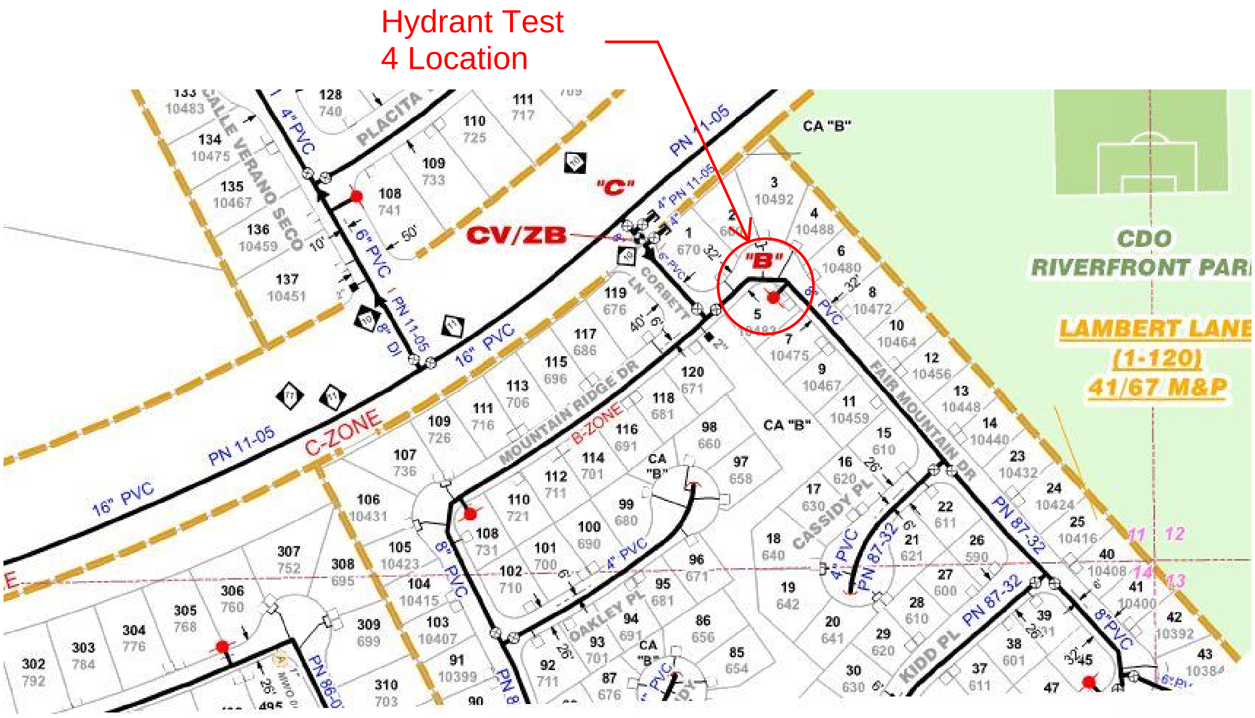
PROJECT OWNER REPRESENTATIVE

NAME: **TITLE:**

SIGNATURE: **DATE:**

Hydrant Test 4

Mountain Ridge Drive and Fair Mountain Drive



DAILY FIELD REPORT

PROJECT NAME: OVWU	**DATE:** 1/5/2018	**DAY:** Friday	**REPORT NO:** ELANSEY's_iPad-23
PROJECT OWNER: OVWU			
	TEMPERATURE:		
HDR PROJECT NO:	**PRECIPITATION:**		
CONTRACTOR: OVWU/HDR	**CONDITIONS:**		

SAFETY CONCERNS/ GENERAL NOTES:
Mountain ridge drive and fair mountain drive

Test started at 1115

Hydrant (1) northmost neighborhood corner
Static 73 psi
Jumping between 55 and 60 psi with 840 GPM stable
50-55psi stable

Hydrant (2) northwest at fair desert and mountain ridge
Static 73 psi
Dropped to 35 PSI then recovered to 50 psi, jumpy at 50
Jumping between 50 and 60 psi
48-50psi stable

Test ended at 1119

WORK PERFORMED/ OBSERVATIONS:

SPECIAL INSPECTIONS:

NOTES:

Vaulted prv On congressional way 90 downstream, 70 upstream. It is Leaking.

La Canada prv is ok

Checking Colbert hydrants for pressure. Went to 140psi after our test.
Want to eliminate congressional way prv by adding new prv at Corbett to accommodate for pressure changes.

PROJECT OWNER REPRESENTATIVE

NAME:	**TITLE:**
SIGNATURE:	**DATE:**

DAILY FIELD REPORT

PHOTOS

There was supposed to be a prv installed on Corbett and lambert that hasn't been. This would fix fire flow to this area.

Outside house 731
Hydrant (2)

PROJECT OWNER REPRESENTATIVE

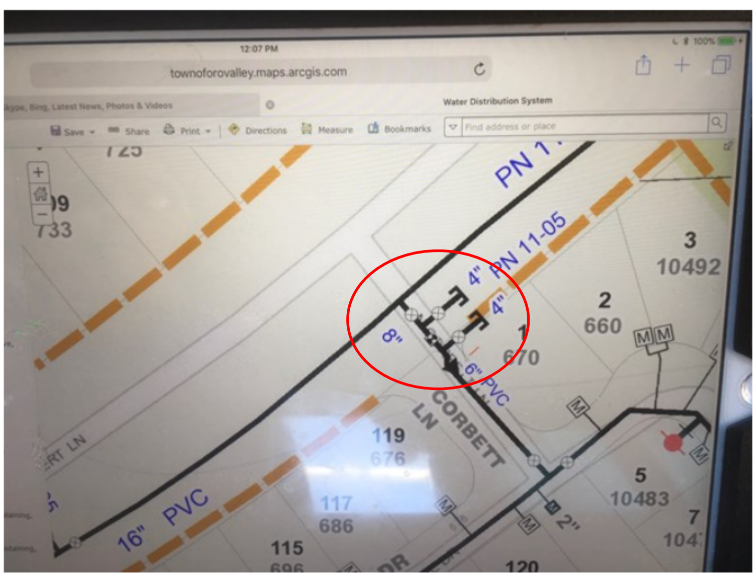
NAME:	**TITLE:**
SIGNATURE:	**DATE:**

Location of 4" stub outs to future PRVs from Lambert Lane.

PROJECT OWNER REPRESENTATIVE

NAME:	**TITLE:**
SIGNATURE:	**DATE:**

Outside house 10483
Hydrant (1)



A5

Two 4 in prvs not installed. Valve on 8" closed at zone boundary on lambert. Water enters subdivision from congressional way neighboring to the west.

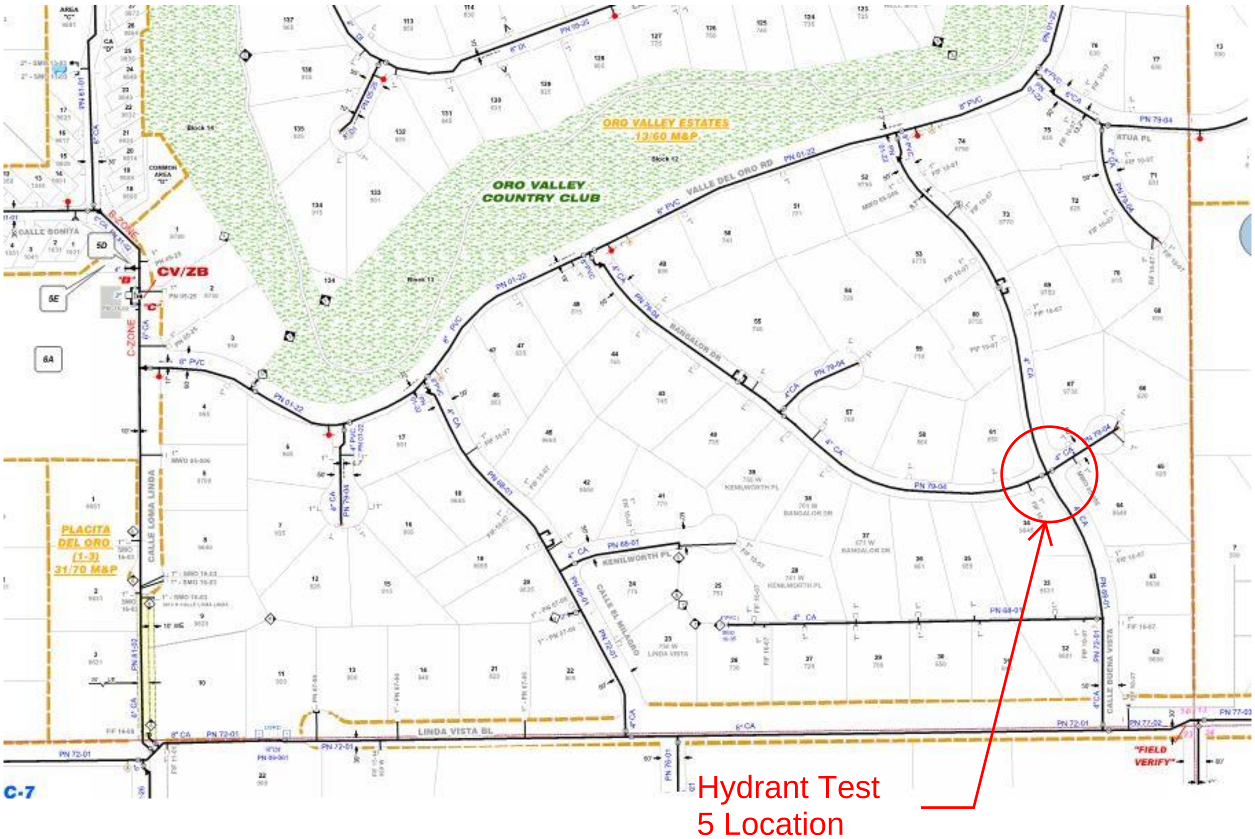
PROJECT OWNER REPRESENTATIVE

NAME: **TITLE:**

SIGNATURE: **DATE:**

Hydrant Test 5

Calle Buenavista and Bungalor Drive



DAILY FIELD REPORT

PROJECT NAME: OVWU	**DATE:** 1/5/2018	**DAY:** Friday	**REPORT NO:** ELANSEY's_iPad-24
PROJECT OWNER: OVWU			
	TEMPERATURE:		
HDR PROJECT NO:	**PRECIPITATION:**		
CONTRACTOR: OVWU/HDR	**CONDITIONS:**		

SAFETY CONCERNS/ GENERAL NOTES:
Calle Buenavista and Bangalor drive

Only hydrants along valle de Oro.

There are only 4 inch lines that run from valle de Oro north towards Linda Vista. No hydrants are located on these lines.

PROJECT OWNER REPRESENTATIVE

NAME:	**TITLE:**
SIGNATURE:	**DATE:**

DAILY FIELD REPORT

PHOTOS

PROJECT OWNER REPRESENTATIVE

NAME:	**TITLE:**
SIGNATURE:	**DATE:**

Appendix B. Current and Future Demand Analysis Technical Memorandum

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Technical Memorandum

Date:	Tuesday, August 07, 2018
Project:	Oro Valley Water Utility Potable Master Plan
To:	Bob Jacklitch, Project Manager, Town of Oro Valley
From:	HDR Engineering
Subject:	Current and Future Demand Analysis

HDR is preparing a master plan for the Town of Oro Valley Water Utility (Town). As part of the master planning effort, HDR has estimated current and future water demands that will be used as part of the modeling task to develop a roadmap for the Town to expand their potable water system. Development of current and future system demands is a typical prerequisite to water distribution hydraulic modeling.

Objectives

To prepare a demand analysis, HDR collected distribution system mapping, demand, and production data to estimate current average, peak and minimum day consumption and the spatial distribution of the consumptions. Future demands were estimated based on growth projections provided by the Town's Planning Department.

The objectives for the demand analysis are to document the following:

- Evaluation of system-wide water production (wells and renewable supplies) data,
- Customer accounts demand and mapping data,
- Daily demand patterns,
- Locations and timelines for future growth,
- Spatial distribution of future demand.

Data Collection and Review

For the purposes of preparing this demand analysis, HDR collected the following data from the Town:

- Two years of water production data, from July 2015 to July 2017, which included daily system-wide production summaries broken down into 30 minute increments.
- Customer water accounts for June 2017 which included monthly demands for 19,684 accounts.
- Geographic Information System (GIS) maps showing meter locations, service connections, pressure zone boundaries, main service area boundary, and planning zone boundaries.

- Hard copy maps showing locations of future residential and commercial developments in increments of 0-5 years, 5-10 years, and 10+ years, as provided by the Town Planning Department, as well as the projected number of housing units.

Existing Demand Analysis

System Demand Data Review

The daily and peak hour demand data from July 2015 through August 2017 provided by the Town was used to determine the minimum, maximum and average demands for the main Oro Valley system. The demands from the Countryside system were not considered. The information provided summarized data for the entire system, compiled in 30 minute increments, and accounts for well production, renewable imports into the distribution system, and change in reservoir storage. The data was compiled and sorted to give the maximum, average, and minimum daily demands, as shown in Table 1.

TABLE 1

Key System Demands for Hydraulic Modeling

Date	Demand (gallons/day)	Model Simulation
6/7/2016	9,256,000	Maximum Day Demand
3/13/2017[1]	5,591,000	Average Day Demand
12/20/2016	3,616,000	Minimum Day Demand

[1]The average daily demand for all dates reviewed was 5,664,000. 3/31/17 was selected as a typical average day.

Note that production data for individual wells, renewable import locations, and changes in reservoir levels was not available for data transfer from the SCADA system. The detailed production data for individual elements is not required for the demands analysis, but will be beneficial for validating the hydraulic performance during model setup. While the detailed production data was not available, HDR collected 24-hour trend screen shots from SCADA that can be used to validate model performance.

HDR used the 30 minute increment production data from 6/8/2016 to prepare a diurnal curve to be applied to the maximum day model simulation to develop the most conservative diurnal curve. The maximum day, peak hour diurnal curve is plotted as Figure 1. Similarly HDR used the 30 minute increment production data from 3/13/2017 to prepare a diurnal curve to be applied to both the average day and minimum day model simulations. The average day diurnal curve is plotted as Figure 2.

FIGURE 1

Maximum Day, Peak Hour Diurnal Curve

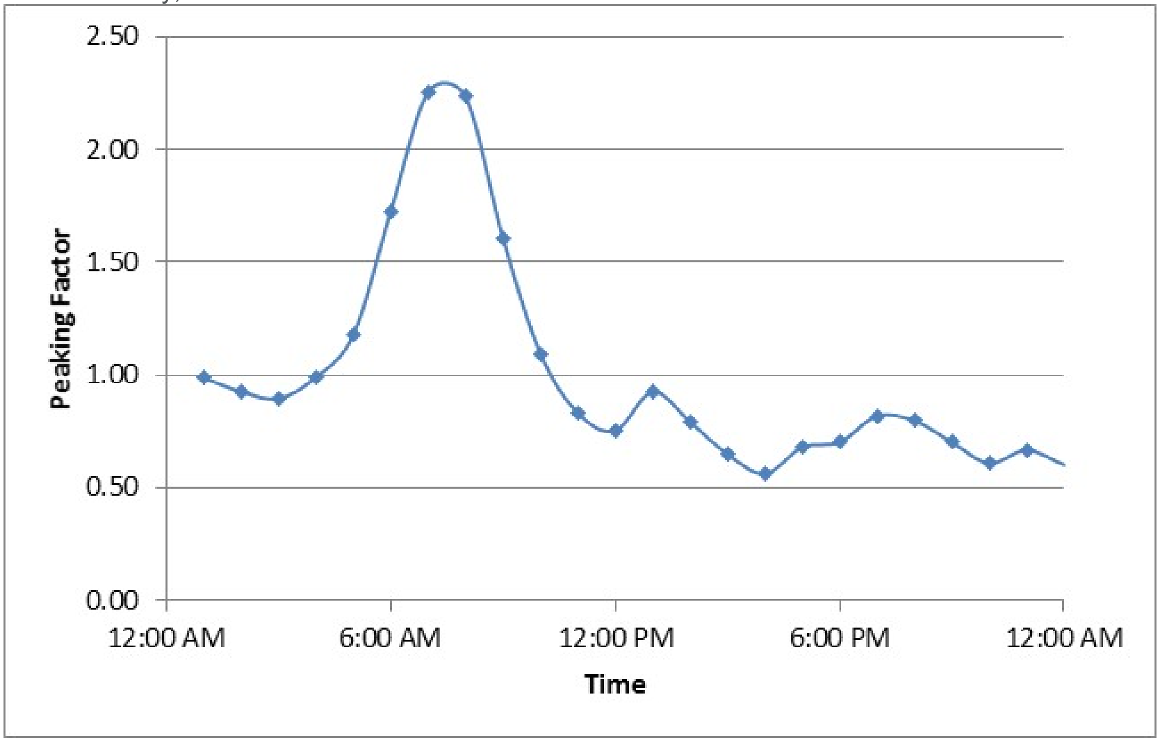
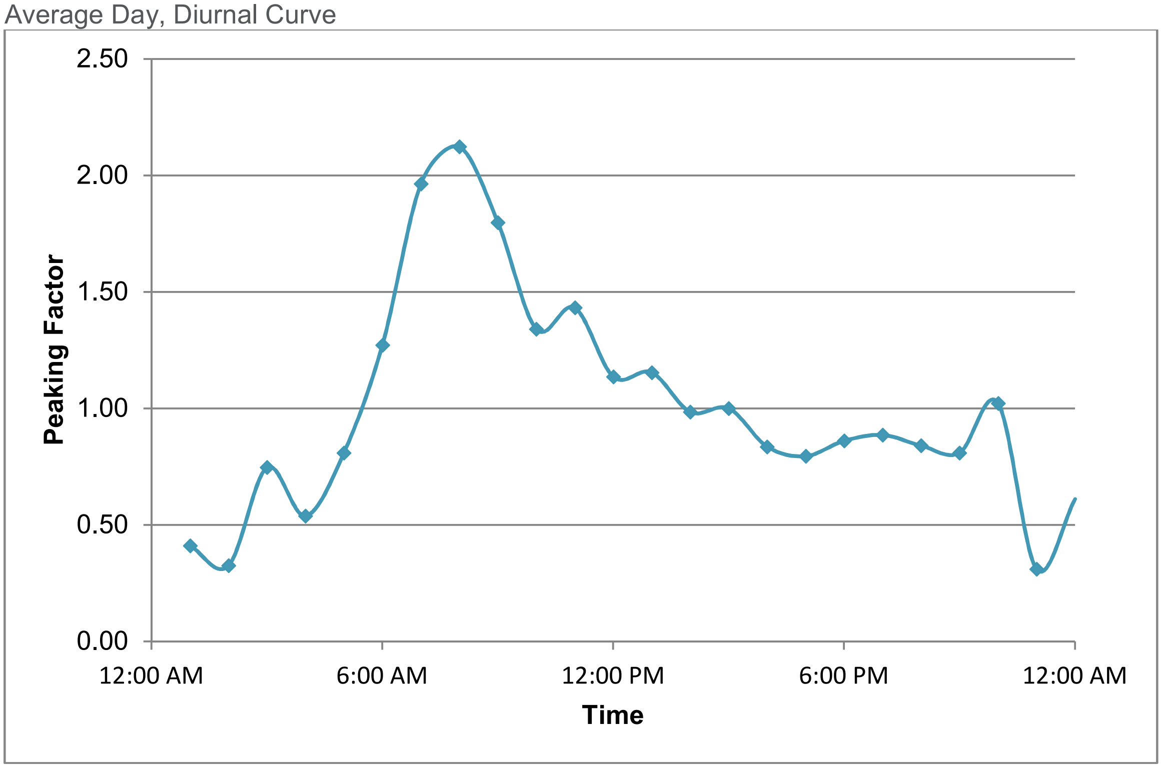


FIGURE 2

Average Day, Diurnal Curve



Customer Demand Data Review

HDR requested and received one month of customer demand data for June 2017. The customer record included account number, meter number, date of the meter reading, and the monthly demand for 19,684 accounts (including Countryside). To determine the spatial distribution for these accounts, HDR requested and received GIS files for the following:

- Meter locations and sizes, main Oro Valley system only
- Pressure zone boundaries, main Oro Valley system only
- Water service area boundary

The customer account records were tied to the GIS meter locations by using the account number, which allowed customer demands to be spatially distributed. The customer demands landing within each pressure zone were them summarized by planning zone and pressure zone. Of the 19,684 accounts received, 15,117 accounts were directly correlated to meter locations in the main Oro Valley system with a total demand of 7,163,000 gallons per day. A summary of the existing demands is provided in Table 2 (by pressure zone) and Table 3 (by planning zone).

TABLE 2

Summary of Existing Demands Per Pressure Zone (June 2017)

Pressure Zone	Daily Demand (gallons)	# of Customer Accounts
B1	382,500	999
C1	40,600	72
C2	859,200	1,522
C4	36,400	94
D1	709,400	1,473
D4	34,900	158
D5	572,000	741
D6	239,200	340
E1	1,576,000	3,761
E2	40,900	109
E3	27,300	63
E4	222,100	567
E5	3,300	14
F1	393,200	1,230
F2	249,500	740
F3	65,600	154
G1	805,100	2,796
G2	92,700	1
G3	42,000	142
H1	48,600	63
H2	128,600	598
H3	6,900	11
H4	1,100	5
I1	6,500	15
Unknown	791,900	2
Total	**7,375,500**	**15,119**

TABLE 3

Summary of Existing Demands Per Planning Zone (June 2017)

Planning Zone	Zone Description	Daily Demand (gallons)	# of Customer Accounts
C-1	Commercial	137,600	55
C-2	Commercial	26,000	29
C-N	Neighborhood Commercial	7,800	7
PAD	Master Planned Communities	3,834,100	9,970
PSC	Private Schools/Churches	65,800	13
R1-10	Single Family Residential	143,400	281
R1-144	Single Family Residential	385,500	303
R1-20	Single Family Residential	32,100	93
R1-300	Single Family Residential	92,700	1
R1-36	Single Family Residential	424,300	722
R1-43	Single Family Residential	265,300	446
R1-7	Single Family Residential	222,100	567
R1-72	Single Family Residential	1,200	2
R-4	Multi-Family Residential	645,900	1911
R-4R	Multi-Family Residential, Resort	204,800	260
R-6	Multi-Family Residential	53,600	83
SDH-6	Site Delivered Housing District	23,400	281
T-P	Technology District	17,900	93
Unknown	Reclaimed Accounts	791,900	2
Total		**7,375,500**	**15,119**

Demands were sorted by planning zone so that they could be segregated by meter size because the meter size in each planning zone is typically homogenous, whereas each pressure zone is comprised of multiple planning zones and meter sizes. Establishing demand per meter size is useful in this case because the future growth areas provided by the Planning Department are defined by planning zone and number of connections. As such, the average meter size per planning zone is the basis by which future demands can be assigned in the system. The summary of meters in the existing system is provided in Table 4, and the median meter size in each planning zone, as shown in Table 5.

TABLE 4

Summary of Existing Meters (June 2017 Demand Records)

Meter Size (in)	Count	Gallon Per Day / Meter	Acre-Feet per Year / Meter
0.625	13,246	295	0.33
0.75	955	380	0.42
1	456	908	1.00
1.5	186	1,630	1.80
2	246	3,264	3.61
3	10	13,173	14.55
4	11	22,455	24.81
6	4	50,667	55.98

TABLE 5
Summary of Existing Meters, June 2017

Planning Zone	Zone Description	Median Meter Size (inch)
C-1	Commercial	1
C-2	Commercial	1
C-N	Neighborhood Commercial	1.5
PAD	Master Planned Communities	0.625
PSC	Private Schools/Churches	1.5
R1-10	Single Family Residential	0.625
R1-144	Single Family Residential	1
R1-20	Single Family Residential	0.75
R1-300	Single Family Residential	6
R1-36	Single Family Residential	0.625
R1-43	Single Family Residential	0.625
R1-7	Single Family Residential	0.625
R1-72	Single Family Residential	0.625
R-4	Multi-Family Residential	0.75
R-4R	Multi-Family Residential, Resort	0.75
R-6	Multi-Family Residential	0.75
SDH-6	Site Delivered Housing District	0.625
T-P	Technology District	0.625

Future Demand Analysis

The Town's Planning Department provided full-size (24-inch x 36-inch) hard copy plots of the Town boundary that graphically identified future growth areas, in most cases identified by individual plots. These plots were colored by growth type (e.g. commercial, residential, multi-family), and labeled as follows:

- "Tier 1" – development in 0-5 years
- "Tier 2" – development in 5-10 years
- "Tier 3" – development in 10+ years

The Planning Department plots were used as the basis for estimating the spatial distribution of future demands. Additionally, in a separate email the Planning Department provided the following growth projections:

- Population projection at Town build-out is 52,900
- This corresponds to 3,838 additional housing units (as estimated by the Planning Department)
    - 1,416 housing units in the 0-5 years
    - 997 housing units in 5-10 years
    - 1,425 housing units in 10+ years

Planning Department Growth Projections

The future growth areas identified by the Planning Department fell into two categories:

1. Individual plots, typically in-fill growth areas, and
2. Undivided, larger parcels for areas that have not yet been subdivided into plots.

Individual plots within each planning zone were manually counted to estimate the number of future meter connections. For the undivided parcels, HDR estimated the number of future meter connections based on the meter density per acre estimated from the GIS maps provided. A summary of the total number of future units is provided in Table 6, which demonstrates that the total projected number of units derived matches the number of units estimated by the Planning Department.

TABLE 6

Projected Number of Future Units by Planning Zone

Planning Zone	Zone Description	Number of Future Units		
		0-5 Years	**5-10 Years**	**10+ Years**
C1 & C2	Commercial	3	77	5
C-N	Neighborhood Commercial	29	11	17
Total Number of Commercial Units		**32**	**88**	**22**
PAD	Master Planned Communities	1011	871	548
R1-10	Single Family Residential	0	0	0
R1-144	Single Family Residential	44	0	97
R1-20	Single Family Residential	0	0	25
R1-300	Single Family Residential	0	0	12
R1-36	Single Family Residential	0	65	136
R1-43	Single Family Residential	0	0	111
R1-7	Single Family Residential	186	0	325
R4, R-4R, R-6	Multi-Family Residential	175	61	170
SDH-6	Site Delivered Housing District	0	0	0
Total Number of Housing Units		**1,416**	**997**	**1,423**

Allocating Demands Spatially Across the Distribution System

Future demands were estimated by multiplying the number of units by the average demand per meter size, as summarized in Tables 4 and 5. Future demands were allocated directly to the pressure zone in which they were located in GIS, and are summarized in Table 7.

TABLE 7

Projected Demands Per Zone (Based on Projections of June 2017 Demands)

Planning Zone	Existing Demand (gallons/day)	Future Demand (gallons/day)		
		0-5 Years	5-10 Years	10+ Years
B1	382,500	0	0	0
C1	40,600	0	0	13,100
C2	859,200	17,000	24,300	27,200
C4	36,400	0	0	0
D1	709,400	17,700	44,200	30,000
D4	34,900	0	0	0
D5	572,000	41,500	13,600	11,800
D6	239,200	0	0	0
E1	1,576,000	172,700	216,900	92,400
E2	40,900	0	0	0
E3	27,300	0	0	0
E4	222,100	0	0	0
E5	3,300	0	0	0
F1	1,185,100	98,000	0	26,900
F2	249,500	0	37,700	0
F3	65,600	0	0	6,800
G1	805,100	0	0	70,000
G2	92,700	0	0	10,000
G3	42,000	0	0	0
H1	48,600	0	0	74,600
H2	128,600	0	0	15,900
H3	6,900	0	0	0
H4	1,100	0	0	0
I1	6,500	0	0	32,700
Total	**7,375,500**	**347,800**	**336,700**	**411,400**
Grand Total		**7,723,300**	**8,060,000**	**8,471,400**

It should be noted that for the purposes of modeling, the demands in each pressure zone will be escalated or de-escalated to match the modeling scenario. For example, when modeling average day conditions, the demand at all nodes will be multiplied by a daily adjustment to bring the total demand down to the average day demands as outlined in Table 1.

Summary of Current and Future Demands

Table 7 summarizes the total system demand for each model simulation.

TABLE 7

Key System Demands, Future Modeling Scenarios

Model Simulation	Existing Demand (gallons/day)	Future Demands (gallons/day)		
		0-5 Years	5-10 Years	10+ Years
Maximum Day Demand	9,256,000	9,705,000	10,140,000	10,672,000
Average Day Demand	5,591,000	5,862,000	6,125,000	6,446,000
Minimum Day Demand	3,616,000	3,873,000	4,069,000	4,339,000