SUNRISE BEACH VILLAGE
WATER DISTRIBUTION SYSTEM IMPROVEMENTS
PHASE 2: CONCEPTUAL DESIGN

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Prepared For:

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Table of Contents

Graphs

Tables

Figures

Executive Summary

Overview

The Phase 2 report presents the results of a Feasibility Study and Conceptual Design, refining and calibrating the Phase 1 static model using real-time field pressure monitoring data to validate system connectivity, and applying topographic survey data collected at the water plant (WP) and ground storage tank (GST) sites. Multiple model scenarios were simulated to evaluate the feasibility and impact of proposed system improvements, with each scenario evaluating system improvements to achieve TCEQ compliance requirements and address operational issues. A conceptual design is presented in this report to outline the next steps and priorities for the Sunrise Beach Village's (SBV) multi-year water distribution system improvements program to be aligned with available funding.

Existing System Characteristics

The existing water system characteristics were further refined and applied in modeling and resultant analysis in this phase through SBV provided SCADA data, field test pressure monitoring, field verification, as well as building upon findings from Phase 1. Specifically, it was verified that the existing 6-inch main serves a dual purpose, supplying water to customers while also supplying water to fill the GST. In addition, the model analysis found that the HSPs are working under conditions that are outside of the manufacturer-recommended efficiency ranges. This is due to the need to maintain elevated operating levels at the GST to meet the capacity and pressure demands of areas served both near the GST and at the lowest elevation served by the water system. Continuously operating the GST at the highest potential operating levels requires the HSPs to overcome a greater head resulting in pressures in the distribution system beyond what the system is designed to manage.

Existing System Operations

The existing 6-inch main acts as a system bottleneck due to its limited flow capacity, resulting in significant system head loss, requiring the HSPs to operate harder/longer to push water through the system, and adding further strain on pipes, pumps, and appurtenances such as valves and pipe joints/connections. These identified restrictions associated with the 6-inch main are consistent with operational inefficiencies and frequent system failures historically experienced. The section of the system served directly from the water plant, immediately downstream of the HSPs' PRV, operates as a medium pressure zone, which experiences elevated pressures (above 90 psi) due to the current system and HSP operations. Operating system pressures, from 90+ psi to 20 psi variations contribute to long-term system stress and thus frequent pipe failures.

Existing System Monitoring and Analysis

System pressure monitoring data at 11 locations within the water system was collected along with SCADA data for pump and tank operational information for the period of July 2, 2024, to September 11, 2024, with one pressure monitor downstream of the HSPs throughout the monitoring period. System operations, SCADA data, and collected system pressure monitoring data were applied to analyze system pressure fluctuations, head losses, and HGL variations across the system when pumps are operated. The comparison of field monitoring pressures with system HGLs assisted in verifying applied system performance factors, head losses, and overall water system performance.

Existing System Modeling and Analysis

The static hydraulic model developed in Phase 1 was refined due to the field conditions identified, system field monitoring, operations & maintenance data, and survey data for the WP site and the GST site, with corrections in system connectivity applied in the model. Model system components were updated based upon pump curves, pressure monitoring and SCADA data, regional LiDAR contour data, and additional system information provided by SBV. The system experiences varying seasonal water demand, with high water usage in the summer and holiday weekends, as impacted by part time residents, thus system usage is modeled considering variability in usage to simulate system operational conditions accurately. Field pressure and SCADA data were applied to calibrate the modeled system’s hydraulic capabilities and analyze pressure fluctuations and HGLs variations across the system.

Existing System Modeling Scenarios and Findings

Model scenarios were developed to represent operating conditions, simulating pump operations, tank levels, control valve operations, and key system functions for existing system operations and proposed system improvements. For each scenario, ADF and MDF conditions were applied for the current 1,034 customers, and a projected future total of 1,200 connections, with demand patterns reflecting seasonal fluctuation in the number of weekdays versus weekend residents (ADF = 0.13 MGD; MDF = 0.3 MGD).

The HSPs operate at approximately 230 gpm with an efficiency of 62.5%, with operating efficiency occurring outside the BEP, primarily due to the head the pumps are working against to fill both the GST and supply water to the system through the same 6-inch main. Pressure fluctuations found in the system (per pressure monitoring applied in modeling) are a function of pump operations and system PRV settings, with elevated pressures when HSP runs, and pressure drops when pumps are off, impacting system stability and operational inefficiencies and failures. Further, the operating levels of the existing Clearwell and GST have a direct impact on pressure stability and HSP operating capacity and efficiency. Other contributing factors to system issues include pipe age, material, and size, as demonstrated in the analysis.

Proposed System Improvements Modeled

Improvements are proposed to address the identified existing system deficiencies. Three (3) modeled scenarios were evaluated to determine the system impact of applying various levels/types of system improvements. Each scenario introduced a series of upgrades aimed at addressing TCEQ regulatory compliance requirements and operational issues related to pressure, flow, and storage observed in the existing system in the feasibility analysis.

Pumping & Distribution System Improvements

The guidelines provided in 30 TAC §290.45 were applied to evaluate the water system and determine minimum system requirements, including requiring "*two or more pumps with a total capacity of 2.0 gpm/conn or a total capacity of at least 1,000 gpm and the ability to meet peak hourly demands with the largest pump out of service, whichever is less*". While 2,400 gpm of pumping capacity would be required to achieve 2.0 gpm/connection, 1,000 gpm of pumping capacity can be provided by operating the HSPs at their best efficiency point (BEP) with a dedicated transmission main. Sizing for the transmission main was evaluated and analyzed to determine if pumps were able to convey a minimum of 1,000 gpm and if two pumps were able to meet peak hourly demands. While the 10-inch main achieves the 1,000-gpm requirement, a 12-inch main is recommended to provide for system resiliency and provide for future demand needs to meet both ADF and MDF conditions with two pumps operating. The 12-inch main sizing also considers that the HSPs will likely be replaced in the near future due to their current age, allowing for the opportunity to size new pumps to maximize the 12-inch main capacity for long-term efficiency and performance.

Storage and Pressure Maintenance Improvements

Two (2) new 70,000-gallon clearwells (tanks) are proposed to achieve TCEQ minimum storage requirements compliance and be constructed at an elevation higher than the existing structure to increase the HGL available to the HSPs, reducing the required operational head. Repurposing and improving the existing Clearwell indefinitely is not feasible, as its height would restrict the HGL of the new tanks. The Clearwell sizing (height and diameter) will be determined during the final design phase, in compliance with the Federal Aviation Administration (FAA) requirements. A 2,000-gallon HPT and 40-gpm dedicated booster pump package system, sized to meet TCEQ minimum requirements, is proposed to achieve pressure maintenance in the immediate downstream areas of the GST, providing consistent pressures above 50 psi in areas limited by the GST's HGL. Proposed and existing system PRV settings were adapted in the model to provide consistent HGLs and pressures throughout the system, creating more stable operating conditions, particularly in areas prone to pressure fluctuations.

Proposed Improvements Conceptual Design

The conceptual design for the SBV water system prioritizes achieving required regulatory compliance and enhancing system reliability to accommodate current and future demands, addressing prioritized system needs, building upon findings from the Phase 1 report, and applying findings from Phase 2 results. The conceptual design focuses on implementing the following key improvements identified in Modeled Scenario 2 to achieve requirements for storage and pumping capacity up to 1,200 connections, and pressure maintenance up to 1,042 connections:

- 12-inch transmission main (~16,500-LF between WP and GST), allowing existing HSPs to deliver up to 1,053 gpm during peak conditions, and with two pumps (third standby) under normal operations.
- 400-LF of existing 2-inch at the end of Sandy Mountain Rd upsized to 4-inch to enhance flow capacity and maintain adequate pressures for homes served by this pipeline.
- Two new PRVs proposed on existing 6-inch main for pressure management.
- Two 70,000-gal clearwells to achieve storage requirements and increase storage height, reducing the pump required operational head. Sizing (height and diameter) will be determined in the final design phase, in compliance with FAA requirements. SCADA integration to be evaluated in final design.
- 2,000-gallon HPT and 40-gpm dedicated booster pump package system and associated PRV to achieve pressure maintenance in the immediate downstream areas of the GST. SCADA integration to be evaluated during final design.
- Emergency power supply (generator) at both the WP and HPT (at GST) to achieve minimum emergency power requirement. Electrical and power supply needs will be evaluated during final design.

Modeled Scenario 3 improvements, which include additional pipeline improvements to meet TCEQ minimum pipe sizing and address system bottlenecks, are recommended for future improvements. Distribution system improvements could be strategically implemented over time through O&M funds as a function of work orders or included in future system improvement projects. The Engineer's Opinion of Probable Project Costs (EOPPC) presented below are calculated using 2024 (fourth quarter) dollars with a contingency of 30 percent, and 15 percent for engineering.

SUMMARY OF PROPOSED IMPROVEMENTS EOPPC

Recommended Improvements	2024 ($)
General Requirements	889,000
Storage & Pumping Improvements	1,132,300
Pipeline Improvements	4,791,250
Contingency & Engineering	3,066,000
Total Cost	**9,878,550**

Definitions

The following key terms, acronyms, and definitions are referenced throughout this report.

- **American Rescue Plan Act (ARPA)** – a federal act providing funds to state and local governments for COVID-19 relief and infrastructure improvements, often used for essential services, including water system upgrades.
- **Average daily flow (ADF) –** the average volume of water flowing through a system daily, typically calculated over a specific period of time, to assess baseline water demand.
- **Best efficiency point (BEP)** – the point (or range) on a pump's performance curve where it operates most efficiently, balancing flow rate and pressure with minimal energy loss, wear, and vibration. Operating near BEP maximizes pump longevity and minimizes operating costs. Pumps are selected during design based on the design flow rate and pressure head.
- **Clearwell –** a potable water reservoir, typically located at a water treatment plant. In the SBV water system, it is located downstream of the in-line chlorine disinfection process, holding treated water before distribution.
- **Diurnal curve –** illustration of the average variation in water demands experienced by a system over a 24-hour period.
- **Dynamic head loss –** loss of pressure caused by water flow through the system, influenced by factors such as pipe friction, bends, fittings, and flow velocity. Dynamic head loss varies with flow rate and pipe diameter, a factor in pump sizing and system.
- **Engineer Opinion of Probable Project Costs (EOPPC)**
- **Extended period simulation (EPS) –** a hydraulic model simulation that produces results based on changing “extended” conditions (i.e., tanks filling or draining, pumps turning off or on, etc.) over a specified time interval. The EPS represents a “real-world” simulation of the system operations by demonstrating the system operations dynamically over a set extended period of time (i.e., 24-hours or 72-hours).
- **Federal Aviation Administration (FAA)**
- **Gallons per minute (gpm) –** a measure of rate of flow, indicating the volume of water (in gallons) moving through a system per minute.
- **Geographic information system (GIS) –** a digital dynamic mapping tool that integrates spatial (GPS coordinates) and descriptive data. It was used to develop an electronic map of the SBV’s water system, including water mains, facilities, and valves.

- **Global positioning system (GPS)** – a satellite-based positioning system used to determine precise locations' coordinates via satellite-equipped equipment. GPS was used in SBV to map infrastructure components like pipes, valves, and facility components.
- **Ground storage tank (GST)** – a tank, used to store potable water for distribution, typically in combination with booster pumping, or positioned at an elevation high enough above points of service to provide adequate service pressures without the need for pumping. The GST in the SBV system is an elevation that functions as elevated storage.
- **High service pump (HSP)** – pumps used to convey water from the Clearwell to the GST (via transmission main) and to service lines (via distribution main).
- **HR Green (HRG)**
- **Hydraulic grade line (HGL)** – a profile line representing the energy available in a flowing fluid and the water pressure within a system at various points.
- **Hydraulic water model** – digital simulation of a water distribution system, incorporating system components (i.e., pumps, tanks, raw water source, valves, and pipelines), flows, pressures, and demand patterns. Hydraulic models are used to analyze system performance, assess capacity, and plan improvements under varying conditions.
- **Hydropneumatic tank (HPT)** – a pressurized tank that stores potable water and uses compressed air to maintain system pressure. When system water demand increases, the tank releases water, reducing the need for constant pump operation.
- **Light Detection and Ranging (LiDAR)** – remote sensing technology that uses laser pulses to measure distances to the Earth's surface, generating precise, high-resolution 3D data about topography and objects
- **Linear Foot (LF)**
- **Maximum daily flow (MDF)** – the maximum volume of water flowing through a system daily, typically calculated over a specific period of time, to assess peak water demands.
- **Million gallons per day (MGD)** – a measure of rate of flow indicating the number of million gallons moving through a system per day.
- **Model junctions** – points within a hydraulic model where demands, flows, pressures, and other conditions are calculated, representing key locations in the water distribution network. ADF and MDF demands are divided equally across model junctions to represent service connections.
- **Operations & Maintenance (O&M)**
- **Pipe roughness coefficient (C-factor)** – coefficient used in fluid dynamics to calculate the resistance of water flowing in a pipe network, considering pipe material and age.

- **Pounds per square inch (psi)** – a unit of pressure measurement indicating the force exerted by water (or another fluid) per square inch of surface area (i.e., pipe cross-sectional area).
- **Pressure reducing valve (PRV)** – a control valve used to regulate downstream water pressure to a set pressure. PRVs help limit maximum pressures and maintain consistent pressures across varying elevations and demand conditions.
- **Pressure zone** – a section of a water distribution system designed to operate within a specific pressure range, typically separated by valves or pumps to manage varying elevations and demand.
- **Static head loss** – the loss of pressure due to elevation differences within a system, independent of water flow. Static head loss occurs when water is moved from a lower to a higher elevation, requiring additional energy to overcome gravity forces.
- **Steady state (SS) simulation** – a hydraulic modeling simulation that produces results based on one initial set of “steady” conditions (i.e., number of pumps running, tank elevations, etc.).
- **Sunrise Beach Village (SBV)**
- **Supervisory Control and Data Acquisition (SCADA)** – a system that monitors and controls water distribution processes in real-time, collecting data and allowing operators to adjust system operations.
- **Texas Administrative Code (TAC)** – rules and regulations for various state agencies, including the TCEQ. 30 TAC specifically pertains to environmental quality regulations, including requirements for public water systems, wastewater systems, and related infrastructure.
- **Texas Commission on Environmental Quality (TCEQ)** – the regulatory agency for environmental protection in Texas, overseeing standards and compliance for water quality, wastewater, and air quality.
- **Water distribution line** – water main that distributes water to service connections.
- **Water Plant (WP)**
- **Water service connections** – total number of connections to a water system, representing individual service points or customer accounts, such as residential or commercial properties. The number of water connections is used to calculate, based on TCEQ minimum requirements, the infrastructure needs to meet both average and peak demands.
- **Water transmission main** – water line that conveys treated water supply to water storage tank.

1.0 Background

1.1 Introduction

The City of Sunrise Beach Village, Texas (SBV) owns and operates a public water supply system, serving a community of 1,034 water connections. SBV is seeking to implement improvements to its storage, pumping capacity, pressure maintenance, and distribution system to achieve system resiliency and meet the Texas Commission on Environmental Quality (TCEQ) minimum requirements.

SBV sought qualifications from interested parties and contracted with HR Green (HRG), a full-service engineering and consulting firm with a local office in Austin, Texas and with over 110 years of service to municipal clients and more than 40 years operating in Texas. Funding for this project combines American Rescue Plan Act (ARPA) funds, administered by Llano County, with SBV's matching and additional funds. An Interlocal Agreement between Llano County and SBV was executed on November 28, 2022, covering the distribution of the funds effective December 1, 2022. In accordance with ARPA fund requirements, funds must be obligated by December 31, 2024, and expended by December 31, 2026.

The work was divided into phases to allow for comprehensive system planning prior to final design and construction. The Phase 1 report, "*Water Distribution System Improvements – Phase 1: Mapping, Modeling, and Planning*", dated February 22, 2024, and developed by HRG, included electronic mapping of the water system, a static hydraulic model of the existing system, future demand evaluations, and a prioritized improvement plan guided by TCEQ regulatory compliance.

The Phase 2 report presents the results of a Feasibility Study and Conceptual Design, refining and calibrating the Phase 1 static model using real-time field pressure monitoring data. Topographic and utility survey data collected at the WP and GST sites were applied to the model to validate system connectivity and pressures. Discussions with SBV and site visits served as a further review of system connectivity, along with field findings from SBV operations applied in the model to correct system connectivity issues and validate model results. SBV-provided pump curves, SCADA data (July 2022–August 2024), field pressure data, and other system information provided by SBV were applied.

Multiple model scenarios were simulated to evaluate the feasibility and impact of proposed system improvements. Each scenario evaluated system improvements to achieve TCEQ compliance requirements and address operational issues related to pressure, flow, and storage observed by SBV and validated by field pressure monitoring and SCADA data. A conceptual design was developed to outline the next steps and priorities for the SBV's multi-year water distribution system improvements program to be aligned with available funding.

1.2 Existing Water System Capacity

The existing water system characteristics were further refined in this phase through SBV provided SCADA data, field test pressure monitoring, field verification, and findings from Phase 1. **Figure 1** and **Table 1** (below) provide a visual and tabulated representation of the existing water system, respectively. **Table 1** notes include the system's size and capacity assumptions.

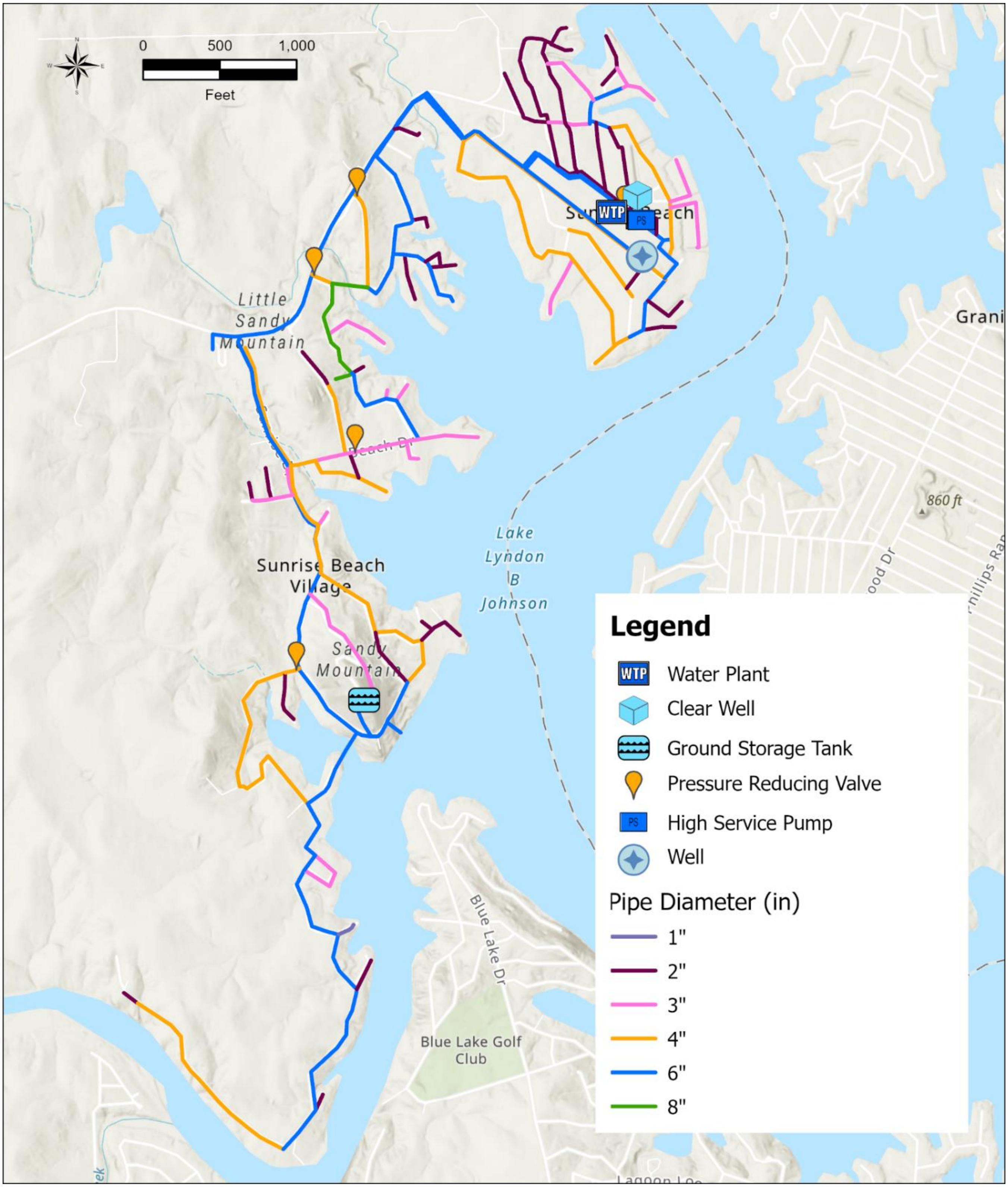
TABLE 1 – EXISTING SYSTEM CHARACTERISTICS

System Component	Characteristics[1]	Size & Capacity[1]	
Water Distribution Pipe	1-inch dia. pipe	291 LF	0.3%
	2-inch dia. pipe	21,193 LF	18.8%
	3-inch dia. pipe	14,027 LF	12.5%
	4-inch dia. pipe	34,823 LF	30.9%
	6-inch dia. pipe	39,920 LF	35.4%
	8-inch dia. pipe	2,639 LF	2.1%
	Total Pipe Length	112,622 LF	
Water Pressure Maintenance	Five (5) System Pressure Reducing Valves[2]	One (1) 3" diameter, three (3) 4" diameter, and one (1) 6" diameter	
Storage Capacity	One (1) 102,200-gallon Ground Storage Tank	▪ Diameter: 32 ft ▪ Height: 18 ft ▪ Operating Range: 16.5 ft – 13 ft ▪ Overflow Level: 17 ft	
	One (1) 19,000 gallon Clearwell	▪ Diameter: 14 ft ▪ Height: 17 ft ▪ Operating Range: 16 ft – 13 ft ▪ Overflow Level: 16.5 ft	
Well Production Capacity	Two (2) Operating Groundwater Wells[3]	Well Pump 4b: 380 gpm	
		Well Pump 4c: 375 gpm	
Pumping Capacity	Three (3) High Service Pumps[4]	Operational Capacity: 230 gpm (each) Rated Capacity: 425 gpm (each)	

Table 1 notes:

1. Data provided by SBV, including record drawings, 2024 SCADA data, and existing system operations.
2. PRVs have a set operating point of 80 psi (per SBV), with set operating points vs. system operations varying.
3. Well production capacity is determined as per 2024 SCADA data without available pump curve and data.
4. HSPs are not currently operated simultaneously, as per SBV. Average individual pump operating capacity is approximately 230 gpm per 2024 SCADA data provided by SBV. Pump operating capacity directly correlates to the system operating head; the reduced system pumping capacity of 230 gpm is a function of the existing system's piping ability to transmit flows.

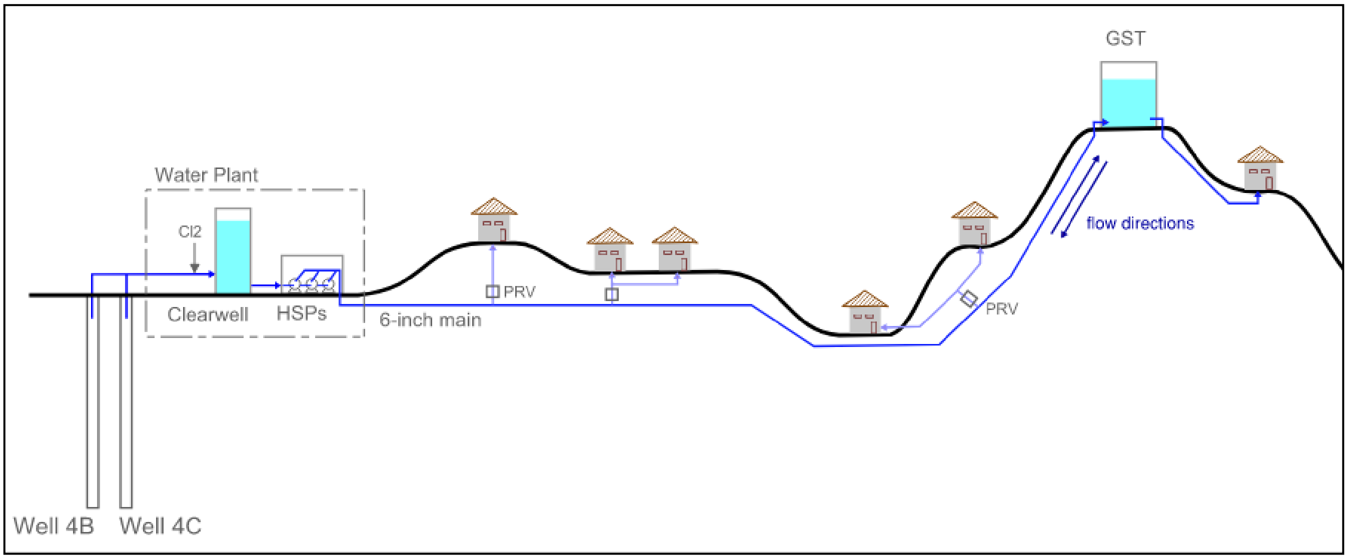
FIGURE 1 – EXISTING SBV WATER SYSTEM LAYOUT



1.3 Existing System Operations and Controls

The water source for the SBV community is existing groundwater wells (identified as Wells 4B and 4C) and disinfected with a chlorine (Cl_2) gas system. The treated groundwater is stored in the Clearwell located at the main WP and the HSPs supply treated (potable) water to the GST located at the Mountain Top site via a 6-inch main that serves as both transmission and distribution main. The 6-inch main extends to serve as distribution to portions of the water system (see **Figure 2** below), with pressures regulated by PRVs due to the high pressures experienced by the 6-inch transmission/distribution main. The elevated position of the GST at the Mountain Top site allows it to function as an elevated storage tank, providing pressure to the portions of the distribution system served directly by the GST.

FIGURE 2 – EXISTING SUNRISE BEACH VILLAGE WATER SYSTEM

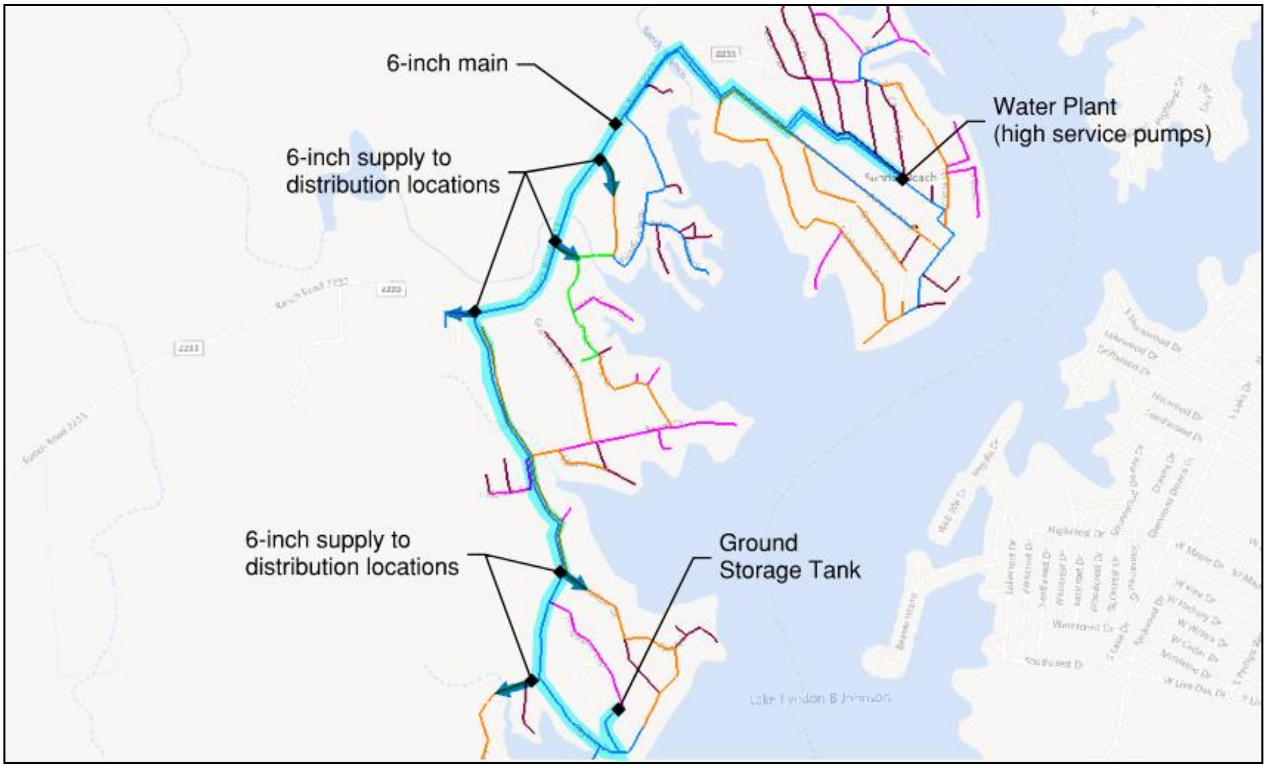


1.3.1 Distribution System Operations

A dedicated water transmission main in a water system provides the ability to supply water to the storage facilities to distribute water to the system through distribution piping from the storage facility. TCEQ defines a **potable water transmission line** as a "*water line directly conveying treated and pressurized water from a pump station to an elevated storage tank, and a **potable water distribution line** as a water main that directly conveys treated and pressurized water to a service connection*." (Reference 30 TAC Chapter 290).

In the SBV water system, the existing 6-inch main serves a dual purpose, simultaneously supplying treated (potable) water to customers while also supplying water to fill the GST that then distributes water to portions of the system. **Figure 3** provides a visual representation of SBV's water distribution system.

FIGURE 3 – DISTRIBUTION SYSTEM OPERATIONS



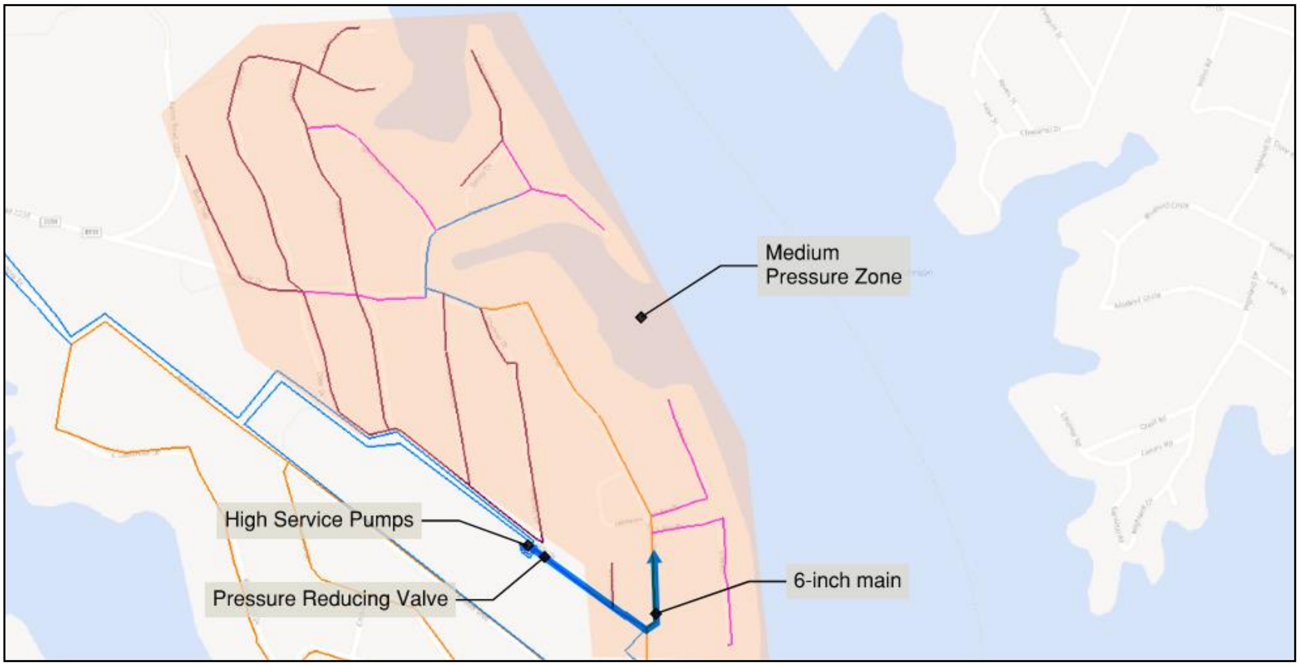
Due to the existing system configuration and operations, the HSPs are working under conditions that are outside of the manufacturer -recommended efficiency ranges (reference **Section 3.6** for existing pump operations). The system is required to operate at its HGL to maintain adequate pressures along Mountain Top Road, thus maintaining elevated operating levels at the GST's highest potential HGL (from low elevation difference to high elevation difference from the GST to the point in the water system served). Continuously operating the GST at the highest potential operating levels requires the HSPs to overcome a greater head (elevation difference between pumps and tank operating level), resulting in pressures in the distribution system beyond what the system was originally designed to handle.

The 6-inch main, which serves dual purposes as both transmission line to the GST and a distribution line to the system, acts as a system bottleneck due to its limited flow capacity, leading to significant system head loss. Due to the head loss experienced, the HSPs must work harder/longer to push treated (potable water) to the system. **The 6-inch diameter pipe has a limited flow capacity and causes the pumps to operate outside of the recommended operating range. Therefore, the system experiences head losses greater than designed for, adding further strain on pipes, pumps, and appurtenances such as valves and pipe joints/connections,** which is consistent with operational inefficiencies and frequent system failures historically experienced by SBV.

1.3.2 Medium Pressure Zone Operations

The section of the system served directly from the water plant, immediately downstream of the HSPs' PRV, operates as a medium pressure zone (see highlighted area on **Figure 4** below). This part of the system experiences elevated pressures (above 90 psi) due to the current system and HSP operations. Reference **Section 1.3.1** for further explanation of system operations.

FIGURE 4 – MEDIUM PRESSURE ZONE



1.3.3 Water System Modeled Operations

The current system operational conditions strain the system, particularly during periods of maximum demand when pressures drop below the required threshold of 35 psi for homes close to the GST. Recommended operating pressures in water systems typically range between 50 and 80 psi, and as regulated by the TCEQ.

Varying operating system pressures resulting from high piping head losses when the pumps are running versus not running (as recorded through pressure system monitoring) are contributing to long-term system stress and experienced frequent pipe failures, as reported by SBV Operations. **Over time, the resilience of pipe materials and fittings is impacted when system operating pressures fluctuate and/or are pushed to design limits, leading to more frequent pipe/joint leaks and failures.** The current operating levels of Clearwell and GST were previously established by SBV operations to meet pressure requirements. Conversations with SBV staff, along with model calibration to field data and subsequent validation, identified modified operational settings from original design.

2.0 Field Data Monitoring

2.1 Methodology

To facilitate obtaining system operating data, and specifically pressure data at key locations within the water system, 11 pressure monitoring locations were identified by HRG based upon analysis of system knowns and unknowns, applying three pressure monitoring devices (Singal Fire Pressure Ranger LTE-M/NB-IoT Cellular Pressure Transmitter) purchased and installed by SBV to record 24-hour data for one week per location. HRG collected the data through a pressure monitor online software access throughout the monitoring period and SBV provided exported SCADA data to obtain pump and tank operational information. Pressure monitoring began on July 2, 2024, and concluded on September 11, 2024. Throughout the system pressure monitoring period, one of the pressure monitors remained at the WP site, downstream of the HSPs. After the system data collection period ended, SBV continued to independently monitor system pressures at various locations across the system to assist with operations and identify pressure drops and leaks.

System operations information and SCADA data provided by SBV were compared with collected system pressure monitoring data. Field monitoring data was correlated/compared with SCADA pump operations to analyze system pressure fluctuations, head losses, and HGL variations across the system when pumps are operated (on and off conditions). The comparison of field monitoring pressures with system HGLs assisted in verifying applied system performance factors, including pipe roughness (measure of degree of interior pipe roughness), head losses, and overall water system functionality. PRVs and their corresponding HGLs were considered when analyzing the results of the field monitoring locations downstream of the control valves.

2.2 Data Analysis and Findings

Figure 5 and **Table 2** provide a map and tabulated summary of the pressure monitoring results by location correlated to HSPs operations (pumps on/pumps off). Reference **Table 2** notes for field monitoring observations and assumptions. GPS coordinates for each location were obtained from the monitoring data's online access (SignalFire cloud monitoring/alarming service), with the system operating HGLs initially estimated by adding 2 feet (assumed for hose bib ground clearance for pressure monitor installation) to the ground elevations obtained from Google Earth®.

FIGURE 5 – FIELD PRESSURE MONITORING LOCATIONS AND FINDINGS

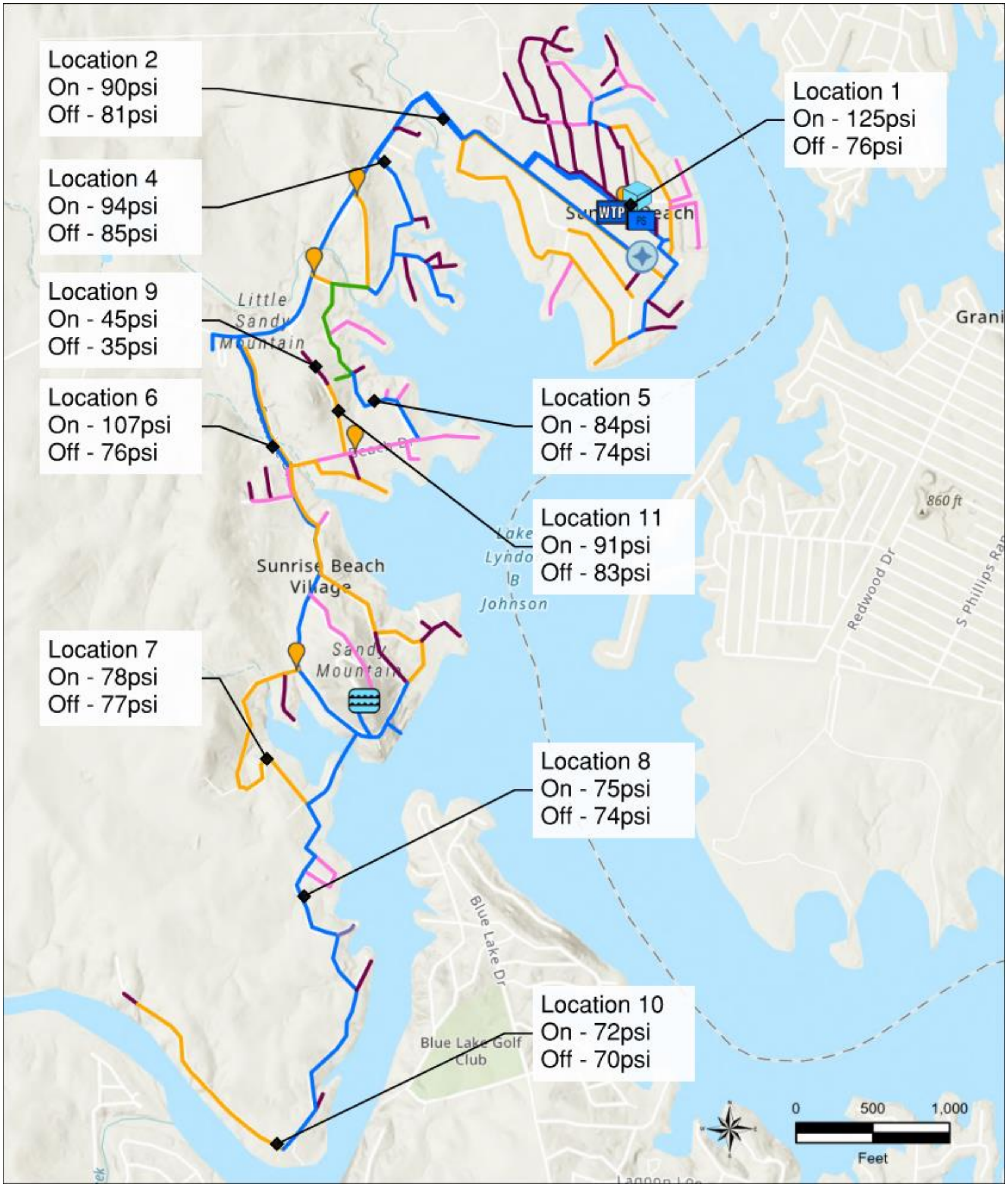


TABLE 2 – FIELD PRESSURE MONITORING LOCATIONS AND FINDINGS

Monitoring Period	Location	Location Description	Avg Recorded Pressure (psi) - HSPs On	Avg Recorded Pressure (psi) - HSPs Off
7/2 - 9/11	HSPs[1]	Downstream of HSPs	125.1	76.4
7/2 - 7/14	Location 2	Sunrise Beach Federated Church	90.0	80.7
7/14 - 7/19	Location 3	Council member's property	NA[2]	NA[2]
7/19 - 7/24	Location 4	Timbercove Park	93.5	84.6
7/25 - 7/31	Location 5	W Lakeshores Dr & Lake Terrace	84.0	74.4
7/31 - 8/6	Location 6	Sunrise Beach Village City Hall	106.6	76.3
8/6 - 8/16	Location 7	Sandy Mountain Dr	77.7	77.0
8/6 - 8/16	Location 8	Sandy Mountain Dr	75.3	74.1
8/16 - 8/27	Location 9[3]	Granite Shoals View	45.0[3]	34.8[3]
8/16 - 8/27	Location 10	Sandy Mountain Dr	72.3	70.2
9/6 - 9/11	Location 11	Granite Shoals View	90.9	82.4

Table 2 Notes:

1. Location 1, downstream of the HSPs, was continuously monitored throughout the pressure monitoring period.
2. Pressure monitoring data could not be collected at this location due to existing operations.
3. Location 9 was considered an outlier during calibration, therefore not applied in the model calibration, as additional pressure readings were collected upstream of Location 9, at Location 11. Reference **Section 3.4** for additional details**.**

The analysis of the field monitoring data validated observations from field operations and further confirmed in the model simulations. System inefficiencies and pressure fluctuations identified both in the model and witnessed in field operations, from our analysis, were found to be driven by a combination of factors, including:

- Pipe age and material,
- Hydraulic bottlenecks and transition points (changes in pipe size, bends, materials, etc.),
- Lack of a dedicated system transmission line,
- PRV placement and settings,
- System valve operations, and
- Calcification of pipe interior due to water source mineral content (reduced inside pipe diameter).

3.0 Water Hydraulic Model

3.1 Hydraulic Modeling Software

WaterGEMS®, developed by Bentley Systems, was the software applied to perform water system hydraulic modeling. WaterGEMS® works in conjunction with AutoCAD, MicroStation, ArcGIS, or as a stand-alone program in Microsoft Windows®. The hydraulic model can be run as a steady-state (SS) simulation, or as an extended period simulation (EPS). SS simulations produce results based on one initial set of "steady" conditions (i.e., number of pumps running, tank elevations, etc.). EPSs produce results based on changing "extended" conditions (i.e., tanks filling or draining, pumps turning off or on, etc.) over a specified time interval. The EPS represents a "real-world" simulation of the system by demonstrating the system operations dynamically over a set extended period.

3.2 Phase 2 Hydraulic Model

The static hydraulic model developed in 2023 during Phase 1 was refined based on system field monitoring and operations & maintenance information identified by SBV. For additional information regarding the Phase 1 model, reference the report "*Water Distribution System Improvements – Phase 1: Mapping, Modeling, and Planning*" dated February 22, 2024, developed by HRG, and delivered to SBV.

In the model refinement the topographic and utility survey data collected at both the WP site and the GST site was reviewed, and corrections in system connectivity were applied in the model accordingly. Discussions with SBV and a site visit on August 8th, 2024, served as a review of system connectivity, with further field findings from SBV operations applied in the model to correct system connectivity issues and validate model results.

System components included in the hydraulic model were updated based on the Geographic Information System (GIS) map of the water system developed by HR Green during the Phase 1 work, SBV-provided pump curves and record drawings, SCADA recorded data from July 2022 through August 2024, regional LiDAR contour data, field pressure monitoring data, and additional system information provided by SBV.

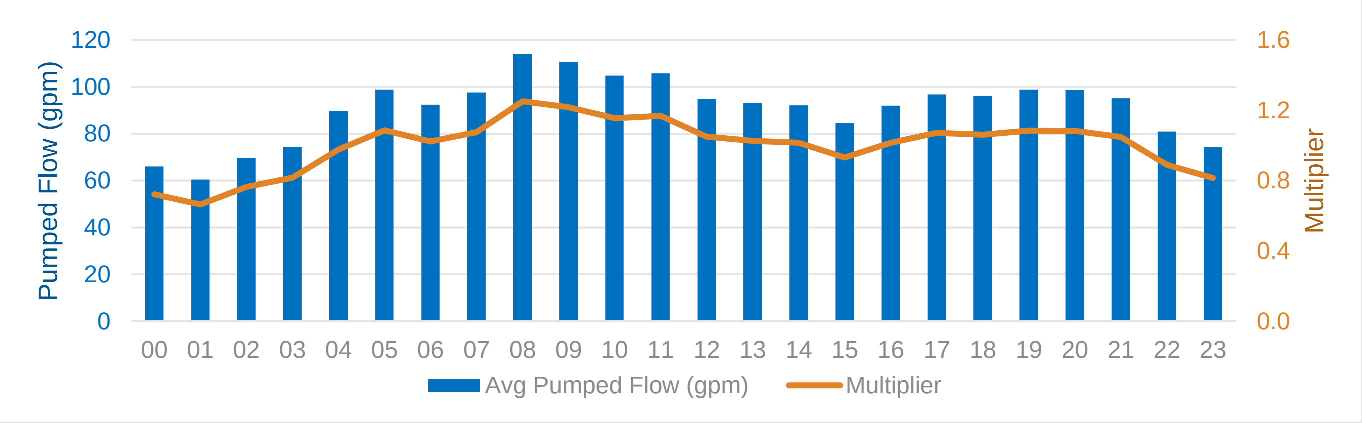
3.3 System Demands

SCADA HSPs pumped flow data for the existing water distribution system, provided by SBV operations, was applied in the model for the period from July 2022 through August 2024. SBV experiences seasonal water demand, with the highest production periods recorded during the summer months and federal holidays. A significant percentage of the area's residents are part-time, often spending weekends and warmer months in the region.

Due to the high variability in flow patterns, system usage curves and multipliers for hourly, daily, and monthly flows were developed as per historical pumped SCADA data and are shown in **Graphs 1 – 3**. These usage curves and multipliers were applied in the model to simulate the 72-hour EPS model for both average and maximum scenarios to closely reflect the demands experienced by the system, providing a more accurate representation of modeled conditions.

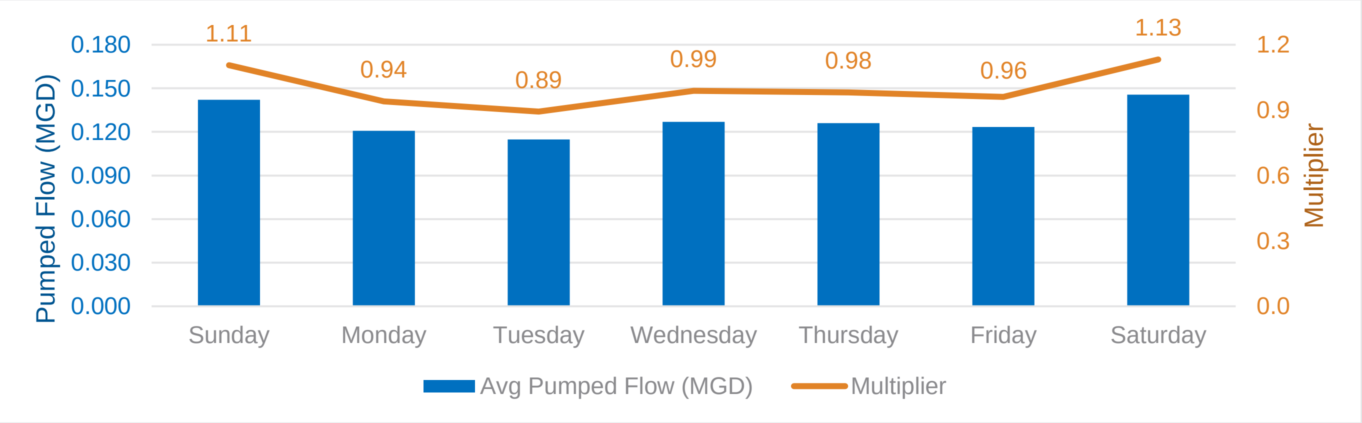
Graph 1 was used to develop the diurnal curves for all modeling scenarios. Diurnal curves illustrate the average variation in water demands experienced by a system over a 24-hour period. The multipliers on a diurnal curve represent each hour's flow relative to the average hourly flow for the system. **Graph 1** shows that 8 am represents the peak hour, with a multiplier of 1.2 (20% above the hourly average), while 11pm has a multiplier of 0.8 (80% of the hourly average).

GRAPH 1 – HOURLY FLOW PATTERN



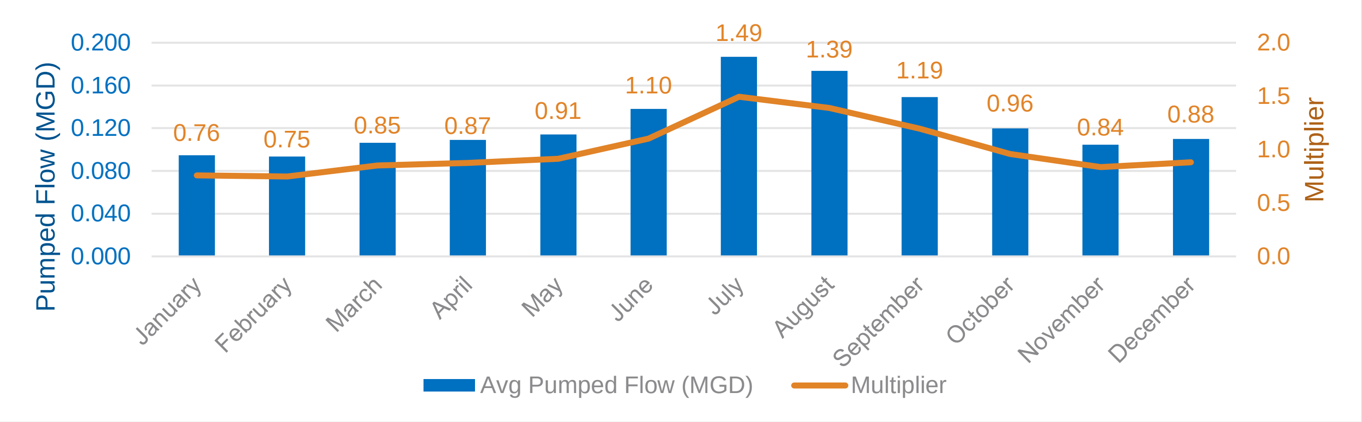
Graph 2 shows the average pumped flow per day of the week, with multipliers indicating the relationship between each day's flow and the ADF. Wednesday flows (multiplier of 0.99) closely represent ADF conditions, while Saturday and Sunday flows represent peak demands, with multipliers above 1.0.

GRAPH 2 – DAILY FLOW PATTERN



Graph 3 shows the average pumped flow per month, along with a trendline of multipliers representing each month's flow relative to the ADF. February exhibits the lowest flows (multiplier of 0.75), while July aligns with peak summer demands, indicating the highest flows (multiplier of 1.49, 49% above ADF).

GRAPH 3 – MONTHLY FLOW PATTERN



Based upon these multipliers, the ADF 72-hour EPS was modeled using April flows (multiplier 0.87, see **Graph 3**), from Monday through Wednesday (multipliers 0.94, 0.89, and 0.99; see **Graph 2**). The maximum daily flow (MDF) EPS was modeled using July flows (multiplier 1.49, see **Graph 3**), from Friday through Sunday (multipliers 0.96, 1.13, and 1.11; see **Graph 2**).

A tabulated and graphical summary of the ADF, MDF, maximum 1-hour peak flows (PF) and maximum 2-hour PFs is presented in **Table 3**Error! Reference source not found. and **Graphs 4 - 6**.

TABLE 3 – SCADA RECORDED PUMPED FLOWS

Flow Scenarios	Pumped Flows	Flow per Connection[1]	Time of Occurrence
Max 1h PF	20,903 gal	0.34 gpm/conn	August 5th, 2022, from 1-3pm
Max 2h PF	39,764 gal	0.32 gpm/conn	June 8th, 2023, from 10-11pm
MDF	0.299 MGD	0.20 gpm/conn	July 4th, 2024
ADF	0.129 MGD	0.09 gpm/conn	July 2022 through August 2024

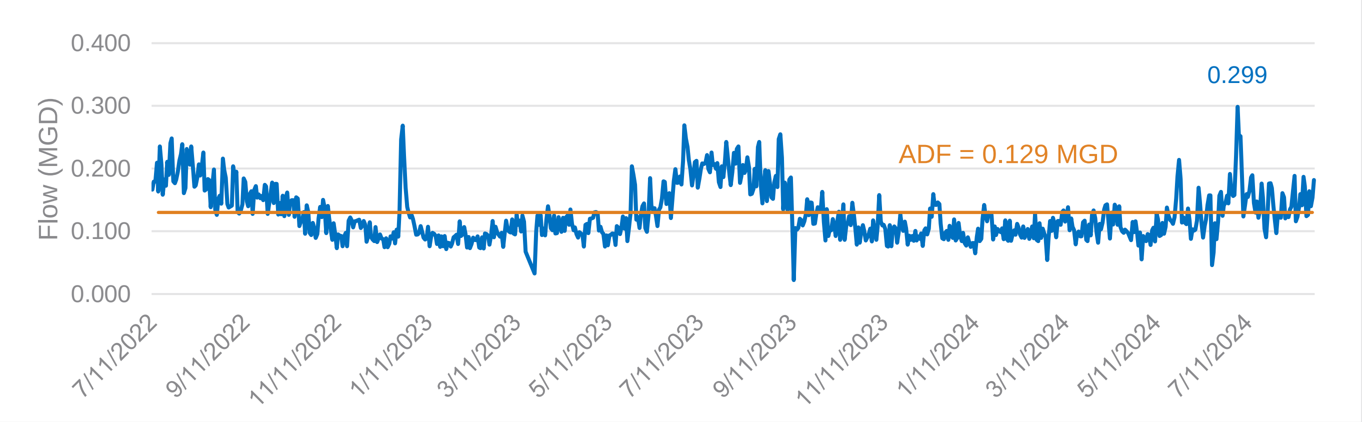
Table 3 notes:

1. Flow per connection calculated based upon SBV-documented customer accounts of 1,034 (August 2024).

While **Graphs 1 – 3** (on previous pages) display flows on an hourly, daily, and monthly basis, **Graphs 4 - 6** present daily recorded flows, further illustrating SBV's demand variability across seasons.

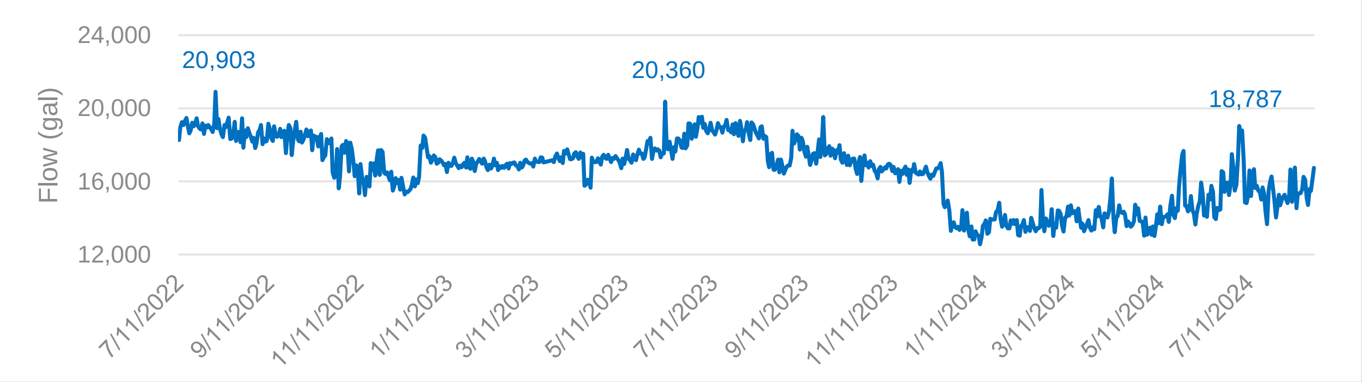
Graph 4 displays SCADA-recorded total daily distribution flows (HSP pumped), as provided by SBV. The orange trendline represents the ADF of 0.129 MGD, and the blue callout highlights the MDF of 0.299 MGD, recorded on July 4th, 2024. The elevated demand on July 4th, 2024, was the result of increased summer usage, the July 4th holiday, and a significant leak in the distribution system identified that impacted system pressures for 12 hours.

GRAPH 4 – TOTAL DAILY DISTRIBUTION FLOWS

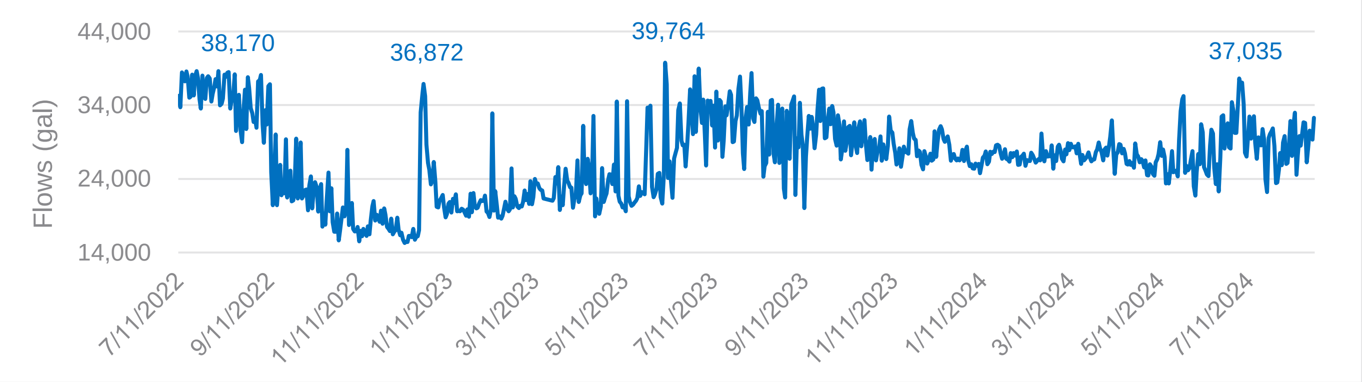


Graphs 5 & 6 display the 1-hour and 2-hour peak flows, calculated based on total pumped flows for continuous 1- and 2-hour intervals. The highlighted peak flows experienced within the past two years illustrate seasonal demands and the impacts of system water main breaks, as reported by SBV operations.

GRAPH 5 – 1 HOUR PEAK FLOWS



GRAPH 6 – 2 HOUR PEAK FLOWS



The ADF and MDF values in **Table 3** were applied to model system demands. **Table 4** provides demand values per model junction. Model junctions are points within a hydraulic model where demands, flows, pressures, and other conditions are calculated, simulating key locations in the water distribution network. ADF and MDF demands were equally distributed across model junctions to represent service connections. Demands were distributed based upon an aerial analysis of building and house connections.

TABLE 4 – EXISTING MODEL JUNCTION DEMANDS

Flow Scenarios	Demand per Connection (1,034 connections)[1]	Demand per Junction (514 junctions)
MDF	0.20 gpm/conn	0.40 gpm/junction
ADF	0.09 gpm/conn	0.17 gpm/junction

Table 4 notes:

1. Flow per connection calculated based on the SBV-documented customer count of 1,034 customers (August 2024). Reference **Table 3** for SCADA-recorded peak flows.

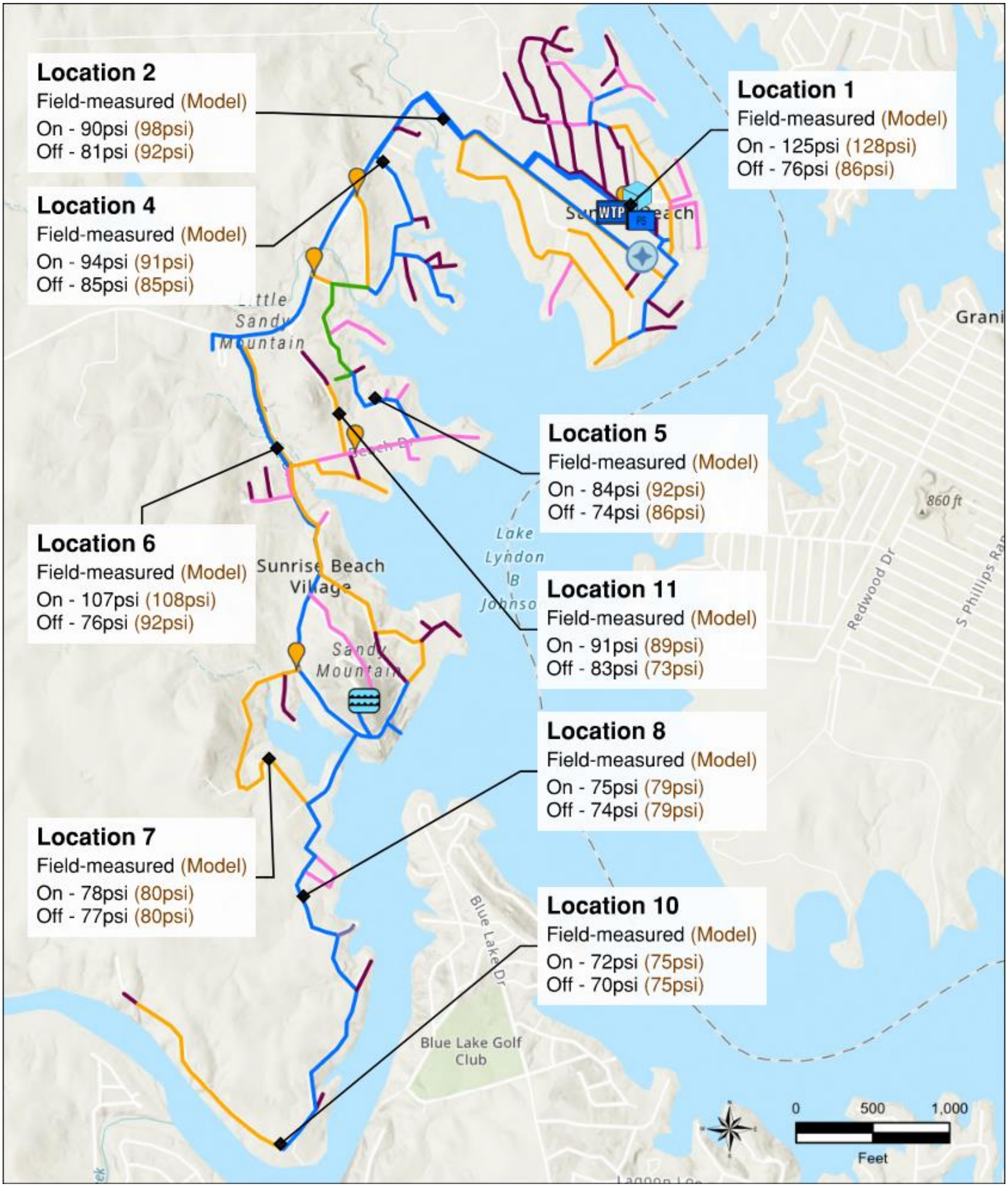
3.4 Model Calibration

Field monitoring data (pressure data) collection and analysis was performed to calibrate the hydraulic water model to emulate the system's hydraulic capability to supply water. The model is intended to be a dynamic tool for planning water system needs, with future updates and refinements as system operations and system characteristics are further defined and improvements are implemented.

Field monitoring data findings, as summarized in **Section 2** of this report, were compared to simultaneous analysis period of historical SCADA data. The monitors HGLs were estimated by adding 2 feet (assumed for hose bib ground clearance) to the ground elevations obtained from Google Earth at each monitoring location and adjusted as per field monitoring HGLs. Field monitoring data was aligned with SCADA pump operations to analyze pressure fluctuations and HGLs variations across the system when pumps were turned on and off. The comparison of field monitored pressures with system HGLs allowed model calibration by adjusting system performance factors, including pipe roughness, valve operations, head losses, and overall system functionality.

Figure 6 and **Table 5** summarize the model results in comparison to the average recorded pressure readings at each location when HSPs were both on and off.

FIGURE 6 – MODEL CALIBRATION RESULTS



Location 1
Field-measured (Model)
On - 125psi (128psi)
Off - 76psi (86psi)

Location 2
Field-measured (Model)
On - 90psi (98psi)
Off - 81psi (92psi)

Location 4
Field-measured (Model)
On - 94psi (91psi)
Off - 85psi (85psi)

Location 5
Field-measured (Model)
On - 84psi (92psi)
Off - 74psi (86psi)

Location 6
Field-measured (Model)
On - 107psi (108psi)
Off - 76psi (92psi)

Location 11
Field-measured (Model)
On - 91psi (89psi)
Off - 83psi (73psi)

Location 8
Field-measured (Model)
On - 75psi (79psi)
Off - 74psi (79psi)

Location 7
Field-measured (Model)
On - 78psi (80psi)
Off - 77psi (80psi)

Location 10
Field-measured (Model)
On - 72psi (75psi)
Off - 70psi (75psi)

TABLE 5 – MODEL CALIBRATION RESULTS

Location[1]	Field Monitor (psi) - HSPs On	Model (psi) - HSPs On	Model vs. Monitor (psi / %)		Field Monitor (psi) - HSPs Off	Model (psi) - HSPs Off	Model vs. Monitor (psi / %)[2]	
HSPs	125.1	128.43	*3.4*	3%	76.4	85.60	*9.3*	11%
Location 2	90.0	98.00	*8.0*	8%	80.7	91.56	*10.8*	12%
Location 4	93.5	91.25	*2.2*	2%	84.6	85.07	*0.4*	1%
Location 5	84.0	92.00	*8.0*	9%	74.4	85.95	*11.5*	13%
Location 6	106.6	107.65	*1.0*	1%	76.3	92.30	*16.0*	17%
Location 7	77.7	79.76	*2.1*	3%	77.0	79.71	*2.7*	3%
Location 8	75.3	78.76	*3.4*	4%	74.1	78.71	*4.6*	6%
Location 10	72.3	75.00	2.7	4%	70.2	75.00	4.8	6%
Location 11	90.9	88.6	2.3	3%	82.4	73.0	9.4	1%

Table 5 notes:

1. Location 3 was omitted from the results table due to lack of pressure readings; Location 9 was omitted due to being determined to be an outlier, with pressure readings from Location 11 applied instead. See **Table 2** footnote and explanation below.
2. Absolute percentage and pressure values.

The highest model to field data calibration variance was identified at Location 9, which SBV operations later determined to be a 2-inch cast iron pipe (IP) with severe calcification (see **Table 2**). After the monitoring period, the 2-inch IP was replaced with a 4-inch polyvinyl chloride (PVC) pipe. As a result, the Location 9 variance was considered an outlier during the calibration, and a second reading (Location 11) was gathered upstream of the 2-inch IP on the existing 4-inch PVC.

Surveying efforts have been limited to inside the fence facilities' boundaries to date, thus water lines and system valves have not been surveyed (except for GPS coordinates collected for key valves during the initial system mapping work in Phase 1) to determine/verify field elevations. While the varying mountain terrain and elevations/grade changes may influence junction elevations and HGLs, calibration results indicate that model accuracy closely aligns with real-world conditions, with a minimal 5.2% variation between field monitor measurements and model outputs.

3.5 Hydraulic Model Scenarios

Hydraulic model scenarios represent a specific set of operating conditions, simulating factors such as pump operations, tank levels, control valve operations, and other key system functions. SBV model scenarios were developed and evaluated for existing system operations and for simulations of proposed system improvements. For each model scenario, ADF and MDF conditions were applied, as described in

Section 3.3. The connection count documented by the SBV in August 2024 was 1,034 customers, and a maximum of 1,200 connections was assumed for proposed future modeled scenarios, as previously identified by SBV during Phase 1.

The hydraulic model can be run as a SS simulation, or as an EPS. SS simulations produce results based upon one initial set of “steady” conditions (i.e., number of pumps running, tank elevations, etc.). An EPS produces results based on changing “extended” conditions (i.e., tanks filling or draining, pumps turning off or on, etc.) over a specified time interval. The EPS represents a “real-world” simulation of the system by demonstrating the system operations dynamically over a set extended period of time.

Usage curves and multipliers (reference **Section 3.3**) were applied in WaterGEMS to simulate the 72-hour EPS for all modeled scenarios. The ADF and MDF 72-hour EPS modeling scenarios were designed to closely represent the demand patterns experienced by the system, reflecting seasonal fluctuation in the number of weekdays versus weekend residents. <u>The ADF condition was modeled to simulate April flows, from Monday through Wednesday (capturing non-summer weekday patterns), while the MDF condition simulated July flows, from Friday through Sunday (capturing summer and weekend demands).</u>

3.6 Existing System Model Analysis

The existing system scenarios were developed using the current system layout (shown in **Figure 1**), existing system operations, and 1,034 connections. The ADF and MDF demands applied were as per SCADA data from July 2022 through August 2024, as follows:

- ADF of 0.129 MGD, corresponding to 0.17gpm/junction
- MDF of 0.299 MGD, corresponding to 0.40gpm/junction

Figure 7 illustrates the existing HSPs pump curve and current pump operations. The pumps operate at approximately 230 gpm with an efficiency of 62.5%, as indicated by the manufacturer’s pump curve. This efficiency falls outside the manufacturer's recommended Best Efficiency Point (BEP), primarily due to the head (pressure required to overcome elevation differences and pipe friction) the pumps are working against. Pump manufacturers typically recommend operating pumps close to the BEP for **optimal energy efficiency and reduced wear.** In the SBV system, the elevated head is primarily due to the **high head losses experienced as a result of pumping the majority of the flow through the single 6-inch main, while acknowledging that head losses would be higher if a portion of the flow wasn’t being distributed in the system, currently**. The dynamic head losses experienced as the flow traverses a 16,500 LF pipe alignment, considering the same roughness friction coefficient of a new pipe, are significantly greater for a 6-inch pipe when compared to a larger pipe such as a 12-inch main. Given the finite flow capacity of a 6-inch pipe, the head losses are approximately 115ft (for 300gpm) compared to approximately 8ft (at 450gpm) for a 12-inch main.

FIGURE 7 – PUMP OPERATIONS: EXISTING SYSTEM

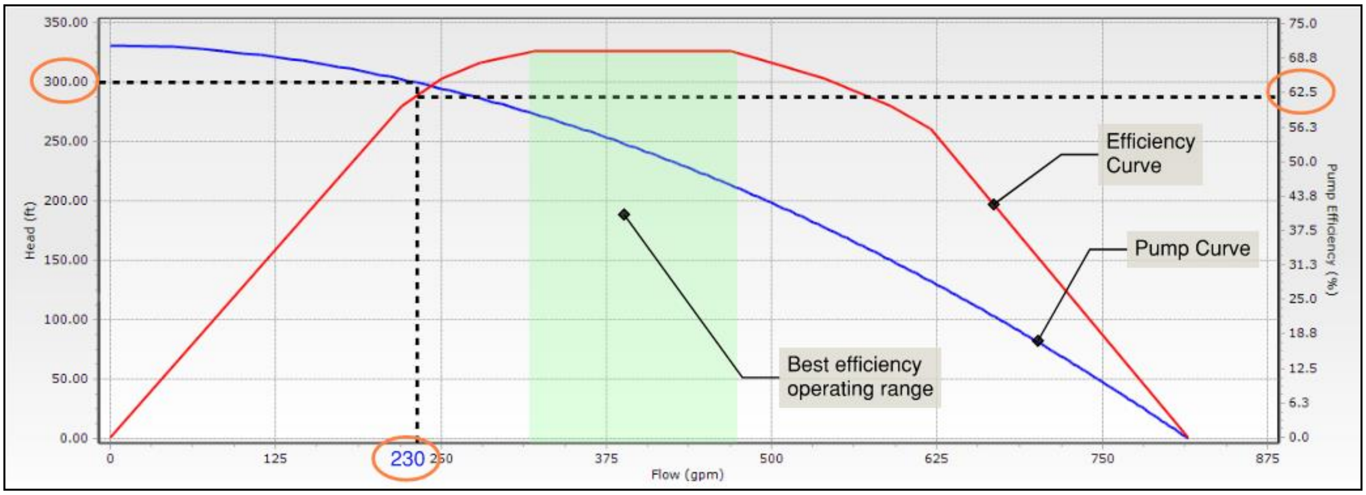


Figure 7 Note: operating the pumps outside the manufacturer-recommended best efficiency range (highlighted in green) requires the pumps to run longer cycles and at a reduced efficiency to deliver the same flow (in gallons).

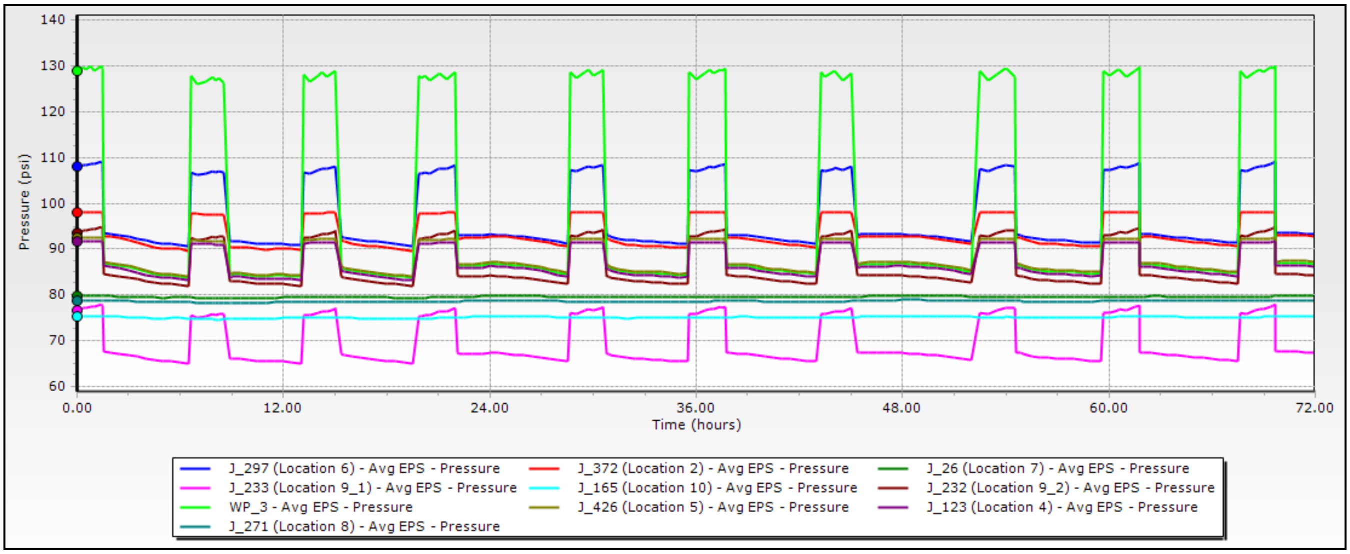
In the SBV system, the 6-inch main functions as both a transmission and distribution line. Due to the extended distance between the WP and GST and the reliance on a single 6-inch main, head losses experienced are significant when the pumps are on vs. when they turn off. This differential in head losses between pump-on and pump-off conditions leads to large pressure fluctuations throughout the system, resulting in expansion and contraction stresses, in which can cause premature material failures and frequent main breaks. Reference **Section 1.3.1** for additional information on transmission versus distribution mains, and the impact on system operations.

The pressure swings particularly affect customer service connections located between the WP and the GST, unless they are downstream of a PRV, which dampens the high pressures experienced when the pumps are operating. Downstream of the GST, however, minimal pressure swings are observed because those areas are not directly influenced by the high head losses in the single 6-inch main. As shown in

Figure 8 and observed during field pressure monitoring (reference **Section 2.2**), sudden pressure fluctuations occur at most locations, except for where the system is regulated by the same PRV (i.e., locations 7, 8, and 10). These fluctuations are caused by the 6-inch main serving dual functions and by PRV set operating points. Modifying PRV settings according to the desired system HGL can improve operating pressures by enabling flow direction as per demand.

When the pumps are operating, discharge pressures remain elevated. When the pumps turn off, the system relies on gravity flow from the GST, resulting in sudden pressure drops. Maintaining consistent pressure in the distribution system is critical for system stability, and pressure variations can lead to operational inefficiencies and potential system failures.

FIGURE 8 – PRESSURE VARIATIONS EXISTING SYSTEM



The sustained pressure variations, along with pressures exceeding 80 psi, contribute to the likelihood of stress/strain on the pipes/joints and resultant leaks and failures. Other contributing factors include:

- Pipe Age: Older pipes are more prone to failure, especially under stress.
- Pipe Materials: The system contains Asbestos Cement (AC) and Iron Pipe (IP), which are more vulnerable to failure under high pressures.
- Small Pipe Diameters: Many pipes are smaller than 6 inches in diameter, which further increases the likelihood of pipe and joint failures due to higher velocity and stress.

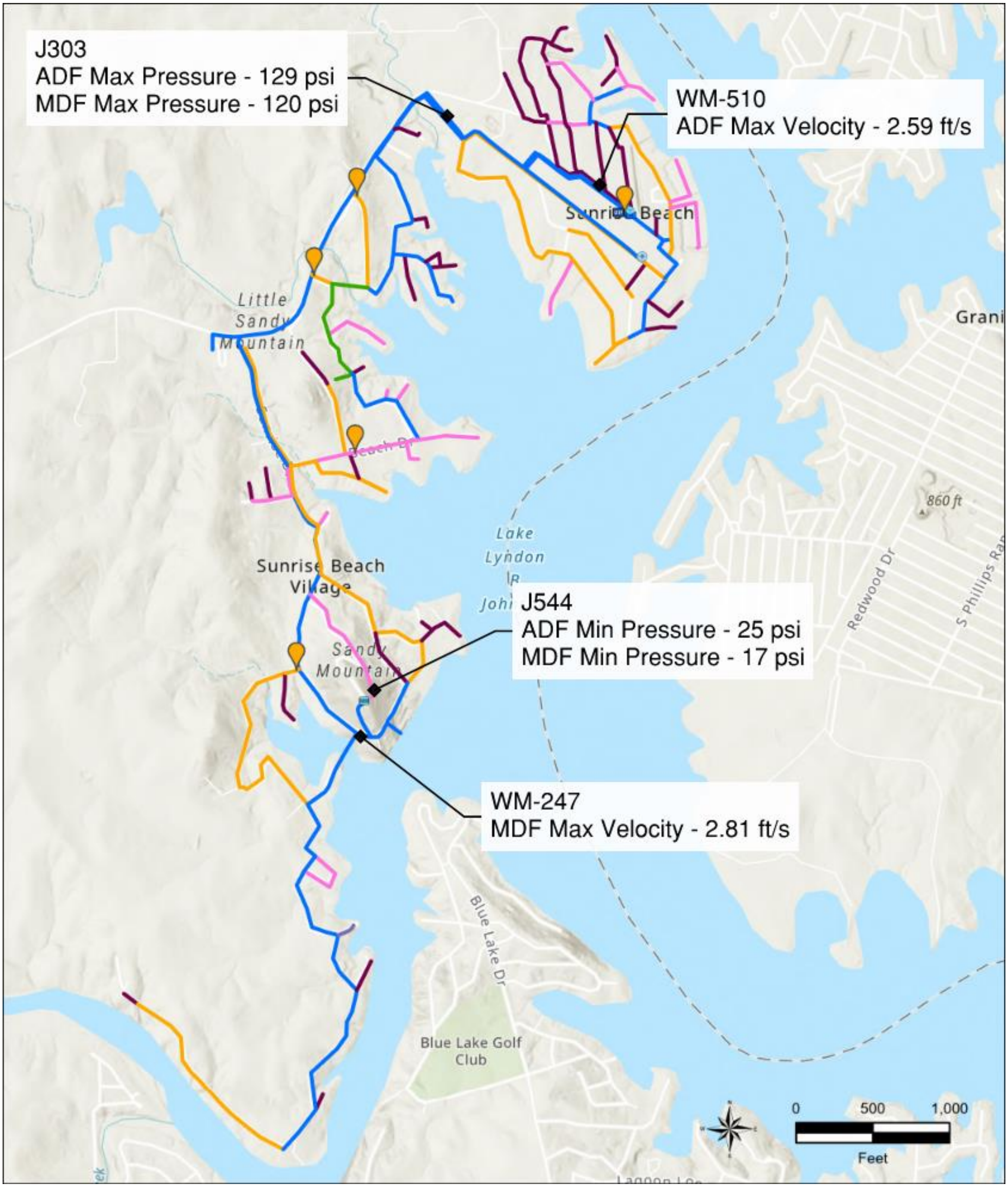
3.6.1 Existing System Model Results

Table 6 and **Figure 9** below present a summary of key results observed in the existing system model analysis, including the lowest and highest pressures, and highest velocities observed during the system's operations for both ADF and MDF conditions. For each resultant condition, a location within the distribution system has been provided to highlight the operational conditions at different points across the system.

TABLE 6 – EXISTING SYSTEM MODEL RESULTS

Scenario		Junction / Pipe	Pressure / Velocity	Location
ADF	Min Pressure	J544	25 psi	Mountain Top (*3in PVC*)
	Max Pressure	J303	129 psi	E Lakeshore Dr (*6in PVC*)
	Max Velocity	WM-510	2.59 ft/s	Circle Dr (*6in PVC*)
MDF	Min Pressure	J544	17 psi	Mountain Top (*3in PVC*)
	Max Pressure	J303	120 psi	E Lakeshore Dr (6in PVC)
	Max Velocity	WM-247	2.81 ft/s	Skyline Dr (*6in AC*)

FIGURE 9 – EXISTING SYSTEM MODEL RESULTS



The operating levels of the existing Clearwell and GST have a direct impact on pressure stability and HSP operating capacity and efficiency, as shown in **Figure 10**, and as described in **Section 6**. The figure below provides a schematic of two operational scenarios:

- **Operations A**: Clearwell at a low operating level (approx. 7 ft), and GST at its highest operating level (approx. 17ft).
- **Operations B**: Clearwell at its highest operating level (approx. 16ft), and GST at a low operating level (approx. 7ft).

These scenarios demonstrate the impact of tank levels on pump operating head. When accounting for the base elevations of each tank, the elevation head difference the HSPs overcome in Operations A is approx. 10% higher than in Operations B. This variation highlights how changes in operating levels can influence pump efficiency and operating ranges (refer to **Figure 7**).

FIGURE 10 – TANK LEVELS VS. PUMP OPERATIONS

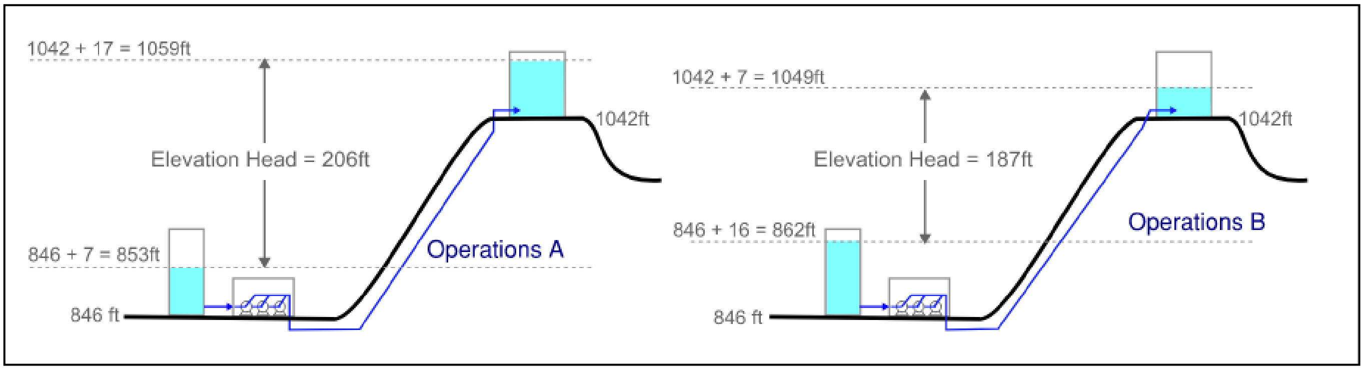


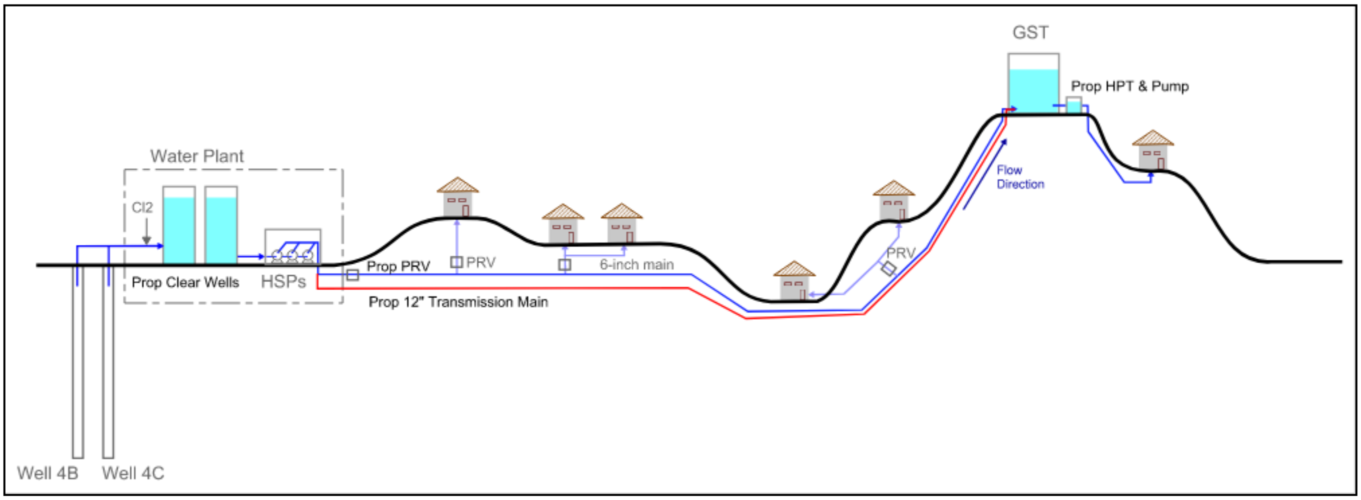
Figure 10 note: this schematic does not represent the total head loss experienced by the system, and is intended for representation purposes only, assuming similar dynamic losses due to pipe alignment for both operations.

3.7 Proposed System Improvements

The following outlined improvements are proposed, per performed feasibility analysis, to address the existing system deficiencies as identified in **Table 6** and **Figure 9** (**Section 3.6.1**). Pressures above 120 psi near the WP are due to the undersized 6-inch main based on the target pumping rates. Pressures below 35 psi at Mountain Top are a result of the HGL limitations associated with the GST and close elevation proximity of the customers being served by the GST. Both the minimum and maximum pressures (refer to **Table 6**) fall outside the required minimum of 35 psi and exceed the industry-recommended maximum of 80-85 psi.

Three (3) modeled scenarios were evaluated to determine the system impact of applying various levels/types of system improvements, as outlined in **Section 3.8.1 through 3.8.3**. Each scenario introduced a series of upgrades aimed at addressing TCEQ regulatory compliance requirements and operational issues related to pressure, flow, and storage observed in the existing system. **Figure 11** provides a schematic of the proposed system improvements described in **Sections 3.7.1 through 3.7.3**.

FIGURE 11 – PROPOSED SUNRISE BEACH VILLAGE WATER SYSTEM



3.7.1 *Pumping & Distribution System Improvements*

The guidelines provided in 30 TAC §290.45 were applied to evaluate the SVB water system and determine minimum system requirements. **§290.45(b)(1)(D)(iii) defines that a water distribution system should have "two or more pumps that have a total capacity of 2.0 gpm/conn or have a total capacity of at least 1,000 gpm and the ability to meet peak hourly demands with the largest pump out of service, whichever is less".** For the SBV system, 2,400 gpm of pumping capacity would be required to achieve 2.0 gpm/connection, based upon the defined criteria. Alternatively, 1,000 gpm of pumping capacity can be provided by operating the HSPs at their best efficiency point (BEP) with a dedicated transmission main. Reference **Section 3.6** for further information on manufacturer-recommended operating points.

Optimal sizing for the transmission main was evaluated through model simulations for the performance of the HSPs with an 8-, 10-, and 12-inch transmission main. ADF and MDF model conditions were analyzed to determine if pumps were able convey a minimum of 1,000 gpm and if two pumps were able to meet peak hourly demands. **Table 7** presents the modeled HSP flows (**with three pumps running**) for each pipe size. For all proposed modeled scenarios, it was assumed that the system operates as originally designed, with two pumps running (2 duty) and one pump on standby, and GST and Clearwell levels were adjusted to align with pumps' BEP and meet TCEQ minimum requirements.

TABLE 7 – TRANSMISSION MAIN SIZE VS. 3-PUMP OPERATIONS

Transmission Line Size	Total HSP Flows ADF (gpm)	Total HSP Flows MDF (gpm)
8-inch	737	854
10-inch	1,042	1,121
12-inch	1,268	1,313

The 8-inch main, as simulated in the model, is unable to meet the 1,000-gpm minimum requirement during peak conditions (even with three pumps operating), thus not considered as part of the analysis.

The SBV system was designed (in accordance with industry standards) with two pumps operating and one pump on standby. With two pumps operating, a 10-inch and a 12-inch main are capable of conveying both ADF and MDF flows while maintaining a flow velocity between 2-3 ft/s, aligning with industry-recommended flows velocities to limit frictional head loss and prevent excessive wear on pipes and joints. American Water Works Association (AWWA), a nation-wide industry guideline, recommends a pipe velocity range of 2-5 ft/s to prevent flow stagnations (water age) and sediment accumulation while limiting friction losses, wear on pipes and joints, and avoiding water hammer effects.

With a single pump running, the modeled velocities for the 10-inch and 12-inch are the following:

- 10-inch ADF = 1.73 ft/s; 10-inch MDF = 1.15 ft/s
- 12-inch ADF = 1.30 ft/s; 12-inch MDF = 1.0 ft/s

With two pumps running, the modeled velocities for the 10-inch and 12-inch are the following:

- 10-inch ADF = 2.89 ft/s; 10-inch MDF = 2.38 ft/s
- 12-inch ADF = 2.50 ft/s; 12-inch MDF = 2.25 ft/s

The 10-inch and 12-inch transmission main, as simulated in the model, have the capacity to convey 1,000 gpm with three pumps operating, while also providing sufficient capacity to meet MDF EPS conditions with one pump out of service, as verified by model results, and as required by TCEQ 30 TAC 290.

While the 10-inch main achieves the 1,000-gpm requirement, a 12-inch main is recommended to provide for system resiliency and provide for future demand needs. The 12-inch main sizing also considers that the high service pumps will likely be replaced in the near future due to their current age, allowing for the opportunity to size new pumps to maximize the 12-inch main capacity for long-term efficiency and performance. The estimated cost difference between a 10-inch and 12-inch main is approximately 7%.

ADF and MDF demands applied were as per scaled SCADA-recorded flows to reflect 1,200 connections, an increase of 166 connections (from the current 1,034):

- ADF of 0.19gpm/junction
- MDF of 0.45gpm/junction

3.7.2 Storage Improvements

Two (2) 70,000-gal new clearwells proposed to achieve TCEQ minimum storage requirements compliance are **applied in all proposed model scenarios**. New proposed clearwells are proposed to be constructed at an elevation higher than the existing structure to increase the HGL available to the HSPs, reducing the required operational head. Repurposing and improving the existing Clearwell indefinitely is not feasible, as its height would restrict the HGL of the new tanks. The clearwells' sizing (height and diameter) will be determined during the final design phase, in compliance with the Federal Aviation Administration (FAA) requirements (see **Section 4.2.2**).

3.7.3 Pressure Maintenance Improvements

A 2,000-gallon HPT and 40-gpm dedicated booster pump package system, sized to meet TCEQ minimum requirements, is proposed to achieve pressure maintenance along Mountain Top Rd., providing consistent pressures above 50 psi in areas limited by the GST's HGL. **HPT package system improvements are included in all proposed model scenarios**.

The installation of the HPT effectively addresses the low pressures experienced by customers served on the Mountain Top Rd, overcoming the lack of elevation difference between the GST operating levels, as described in **Section 3.6**. The proposed PRV 6 (see **Table 8**) will prevent pressure increases at the lower elevations along the road.

Figure 12 shows a graphical profile of the alignment, displaying both pressures and elevations along Mountain Top Rd. The yellow pressure marker in **Figure 12** indicates the junction immediately downstream of the HPT, with a pressure of 65 psi at an elevation of 993 ft. PRV 6 is proposed approximately halfway down Mountain Top Rd., at an elevation of 961 ft, reducing pressures from approximately 80 psi to 50 psi., allowing the pressures to naturally rise again due to the elevation decline, resulting in a pressure of approximately 80 psi at the lowest point along the road. The existing gate valve upstream of the intersection should remain closed to maintain isolation of this area as a separate pressure zone, per the feasibility analysis performed.

The PRV settings were adapted in the model to provide consistent HGLs and pressures throughout the system, with the goal of creating more stable operating conditions, particularly in areas prone to pressure fluctuations. **Table 8** provides graphical details of the updated existing PRV settings and proposed PRV settings (further discussed in the following sections). Following the construction of the transmission main, pressure monitoring is recommended to evaluate real-world conditions and further refine the hydraulic model, allowing for fine-tuning of the PRV set operating points as needed.

FIGURE 12 – PRESSURE MAINTENANCE PROPOSED IMPROVEMENTS

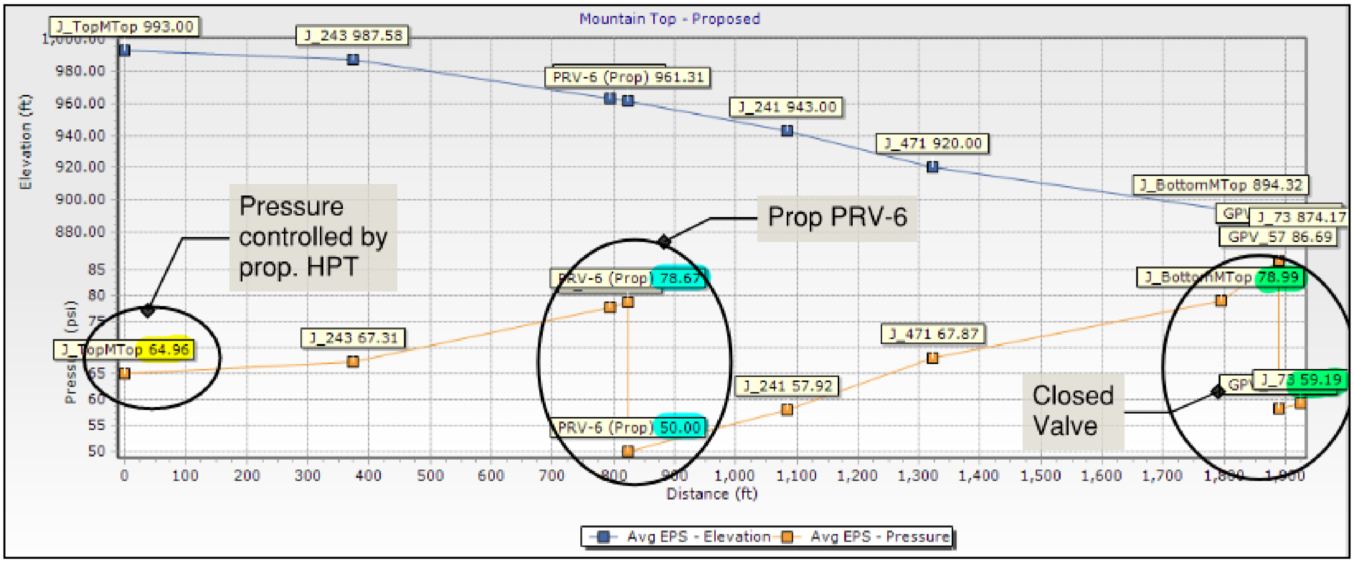


TABLE 8 – PRV PROPOSED SETTINGS

PRV Label[1]	Location	Pressure Setting (psi)	HGL Setting (ft)
PRV-1	Beach Dr	73	1,013
PRV-2	Sandy Mountain	80	1,024
PRV-3	Winding Way	50	1,016
PRV-4	W Lakeshore	50	996
PRV-5	Water Plant	70	1,010
PRV-6 (Prop)	*Mountain Top*	*50*	*1,077*
PRV-7 (Prop)	*6" Distribution (WP)*	*70*	*1,010*
PRV-8 (Prop)	*6" Distribution (12” Tie-In)*	*50*	*1,005*

Table 8 notes:

1. Refer to **Sections 3.8.1 through 3.8.3** for the location of proposed PRVs.

3.8 Proposed Improvements’ Model Scenarios

The iterative modeling of proposed improvements allowed for a detailed evaluation of system modifications necessary to meet operational requirements and regulatory standards. Each scenario illustrates the impacts of the proposed transmission line, PRV pressure settings, pumping capacity, and storage improvements. The model scenarios’ results emphasize the importance of optimizing flow distribution between the transmission main and storage in achieving reliable and efficient system operations. The scenarios also demonstrate how PRV set points contribute to maintaining consistent system pressures.

The following sections describe proposed improvements resulting from the modeled scenario. Each scenario builds progressively on the previous one, with Scenario 2 incorporating improvements from Scenario1, and Scenario 3 further expanding on improvements from both Scenarios 1 and 2.

3.8.1 Model Scenario 1

The purpose of this simulation is to assess the impact of initially constructing half of the new transmission line in addition to addressing TCEQ minimum requirements for storage and pressure maintenance. The following improvements were simulated in the hydraulic model:

- Two (2) 70,000-gallon clearwells at the WP,
- A 2,000-gallon HPT and 40-gpm booster pump at the GST site,
- Approximately 8,000 LF of 12-inch transmission main (representing half of the full transmission line), and
- Three (3) PRVs located at Sandy Mountain, the 6-inch main leaving the WP, and the 6-inch tie-in to the 12-inch transmission line.

Reference **Figure 15** (page 39) for a visual representation of the proposed system improvements.

By implementing half of the proposed pipeline improvements, some high system pressures and pressure variations were reduced during ADF conditions. However, during MDF conditions, the system model continues to experience pressure-related issues like those observed in the existing system. Without a dedicated transmission line from the HSPs to the GST, pressure fluctuations remain controlled by the intermittent operation of the pumps, impacting system stability during higher demand periods. A comparison of the pressure variations between ADF and MDF conditions is illustrated in **Figure 13** and **Figure 14**, respectively, which display the impacts of the absence of a dedicated transmission line.

FIGURE 13 – PRESSURE VARIATIONS MODEL SCENARIO 1: ADF

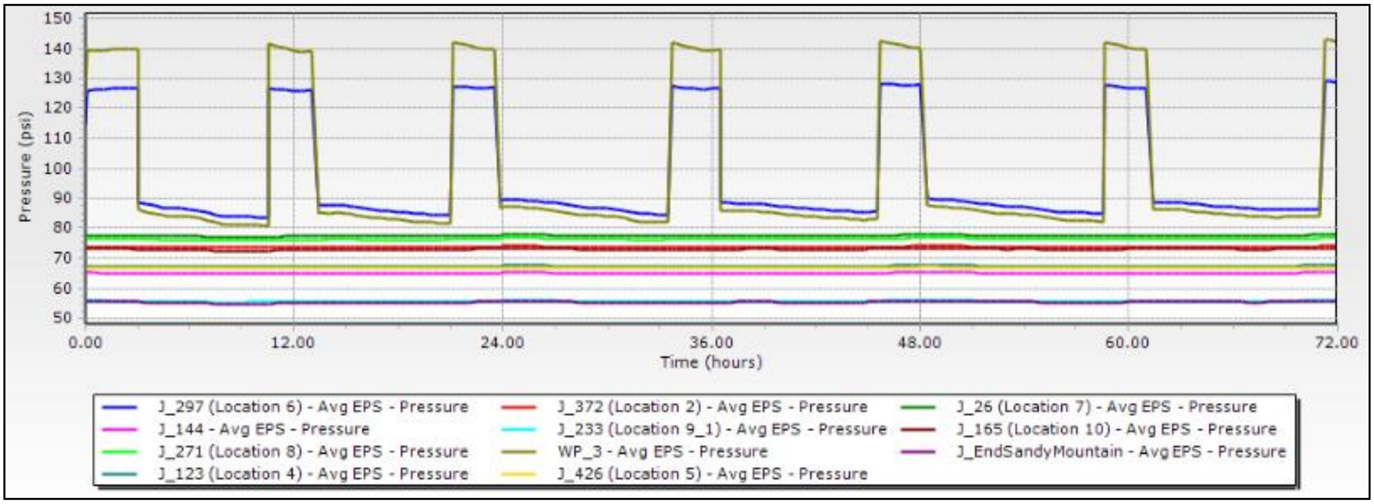


FIGURE 14 – PRESSURE VARIATIONS MODEL SCENARIO 1: MDF

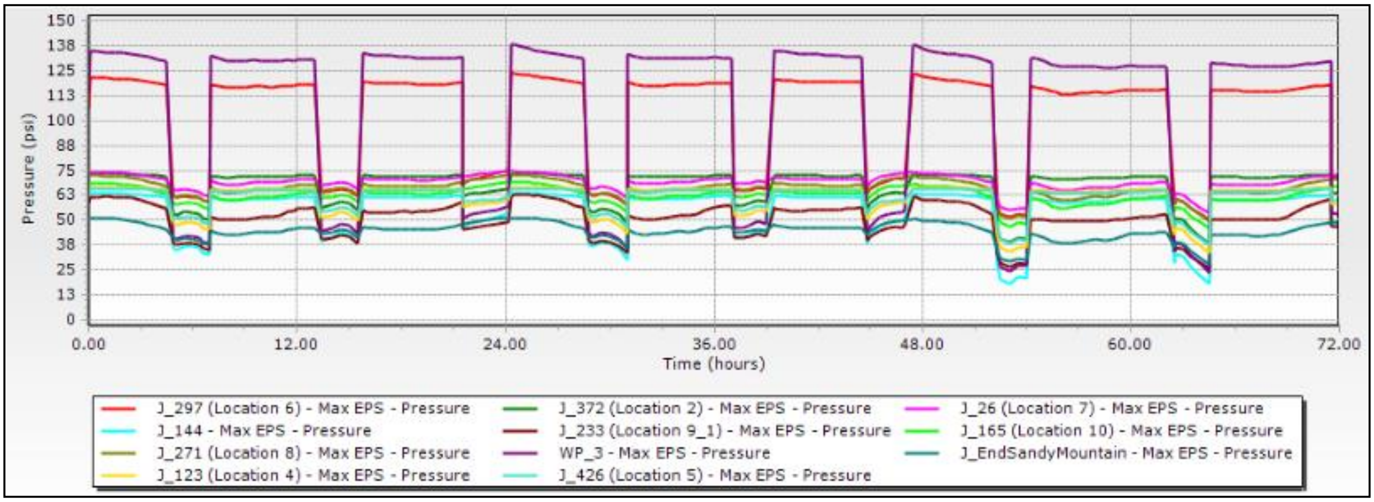
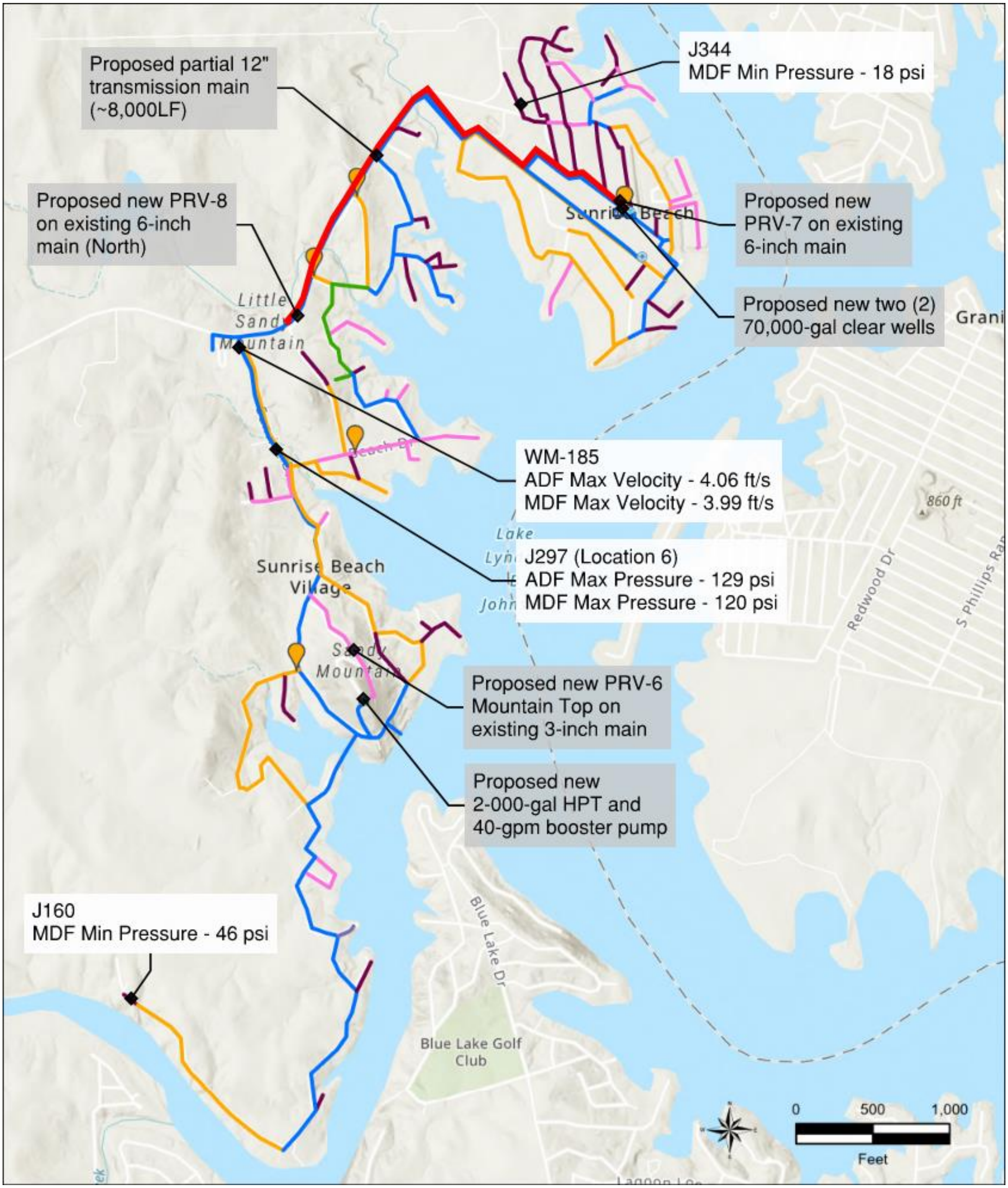


Table 9 and **Figure 15** present a summary of key results for both ADF and MDF conditions, including the minimum pressure, maximum pressure, and maximum velocity. These results highlight the system's performance across different operational scenarios. Water system operating pressures lower than 35 psi were observed at Junction J334, falling below the TCEQ minimum pressure requirement. The modeled pressure of 18 psi fails to meet regulatory standards, as it can negatively impact water quality and daily activities (i.e., lawn watering, showing, washing dishes, etc.). Additionally, 129 psi was recorded at Junction J297 (corresponding to Location 6 during field monitoring), where the 6-inch main continues to serve dual purpose for both distribution and transmission.

TABLE 9 – MODEL SCENARIO 1 IMPROVEMENTS

Scenario		Junction / Pipe	Pressure / Velocity	Location
ADF	Min Pressure	J160	46 psi	Winding Way (4in PVC)
	Max Pressure	J297 (Location 6)	129 psi	Sunrise Dr (6in PVC)
	Max Velocity	WM-185	4.06 ft/s	Sunrise Dr (6in PVC)
MDF	Min Pressure	J334	18 psi	Buck Trail (2in PVC)
	Max Pressure	J297 (Location 6)	124 psi	Sunrise Dr (6in PVC)
	Max Velocity	WM-185	3.99 ft/s	Sunrise Dr (6in PVC)

FIGURE 15 – MODEL SCENARIO 1: IMPROVEMENTS & RESULTS



3.8.2 Model Scenario 2

The purpose of this simulation is to assess the impact of constructing the full transmission line along with addressing TCEQ minimum requirements for storage and pressure maintenance, paired with minimal pipeline improvements. The following improvements were simulated in the model:

- All improvements from Scenario 1,
- A total of approximately 16,500 LF of 12-inch transmission main (from WP to GST), and
- Approximately 400 LF of 4-inch PVC pipe replacement at Sandy Mountain Dr to address a 2-inch IP section.

Reference **Figure 19** (on page 43) for a visual representation of the proposed system improvements.

The dedicated 12” transmission main provided stability in pressures across the system, with most areas maintaining stable pressures between 50 and 80 psi. In this model scenario, with two pumps operating, the pumps each achieved an operating range of approximately 400-450 gpm during ADF conditions, which falls within the pump’s manufacturer recommended best efficiency operating range. **Figure 16** shows a comparison between the proposed pump operations and the existing pump operations. Installing a dedicated 12-inch transmission main reduces the system’s total operating head to approx. 235 feet and allows the existing HSPs to operate at their highest rated efficiency of approximately 70%.

FIGURE 16 – PUMP OPERATIONS: PROPOSED SYSTEM

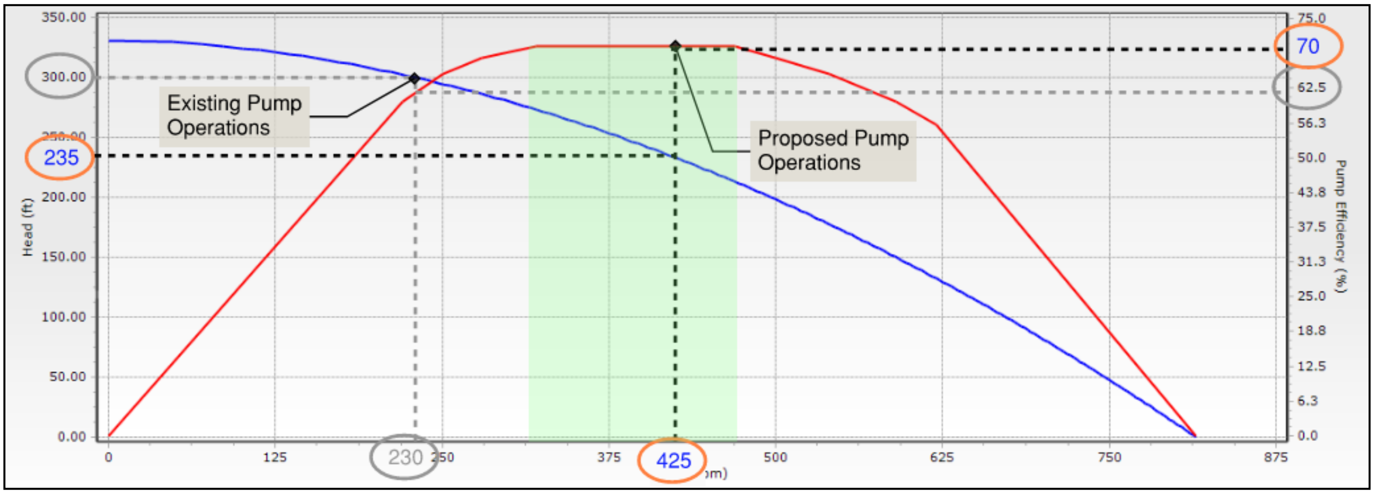


Figure 17 and **Figure 18** illustrate the model pressure at various junctions for ADF and MDF conditions, respectively. A pressure variation is observed at the junction for the transmission main, which is expected for a dedicated transmission main and does not impact the distribution system operations. The pressure stability across the system is due to the adjusted PRV settings (refer to **Table 8**), tank levels, and pumps proposed operating conditions.

FIGURE 17 – PRESSURE VARIATIONS MODEL SCENARIO 2: ADF

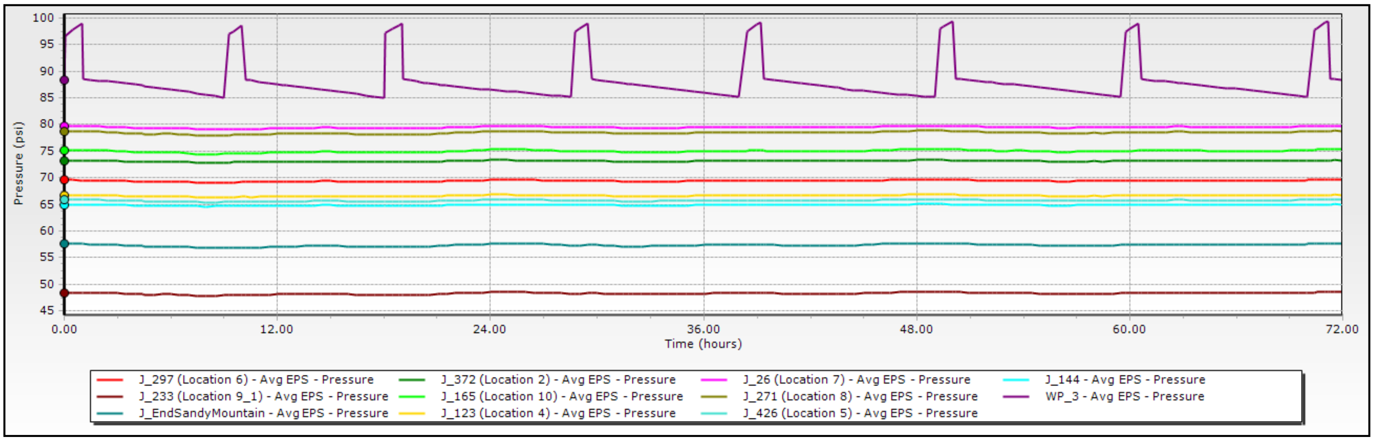


FIGURE 18 – PRESSURE VARIATIONS MODEL SCENARIO 2: MDF

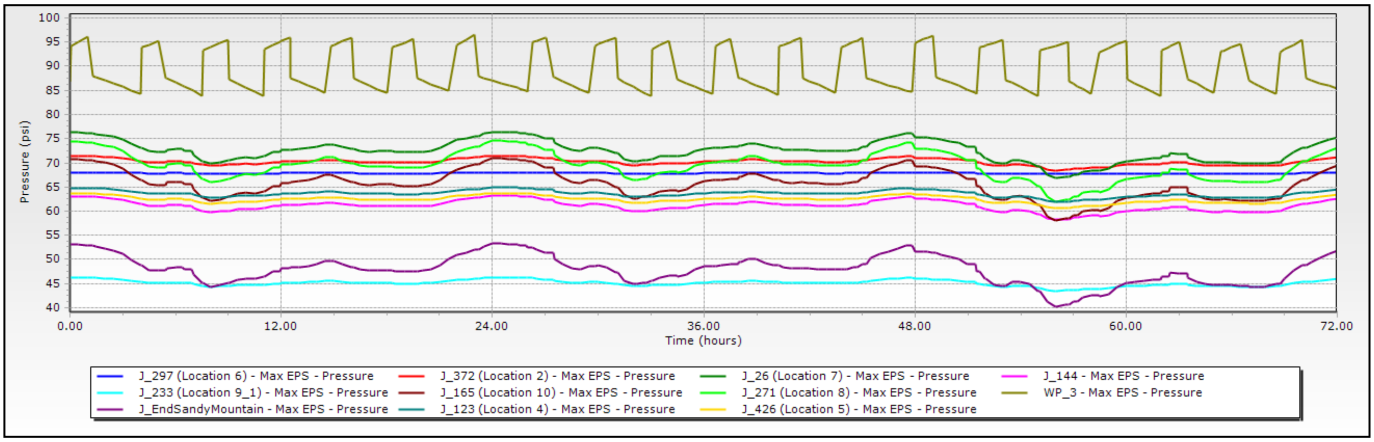


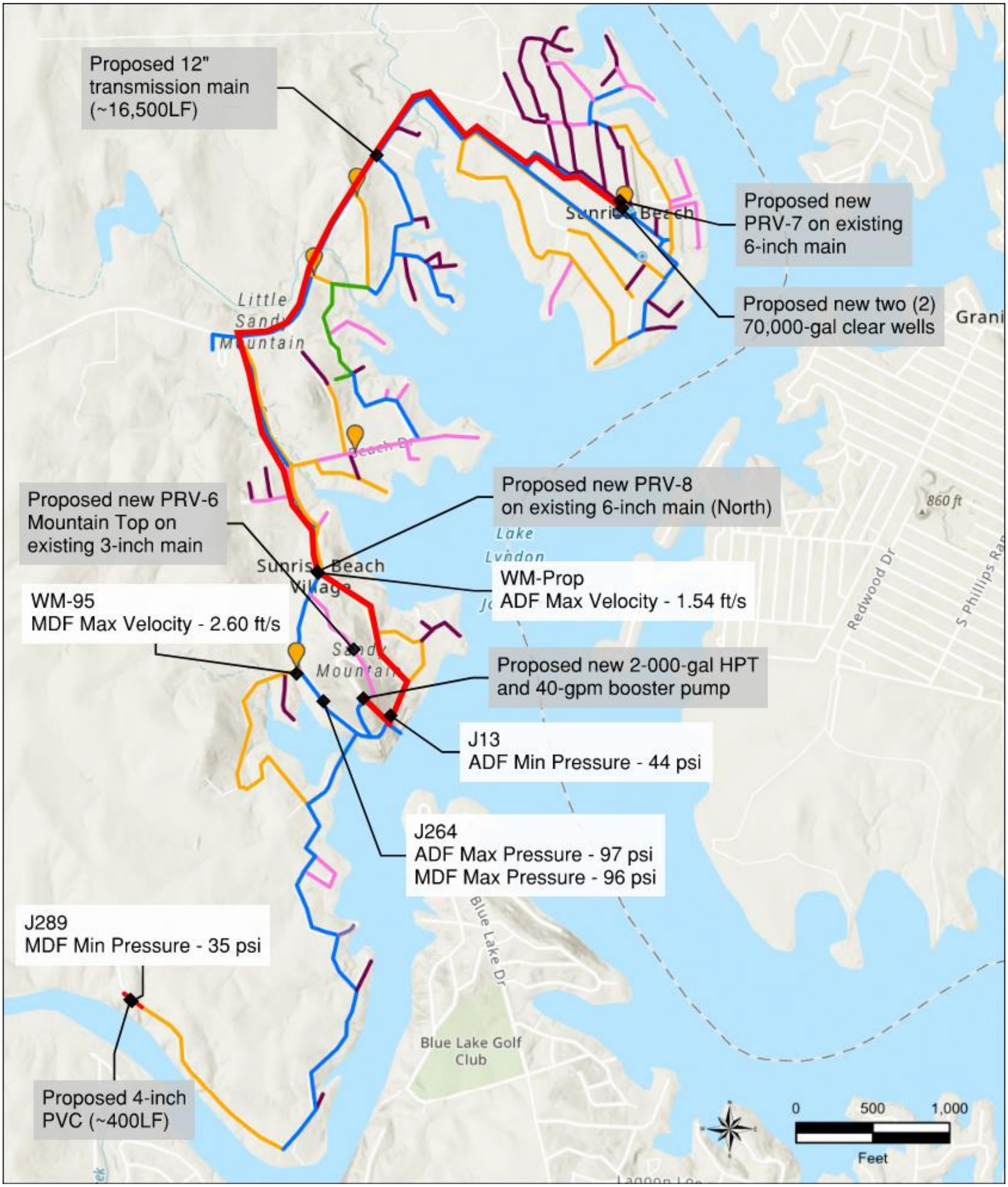
Table 10 and **Figure 19** present a summary of key results for both ADF and MDF conditions, including the minimum pressure, maximum pressure, and maximum velocity. In this simulation, both ADF and MDF conditions meet TCEQ minimum pressure requirements of 35 psi. The higher pressures (above 80 psi) simulated in the model at a few locations near the GST, primarily due to the variability in elevation across the system.

National industry standards such as the International Plumbing Code (IPC) specify minimum pressure requirements for daily water usage activities (i.e., minimum 20 psi for showers), and maximum pressure for plumbing fixtures (i.e., maximum 80 psi for shower head), which relate to a minimum pressure delivered to the home.

TABLE 10 – MODEL SCENARIO 2 IMPROVEMENTS

Scenario		Junction / Pipe	Pressure / Velocity	Location
ADF	Min Pressure	J13	43 psi	Skyline Dr (6in AC)
	Max Pressure	J264	97 psi	Skyline Dr (6in AC)
	Max Velocity	WM-Prop	1.06 ft/s	Sandy Mountain Dr (6in PVC)
MDF	Min Pressure	J289	35 psi	Sandy Mountain Dr (4in AC)
	Max Pressure	J264	96 psi	Skyline Dr (6in AC)
	Max Velocity	WM-95	2.60 ft/s	Sandy Mountain Dr (4in AC)

FIGURE 19 – MODEL SCENARIO 2: IMPROVEMENTS & RESULTS



3.8.3 Model Scenario 3

The purpose of this simulation is to assess the impact of constructing the full transmission line improvements along with addressing TCEQ minimum requirements for storage and pressure maintenance, paired with key pipeline improvements. The following improvements were implemented in the model:

- All improvements from Scenario 2,
- Approximately 4,000 LF of 6-inch PVC to address bottlenecks at Sandy Mountain Dr, and
- Approximately 10,000 LF of 4-inch PVC to replace all 2-inch lines in the North medium pressure zone.

In model Scenario 3, improvements from Scenarios 1 and 2 were applied, along with key pipe upgrades, to enhance system resiliency and achieve compliance with TCEQ minimum pipe size requirements for the number of connections served. Reference **Figure 22** (on page 46) for a visual representation of the proposed system improvements.

The pressure recorded of 35 psi during MDF conditions in model scenario 2 (refer to **Table 10** results), at the southern end of Sandy Mountain Road, was improved to 55 psi in model scenario 3. This 20-psi increase was achieved by addressing the 4-inch bottleneck along Sandy Mountain, where the pipeline transitioned from 6-inch to 4-inch and then back to 6-inch. This bottleneck was replaced with a continuous 6-inch PVC, reducing the head loss in this section while maintaining a more linear HGL.

Figure 20 and **Figure 21** illustrate the pressure distribution across the system for both ADF and MDF conditions, displaying the effects of these additional improvements and the resulting stabilization of pressures across the network.

FIGURE 20 – PRESSURE VARIATIONS SCENARIO 3: ADF

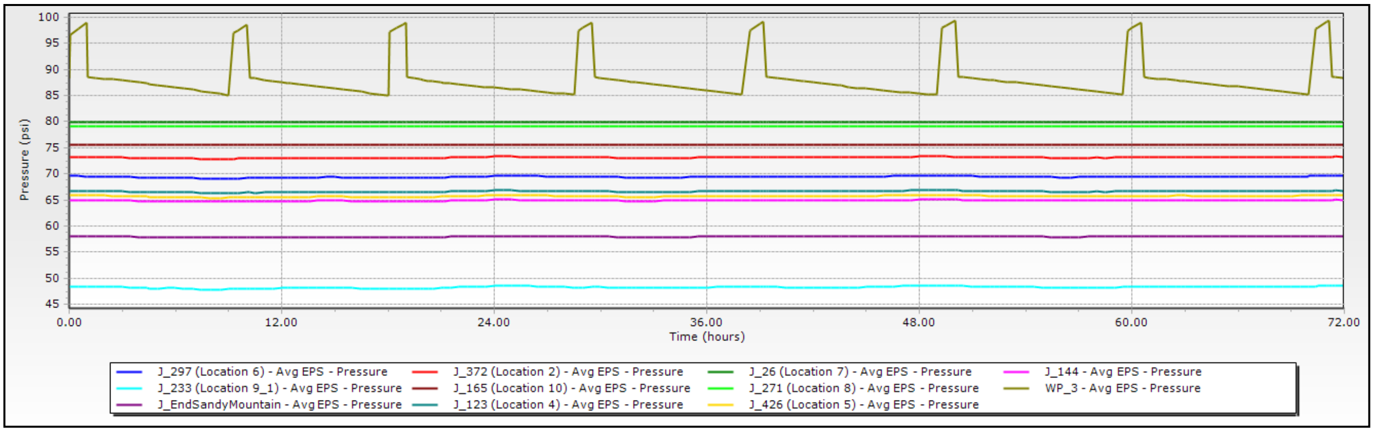
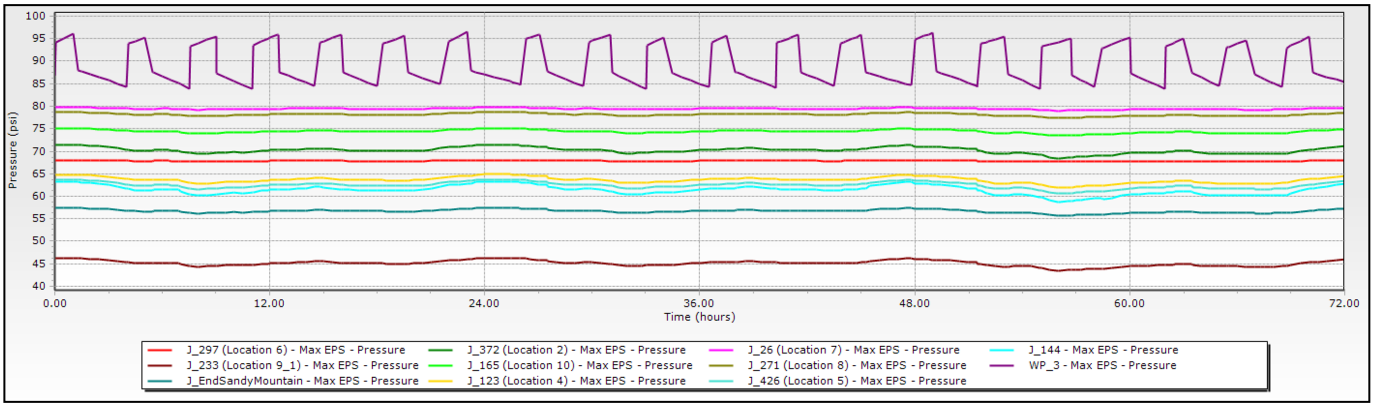


FIGURE 21 – PRESSURE VARIATIONS SCENARIO 3: MDF



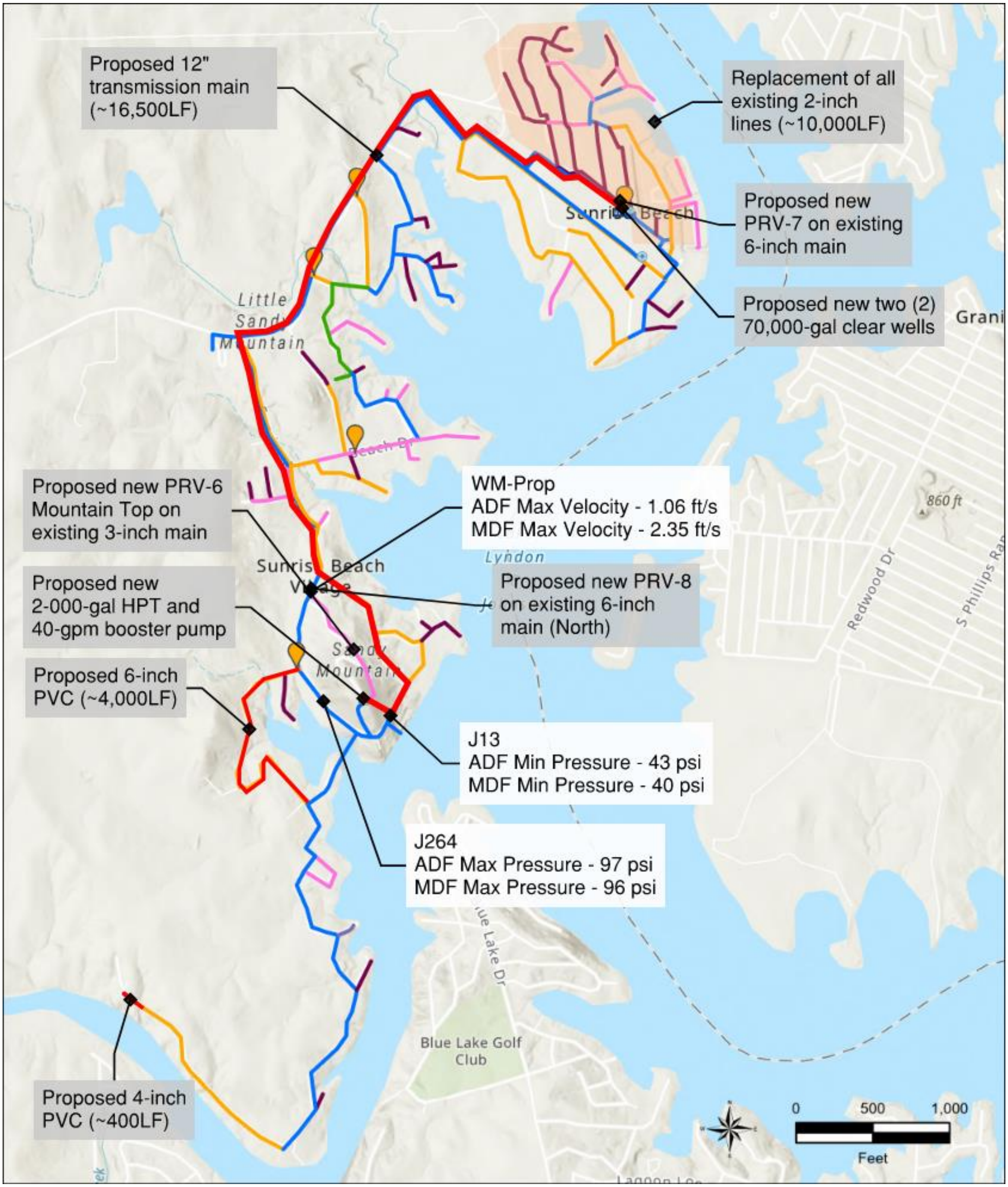
Additional improvements were made in the Medium Pressure Zone (see **Figure 4** on page 14) by replacing undersized 2-inch with 4-inch mains. The modeled improvements addressed the low pressure during MDF conditions while also achieving compliance with TCEQ requirements for pipe sizing relative to the number of connections served.

Table 11 and **Figure 22** present a summary of key results for both ADF and MDF conditions, including the minimum pressure, maximum pressure, and maximum velocity. In this scenario, both ADF and MDF conditions meet TCEQ minimum pressure requirements, with a minimum pressure across the system model of 43 psi for all conditions. The higher pressures (above 80 psi) occur at the same locations identified in Scenario 2 (refer to **Table 10**).

TABLE 11 – MODEL SCENARIO 3 IMPROVEMENTS

Scenario		Junction / Pipe	Pressure / Velocity	Location
ADF	Min Pressure	J13	43psi	Skyline Dr (6in AC)
	Max Pressure	J264	97 psi	Skyline Dr (6in AC)
	Max Velocity	WM-Prop	1.06 ft/s	Sandy Mountain Dr (6in PVC)
MDF	Min Pressure	J13	40 psi	Skyline Dr (6in AC)
	Max Pressure	J264	96 psi	Skyline Dr (6in AC)
	Max Velocity	WM-Prop	2.35 ft/s	Sandy Mountain Dr (6in PVC)

FIGURE 22 – MODEL SCENARIO 3: IMPROVEMENTS & RESULTS



4.0 Conceptual Design

4.1 Proposed Improvements

The conceptual design for the SBV water system prioritizes achieving the required regulatory compliance and enhancing the system's reliability to accommodate current and future demands, primarily addressing transmission main needs, pumping, storage, and pressure maintenance improvements. This design builds upon the results of the Phase 1 report, incorporating findings from field pressure monitoring, model calibration, and EPS modeling. Three modeled scenarios (summarized below and discussed in detail in **Section 3.8**) were evaluated to assess the impact of the proposed improvements.

- **Scenario 1:** Implements a partial 12" transmission main but is unable to meet TCEQ's minimum pressure and pumping capacity requirements. Model results demonstrate pressure-related issues similar to those observed in the existing system.
- **Scenario 2:** Achieves TCEQ compliance for pumping and storage for up to 1,200 connections, and pressure maintenance up to 1,042 connections. The dedicated 12" transmission main provides stability in pressures across the system, with most areas maintaining stable pressures between 50 and 80 psi.
- **Scenario 3:** Introduces further pipeline improvements to meet TCEQ's minimum water pipe sizing requirements per connection, as outlined in 30 TAC §290.44(C). Key system bottlenecks were addressed through the application of a continuous pipe size in the model simulation, reducing head losses and maintaining a more linear HGL across areas of the system.

The conceptual design focuses on implementing the key improvements identified in Scenario 2 to efficiently achieve the required regulatory compliance and system reliability. Scenario 3 improvements, which include additional pipeline improvements to meet TCEQ minimum pipe sizing requirements as well as address system bottlenecks, is recommended for future planned improvements.

The improvements identified in **Scenario 2** collectively enable the system to meet TCEQ's regulatory requirements for storage, pumping capacity, and pressure maintenance up to 1,042 connections, as summarized in **Table 12** and described in **Sections 4.1.1 through 4.1.3**.

TABLE 12 – WATER SYSTEM CAPACITY PER CONNECTION

System Parameters	TCEQ Minimum System Requirements[1]	Existing System Capacity[2]	Proposed System Improvements Capacity[3]
Water Supply	0.60 gpm/conn	0.73 gpm/conn	0.72 gpm/conn
Storage	200 gal/conn	117 gal/conn	232 gal/conn
Pumping[4]	1,000 gpm or 2.0gpm/conn	0.70 gpm/conn[4]	1,093 gpm[4]
Pressure Maintenance	100 gal/conn	98.8 gal/conn	100 gal/conn[3]

Table 12 Notes:

1. All minimum requirements are based on 30 TAC §290.45(b)(1)(D).
2. Reference **Table 1** for existing system capacity breakdown and assumptions. Calculated existing capacity based on SBV-documented 1,034 connections (August 2024).
3. Calculated proposed system capacity includes conceptual design system improvements. Calculations are based on 1,042 connections, in accordance with pressure maintenance maximum allowed connections.
4. Reference **Section 3.7** for TCEQ minimum pumping capacity requirements.

4.1.1 Transmission Main and Associated Improvements

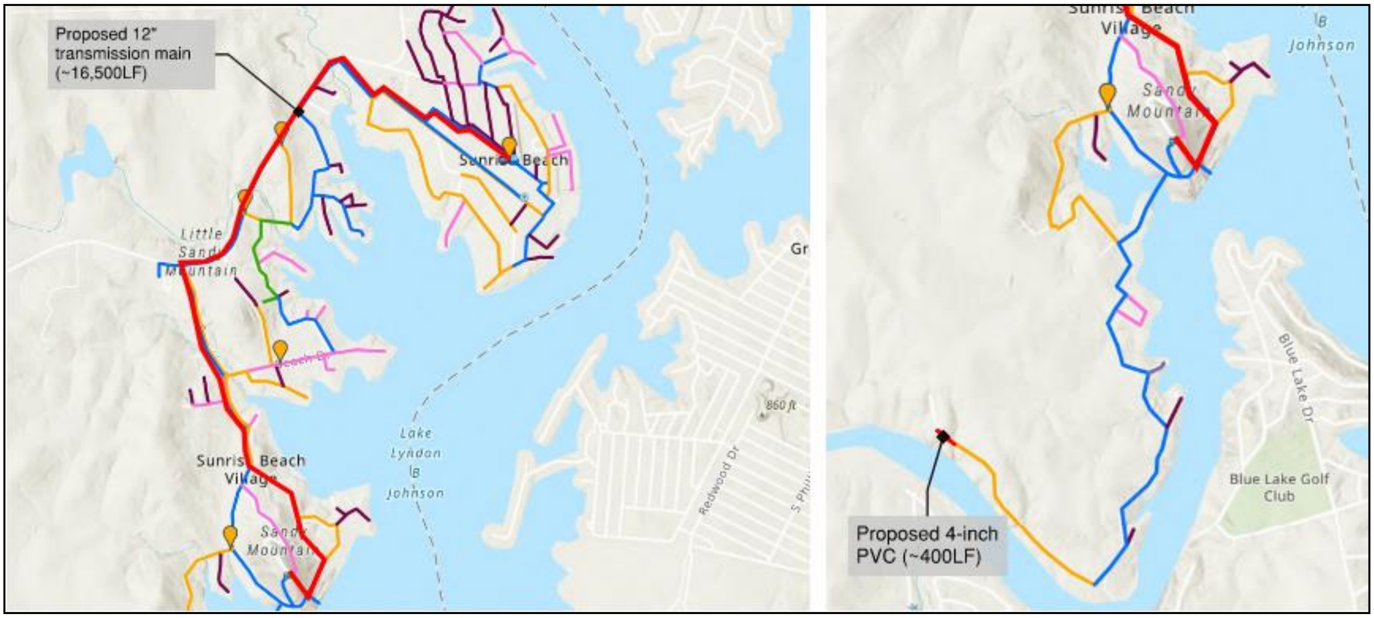
A new 12-inch transmission main (approximately 16,500-LF between WP and GST) is proposed to address system pressure and capacity needs, along with regulatory compliance (see **Figure 23** for approximate conceptual design alignment). Final alignment will be defined during the final design phase, pending surveying and geotechnical efforts (discussed in **Section 4.1.4**), and may involve easement acquisitions (by City) and road improvements along the associated alignment.

The transmission main will stabilize system pressures and improve HSPs operations efficiency, as described in **Section 3.8.2**. The dedicated 12-inch transmission main allows the existing HSPs to deliver up to 1,053 gpm (refer to **Table 7**), meeting average and peak demand capacity requirements, as outlined by TCEQ. For all proposed modeled scenarios, it was assumed that the system operates as originally designed, with two pumps running (2 duty) and one pump on standby, and GST and Clearwell levels were adjusted to align with pumps' BEP and meet TCEQ minimum requirements. The 12-inch main is required to meet TCEQ minimum pumping capacity requirements of 1,000 gpm during peak conditions while also ensuring that the two operating pumps can maintain minimum recommended velocities of 2 ft/s, aligning with AWWA guidelines for water quality and system efficiency.

This approach utilizes the existing HSPs to minimize the electrical and mechanical improvements and to reduce the overall construction cost. The existing HSPs should be further evaluated for required repairs and/or replacements by SBV due to age and deterioration. If it is determined that the pumps need to be modified or replaced, it should be with like-sized pumps to ensure compatibility with existing and proposed electrical, structural and mechanical systems.

A 400-LF section of the 2-inch IP at the end of Sandy Mountain Rd will be upsized to a 4-inch PVC pipe (see **Figure 23**). This improvement will enhance flow capacity and maintain adequate pressures for homes along this segment, as identified in model evaluations (reference **Table 10**).

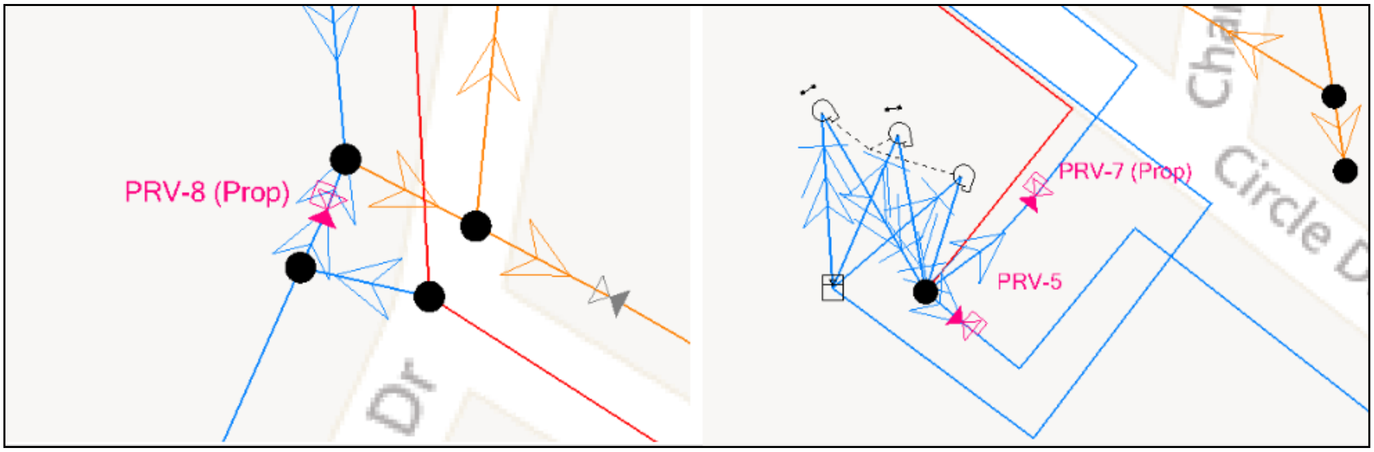
FIGURE 23 – PROPOSED 12" & 4" ALIGNMENT



Two PRVs are proposed – associated with existing 6-inch main and proposed 12-inch main – to ensure balanced pressure and HGL across the system. Reference **Table 8** for PRV proposed settings.

- PRV-7: proposed at the WP on the existing 6-inch main to regulate pressures within the distribution network, allowing the existing main to serve as a dedicated distribution main
- PRV-8: proposed at the tie-in point between the transmission main and the distribution system (downstream of the GST) maintaining stable system pressures across the distribution network..

FIGURE 24 – PROPOSED PRV 7 & PRV 8



TCEQ 30 TAC §290.45(b)(1)(D)(v) outlines the minimum emergency power requirement for systems serving more than 250 connections and that do not meet the elevated storage requirement of 100 gallons per connection. TCEQ requires sufficient emergency power to provide a minimum of 0.35 gpm per connection in the event of loss of normal power supply. Electrical and power supply needs at the WP will be evaluated during final design, along with appropriate generator size requirements.

4.1.2 Storage Improvements

Two (2) 70,000-gal clearwells are proposed to achieve compliance with the TCEQ minimum storage requirements (see **Figure 25**). The proposed clearwells construction will be phased to ensure uninterrupted storage capacity. The existing Clearwell will remain in service while the first 70,000-gallon Clearwell is constructed. Once the first new Clearwell is operational, the existing Clearwell will be demolished to allow for the second proposed Clearwell to be constructed.

Constructing the new clearwells at an elevation higher than the existing Clearwell will increase the HGL available to the HSPs, reducing the required operational head. Repurposing and improving the existing Clearwell is not feasible for achieving the operational improvements needed, as the height restricts the operating HGL of the new clearwells. The clearwells' sizing (height and diameter) will be determined during the final design phase, in compliance with the Federal Aviation Administration (FAA) requirements (see **Section 4.3.2**). SCADA integration options will be evaluated during final design to incorporate new clearwells into the existing SCADA system.

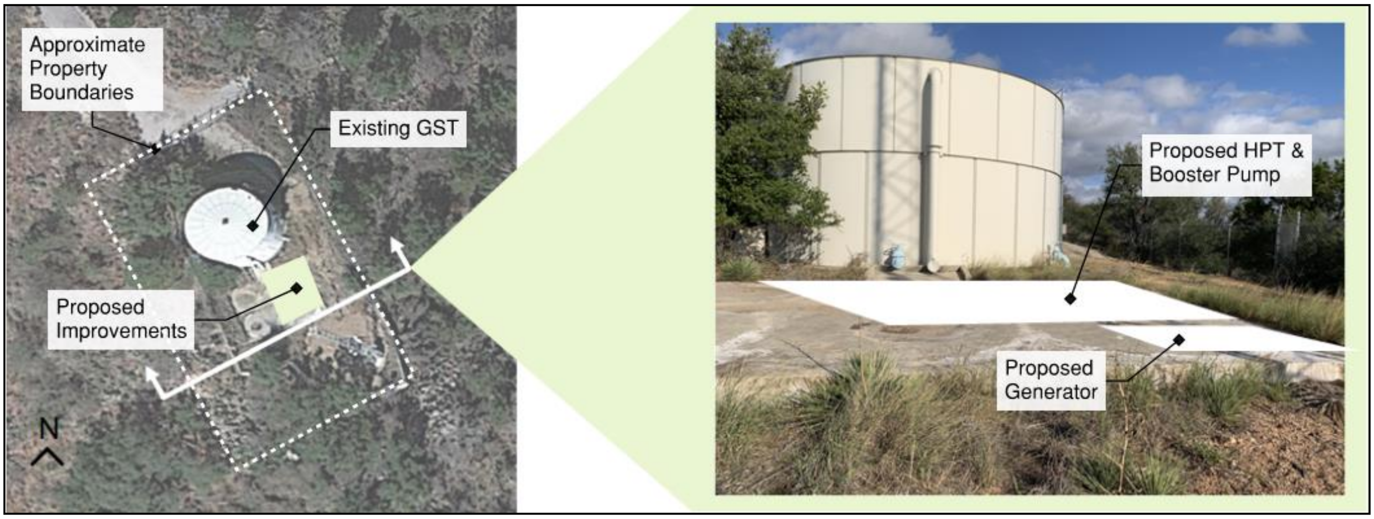
FIGURE 25 – PROPOSED CLEARWELLS

4.1.3 Pressure Maintenance and Associated Improvements

A 2,000-gallon HPT and 40-gpm dedicated booster pump package system (see **Figure 26**), sized to meet TCEQ minimum requirements, is proposed to achieve pressure maintenance in the immediate vicinity of the GST, providing consistent pressures above 50 psi in areas limited by the GST's HGL (as discussed in **Section 3.6**). The proposed improvements are designed to meet TCEQ's pressure maintenance and pumping requirements, supporting up to 1,042 connections (reference **Table 12** notes). Expanding the HPT capacity to meet a projected maximum of 1,200 connections (in 2034, as noted by SBV) is not feasible due to limited space at the Mountain Top site. SCADA integration options will be evaluated during final design to incorporate HPT and pump controls into the existing SCADA system.

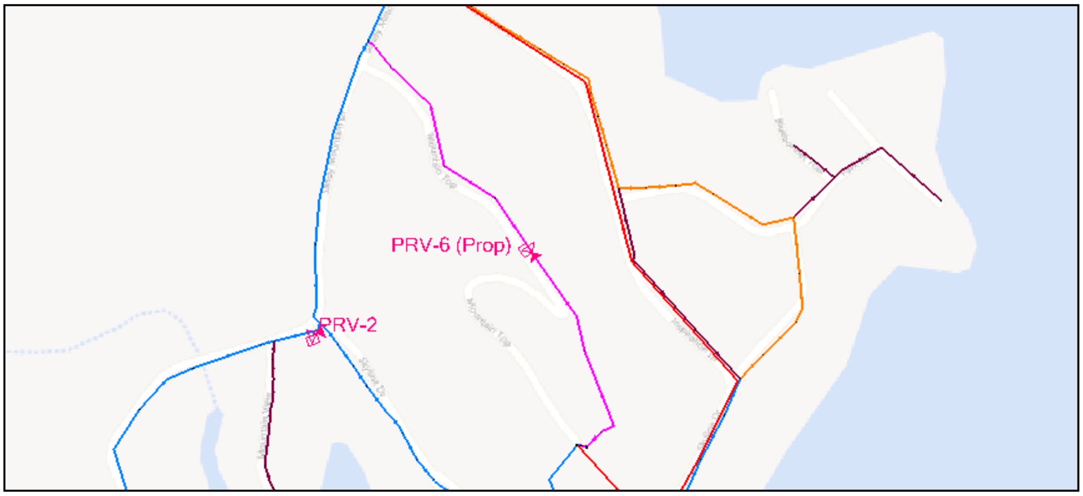
TCEQ 30 TAC §290.45(b)(1)(D)(v) outlines the minimum emergency power requirement for systems serving more than 250 connections and that do not meet the elevated storage requirement of 100 gallons per connection. TCEQ requires sufficient emergency power to provide a minimum of 0.35 gpm per connection in the event of loss of normal power supply. Electrical and power supply needs for the HPT & booster pump system will be evaluated during final design, along with appropriate generator size requirements.

FIGURE 26 – PROPOSED HPT AND BOOSTER PUMP



PRV-6 is proposed along the road at Mountain Top (see **Figure 27**), designed to prevent pressure increases in lower elevation areas of the road. Refer to **Section 3.7** and **Figure 12** for a detailed illustration of the PRV's strategic placement and impact on the system.

FIGURE 27 – PROPOSED PRV 6

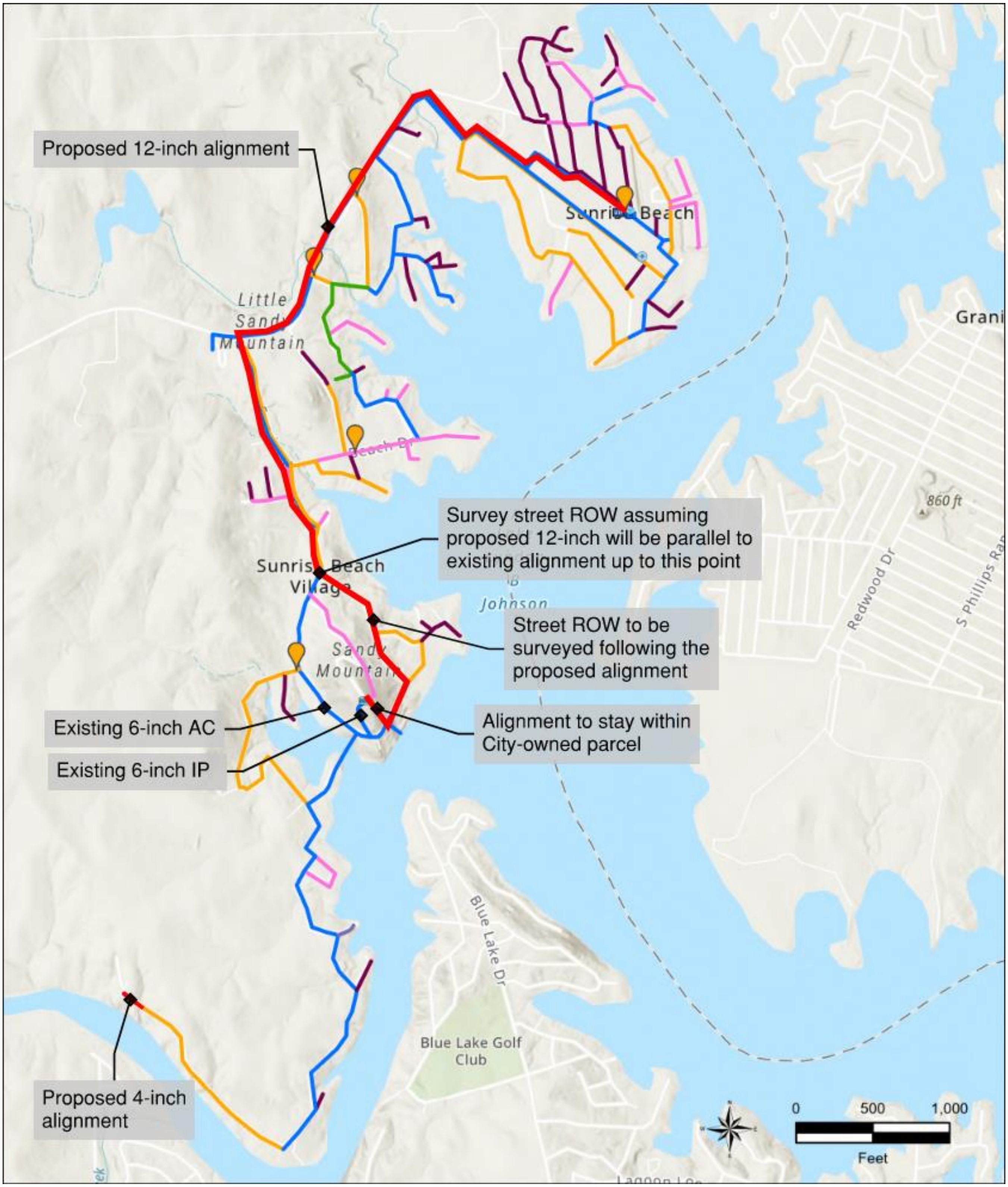


4.1.4 Surveying and Geotechnical Needs

Surveying efforts to date have been limited to the facilities' boundaries, establishing key elevations at the WP and GST for HGL calculations. The phased surveying approach is to allow for targeted planning, aligning the level of effort with the stage of design, and optimizing the use of the surveying allowance. Reference **Figure 28** for proposed surveying efforts.

Geotechnical boring assessments will be conducted by a geotechnical engineering firm at the defined structural components' locations (clearwells and HPT), and at key points along the 12-inch alignment, in the final design phase.

FIGURE 28 – PROPOSED SURVEYING EFFORTS



4.1.5 Future Distribution System Improvements

Additional upsizing and replacement of existing water lines is recommended to enhance system resilience and achieve TCEQ's minimum water pipe sizing requirements per connection, as outlined in 30 TAC §290.44(C). Many of the system's existing pipes, including aged IP and AC pipes, have exceeded their industry-recommended useful life. Key system bottlenecks and water lines smaller than 2-inch should be planned for replacement as funding allows to facilitate distribution capacity needs. Reference Phase 1 report for a detailed list of identified improvements to the water distribution system pipelines and appurtenances. Of note, distribution system improvements could be strategically implemented over time through O&M funds as a function of work orders or included in future system improvement projects.

4.2 Engineering Opinion of Probable Project Costs (EOPPC)

The presented costs are calculated using 2024 (fourth quarter) dollars and have not been escalated to account for anticipated time of construction and projected inflation. The total cost value includes a contingency of 30 percent, and 15 percent for engineering cost and construction. **Table 13** summarizes the Engineer's Opinion of Probable Project Costs (EOPPC). The EOPPC provided below is a Class 5 estimate as defined by the Association of the Advancement of Cost Engineering (AACE).

TABLE 13 – SUMMARY OF PROPOSED IMPROVEMENTS EOPPC

Recommended Improvements	Qty	Unit	Unit Price	Subtotal Price
General Requirements	1	LS	$ 889,000	$ 889,000
Storage & Pumping Improvements				
70,000-gal Clear Well	2	EA	$ 289,000	$ 578,000
2,000-gal Hydropneumatic Tank	1	LS	$ 74,000	$ 74,000
40-gpm Booster Pump and Backup Generator	1	LS	$ 219,000	$ 219,000
Associated Storage & Pumps Improvements	1	LS	$ 261,300	$ 261,300
Pipeline Improvements				
12" Transmission Line (PVC)	16,500	LF	$ 275	$ 4,537,500
6" Distribution Line (PVC)	100	LF	$ 200	$ 20,000
4" Distribution Line (PVC)[1]	400	LF	$ 185	$ 74,000
3" Distribution Line (PVC)[1]	150	LF	$ 185	$ 27,750
Pressure Release Valves (PRVs)	3	EA	$ 44,000	$ 132,000
Subtotal				**$ 6,812,550**
Contingency (30%)				$ 2,044,000
Engr Design/Admin (15%)				$ 1,022,000
Total Cost				**$ 9,878,550**

Note 1: projects may be implemented through O&M funds as a function of work orders.

4.3 Permit Requirements

4.3.1 TCEQ Permit

TCEQ permit coordination is required prior to bidding and construction phases. Final design plans will be submitted to TCEQ for review, along with the required Form 10233 – Public Water System Plan Review Submittal Form. TCEQ's review process is an estimated duration of 90 days, assuming no additional review iterations are required. To ensure adherence to TCEQ's minimum requirements, the design process will incorporate TCEQ-provided checklists for water tank, HPT, and pipeline design.

4.3.2 Federal Aviation Administration Permit

Due to the proximity of a local airport near the WP, coordination with the Federal Aviation Administration (FAA) will be necessary to establish the maximum allowable height for the proposed clearwells. Preliminary analysis using the FAA's Obstruction Evaluation/Airport Airspace Analysis (OE/AAA) tool indicates that the structure's proximity to navigation facilities may impact navigation signal reception, as per Part 77.9(b). The nearest airport, 2KL, and runway 12/30 require filing under these FAA guidelines.

The clearwells' final dimensions will be determined following geotechnical and structural analysis and coordination with FAA in the early design stage with respect to the depth of the foundation and height limitations of the Clearwell. A constructability and cost assessment will then establish the optimal Clearwell diameter (in conjunction with height limitations) to achieve the estimated design total storage capacity of 140,000-gallons. Once dimensions are finalized, formal FAA permit coordination will proceed, and a letter from FAA detailing requirements can be expected within 30 days. Upon FAA height approval, the structural design aspect of the proposed facility improvements will commence.

4.4 Final Design, Construction Sequencing & Utility & Regulatory Coordination

Final design and construction sequencing will follow a phased approach, with steps organized to meet regulatory requirements efficiently. Construction sequencing will be determined based on available funding and regulatory compliance as determined by SBV. It is recommended that improvements be designed concurrently to reduce design costs and to ensure more competitive bids by advertising the project as one package. The construction of the 12-in transmission main and other distribution lines can proceed simultaneously with the storage improvements.

Should the final alignment of the proposed 12-inch main be required to be located within a 100-year flood plain boundary, additional analysis and permitting processes will be required beyond the current scope.

A high-level overview of the critical path emphasizing the order of priority and regulatory agency coordination required during the final design and construction phases of the project are outlined below:

Anticipated Final Design Sequence:

1. Begin utilities coordination to evaluate the existing power supply at the Mountain Top and the WP for electrical improvements and sizing of emergency power (generators). Analyze the feasibility of SCADA integration for the proposed improvements.
2. Mobilize the survey & geotechnical team.
3. Preliminary coordination with TCEQ and FAA.
4. Submit final design plans for TCEQ and FAA review. Response times of 90 and 30 calendar days, respectively, are expected for permit approvals.
5. Advertising and bidding (services to be negotiated).

Q1 2025	Q2 2025	Q3 2025	Q4 2025	Q1 2026	Q2 2026
Final Design Phase (*pressure maintenance, storage, & transmission*)				TCEQ/FAA Review Requirements	
Surveying & Geotechnical					
Electrical and I&C					
	FAA Coordination (~30 days)				
				FAA & TCEQ Review (~90 days)	
					Advertising & Bid

Anticipated Construction Sequence:

1. Secure all applicable permits and easements.
2. Construct the HPT & Booster Pump Station systems with associated electrical/structural/mechanical improvements (as described in **Section 4.1.3**).
3. Construct the 12-in transmission main & associated distribution system and PRV improvements (as described in **Section 4.1.1)**
4. Construct and commission Clearwell 1 (as described in **Section 4.1.2**).
5. Decommission and demolish the existing Clearwell.
6. Construct and commission Clearwell 2.

Construction Phase – anticipated 2026 through 2028				
HPT & Pump Packaged Improvements				
Clearwell 1				
		Decommission of existing Clearwell		
			Clearwell 2	
Transmission Main				

4.5 References

- TCEQ 30 TAC Chapter 290 – Public Drinking Water
- TCEQ Form 10233 – Public Water System Plan Review Submittal Form
- FAA CFR Title 14
- AWWA Design & Manual Standards for Drinking Water Systems
- International Plumbing Code (IPC)