Section 5. WATER DISTRIBUTION MODEL

SECTIONS 1 *THRU* ***SECTION 4*** *PROVIDE THE BACKGROUND, FACTS, ASSUMPTIONS, AND TOOLS TO NOW BEGIN LOOKING AT THE NECESSARY WATER FACILITY REQUIREMENTS. THIS SECTION DISCUSSES THE APPROACH USED IN THE HYDRAULIC MODELING MOVING THE VARIOUS SUPPLY SOURCES THROUGH RAW AND TREATED WATER TREATMENT AND CONVEYANCE SYSTEMS.*

5.1 Modeling Objectives

The hydraulic model developed for this WSIP will evaluate what major facilities are required at build-out as well as the operational strategies for each facility in accordance with the requirements of the conjunctive use program outlined in the WSMP and in **Section 4**. Specific modeling objectives include:

- Develop Zone 40 water system infrastructure needed to meet build-out water demands.
- Develop operational rules for each facility under different demand/supply conditions.
- Evaluate the need for multiple pressure zones.
- Expand supply capacity to allow for water supply commitments outside of Zone 40 (including SMUD’s dry year water needs from the Folsom South Canal).
- Develop sufficient redundancy in the water system to account for Sacramento River reverse flow conditions when the Vineyard SWTP could be shut down for up to 8 hours.
- Develop infrastructure phasing to meet the growth projection of water demand from present to build-out.
- Address requirements and provisions in special agreements and in policy documents like the WFA.

5.2 Modeling Methodology

The hydraulic model for this WSIP is a planning model and not an operation or calibration model (A planning model is the first step toward developing a calibration model, which is generally an effort that is continuously ongoing and requires a significant amount of time to capture the variations in water use spanning hydrologic years). As such, no actual "in field" calibration was preformed as part of the WSIP modeling effort. To verify the adequacy of the model, System Control and Data Acquisition (SCADA) data was taken from the existing system and compared to specific model results at given points within the system. The planning model components are summarized below:

The distribution network in the model includes existing T-mains and D-mains, but only T-mains are included for those portions of the system that will be constructed in the future. T-mains are defined as major pipelines with diameters no less than 16 inches and D-mains are pipelines with diameters less than 16 inches.

Demand nodes for future demands are placed on the T-main network resulting in a skeletonized representation of the various demand zones. In contrast, a calibration model requires demand nodes on the D-main network at points corresponding to actual dwelling units in order to capture real-time behavior in the system.

Existing and future water supply sources are included in the model.

5.3 Model Development

In order to achieve the Modeling Objectives outlined in **Section 5.1** four models were developed that represent existing, build-out, and interim conditions.

5.3.1 Existing Condition Model

Much of the information about the existing pipe network and various production facilities was available through a "Cybernet" model originally developed by SCWA. The existing Cybernet calibration model was converted to an "H2Onet" model at the request of SCWA in order to enhance the ability of the model to perform more complex analysis of the water system. Because only a planning model is needed for this WSIP certain calibration model data was not used in WSIP to keep the planning model efficient in its setup and runtime. Information removed from the model will be used to develop an updated calibration model in the future. A verification (vs. calibration) process was conducted on the existing model by looking at pressures and velocities in the distribution network and confirming that the model was meeting the minimum SCWA design criteria.

5.3.2 Build-out Condition Model

After completion and verification of the Existing Condition Model, a model representing build-out conditions was developed. Development of this model required a detailed design of the required facilities and transmission system. This detailed design included well locations, water treatment plant details, storage tank sizing, pump designs, valve locations, as well as sizing and locating of T-mains. T-main locations were based on existing and future major roadway corridors. T-main sizing was based on SCWA design criteria, as discussed later in this section.

The resulting build-out model provides a comprehensive description of the water system infrastructure based on the goals set forth in the WSMP. Along with the infrastructure, the model includes operational rules for each of its components. The methodology used to determine an appropriate system design consisted of multiple model runs to simulate system operations under various conditions. Situations such as “reduced surface water availability” or “maximum surface water availability” were investigated to understand how the system operated under these conditions and ultimately provide the necessary information to design a network that has the ability to operate under varying hydrologic conditions. A scenario is considered to be a model run representing a given point in time or demand level and a given set of hydrologic conditions. The simulation of these scenarios resulted in a design that best fit the goals of the WSMP.

5.3.3 Interim Conditions Models

Once there is an understanding of water system requirements under build-out conditions it is necessary to look back and see how the water system may develop between existing conditions and build-out, this is called “phasing.” In order to understand system phasing requirements, model scenarios representing various interim conditions were developed. Several scenarios between existing and build-out conditions where selected that correspond to phases of the Vineyard SWTP or other logical points in time. The underlying theory in selecting these points is that it is not the year that is important but the level of demand and where growth is or may actually take place. Information obtained from SACOG in conjunction with assumptions made by staff was used to identify where and at what rate growth would be for each demand region.

The approach used for designing interim models is based on “turning off” facilities in the build-out model in order to simulate interim demand conditions. Interim models are summarized below:

- Pre-Phase I of Vineyard SWTP model: Vineyard SWTP is not built
- Post-Phase I of Vineyard SWTP model: Vineyard SWTP is built with an output capacity of 50 MGD
- Post-Phase II of Vineyard SWTP model: Vineyard SWTP is built with an output capacity of 100 MGD

5.3.4 Pressure Zones

Because of the relatively flat terrain in the southern portion of Zone 40, SCWA has had limited experience in moving water between pressure zones. Currently there are two pressure zones within Zone 40, the SSA and CSA systems. Operationally, these two systems are kept isolated from each other unless there is an emergency. This separation is possible because each system has sufficient capacity to meet their respective water supply needs. In cases where changes in topography are more pronounced and sufficient capacity cannot be developed entirely within that area it is necessary to design a method for moving water from its source to that area without exceeding design criteria. This can be done through the use of pressure zones which avoid excessively high or low pressures in the system. Because of the topography in the NSA it is necessary to create a number of different pressure zones in order to provide water service at acceptable operational pressures.

In order to minimize operational concerns and the long-term maintenance costs associated with operating and maintaining pressure reducing valves (PRV) and booster pumps, this WSIP has minimized the number of pressure zones and set pressure zone boundaries that accommodate infrastructure phasing (e.g., follow major road right-of-way, drainage easement alignments, etc). To avoid confusion, pipeline alignments were identified that minimized the number of locations where pipelines from two separate pressure zones would be placed in the same right-of-way (i.e., a high pressure and low pressure zone pipe in close proximity may make it difficult to ascertain which pipe is appropriate for connecting a D-main to serve a given pressure zone).

5.4 Modeling Scenarios

Under the various modeling conditions there are modeling scenarios that represent various facility/demand/supply conditions in Zone 40. These are distinguished by:

- Demand conditions: maximum demand, average demand, and emergency demand (fire flow) conditions
- Supply conditions: dry and wet years, and reverse flow conditions (no surface water diversion from Freeport).

Table 5-1 best summarizes the critical permutations of water supply scenarios to “bookend” the Zone 40 facility requirements to provide for build out conditions and interim conditions. Either one may be controlling

Table 5-1. Summary of Modeling Scenarios

Model	Water Demand Condition	Available Groundwater WTP Capacity	Vineyard SWTP Capacity	Scenario Purpose
Exiting Conditions	2004 max day	52 MGD	0 MGD	• Understand existing system • Calibrate against existing system
Exiting Conditions	2004 max day + Fire flow	52 MGD	0 MGD	Evaluate existing system fire flow capacity
Build-out Conditions	2030 max day	123 MGD	56 MGD	Determine system design and operation under minimum surface water conditions
Build-out Conditions	2030 max day	123 MGD	100 MGD	• Size Backbone t-main • Size Vineyard SWTP pumps • Determine system operation under high demand, high supply conditions
Build-out Conditions	2030 max day	123 MGD	0 MGD	Evaluate system sustainability under reverse flow conditions
Build-out Conditions	2030 average day	123 MGD	100 MGD	Determine system operation under low demand, high supply conditions
Build-out Conditions	2030 max day + Fire flow	123 MGD		Evaluate system fire flow capacity
Interim Conditions: Pre-Phase I of Vineyard SWTP model	2010/11 max day	97 MGD	0 MGD	Considers meeting demands up to the year when the Phase 1 Vineyard SWTP is operational.
Interim Conditions: Post-Phase 1 of Vineyard SWTP model	2010/11 max day	97 MGD	50 MGD	Looks at how operations change from the previous scenario as a result of the Vineyard SWTP becoming operational.
Interim Conditions: Post-Phase 2 of Vineyard SWTP model	2022/23 max day	123 MGD	100 MGD	Considers meeting demands up to the year when the Phase 2 Vineyard SWTP is operational.

5.5 SCWA Water System Design Criteria

This section outlines the design criteria as set forth in the 1999 Sacramento County Improvement Standards and from SCWA staff for the construction of Zone 40 facilities.

5.5.1 Minimum Fire Flow Requirements

Required fire flows are determined by the Uniform Fire Code, the fire protection district having jurisdiction, and SCWA:

Single Family Residential Less than 3,600 sq. ft. (for 2 hours) – 1,500 gpm.

Single Family Residential Greater than 3,600 sq. ft. (for 2 hours) – 2,000 gpm.

Commercial (for 3 hours) – 3,000 gpm.

Industrial (for 3 hours) – 4,000 gpm.

5.5.2 Storage Requirements

Analysis of adequacy of storage facilities is carried-out in a two-steps process. An initial estimate of storage requirements is done using SCWA design criteria followed by hydraulic modeling to confirm the adequacy of the storage assessment. The initial estimate of storage is done as follows:

Calculate: 4 x (peak hour demand)/24 - maximum day demand

Calculate: 4 x (maximum day demand)/24 + fire flow (appropriate fire flow volume is selected based on the location of fire event).

Calculate: greater of (a) or (b) + 0.5 million gallons (MG) for emergency storage.

Round (c) upward to the nearest 1.5 Million Gallons (MG) increment.

A determination of the adequacy of the proposed operational storage is made when the model simulates two back-to-back maximum days without storage falling below the minimum operational storage volume. The bottom 10 percent of the tank is typically held as non-operable unless emergency conditions exist. Storage should also be capable of recovering at the end of hour 28 of the simulation (end of first complete cycle of diurnal demand pattern assuming that the first four hours of the simulation is typically considered unstable).

Additional model runs are conducted assuming fire flow conditions at various locations throughout the system and at various durations and rates based on residential, commercial, and industrial fire flows; however, as demands become greater, the peak hour (or maximum day) demand scenario typically governs over fire flow conditions for sizing of storage reservoirs.

5.5.3 Emergency Interties with Adjacent Purveyors

The water system should provide for interties with adjacent purveyors for use under emergency conditions with a lockable positive shut-off valve (post indicator valve).

5.5.4 Design Pressures and Velocities

5.5.4.1 <u>Operational Pressures</u>

- Operational pipe pressures should meet the following requirements:
- Maximum System Pressure < 75 pounds per square inch ("psi")
- Maximum Day and Peak Hour:
- Pressure at service connection > 35 psi
- Pressure at T-mains > 40 psi
- Maximum Day plus Fire flow:
- Minimum system pressure (including fire hydrant) > 25 psi

5.5.4.2 <u>Operational Velocities</u>

Operational pipe velocities should not exceed 5 feet per second (fps) over the diurnal period. However, velocities may exceed 5 fps during fire flow conditions and, if necessary, may go as high as 7 fps during peak hour periods.

5.5.5 System Losses

System losses due to unaccounted for uses in the system and leakage in the pipe network is estimated to be 7.5 percent of the net water demand.

5.5.6 Peaking Factors

The water demands shown in Table 3-2 represent average annual demands and maximum day demands. The design of a water system requires adjusting average demands to reflect seasonal, daily, and hourly variations in water use. July and August are typically the hottest months of the year and experience increased water demands because of landscape irrigation requirements. SCWA has conducted studies and tracked average month, maximum day, and peak hour water demands over a period of time to determine the appropriate multipliers to increase estimated average annual demands. **Figures 5-1** and **5-2** illustrate the relationship between the average annual, average monthly, maximum day and peak hour water demands. These water demand scenarios are discussed in more detail below.

5.5.6.1 Average Annual Demands

Average annual demand is used to evaluate the adequacy of existing water supplies over the range of hydrologic conditions (i.e., wet, dry, and critically dry). These demands are determined by multiplying the unit water demand factors by the number of acres of a particular land use (see **Table 3-1**). Average day demand is the average annual demand divided by 365 days.

5.5.6.2 Average Monthly Demands

This demand is generally used to evaluate surface water diversions that are subject to a range of conditions that constrain diversion amounts on a monthly basis. In addition, this demand is used in the design of a true surface water-groundwater conjunctive use water system in which more expensive surface water facilities are designed to accommodate the more sustained average monthly demands and groundwater facilities (or other supplemental supplies) are used to meet the shorter duration maximum day demands as described below. These demands are determined by multiplying the average day demand by a monthly multiplier as shown on the top of each bar in **Figure 5-1**. The highest water demand month of July has a 1.56 multiplier.

5.5.6.3 Maximum Day Demands

This demand typically occurs during the hottest month of the year and represents the hottest days within that month (see circled portion of **Figure 5-1**). Water treatment facilities are designed to accommodate these demands by delivering water to storage reservoirs when demands are less than maximum day. This water is used, along with directly treated water, to meet maximum day demands. Regional treated water conveyance systems (i.e., large pipelines) may also be designed using this demand scenario. The maximum day demand multiplier is 2.0 (times the average day demand).

5.5.6.4 Peak Hour Demands

This demand occurs during a maximum day event and represents the maximum hour within that day. This demand scenario is used for the design of storage and local water conveyance pipelines. **Figure 5-2** presents the maximum day demand multipliers for each hour of the day. The peak hour demand multiplier is 2.0 (times the maximum day demand).

Figure 5-1. Average Annual and Maximum Day Water Demands

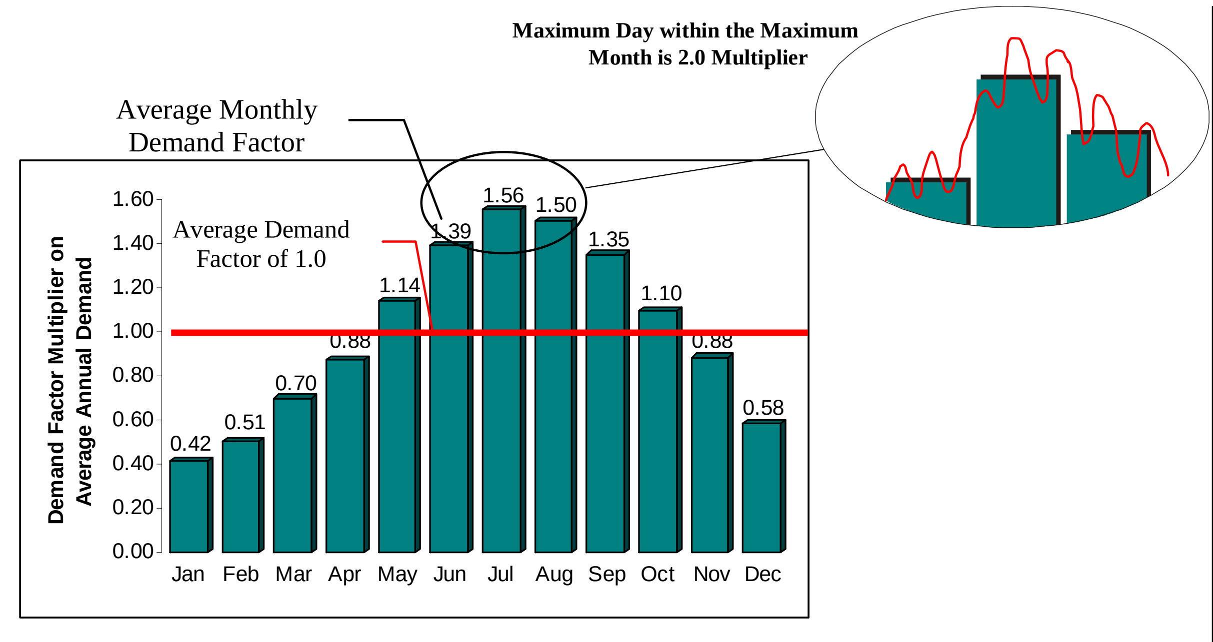

Figure 5-2. Hourly Water Demands as Percent of Maximum Day Demand