Section 7. CONJUNCTIVE USE OPERATIONS

THE SUCCESS OF THE ZONE 40 CONJUNCTIVE USE PROGRAM WILL LIE IN THE HANDS OF THE OPERATORS AND THEIR UNDERSTANDING OF THE CONJUNCTIVE USE GOALS. FULL DEVELOPMENT OF THE CAPITAL PROGRAM IN THIS WSIP WILL LEAVE A SIGNIFICANT AMOUNT OF REDUNDANCY IN SUPPLY CAPACITY IN MOST YEARS LEAVING IT UP TO THE OPERATORS TO DECIDE ON HOW MUCH WATER FROM EACH SUPPLY SOURCE WILL BE USED. THIS SECTION PROVIDES SOME GUIDELINES AND TOOLS THAT CAN BE USED IN MAKING JUDGEMENTS IN HOW TO OPERATE SURFACE WATER AND GROUNDWATER FACILTIES SIMULTANEOUSLY.

7.1 Introduction

The tool described in **Section 4.3.2 Use of Mini CALSIM for Zone 40** is intended for use as a means to establish a set of guidelines that will assist the operators in how the system will be run in any given hydrologic year. The use of this tool, however, still requires a certain level of understanding to evaluate if the desired operation scheme can actually be done given the conditions of the water system and institutional obligations at the time (e.g., wells that are not working, agreements with other agencies, etc). What is provided in this section is a brief synopsis of how operations of the water system should move forward with the construction of the proposed infrastructure.

7.2 Summary of Supply and Demands

From **Table 7-1**, the total water supplies and the total water demand are brought together to evaluate (from an operators perspective) the many variables of what there is to work with in providing supplies to the customers. This table shows that there is 257 MGD of maximum day supply capacity and 211.15 MGD of maximum day demand. Under average rainfall conditions, the operator truly has a broad range of supplies to work within to meet water demands. Under dry or critical year conditions, as illustrated in Figure 6-1, the level of redundancy is close to zero giving the operators very little margin for flexibility.

Throughout this document, there has been a continual mention of the Zone 40 Conjunctive Use Program. When the facilities shown in this WSIP are constructed, steps to achieve the program goals are necessary. The purpose of **Section 7** is to accomplish the following:

Table 7-1. Summary of Water Demand and Capacities for Each Service Area

Zone 40 Service Areas	Demand (MGD)	Average Day Demand	Maximum Day Demand	Peak Hour Demand	Supply (MGD)	Anatolia GWTP	Mather Housing GWTP	Suncreek GWTP	Waterman GWTP	Wildhawk GWTP	Calvine Meadows GWTP	Eask Park GWTP	East Elk Grove GWTP	Bond GWTP	Lakeside GWTP	Poppy Ridge GWTP	Big Horn GWTP	Franklin GWTP	Whitelock GWTP	Total GW Supply (MGD)	POU Water	Wheeling Agreement	Central WTP [a]	Total SW Supply (MGD)	Total Supply (MGD)
NSA		33	67	133		13	6	4												23			65	65	88
CSA		35	70	140					8.6	10	10	2.9	13	6.5						51	19		35	54	105
SSA		28	56	113											6.5	13	13	7	13	52.5		11		11	64
Total		**96**	**193**	**386**																**127**				**130**	**257**

Note:

The allocation of Vineyard SWTP's capacity to NSA includes meeting NSA's demand and providing replacement water supply to Golden State with appropriate max day peaking factor considered. The replacement water supply is 10,200 AF/year according to Golden State Agreement. Also, the allocation represents the build out under max day condition and the Vineyard SWTP runs at the 100 MGD full capacity.

- A procedural process of developing conjunctive use operation guidelines for groundwater and surface water treatment plants for any month of any year into the future.
- An understanding of how water moves through the water distribution system.
- An evaluation of how storage is used to meet peak hour conditions and provide system reliability.

7.3 Zone 40 Conjunctive Use Program Operation Guidelines

Appendix E Conjunctive Use Guideline Tool provides a comprehensive understanding of how to apply the tool illustrated in **Section 4.3.2 Use of Mini CALSIM for Zone 40**. In this section, the tool is applied in a few examples along with some additional supporting information to grasp an understanding of what is taking place in the tool when it is applied and how the tool and the water distribution model work together.

7.3.1 Hydrologic Year Differences

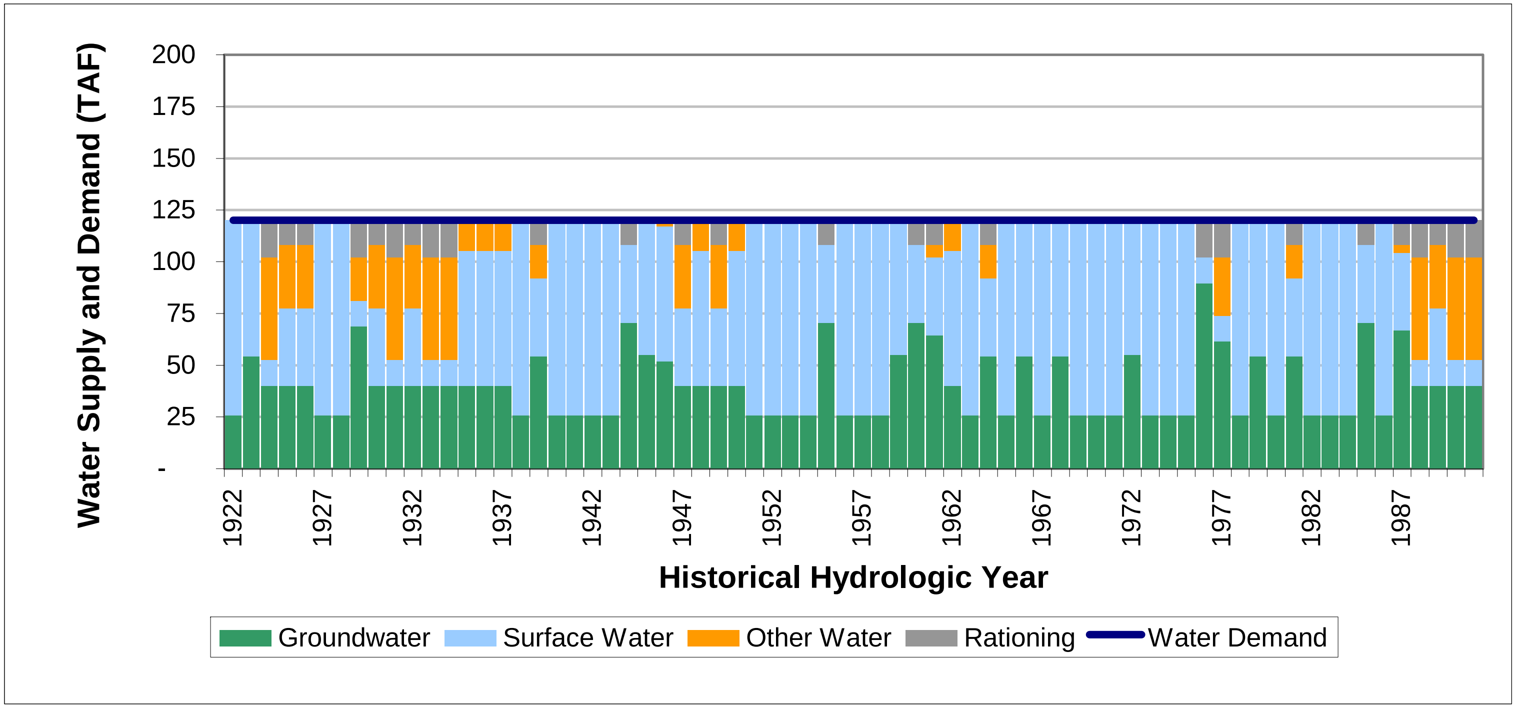
In wet/average years, which occur in 64 percent of the years (i.e., the 70-year hydrologic period), surface water diversions will be maximized. In those years, surface water use by SCWA within Zone 40 will total approximately 78,000 AF/year to 84,000 AF/year. Supplemental supplies including groundwater, additional recycled water, and water conservation will make up the difference between demands and available surface water supplies. In wet/average years, the need for groundwater is estimated to be approximately 30,000 AF/year. It should be noted that this is well below Zone 40's estimated long-term average use of 40,900 AF/year.

In drier years, which occur in 28 percent of the years, surface water diversions will be less than in wet/average years, ranging from 44,000 to 78,000 AF/year. The need for groundwater in these years is estimated to be up to 56,000 AF/year. It should be noted that in drier years, the groundwater extraction rate exceeds Zone 40's estimated long-term average use of 40,900 AF/year.

In the driest years, which occur in only 8 percent of the years, surface water diversions will be minimized due to CVP shortages and availability of appropriative water is greatly reduced, totaling 27,000 AF/year. In the driest years, the need for supplemental supplies will increase to 82,000 AF/year. The majority of these supplemental supplies will be derived from groundwater extractions, exceeding the 40,900 AF/year estimated long-term average use of groundwater for Zone 40.

Figure 7-1 illustrates how water demands would be met given the historical hydrologic conditions from 1922 to 1990. This figure illustrates the change in groundwater and surface water over time depending on the individual year types. While this figure provides some insight into how operations may take place, keep in mind that this figure is from a model that has perfect foresight and knows what will occur for every month within the given year. In reality, operators will not have this same foresight and will need to depend on communicating with Reclamation as to the availability of CVP surface water and then determine the need to purchase “other” water, if necessary.

Figure 7-1. Illustration of Conjunctive Use Program over Historical Hydrologic Period from 1922 to 1990.



The consequences of not following through may result in having insufficient supply capacity because of no surface water and also may result in potential long term impacts to the groundwater basin by over pumping.

Inputs to the Operations Guideline Model should be continuously monitored by month to verify that the many variables are being distilled into the proper operational settings. **Figure 7-2** and **Figure 7-3** show the variability in GWTP operations based on month and hydrologic year. If this tool was applied each month, the emphasis of where pumping should be occurring and how much could be decided and then carried out until the next month and so on.

Figure 7-2. Groundwater Treatment Plants Operation – Buildout, Month of July, "Dry" Year

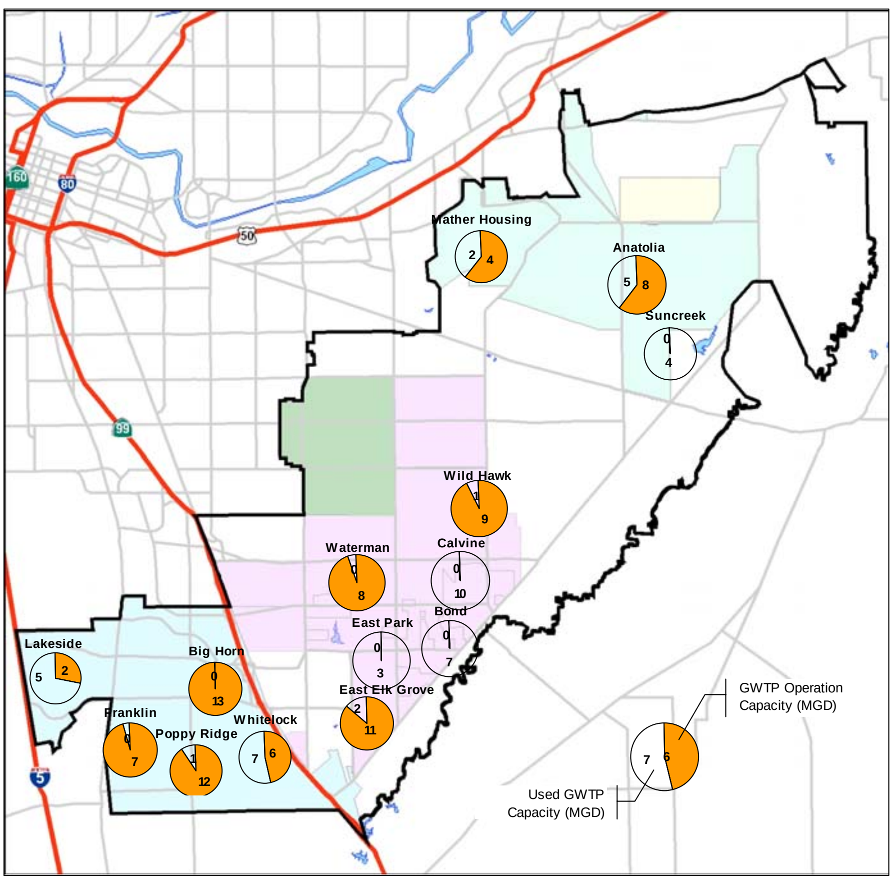
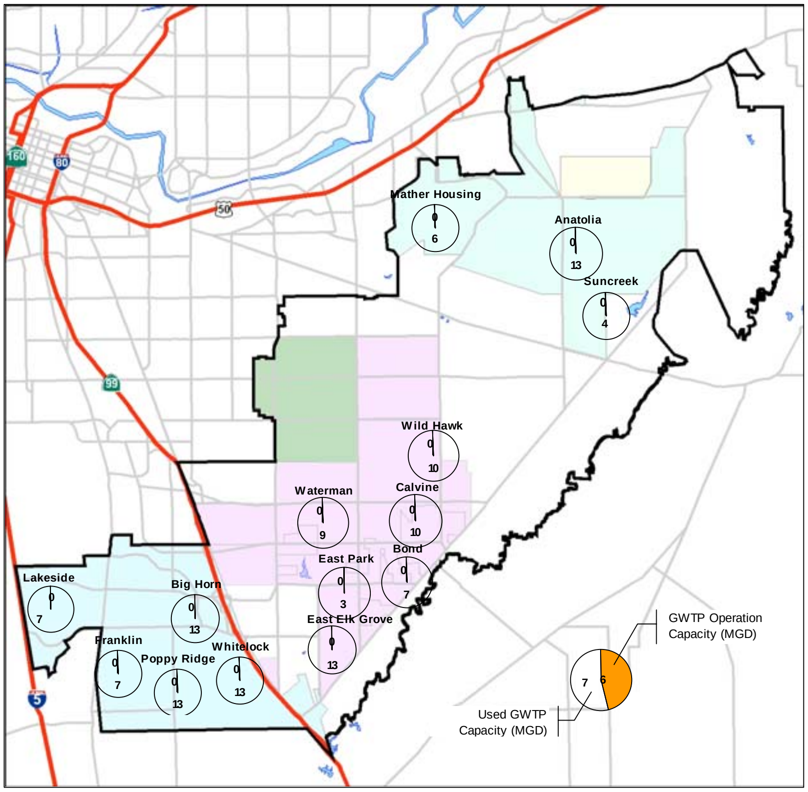


Figure 7-3. Groundwater Treatment Plants Operation – Buildout, Month of March, "Wet" Year



7.3.2 Vineyard SWTP Operation Pattern

Using the Operational Guideline tool for determining groundwater usage leaves the remaining supply to come from surface water and the appropriate operation of the Vineyard SWTP and surface water connections with the City. As discussed in **Section 4**, the operation of the Vineyard SWTP will be set up to operate to independent pressure zones. Water to the NSA (higher elevation zone) is assumed to be steady state with peaking coming from within the storage and groundwater systems within NSA. Water to CSA will be pumped into the water distribution system at service level pressure with some peaking occurring within the clear well of the Vineyard SWTP. This is shown in **Figure 7-4** and **Figure 7-5** which shows the peaking effect in the CSA riding on top of the steady state service to NSA for the Replacement Water Supply Project and surface water supplies.

Figure 7-4. Vineyard SWTP Output Curves – Buildout, Max Day, "Dry" Year Scenario

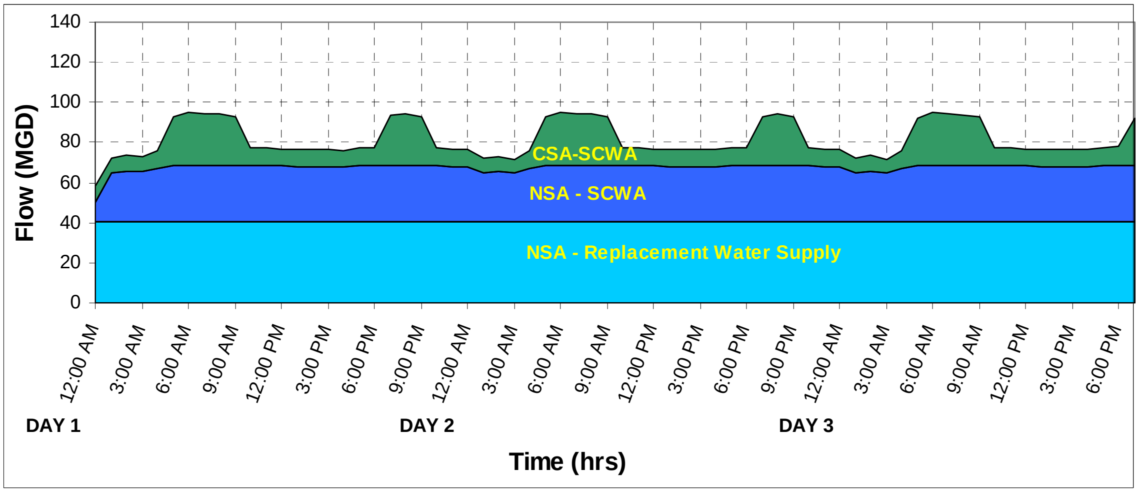
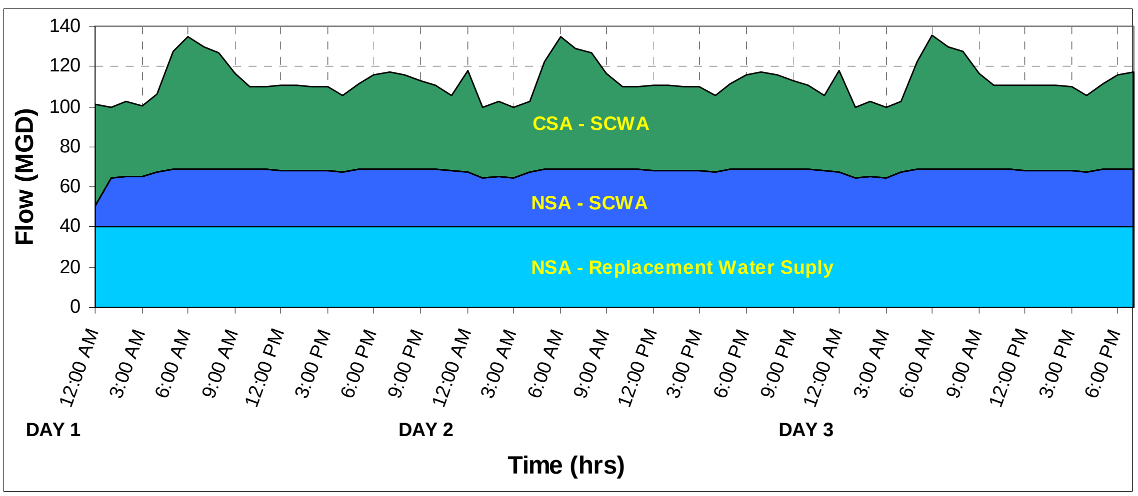


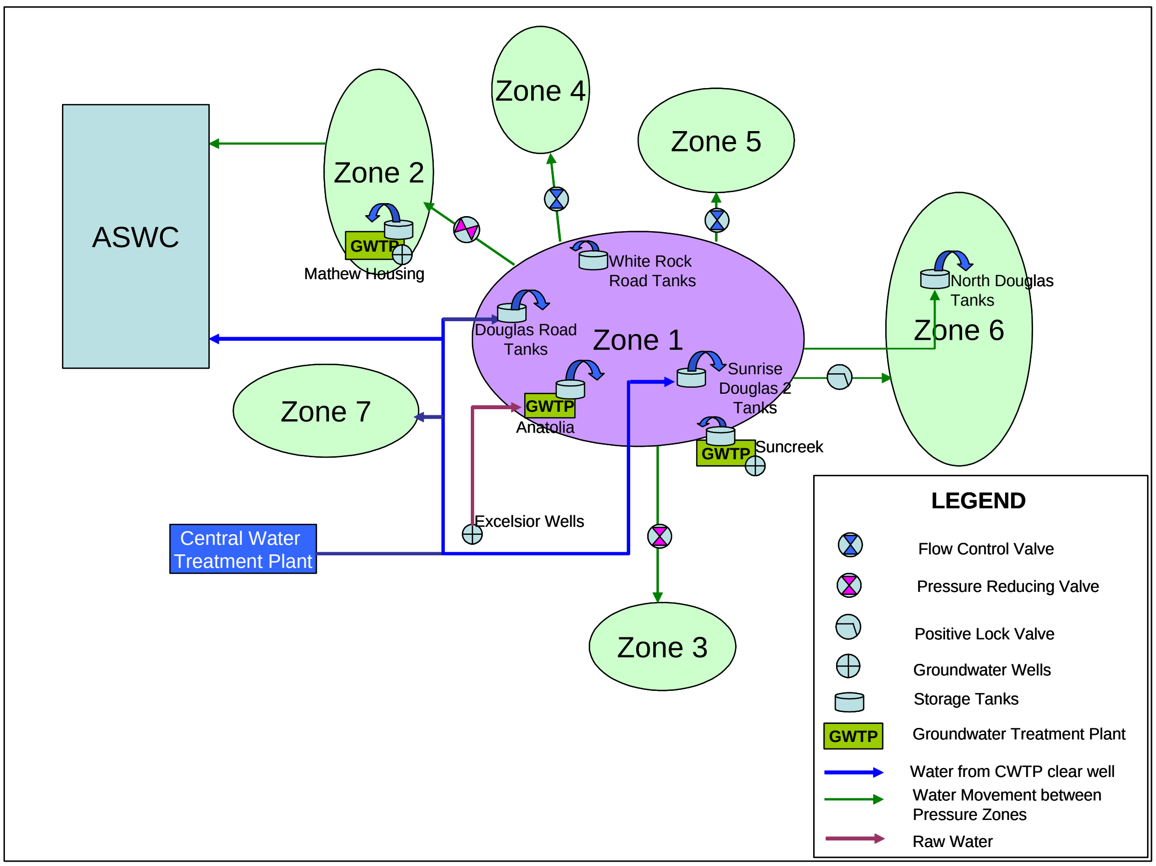
Figure 7-5. Vineyard SWTP Output Curves – Buildout, Max Day, "Wet" Year Scenario



7.4 Water Movement within the Water Distribution System

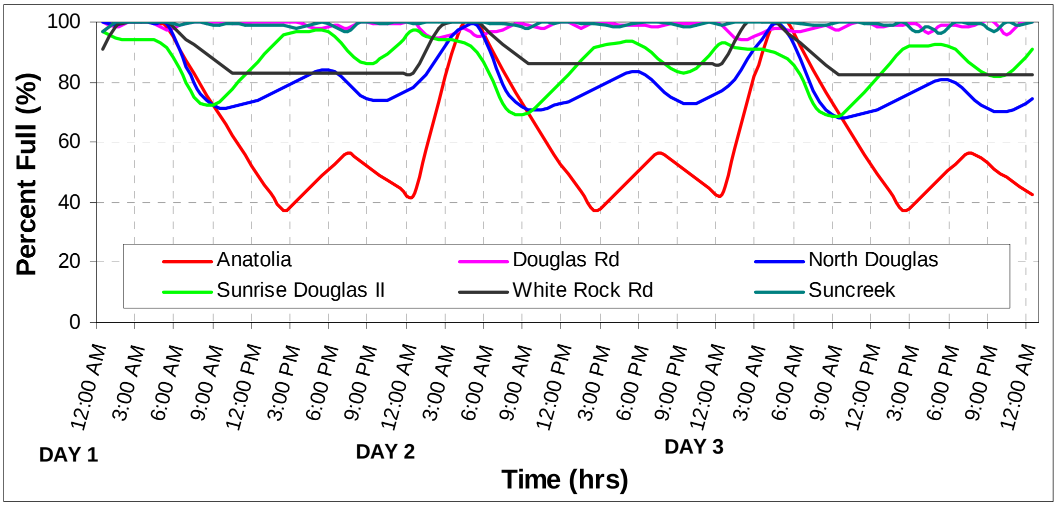
With both groundwater and surface water now feeding the water distribution system, operations of the various pressure zones now becomes the next challenge. **Figure 7-6** provides a schematic of the various pressure zones in NSA and where they get their water and what valves are being used to control flow and pressure. A significant amount of time will be needed to evaluate the optimum operational strategy over time to meet water demands and maintain pressures. In most cases, there is a storage tank that can be used to regulate the operations to within the acceptable criteria. Interim conditions, however, may produce unwanted pressure problems that will need to worked through using in the field data and the water model to decide if additional interim facilities are necessary. The WSIP does include some interim facilities to accommodate near term concerns in the NSA.

Figure 7-6. Water Movement Diagram in NSA



Operation of the NSA tanks under maximum day conditions are illustrated in **Figure 7-7**. There are some tanks such as Anatolia that are exercised more than others. Much of this depends on the supply source to the tank. In the case of Anatolia, only groundwater from the Excelsior Well Field is used. This could be modified in the future to have the tanks take some surface water during the off peak hours if storage is depleted to an undesirable level. Under all other conditions, the tanks operate close to full capacity.

Figure 7-7. NSA Tank Curves – Buildout, Max Day Scenario



7.4.1 System Pressures

Water system pressures are of significant importance throughout the period of build up in water demands. As mentioned in **Section 6**, the design of the water system at build-out and at interim phases were all done with the constraints of maintaining pressures and velocities in the pipelines at acceptable ranges. The conjunctive use element of the WSIP also needs to manipulate pressure in a way that provides the least resistance for moving surface water throughout the water distribution system. **Figure 7-2** and **Figure 7-3** identify operational ranges for groundwater treatment plant usage that provides the least resistance to surface water from the Vineyard SWTP and the City connections.

Figure 7-8 and **Figure 7-9** both show the operation range of pressures at specific points throughout the NSA water distribution system. By themselves, these graphs merely point out that pressures are not exceedingly high or low based on buildout conditions. The same type of graphs can be shown for other phases in the build out of the entire system and are provided in **Appendix F Additional Model Results**.

Figure 7-8. NSA Pressure Curves at Discharge End of Booster Pump Stations – Buildout, Max Day, both "Wet" and "Dry" Year Scenarios

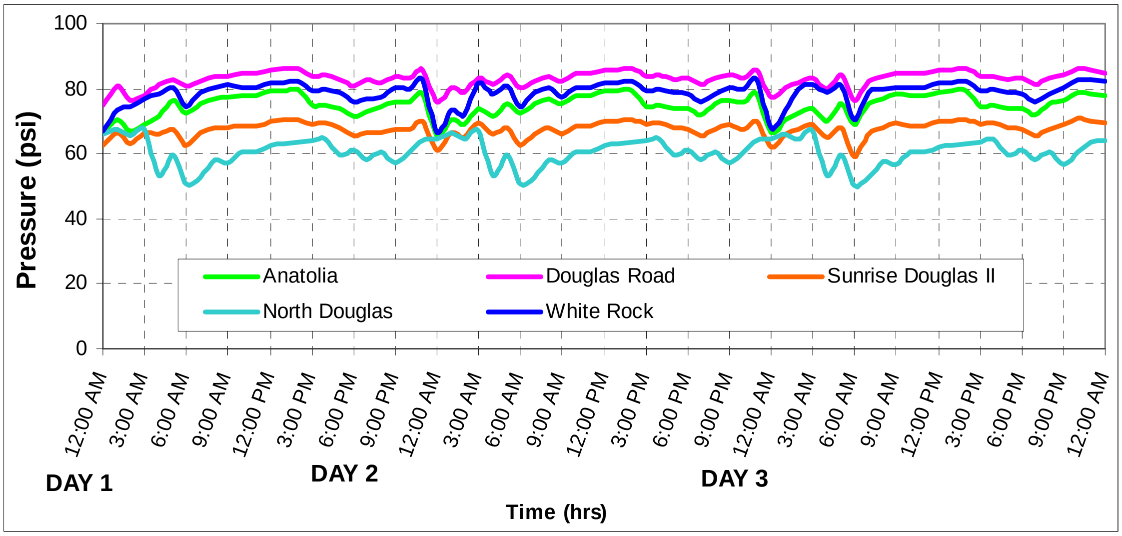
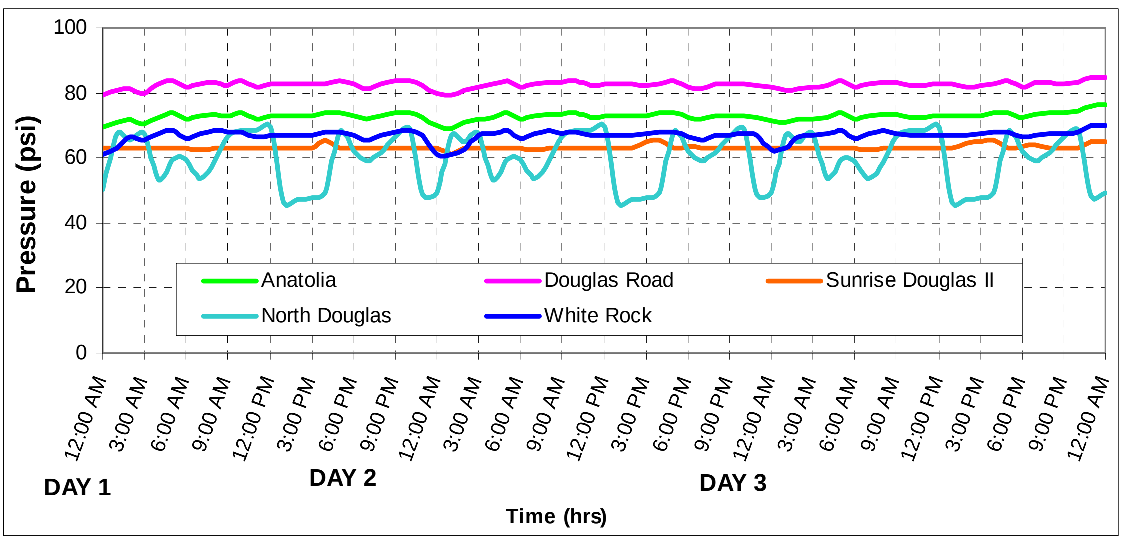


Figure 7-9. NSA Pressure Curves at Discharge End of Booster Pump Stations – Buildout, Average Day Scenario



Of more important value are the pressure contours throughout the distribution system and seeing visually how the hydraulic topography is designed. Imagine that the area comprising the distribution system has a topographic layer that represents the pressure in the system at any point in the service area (i.e., even for locations where no pipeline exists). The topography can be visualized in **Figure 7-10** peak hour pressures during a dry year. This is a year when much of supply is coming from groundwater facilities and most of the surface water is being used in the NSA. Beyond indicating the range in pressures throughout the distribution system, this figure shows where the peaks and valleys in pressure are to evaluate where water is likely to go (or not go) due to the hydraulic impediments in the system. For instance, the south area of the CSA has high pressures because it is lowest in elevation and has multiple supply sources located in the area. If these supply sources were shut down or reduced considerably, a low point in the topography would be created providing a path for surface from the Vineyard SWTP to fill. This is shown in **Figure 7-11** where the low point is created and the finger of relatively higher pressure from the Vineyard SWTP is permitted to travel significantly south during maximum day conditions. **Figure 7-12** illustrates that in the wet months, the groundwater plants can be turned down even further, creating a low pressure sink that the Vineyard SWTP can be used to fill.

There are operational issues that will be discovered as this type of conjunctive use operation takes place. For instance, pressures in the CSA near Sheldon Road and State Highway 99 become very high under conditions where significant water is being provided by the Vineyard SWTP. This requires that PRVs be put in place and that this area be operated as a separate pressure zone or of the same pressure zone as the SSA.

Figure 7-10. Peak Hour Pressures - Buildout, Max Day, "Dry" Year Scenario

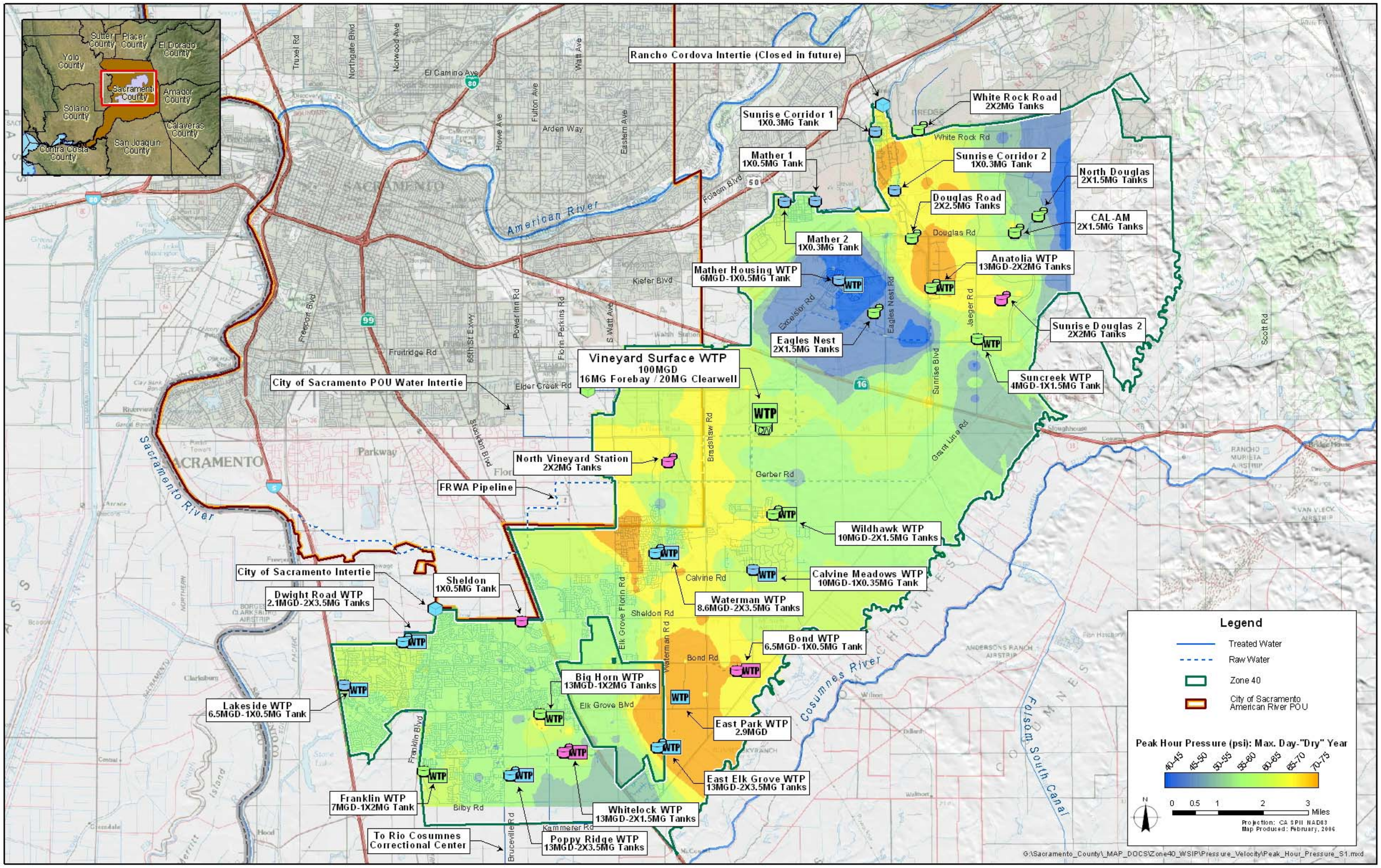


Figure 7-11. Peak Hour Pressures - Buildout, Max Day, "Wet" Year Scenario

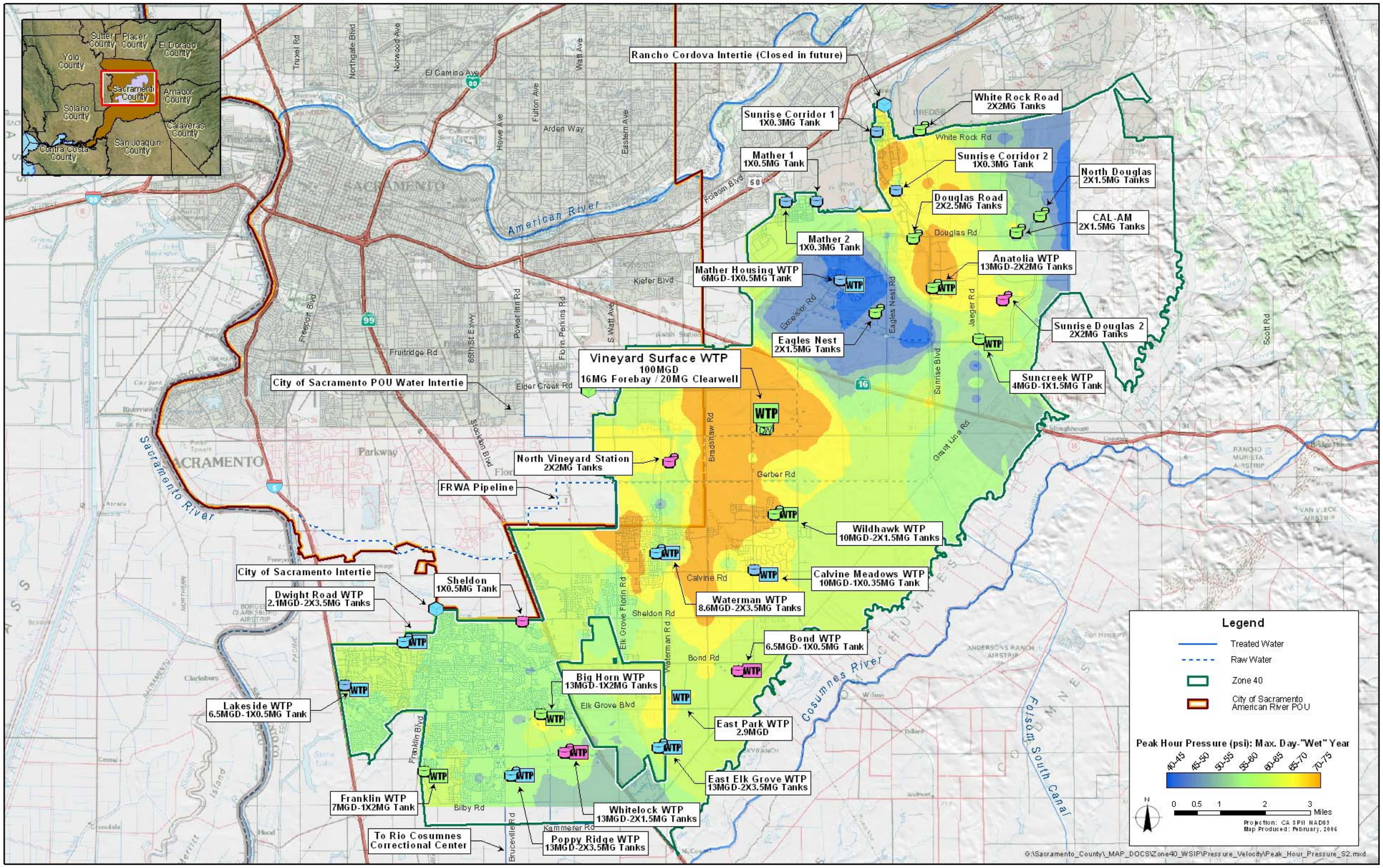
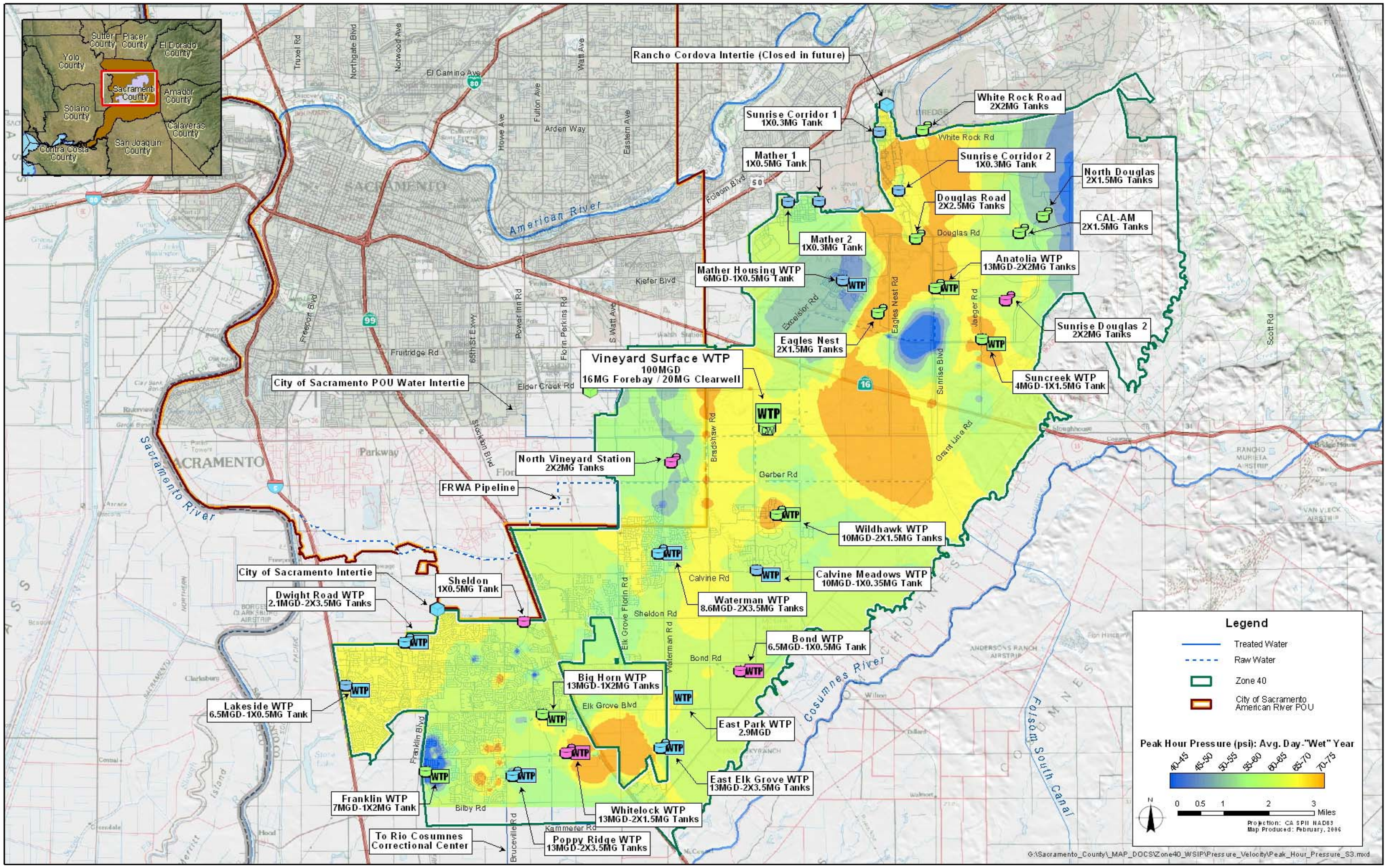


Figure 7-12. Peak Hour Pressures - Buildout, Average Day, "Wet" Year Scenario



7.4.2 Fire Flow Analysis

Fire flow is another important element of system operations. From a design standpoint, fire flow protection is always built into storage, booster pump, and conveyance facilities. From an operations standpoint, when talking about turning certain facilities off or reducing their contribution to maximize conjunctive use, there has to be a check to insure fire flow protection is guaranteed under all circumstances. This implies that tanks are maintained a full status and booster pumps are in a ready mode of operation if large quantities of water were needed at moments notice.

7.4.3 Reverse Flow Events

Much has been discussed in previous sections regarding reverse flow events occurring in the Sacramento River and likely shutting down diversion through the FRWA project from some duration of time. To alleviate this concern, raw water basins are being placed into the design of the Vineyard SWTP that will permit storage of raw water if given sufficient notice ahead of time (unless it is decided that the basins will be used as a continuous flow-through element of the treatment process to reduce peak energy costs). The reverse flow condition poses the most significant risk to the water distribution system. A continuous reverse flow event would eventually use all raw water stored and rely on clear well storage. Clear well storage combined with optimal use of raw water storage and treatment plant operations, could provide up to 16 hours of flow as shown in **Figure 7-13**.

Once clear well storage is used up at the Vineyard SWTP, the NSA becomes compromised unless some other source is introduced into the clear well. Throughout this paper there have been discussions regarding use of ASR wells for back up into the raw water basins, and also looking at filling the clear well directly from the CSA water distribution system with groundwater capacity that is turned to maximum output in CSA and NSA.

Figure 7-13. Vineyard SWTP Clear Well Operation Curve under Reverse Flow Scenario (Freeport Diversion is Shut down Temporarily)