FINAL

TECHNICAL MEMORANDUM

UNITED WATER CONSERVATION DISTRICT

# South Oxnard Plain Brackish Water Treatment Feasibility Study

AUGUST 2014

carollo
Engineers...Working Wonders With Water®

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# UNITED WATER CONSERVATION DISTRICT

# SOUTH OXNARD PLAIN BRACKISH WATER TREATMENT FEASIBILITY STUDY

## TECHNICAL MEMORANDUM

August 2014

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# UNITED WATER CONSERVATION DISTRICT

# SOUTH OXNARD PLAIN BRACKISH WATER TREATMENT FEASIBILITY STUDY

# TECHNICAL MEMORANDUM

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# SOUTH OXNARD PLAIN BRACKISH WATER TREATMENT FEASIBILITY STUDY

## 1.0 EXECUTIVE SUMMARY

United Water Conservation District (UWCD) is fostering a vision of a regional desalter on the South Oxnard Plain to utilize a local resource impaired by salt-water intrusion. The first steps in developing this vision are to:

- Confirm that a desalter is technically feasible
- Demonstrate a treated water cost that makes desalter development a viable long term water supply option

For a desalter project to be successful, three primary technical questions must be answered:

- Is there raw water available?
- Is there a viable waste brine disposal option?
- Are there customers for the treated water?

Using an assembly of data provided by UWCD, Carollo Engineers, Inc. (Carollo) was tasked with evaluating the basic technical efficacy of groundwater desalting in the South Oxnard Plain and developing conceptual facility concepts and estimates of capital and operating costs.

In order to define the treatment process, raw water quality and finished water goals must be established. UWCD provided water quality data for three representative wells, and the qualities were blended to develop a composite design water quality with a total dissolved solids (TDS) of approximately 6,400 mg/L. A “worst case” water quality was developed by increasing the individual ions by 50 percent, resulting in a raw water TDS of approximately 9,600 mg/L. Therefore, the raw water quality for design ranges from a 6,000 to 10,000 mg/L TDS. Product water quality was defined by UWCD and is consistent with the local growers’ needs for irrigation. Based on the raw water quality and product water goals, reverse osmosis (RO) was selected as the most appropriate desalination technology. Further, the proximity of the Salinity Management Pipeline (SMP), constructed and operated by Calleguas Municipal Water District (CMWD), provides a reliable long-term solution for disposal of the brine residuals from the desalter.

Using the water quality information, design criteria were developed for a 10,000 acre-ft/yr (AFY) desalter and a 20,000 AFY desalter. The primary components of the facilities include:

- Wells
- Raw Water Pipelines
- RO Pretreatment
    - Sand Separators
    - Acid Addition
    - Cartridge Filtration
    - Scale Inhibitor Addition
- Reverse Osmosis Systems
    - High Pressure Feed Pumps
    - Membranes and Pressure Vessels
    - Clean-In-Place System
    - RO Flushing System
- Post Treatment
    - Lime addition
    - Chlorine addition
- Product Water Storage
- Product Water Pumping
- Product Water Pipelines to the PTP and PVCWD distribution systems

Estimated unit operating cost assumptions, and site layouts generated for both the 10,000 AFY and 20,000 AFY facilities, budget level capital and operating costs were developed using the developed design criteria. The capital cost for both raw water quality conditions is the same for the RO facility, as it is assumed that the full-scale facility would be capable of accommodating the proposed water quality range. A summary of the costs are as follows:

- Design Water Quality
    - 10,000 AFY
        - Capital Cost = $85,137,000
        - Operating Cost = $653/AF
        - Amortized Cost = $1,111/AF

  - 20,000 AFY
    - Capital Cost = $147,966,000
    - Operating Cost = $601/AF
    - Amortized Cost = $998/AF

- Worst Case Water Quality
  - 10,000 AFY
    - Capital Cost = $85,137,000
    - Operating Cost = $821/AF
    - Amortized Cost = $1,278/AF
  - 20,000 AFY
    - Capital Cost = $147,966,000
    - Operating Cost = $733/AF
    - Amortized Cost = $1,130/AF

Based on the information provided by UWCD, SMP costs provided by CMWD, and the process selection, design criteria development, and cost information generated by Carollo, the following conclusions were made:

- The impaired groundwater in the South Oxnard Plain is suitable for treatment by reverse osmosis at an acceptable recovery range of 72 to 80 percent.

- With the exception of pH, the “ideal” product water quality can be met with traditional pretreatment, desalination, and post treatment systems.

- An amortized water cost of $998 to $1,111 per AF for the design water condition is competitive with imported water and has superior quality.

- Utilizing impaired groundwater treated to low TDS levels reduces salt import into the region, unlike irrigation with imported water.

- Connection to the SMP at the intersection of Hueneme Road and Edison Avenue is a viable option for concentrate disposal.

- Additional water quality sampling should be performed to confirm that the RO concentrate will comply with the SMP NPDES permit discharge limits.

# 2.0 BACKGROUND

Many agencies and users in Ventura County, particularly the Calleguas Creek Watershed, have seen an increase in salinity in both groundwater and surface water supplies. The source of the salts is a combination of agricultural, industrial, and residential activities in conjunction with salts in the water imported through the State Water Project.

When early settlers began pumping on the Oxnard Plain to support farming activities, the recipe was in place for the eventual overdraft of the groundwater. For nearly 100 years, United Water Conservation District has battled groundwater overdraft through a combination of aquifer recharge and alternative surface water supplies. Despite these efforts, salt-water intrusion has occurred in the southern Oxnard Plain. Unlike coastal Los Angeles and Orange County, Ventura County has no salt-water intrusion barrier in place, and the salt-impairment renders the groundwater useless for agricultural or potable uses. In fact, chloride levels in the southernmost areas of the Plain are approaching true seawater concentrations, as shown in the graphics provided by UWCD in the Request for Proposals for this project.

Managing the increase in salts will require demineralization of the water, leading many water supply agencies in Ventura County to investigate the efficacy of mining impaired groundwater for potable and non-potable uses. Specifically, UWCD is fostering a vision of a regional desalter on the South Oxnard Plain, where salt water intrusion into the shallow aquifer has occurred. The first steps in developing this vision are to:

- Confirm that a desalter is technically feasible
- Demonstrate a treated water cost that makes desalter development a viable long term water supply option

For a desalter project to be successful, three primary technical questions must be answered:

- Is there raw water available?
- Is there a viable waste brine disposal option?
- Are there customers for the treated water?

Using an assembly of data provided by UWCD, Carollo Engineers, Inc. (Carollo) was tasked with evaluating the basic technical efficacy of groundwater desalting in the South Oxnard Plain and developing conceptual facility concepts and estimates of capital and operating costs. This memorandum presents the results of this analysis, and is organized as follows:

- Section 3: Water Quality
  - An evaluation water quality data provided by UWCD, establishment of design and worst-case raw water quality, and definition of finished water goals.
- Section 4: Design Criteria
  - A discussion of technology selection, specific unit processes components and sizing, raw and product water transmission, and facility site plan and layout.
- Section 5: Capital and Operating Cost Opinion
  - A breakdown of the capital and operating costs, including unit cost assumptions, and amortized costs for two capacities and composite water qualities.

## 3.0 WATER QUALITY

Throughout this report, the groundwater supply pumped to the proposed treatment facility is referred to as raw water. The output of the treatment facility is referred to as product water, which is either treated water from the facility or a blend of treated and raw water that meets the effluent quality standards. A fundamental rule in water treatment is that the treatment process will be determined based on the design raw water quality and the product water quality goals.

For the South Oxnard Plain desalter, raw water quality and finished water goals were provided to Carollo by UWCD and were used to establish the treatment process. The proposed treatment facility includes among its primary objectives the removal dissolved salts, for example, sodium and chloride ions, from the raw water. Other raw water contaminants are also removed, but the treatment facility is referred to herein as a “desalter” to reflect the removal of salinity and in keeping with standard local terminology.

### 3.1 Required Capacity

For the purposes of this report, the required product water capacity has been defined as either 10,000 acre-feet per year (AFY) or 20,000 AFY; consequently, tabulations of capacity indicate both values. Capacity requirements for the proposed desalter are expressed in terms of annual volumes and nameplate capacity in Table 3.1.

**Table 3.1 Proposed Desalter Volumes and Capacities**

| Annual Product Water (AFY) | Annual Raw Water (AFY) | Desalter Nameplate Capacity (mgd) | Overall Desalter Recovery (percent) | Desalter Operation Factor (percent) |
|---|---|---|---|---|
| 10,000 | 13,900 to 12,500 | 8.9 | 72 to 80 | 98 |
| 20,000 | 27,800 to 25,000 | 17.8 | 72 to 80 | 98 |

Table 3.1 refers to two parameters that determine raw water volume and desalter nameplate capacity for a given annual product water requirement.

- Recovery is the efficiency of the treatment facility in transforming raw water into product water; in other words, Recovery = Product Water Volume/Raw Water Volume. Overall desalter recovery is dependent upon the processes used and the amount of raw water bypass (if any). As discussed later, an overall desalter recovery range of 72 to 80 percent has been selected for this report and is reflective of both the design and worst-case raw water qualities.
- Operation factor is the ratio between the nameplate capacity of a facility and the annual average flow required to deliver a specified volume of water per year. The operation factor accounts for the fact that facilities are generally unable to operate continuously at nameplate capacity for an entire year.[1] Because of the simplicity of the proposed system and the redundancy assumed for the raw water well field, a desalter operating factor of approximately 98 percent is appropriate.

The nameplate capacity of the desalter is the instantaneous product water flow rate capacity. The nameplate capacity is higher than the average annual flow required to produce the annual product water volume by the ratio of the operation factor.

Similarly, the annual raw water volume is greater than the annual product water volume by the ratio of the overall desalter recovery. The difference between the raw water volume and the product water volume is the amount of treatment byproduct waste. The waste volume is referred to herein as brine because of its high salinity.

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[1] The operation factor accounts for equipment downtime for repairs, cleaning, replacement and maintenance, power outages and other shutdowns, both planned and unplanned.

The brine production of the proposed desalter facility is indicated in Table 3.2.

**Table 3.2 Proposed Desalter Brine Production**

| **Product Water (AFY)** | **Brine (AFY)** | **Desalter Nameplate Capacity (mgd)** | **Brine Flow at Desalter Nameplate Capacity (mgd)** | **Overall Recovery (percent)** |
|---|---|---|---|---|
| 10,000 | 3,900 to 2,500 | 8.9 | 3.47 to 1.79 | 72 to 80 |
| 20,000 | 7,800 to 5,000 | 17.8 | 6.95 to 3.57 | 72 to 80 |

## 3.2 Proposed Well Field

The number of wells required for the proposed South Oxnard Plain Well Field depends upon the following parameters.

- The product water requirement, which is either 10,000 AFY or 20,000 AFY.
- The overall desalter recovery, which is assumed as 80 percent for the design raw water and 72 percent for the worst-case raw water.
- The overall well field operating factor, which is assumed as not greater than 75 percent.[2]
- The nameplate capacity of an individual well, which is assumed as 2,000 gpm, or 2.88 mgd.[3]

The well field operating factor represents the ratio of the total nameplate capacity of the wells and the required volume of raw water per year, expressed as an annual average flow. The risk of *not* producing the required annual product water delivery volume increases as the well field operating factor increases.

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[2] This is a typical well field operating factor for a high reliability water supply. For example, the Chino Basin Desalter Authority (CDA) currently operates two well fields to support two desalters producing approximately 10,000 AF/yr of product water for municipal use. The CDA has “take or pay” contracts with its member agencies and there are significant ramifications if it were unable to produce the required annual contract volumes. The CDA has established criteria of operating factors not less than 70 percent for each well field.

[3] This is the proposed nameplate capacity per well given in the project kickoff meeting held March 27, 2014 (see minutes dated April 8, 2014).

Using the previously stated assumptions, Table 3.3 indicates the number of wells needed to produce the raw water required for treatment of 10,000 AFY and 20,000 AFY of product water. The number of wells required has been rounded up to the next integer value and the well field operating factor adjusted accordingly.

**Table 3.3 Proposed Desalter Well Field**

| Product Water (AF/year) | Raw Water (AF/year) | Average Capacity per Well (gpm) | Number of Wells Required (No.) | Overall Well Field Operating Factor (percent) |
|---|---|---|---|---|
| 10,000 | 13,889 | 2,000 | 4 | 108 |
| | | | 5 | 86 |
| | | | **6** | **72** |
| 20,000 | 27,778 | 2,000 | 10 | 86 |
| | | | 11 | 78 |
| | | | **12** | **72** |

Note:
(1) Bold indicates acceptable well field operating factor (i.e., ≤ 75%)

Proposed well locations and pipelines to the desalter facility are shown in Figure 3.1.

## 3.3 Raw Water Quality

UWCD has provided water quality data for three wells that are proposed as representative of the desalter well field quality.[4] Although the wells vary in water quality, it is assumed that UWCD would operate wells in various locations to provide a blended water quality that is within the design parameters of the proposed desalter, even under changing water quality conditions.[5]

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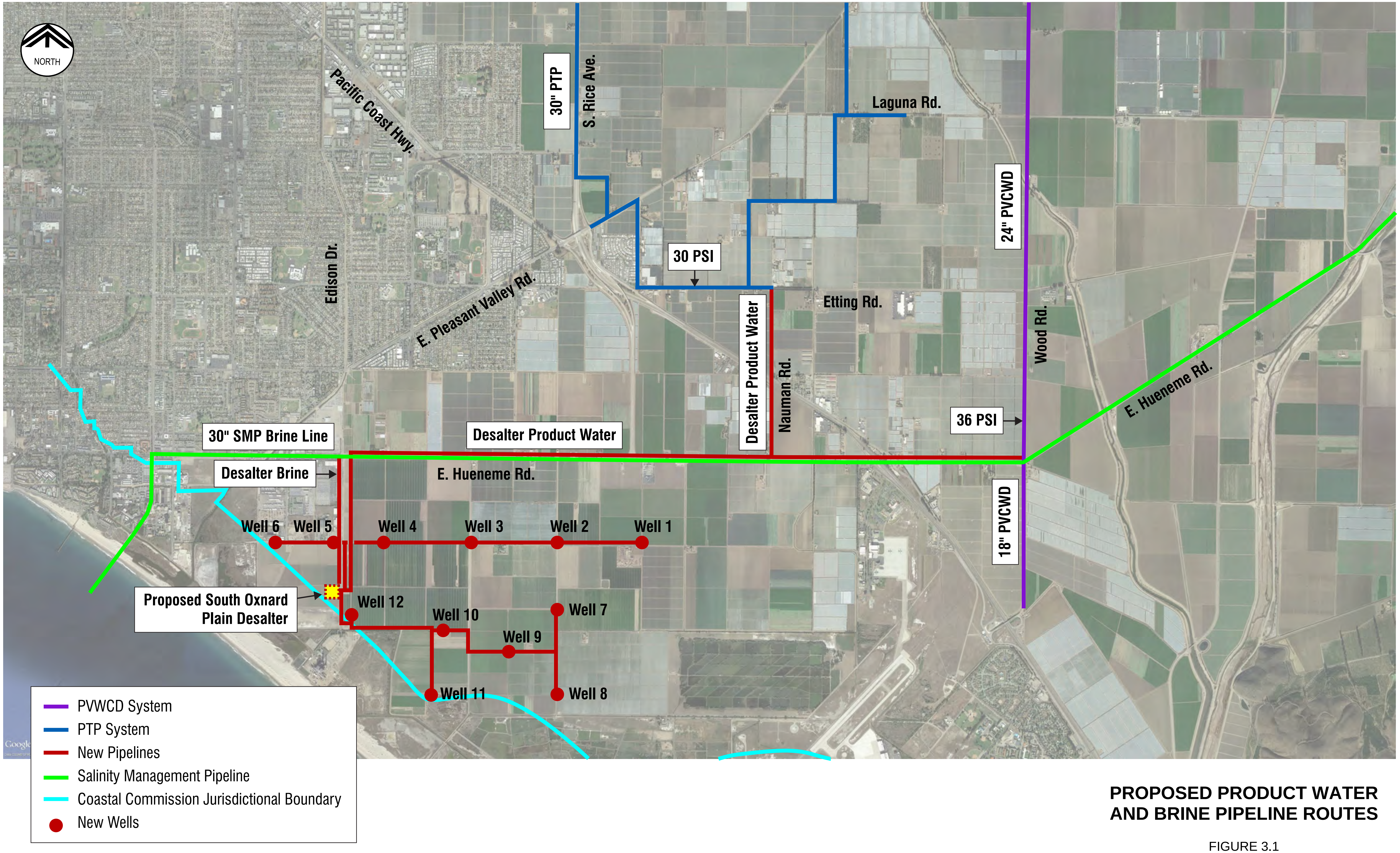
[4] Water quality files are “1990-91 USGS Rasa_wq - coastal.xlsx” and “Brackish Study WQ Export.xlsx” provided by Dan Detmer via email dated March 25, 2014.

[5] See minutes of the project kickoff meeting held March 27, 2014 (minutes dated April 8, 2014).



PROPOSED PRODUCT WATER
AND BRINE PIPELINE ROUTES

FIGURE 3.1

UNITED WATER CONSERVATION DISTRICT
*OXNARD PLAIN BRACKISH WATER TREATMENT FEASIBILITY*

The three wells that represent the range of potential raw water quality for the well field are as follows.

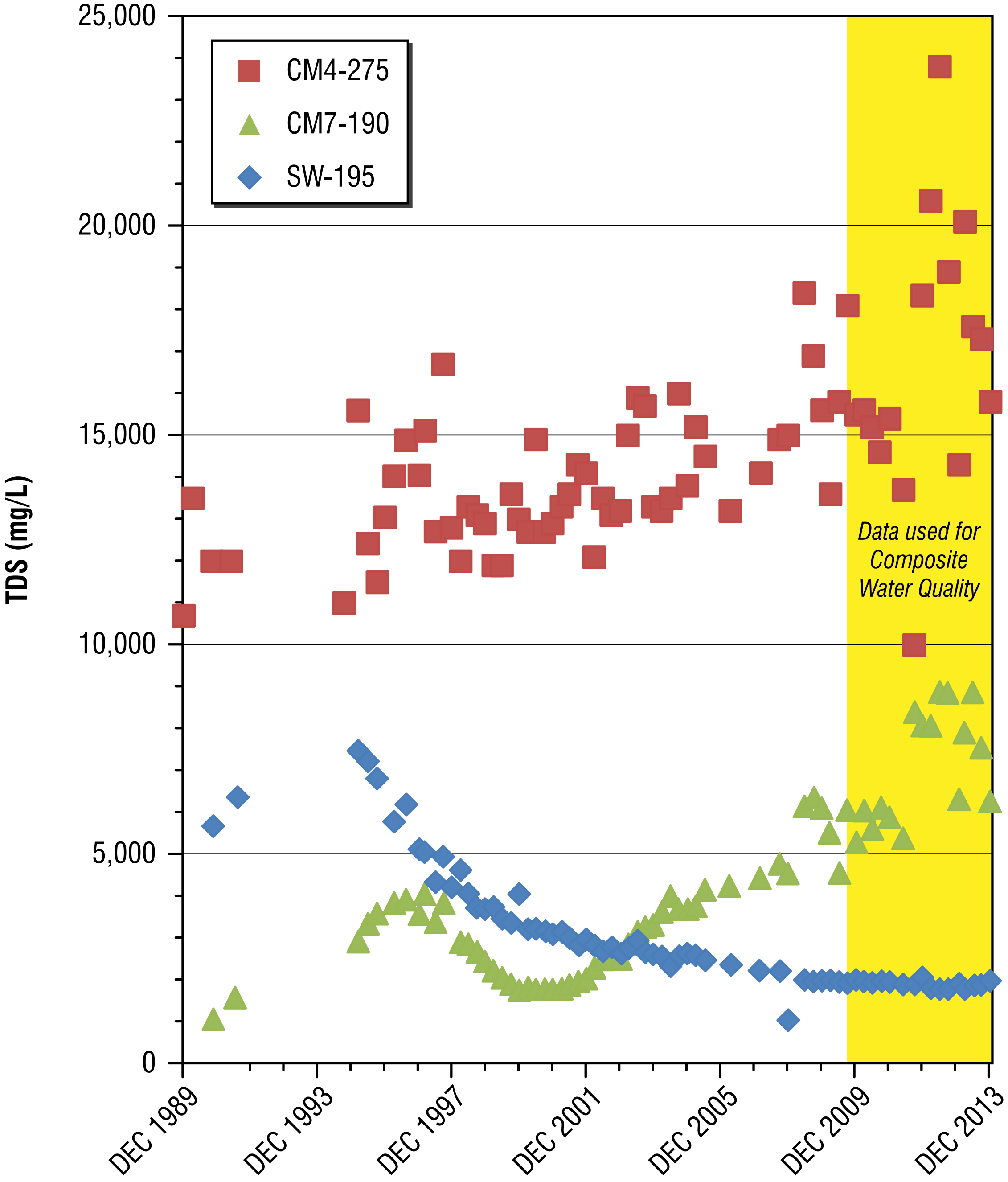
- Well SW-195 (State ID: 01N22W27C03S)
- Well CM7-190 (State ID: 01N22W27R04S)
- Well CM4-275 (State ID: 01N22W28G04S)

Water quality data provided by UWCD cover a period of approximately 15 years with data collected four times per year for some parameters of interest (e.g., chlorides and TDS) and less frequently, once or twice per year at the most, for other parameters of interest (e.g., calcium, silica and iron).

The water quality in the three representative wells has changed significantly over the past 15 years. As indicated on the following figures, the last four years of record (November 2009 – December 2013) are used for the purposes of creating a current composite raw water quality for design criteria.

- Figure 3.2 indicates TDS levels.
- Figure 3.3 indicates chloride levels.
- Figure 3.4 indicates calcium levels.
- Figure 3.5 indicates iron levels.

Table 3.4 indicates the average water quality for each of the three wells over the past four years for parameters of interest. The water quality data for the individual wells were blended to provide a composite current design water quality with a TDS of approximately 6,400 mg/L. A “worst case” water quality was developed by increasing the individual ions by 50 percent, resulting in a raw water TDS of approximately 9,600 mg/L. Therefore, the raw water quality for design ranges from a 6,000 to 10,000 mg/L TDS.



## TDS IN REPRESENTATIVE WELLS

FIGURE 3.2

UNITED WATER CONSERVATION DISTRICT
*OXNARD PLAIN BRACKISH WATER TREATMENT FEASIBILITY*

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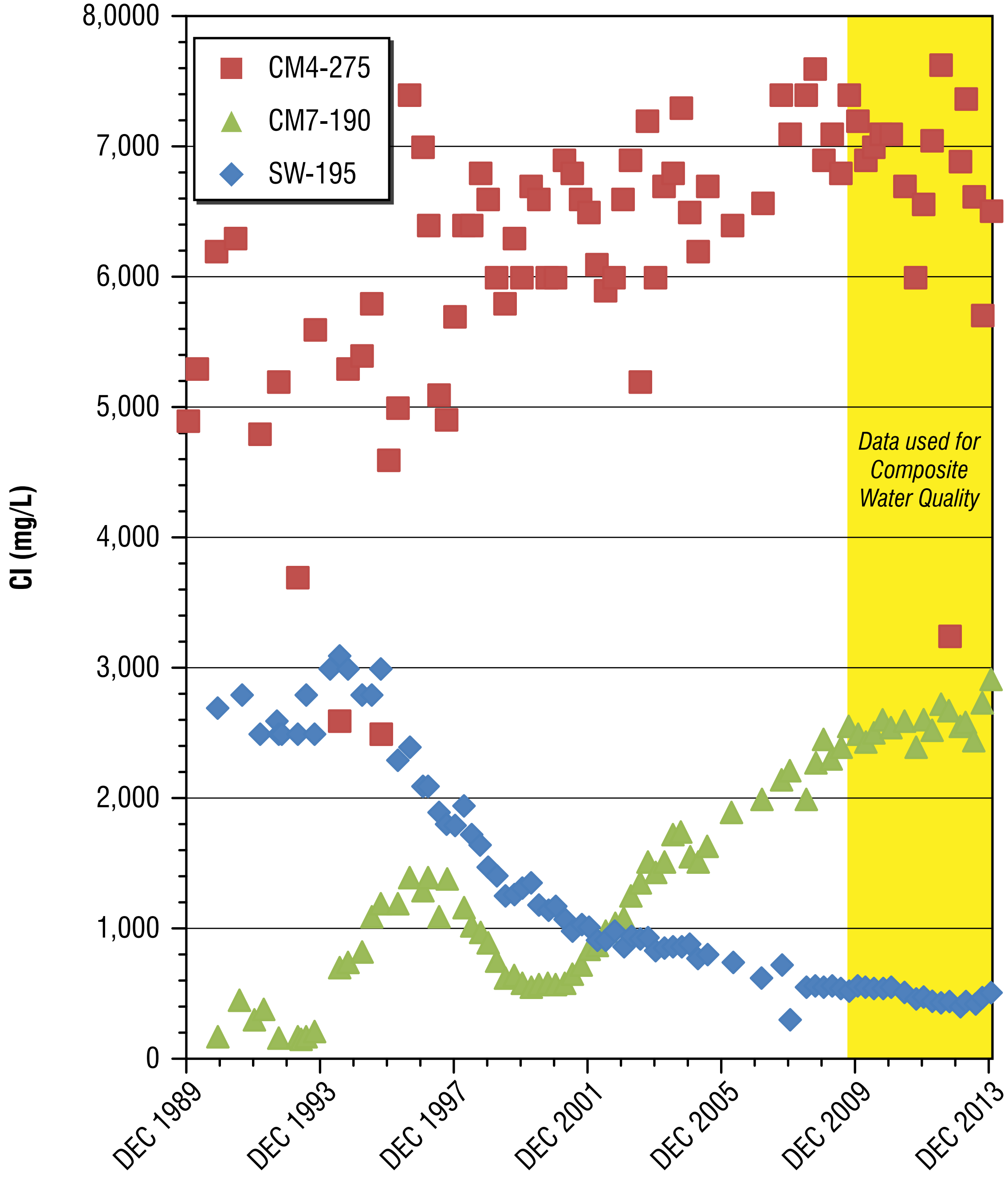
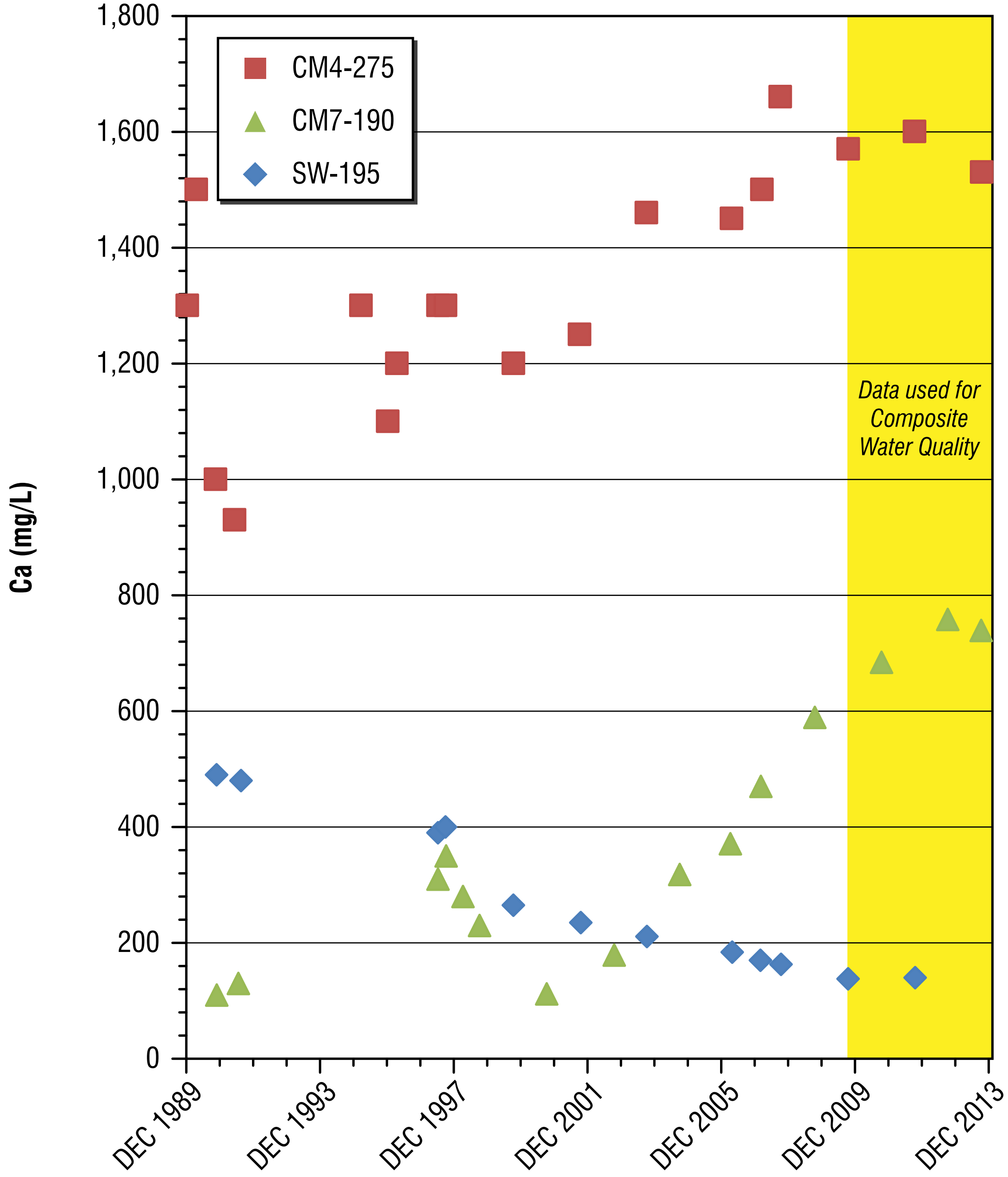


## CHLORIDE CONCENTRATION IN REPRESENTATIVE WELLS

FIGURE 3.3

UNITED WATER CONSERVATION DISTRICT

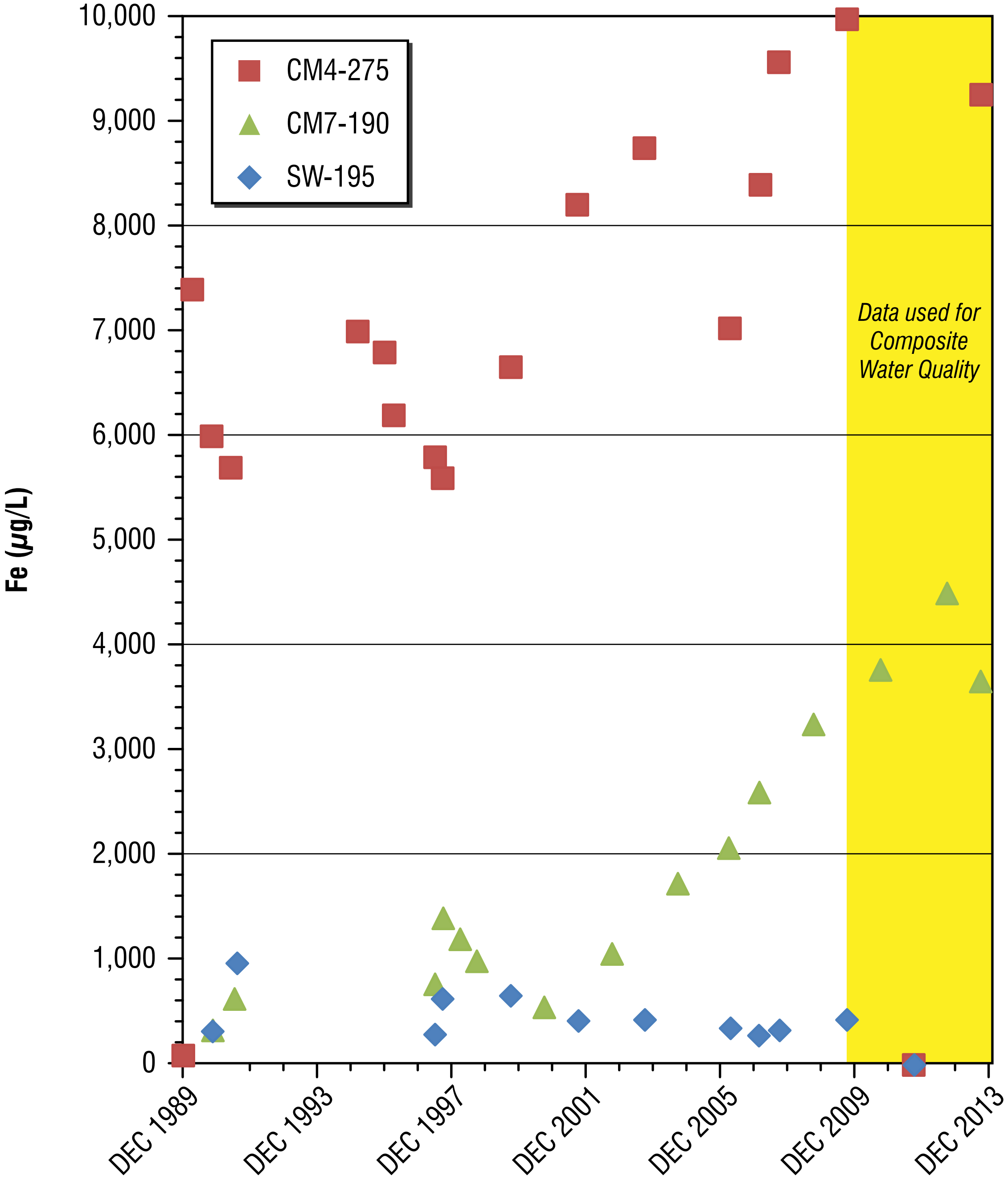
*OXNARD PLAIN BRACKISH WATER TREATMENT FEASIBILITY*



# CALCIUM CONCENTRATION IN REPRESENTATIVE WELLS

FIGURE 3.4

UNITED WATER CONSERVATION DISTRICT
*OXNARD PLAIN BRACKISH WATER TREATMENT FEASIBILITY*



## IRON CONCENTRATION IN REPRESENTATIVE WELLS

FIGURE 3.5

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*OXNARD PLAIN BRACKISH WATER TREATMENT FEASIBILITY*

**Table 3.4 Raw Water Quality**

| | Well SW-195 | Well CM7-190 | Well CM4-275 | Composite Design Raw Water | Composite Worst Case Raw Water |
|---|---|---|---|---|---|
| Calcium (mg/L $Ca^{2+}$) | 139 | 727 | 1,565 | 810 | 1,216 |
| Magnesium (mg/L $Mg^{2+}$) | 46 | 374 | 488 | 303 | 454 |
| Sodium (mg/L $Na^{+}$) | 438 | 507 | 2,285 | 1,077 | 1,615 |
| Potassium (mg/L $K^{+}$) | 7.6 | 17.7 | 31.9 | 19.1 | 28.6 |
| Barium (mg/L $Ba^{2+}$) | 0.0510 | 0.0155 | 0.0515 | 0.0393 | 0.059 |
| Strontium (mg/L $Sr2^{+}$) | 4.9 | 1.3 | 8.3 | 4.8 | 7.2 |
| Iron (mg/L $Fe^{2+}$) | 0.426 | 1.901 | 6.581 | 2.969 | 4.5 |
| Manganese (mg/L $Mn^{2+}$) | 0.780 | 0.915 | 2.476 | 1.390 | 2.1 |
| Ammonium (mg/L $NH_4^{+}$) | 1.40 | 0.38 | 3.95 | 1.91 | 2.9 |
| Cations (mg/L) | 638 | 1,630 | 4,391 | 2,220 | 3,330 |
| Bicarbonate (mg/L $HCO_3^{-}$) | 281 | 192 | 265 | 246 | 369 |
| Sulfate (mg/L $SO_4^{2-}$) | 605 | 691 | 1,140 | 812 | 1,218 |
| Chloride (mg/L $Cl^{-}$) | 496 | 2,589 | 6,600 | 3,228 | 4,843 |
| Fluoride (mg/L $F^{-}$) | 0.37 | 0.47 | 0.29 | 0.38 | 0.6 |
| Carbonate (mg/L $CO_3^{2-}$) | 0.46 | 0.40 | 0.21 | 0.33 | 0.5 |
| Nitrate (mg/L $NO_3^{-}$) | 1.3 | 1.2 | 1.0 | 1.2 | 2 |
| Phosphate (mg/L $PO_4^{3-}$) | 3.4 | 1.8 | 0.4 | 1.9 | 2.8 |
| Bromide (mg/L $Br^{-}$) | 8.5 | 1.2 | 20.3 | 10.0 | 15.0 |
| Anions (mg/L) | 1,395 | 3,476 | 8,027 | 4,300 | 6,449 |
| Silica (mg/L $SiO_2$) | 30.5 | 32.5 | 32.0 | 31.7 | 47.5 |
| Boron (mg/L B) | 0.888 | 0.098 | 0.258 | 0.415 | 0.622 |
| Color | na [1] | na [1] | na [1] | | |
| Hydrogen Sulfide (mg/L) | na [1] | na [1] | na [1] | | |
| pH (units) | 7.30 | 7.34 | 6.94 | 7.14 | 7.14 |

**Table 3.4 Raw Water Quality**

| | Well SW-195 | Well CM7-190 | Well CM4-275 | Composite Design Raw Water | Composite Worst Case Raw Water |
|---|---|---|---|---|---|
| Alkalinity (mg/l as $CaCO_3$) | 230 | 157 | 217 | 201 | 302 |
| Hardness (mg/l as $CaCO_3$) | 537 | 3,355 | 5,919 | 3,270 | 4,906 |
| $CO_2$ (mg/L) | 17.4 | 10.0 | 36.2 | 20.0 | 30.3 |
| TOC (mg/L) | na [1] | na [1] | na [1] | | |
| Temperature (°C) | 19.1 | 19.1 | 18.4 | 18.9 | 18.9 |
| Total Ions + $SiO_2$ | 2,064 | 5,139 | 12,450 | 6,551 | 9,827 |
| TDS by Evaporation at 180°C (mg/l) | 1,913 | 7,098 | 16,671 | | |
| TDS by Ion Summation (mg/l) | 1,921 | 5,041 | 12,315 | 6,426 | 9,639 |
| Evaporation/Summation Ratio | 1.00 | 1.41 | 1.35 | | |
| Ion Balance Deviation (%) | -2.0 | -0.5 | 1.1 | 0.4 | 0.4 |

Notes:

(1) na = not available
(2) Includes total ions (no silica) and 49 percent of the bicarbonate concentration.

## 3.4 Product Water Quality

Product water quality objectives have been provided by UWCD and are consistent with “ideal” product water based on agricultural requirements. The product water requirements are indicated in Table 3.5.

**Table 3.5 Ideal Product Water Based on Agricultural Requirements**

| Parameter | Units | Criteria |
|---|---|---|
| Chloride | mg/L | < 50 |
| Sodium | mg/L | < 50 |
| Sulfate | mg/L | < 150 |
| Bicarbonate | mg/L | < 150 |
| Boron | mg/L | < 0.8 |
| TDS | mg/L | < 600 |
| pH | mg/L | > 6.5 and < 7.0 |

## 3.5 Concentrate Water Quality and Disposal Considerations

The Calleguas Municipal Water District (CMWD) has constructed the Salinity Management Pipeline (SMP), which will ultimately run from Simi Valley southwest to an ocean outfall in Port Hueneme. The SMP is an effective, sustainable mechanism for salt export from Ventura County. Since Phase 1 of the SMP runs west along Hueneme Road, it opens the door for desalter development on the South Oxnard Plain.

### 3.5.1 Discharge Limits

Discharge limits are established by CMWD in concert with the SMP NPDES permit. Table 3.6 presents the SMP discharge limits (taken from the *CMWD Salinity Management Pipeline Information for Potential Dischargers*, November 2011) for the constituents regulated by the NPDES permit.

**Table 3.6 SMP Discharge Limits**

| Constituent | Units | Average Monthly | Average Weekly | Daily Maximum | Instantaneous Maximum | 6-month Median |
|---|---|---|---|---|---|---|
| N-Nitrosodiphenylamine | μg/L | 182 | -- | -- | -- | -- |
| Nitrobenzene | μg/L | 358 | -- | -- | -- | -- |
| PAH | μg/L | 0.64 | -- | -- | -- | -- |
| Arsenic | μg/L | -- | -- | 2120 | 5624 | 368 |
| Beryllium | μg/L | 2.4 | -- | -- | -- | -- |
| Cadmium | μg/L | -- | -- | 292 | 730 | 73 |
| Chromium VI | μg/L | -- | -- | 584 | 1460 | 146 |
| Copper | μg/L | -- | -- | 732 | 2046 | 75 |
| Lead | μg/L | -- | -- | 584 | 1460 | 146 |
| Mercury | μg/L | -- | -- | 12 | 29 | 3 |
| Nickel | μg/L | -- | -- | 1460 | 3650 | 365 |
| Selenium | μg/L | -- | -- | 4380 | 10950 | 1095 |
| Silver | μg/L | -- | -- | 193 | 500 | 40 |
| Thallium | μg/L | 146 | -- | -- | -- | -- |
| Zinc | μg/L | -- | -- | 5,264 | 14,024 | 884 |
| Cyanide | μg/L | -- | -- | 292 | 730 | 73 |
| TCDD Equivalents | μg/L | 2.85E-07 | -- | -- | -- | -- |
| Aldrin | μg/L | 0.002 | -- | -- | -- | -- |

**Table 3.6 SMP Discharge Limits**

| Constituent | Units | Average Monthly | Average Weekly | Daily Maximum | Instantaneous Maximum | 6-month Median |
|---|---|---|---|---|---|---|
| Chlordane | µg/L | 0.002 | -- | -- | -- | -- |
| Chlorinated Phenolics | µg/L | -- | -- | 292 | 730 | 73 |
| DDT | µg/L | 0.012 | -- | -- | -- | -- |
| Dieldrin | µg/L | 0.003 | -- | -- | -- | -- |
| Endosulfan | µg/L | -- | -- | 1.314 | 1.971 | 0.657 |
| Endrin | µg/L | -- | -- | 0.292 | 0.438 | 0.146 |
| HCH* | µg/L | -- | -- | 0.58 | 0.88 | 0.29 |
| Heptachlor | µg/L | 0.004 | -- | -- | -- | -- |
| Heptachlor Epoxide | µg/L | 0.002 | -- | -- | -- | -- |
| Non-chlorinated Phenolic Compounds | µg/L | -- | -- | 8,760 | 21,900 | 2,190 |
| PCBs* | µg/L | 0.001 | -- | -- | -- | -- |
| Toxaphene | µg/L | 0.015 | -- | -- | -- | -- |
| Tributyltin | µg/L | 0.102 | -- | -- | -- | -- |
| Total Residual Chlorine | µg/L | -- | -- | 584 | 4,380 | 146 |
| Acute Toxicity | TUa | -- | -- | 2.46 | -- | -- |
| Chronic Toxicity | TUc | -- | -- | 73 | -- | -- |
| Total Suspended Solids | mg/L | 60 | -- | -- | -- | -- |
| Settleable Solids | mL/L | 1.0 | 1.5 | -- | 3.0 | -- |
| Ammonia (as N) | µg/L | -- | -- | 175,200 | 438,000 | 43,800 |
| BOD (5-day @ 20°C) | mg/L | 30 | 45 | -- | -- | -- |
| Oil and Grease | mg/L | 25 | 40 | -- | 75 | -- |
| Gross alpha | pCi/L | -- | -- | 15 | -- | -- |
| Gross beta | pCi/L | -- | -- | 50 | -- | -- |
| Combined Radium-226 & Radium-228 | pCi/L | -- | -- | 5.0 | -- | -- |
| Tritium | pCi/L | -- | -- | 20,000 | -- | -- |
| Strontium-90 | pCi/L | -- | -- | 8.0 | -- | -- |
| Uranium | pCi/L | -- | -- | 20 | -- | -- |

The water quality data provided by UWCD does not contain information on the constituents listing in Table 3.6 (except for aluminum). For the purposes of this study, it is assumed that these contaminants are not present in the shallow aquifer at levels that would violate the discharge limits after concentration in the RO process. Carollo recommends that the UWCD implement a sampling plan to test for the constituents in Table 3.6 to confirm the stated assumption. The sampling plan should include quarterly sampling for at least one year to capture seasonal variations in quality. The suitability of the sampled wells for capturing the anticipated water quality should be verified with hydrological modeling and well pumping capability (outside to scope of this study). Wells should be pumped during sampling to ensure that the water is representative of the actual aquifer quality.

# 4.0 DESIGN CRITERIA

As mentioned previously, raw water quality and product water objectives determine the appropriate treatment process options. It is possible to narrow the selection among treatment alternatives that can meet the treatment objectives for a given raw water quality by differentiating them in appropriate selection criteria of importance to the application. Such selection criteria may include reliability, robustness, capital costs, and O&M costs.

## 4.1 Process Selection

A preliminary screening of process alternatives is used to narrow the selection to a single treatment process option.

### 4.1.1 Preliminary Screening of Process Alternatives

There are three basic process options to be initially evaluated for the proposed South Oxnard Plain desalter facility.

- Reverse osmosis (RO): a physical membrane process that removes dissolved salts by applying pressure to promote diffusion of water through a semi-permeable membrane. This is the lowest cost treatment process that can meet the product water objectives for the proposed raw water criteria. It is the recommended process.
- Electrodialysis reversal (EDR): an electrochemical separation process in which ions are transferred through ion exchange membranes by means of a DC voltage. EDR is not energy cost competitive with RO for treating the range of raw water quality (TDS = 5,000 – 10,000 mg/L) to meet the product water objective (TDS < 600 mg/L). In cases where concentrate disposal is expensive and RO systems are recovery limited by silica, higher EDR energy usage can be offset by higher recovery and lower concentrate disposal costs. However, calcium sulfate is the recovery-limiting constituent for this raw water, so EDR offers no advantage with respect to increased recovery. Therefore, EDR is not considered as the desalination process.

- Thermal distillation processes: not cost effective for treatment of brackish groundwater.

RO is proposed as the most appropriate treatment process for the proposed South Oxnard Plain desalter facility.

### 4.1.2 RO Process Description

Typical RO membranes used for desalting are formed as flat sheets that combine with spacers into a spiral wound membrane element. The cylindrical membrane elements are stacked in series within a pressure vessel so that pressurized feedwater can be applied to the membrane material. The pressure vessel has separate connections for feedwater, desalted water (permeate), and concentrated dissolved solids (brine).

The RO pressure vessels are staged into an array to produce desirable hydraulics for a given recovery or range of recoveries. A set of pressure vessels grouped into an array as an independent operating unit forms an RO train. Each RO train has constant capacity (measure as permeate flow), thus providing modular increments of capacity for operation of the entire RO plant.

#### *4.1.2.1 Membrane Fouling*

RO membranes are designed to remove dissolved contaminants from water but they are not intended to be exposed to particles or biology. The capacity of an RO membrane can decrease over time due to the following types of fouling.

- Particle fouling
- Mineral scaling
- Biological fouling
- Organic fouling

RO elements can be chemically cleaned in place to remove mineral fouling and some types of biological and organic fouling but they cannot be backwashed or flushed to remove particulates. The RO system must be protected from particles and biology.

Protection from biology is simplified when the raw water supply is groundwater, as is the case for the proposed South Oxnard Plain desalter. Protection from particles is provided by careful well construction practices and installation of cartridge filters upstream of the RO system. Wells that produce significant amounts of sand require an additional sand removal process (e.g., self-flushing filter screens) to prevent overloading the cartridge filters.

The recovery of an RO system is limited by the precipitation of chemical foulants in the concentrate. Operation at high recovery can require the addition of an acid (typically sulfuric acid) and scale inhibitors to the RO system feedwater in order to reduce the precipitation of the limiting foulants. Based upon the raw water quality, the limiting foulant for the proposed desalter is calcium sulfate. Silica concentrations are in excess of solubility, but are below the 180 to 200 mg/L range that is considered reasonably controllable with current scale inhibitors.

Periodic application of clean-in-place (CIP) chemicals can remove calcium sulfate and silica foulants; however, CIP represents an added cost of operation and production downtime. In addition, the aggressive chemicals used for CIP can increase salt passage through the RO membranes and reduce the useful life of the RO elements. The RO design criteria proposed in this report are intended to limit CIP frequency to 3 times per year, on average.

#### *4.1.2.2 Post-treatment*

Carbonate alkalinity is significantly reduced via rejection by the RO membranes, but carbon dioxide gas is not. The proposed process includes raw water sulfuric acid addition to depress the feedwater pH, which helps reduce RO element fouling from iron and manganese. However, lowering the pH converts some carbonate alkalinity to carbon dioxide, which then passes through the membrane to the RO permeate. Post-treatment of the RO permeate by addition of a base is required to raise the pH to a level that, in conjuction with the permeate hardness and alkalinity, results in a stable finished water that is not corrosive to distribution system piping (existing and new). Common practice for groundwater desalters is to bypass a portion of the raw water and blend it with the treated permeate to add the necessary hardness and alkalinity to stabilize the finished water. However, due to the stringent chloride goals defined in Table 3.5, no raw water bypass is possible. Therefore, in order to achieve stable finished water, hydrated lime will be added to 1) increase RO permeate pH and convert dissolved $CO_2$ to bicarbonate alkalinity and 2) add calcium to increase the calcium carbonate precipitation potential (CCPP) to 4 to 10 mg/L, a value recommended to protect distribution system piping from corrosion.

### 4.1.3 <u>RO System Process Elements</u>

The process flow diagram for the proposed desalter options are shown in Figures 4.1 through 4.4. The diagram shows the following major process elements.

- RO Pretreatment
  - Sand separators to remove sand or other suspended solids larger than 25 micron
  - Cartridge filters to provide the final protective barrier against suspended solids and turbidity.
  - Acid and threshold inhibitor addition for scale control to reduce mineral scaling that may foul the RO membrane elements.
- RO System
  - RO feed pumps for boosting the RO feed pressure.
  - RO membrane trains for removing dissolved solids.

- RO Post-treatment
  - pH adjustment and remineralization with hydrated lime addition.
  - Chlorination with sodium hypochlorite

Each of these process elements is presented in more detail, with preliminary design criteria, later in this section of the report.

## 4.2 System Hydraulics and Plant Hydraulic Profile

Raw water and product water hydraulics were modeled for both design recoveries and both product water capacities.

### 4.2.1 Raw Water Hydraulic Modeling Parameters

Raw water pipelines were modeled as HDPE DR13.5 and sized to maintain flow velocities to not more than 5 feet per second. In order to represent worst case operating cost conditions, wells were selected that created the maximum pressure loss and energy usage. In all cases, well output was evenly distributed amongst online wells and pumping requirements were based on delivering the required feedwater at 50 psig at the entrance to the desalter.

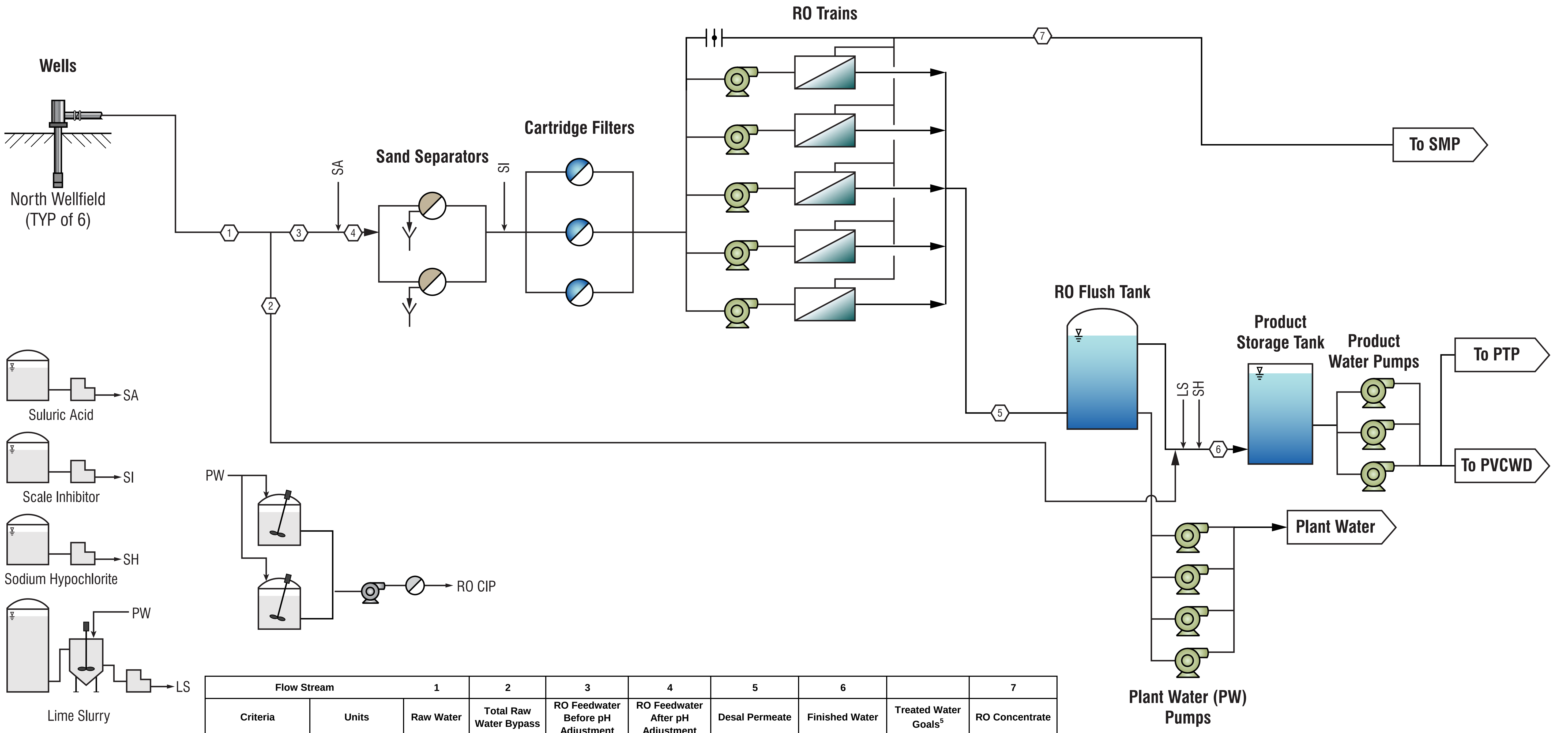
### 4.2.2 Product Water Hydraulic Modeling Parameters

Product water pipelines were modeled as welded steel and sized to maintain flow velocities to not more than 5 feet per second. Additionally, pipeline sizing was selected to allow the entire product water capacity to be delivered to either the PTP or the PVCWD distribution systems. Pipeline routing to the PTP and PVCWD is presented in Figure 3.1 in Section 3.

Hydraulic model outputs are provided in Appendix A for both water quality conditions and both capacities

### 4.2.3 Desalter Hydraulic Profile

The proposed hydraulic profile for the RO system process is shown in Figure 4.5. The hydraulic profile shows facilities located on the South Oxnard Plain desalter site, including the membrane process, RO flush tank, product water storage tank, and product water pumping. The hydraulic profile represents a general estimate of flow conditions through the plant and includes RO feed pressure points for both the design water and worst case water, as well as product water discharge requirements at both 10,000 AFY and 20,000 AFY.



| Flow Stream | | 1 | 2 | 3 | 4 | 5 | 6 | | 7 |
|---|---|---|---|---|---|---|---|---|---|
| **Criteria** | **Units** | **Raw Water** | **Total Raw Water Bypass** | **RO Feedwater Before pH Adjustment** | **RO Feedwater After pH Adjustment** | **Desal Permeate** | **Finished Water** | **Treated Water Goals[5]** | **RO Concentrate** |
| **Flow Rate** | **(gpm)** | 7,725 | 0 | 7,725 | 7,725 | 6,180 | 6,180 | | 1,545 |
| **Flow Rate** | **(mgd)** | 11.13 | 0.00 | 11.13 | 11.13 | 8.90 | 8.90 | | 2.23 |
| | | | | | | | | | |
| **Water Quality[1,3,4]** | | | | | | | | | |
| **TDS** | **(mg/L)** | 6426 | 6426 | 6426 | 6361 | 48 | 259 | <600 | 31609 |
| **Calcium Hardness** | **(mg/L as $CaCO_3$)** | 2026 | 2026 | 2026 | 2026 | 9 | 88 | | 10092 |
| **Total Hardness** | **(mg/L as $CaCO_3$)** | 3270 | 3270 | 3270 | 3270 | 15 | 94 | | 16291 |
| **pH** | | 7.14 | 7.15 | 7.15 | 6.17 | 5.03 | 8.38 | 6.5 to 7 | 6.95 |
| **Sodium** | **(mg/L)** | 1076.7 | 1076.7 | 1076.7 | 1076.7 | 12.0 | 13.5 | <50 | 5335.3 |
| **Bicarbonate** | **(mg/L)** | 246 | 244 | 244 | 113 | 4 | 103 | <150 | 935 |
| **Chlorides** | **(mg/L)** | 3228 | 3228 | 3228 | 3228 | 27 | 27 | <50 | 16036 |
| **Sulfate** | **(mg/L)** | 812 | 812 | 812 | 812 | 2 | 2 | <150 | 4052 |
| **Boron** | **(mg/L)** | 0.41 | 0.41 | 0.41 | 0.41 | 0.14 | 0.14 | <0.8 | 1.51 |
| **CCPP[2]** | **(mg/L)** | 107.7 | 107.7 | 107.7 | -58.6 | -124.7 | 4.3 | | 372.5 |

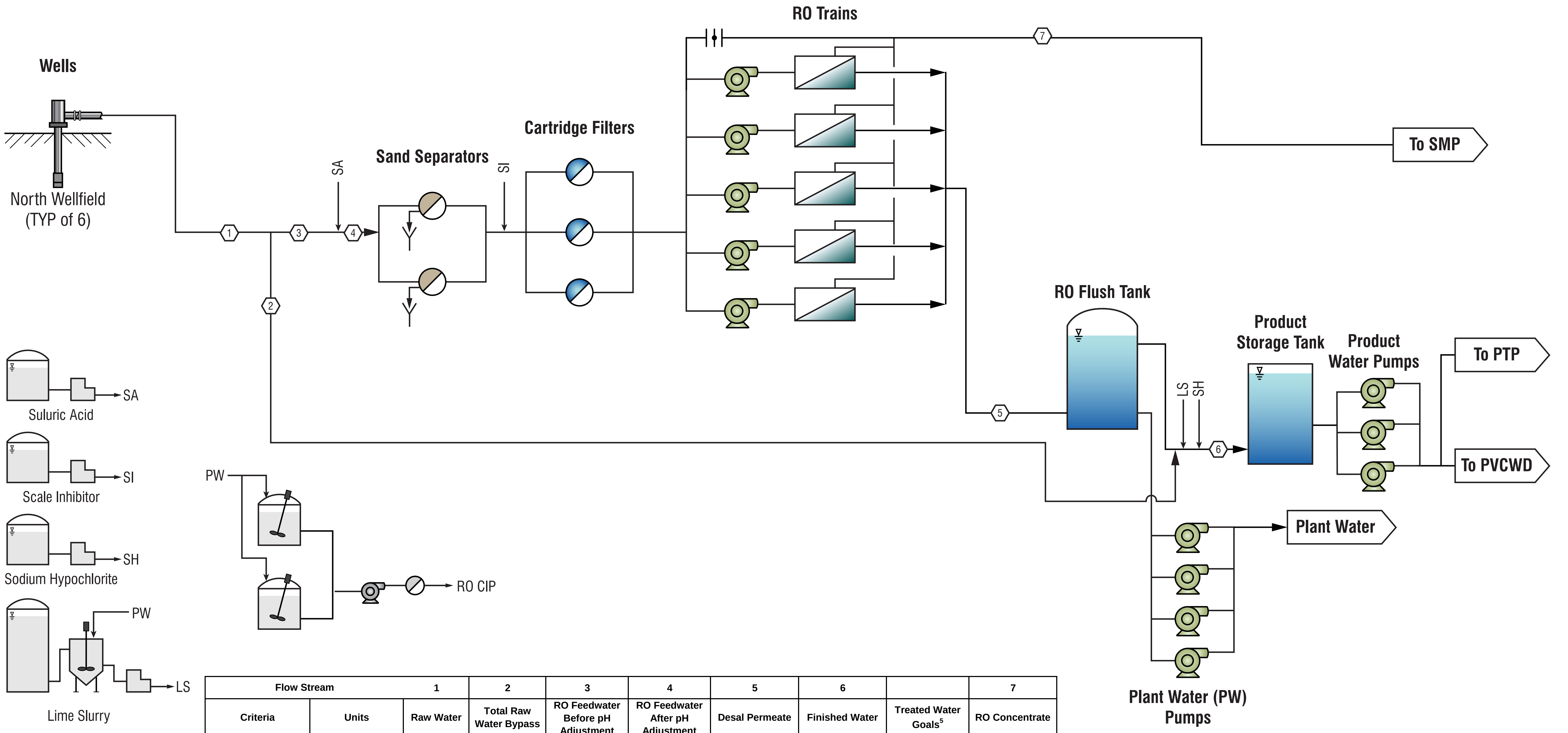
**NOTES:**
1. **Water quality based on information provided by Dan Detmer, UWCD.**
2. **CCPP = Calcium Carbonate Precipitation Potential. Target finished water range = 4 -10 mg/L.**
3. **Water quality and chemical dosing estimated using Rothberg, Tamburini & Winsor Model for Corrosion Control and Process Chemistry®)**
4. **Permeate quality estimated using ROSA v9.1 projection software from FILMTEC (Dow).**
5. **Water quality goals provided by UWCD.**

# 10,000 AFY Process Flow and Mass Balance Diagram Design Raw Water Quality

FIGURE 4.1

UNITED WATER CONSERVATION DISTRICT
*OXNARD PLAIN BRACKISH WATER TREATMENT FEASIBILITY*

Figure 4-1.ai



| Flow Stream | | 1 | 2 | 3 | 4 | 5 | 6 | | 7 |
|---|---|---|---|---|---|---|---|---|---|
| Criteria | Units | Raw Water | Total Raw Water Bypass | RO Feedwater Before pH Adjustment | RO Feedwater After pH Adjustment | Desal Permeate | Finished Water | Treated Water Goals[5] | RO Concentrate |
| Flow Rate | (gpm) | 8,584 | 0 | 8,584 | 8,584 | 6,180 | 6,180 | | 2,403 |
| Flow Rate | (mgd) | 12.36 | 0.00 | 12.36 | 12.36 | 8.90 | 8.90 | | 3.46 |
| | | | | | | | | | |
| Water Quality[1,3,4] | | | | | | | | | |
| TDS | (mg/L) | 9639 | 9638 | 9638 | 9524 | 72 | 342 | <600 | 33832 |
| Calcium Hardness | (mg/L as $CaCO_3$) | 3039 | 3039 | 3039 | 3039 | 14 | 113 | | 10816 |
| Total Hardness | (mg/L as $CaCO_3$) | 4906 | 4906 | 4906 | 4906 | 23 | 122 | | 17460 |
| pH | | 7.14 | 7.15 | 7.15 | 6.07 | 5.04 | 8.00 | 6.5 to 7 | 6.86 |
| Sodium | (mg/L) | 1615.0 | 1615.0 | 1615.0 | 1615.0 | 17.6 | 19.1 | <50 | 5722.7 |
| Bicarbonate | (mg/L) | 369 | 367 | 367 | 136 | 5 | 130 | <150 | 1028 |
| Chlorides | (mg/L) | 4843 | 4843 | 4843 | 4843 | 39 | 39 | <50 | 17194 |
| Sulfate | (mg/L) | 1218 | 1218 | 1218 | 1218 | 3 | 3 | <150 | 4342 |
| Boron | (mg/L) | 0.62 | 0.62 | 0.62 | 0.62 | 0.19 | 0.19 | <0.8 | 1.73 |
| CCPP[2] | (mg/L) | 199.7 | 199.7 | 199.7 | -52.5 | -154.3 | 4.4 | | 318.4 |

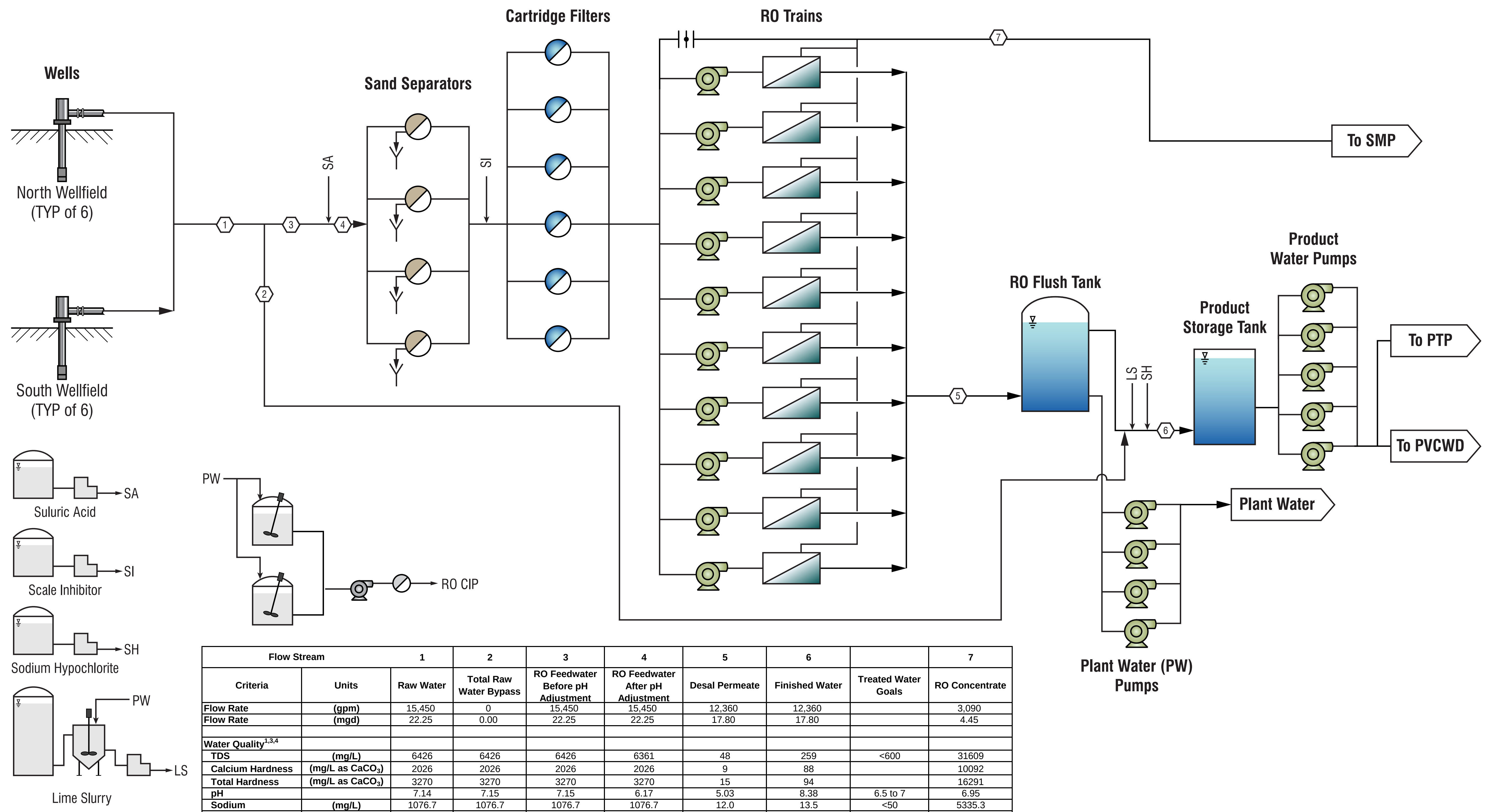
NOTES:

1. Water quality based on information provided by Dan Detmer, UWCD.
2. CCPP = Calcium Carbonate Precipitation Potential. Target finished water range = 4 -10 mg/L.
3. Water quality and chemical dosing estimated using Rothberg, Tamburini & Winsor Model for Corrosion Control and Process Chemistry®)
4. Permeate quality estimated using ROSA v9.1 projection software from FILMTEC (Dow).
5. Water quality goals provided by UWCD.

# 10,000 AFY Process Flow and Mass Balance Diagram
# Worst Case Raw Water Quality

FIGURE 4.2

UNITED WATER CONSERVATION DISTRICT
*OXNARD PLAIN BRACKISH WATER TREATMENT FEASIBILITY*



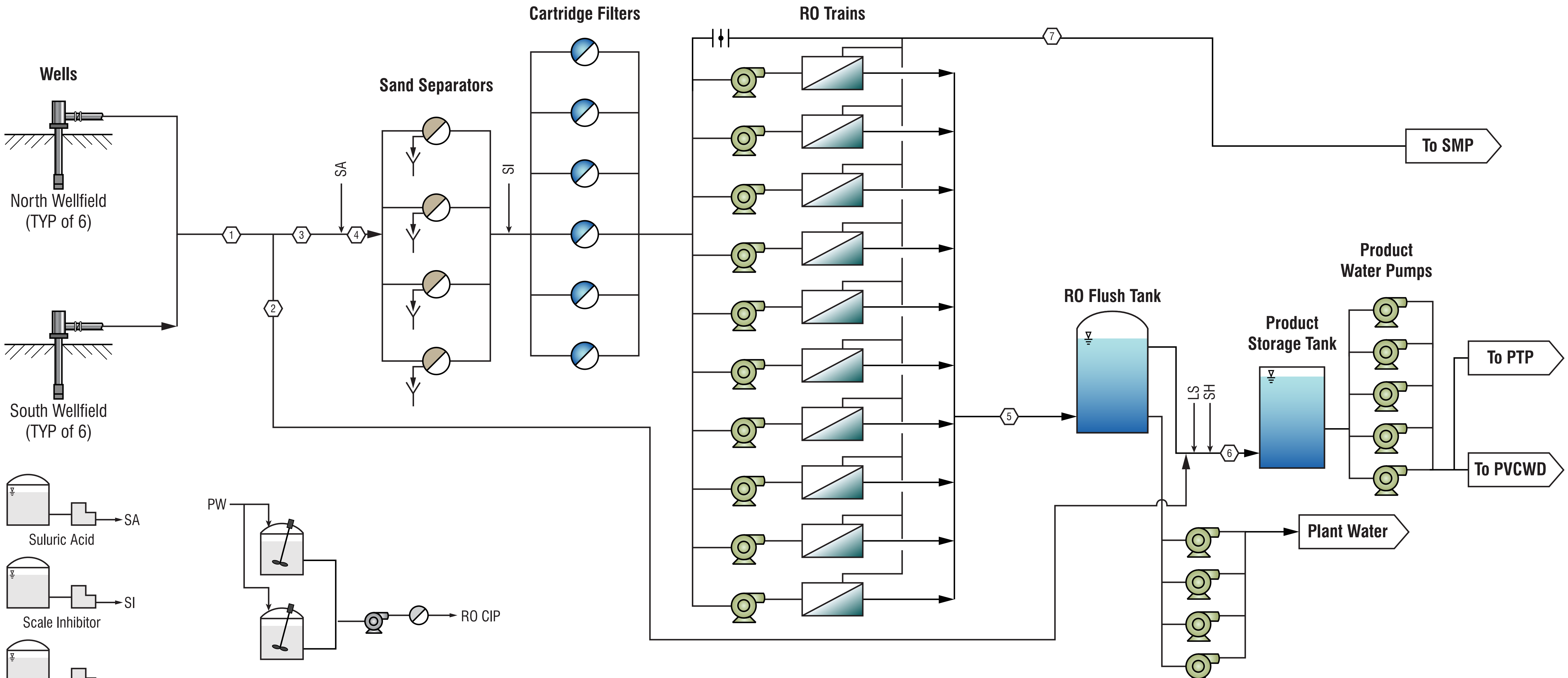
| Flow Stream | | 1 | 2 | 3 | 4 | 5 | 6 | | 7 |
|---|---|---|---|---|---|---|---|---|---|
| Criteria | Units | Raw Water | Total Raw Water Bypass | RO Feedwater Before pH Adjustment | RO Feedwater After pH Adjustment | Desal Permeate | Finished Water | Treated Water Goals | RO Concentrate |
| Flow Rate | (gpm) | 15,450 | 0 | 15,450 | 15,450 | 12,360 | 12,360 | | 3,090 |
| Flow Rate | (mgd) | 22.25 | 0.00 | 22.25 | 22.25 | 17.80 | 17.80 | | 4.45 |
| | | | | | | | | | |
| Water Quality[1,3,4] | | | | | | | | | |
| TDS | (mg/L) | 6426 | 6426 | 6426 | 6361 | 48 | 259 | <600 | 31609 |
| Calcium Hardness | (mg/L as $CaCO_3$) | 2026 | 2026 | 2026 | 2026 | 9 | 88 | | 10092 |
| Total Hardness | (mg/L as $CaCO_3$) | 3270 | 3270 | 3270 | 3270 | 15 | 94 | | 16291 |
| pH | | 7.14 | 7.15 | 7.15 | 6.17 | 5.03 | 8.38 | 6.5 to 7 | 6.95 |
| Sodium | (mg/L) | 1076.7 | 1076.7 | 1076.7 | 1076.7 | 12.0 | 13.5 | <50 | 5335.3 |
| Bicarbonate | (mg/L) | 246 | 244 | 244 | 113 | 4 | 103 | <150 | 935 |
| Chlorides | (mg/L) | 3228 | 3228 | 3228 | 3228 | 27 | 27 | <50 | 16036 |
| Sulfate | (mg/L) | 812 | 812 | 812 | 812 | 2 | 2 | <150 | 4052 |
| Boron | (mg/L) | 0.41 | 0.41 | 0.41 | 0.41 | 0.14 | 0.14 | <0.8 | 1.51 |
| CCPP[2] | (mg/L) | 107.7 | 107.7 | 107.7 | -58.6 | -124.7 | 4.3 | | 372.5 |

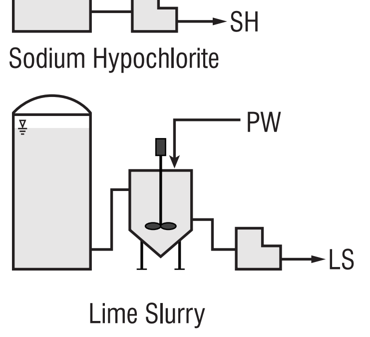
NOTES:
1. Water quality based on information provided by Dan Detmer, UWCD.
2. CCPP = Calcium Carbonate Precipitation Potential. Target finished water range = 4 -10 mg/L.
3. Water quality and chemical dosing estimated using Rothberg, Tamburini & Winsor Model for Corrosion Control and Process Chemistry®)
4. Permeate quality estimated using ROSA v9.1 projection software from FILMTEC (Dow).
5. Water quality goals provided by UWCD.

## 20,000 AFY Process Flow and Mass Balance Diagram Design Raw Water

FIGURE 4.3

UNITED WATER CONSERVATION DISTRICT
*OXNARD PLAIN BRACKISH WATER TREATMENT FEASIBILITY*





| Flow Stream | | 1 | 2 | 3 | 4 | 5 | 6 | | 7 |
|---|---|---|---|---|---|---|---|---|---|
| Criteria | Units | Raw Water | Total Raw Water Bypass | RO Feedwater Before pH Adjustment | RO Feedwater After pH Adjustment | Desal Permeate | Finished Water | Treated Water Goals[5] | RO Concentrate |
| Flow Rate | (gpm) | 17,167 | 0 | 17,167 | 17,167 | 12,360 | 12,360 | | 4,807 |
| Flow Rate | (mgd) | 24.72 | 0.00 | 24.72 | 24.72 | 17.80 | 17.80 | | 6.92 |
| | | | | | | | | | |
| Water Quality[1,3,4] | | | | | | | | | |
| TDS | (mg/L) | 9639 | 9638 | 9638 | 9524 | 72 | 342 | <600 | 33832 |
| Calcium Hardness | (mg/L as $CaCO_3$) | 3039 | 3039 | 3039 | 3039 | 14 | 113 | | 10816 |
| Total Hardness | (mg/L as $CaCO_3$) | 4906 | 4906 | 4906 | 4906 | 23 | 122 | | 17460 |
| pH | | 7.14 | 7.15 | 7.15 | 6.07 | 5.04 | 8.00 | 6.5 to 7 | 6.86 |
| Sodium | (mg/L) | 1615.0 | 1615.0 | 1615.0 | 1615.0 | 17.6 | 19.1 | <50 | 5722.7 |
| Bicarbonate | (mg/L) | 369 | 367 | 367 | 136 | 5 | 130 | <150 | 1028 |
| Chlorides | (mg/L) | 4843 | 4843 | 4843 | 4843 | 39 | 39 | <50 | 17194 |
| Sulfate | (mg/L) | 1218 | 1218 | 1218 | 1218 | 3 | 3 | <150 | 4342 |
| Boron | (mg/L) | 0.62 | 0.62 | 0.62 | 0.62 | 0.19 | 0.19 | <0.8 | 1.73 |
| CCPP[2] | (mg/L) | 199.7 | 199.7 | 199.7 | -52.5 | -154.3 | 4.4 | | 318.4 |

NOTES:
1. Water quality based on information provided by Dan Detmer, UWCD.
2. CCPP = Calcium Carbonate Precipitation Potential. Target finished water range = 4 -10 mg/L.
3. Water quality and chemical dosing estimated using Rothberg, Tamburini & Winsor Model for Corrosion Control and Process Chemistry®)
4. Permeate quality estimated using ROSA v9.1 projection software from FILMTEC (Dow).
5. Water quality goals provided by UWCD.

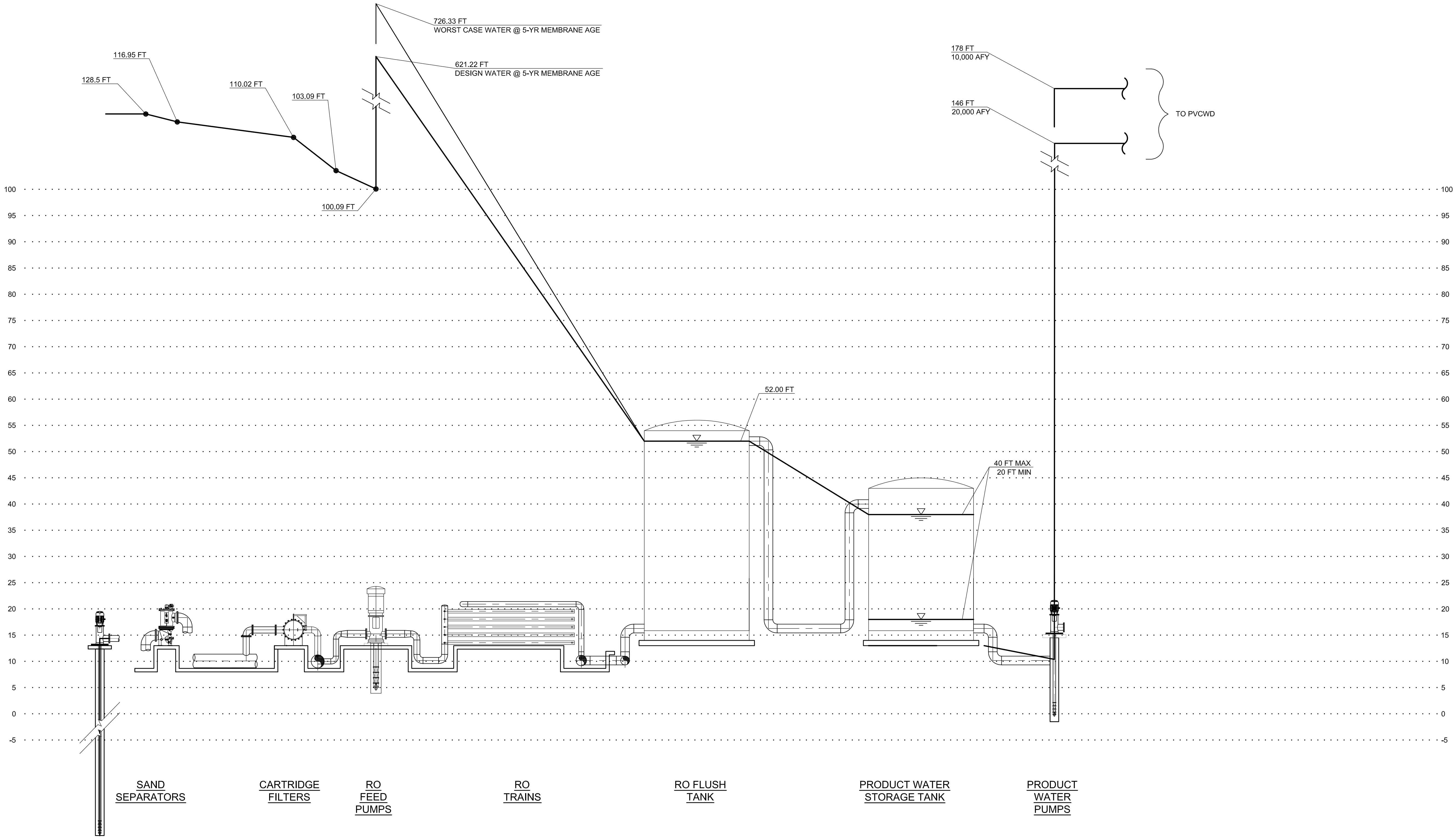
# 20,000 AFY Process Flow and Mass Balance Diagram Worst Case Raw Water

FIGURE 4.4

UNITED WATER CONSERVATION DISTRICT
*OXNARD PLAIN BRACKISH WATER TREATMENT FEASIBILITY*

carollo

Figure 4-4.ai



MAIN PROCESS HYDRAULIC PROFILE

VERTICAL SCALE: 1" = 10'

**Figure No. 4.5**
**PRELIMINARY DESALTER HYDRAULIC PROFILE**
**UNITED WATER CONSERVATION DISTRICT**
OXNARD PLAIN BRACKISH WATER
TREATMENT FEASIBILTIY

*Engineers...Working Wonders With Water ™*

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## 4.3 Desalter Preliminary Design Criteria

The following material presents a brief overview of the purpose of the major process elements in the proposed desalter facility together with preliminary design criteria for each process element. Design criteria are presented for facilities required to produce annual product water volumes of 10,000 AF/yr and 20,000 AF/yr. These preliminary design criteria are the basis for both the desalter site layouts and the estimated capital and O&M costs presented in this report.

### 4.3.1 Sand Separators

Groundwater wells have the potential to produce significant amounts of sand. RO systems and their protective upstream cartridge filters are not designed for continuous removal of particles. Therefore, a sand separation process capable of removing sand down to 25-micron size is included in the treatment process.

The sand separators will be located on the raw water line upstream of the cartridge filters. The basic construction consists of a stainless steel main housing, inlet and outlet ports with flanged connections, stainless steel wedgewire filter elements, outlet valves and actuators, and electronic operating controls. The combination of features provides a completely automated backwashing filtration system.

The process begins with fluid passing through the inlet flange, reaching the filter elements by flowing from inside the element to outside. Solids are then trapped on the inside of the wedgewire filter element. As solids loading increases, the differential pressure between the dirty and clean side of the screens increases. When the set differential pressure is reached, typically at 7 psig, the backwash process is triggered. Alternatively, the backwash cycle can be activated based on a time setting.

The backwash process is one complete cycle, which cleans one element at a time in succession. The geared motor turns the backwash discharge arm under the filter element to be cleaned. The backwash discharge valve is then opened by a pneumatic actuator. The quick opening valve and the exposure to atmospheric pressure results in a strong pulsation and high pressure drop within the filter element being cleaned, which forces the particles into the discharge line. During this operation, a small amount of clean fluid is used to complete the cleaning process. A typical self-cleaning cycle takes less than 60 seconds. The cleaning cycle takes place with no interruption in flow to the cartridge filters, although a drop in downstream pressure is observed during each purge cycle. Typically, the flush waste will enter the plant’s sewer or will discharge to the brine line

A photo of an automatic backwashing sand separator is presented in Figure 4.6. Design criteria for the sand separators are presented in Table 4.1.

**Table 4.1 Sand Separator Criteria**

| Description | Units | 10,000 AFY | 20,000 AFY |
|---|---|---|---|
| Vessel Orientation: Vertical | | | |
| Filter Type: Wedgewire Screen | | | |
| Filter Material: 316 SST | | | |
| Filter Rating | micron | 25 | 25 |
| Maximum Pressure Drop | | | |
| Clean Filter | psi | 2 | 2 |
| Dirty Filter | psi | 7 | 7 |
| Number of Vessels | | | |
| In-Service | No. | 2 | 4 |
| Reliability | No. | 0 | 0 |
| Total | No. | 2 | 4 |
| Flow Per Vessel (Firm Capacity) | | | |
| Maximum (75 Percent Recovery) | gpm (mgd) | 4,290 (6.18) | 4,293 (6.19) |
| Design (83 Percent Recovery) | gpm (mgd) | 3,865 (5.57) | 3,863 (5.57) |

**Figure 4.6 Automatic Backwashing Sand Separator**

### 4.3.2 RO Feedwater Chemical Conditioning

As water is pushed through the RO membranes, sparingly soluble salts of calcium, barium, strontium, and silica are concentrated and can precipitate on the membrane surface. The pretreatment chemicals, sulfuric acid and scale inhibitor, allow operation at supersaturated conditions for calcium carbonate, calcium sulfate, and silica, and prevent iron and manganese fouling, which in turn allows the RO systems to operate at higher system recovery. Higher recovery operation reduces the raw water requirement and the volume of waste concentrate for disposal.

The sulfuric acid storage and feed systems consist of a bulk liquid storage tank and metering pumps for delivery into the RO feedwater. Preliminary design criteria for the feedwater chemical conditioning systems are shown in Tables 4.2 and 4.3. Projections for a typical scale inhibitor are presented in Appendix B.

### 4.3.3 Cartridge Filters

Cartridge filters are provided as a protective measure to prevent solids from reaching the RO membrane process. Solids, such as fine sands or silts, will result in RO membrane fouling and may cause serious mechanical damage to the RO membranes. The cartridge filters are provided as the final barrier to protect the valuable RO membranes against fouling or damage from particulates.

The cartridge filter vessels share a common inlet manifold as well as a common outlet manifold. Therefore, a single cartridge filter vessel provides redundancy for the entire system if one cartridge filter vessel is out of service for maintenance or replacement of cartridges.

A photo of a cartridge filter housing is presented in Figure 4.7. Preliminary design criteria for the cartridge filters are shown in Table 4.4.

**Table 4.2 Sulfuric Acid Design Criteria**

**Sulfuric Acid Characteristics**

| | |
|---|---|
| Concentration: | 93 % |
| Specific Gravity: | 1.8 |
| Solution Strength: | 13.94 |

| | | 10,000 AFY | | 20,000 AFY | |
|---|---|---|---|---|---|
| **Parameters** | **Units** | **Design** | **Maximum** | **Design** | **Maximum** |
| Product Water | | | | | |
| Chemical Usage | | | | | |
| Location: RO Feed | | | | | |
| Process Flow | mgd | 11.1 | 12.4 | 22.3 | 24.7 |
| Chemical Dose | mg/L | 44.0 | 62.0 | 44.0 | 62.0 |
| Chemical Usage | lb/day | 4,085 | 6,396 | 8,170 | 12,791 |
| Chemical Feed Rate | gpd | 293 | 459 | 586 | 918 |
| Chemical Feed Rate | gph | 12.2 | 19.1 | 24.4 | 38.2 |
| No. of Standby Pumps | | 1 | 1 | 1 | 1 |
| No. of Pumps in Service | | 1 | 1 | 2 | 2 |
| Chemical Feed Rate Per Pump | gph | 12.2 | 19.1 | 12.2 | 19.1 |
| Chemical Feed Rate Per Pump | gpm | 0.20 | 0.32 | 0.20 | 0.32 |
| Bulk Storage Tanks | | | | | |
| Number of Tanks | No. | 1 | | 1 | |
| Tank Capacity, each | gal | 5,000 | | 9,000 | |
| Tank Capacity, total | gal | 5,000 | | 9,000 | |
| Total Usage | gal/day | 293 | | 586 | |
| Storage Time | days | 17 | | 15 | |
| Delivery Truck Full Load | gal | 3,000 | | 3,000 | |
| Time Between Delivery | days | 10 | | 5 | |

## Table 4.3 Scale Inhibitor Design Criteria

**Scale Inhibitor Characteristics**

| | |
|---|---|
| | Avista Vitec 4000 |
| Concentration: | 100 % |
| Specific Gravity: | 1.1 |
| Solution Strength: | 9.16 |

| | | 10,000 AFY | | 20,000 AFY | |
|---|---|---|---|---|---|
| **Parameters** | **Units** | **Design** | **Maximum** | **Design** | **Maximum** |
| Product Water | | | | | |
| Chemical Usage | | | | | |
| Location: RO Feed | | | | | |
| Process Flow | MGD | 11.1 | 12.4 | 22.3 | 24.7 |
| Chemical Dose | mg/L | 3.0 | 5.2 | 3.0 | 5.2 |
| Chemical Usage | lb/day | 279 | 536 | 557 | 1,073 |
| Chemical Feed Rate | gpd | 30 | 59 | 61 | 117 |
| Chemical Feed Rate | gph | 1.3 | 2.4 | 2.5 | 4.9 |
| No. of Standby Pumps | | 1 | 1 | 1 | 1 |
| No. of Pumps in Service | | 1 | 1 | 1 | 1 |
| Chemical Feed Rate Per Pump | gph | 1.3 | 2.4 | 2.5 | 4.9 |
| Chemical Feed Rate Per Pump | gpm | 0.02 | 0.04 | 0.04 | 0.08 |
| Bulk Storage Tanks | | | | | |
| Number of Tanks | No. | 1 | | 1 | |
| Tank Capacity, each | gal | 5,000 | | 5,000 | |
| Tank Capacity, total | gal | 5,000 | | 5,000 | |
| Total Usage | gal/day | 30 | | 61 | |
| Storage Time | days | 164 | | 82 | |
| Delivery Truck Full Load | gal | 3,000 | | 3,000 | |
| Time Between Delivery | days | 99 | | 49 | |

**Table 4.4 Cartridge Filter Criteria**

| Description | Units | 10,000 AFY | 20,000 AFY |
|---|---|---|---|
| Vessel Orientation: Horizontal | | | |
| Cartridge Filter Type: Melt Blown | | | |
| Cartridge Filter Material: Polypropylene | | | |
| Cartridge Filter End Connection: Single Open End, Double O-ring | | | |
| Cartridge Filter Rating | micron | 5 | 5 |
| Cartridge Filter Length | inches | 40 | 40 |
| Cartridge Filter Loading Rate | | | |
| Maximum (75 Percent Recovery) | gpm/10-inch | 4.1 | 4.1 |
| Design (83 Percent Recovery) | gpm/10-inch | 3.7 | 3.7 |
| Maximum Pressure Drop | | | |
| Clean Filter | psi | 3 | 3 |
| Dirty Filter | psi | 15 | 15 |
| Number of Vessels | | | |
| In-Service | No. | 3 | 6 |
| Reliability | No. | 0 | 0 |
| Total | No. | 3 | 6 |
| Flow Per Vessel (Firm Capacity) | | | |
| Maximum (75 Percent Recovery) | gpm (mgd) | 2,860 (4.12) | 2,862 (4.12) |
| Design (83 Percent Recovery) | gpm (mgd) | 2,577 (3.71) | 2,575 (3.71) |
| Cartridge Filters Per Vessel | No. | 176 | 176 |
| Total Number of Catridges | No. | 528 | 1,056 |

**Figure 4.7 Cartridge Filter Housings**

### 4.3.4 RO Feed Pumps

The purpose of the RO feed pumps is to provide the energy to overcome osmotic pressure and dynamic head losses through the RO system. Each RO feed pump is dedicated to a single RO membrane train. For maximum efficiency, RO feed pumps are multistage vertical turbines, mounted in cans with both the suction and discharge flanges on the pump head. RO feed pumps are typically located in the process room with roof hatches for crane access to the pumps (for maintenance).

A photo of a typical RO feed pump is presented in Figure 4.8. Preliminary design criteria for the RO feed pumps are shown in Table 4.5.

**Table 4.5 Reverse Osmosis Feed Pump Criteria**

| Description | Units | 10,000 AFY | 20,000 AFY |
|---|---|---|---|
| Type: Vertical Turbine in Closed Bottom Cans | | | |
| Number of Pumps | | | |
| In-Service | No. | 5 | 10 |
| Reliability | No. | 0 | 0 |
| Total | No. | 5 | 10 |
| Capacity (per Pump) | | | |
| Design (80 Percent Recovery) | gpm | 1,546 | 1,545 |
| Maximum (72 Percent Recovery) | gpm | 1,716 | 1,717 |
| Suction Pressure | | | |
| Maximum (Best Case) | psig | 50 | 50 |
| Design | psig | 30 | 30 |
| Discharge Pressure | | | |
| Design | psig | 263 | 263 |
| Maximum (Worst Case) | psig | 309 | 309 |
| Total Dynamic Head (TDH) | | | |
| Design | ft | 538 | 538 |
| Maximum (Worst Case) | ft | 644 | 644 |
| Motor Size | | | |
| Pump Efficiency | percent | 82 | 82 |
| Worst Case BHP | hp | 341 | 341 |
| Motor hp (per Pump) | hp | 500 | 500 |
| Motor hp (Total) | hp | 2,500 | 5,000 |
| Drive | type | VFD | VFD |

**Figure 4.8 RO Feed Pump**

### 4.3.5 RO Membrane Trains

The RO trains receive pressurized feedwater from the RO feed pumps. The pressure "pushes" water through the membranes while salt is rejected. The rejected salts are concentrated into a small percentage of the flow and exit the system as waste. The proposed design criteria will allow the RO trains to operate across a recovery range of 72 to 80 percent.

A photo of a typical two stage brackish RO system is presented in Figure 4.9. Proposed design criteria for the RO trains are shown in Table 4.6.

**Table 4.6 RO Trains**

| Description | Units | 10,000 AFY | | 20,000 AFY | |
|---|---|---|---|---|---|
| Type: Reverse Osmosis (RO) | | | | | |
| Number of Membrane Trains | | | | | |
| In-Service | No. | 5 | | 10 | |
| Reliability | No. | 0 | | 0 | |
| Total | No. | 5 | | 10 | |
| Train Flux Rate[1] | gfd | 13.2 | | 13.2 | |
| Recovery (Permeate/Feed Flow) | | | | | |
| Minimum | percent | 72 | | 72 | |
| Design | percent | 80 | | 80 | |
| Total Permeate Flow per Train | gpm (mgd) | 1,236 | (1.78) | 1,236 | (1.78) |
| Second Stage Permeate Flow per Train | gpm (mgd) | 411 | (0.59) | 408 | (0.59) |
| Brine Flow per Train | | | | | |
| Design | gpm (mgd) | 309 | (0.45) | 309 | (0.45) |
| Maximum | gpm (mgd) | 481 | (0.69) | 481 | (0.69) |
| Number of Array Stages Per Train | No. | 2 | | 2 | |
| 1st Stage | | | | | |
| Pressure Vessels per Train | No. | 32 | | 32 | |
| Elements per Pressure Vessel | No. | 7 | | 7 | |
| 2nd Stage | | | | | |
| Pressure Vessels per Train | No. | 16 | | 16 | |
| Elements per Pressure Vessel | No. | 7 | | 7 | |
| Number of Elements | | | | | |
| Per Train | No. | 336 | | 336 | |
| Total (In-Service) | No. | 1,680 | | 3,360 | |
| Membrane Area | | | | | |
| Per Element | sq. ft. | 400 | | 400 | |
| Per Train | sq. ft. | 134,400 | | 134,400 | |
| Total (In-service) | sq. ft. | 672,000 | | 1,344,000 | |

Note:

(1) Flux is balanced between the RO stages using an interstage booster pumps.

**Figure 4.9 Two Stage Brackish RO Train**

As shown in Table 4.6, flux balance between the first and second stage of the RO train is controlled using an interstage booster pump. Interstage boost pumps deliver pressure to the feed of the second stage to maintain a second stage permeate flowrate. The piping is configured on the RO trains to allow for operation of the system with the interstage boost pump out of service. Performance projections for the RO system design considered herein are presented in Appendix C.

Preliminary design criteria for the inter-stage booster pumps is shown in Table 4.7.

**Table 4.7 RO Train Interstage Booster Pumps**

| Description | Units | 10,000 AFY | 20,000 AFY |
|---|---|---|---|
| Type: Inline Vertical Centrifugal | | | |
| Booster Pumps Per RO Train | No. | 1 | 1 |
| Pump Data | | | |
| Stages | No. | 1 | 1 |
| Flow | | | |
| At 72 Percent RO Recovery | gpm | 888 | 888 |
| At 80 Percent RO Recovery | gpm | 720 | 655 |
| Total Dynamic Head at 72 Percent Recovery | ft | 461 | 461 |
| Total Dynamic Head at 80 Percent Recovery | ft | 461 | 461 |
| Motor Size | | | |
| Pump Efficiency | percent | 70 | 70 |
| Worst Case BHP | hp | 148 | 148 |
| Motor hp (per Pump) | hp | 200 | 200 |
| Drive | type | VFD | VFD |

### 4.3.6 Membrane CIP System

The CIP system is used to chemically clean and remove foulants (e.g., particles, mineral scale, and biology) from the RO membranes. Foulants result in additional headloss and increased energy requirements to maintain production flow rates. Additionally, foulants may result in a deterioration of permeate water quality.

The CIP system circulates cleaning chemicals to the RO membrane trains. The CIP system is permanently connected to the membrane skid piping in order to avoid the labor, time, and safety issues involved in connecting and disconnecting hoses or pipe spools. CIP connections to the permeate side of the RO membrane will have block valves and removable spool pieces to insure that the treated water is isolated from the cleaning solution while in service.

Each stage on the membrane train is cleaned separately to deliver the required cleaning flow velocities to each pressure vessel in the array.

Preliminary design criteria for the CIP system are shown in Table 4.8. A photo of a typical CIP system is presented in Figure 4.10.

**Table 4.8 Reverse Osmosis Clean-in-Place System Design Criteria**

| Description | Units | Both Options |
|---|---|---|
| Pressure Vessel Cleaning Flow Rate | | |
| Stage 1 (Flow Per Vessel) | gpm | 45 |
| Vessels Cleaned Per Cycle | No. | 32 |
| Stage 1 Cleaning Flowrate | gpm | 1,440 |
| Stage 2 (Flow Per Vessel) | gpm | 45 |
| Vessels Cleaned Per Cycle | No. | 16 |
| Stage 2 Cleaning Flowrate | gpm | 720 |
| CIP Chemical Tank | | |
| Number | No. | 2 |
| Volume (Each) | gallons | 4,500 (nominal) |
| Tank Heater | | |
| Type: Immersion | | |
| Number of Units Per Tank | No. | 2 |
| Size | | |
| Each | kW | 100 |
| Total | kW | 400 |
| CIP Recirculation Pump | | |
| Type: FRP End Suction Centrifugal | | |
| Number | No. | 1 |
| Flow | gpm | 1,440 |
| TDH | ft $H_2O$ (psig) | 170 |
| Motor Load | hp | 125 |
| Drive | | VFD |
| Cartridge Filter | | |
| Vessel Orientation: Vertical | | |
| Cartridge Filter Type: Melt Blown | | |
| Cartridge Filter Material: Polypropylene | | |
| Cartridge Filter End Connection: Single Open End, Double O-Ring | | |
| Cartridge Filter Rating | micron | 5 |
| Cartridge Filter Length | inches | 40 |
| Cartridge Filter Loading Rate | | |
| At Maximum Flowrate | gpm/10-inch | 4.19 |
| At Minimum Flowrate | gpm/10-inch | 2.09 |
| Maximum Pressure Drop | | |
| Clean Filter | psig | 3 |
| Dirty Filter | psig | 15 |
| Cartridge Filters per Vessel | No. | 86 |

**Figure 4.10 Typical CIP System**

### 4.3.7 RO Permeate Chemical Conditioning

RO permeate does not meet the water quality objective for effluent pH and alkalinity without chemical conditioning. Typical practice for municipal drinking water RO facilities is addition of sodium hydroxide (caustic soda); however, for the proposed irrigation usage this has the detrimental effect of raising the sodium level resulting in a higher sodium adsorption ratio (SAR).[6] Further, the use of caustic soda does not add calcium, which is useful, in conjunction with pH and alkalinity, to protecting distribution system piping. The proposed chemical conditioning for the South Oxnard Plain desalter is the addition of hydrated lime (as a 35 percent slurry). The advantage of adding lime is that there is no increase in sodium and the addition of calcium ions will reduce the SAR as well as increase the calcium carbonate precipitation potential (CCPP), which helps protect distribution system piping.

Chlorine, provided as sodium hypochlorite, is also added to the permeate to prevent biological growth in the distribution system. Additionally, the addition of chlorine will oxidize low levels of hydrogen sulfide. Based on information provided by UWCD, hydrogen sulfide levels in the shallow aquifer targeted for this facility are low. Therefore, for the purposes of this study, hydrogen sulfide levels are assumed to be less than 0.5 mg/L and will be managed by oxidation with chlorine in the permeate.

Preliminary design criteria for RO permeate lime and sodium hypochlorite feed systems are shown in Table 4.9 and 4.10, respectively.

---

[6] $\mathrm{SAR} = \frac{Na}{\sqrt{\frac{1}{2}(Ca+Mg)}}$

where sodium, calcium, and magnesium are expressed in meq/L. In general, the lower the SAR, the more suitable the water is for irrigation.

**Table 4.9 Lime Slurry Design Criteria**

| | | 10,000 AFY | | 20,000 AFY | |
|---|---|---|---|---|---|
| **Parameters** | **Units** | **Design** | **Maximum** | **Design** | **Maximum** |
| **Lime Characteristics** | | | | | |
| Lime Purity | % | 97% | | | |
| Dry Lime Bulk Density (Storage Value) | lb/cu ft | 30 | | | |
| Concentration: | % | 35 % | | | |
| Specific Gravity: | | 1.271 | | | |
| Solution Strength: | lb/gal | 3.70 | | | |
| Post Treatment | | | | | |
| Chemical Usage | | | | | |
| Location: After RO Flush Tank | | | | | |
| Process Flow | mgd | 8.9 | 8.9 | 17.80 | 17.80 |
| Chemical Dose | mg/L | 58 | 73 | 58 | 73 |
| Chemical Dose (as stored weight) | mg/L | 60 | 75 | 60 | 75 |
| Chemical Usage | lb/day | 4,441 | 5,589 | 8,882 | 11,179 |
| Chemical Feed Rate | gpd | 1,199 | 1,509 | 2,398 | 3,018 |
| Chemical Feed Rate | gph | 50.0 | 62.9 | 99.9 | 125.8 |
| Number of Duty Metering Pumps | No. | 1.0 | 1.0 | 2.0 | 2.0 |
| Number of Standby Metering Pumps | No. | 1.0 | 1.0 | 1.0 | 1.0 |
| Chemical Feed Rate Per Pump | gph | 50.0 | 62.9 | 50.0 | 62.9 |
| Lime Storage Silos | | | | | |
| Number of Silos | No. | 1 | | 1 | |
| Silo Capacity, each | cu ft | 2,250 | | 4,500 | |
| Silo Capacity, each | lbs | 67,500 | | 135,000 | |
| Silo Capacity, total | Tons | 33.75 | | 67.5 | |
| Silo Diameter, each | ft | 14 | | 14 | |
| Silo Sideshell Height, each | ft | 15 | | 30 | |
| Dry Usage | lbs/day | 4,441 | | 8,882 | |
| Dry Usage | tons/day | 2.2 | | 4.4 | |

**Table 4.9 Lime Slurry Design Criteria**

| | | 10,000 AF/yr | | 20,000 AF/yr | |
|---|---|---|---|---|---|
| **Parameters** | **Units** | **Design** | **Maximum** | **Design** | **Maximum** |
| Storage Time | days | 15 | | 15 | |
| Delivery Truck Full Load | tons | 24 | | 24 | |
| Time Between Delivery | days | 10.8 | | 5.4 | |
| <u>Lime Slurry Storage</u> | | | | | |
| Number of Tanks | No. | 1 | | 1 | |
| Tank Capacity, each | gal | 9,000 | | 9,000 | |
| Tank Capacity, total | gal | 9,000 | | 9,000 | |
| Total Usage | gal/day | 1,199 | | 2,398 | |
| Storage Time | days | 7.5 | | 3.8 | |
| Delivery Truck Full Load | gal | 4,000 | | 4,000 | |
| Time Between Delivery | days | 3.34 | | 1.67 | |

**Table 4.10 Sodium Hypochlorite Design Criteria**

| **Sodium Hypochlorite Characteristics** | | | |
|---|---|---|---|
| Concentration: | 10.5 % | | |
| Specific Gravity: | 1.15 | | |
| Solution Strength: | 1.01 | | |
| **Parameters** | **Units** | **Design** | **Design** |
| Post Treatment | | | |
| Chemical Usage | | | |
| Location: After RO Flush Tank | | | |
| Process Flow | mgd | 8.9 | 17.8 |
| Chemical Dose | mg/L | 5.0 | 5.0 |
| Chemical Usage | lb/day | 371 | 743 |
| Chemical Feed Rate | gpd | 369 | 739 |
| Chemical Feed Rate | gph | 15.4 | 30.8 |
| No. of Standby Pumps | | 1 | 1 |
| No. of Pumps in Service | | 1 | 2 |
| Chemical Feed Rate Per Pump | gph | 15.4 | 15.4 |
| Chemical Feed Rate Per Pump | gpm | 0.26 | 0.26 |
| Bulk Storage Tanks | | | |
| Number of Tanks | No. | 1 | 1 |
| Tank Capacity, each | gal | 5,500 | 11,000 |
| Tank Capacity, total | gal | 5,500 | 11,000 |
| Total Usage | gal/day | 369 | 739 |
| Storage Time | days | 15 | 15 |
| Delivery Truck Full Load | gal | 3,000 | 3,000 |
| Time Between Delivery | days | 8 | 4 |

### 4.3.8 RO Flush Tank

For higher TDS RO systems such as this, shutdown flushing using treated RO permeate is typical to prevent chloride corrosion of stainless steel piping and valves. Permeate storage must be free from chlorine and must also remain “fresh.” Therefore, permeate storage is configured as a flow- through tank that is fed at the bottom and overflows to the ground storage tank. In between the permeate storage tank and the ground storage tank, lime and sodium hypochlorite are added to stabilize and disinfect the product water. This arrangement prevents the chlorinated water from being introduced in the RO systems during flushing or CIP makeup, and continuously turns over the tank volume to keep the water from stagnating.

Preliminary design criteria for RO flush tank are shown in Table 4.11.

**Table 4.11 RO Flush Tank**

| Description | Units | 10,000 AFY | 20,000 AFY |
|---|---|---|---|
| Product Water Storage | | | |
| Type: Circular, Above-ground, FRP | | | |
| Number of Tanks | No. | 1 | |
| Tank Dimensions | | | |
| Depth | ft | 40 | |
| Diameter | ft | 14 | |
| Volume | gallons | 38,000 | |

### 4.3.9 Product Water Storage and Pumps

Above ground storage can be constructed using an economical bolted steel tank with glass-lined panels that are low maintenance. Can mounted vertical turbine product water pumps are proposed to transfer water from the ground storage tank to the PTP and PVCWD systems. Vertical turbine pumps have higher efficiency than split case or other types of surface mounted pumps and have steeper performance curves that respond well on variable speed drives.

Figures 4.11 and 4.12 present a glass lined storage tank and can mounted vertical turbine product water pump station, respectively. Preliminary design criteria for the on-site product water storage and pumps are shown in Table 4.12.

**Table 4.12 Product Water Storage Tank and Pump Station Criteria**

| Description | Units | 10,000 AF/yr | 20,000 AF/yr |
|---|---|---|---|
| Product Water Pumps | | | |
| Type: Vertical Turbine in Closed Bottom Cans | | | |
| Number of Pumps | | | |
| In-Service | No. | 2 | 4 |
| Reliability | No. | 1 | 1 |
| Total | No. | 3 | 5 |
| Capacity | | | |
| Per Pump | gpm (mgd) | 3,088 (4.45) | 3,088 (4.45) |
| Firm (One Pump Out of Service) | gpm (mgd) | 6,177 (8.90) | 12,353 (17.80) |
| Total | gpm (mgd) | 9,265 (13.35) | 15,442 (22.25) |
| Total Dynamic Head Required (TDH) [1] | feet | 165 | 135 |
| Motor Size | | | |
| Pump Efficiency | percent | 80 | 80 |
| Required BHP | hp | 161 | 132 |
| Selected | hp | 200 | 200 |
| Drive | type | VFD | VFD |
| Product Water Storage | | | |
| Type: Circular, Above-ground, Glass-lined, Steel Bolt-up Tank | | | |
| Number of Tanks | No. | 1 | 1 |
| Tank Dimensions (Each) [2] | | | |
| Depth | ft | 27 | 27 |
| Diameter | ft | 112 | 159 |
| Area | sq ft | 9,852 | 19,856 |
| Volume | | | |
| Each | gallons | 1,990,000 | 4,010,000 |
| Total | gallons | 1,990,000 | 4,010,000 |
| Storage Time at Design Flow | hours | 5.4 | 5.4 |
| Storage as Percent of Daily Flow | percent | 22 | 23 |

Notes:

(1) Using 24-inch diameter pipe for 10,000 AFY capacity and 36-inch diameter pipe for 20,000 AFY capacity.

(2) Using Manufacturer's standard dimensions.

**Figure 4.11** Typical Glass Lined Ground Storage Tank (Photo adapted from CST Industries website - http://www.cstindustries.com/products/aquastore)

**Figure 4.12** Can-Mounted Vertical Turbine Product Water Pump Station

## 4.4 Site Layouts

Preliminary site layouts for the 10,000 AFY desalter facility are presented in Figures 4.13 through 4.17. Preliminary site layouts for the 20,000 AFY desalter facility are presented in Figures 4.18 through 4.22. The site layouts show all of the major process components for both the 10,000 AFY and 20,000 AFY scenarios. The primary purpose of the preliminary site layouts is to provide conceptual arrangements that furnish guidance on area requirements for the proposed desalter facility.

# 5.0 COSTS AND CONCLUSIONS

Estimated capital costs were developed using a combination of vendor quotes, recently bid projects, and unit cost assumptions. Carollo has recently been involved with several Southern California projects of similar scope, including:

- Chino II Desalter Expansion
- Mesa Water Reliability Facility
- Irvine Ranch Water District Well 21/22 Desalter

Costs for RO equipment, chemical feed systems, and other ancillary systems were derived from the bids for these projects.

The layouts presented in Section 4 were used to estimate building costs. Different unit costs were used for each area to reflect the level of complexity of the defined space. For example, a covered chemical storage area has a lower unit cost than administrative areas because there are limited HVAC and building mechanical requirements and no interior finishing requirements, such as drywall, paint, specialized flooring, etc. The building classifications were divided into the following categories:

- Main process areas
- Covered chemical storage areas
- Non-process areas
  - Administrative
  - Electrical Room
  - Control Room
  - Laboratory
  - Shop/Storage Area

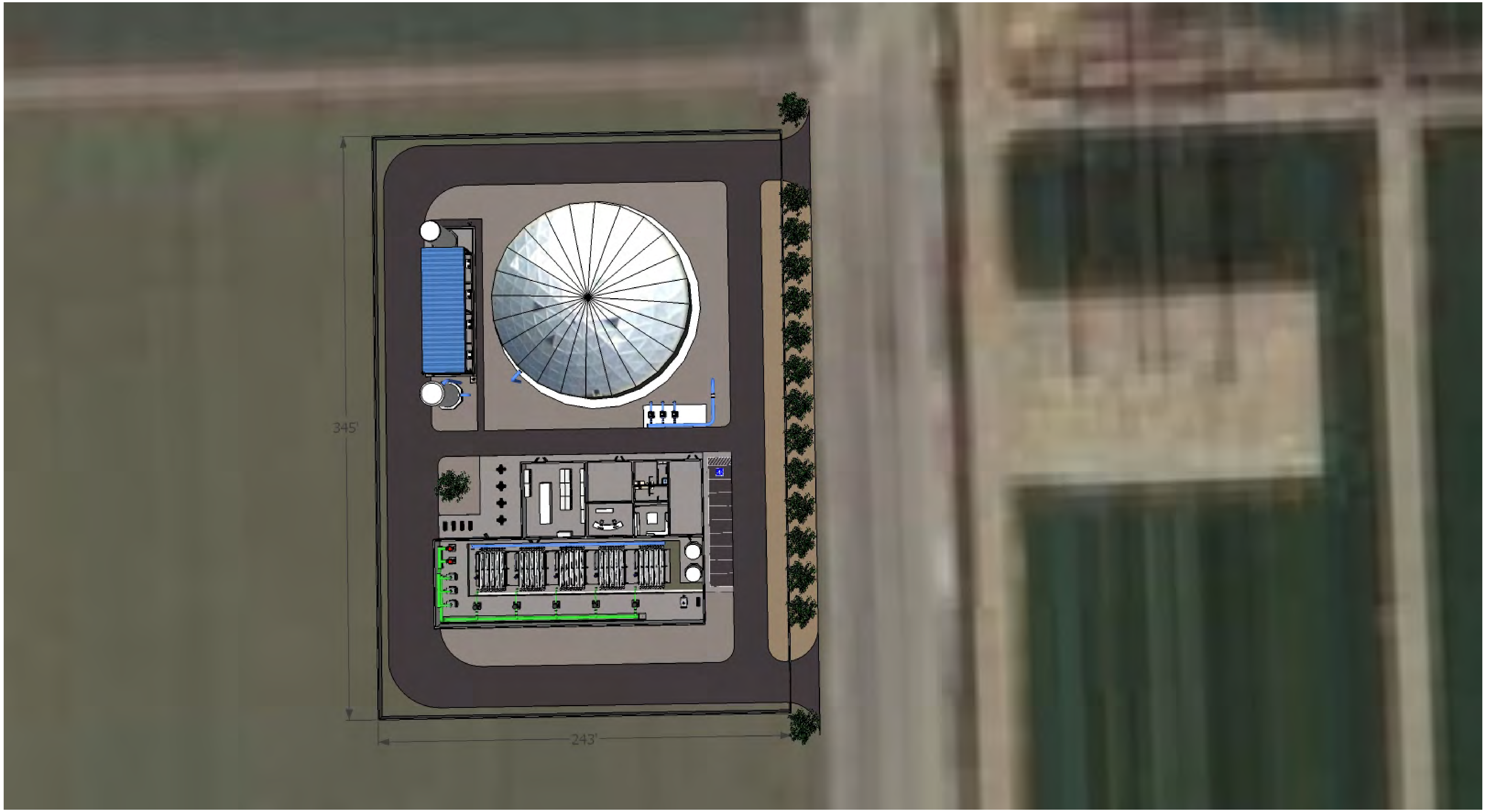


Figure 4.13 10,000 AFY RO Facility – Site Plan

Figure 4.14 10,000 AFY RO Facility – Isometric View Looking Northwest

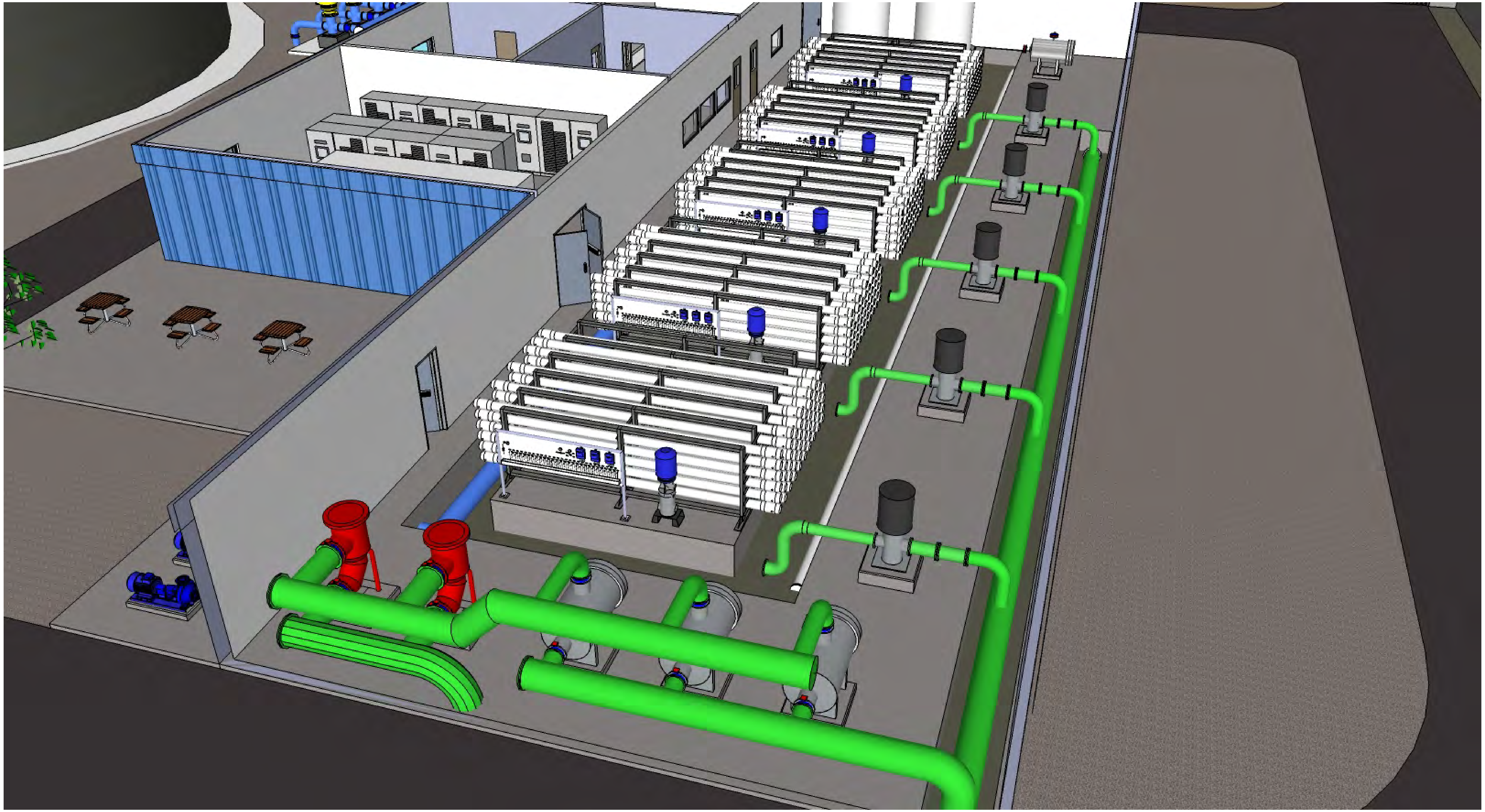


Figure 4.15 10,000 AFY RO Facility – Sand Separators, Cartridge Filters, and RO Systems

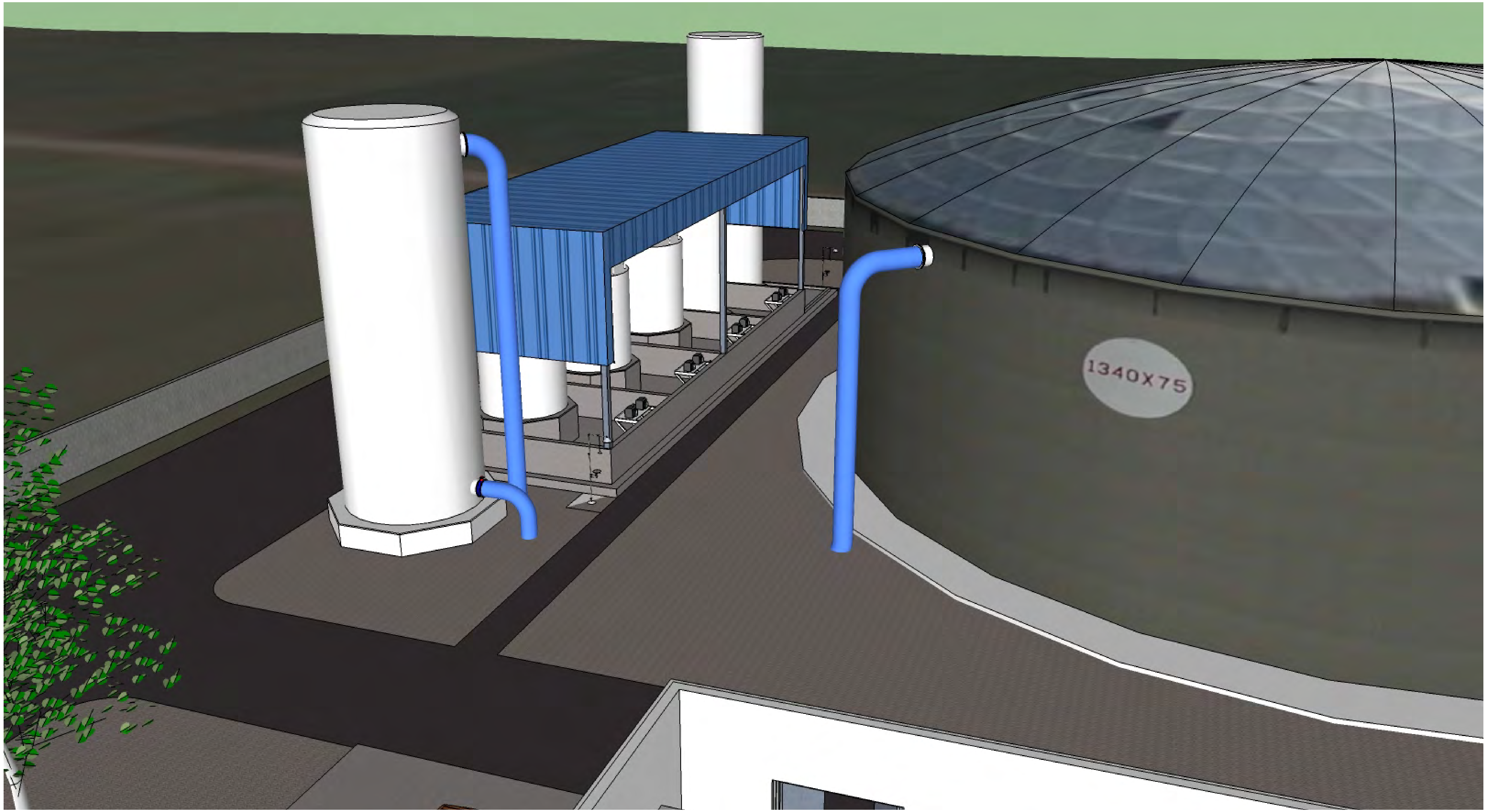


Figure 4.16 10,000 AFY RO Facility – Chemical Storage, RO Flush Tank, and Product Water Storage

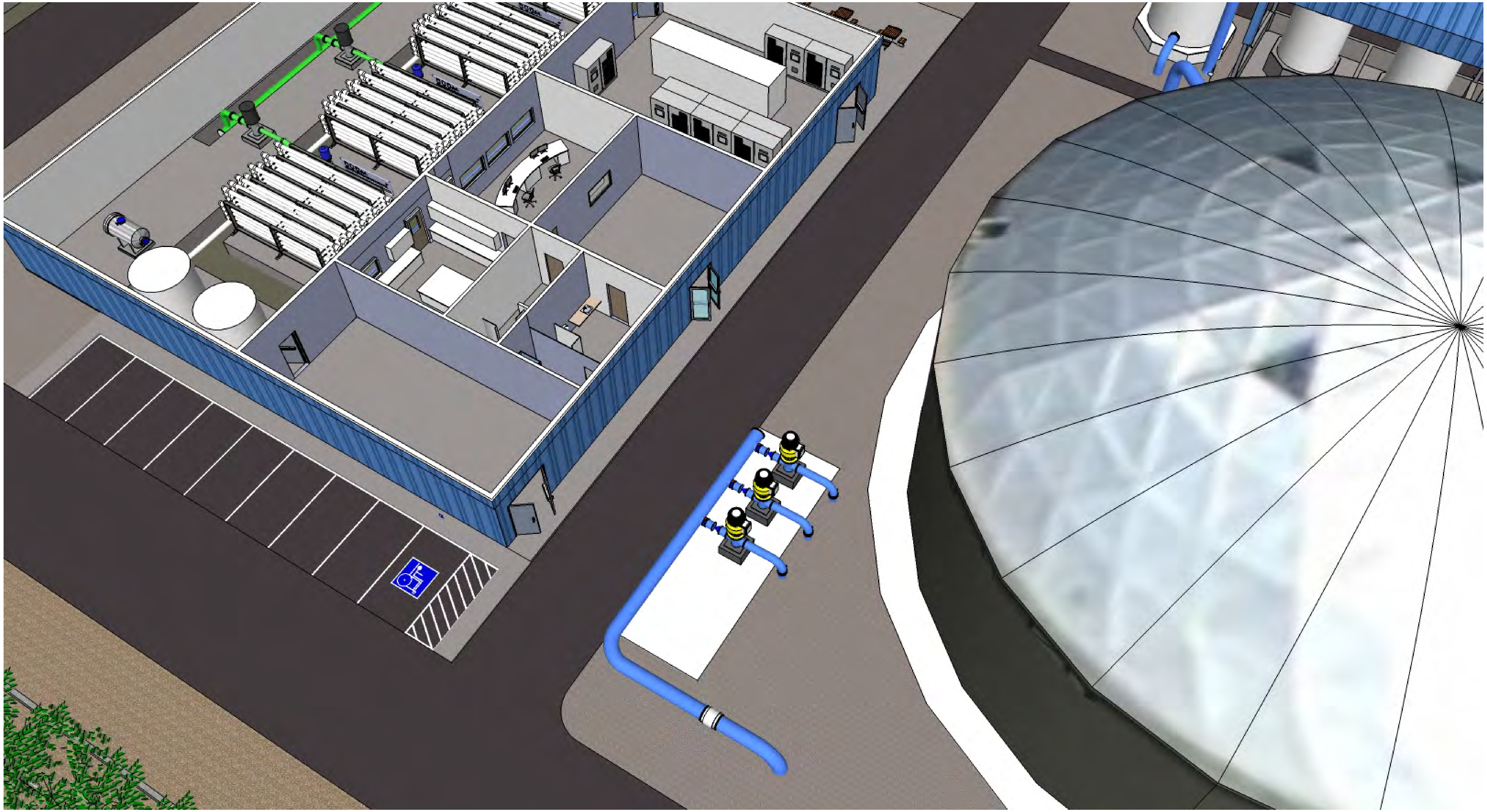


**Figure 4.17** 10,000 AFY RO Facility – Product Water Pumps, Admin/Storage/Lab/Control/Electrical Rooms

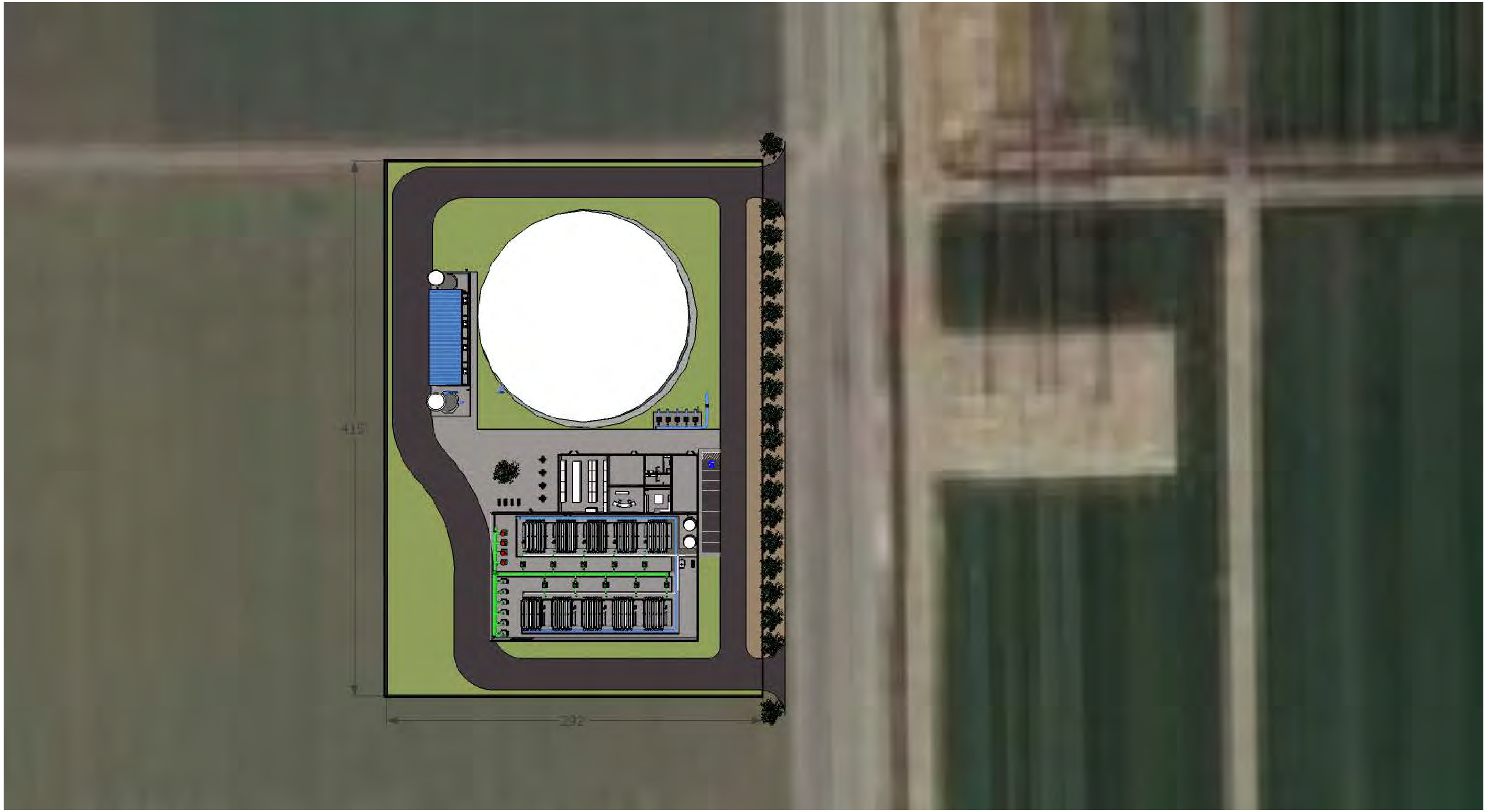


**Figure 4.18** 20,000 AFY RO Facility – Site Plan

Figure 4.19 20,000 AFY RO Facility – Isometric View Looking Northwest

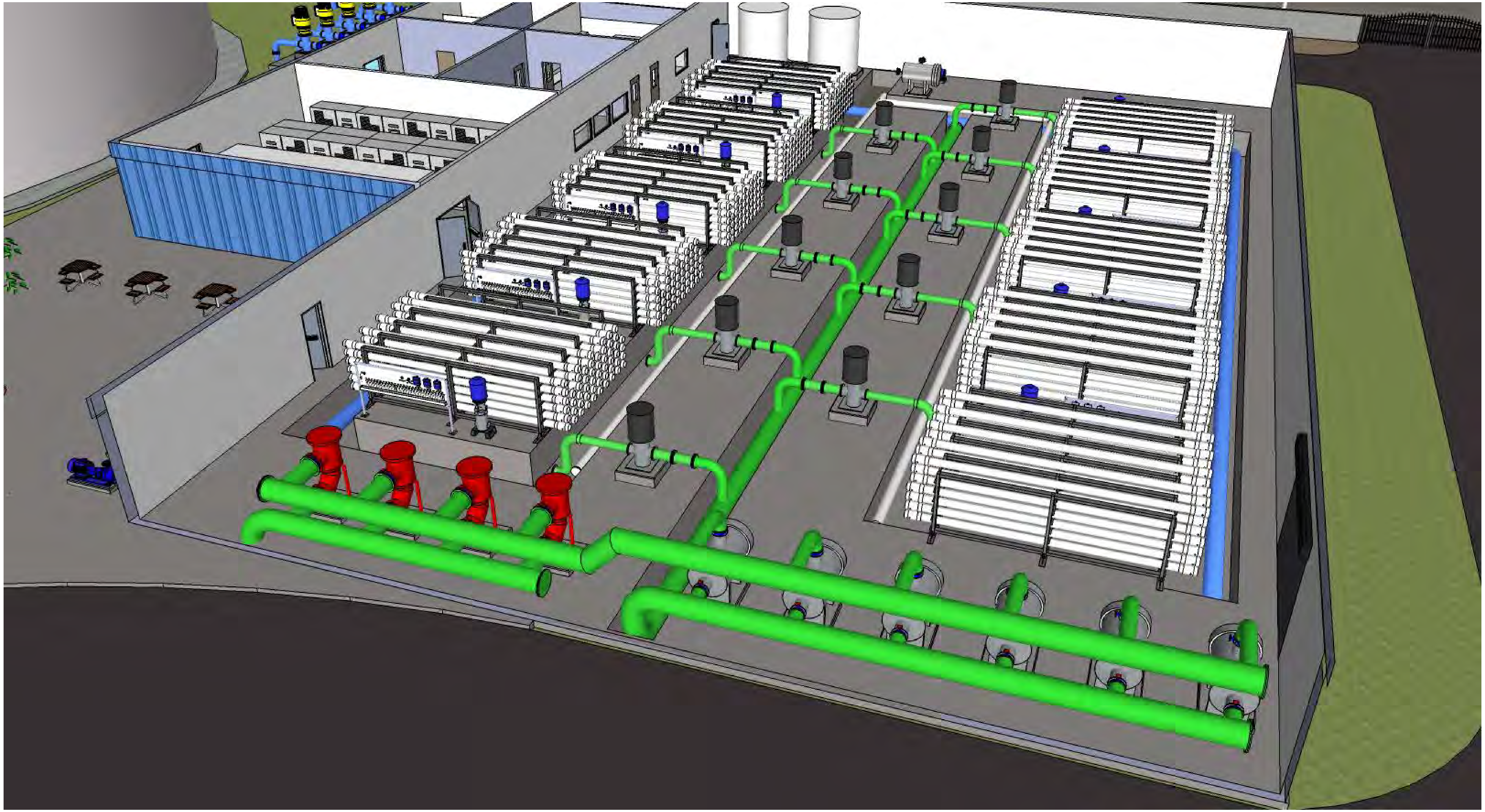


Figure 4.20 20,000 AFY RO Facility – Sand Separators, Cartridge Filters, and RO Systems

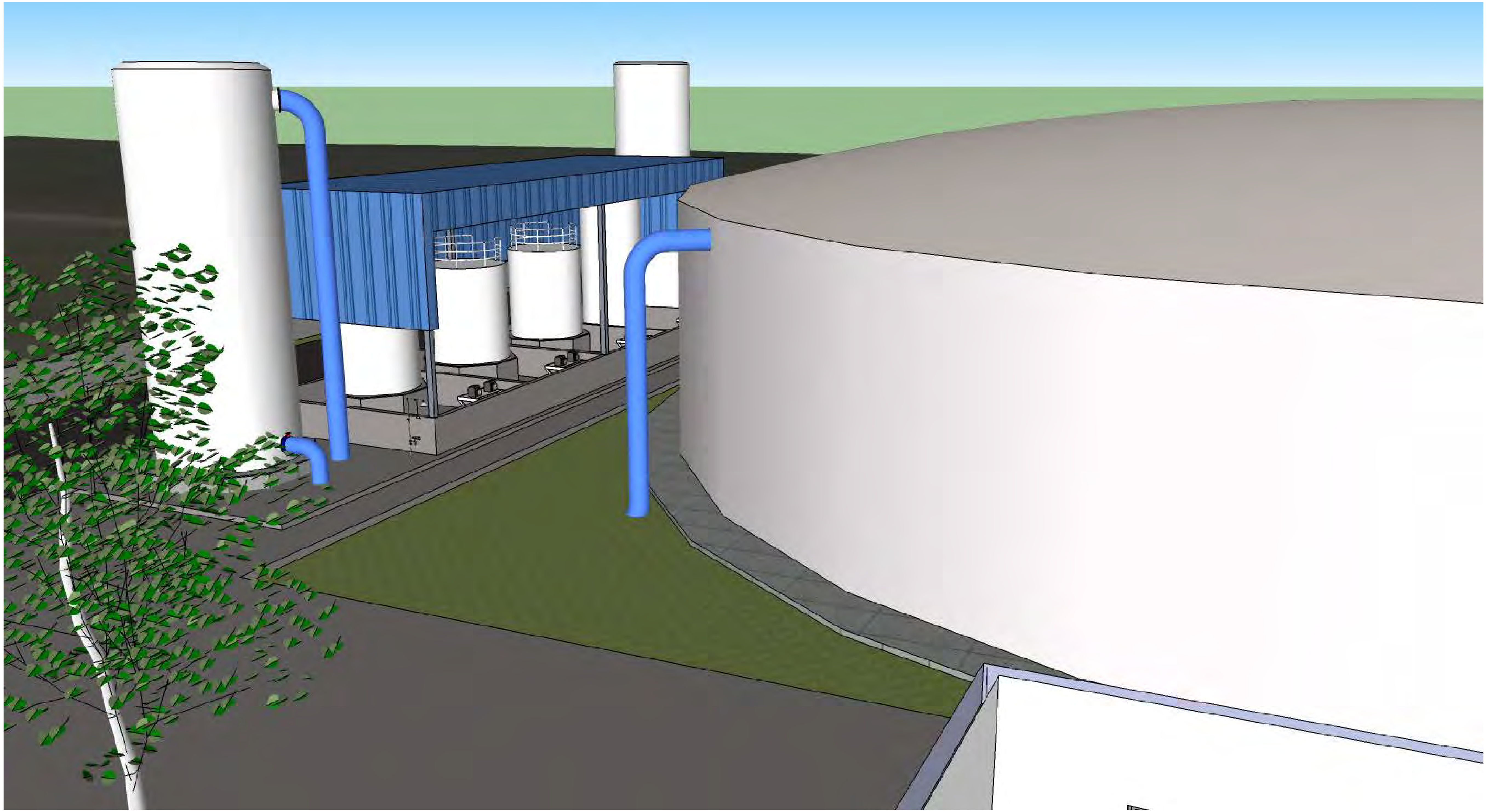


**Figure 4.21** 20,000 AFY RO Facility – Chemical Storage, RO Flush Tank, and Product Water Storage

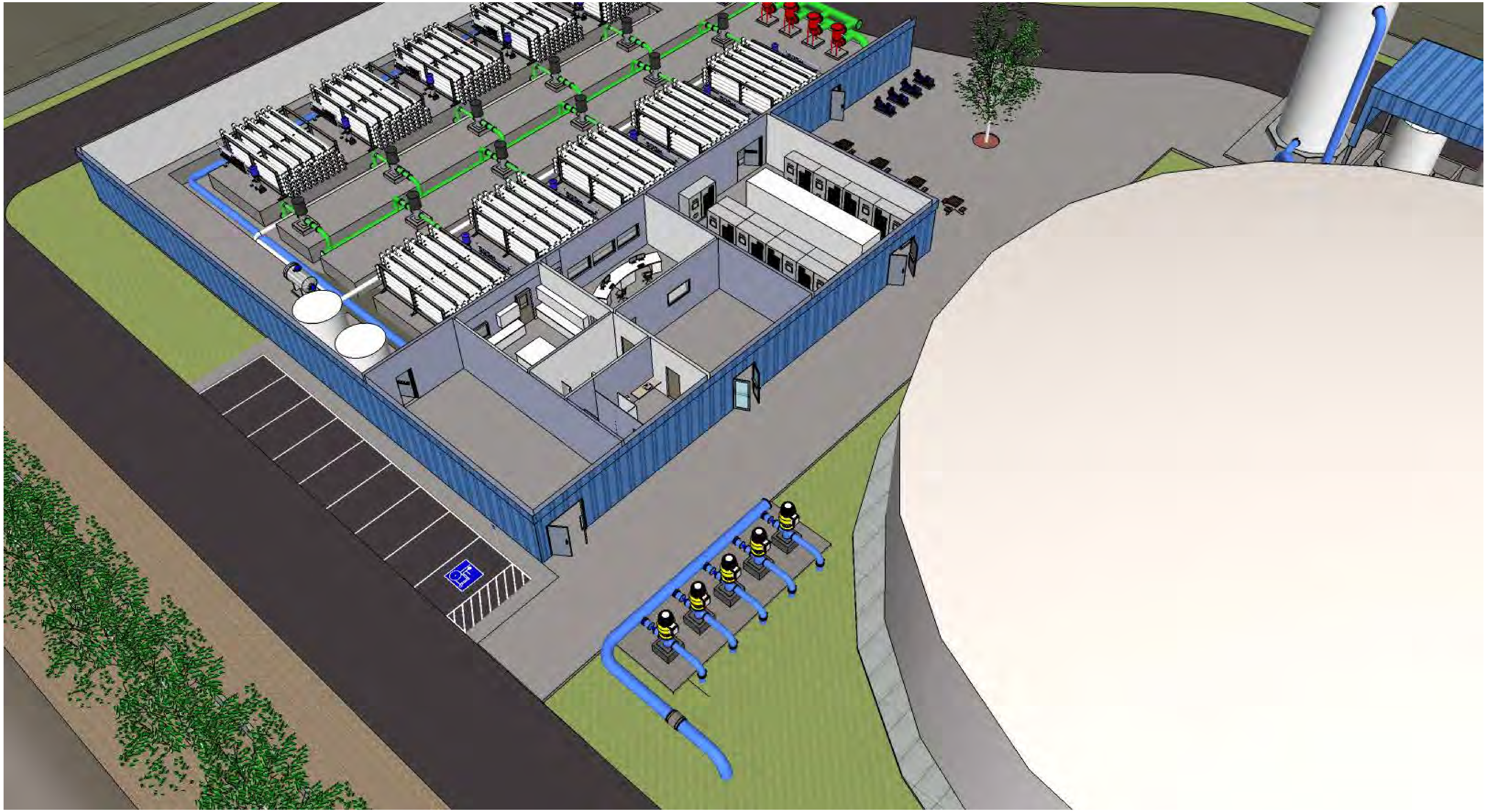


Figure 4.22 20,000 AFY RO Facility – Product Water Pumps, Admin/Storage/Lab/Control/Electrical Rooms

Unit costs were applied to known quantities, such as building square footage and gallons per day of capacity. Process equipment unit costs were based on vendor quotes and historical data from past projects. Detailed breakdowns of the capital costs for the water treatment plant and pipelines are presented in Appendix D.

### 5.1.1 SMP Connections

Connections to the SMP are allowed through existing blowoff branches incorporated into the pipeline design, per correspondence with Kristine McCaffrey, CMWD Manager of Engineering. As shown in Figure 5.1, a 24" blowoff connection is available at Station 106+70.00 at the intersection of Hueneme Road and Edison Drive.

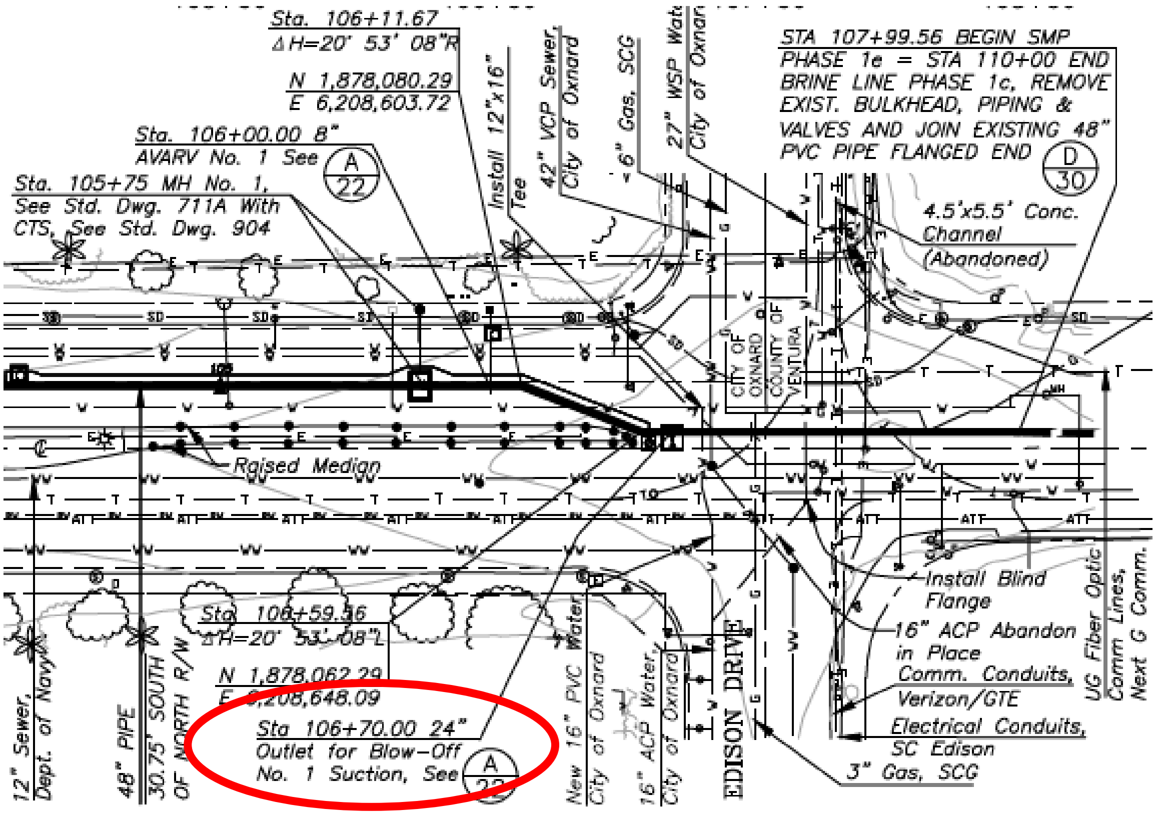


**Figure 5.1 Potential Connection Point to SMP**

Discharge stations are designed and constructed by CMWD at an estimated cost, provided by CMWD, of approximately $300,000. The typical discharge station design is presented in Figure 5.2.

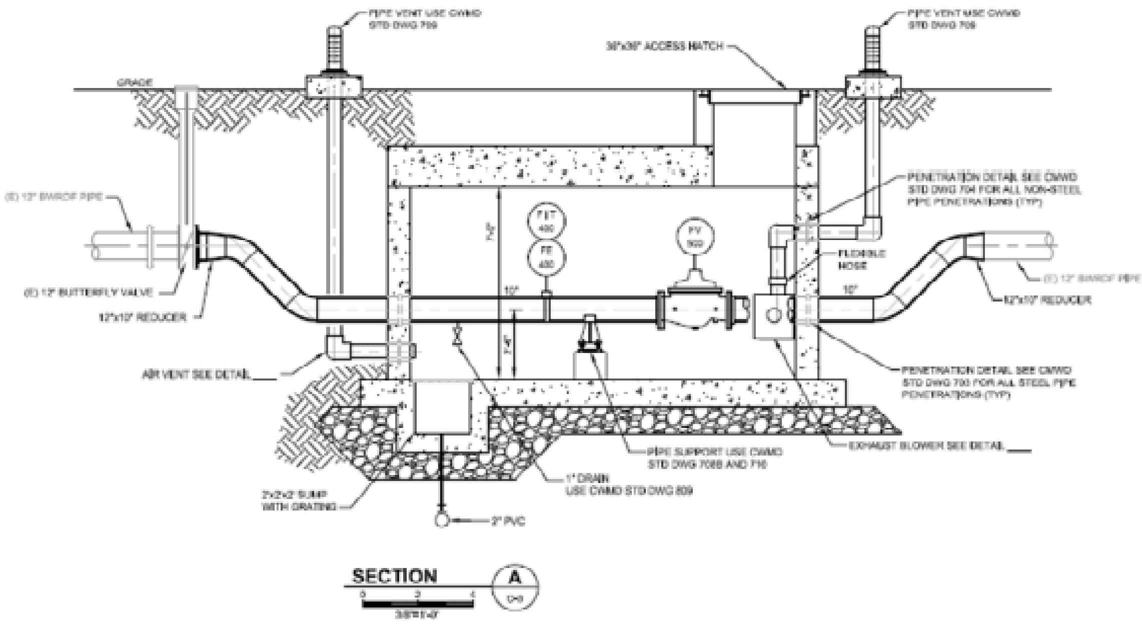


**Figure 5.2 Typical SMP Discharge Flow Measurement Station**

## 5.2 Operation and Maintenance (O&M) Costs

Operations costs were based on assumptions for:

- Power
- Chemicals
- Cartridge Filters
- Membranes
- Concentrate Disposal
- Water Quality Sampling and Analysis
- Miscellaneous Repair
- Miscellaneous Power (Lights, Air Conditioning, etc.)
- Labor

Chemical usage and power consumption were developed using data from manufacturers' projection software, water chemistry modeling, and hydraulic modeling using selected pump curves and required flow and pressure conditions for each capacity and water quality. For example, RO cleaning intervals and cleaning chemical costs were developed based on the Arlington Desalter in Southern California. Chemical costs were based on information in the *Chino Phase III Expansion Financial Projections Update* (Carollo Engineers, August 2012).

### 5.2.1 SMP Disposal Costs

Based on information provided by CMWD, disposal costs into the brine line are dependent upon the areas served by the water produced. For water distribution within the service area, concentrate disposal costs are $500/AF. Because the SMP is subsidized by potable water rates, lower disposal rates apply to those discharges that are producing and distributing potable water. Outside of the service area, including the agriculture users to be served by the South Oxnard Plain desalter via the PTP and PVCWD, cost for use of the brine line is $750/AF. Estimated brine flows are presented in Table 3.2.

### 5.2.2 O&M Estimate Unit Cost Assumptions

The assumed costs used in developing O&M Costs are presented in Table 5.1. Detailed breakdowns of the O&M costs are presented in Appendix E.

**Table 5.1 Operation and Maintenance Cost Assumptions**

| | |
|---|---|
| **Chemicals** | |
| Hydrated Lime ($/lb): | $0.20 |
| Sulfuric Acid ($/lb): | $0.034 |
| Scale Inhibitor ($/lb): | $0.95 |
| Sodium Hypochlorite ($/lb): | $0.35 |
| **Membranes and Filters** | |
| Membrane Elements - 8 inch diameter($/element): | $500 |
| Cartridge Filters ($/filter): | $12.00 |
| **Chemical Cleanings** | |
| Step 1 Cleaning Chemical Cost ($/lb): | $2.82 |
| Step 2 Cleaning Chemical Cost ($/lb): | $3.16 |
| Step 3 Cleaning Chemical Cost ($/lb): | $2.00 |
| **Other Non- Labor Costs** | |
| Power ($/kWh): | $0.125 |
| Miscellaneous Equipment and Building Maintenance ($/yr): | $50,000 |
| Well Maintenance (% of capital cost): | 2% |
| Laboratory Sample Analysis ($/yr): | $150,000 |
| Percentage Adder for Miscellaneous Power (%): | 2% |
| SMP Discharge ($/AF): | 750 |
| Annual SMP Discharge Station Maintenance and Sampling ($/yr): | $45,000 |
| **Labor** | |
| Annual T2 Operator Salary ($/yr): | $72,696 |
| Annual T1 Operator Salary ($/yr): | $59,821 |
| Fringe Percentage (%): | 40% |
| Administrative Cost Percentage (%): | 55% |
| **Plant Operating Factor (% of Time in Operation)** | 98% |

## 5.3 Cost Summary

Table 5.2 summarizes the capital and operational costs for each option. Capital costs presented herein represent a Class 4 budget estimate, as defined by the AACEI's Revised Classification (1999), with an expected accuracy range of +30 percent or -15 percent. This cost estimate is based upon Carollo Engineers' perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided in the project area occur. A detailed summary of the capital cost estimate is presented in Appendix F.

The unit water cost was developed by amortizing the capital costs across a 30-year period at a 3.22 percent interest rate (term and rate provided by UWCD). The annual capital repayment was then added to the annual operation and maintenance costs. The combination of the amortized capital and operations costs constitutes the annualized costs for each alternative.

Since operating costs are sensitive to power costs, a power cost sensitivity analysis was performed for each scenario. The impact to the O&M costs was assessed between $0.07 and $0.15 per kWh. The results are presented in Figures 5.3 through 5.6.

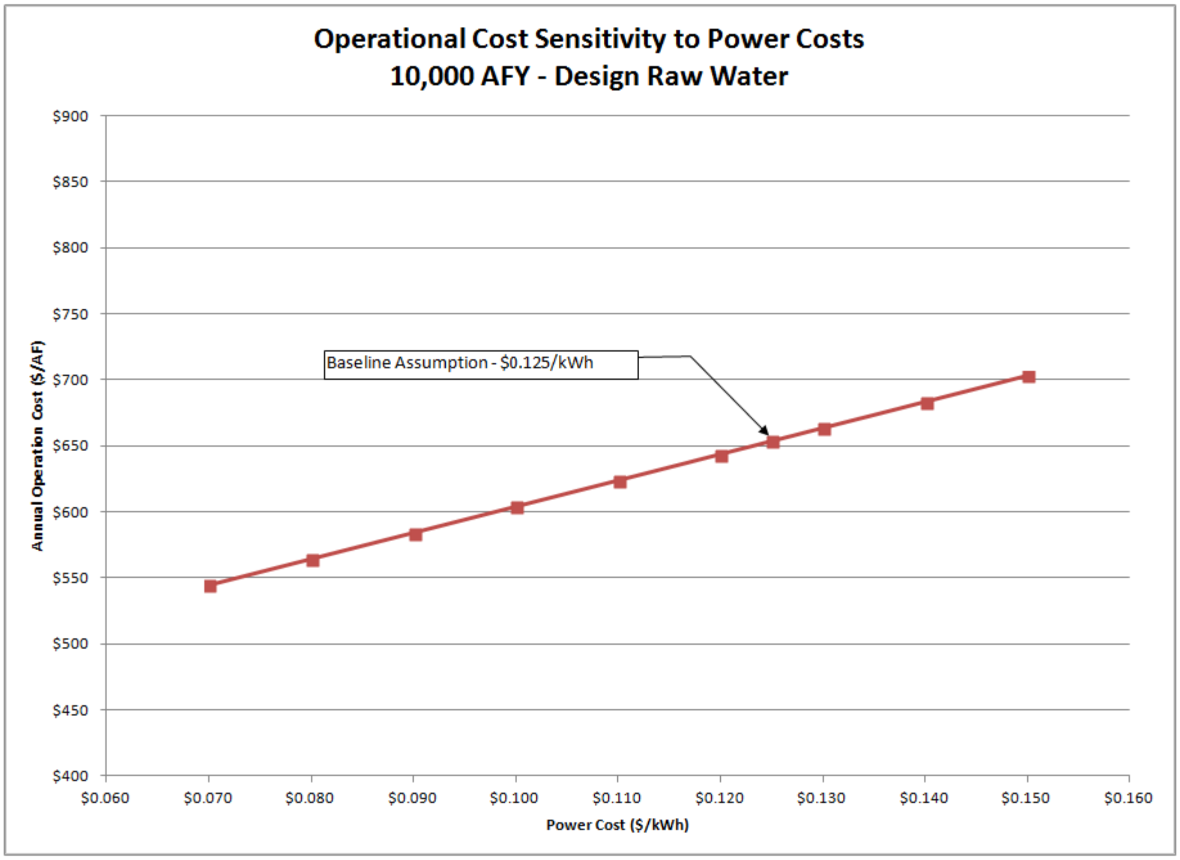


**Figure 5.3 O&M Cost Sensitivity to Power Costs – Design Raw Water at 10,000 AFY**

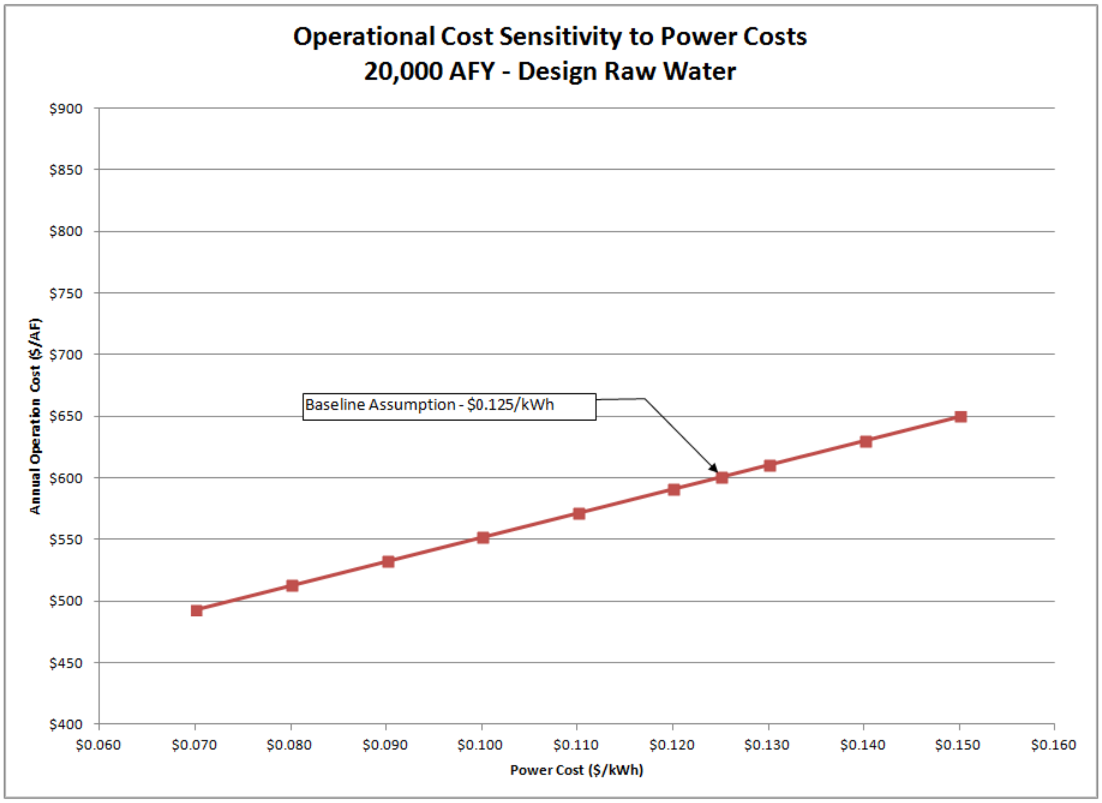


**Figure 5.4** O&M Cost Sensitivity to Power Costs – Design Raw Water at 20,000 AFY

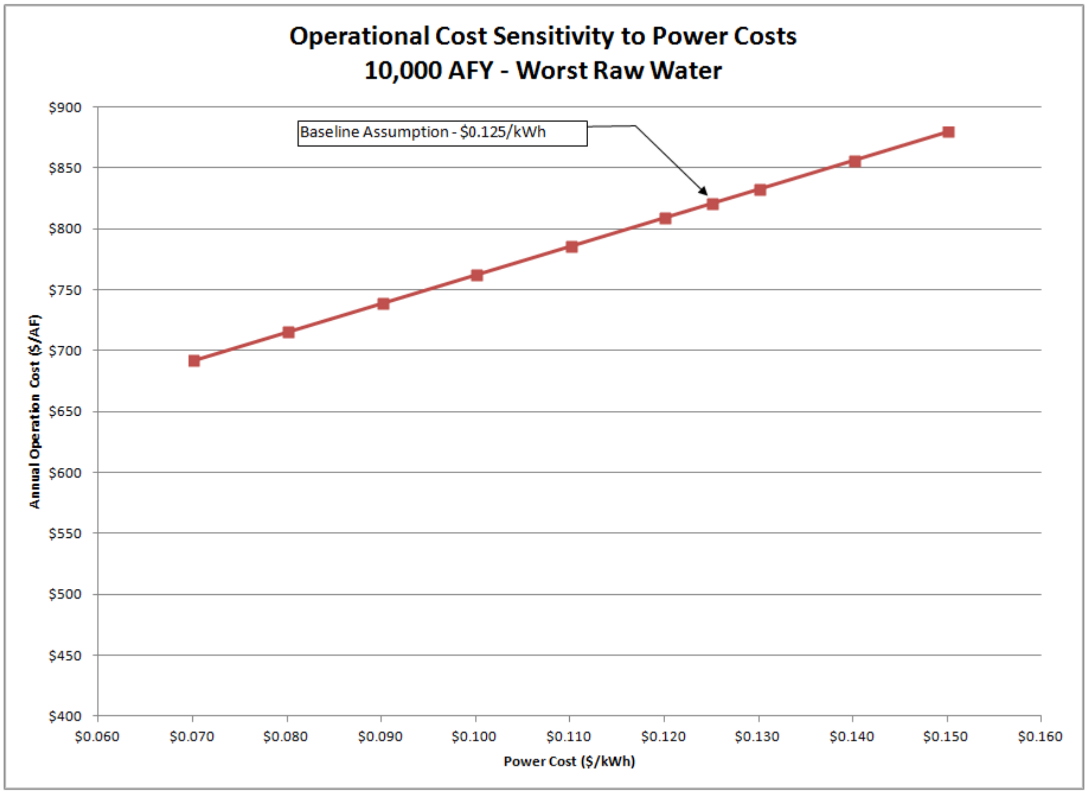


**Figure 5.5** O&M Cost Sensitivity to Power Costs – Worst Raw Water at 10,000 AFY

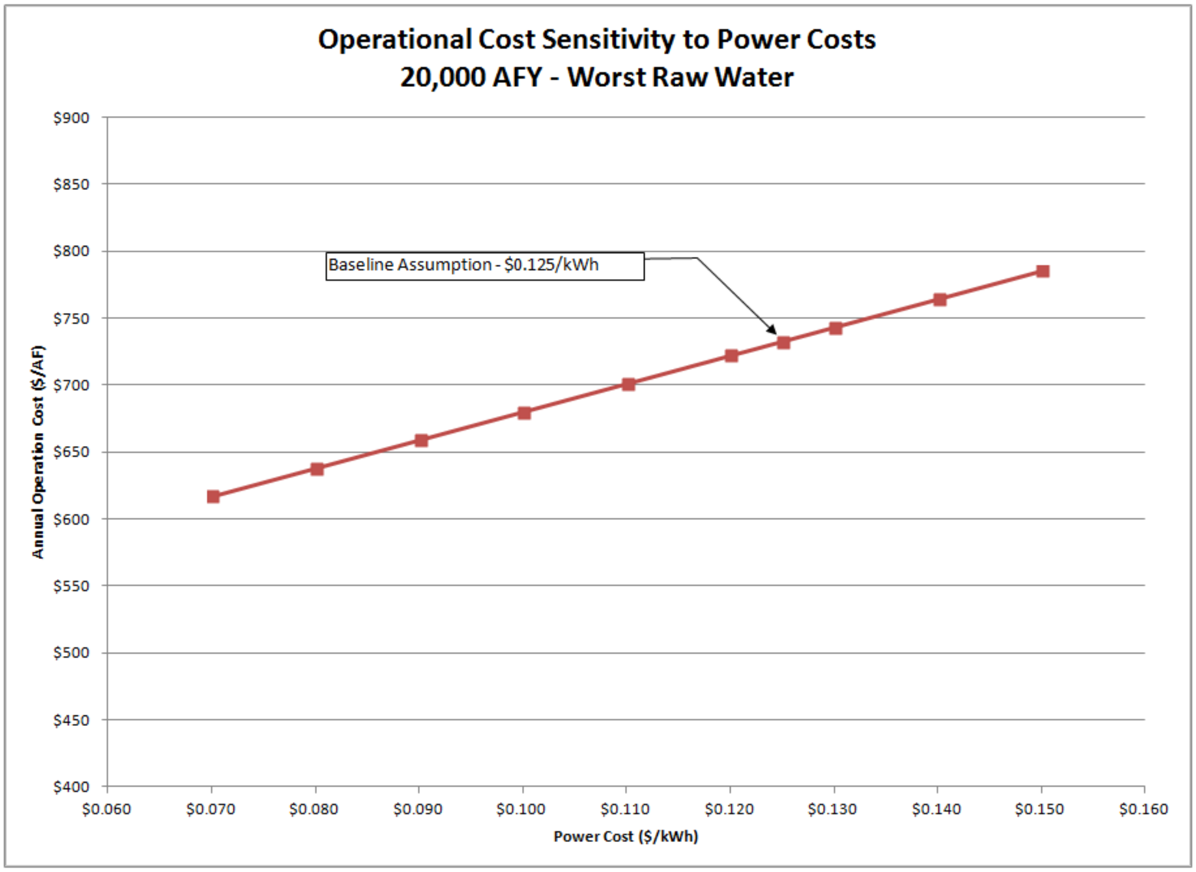


Figure 5.6 **O&M Cost Sensitivity to Power Costs – Worst Raw Water at 20,000 AFY**

## 5.4 Conclusions

The following conclusions are based on the information provided by UWCD and CMWD, and the process selection, design criteria development, and cost information generated by Carollo:

- The impaired groundwater in the South Oxnard Plain is suitable for treatment by reverse osmosis at an acceptable recovery range of 72 to 80 percent.
- With the exception of pH, the “ideal” product water quality can be met with traditional pretreatment, desalination, and post treatment systems.
- An amortized water cost of $998 to $1,111 per AF for the design water condition is competitive with imported water and has superior quality.
- Utilizing impaired groundwater treated to low TDS levels reduces salt import into the region, unlike irrigation with imported water.
- Connection to the SMP at the intersection of Hueneme Road and Edison Avenue is a viable option for concentrate disposal.
- Additional water quality sampling should be performed to confirm that the RO concentrate will comply with the SMP NPDES permit discharge limits.

**Table 5.2 Cost Summary**

| | 10,000 AFY Design Water Quality | 10,000 AFY Worst Case Water Quality | 20,000 AFY Design Water Quality | 20,000 AFY Worst Case Water Quality |
|---|---|---|---|---|
| **Capital Costs** | | | | |
| Conceptual WTP Construction Cost Estimate ($): | $85,137,000 | $85,137,000 | $147,966,000 | $147,966,000 |
| **Operation and Maintenance Costs** | | | | |
| Annual O&M Cost ($/yr): | $6,383,700 | $8,021,500 | $11,737,900 | $14,316,200 |
| Annual O&M Cost ($/kgal): | $2.01 | $2.52 | $1.84 | $2.2.25 |
| Annual O&M Cost ($/AF): | $653 | $821 | $601 | $733 |
| **Annualized Costs** | | | | |
| Annual O&M Cost with Capital Recovery ($/yr): | $10,850,700 | $12,489,500 | $19,503,300 | $22,081,600 |
| Annual O&M Cost with Capital Recovery ($/kgal): | $3.41 | $3.92 | $3.06 | $3.47 |
| Annual O&M Cost with Capital Recovery ($/AF): | $1,111 | $1,278 | $998 | $1,130 |

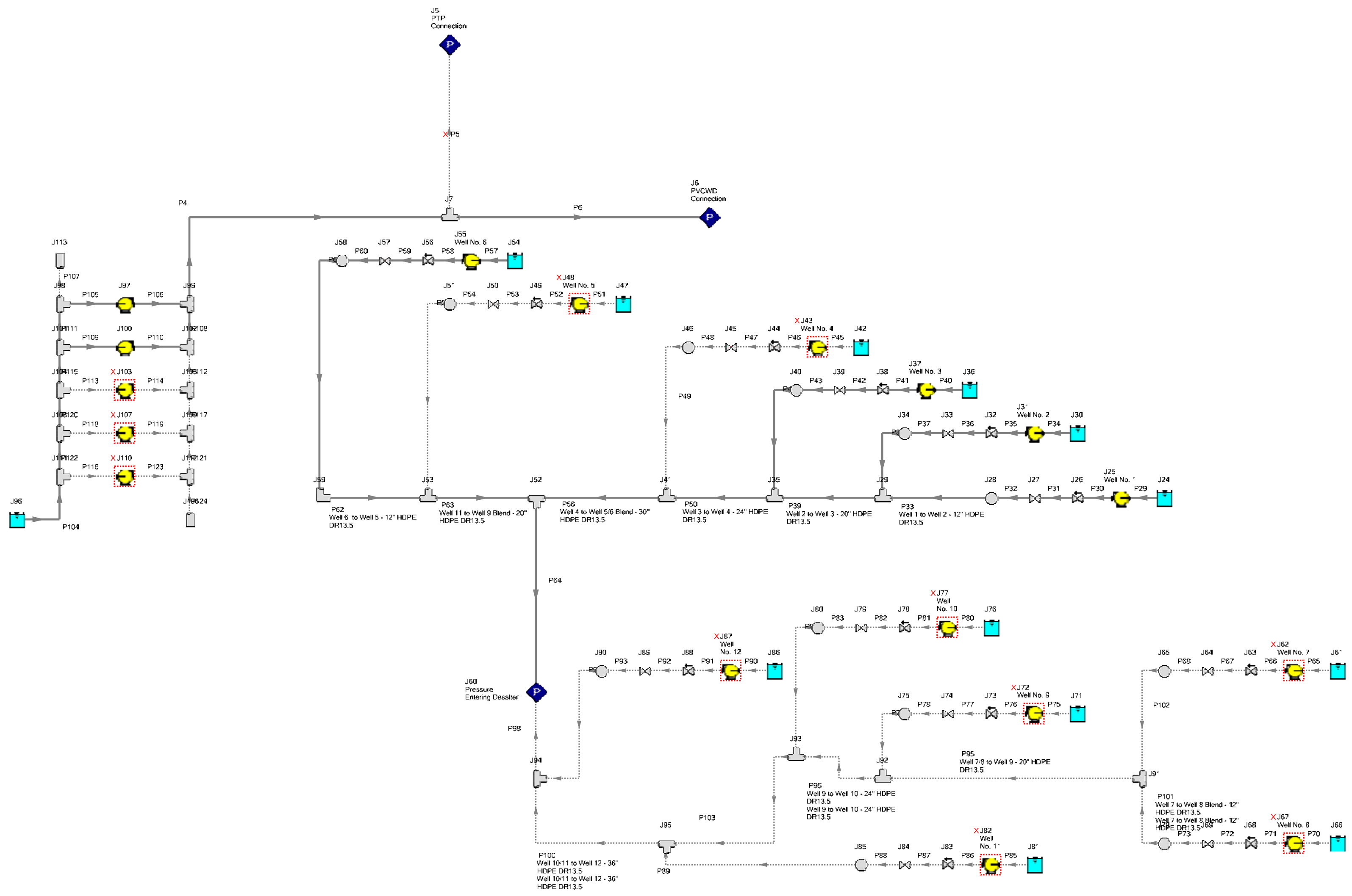
## 5.5 Future Project Development Activities

In order to advance the desalter project beyond the feasibility level toward design and construction, several additional preliminary steps must be taken that are outside the scope of this feasibility study. These steps include:

- Well Sampling – UWCD should initiate the well sampling plan recommended in Section 3.5.1. This information will increase the water quality database to refine the process design and insure that SMP regulated contaminants are not problematic for concentrate disposal.
- Finalize GMA Agreements – UWCD has initiated conversations with the GMA regarding the utilization of the impaired groundwater and the exemption from groundwater pumping surcharges. A formal groundwater usage agreement should be finalized between the GMA and UWCD.
- Finalize Sites for Wells – Figure 3.1 presents approximate well sites based on information provided by UWCD. The well sites should be finalized, and the ability to acquire the property should be confirmed.
- Finalize Plant Site – Figure 3.1 identifies a potential location for the desalter. MWD is the owner of the parcel shown, and has earmarked that property for a future desalter. The availability of this land for use as the desalter site should be coordinated with MWD, and a finalized use agreement or property acquisition plan should be developed.
- Electrical Infrastructure Investigation – As part of the feasibility study, the capability of the SCE grid to support the desalter and wells has been confirmed. However, specifics regarding modifications and the capital cost implications have not been developed to a detailed design level. Therefore, a large load study should be performed by SCE to establish infrastructure improvements requirements for power supply to the wells and the desalter
- Pipeline Routing – Once the well and plant sites are selected, the pipeline routing should be finalized, including a right of way acquisition study.
- CEQA – Once the previous items have been finalized, an environmental impact study should be conducted in accordance with CEQA guidelines. An initial study will determine if the potential environmental effects require a more substantial Environmental Impact Report (EIR). The feasibility report will need to be amended with any information necessary to support the CEQA study.
- Survey and Geotechnical Investigation – In support of the pipeline, well, and desalter facility designs, survey and geotechnical information should be developed.

- Pipelines - Aerial surveys at 1-ft contours overlaid on the aerial photos should be developed. Geotechnical borings at 1000-ft intervals along the pipeline alignment should be conducted.
- Wells and Desalter – Detailed site surveys for the proposed sites. Geotechnical investigations should be performed on each well site and the desalter site, complete with foundation design recommendations.

# APPENDIX A – HYDRAULIC MODELING RESULTS



Fathom 8 (Workspace)
5/30/2014
Page 1 of 1
CAROLLO\byallaly

## General

Title: AFT Fathom Model
Analysis run on: 5/30/2014 4:33:36 PM
Application version: AFT Fathom Version 8 (2013.10.24)
Input File: C:\Users\byallaly\Desktop\UWCD Raw and Product Water Pumping.fth
Scenario: Base Scenario/10,000 AFY_Design Water
Output File: C:\Users\byallaly\Desktop\UWCD Raw and Product Water Pumping_1.out

Execution Time= 0.38 seconds
Total Number Of Head/Pressure Iterations= 0
Total Number Of Flow Iterations= 2
Total Number Of Temperature Iterations= 0
Number Of Pipes= 95
Number Of Junctions= 93
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Temperature Tolerance= 0.0001 relative change
Flow Relaxation= (Automatic)
Pressure Relaxation= (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 22 deg. C
Density= 62.29622 lbm/ft3
Viscosity= 2.30822 lbm/hr-ft
Vapor Pressure= 0.38264 psia
Viscosity Model= Newtonian
Apply laminar and non-Newtonian correction to: Pipe Fittings & Losses, Junction K factors, Junction Special Losses, Junction Polynomials
Corrections applied to the following junctions: Branch, Reservoir, Assigned Flow, Assigned Pressure, Area Change, Bend, Tee or Wye, Control Valve, Spray Discharge, Relief Valve

Ambient Pressure (constant)= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300
Total Inflow= 13,898 gal/min
Total Outflow= 13,898 gal/min
Maximum Static Pressure is 91.50 psia at Pipe 33 Inlet
Minimum Static Pressure is 14.67 psia at Pipe 104 Inlet
Fixed Energy Cost = 0.0125 U.S. Dollars per kW-hr
The following cost databases were used:
Total of All Model Costs = 0 U.S. Dollars

Warnings

No Warnings

Pump Summary

| Jct | Name | Vol. Flow (gal/min) | dH (feet) | Overall Efficiency (Percent) | Speed (Percent) | Overall Power (hp) | NPSHA (feet) | NPSHR (feet) | Energy Cost (U.S. Dollars) |
|---|---|---|---|---|---|---|---|---|---|
| 25 | Well No. 1 | 1,931 | 225.6 | 100.0 | N/A | 109.93 | 39.08 | N/A | 0 |
| 31 | Well No. 2 | 1,931 | 199.6 | 100.0 | N/A | 97.26 | 40.08 | N/A | 0 |
| 37 | Well No. 3 | 1,931 | 188.4 | 100.0 | N/A | 91.78 | 40.08 | N/A | 0 |
| X43 | Well No. 4 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X48 | Well No. 5 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| 55 | Well No. 6 | 1,931 | 194.2 | 100.0 | N/A | 94.60 | 42.08 | N/A | 0 |
| X62 | Well No. 7 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X67 | Well No. 8 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X72 | Well No. 9 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X77 | Well No. 10 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X82 | Well No. 11 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X87 | Well No. 12 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| 97 | Pump | 3,087 | 154.5 | 100.0 | N/A | 120.38 | 40.17 | N/A | 0 |
| 100 | Pump | 3,087 | 155.0 | 100.0 | N/A | 120.71 | 40.14 | N/A | 0 |
| X103 | Pump | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X107 | Pump | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X110 | Pump | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |

## Valve Summary

| Jct | Name | Valve Type | Vol. Flow (gal/min) | dH (feet) | P Static In (psia) | Cv | K | Valve State |
|---|---|---|---|---|---|---|---|---|
| 27 | Valve | REGULAR | 1,931 | 0.6831 | 86.65 | 3,550 | 0.8328 | Open |
| 33 | Valve | REGULAR | 1,931 | 0.6831 | 75.83 | 3,550 | 0.8328 | Open |
| 39 | Valve | REGULAR | 1,931 | 0.6831 | 70.96 | 3,550 | 0.8328 | Open |
| 45 | Valve | REGULAR | 0 | N/A | 66.01 | N/A | N/A | Open |
| 50 | Valve | REGULAR | 0 | N/A | 66.70 | N/A | N/A | Open |
| 57 | Valve | REGULAR | 1,931 | 0.6831 | 74.33 | 3,550 | 0.8328 | Open |
| 64 | Valve | REGULAR | 0 | N/A | 65.56 | N/A | N/A | Open |
| 69 | Valve | REGULAR | 0 | N/A | 66.86 | N/A | N/A | Open |
| 74 | Valve | REGULAR | 0 | N/A | 66.43 | N/A | N/A | Open |
| 79 | Valve | REGULAR | 0 | N/A | 68.16 | N/A | N/A | Open |
| 84 | Valve | REGULAR | 0 | N/A | 66.86 | N/A | N/A | Open |
| 89 | Valve | REGULAR | 0 | N/A | 66.86 | N/A | N/A | Open |
| 26 | Check Valve | CHECK | 1,931 | 0.3842 | 86.84 | 4,733 | 0.4684 | Open |
| 32 | Check Valve | CHECK | 1,931 | 0.3842 | 76.03 | 4,733 | 0.4684 | Open |
| 38 | Check Valve | CHECK | 1,931 | 0.3842 | 71.15 | 4,733 | 0.4684 | Open |
| 44 | Check Valve | CHECK | 0 | N/A | 66.01 | N/A | N/A | Open |
| 49 | Check Valve | CHECK | 0 | N/A | 66.70 | N/A | N/A | Open |
| 56 | Check Valve | CHECK | 1,931 | 0.3842 | 74.52 | 4,733 | 0.4684 | Open |
| 63 | Check Valve | CHECK | 0 | N/A | 65.56 | N/A | N/A | Open |
| 68 | Check Valve | CHECK | 0 | N/A | 66.86 | N/A | N/A | Open |
| 73 | Check Valve | CHECK | 0 | N/A | 66.43 | N/A | N/A | Open |
| 78 | Check Valve | CHECK | 0 | N/A | 68.16 | N/A | N/A | Open |
| 83 | Check Valve | CHECK | 0 | N/A | 66.86 | N/A | N/A | Open |
| 88 | Check Valve | CHECK | 0 | N/A | 66.86 | N/A | N/A | Open |

Reservoir Summary

| Jct | Name | Type | Liq. Height (feet) | Liq. Elevation (feet) | Surface Pressure (psia) | Liquid Volume (feet3) | Liquid Mass (lbm) | Net Vol. Flow (gal/min) | Net Mass Flow (lbm/sec) |
|---|---|---|---|---|---|---|---|---|---|
| 24 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,931 | -268.0 |
| 30 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,931 | -268.0 |
| 36 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,931 | -268.0 |
| 42 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 47 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 54 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,931 | -268.0 |
| 61 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 66 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 71 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 76 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 81 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 86 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 96 | Reservoir | Infinite | N/A | 20.00 | 14.70 | N/A | N/A | -6,174 | -856.9 |

Pipe Output Table

| Pipe | Name | Vol. Flow Rate (MGD) | Velocity (feet/sec) | dH (feet) |
|---|---|---|---|---|
| 4 | Pipe | 8.891 | 4.3786 | 44.8662936 |
| X5 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 6 | Pipe | 8.891 | 4.3786 | 20.6001902 |
| 29 | Pipe | 2.781 | 7.2650 | 0.0012805 |
| 30 | Pipe | 2.781 | 7.2650 | 1.0397569 |
| 31 | Pipe | 2.781 | 7.2650 | 0.0640244 |
| 32 | Pipe | 2.781 | 7.2650 | 0.1920731 |
| 33 | Well 1 to Well 2 - 12" HDPE DR13.5 | 2.781 | 6.8286 | 27.0354544 |
| 34 | Pipe | 2.781 | 7.2650 | 0.0012805 |
| 35 | Pipe | 2.781 | 7.2650 | 1.0397569 |
| 36 | Pipe | 2.781 | 7.2650 | 0.0640244 |
| 37 | Pipe | 2.781 | 7.2650 | 0.1920731 |
| 38 | Pipe | 2.781 | 6.8286 | 0.7560194 |
| 39 | Well 2 to Well 3 - 20" HDPE DR13.5 | 5.561 | 5.5499 | 11.3071764 |
| 40 | Pipe | 2.781 | 7.2650 | 0.0012805 |
| 41 | Pipe | 2.781 | 7.2650 | 1.0397569 |
| 42 | Pipe | 2.781 | 7.2650 | 0.0640244 |
| 43 | Pipe | 2.781 | 7.2650 | 0.1920731 |
| 44 | Pipe | 2.781 | 6.8286 | 0.7560196 |
| 45 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 46 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 47 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 48 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 49 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 50 | Well 3 to Well 4 - 24" HDPE DR13.5 | 8.342 | 5.7817 | 9.8380571 |
| 51 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 52 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 53 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 54 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 55 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 56 | Well 4 to Well 5/6 Blend - 30" HDPE DR13.5 | 8.342 | 3.7002 | 1.6723998 |
| 57 | Pipe | 2.781 | 7.2650 | 0.0012807 |
| 58 | Pipe | 2.781 | 7.2650 | 1.0397569 |
| 59 | Pipe | 2.781 | 7.2650 | 0.0640244 |
| 60 | Pipe | 2.781 | 7.2650 | 0.1920731 |
| 61 | Pipe | 2.781 | 6.8286 | 0.7560153 |
| 62 | Well 6 to Well 5 - 12" HDPE DR13.5 | 2.781 | 6.8286 | 17.6770025 |

| Pipe | Name | Vol. Flow Rate (MGD) | Velocity (feet/sec) | dH (feet) |
|---|---|---|---|---|
| 63 | Well 11 to Well 9 Blend - 20" HDPE DR13.5 | 2.781 | 2.2176 | 0.3103212 |
| 64 | North Wells to Desalter - 36" HDPE DR13.5 | 11.123 | 3.4261 | 1.2160755 |
| 65 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 66 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 67 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 68 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 70 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 71 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 72 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 73 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 75 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 76 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 77 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 78 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 79 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 80 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 81 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 82 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 83 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 84 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 85 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 86 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 87 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 88 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 89 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 90 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 91 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 92 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 93 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 94 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 95 | Well 7/8 to Well 9 - 20" HDPE DR13.5 | 0.000 | 0.0000 | 0.0000000 |
| 96 | Well 9 to Well 10 - 24" HDPE DR13.5 | 0.000 | 0.0000 | 0.0000000 |
| 98 | Well 12 to Desalter - 36" HDPE DR13.5 | 0.000 | 0.0000 | 0.0000000 |
| 100 | Well 10/11 to Well 12 - 36" HDPE DR13.5 | 0.000 | 0.0000 | 0.0000000 |
| 101 | Well 7 to Well 8 Blend - 12" HDPE DR13.5 | 0.000 | 0.0000 | 0.0000000 |
| 102 | Well 7 to Well 8 Blend - 12" HDPE DR13.5 | 0.000 | 0.0000 | 0.0000000 |
| 103 | Well 10 to Well 11 - 30" HDPE DR13.5 | 0.000 | 0.0000 | 0.0000000 |
| 104 | Pipe | 8.891 | 1.9460 | 0.2057422 |
| 105 | Pipe | 4.445 | 3.8921 | 0.3487453 |
| 106 | Pipe | 4.445 | 4.9259 | 1.1992354 |

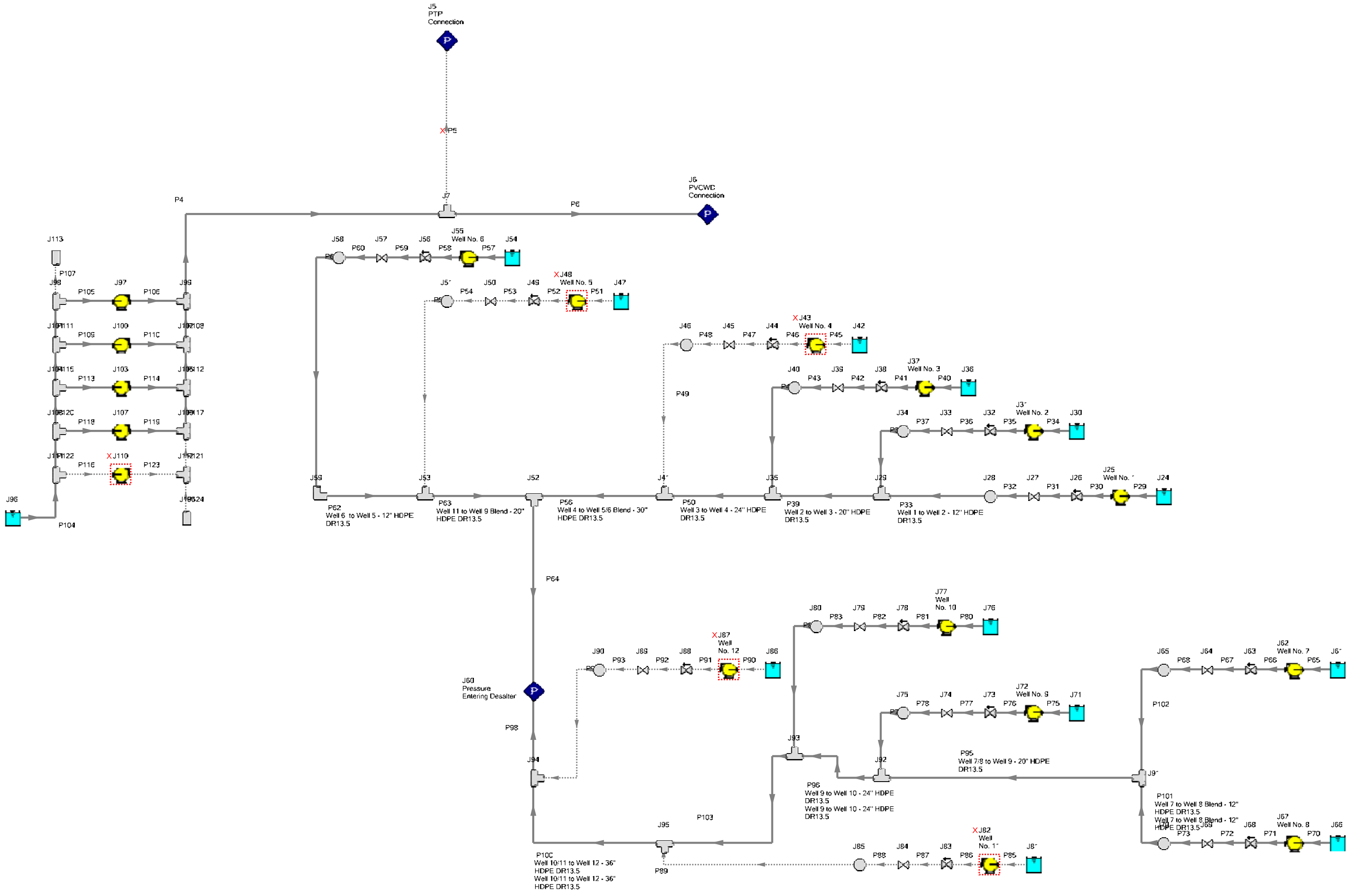
| Pipe | Name | Vol. Flow Rate (MGD) | Velocity (feet/sec) | dH (feet) |
|---|---|---|---|---|
| 107 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 108 | Pipe | 4.445 | 0.9730 | 0.0009715 |
| 109 | Pipe | 4.445 | 3.8921 | 0.3487453 |
| 110 | Pipe | 4.445 | 4.9259 | 1.1992354 |
| 111 | Pipe | 4.445 | 0.9730 | 0.0009715 |
| 112 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 113 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 114 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 115 | Pipe | 8.891 | 1.9460 | 0.0035070 |
| 116 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 117 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 118 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 119 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 120 | Pipe | 8.891 | 1.9460 | 0.0035069 |
| 121 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 122 | Pipe | 8.891 | 1.9460 | 0.0035069 |
| 123 | Pipe | 0.000 | 0.0000 | 0.0000000 |
| 124 | Pipe | 0.000 | 0.0000 | 0.0000000 |

All Junction Table

| Jct | Name | Vol. Flow Rate Thru Jct (gal/min) | Mass Flow Rate Thru Jct (lbm/sec) | Loss Factor (K) | dH (feet) |
|---|---|---|---|---|---|
| 5 | PTP Connection | 0 | 0.0 | 0.0000 | 0.0000 |
| 6 | PVCWD Connection | 6,174 | 856.9 | 0.0000 | 0.0000 |
| 7 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 24 | Reservoir | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 25 | Well No. 1 | 1,931 | 268.0 | 0.0000 | -225.6302 |
| 26 | Check Valve | 1,931 | 268.0 | 0.4684 | 0.3842 |
| 27 | Valve | 1,931 | 268.0 | 0.8328 | 0.6831 |
| 28 | Branch | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 29 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 30 | Reservoir | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 31 | Well No. 2 | 1,931 | 268.0 | 0.0000 | -199.6296 |
| 32 | Check Valve | 1,931 | 268.0 | 0.4684 | 0.3842 |
| 33 | Valve | 1,931 | 268.0 | 0.8328 | 0.6831 |
| 34 | Branch | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 35 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 36 | Reservoir | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 37 | Well No. 3 | 1,931 | 268.0 | 0.0000 | -188.3640 |
| 38 | Check Valve | 1,931 | 268.0 | 0.4684 | 0.3842 |
| 39 | Valve | 1,931 | 268.0 | 0.8328 | 0.6831 |
| 40 | Branch | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 41 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 42 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X43 | Well No. 4 | 0 | 0.0 | 0.0000 | N/A |
| 44 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 45 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 46 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 47 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X48 | Well No. 5 | 0 | 0.0 | 0.0000 | N/A |
| 49 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 50 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 51 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 52 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 53 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 54 | Reservoir | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 55 | Well No. 6 | 1,931 | 268.0 | 0.0000 | -194.1538 |
| 56 | Check Valve | 1,931 | 268.0 | 0.4684 | 0.3842 |
| 57 | Valve | 1,931 | 268.0 | 0.8328 | 0.6831 |

| Jct | Name | Vol. Flow Rate Thru Jct (gal/min) | Mass Flow Rate Thru Jct (lbm/sec) | Loss Factor (K) | dH (feet) |
|---|---|---|---|---|---|
| 58 | Branch | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 59 | Bend | 1,931 | 268.0 | 0.1908 | 0.1382 |
| 60 | Pressure Entering Desalter | N/A | N/A | 0.0000 | 0.0000 |
| 61 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X62 | Well No. 7 | 0 | 0.0 | 0.0000 | N/A |
| 63 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 64 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 65 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 66 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X67 | Well No. 8 | 0 | 0.0 | 0.0000 | N/A |
| 68 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 69 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 70 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 71 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X72 | Well No. 9 | 0 | 0.0 | 0.0000 | N/A |
| 73 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 74 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 75 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 76 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X77 | Well No. 10 | 0 | 0.0 | 0.0000 | N/A |
| 78 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 79 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 80 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 81 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X82 | Well No. 11 | 0 | 0.0 | 0.0000 | N/A |
| 83 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 84 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 85 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 86 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X87 | Well No. 12 | 0 | 0.0 | 0.0000 | N/A |
| 88 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 89 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 90 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 91 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 92 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 93 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 94 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 95 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 96 | Reservoir | 6,174 | 856.9 | 0.0000 | 0.0000 |
| 97 | Pump | 3,087 | 428.5 | 0.0000 | -154.5463 |

| Jct | Name | Vol. Flow Rate Thru Jct (gal/min) | Mass Flow Rate Thru Jct (lbm/sec) | Loss Factor (K) | dH (feet) |
|---|---|---|---|---|---|
| 98 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 99 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 100 | Pump | 3,087 | 428.5 | 0.0000 | -154.9698 |
| 101 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 102 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| X103 | Pump | 0 | 0.0 | 0.0000 | N/A |
| 104 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 105 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 106 | Dead End | 0 | 0.0 | 0.0000 | 0.0000 |
| X107 | Pump | 0 | 0.0 | 0.0000 | N/A |
| 108 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 109 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| X110 | Pump | 0 | 0.0 | 0.0000 | N/A |
| 111 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 112 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 113 | Dead End | 0 | 0.0 | 0.0000 | 0.0000 |



Fathom 8 (Workspace)
5/30/2014
Page 1 of 1
CAROLLO\byallaly

```
General

Title: AFT Fathom Model
Analysis run on: 5/30/2014 4:36:08 PM
Application version: AFT Fathom Version 8 (2013.10.24)
Input File: C:\Users\byallaly\Desktop\UWCD Raw and Product Water Pumping.fth
Scenario: Base Scenario/20,000 AFY_Design Water
Output File: C:\Users\byallaly\Desktop\UWCD Raw and Product Water Pumping_2.out

Execution Time= 0.11 seconds
Total Number Of Head/Pressure Iterations= 0
Total Number Of Flow Iterations= 2
Total Number Of Temperature Iterations= 0
Number Of Pipes= 95
Number Of Junctions= 93
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Temperature Tolerance= 0.0001 relative change
Flow Relaxation=  (Automatic)
Pressure Relaxation=  (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 22 deg. C
Density= 62.29622 lbm/ft3
Viscosity= 2.30822 lbm/hr-ft
Vapor Pressure= 0.38264 psia
Viscosity Model= Newtonian
Apply laminar and non-Newtonian correction to: Pipe Fittings & Losses, Junction K factors, Junction Special Losses, Junction
Polynomials
Corrections applied to the following junctions: Branch, Reservoir, Assigned Flow, Assigned Pressure, Area Change, Bend, Tee or
Wye, Control Valve, Spray Discharge, Relief Valve

Ambient Pressure (constant)= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300
Total Inflow= 27,796 gal/min
Total Outflow= 27,796 gal/min
Maximum Static Pressure is 91.50 psia at Pipe 33 Inlet
Minimum Static Pressure is 14.59 psia at Pipe 104 Inlet
Fixed Energy Cost = 0.0125 U.S. Dollars per kW-hr
The following cost databases were used:
Total of All Model Costs = 0  U.S. Dollars
```

Warnings

No Warnings

Pump Summary

| Jct | Name | Vol. Flow (gal/min) | dH (feet) | Overall Efficiency (Percent) | Speed (Percent) | Overall Power (hp) | NPSHA (feet) | NPSHR (feet) | Energy Cost (U.S. Dollars) |
|---|---|---|---|---|---|---|---|---|---|
| 25 | Well No. 1 | 1,931 | 225.6 | 100.0 | N/A | 109.93 | 39.08 | N/A | 0 |
| 31 | Well No. 2 | 1,931 | 199.6 | 100.0 | N/A | 97.26 | 40.08 | N/A | 0 |
| 37 | Well No. 3 | 1,931 | 188.4 | 100.0 | N/A | 91.78 | 40.08 | N/A | 0 |
| X43 | Well No. 4 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X48 | Well No. 5 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| 55 | Well No. 6 | 1,931 | 194.2 | 100.0 | N/A | 94.60 | 42.08 | N/A | 0 |
| 62 | Well No. 7 | 1,931 | 210.8 | 100.0 | N/A | 102.70 | 42.08 | N/A | 0 |
| 67 | Well No. 8 | 1,931 | 212.6 | 100.0 | N/A | 103.59 | 45.08 | N/A | 0 |
| 72 | Well No. 9 | 1,931 | 191.0 | 100.0 | N/A | 93.07 | 44.08 | N/A | 0 |
| 77 | Well No. 10 | 1,931 | 179.2 | 100.0 | N/A | 87.31 | 48.08 | N/A | 0 |
| X82 | Well No. 11 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X87 | Well No. 12 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| 97 | Pump | 3,087 | 123.3 | 100.0 | N/A | 96.01 | 39.27 | N/A | 0 |
| 100 | Pump | 3,087 | 123.7 | 100.0 | N/A | 96.39 | 39.24 | N/A | 0 |
| 103 | Pump | 3,087 | 123.2 | 100.0 | N/A | 95.92 | 39.53 | N/A | 0 |
| 107 | Pump | 3,087 | 123.8 | 100.0 | N/A | 96.46 | 39.22 | N/A | 0 |
| X110 | Pump | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |

Valve Summary

| Jct | Name | Valve Type | Vol. Flow (gal/min) | dH (feet) | P Static In (psia) | Cv | K | Valve State |
|---|---|---|---|---|---|---|---|---|
| 27 | Valve | REGULAR | 1,931 | 0.6831 | 86.65 | 3,550 | 0.8328 | Open |
| 33 | Valve | REGULAR | 1,931 | 0.6831 | 75.83 | 3,550 | 0.8328 | Open |
| 39 | Valve | REGULAR | 1,931 | 0.6831 | 70.96 | 3,550 | 0.8328 | Open |
| 45 | Valve | REGULAR | 0 | N/A | 66.01 | N/A | N/A | Open |
| 50 | Valve | REGULAR | 0 | N/A | 66.70 | N/A | N/A | Open |
| 57 | Valve | REGULAR | 1,931 | 0.6831 | 74.33 | 3,550 | 0.8328 | Open |
| 64 | Valve | REGULAR | 1,931 | 0.6831 | 81.53 | 3,550 | 0.8328 | Open |
| 69 | Valve | REGULAR | 1,931 | 0.6831 | 83.61 | 3,550 | 0.8328 | Open |
| 74 | Valve | REGULAR | 1,931 | 0.6831 | 73.84 | 3,550 | 0.8328 | Open |
| 79 | Valve | REGULAR | 1,931 | 0.6831 | 70.45 | 3,550 | 0.8328 | Open |
| 84 | Valve | REGULAR | 0 | N/A | 68.47 | N/A | N/A | Open |
| 89 | Valve | REGULAR | 0 | N/A | 67.45 | N/A | N/A | Open |
| 26 | Check Valve | CHECK | 1,931 | 0.3842 | 86.84 | 4,733 | 0.4684 | Open |
| 32 | Check Valve | CHECK | 1,931 | 0.3842 | 76.03 | 4,733 | 0.4684 | Open |
| 38 | Check Valve | CHECK | 1,931 | 0.3842 | 71.15 | 4,733 | 0.4684 | Open |
| 44 | Check Valve | CHECK | 0 | N/A | 66.01 | N/A | N/A | Open |
| 49 | Check Valve | CHECK | 0 | N/A | 66.70 | N/A | N/A | Open |
| 56 | Check Valve | CHECK | 1,931 | 0.3842 | 74.52 | 4,733 | 0.4684 | Open |
| 63 | Check Valve | CHECK | 1,931 | 0.3842 | 81.72 | 4,733 | 0.4684 | Open |
| 68 | Check Valve | CHECK | 1,931 | 0.3842 | 83.81 | 4,733 | 0.4684 | Open |
| 73 | Check Valve | CHECK | 1,931 | 0.3842 | 74.03 | 4,733 | 0.4684 | Open |
| 78 | Check Valve | CHECK | 1,931 | 0.3842 | 70.65 | 4,733 | 0.4684 | Open |
| 83 | Check Valve | CHECK | 0 | N/A | 68.47 | N/A | N/A | Open |
| 88 | Check Valve | CHECK | 0 | N/A | 67.45 | N/A | N/A | Open |

Reservoir Summary

| Jct | Name | Type | Liq. Height (feet) | Liq. Elevation (feet) | Surface Pressure (psia) | Liquid Volume (feet3) | Liquid Mass (lbm) | Net Vol. Flow (gal/min) | Net Mass Flow (lbm/sec) |
|---|---|---|---|---|---|---|---|---|---|
| 24 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,931 | -268.0 |
| 30 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,931 | -268.0 |
| 36 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,931 | -268.0 |
| 42 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 47 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 54 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,931 | -268.0 |
| 61 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,931 | -268.0 |
| 66 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,931 | -268.0 |
| 71 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,931 | -268.0 |
| 76 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,931 | -268.0 |
| 81 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 86 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 96 | Reservoir | Infinite | N/A | 20.00 | 14.70 | N/A | N/A | -12,348 | -1,713.9 |

Pipe Output Table

| Pipe | Name | Vol. Flow Rate (gal/min) | Velocity (feet/sec) | dH (feet) |
|---|---|---|---|---|
| 4 | Pipe | 12,348 | 3.8921 | 22.7969367 |
| X5 | Pipe | 0 | 0.0000 | 0.0000000 |
| 6 | Pipe | 12,348 | 3.8921 | 10.5273357 |
| 29 | Pipe | 1,931 | 7.2650 | 0.0012805 |
| 30 | Pipe | 1,931 | 7.2650 | 1.0397569 |
| 31 | Pipe | 1,931 | 7.2650 | 0.0640244 |
| 32 | Pipe | 1,931 | 7.2650 | 0.1920731 |
| 33 | Well 1 to Well 2 - 12" HDPE DR13.5 | 1,931 | 6.8286 | 27.0354544 |
| 34 | Pipe | 1,931 | 7.2650 | 0.0012805 |
| 35 | Pipe | 1,931 | 7.2650 | 1.0397569 |
| 36 | Pipe | 1,931 | 7.2650 | 0.0640244 |
| 37 | Pipe | 1,931 | 7.2650 | 0.1920731 |
| 38 | Pipe | 1,931 | 6.8286 | 0.7560194 |
| 39 | Well 2 to Well 3 - 20" HDPE DR13.5 | 3,862 | 5.5499 | 11.3071764 |
| 40 | Pipe | 1,931 | 7.2650 | 0.0012805 |
| 41 | Pipe | 1,931 | 7.2650 | 1.0397569 |
| 42 | Pipe | 1,931 | 7.2650 | 0.0640244 |
| 43 | Pipe | 1,931 | 7.2650 | 0.1920731 |
| 44 | Pipe | 1,931 | 6.8286 | 0.7560196 |
| 45 | Pipe | 0 | 0.0000 | 0.0000000 |
| 46 | Pipe | 0 | 0.0000 | 0.0000000 |
| 47 | Pipe | 0 | 0.0000 | 0.0000000 |
| 48 | Pipe | 0 | 0.0000 | 0.0000000 |
| 49 | Pipe | 0 | 0.0000 | 0.0000000 |
| 50 | Well 3 to Well 4 - 24" HDPE DR13.5 | 5,793 | 5.7817 | 9.8380571 |
| 51 | Pipe | 0 | 0.0000 | 0.0000000 |
| 52 | Pipe | 0 | 0.0000 | 0.0000000 |
| 53 | Pipe | 0 | 0.0000 | 0.0000000 |
| 54 | Pipe | 0 | 0.0000 | 0.0000000 |
| 55 | Pipe | 0 | 0.0000 | 0.0000000 |
| 56 | Well 4 to Well 5/6 Blend - 30" HDPE DR13.5 | 5,793 | 3.7002 | 1.6723998 |
| 57 | Pipe | 1,931 | 7.2650 | 0.0012807 |
| 58 | Pipe | 1,931 | 7.2650 | 1.0397569 |
| 59 | Pipe | 1,931 | 7.2650 | 0.0640244 |
| 60 | Pipe | 1,931 | 7.2650 | 0.1920731 |
| 61 | Pipe | 1,931 | 6.8286 | 0.7560153 |
| 62 | Well 6 to Well 5 - 12" HDPE DR13.5 | 1,931 | 6.8286 | 17.6770025 |

| Pipe | Name | Vol. Flow Rate (gal/min) | Velocity (feet/sec) | dH (feet) |
|---|---|---|---|---|
| 63 | Well 11 to Well 9 Blend - 20" HDPE DR13.5 | 1,931 | 2.2176 | 0.3103212 |
| 64 | North Wells to Desalter - 36" HDPE DR13.5 | 7,724 | 3.4261 | 1.2160755 |
| 65 | Pipe | 1,931 | 7.2650 | 0.0012807 |
| 66 | Pipe | 1,931 | 7.2650 | 1.0397569 |
| 67 | Pipe | 1,931 | 7.2650 | 0.0640244 |
| 68 | Pipe | 1,931 | 7.2650 | 0.1920731 |
| 70 | Pipe | 1,931 | 7.2650 | 0.0012804 |
| 71 | Pipe | 1,931 | 7.2650 | 1.0397569 |
| 72 | Pipe | 1,931 | 7.2650 | 0.0640244 |
| 73 | Pipe | 1,931 | 7.2650 | 0.1920731 |
| 75 | Pipe | 1,931 | 7.2650 | 0.0012809 |
| 76 | Pipe | 1,931 | 7.2650 | 1.0397569 |
| 77 | Pipe | 1,931 | 7.2650 | 0.0640244 |
| 78 | Pipe | 1,931 | 7.2650 | 0.1920731 |
| 79 | Pipe | 1,931 | 6.8286 | 0.7560195 |
| 80 | Pipe | 1,931 | 7.2650 | 0.0012801 |
| 81 | Pipe | 1,931 | 7.2650 | 1.0397569 |
| 82 | Pipe | 1,931 | 7.2650 | 0.0640244 |
| 83 | Pipe | 1,931 | 7.2650 | 0.1920731 |
| 84 | Pipe | 1,931 | 6.8286 | 0.7560194 |
| 85 | Pipe | 0 | 0.0000 | 0.0000000 |
| 86 | Pipe | 0 | 0.0000 | 0.0000000 |
| 87 | Pipe | 0 | 0.0000 | 0.0000000 |
| 88 | Pipe | 0 | 0.0000 | 0.0000000 |
| 89 | Pipe | 0 | 0.0000 | 0.0000000 |
| 90 | Pipe | 0 | 0.0000 | 0.0000000 |
| 91 | Pipe | 0 | 0.0000 | 0.0000000 |
| 92 | Pipe | 0 | 0.0000 | 0.0000000 |
| 93 | Pipe | 0 | 0.0000 | 0.0000000 |
| 94 | Pipe | 0 | 0.0000 | 0.0000000 |
| 95 | Well 7/8 to Well 9 - 20" HDPE DR13.5 | 3,862 | 5.5506 | 6.8830311 |
| 96 | Well 9 to Well 10 - 24" HDPE DR13.5 | 5,793 | 5.7817 | 11.5947870 |
| 98 | Well 12 to Desalter - 36" HDPE DR13.5 | 7,724 | 3.4261 | 1.3554621 |
| 100 | Well 10/11 to Well 12 - 36" HDPE DR13.5 | 7,724 | 3.4261 | 2.3635106 |
| 101 | Well 7 to Well 8 Blend - 12" HDPE DR13.5 | 1,931 | 6.8286 | 15.7225200 |
| 102 | Well 7 to Well 8 Blend - 12" HDPE DR13.5 | 1,931 | 6.8286 | 13.9028265 |
| 103 | Well 10 to Well 11 - 30" HDPE DR13.5 | 7,724 | 4.9337 | 0.1048668 |
| 104 | Pipe | 12,348 | 3.8921 | 0.8092790 |
| 105 | Pipe | 3,087 | 3.8921 | 0.3487453 |
| 106 | Pipe | 3,087 | 4.9259 | 1.1992354 |

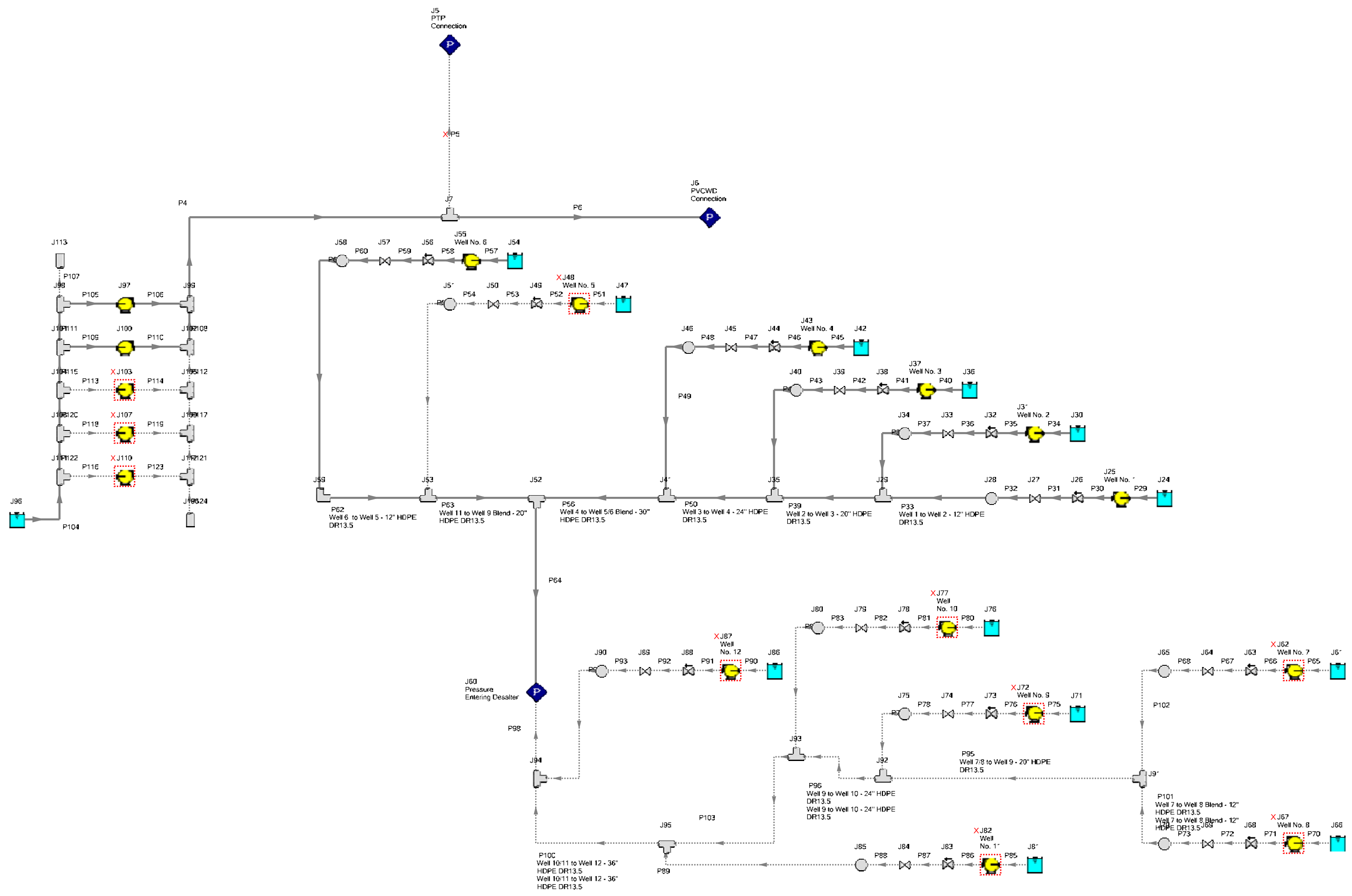
| Pipe | Name | Vol. Flow Rate (gal/min) | Velocity (feet/sec) | dH (feet) |
|---|---|---|---|---|
| 107 | Pipe | 0 | 0.0000 | 0.0000000 |
| 108 | Pipe | 9,261 | 2.9191 | 0.0074305 |
| 109 | Pipe | 3,087 | 3.8921 | 0.3487453 |
| 110 | Pipe | 3,087 | 4.9259 | 1.1992354 |
| 111 | Pipe | 3,087 | 0.9730 | 0.0009715 |
| 112 | Pipe | 6,174 | 1.9460 | 0.0035069 |
| 113 | Pipe | 3,087 | 3.8921 | 0.3487453 |
| 114 | Pipe | 3,087 | 4.9259 | 1.1992354 |
| 115 | Pipe | 6,174 | 1.9460 | 0.0035069 |
| 116 | Pipe | 0 | 0.0000 | 0.0000000 |
| 117 | Pipe | 3,087 | 0.9730 | 0.0009715 |
| 118 | Pipe | 3,087 | 3.8921 | 0.3487453 |
| 119 | Pipe | 3,087 | 4.9259 | 1.1992354 |
| 120 | Pipe | 9,261 | 2.9191 | 0.0074305 |
| 121 | Pipe | 0 | 0.0000 | 0.0000000 |
| 122 | Pipe | 12,348 | 3.8921 | 0.0126588 |
| 123 | Pipe | 0 | 0.0000 | 0.0000000 |
| 124 | Pipe | 0 | 0.0000 | 0.0000000 |

All Junction Table

| Jct | Name | Vol. Flow Rate Thru Jct (gal/min) | Mass Flow Rate Thru Jct (lbm/sec) | Loss Factor (K) | dH (feet) |
|---|---|---|---|---|---|
| 5 | PTP Connection | 0 | 0.0 | 0.0000 | 0.0000 |
| 6 | PVCWD Connection | 12,348 | 1,713.9 | 0.0000 | 0.0000 |
| 7 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 24 | Reservoir | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 25 | Well No. 1 | 1,931 | 268.0 | 0.0000 | -225.6302 |
| 26 | Check Valve | 1,931 | 268.0 | 0.4684 | 0.3842 |
| 27 | Valve | 1,931 | 268.0 | 0.8328 | 0.6831 |
| 28 | Branch | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 29 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 30 | Reservoir | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 31 | Well No. 2 | 1,931 | 268.0 | 0.0000 | -199.6296 |
| 32 | Check Valve | 1,931 | 268.0 | 0.4684 | 0.3842 |
| 33 | Valve | 1,931 | 268.0 | 0.8328 | 0.6831 |
| 34 | Branch | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 35 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 36 | Reservoir | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 37 | Well No. 3 | 1,931 | 268.0 | 0.0000 | -188.3640 |
| 38 | Check Valve | 1,931 | 268.0 | 0.4684 | 0.3842 |
| 39 | Valve | 1,931 | 268.0 | 0.8328 | 0.6831 |
| 40 | Branch | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 41 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 42 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X43 | Well No. 4 | 0 | 0.0 | 0.0000 | N/A |
| 44 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 45 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 46 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 47 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X48 | Well No. 5 | 0 | 0.0 | 0.0000 | N/A |
| 49 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 50 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 51 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 52 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 53 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 54 | Reservoir | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 55 | Well No. 6 | 1,931 | 268.0 | 0.0000 | -194.1538 |
| 56 | Check Valve | 1,931 | 268.0 | 0.4684 | 0.3842 |
| 57 | Valve | 1,931 | 268.0 | 0.8328 | 0.6831 |

| Jct | Name | Vol. Flow Rate Thru Jct (gal/min) | Mass Flow Rate Thru Jct (lbm/sec) | Loss Factor (K) | dH (feet) |
|---|---|---|---|---|---|
| 58 | Branch | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 59 | Bend | 1,931 | 268.0 | 0.1908 | 0.1382 |
| 60 | Pressure Entering Desalter | N/A | N/A | 0.0000 | 0.0000 |
| 61 | Reservoir | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 62 | Well No. 7 | 1,931 | 268.0 | 0.0000 | -210.7906 |
| 63 | Check Valve | 1,931 | 268.0 | 0.4684 | 0.3842 |
| 64 | Valve | 1,931 | 268.0 | 0.8328 | 0.6831 |
| 65 | Branch | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 66 | Reservoir | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 67 | Well No. 8 | 1,931 | 268.0 | 0.0000 | -212.6103 |
| 68 | Check Valve | 1,931 | 268.0 | 0.4684 | 0.3842 |
| 69 | Valve | 1,931 | 268.0 | 0.8328 | 0.6831 |
| 70 | Branch | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 71 | Reservoir | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 72 | Well No. 9 | 1,931 | 268.0 | 0.0000 | -191.0212 |
| 73 | Check Valve | 1,931 | 268.0 | 0.4684 | 0.3842 |
| 74 | Valve | 1,931 | 268.0 | 0.8328 | 0.6831 |
| 75 | Branch | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 76 | Reservoir | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 77 | Well No. 10 | 1,931 | 268.0 | 0.0000 | -179.1985 |
| 78 | Check Valve | 1,931 | 268.0 | 0.4684 | 0.3842 |
| 79 | Valve | 1,931 | 268.0 | 0.8328 | 0.6831 |
| 80 | Branch | 1,931 | 268.0 | 0.0000 | 0.0000 |
| 81 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X82 | Well No. 11 | 0 | 0.0 | 0.0000 | N/A |
| 83 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 84 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 85 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 86 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X87 | Well No. 12 | 0 | 0.0 | 0.0000 | N/A |
| 88 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 89 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 90 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 91 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 92 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 93 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 94 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 95 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 96 | Reservoir | 12,348 | 1,713.9 | 0.0000 | 0.0000 |
| 97 | Pump | 3,087 | 428.5 | 0.0000 | -123.2630 |

| Jct | Name | Vol. Flow Rate Thru Jct (gal/min) | Mass Flow Rate Thru Jct (lbm/sec) | Loss Factor (K) | dH (feet) |
|---|---|---|---|---|---|
| 98 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 99 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 100 | Pump | 3,087 | 428.5 | 0.0000 | -123.7482 |
| 101 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 102 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 103 | Pump | 3,087 | 428.5 | 0.0000 | -123.1512 |
| 104 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 105 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 106 | Dead End | 0 | 0.0 | 0.0000 | 0.0000 |
| 107 | Pump | 3,087 | 428.5 | 0.0000 | -123.8470 |
| 108 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 109 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| X110 | Pump | 0 | 0.0 | 0.0000 | N/A |
| 111 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 112 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 113 | Dead End | 0 | 0.0 | 0.0000 | 0.0000 |



Fathom 8 (Workspace)
5/30/2014
Page 1 of 1
CAROLLO\byallaly

```
General

Title: AFT Fathom Model
Analysis run on: 5/30/2014 4:38:47 PM
Application version: AFT Fathom Version 8 (2013.10.24)
Input File: C:\Users\byallaly\Desktop\UWCD Raw and Product Water Pumping.fth
Scenario: Base Scenario/10,000 AFY_Worst Water
Output File: C:\Users\byallaly\Desktop\UWCD Raw and Product Water Pumping_3.out

Execution Time= 0.11 seconds
Total Number Of Head/Pressure Iterations= 0
Total Number Of Flow Iterations= 2
Total Number Of Temperature Iterations= 0
Number Of Pipes= 95
Number Of Junctions= 93
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Temperature Tolerance= 0.0001 relative change
Flow Relaxation=  (Automatic)
Pressure Relaxation=  (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 22 deg. C
Density= 62.29622 lbm/ft3
Viscosity= 2.30822 lbm/hr-ft
Vapor Pressure= 0.38264 psia
Viscosity Model= Newtonian
Apply laminar and non-Newtonian correction to: Pipe Fittings & Losses, Junction K factors, Junction Special Losses, Junction
Polynomials
Corrections applied to the following junctions: Branch, Reservoir, Assigned Flow, Assigned Pressure, Area Change, Bend, Tee or
Wye, Control Valve, Spray Discharge, Relief Valve

Ambient Pressure (constant)= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300
Total Inflow= 14,759 gal/min
Total Outflow= 14,759 gal/min
Maximum Static Pressure is 87.94 psia at Pipe 33 Inlet
Minimum Static Pressure is 14.67 psia at Pipe 104 Inlet
Fixed Energy Cost = 0.0125 U.S. Dollars per kW-hr
The following cost databases were used:
Total of All Model Costs = 0  U.S. Dollars
```

Warnings

No Warnings

Pump Summary

| Jct | Name | Vol. Flow (gal/min) | dH (feet) | Overall Efficiency (Percent) | Speed (Percent) | Overall Power (hp) | NPSHA (feet) | NPSHR (feet) | Energy Cost (U.S. Dollars) |
|---|---|---|---|---|---|---|---|---|---|
| 25 | Well No. 1 | 1,717 | 216.8 | 100.0 | N/A | 93.90 | 39.08 | N/A | 0 |
| 31 | Well No. 2 | 1,717 | 195.8 | 100.0 | N/A | 84.81 | 40.08 | N/A | 0 |
| 37 | Well No. 3 | 1,717 | 186.7 | 100.0 | N/A | 80.87 | 40.08 | N/A | 0 |
| 43 | Well No. 4 | 1,717 | 178.6 | 100.0 | N/A | 77.36 | 42.08 | N/A | 0 |
| X48 | Well No. 5 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| 55 | Well No. 6 | 1,717 | 190.3 | 100.0 | N/A | 82.45 | 42.08 | N/A | 0 |
| X62 | Well No. 7 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X67 | Well No. 8 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X72 | Well No. 9 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X77 | Well No. 10 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X82 | Well No. 11 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X87 | Well No. 12 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| 97 | Pump | 3,087 | 154.5 | 100.0 | N/A | 120.38 | 40.17 | N/A | 0 |
| 100 | Pump | 3,087 | 155.0 | 100.0 | N/A | 120.71 | 40.14 | N/A | 0 |
| X103 | Pump | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X107 | Pump | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X110 | Pump | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |

Valve Summary

| Jct | Name | Valve Type | Vol. Flow (gal/min) | dH (feet) | P Static In (psia) | Cv | K | Valve State |
|---|---|---|---|---|---|---|---|---|
| 27 | Valve | REGULAR | 1,717 | 0.5401 | 83.02 | 3,550 | 0.8328 | Open |
| 33 | Valve | REGULAR | 1,717 | 0.5401 | 74.37 | 3,550 | 0.8328 | Open |
| 39 | Valve | REGULAR | 1,717 | 0.5401 | 70.44 | 3,550 | 0.8328 | Open |
| 45 | Valve | REGULAR | 1,717 | 0.5401 | 66.93 | 3,550 | 0.8328 | Open |
| 50 | Valve | REGULAR | 0 | N/A | 66.80 | N/A | N/A | Open |
| 57 | Valve | REGULAR | 1,717 | 0.5401 | 72.87 | 3,550 | 0.8328 | Open |
| 64 | Valve | REGULAR | 0 | N/A | 65.56 | N/A | N/A | Open |
| 69 | Valve | REGULAR | 0 | N/A | 66.86 | N/A | N/A | Open |
| 74 | Valve | REGULAR | 0 | N/A | 66.43 | N/A | N/A | Open |
| 79 | Valve | REGULAR | 0 | N/A | 68.16 | N/A | N/A | Open |
| 84 | Valve | REGULAR | 0 | N/A | 66.86 | N/A | N/A | Open |
| 89 | Valve | REGULAR | 0 | N/A | 66.86 | N/A | N/A | Open |
| 26 | Check Valve | CHECK | 1,717 | 0.2962 | 83.17 | 4,793 | 0.4568 | Open |
| 32 | Check Valve | CHECK | 1,717 | 0.2962 | 74.52 | 4,793 | 0.4568 | Open |
| 38 | Check Valve | CHECK | 1,717 | 0.2962 | 70.59 | 4,793 | 0.4568 | Open |
| 44 | Check Valve | CHECK | 1,717 | 0.2962 | 67.08 | 4,793 | 0.4568 | Open |
| 49 | Check Valve | CHECK | 0 | N/A | 66.80 | N/A | N/A | Open |
| 56 | Check Valve | CHECK | 1,717 | 0.2962 | 73.02 | 4,793 | 0.4568 | Open |
| 63 | Check Valve | CHECK | 0 | N/A | 65.56 | N/A | N/A | Open |
| 68 | Check Valve | CHECK | 0 | N/A | 66.86 | N/A | N/A | Open |
| 73 | Check Valve | CHECK | 0 | N/A | 66.43 | N/A | N/A | Open |
| 78 | Check Valve | CHECK | 0 | N/A | 68.16 | N/A | N/A | Open |
| 83 | Check Valve | CHECK | 0 | N/A | 66.86 | N/A | N/A | Open |
| 88 | Check Valve | CHECK | 0 | N/A | 66.86 | N/A | N/A | Open |

Reservoir Summary

| Jct | Name | Type | Liq. Height (feet) | Liq. Elevation (feet) | Surface Pressure (psia) | Liquid Volume (feet3) | Liquid Mass (lbm) | Net Vol. Flow (gal/min) | Net Mass Flow (lbm/sec) |
|---|---|---|---|---|---|---|---|---|---|
| 24 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,717 | -238.3 |
| 30 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,717 | -238.3 |
| 36 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,717 | -238.3 |
| 42 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,717 | -238.3 |
| 47 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 54 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,717 | -238.3 |
| 61 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 66 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 71 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 76 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 81 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 86 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 96 | Reservoir | Infinite | N/A | 20.00 | 14.70 | N/A | N/A | -6,174 | -856.9 |

Pipe Output Table

| Pipe | Name | Vol. Flow Rate (gal/min) | Velocity (feet/sec) | dH (feet) |
|---|---|---|---|---|
| 4 | Pipe | 6,174 | 4.3786 | 44.8662936 |
| X5 | Pipe | 0 | 0.0000 | 0.0000000 |
| 6 | Pipe | 6,174 | 4.3786 | 20.6001902 |
| 29 | Pipe | 1,717 | 6.4599 | 0.0010284 |
| 30 | Pipe | 1,717 | 6.4599 | 0.8316896 |
| 31 | Pipe | 1,717 | 6.4599 | 0.0514217 |
| 32 | Pipe | 1,717 | 6.4599 | 0.1542651 |
| 33 | Well 1 to Well 2 - 12" HDPE DR13.5 | 1,717 | 6.0719 | 21.8167310 |
| 34 | Pipe | 1,717 | 6.4599 | 0.0010285 |
| 35 | Pipe | 1,717 | 6.4599 | 0.8316896 |
| 36 | Pipe | 1,717 | 6.4599 | 0.0514217 |
| 37 | Pipe | 1,717 | 6.4599 | 0.1542651 |
| 38 | Pipe | 1,717 | 6.0719 | 0.6062272 |
| 39 | Well 2 to Well 3 - 20" HDPE DR13.5 | 3,434 | 4.9349 | 9.1220243 |
| 40 | Pipe | 1,717 | 6.4599 | 0.0010285 |
| 41 | Pipe | 1,717 | 6.4599 | 0.8316896 |
| 42 | Pipe | 1,717 | 6.4599 | 0.0514217 |
| 43 | Pipe | 1,717 | 6.4599 | 0.1542651 |
| 44 | Pipe | 1,717 | 6.0719 | 0.6062273 |
| 45 | Pipe | 1,717 | 6.4599 | 0.0010287 |
| 46 | Pipe | 1,717 | 6.4599 | 0.8316896 |
| 47 | Pipe | 1,717 | 6.4599 | 0.0514217 |
| 48 | Pipe | 1,717 | 6.4599 | 0.1542651 |
| 49 | Pipe | 1,717 | 6.0719 | 0.6062273 |
| 50 | Well 3 to Well 4 - 24" HDPE DR13.5 | 5,151 | 5.1410 | 7.9339072 |
| 51 | Pipe | 0 | 0.0000 | 0.0000000 |
| 52 | Pipe | 0 | 0.0000 | 0.0000000 |
| 53 | Pipe | 0 | 0.0000 | 0.0000000 |
| 54 | Pipe | 0 | 0.0000 | 0.0000000 |
| 55 | Pipe | 0 | 0.0000 | 0.0000000 |
| 56 | Well 4 to Well 5/6 Blend - 30" HDPE DR13.5 | 6,868 | 4.3869 | 2.2833119 |
| 57 | Pipe | 1,717 | 6.4599 | 0.0010287 |
| 58 | Pipe | 1,717 | 6.4599 | 0.8316896 |
| 59 | Pipe | 1,717 | 6.4599 | 0.0514217 |
| 60 | Pipe | 1,717 | 6.4599 | 0.1542651 |
| 61 | Pipe | 1,717 | 6.0719 | 0.6062235 |
| 62 | Well 6 to Well 5 - 12" HDPE DR13.5 | 1,717 | 6.0719 | 14.2647646 |

| Pipe | Name | Vol. Flow Rate (gal/min) | Velocity (feet/sec) | dH (feet) |
|---|---|---|---|---|
| 63 | Well 11 to Well 9 Blend - 20" HDPE DR13.5 | 1,717 | 1.9719 | 0.2507781 |
| 64 | North Wells to Desalter - 36" HDPE DR13.5 | 8,585 | 3.8080 | 1.4755265 |
| 65 | Pipe | 0 | 0.0000 | 0.0000000 |
| 66 | Pipe | 0 | 0.0000 | 0.0000000 |
| 67 | Pipe | 0 | 0.0000 | 0.0000000 |
| 68 | Pipe | 0 | 0.0000 | 0.0000000 |
| 70 | Pipe | 0 | 0.0000 | 0.0000000 |
| 71 | Pipe | 0 | 0.0000 | 0.0000000 |
| 72 | Pipe | 0 | 0.0000 | 0.0000000 |
| 73 | Pipe | 0 | 0.0000 | 0.0000000 |
| 75 | Pipe | 0 | 0.0000 | 0.0000000 |
| 76 | Pipe | 0 | 0.0000 | 0.0000000 |
| 77 | Pipe | 0 | 0.0000 | 0.0000000 |
| 78 | Pipe | 0 | 0.0000 | 0.0000000 |
| 79 | Pipe | 0 | 0.0000 | 0.0000000 |
| 80 | Pipe | 0 | 0.0000 | 0.0000000 |
| 81 | Pipe | 0 | 0.0000 | 0.0000000 |
| 82 | Pipe | 0 | 0.0000 | 0.0000000 |
| 83 | Pipe | 0 | 0.0000 | 0.0000000 |
| 84 | Pipe | 0 | 0.0000 | 0.0000000 |
| 85 | Pipe | 0 | 0.0000 | 0.0000000 |
| 86 | Pipe | 0 | 0.0000 | 0.0000000 |
| 87 | Pipe | 0 | 0.0000 | 0.0000000 |
| 88 | Pipe | 0 | 0.0000 | 0.0000000 |
| 89 | Pipe | 0 | 0.0000 | 0.0000000 |
| 90 | Pipe | 0 | 0.0000 | 0.0000000 |
| 91 | Pipe | 0 | 0.0000 | 0.0000000 |
| 92 | Pipe | 0 | 0.0000 | 0.0000000 |
| 93 | Pipe | 0 | 0.0000 | 0.0000000 |
| 94 | Pipe | 0 | 0.0000 | 0.0000000 |
| 95 | Well 7/8 to Well 9 - 20" HDPE DR13.5 | 0 | 0.0000 | 0.0000000 |
| 96 | Well 9 to Well 10 - 24" HDPE DR13.5 | 0 | 0.0000 | 0.0000000 |
| 98 | Well 12 to Desalter - 36" HDPE DR13.5 | 0 | 0.0000 | 0.0000000 |
| 100 | Well 10/11 to Well 12 - 36" HDPE DR13.5 | 0 | 0.0000 | 0.0000000 |
| 101 | Well 7 to Well 8 Blend - 12" HDPE DR13.5 | 0 | 0.0000 | 0.0000000 |
| 102 | Well 7 to Well 8 Blend - 12" HDPE DR13.5 | 0 | 0.0000 | 0.0000000 |
| 103 | Well 10 to Well 11 - 30" HDPE DR13.5 | 0 | 0.0000 | 0.0000000 |
| 104 | Pipe | 6,174 | 1.9460 | 0.2057422 |
| 105 | Pipe | 3,087 | 3.8921 | 0.3487453 |
| 106 | Pipe | 3,087 | 4.9259 | 1.1992354 |

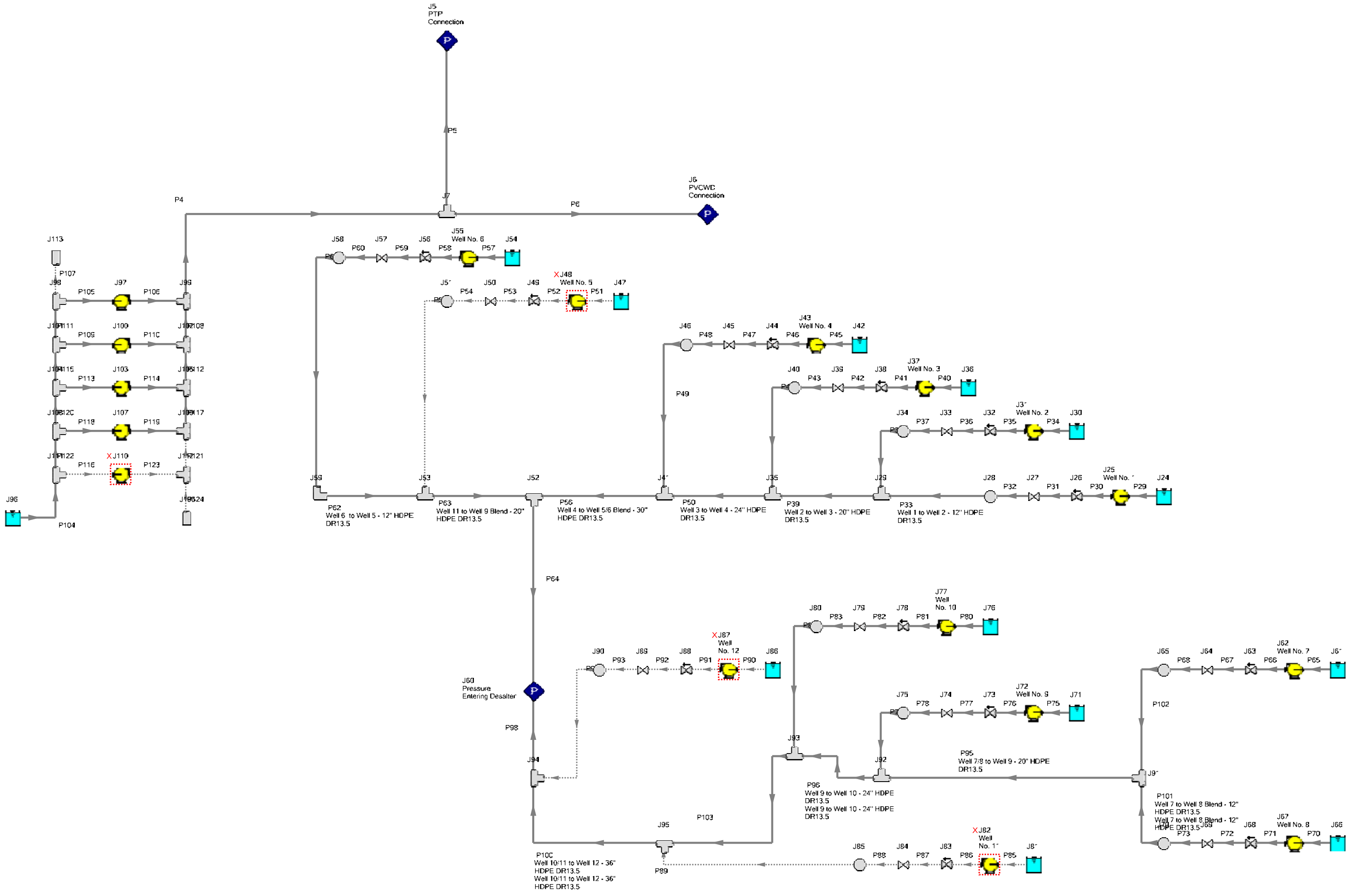
| Pipe | Name | Vol. Flow Rate (gal/min) | Velocity (feet/sec) | dH (feet) |
|---|---|---|---|---|
| 107 | Pipe | 0 | 0.0000 | 0.0000000 |
| 108 | Pipe | 3,087 | 0.9730 | 0.0009715 |
| 109 | Pipe | 3,087 | 3.8921 | 0.3487453 |
| 110 | Pipe | 3,087 | 4.9259 | 1.1992354 |
| 111 | Pipe | 3,087 | 0.9730 | 0.0009715 |
| 112 | Pipe | 0 | 0.0000 | 0.0000000 |
| 113 | Pipe | 0 | 0.0000 | 0.0000000 |
| 114 | Pipe | 0 | 0.0000 | 0.0000000 |
| 115 | Pipe | 6,174 | 1.9460 | 0.0035070 |
| 116 | Pipe | 0 | 0.0000 | 0.0000000 |
| 117 | Pipe | 0 | 0.0000 | 0.0000000 |
| 118 | Pipe | 0 | 0.0000 | 0.0000000 |
| 119 | Pipe | 0 | 0.0000 | 0.0000000 |
| 120 | Pipe | 6,174 | 1.9460 | 0.0035069 |
| 121 | Pipe | 0 | 0.0000 | 0.0000000 |
| 122 | Pipe | 6,174 | 1.9460 | 0.0035069 |
| 123 | Pipe | 0 | 0.0000 | 0.0000000 |
| 124 | Pipe | 0 | 0.0000 | 0.0000000 |

All Junction Table

| Jct | Name | Vol. Flow Rate Thru Jct (gal/min) | Mass Flow Rate Thru Jct (lbm/sec) | Loss Factor (K) | dH (feet) |
|---|---|---|---|---|---|
| 5 | PTP Connection | 0 | 0.0 | 0.0000 | 0.0000 |
| 6 | PVCWD Connection | 6,174 | 856.9 | 0.0000 | 0.0000 |
| 7 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 24 | Reservoir | 1,717 | 238.3 | 0.0000 | 0.0000 |
| 25 | Well No. 1 | 1,717 | 238.3 | 0.0000 | -216.7528 |
| 26 | Check Valve | 1,717 | 238.3 | 0.4568 | 0.2962 |
| 27 | Valve | 1,717 | 238.3 | 0.8328 | 0.5401 |
| 28 | Branch | 1,717 | 238.3 | 0.0000 | 0.0000 |
| 29 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 30 | Reservoir | 1,717 | 238.3 | 0.0000 | 0.0000 |
| 31 | Well No. 2 | 1,717 | 238.3 | 0.0000 | -195.7628 |
| 32 | Check Valve | 1,717 | 238.3 | 0.4568 | 0.2962 |
| 33 | Valve | 1,717 | 238.3 | 0.8328 | 0.5401 |
| 34 | Branch | 1,717 | 238.3 | 0.0000 | 0.0000 |
| 35 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 36 | Reservoir | 1,717 | 238.3 | 0.0000 | 0.0000 |
| 37 | Well No. 3 | 1,717 | 238.3 | 0.0000 | -186.6736 |
| 38 | Check Valve | 1,717 | 238.3 | 0.4568 | 0.2962 |
| 39 | Valve | 1,717 | 238.3 | 0.8328 | 0.5401 |
| 40 | Branch | 1,717 | 238.3 | 0.0000 | 0.0000 |
| 41 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 42 | Reservoir | 1,717 | 238.3 | 0.0000 | 0.0000 |
| 43 | Well No. 4 | 1,717 | 238.3 | 0.0000 | -178.5595 |
| 44 | Check Valve | 1,717 | 238.3 | 0.4568 | 0.2962 |
| 45 | Valve | 1,717 | 238.3 | 0.8328 | 0.5401 |
| 46 | Branch | 1,717 | 238.3 | 0.0000 | 0.0000 |
| 47 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X48 | Well No. 5 | 0 | 0.0 | 0.0000 | N/A |
| 49 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 50 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 51 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 52 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 53 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 54 | Reservoir | 1,717 | 238.3 | 0.0000 | 0.0000 |
| 55 | Well No. 6 | 1,717 | 238.3 | 0.0000 | -190.3046 |
| 56 | Check Valve | 1,717 | 238.3 | 0.4568 | 0.2962 |
| 57 | Valve | 1,717 | 238.3 | 0.8328 | 0.5401 |

| Jct | Name | Vol. Flow Rate Thru Jct (gal/min) | Mass Flow Rate Thru Jct (lbm/sec) | Loss Factor (K) | dH (feet) |
|---|---|---|---|---|---|
| 58 | Branch | 1,717 | 238.3 | 0.0000 | 0.0000 |
| 59 | Bend | 1,717 | 238.3 | 0.1908 | 0.1093 |
| 60 | Pressure Entering Desalter | N/A | N/A | 0.0000 | 0.0000 |
| 61 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X62 | Well No. 7 | 0 | 0.0 | 0.0000 | N/A |
| 63 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 64 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 65 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 66 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X67 | Well No. 8 | 0 | 0.0 | 0.0000 | N/A |
| 68 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 69 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 70 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 71 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X72 | Well No. 9 | 0 | 0.0 | 0.0000 | N/A |
| 73 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 74 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 75 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 76 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X77 | Well No. 10 | 0 | 0.0 | 0.0000 | N/A |
| 78 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 79 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 80 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 81 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X82 | Well No. 11 | 0 | 0.0 | 0.0000 | N/A |
| 83 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 84 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 85 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 86 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X87 | Well No. 12 | 0 | 0.0 | 0.0000 | N/A |
| 88 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 89 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 90 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 91 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 92 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 93 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 94 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 95 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 96 | Reservoir | 6,174 | 856.9 | 0.0000 | 0.0000 |
| 97 | Pump | 3,087 | 428.5 | 0.0000 | -154.5463 |

| Jct | Name | Vol. Flow Rate Thru Jct (gal/min) | Mass Flow Rate Thru Jct (lbm/sec) | Loss Factor (K) | dH (feet) |
|---|---|---|---|---|---|
| 98 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 99 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 100 | Pump | 3,087 | 428.5 | 0.0000 | -154.9698 |
| 101 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 102 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| X103 | Pump | 0 | 0.0 | 0.0000 | N/A |
| 104 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 105 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 106 | Dead End | 0 | 0.0 | 0.0000 | 0.0000 |
| X107 | Pump | 0 | 0.0 | 0.0000 | N/A |
| 108 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 109 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| X110 | Pump | 0 | 0.0 | 0.0000 | N/A |
| 111 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 112 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 113 | Dead End | 0 | 0.0 | 0.0000 | 0.0000 |



Fathom 8 (Workspace)
5/30/2014
Page 1 of 1
CAROLLO\byallaly

## General

```
Title: AFT Fathom Model
Analysis run on: 5/30/2014 4:40:15 PM
Application version: AFT Fathom Version 8 (2013.10.24)
Input File: C:\Users\byallaly\Desktop\UWCD Raw and Product Water Pumping.fth
Scenario: Base Scenario/20,000 AFY_Worst Water
Output File: C:\Users\byallaly\Desktop\UWCD Raw and Product Water Pumping_4.out

Execution Time= 0.13 seconds
Total Number Of Head/Pressure Iterations= 51
Total Number Of Flow Iterations= 5
Total Number Of Temperature Iterations= 0
Number Of Pipes= 95
Number Of Junctions= 93
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Temperature Tolerance= 0.0001 relative change
Flow Relaxation=  (Automatic)
Pressure Relaxation=  (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 22 deg. C
Density= 62.29622 lbm/ft3
Viscosity= 2.30822 lbm/hr-ft
Vapor Pressure= 0.38264 psia
Viscosity Model= Newtonian
Apply laminar and non-Newtonian correction to: Pipe Fittings & Losses, Junction K factors, Junction Special Losses, Junction
Polynomials
Corrections applied to the following junctions: Branch, Reservoir, Assigned Flow, Assigned Pressure, Area Change, Bend, Tee or
Wye, Control Valve, Spray Discharge, Relief Valve

Ambient Pressure (constant)= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300
Total Inflow= 29,511 gal/min
Total Outflow= 29,511 gal/min
Maximum Static Pressure is 91.85 psia at Pipe 33 Inlet
Minimum Static Pressure is 14.59 psia at Pipe 104 Inlet
Fixed Energy Cost = 0.0125 U.S. Dollars per kW-hr
The following cost databases were used:
Total of All Model Costs = 0  U.S. Dollars
```

Warnings

No Warnings

Pump Summary

| Jct | Name | Vol. Flow (gal/min) | dH (feet) | Overall Efficiency (Percent) | Speed (Percent) | Overall Power (hp) | NPSHA (feet) | NPSHR (feet) | Energy Cost (U.S. Dollars) |
|---|---|---|---|---|---|---|---|---|---|
| 25 | Well No. 1 | 1,907 | 226.4 | 100.0 | N/A | 108.92 | 39.08 | N/A | 0 |
| 31 | Well No. 2 | 1,907 | 200.9 | 100.0 | N/A | 96.69 | 40.08 | N/A | 0 |
| 37 | Well No. 3 | 1,907 | 189.9 | 100.0 | N/A | 91.39 | 40.08 | N/A | 0 |
| 43 | Well No. 4 | 1,907 | 180.1 | 100.0 | N/A | 86.66 | 42.08 | N/A | 0 |
| X48 | Well No. 5 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| 55 | Well No. 6 | 1,907 | 194.3 | 100.0 | N/A | 93.49 | 42.08 | N/A | 0 |
| 62 | Well No. 7 | 1,907 | 209.9 | 100.0 | N/A | 101.00 | 42.08 | N/A | 0 |
| 67 | Well No. 8 | 1,907 | 211.7 | 100.0 | N/A | 101.85 | 45.08 | N/A | 0 |
| 72 | Well No. 9 | 1,907 | 190.6 | 100.0 | N/A | 91.70 | 44.08 | N/A | 0 |
| 77 | Well No. 10 | 1,907 | 179.0 | 100.0 | N/A | 86.14 | 48.08 | N/A | 0 |
| X82 | Well No. 11 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| X87 | Well No. 12 | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| 97 | Pump | 3,087 | 117.9 | 100.0 | N/A | 91.82 | 39.27 | N/A | 0 |
| 100 | Pump | 3,087 | 118.4 | 100.0 | N/A | 92.20 | 39.24 | N/A | 0 |
| 103 | Pump | 3,087 | 117.8 | 100.0 | N/A | 91.73 | 39.53 | N/A | 0 |
| 107 | Pump | 3,087 | 118.5 | 100.0 | N/A | 92.28 | 39.22 | N/A | 0 |
| X110 | Pump | 0 | N/A | N/A | 0 | N/A | N/A | N/A | 0 |

Valve Summary

| Jct | Name | Valve Type | Vol. Flow (gal/min) | dH (feet) | P Static In (psia) | Cv | K | Valve State |
|---|---|---|---|---|---|---|---|---|
| 27 | Valve | REGULAR | 1,907 | 0.6662 | 86.99 | 3,550 | 0.8328 | Open |
| 33 | Valve | REGULAR | 1,907 | 0.6662 | 76.43 | 3,550 | 0.8328 | Open |
| 39 | Valve | REGULAR | 1,907 | 0.6662 | 71.66 | 3,550 | 0.8328 | Open |
| 45 | Valve | REGULAR | 1,907 | 0.6662 | 67.41 | 3,550 | 0.8328 | Open |
| 50 | Valve | REGULAR | 0 | N/A | 66.98 | N/A | N/A | Open |
| 57 | Valve | REGULAR | 1,907 | 0.6662 | 74.42 | 3,550 | 0.8328 | Open |
| 64 | Valve | REGULAR | 1,907 | 0.6662 | 81.16 | 3,550 | 0.8328 | Open |
| 69 | Valve | REGULAR | 1,907 | 0.6662 | 83.23 | 3,550 | 0.8328 | Open |
| 74 | Valve | REGULAR | 1,907 | 0.6662 | 73.67 | 3,550 | 0.8328 | Open |
| 79 | Valve | REGULAR | 1,907 | 0.6662 | 70.40 | 3,550 | 0.8328 | Open |
| 84 | Valve | REGULAR | 0 | N/A | 68.43 | N/A | N/A | Open |
| 89 | Valve | REGULAR | 0 | N/A | 67.43 | N/A | N/A | Open |
| 26 | Check Valve | CHECK | 1,907 | 0.3738 | 87.18 | 4,739 | 0.4672 | Open |
| 32 | Check Valve | CHECK | 1,907 | 0.3738 | 76.61 | 4,739 | 0.4672 | Open |
| 38 | Check Valve | CHECK | 1,907 | 0.3738 | 71.85 | 4,739 | 0.4672 | Open |
| 44 | Check Valve | CHECK | 1,907 | 0.3738 | 67.59 | 4,739 | 0.4672 | Open |
| 49 | Check Valve | CHECK | 0 | N/A | 66.98 | N/A | N/A | Open |
| 56 | Check Valve | CHECK | 1,907 | 0.3738 | 74.61 | 4,739 | 0.4672 | Open |
| 63 | Check Valve | CHECK | 1,907 | 0.3738 | 81.35 | 4,739 | 0.4672 | Open |
| 68 | Check Valve | CHECK | 1,907 | 0.3738 | 83.42 | 4,739 | 0.4672 | Open |
| 73 | Check Valve | CHECK | 1,907 | 0.3738 | 73.86 | 4,739 | 0.4672 | Open |
| 78 | Check Valve | CHECK | 1,907 | 0.3738 | 70.59 | 4,739 | 0.4672 | Open |
| 83 | Check Valve | CHECK | 0 | N/A | 68.43 | N/A | N/A | Open |
| 88 | Check Valve | CHECK | 0 | N/A | 67.43 | N/A | N/A | Open |

Reservoir Summary

| Jct | Name | Type | Liq. Height (feet) | Liq. Elevation (feet) | Surface Pressure (psia) | Liquid Volume (feet3) | Liquid Mass (lbm) | Net Vol. Flow (gal/min) | Net Mass Flow (lbm/sec) |
|---|---|---|---|---|---|---|---|---|---|
| 24 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,907 | -264.7 |
| 30 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,907 | -264.7 |
| 36 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,907 | -264.7 |
| 42 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,907 | -264.7 |
| 47 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 54 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,907 | -264.7 |
| 61 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,907 | -264.7 |
| 66 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,907 | -264.7 |
| 71 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,907 | -264.7 |
| 76 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | -1,907 | -264.7 |
| 81 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 86 | Reservoir | Infinite | N/A | -40.00 | 14.70 | N/A | N/A | 0 | 0.0 |
| 96 | Reservoir | Infinite | N/A | 20.00 | 14.70 | N/A | N/A | -12,348 | -1,713.9 |

Pipe Output Table

| Pipe | Name | Vol. Flow Rate (gal/min) | Velocity (feet/sec) | dH (feet) |
|---|---|---|---|---|
| 4 | Pipe | 12,348 | 3.8921 | 22.7969367 |
| 5 | Pipe | 3,926 | 1.2375 | 0.8097693 |
| 6 | Pipe | 8,422 | 2.6546 | 5.1676385 |
| 29 | Pipe | 1,907 | 7.1747 | 0.0012509 |
| 30 | Pipe | 1,907 | 7.1747 | 1.0153057 |
| 31 | Pipe | 1,907 | 7.1747 | 0.0625456 |
| 32 | Pipe | 1,907 | 7.1747 | 0.1876368 |
| 33 | Well 1 to Well 2 - 12" HDPE DR13.5 | 1,907 | 6.7438 | 26.4246952 |
| 34 | Pipe | 1,907 | 7.1747 | 0.0012510 |
| 35 | Pipe | 1,907 | 7.1747 | 1.0153057 |
| 36 | Pipe | 1,907 | 7.1747 | 0.0625456 |
| 37 | Pipe | 1,907 | 7.1747 | 0.1876368 |
| 38 | Pipe | 1,907 | 6.7438 | 0.7384383 |
| 39 | Well 2 to Well 3 - 20" HDPE DR13.5 | 3,814 | 5.4809 | 11.0514290 |
| 40 | Pipe | 1,907 | 7.1747 | 0.0012510 |
| 41 | Pipe | 1,907 | 7.1747 | 1.0153057 |
| 42 | Pipe | 1,907 | 7.1747 | 0.0625456 |
| 43 | Pipe | 1,907 | 7.1747 | 0.1876368 |
| 44 | Pipe | 1,907 | 6.7438 | 0.7384384 |
| 45 | Pipe | 1,907 | 7.1747 | 0.0012511 |
| 46 | Pipe | 1,907 | 7.1747 | 1.0153057 |
| 47 | Pipe | 1,907 | 7.1747 | 0.0625456 |
| 48 | Pipe | 1,907 | 7.1747 | 0.1876368 |
| 49 | Pipe | 1,907 | 6.7438 | 0.7384383 |
| 50 | Well 3 to Well 4 - 24" HDPE DR13.5 | 5,721 | 5.7099 | 9.6151748 |
| 51 | Pipe | 0 | 0.0000 | 0.0000000 |
| 52 | Pipe | 0 | 0.0000 | 0.0000000 |
| 53 | Pipe | 0 | 0.0000 | 0.0000000 |
| 54 | Pipe | 0 | 0.0000 | 0.0000000 |
| 55 | Pipe | 0 | 0.0000 | 0.0000000 |
| 56 | Well 4 to Well 5/6 Blend - 30" HDPE DR13.5 | 7,628 | 4.8723 | 2.7672518 |
| 57 | Pipe | 1,907 | 7.1747 | 0.0012511 |
| 58 | Pipe | 1,907 | 7.1747 | 1.0153057 |
| 59 | Pipe | 1,907 | 7.1747 | 0.0625456 |
| 60 | Pipe | 1,907 | 7.1747 | 0.1876368 |
| 61 | Pipe | 1,907 | 6.7438 | 0.7384382 |
| 62 | Well 6 to Well 5 - 12" HDPE DR13.5 | 1,907 | 6.7438 | 17.2776857 |

| Pipe | Name | Vol. Flow Rate (gal/min) | Velocity (feet/sec) | dH (feet) |
|---|---|---|---|---|
| 63 | Well 11 to Well 9 Blend - 20" HDPE DR13.5 | 1,907 | 2.1901 | 0.3033314 |
| 64 | North Wells to Desalter - 36" HDPE DR13.5 | 9,535 | 4.2294 | 1.7882675 |
| 65 | Pipe | 1,907 | 7.1747 | 0.0012511 |
| 66 | Pipe | 1,907 | 7.1747 | 1.0153057 |
| 67 | Pipe | 1,907 | 7.1747 | 0.0625456 |
| 68 | Pipe | 1,907 | 7.1747 | 0.1876368 |
| 70 | Pipe | 1,907 | 7.1747 | 0.0012509 |
| 71 | Pipe | 1,907 | 7.1747 | 1.0153057 |
| 72 | Pipe | 1,907 | 7.1747 | 0.0625456 |
| 73 | Pipe | 1,907 | 7.1747 | 0.1876368 |
| 75 | Pipe | 1,907 | 7.1747 | 0.0012513 |
| 76 | Pipe | 1,907 | 7.1747 | 1.0153057 |
| 77 | Pipe | 1,907 | 7.1747 | 0.0625456 |
| 78 | Pipe | 1,907 | 7.1747 | 0.1876368 |
| 79 | Pipe | 1,907 | 6.7438 | 0.7384383 |
| 80 | Pipe | 1,907 | 7.1747 | 0.0012506 |
| 81 | Pipe | 1,907 | 7.1747 | 1.0153057 |
| 82 | Pipe | 1,907 | 7.1747 | 0.0625456 |
| 83 | Pipe | 1,907 | 7.1747 | 0.1876368 |
| 84 | Pipe | 1,907 | 6.7438 | 0.7384382 |
| 85 | Pipe | 0 | 0.0000 | 0.0000000 |
| 86 | Pipe | 0 | 0.0000 | 0.0000000 |
| 87 | Pipe | 0 | 0.0000 | 0.0000000 |
| 88 | Pipe | 0 | 0.0000 | 0.0000000 |
| 89 | Pipe | 0 | 0.0000 | 0.0000000 |
| 90 | Pipe | 0 | 0.0000 | 0.0000000 |
| 91 | Pipe | 0 | 0.0000 | 0.0000000 |
| 92 | Pipe | 0 | 0.0000 | 0.0000000 |
| 93 | Pipe | 0 | 0.0000 | 0.0000000 |
| 94 | Pipe | 0 | 0.0000 | 0.0000000 |
| 95 | Well 7/8 to Well 9 - 20" HDPE DR13.5 | 3,814 | 5.4816 | 6.7269729 |
| 96 | Well 9 to Well 10 - 24" HDPE DR13.5 | 5,721 | 5.7099 | 11.3314816 |
| 98 | Well 12 to Desalter - 36" HDPE DR13.5 | 7,628 | 3.3835 | 1.3247180 |
| 100 | Well 10/11 to Well 12 - 36" HDPE DR13.5 | 7,628 | 3.3835 | 2.3098418 |
| 101 | Well 7 to Well 8 Blend - 12" HDPE DR13.5 | 1,907 | 6.7438 | 15.3665173 |
| 102 | Well 7 to Well 8 Blend - 12" HDPE DR13.5 | 1,907 | 6.7438 | 13.5879313 |
| 103 | Well 10 to Well 11 - 30" HDPE DR13.5 | 7,628 | 4.8723 | 0.1024908 |
| 104 | Pipe | 12,348 | 3.8921 | 0.8092790 |
| 105 | Pipe | 3,087 | 3.8921 | 0.3487453 |
| 106 | Pipe | 3,087 | 4.9259 | 1.1992354 |

| Pipe | Name | Vol. Flow Rate (gal/min) | Velocity (feet/sec) | dH (feet) |
|---|---|---|---|---|
| 107 | Pipe | 0 | 0.0000 | 0.0000000 |
| 108 | Pipe | 9,261 | 2.9191 | 0.0074305 |
| 109 | Pipe | 3,087 | 3.8921 | 0.3487453 |
| 110 | Pipe | 3,087 | 4.9259 | 1.1992354 |
| 111 | Pipe | 3,087 | 0.9730 | 0.0009715 |
| 112 | Pipe | 6,174 | 1.9460 | 0.0035069 |
| 113 | Pipe | 3,087 | 3.8921 | 0.3487453 |
| 114 | Pipe | 3,087 | 4.9259 | 1.1992354 |
| 115 | Pipe | 6,174 | 1.9460 | 0.0035069 |
| 116 | Pipe | 0 | 0.0000 | 0.0000000 |
| 117 | Pipe | 3,087 | 0.9730 | 0.0009715 |
| 118 | Pipe | 3,087 | 3.8921 | 0.3487453 |
| 119 | Pipe | 3,087 | 4.9259 | 1.1992354 |
| 120 | Pipe | 9,261 | 2.9191 | 0.0074305 |
| 121 | Pipe | 0 | 0.0000 | 0.0000000 |
| 122 | Pipe | 12,348 | 3.8921 | 0.0126588 |
| 123 | Pipe | 0 | 0.0000 | 0.0000000 |
| 124 | Pipe | 0 | 0.0000 | 0.0000000 |

All Junction Table

| Jct | Name | Vol. Flow Rate Thru Jct (gal/min) | Mass Flow Rate Thru Jct (lbm/sec) | Loss Factor (K) | dH (feet) |
|---|---|---|---|---|---|
| 5 | PTP Connection | 3,926 | 544.9 | 0.0000 | 0.0000 |
| 6 | PVCWD Connection | 8,422 | 1,169.0 | 0.0000 | 0.0000 |
| 7 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 24 | Reservoir | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 25 | Well No. 1 | 1,907 | 264.7 | 0.0000 | -226.3566 |
| 26 | Check Valve | 1,907 | 264.7 | 0.4672 | 0.3738 |
| 27 | Valve | 1,907 | 264.7 | 0.8328 | 0.6662 |
| 28 | Branch | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 29 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 30 | Reservoir | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 31 | Well No. 2 | 1,907 | 264.7 | 0.0000 | -200.9423 |
| 32 | Check Valve | 1,907 | 264.7 | 0.4672 | 0.3738 |
| 33 | Valve | 1,907 | 264.7 | 0.8328 | 0.6662 |
| 34 | Branch | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 35 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 36 | Reservoir | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 37 | Well No. 3 | 1,907 | 264.7 | 0.0000 | -189.9314 |
| 38 | Check Valve | 1,907 | 264.7 | 0.4672 | 0.3738 |
| 39 | Valve | 1,907 | 264.7 | 0.8328 | 0.6662 |
| 40 | Branch | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 41 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 42 | Reservoir | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 43 | Well No. 4 | 1,907 | 264.7 | 0.0000 | -180.0939 |
| 44 | Check Valve | 1,907 | 264.7 | 0.4672 | 0.3738 |
| 45 | Valve | 1,907 | 264.7 | 0.8328 | 0.6662 |
| 46 | Branch | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 47 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X48 | Well No. 5 | 0 | 0.0 | 0.0000 | N/A |
| 49 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 50 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 51 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 52 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 53 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 54 | Reservoir | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 55 | Well No. 6 | 1,907 | 264.7 | 0.0000 | -194.3068 |
| 56 | Check Valve | 1,907 | 264.7 | 0.4672 | 0.3738 |
| 57 | Valve | 1,907 | 264.7 | 0.8328 | 0.6662 |

| Jct | Name | Vol. Flow Rate Thru Jct (gal/min) | Mass Flow Rate Thru Jct (lbm/sec) | Loss Factor (K) | dH (feet) |
|---|---|---|---|---|---|
| 58 | Branch | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 59 | Bend | 1,907 | 264.7 | 0.1908 | 0.1348 |
| 60 | Pressure Entering Desalter | N/A | N/A | 0.0000 | 0.0000 |
| 61 | Reservoir | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 62 | Well No. 7 | 1,907 | 264.7 | 0.0000 | -209.8959 |
| 63 | Check Valve | 1,907 | 264.7 | 0.4672 | 0.3738 |
| 64 | Valve | 1,907 | 264.7 | 0.8328 | 0.6662 |
| 65 | Branch | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 66 | Reservoir | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 67 | Well No. 8 | 1,907 | 264.7 | 0.0000 | -211.6745 |
| 68 | Check Valve | 1,907 | 264.7 | 0.4672 | 0.3738 |
| 69 | Valve | 1,907 | 264.7 | 0.8328 | 0.6662 |
| 70 | Branch | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 71 | Reservoir | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 72 | Well No. 9 | 1,907 | 264.7 | 0.0000 | -190.5735 |
| 73 | Check Valve | 1,907 | 264.7 | 0.4672 | 0.3738 |
| 74 | Valve | 1,907 | 264.7 | 0.8328 | 0.6662 |
| 75 | Branch | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 76 | Reservoir | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 77 | Well No. 10 | 1,907 | 264.7 | 0.0000 | -179.0197 |
| 78 | Check Valve | 1,907 | 264.7 | 0.4672 | 0.3738 |
| 79 | Valve | 1,907 | 264.7 | 0.8328 | 0.6662 |
| 80 | Branch | 1,907 | 264.7 | 0.0000 | 0.0000 |
| 81 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X82 | Well No. 11 | 0 | 0.0 | 0.0000 | N/A |
| 83 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 84 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 85 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 86 | Reservoir | 0 | 0.0 | 0.0000 | 0.0000 |
| X87 | Well No. 12 | 0 | 0.0 | 0.0000 | N/A |
| 88 | Check Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 89 | Valve | 0 | 0.0 | 0.0000 | 0.0000 |
| 90 | Branch | 0 | 0.0 | 0.0000 | 0.0000 |
| 91 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 92 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 93 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 94 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 95 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 96 | Reservoir | 12,348 | 1,713.9 | 0.0000 | 0.0000 |
| 97 | Pump | 3,087 | 428.5 | 0.0000 | -117.8860 |

| Jct | Name | Vol. Flow Rate Thru Jct (gal/min) | Mass Flow Rate Thru Jct (lbm/sec) | Loss Factor (K) | dH (feet) |
|---|---|---|---|---|---|
| 98 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 99 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 100 | Pump | 3,087 | 428.5 | 0.0000 | -118.3712 |
| 101 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 102 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 103 | Pump | 3,087 | 428.5 | 0.0000 | -117.7742 |
| 104 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 105 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 106 | Dead End | 0 | 0.0 | 0.0000 | 0.0000 |
| 107 | Pump | 3,087 | 428.5 | 0.0000 | -118.4700 |
| 108 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 109 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| X110 | Pump | 0 | 0.0 | 0.0000 | N/A |
| 111 | Tee or Wye | N/A | N/A | See Mult. Losses | See Mult. Losses |
| 112 | Tee or Wye | N/A | N/A | See Mult. Losses | 0.0000 |
| 113 | Dead End | 0 | 0.0 | 0.0000 | 0.0000 |

# APPENDIX B – SCALE INHIBITOR PROJECTIONS

## Project Details

Project: South Oxnard Plain Desalter
Permeate Flowrate: 6180USGPM This is split into 5 trains of 1236.0USGPM
System Recovery: 80%

## Antiscalant

Vitec 4000 is the selected product at a dose of 3.00mg/l. Assuming the plant operates continuously, then this will require 101385lb of antiscalant per year. This may be supplied in 41 x 2500lb Totes, 203 x 500lb Drums, or 2253 x 45lb Pails.

## Chemical Cleaning

The chemical cleaning calculation has not been completed for this project.

## Biocide

No biocide has been selected for this system. It is always recommended that a biocide injection point be included to allow for the retrofit of a biocide system at a later date.

## Coagulant

No coagulant has been selected for this system. It is always recommended that a coagulant injection point be included to allow for the retrofit of a coagulant system at a later date.

## Dechlorination

No dechlorination has been selected for this system.

# Avista Advisor

## Project Details

| | |
|---|---|
| Project: | South Oxnard Plain Desalter |
| Permeate Flowrate: | 6180USGPM  This is split into 5 trains of 1236.0USGPM |
| System Recovery: | 80% |

## Antiscalant Projection

The projection is based on the following feed water analysis. The adjusted feed is the analysis after pH correction, and any ions have been added to balance the analysis. The concentrate analysis has been calculated based on the adjusted feed, using typical rejections of a High Rejection polyamide membrane.

| Ion | Feed Water | Adjusted Feed | Concentrate | |
|---|---|---|---|---|
| Sodium | 1077.00 | 1078.66 | 5342.96 | mg/l |
| Potassium | 19.10 | 19.10 | 94.35 | mg/l |
| Calcium | 810.00 | 810.00 | 4044.13 | mg/l |
| Magnesium | 303.00 | 303.00 | 1512.32 | mg/l |
| Iron | 0.00 | 0.00 | 0.00 | mg/l |
| Manganese | 0.00 | 0.00 | 0.00 | mg/l |
| Barium | 0.04 | 0.04 | 0.20 | mg/l |
| Strontium | 4.80 | 4.80 | 23.97 | mg/l |
| Aluminium | 0.00 | 0.00 | 0.00 | mg/l |
| Chloride | 3257.00 | 3257.00 | 16148.71 | mg/l |
| Sulfate | 855.00 | 901.96 | 4503.28 | mg/l |
| Bicarbonate | 193.00 | 133.75 | 657.33 | mg/l |
| Nitrate | 1.20 | 1.20 | 5.76 | mg/l |
| Fluoride | 0.40 | 0.40 | 1.98 | mg/l |
| Phosphate | 0.00 | 0.00 | 0.00 | mg/l |
| Silica | 31.70 | 31.70 | 157.12 | mg/l |
| CO2 | 22.21 | 82.65 | 82.65 | mg/l |
| TDS | | 6541.61 | 32492.11 | |
| pH | 7.13 | 6.40 | 7.09 | |

Water Source: Well Water

Water Temperature: 18.9º C

## Product Choice

| | |
|---|---|
| Vitec Choice: | Vitec 4000 |
| Dosage: | 3.00mg/l |
| Usage: | 277.77 lb per day. |

There is one dosing pump and chemical tank per membrane train.
With 5 trains, each pump will deliver 5.80USGPD

## Application

Dosed Solution Strength: 100%

Pump Rate: 28.98USGPD
76.24ml/m

## pH Correction

| | |
|---|---|
| Chemical choice: | Sulfuric acid |
| Dosage: | 47.45ppm 100% H2SO4 |

## Project Details

| | |
|---|---|
| Project: | South Oxnard Plain Desalter |
| Permeate Flowrate: | 6180USGPM This is split into 5 trains of 1236.0USGPM |
| System Recovery: | 80% |

## Scaling Potential.

### Stiff and Davies Index (S&DI)

The reject stream has a S&DI of 0.77.
Vitec 4000 has a limit of 3.00

### Calcium Carbonate Precipitation Potential (CCPP)

The concentrate has a CCPP of 334mg/l.
This is within the limits of Vitec 4000.

### Calcium Sulfate

The concentrate has a calcium sulphate saturation of 319.94%.
This is within the limits of Vitec 4000.

### Barium Sulfate

The concentrate has a barium sulphate saturation of 1200.50%.
This is within the limits of Vitec 4000.

### Strontium Sulfate

The concentrate has a strontium sulphate saturation of 76.23%.
This is within the limits of Vitec 4000.

### Calcium Fluoride

The concentrate has a calcium fluoride saturation of 370.84%.
This is within the limits of Vitec 4000.

### Silica

The concentrate has a silica level of 157.12mg/l.
This is within the limits of Vitec 4000.

### Magnesium Hydroxide

The concentrate has a magnesium hydroxide saturation of 0.00%.

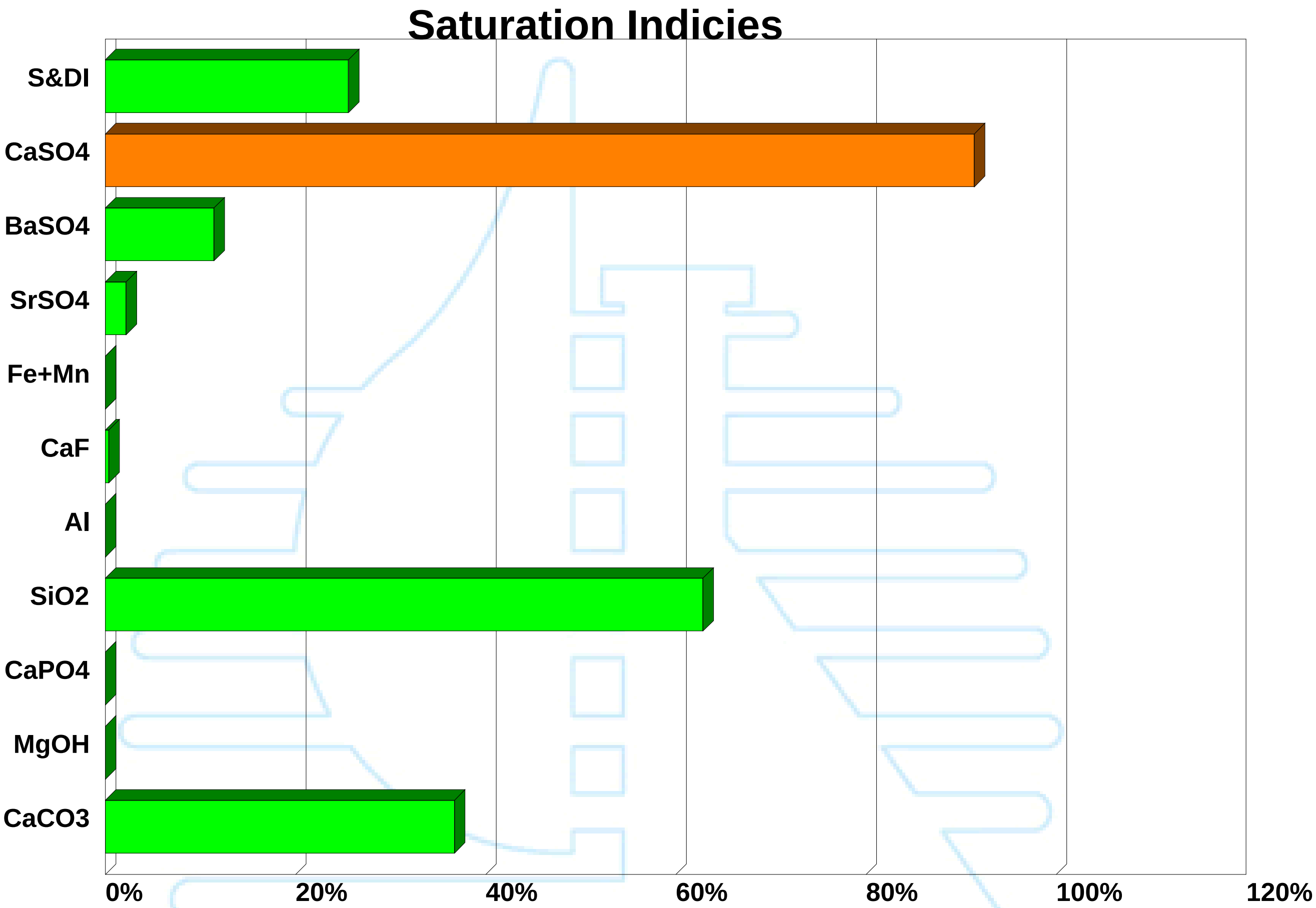
### Calcium Phosphate

No phosphate was included in the feed water analysis.

# Avista Advisor

## Project Details

| | |
|---|---|
| Project: | South Oxnard Plain Desalter |
| Permeate Flowrate: | 6180USGPM This is split into 5 trains of 1236.0USGPM |
| System Recovery: | 80% |



## Product Choice

| | |
|---|---|
| Vitec Choice: | Vitec 4000 |
| Dosage: | 3.00mg/l |
| Usage: | 277.77 lb per day. |

There is one dosing pump and chemical tank per membrane train.
With 5 trains, each pump will deliver 5.80USGPD

## Application

Dosed Solution Strength: 100%
Pump Rate: 28.98USGPD
76.24ml/m

## pH Correction

| | |
|---|---|
| Chemical choice: | Sulfuric acid |
| Dosage: | 47.45ppm 100% $H_2SO_4$ |

# Avista Advisor

## Project Details

| | |
|---|---|
| Project: | South Oxnard Plain Desalter |
| Permeate Flowrate: | 6180USGPM  This is split into 5 trains of 1236.0USGPM |
| System Recovery: | 72% |

## Antiscalant

Vitec 4000 is the selected product at a dose of 5.20mg/l. Assuming the plant operates continuously, then this will require 195104lb of antiscalant per year. This may be supplied in 79 x 2500lb Totes, 391 x 500lb Drums,  or 4336 x 45lb Pails.

## Chemical Cleaning

The chemical cleaning calculation has not been completed for this project.

## Biocide

No biocide has been selected for this system. It is always recommended that a biocide injection point be included to allow for the retrofit of a biocide system at a later date.

## Coagulant

No coagulant has been selected for this system. It is always recommended that a coagulant injection point be included to allow for the retrofit of a coagulant system at a later date.

## Dechlorination

No dechlorination has been selected for this system.

# Avista Advisor

## Project Details

Project: South Oxnard Plain Desalter
Permeate Flowrate: 6180USGPM This is split into 5 trains of 1236.0USGPM
System Recovery: 72%

## Antiscalant Projection

The projection is based on the following feed water analysis. The adjusted feed is the analysis after pH correction, and any ions have been added to balance the analysis. The concentrate analysis has been calculated based on the adjusted feed, using typical rejections of a High Rejection polyamide membrane.

| Ion | Feed Water | Adjusted Feed | Concentrate | |
|---|---|---|---|---|
| Sodium | 1615.00 | 1645.96 | 5835.01 | mg/l |
| Potassium | 28.60 | 28.60 | 101.17 | mg/l |
| Calcium | 1216.00 | 1216.00 | 4337.88 | mg/l |
| Magnesium | 454.00 | 454.00 | 1619.16 | mg/l |
| Iron | 0.00 | 0.00 | 0.00 | mg/l |
| Manganese | 0.00 | 0.00 | 0.00 | mg/l |
| Barium | 0.06 | 0.06 | 0.21 | mg/l |
| Strontium | 7.20 | 7.20 | 25.68 | mg/l |
| Aluminium | 0.00 | 0.00 | 0.00 | mg/l |
| Chloride | 4885.00 | 4885.00 | 17330.94 | mg/l |
| Sulfate | 1278.00 | 1349.65 | 4814.65 | mg/l |
| Bicarbonate | 369.00 | 278.71 | 981.97 | mg/l |
| Nitrate | 2.00 | 2.00 | 6.92 | mg/l |
| Fluoride | 0.60 | 0.60 | 2.13 | mg/l |
| Phosphate | 0.00 | 0.00 | 0.00 | mg/l |
| Silica | 47.50 | 47.50 | 168.48 | mg/l |
| CO2 | 41.48 | 133.69 | 133.69 | mg/l |
| TDS | | 9915.28 | 35224.20 | |
| pH | 7.13 | 6.50 | 7.06 | |

Water Source: Well Water

Water Temperature: 18.9º C

## Product Choice

Vitec Choice: Vitec 4000
Dosage: 5.20mg/l
Usage: 534.53 lb per day.

## Application

Dosed Solution Strength: 100%
Pump Rate: 55.78USGPD
146.72ml/m

There is one dosing pump and chemical tank per membrane train.
With 5 trains, each pump will deliver 11.16USGPD

## pH Correction

Chemical choice: Sulfuric acid
Dosage: 72.39ppm 100% H2SO4

# Avista Advisor

## Project Details

Project: South Oxnard Plain Desalter
Permeate Flowrate: 6180USGPM This is split into 5 trains of 1236.0USGPM
System Recovery: 72%

## Scaling Potential.

### Stiff and Davies Index (S&DI)

The reject stream has a S&DI of 0.91.
Vitec 4000 has a limit of 3.00

### Calcium Carbonate Precipitation Potential (CCPP)

The concentrate has a CCPP of 556mg/l.
This is within the limits of Vitec 4000.

### Calcium Sulfate

The concentrate has a calcium sulphate saturation of 344.91%.
This is within the limits of Vitec 4000.

### Barium Sulfate

The concentrate has a barium sulphate saturation of 1286.43%.
This is within the limits of Vitec 4000.

### Strontium Sulfate

The concentrate has a strontium sulphate saturation of 81.43%.
This is within the limits of Vitec 4000.

### Calcium Fluoride

The concentrate has a calcium fluoride saturation of 443.81%.
This is within the limits of Vitec 4000.

### Silica

The concentrate has a silica level of 168.48mg/l.
This is within the limits of Vitec 4000.

### Magnesium Hydroxide

The concentrate has a magnesium hydroxide saturation of 0.00%.

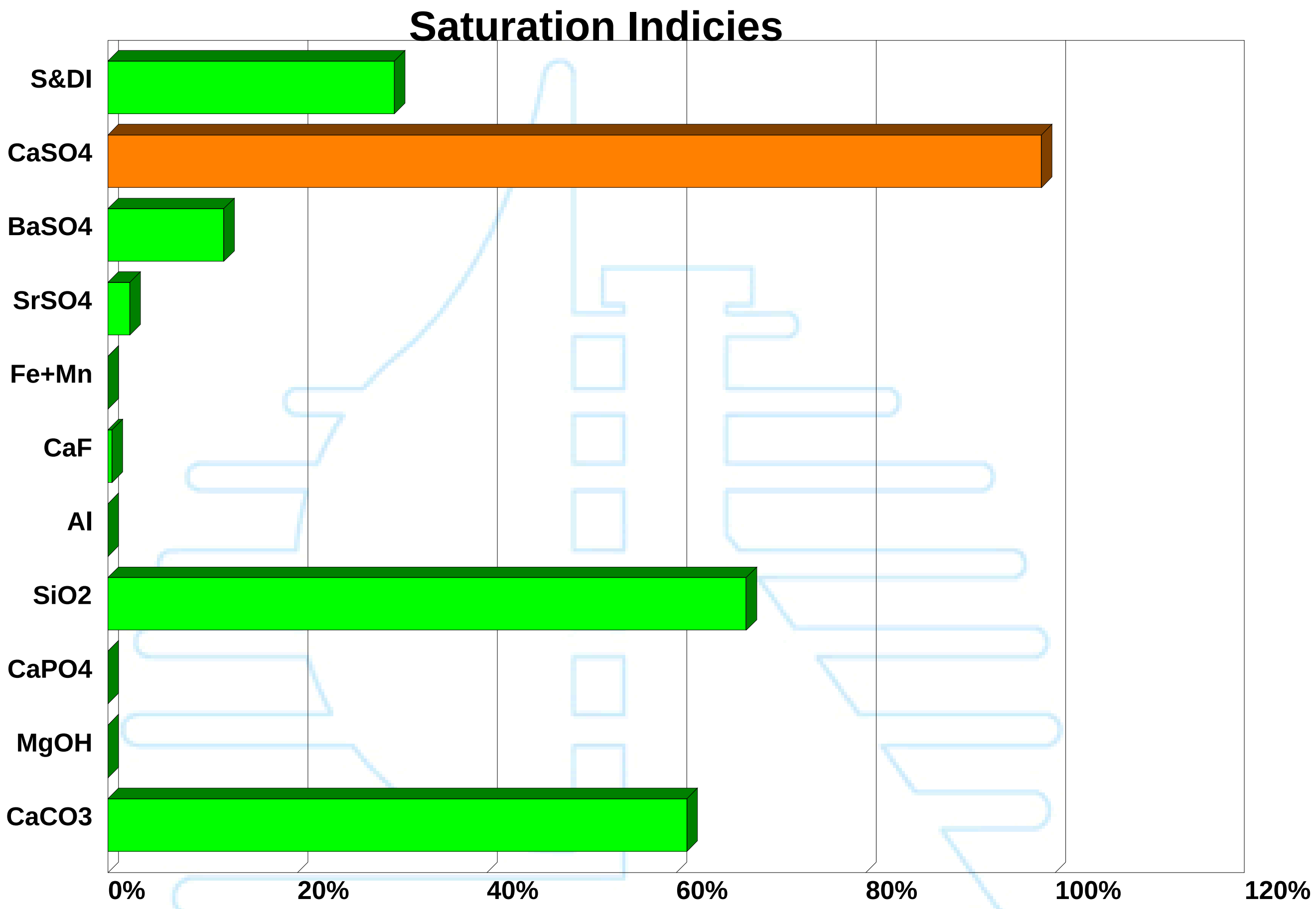
### Calcium Phosphate

No phosphate was included in the feed water analysis.

# Avista Advisor

## Project Details

| | |
|---|---|
| Project: | South Oxnard Plain Desalter |
| Permeate Flowrate: | 6180USGPM  This is split into 5 trains of 1236.0USGPM |
| System Recovery: | 72% |


Saturation Indicies

## Product Choice

| | |
|---|---|
| Vitec Choice: | Vitec 4000 |
| Dosage: | 5.20mg/l |
| Usage: | 534.53 lb per day. |

## Application

Dosed Solution Strength: 100%
Pump Rate: 55.78USGPD
146.72ml/m

There is one dosing pump and chemical tank per membrane train.
With 5 trains, each pump will deliver 11.16USGPD

## pH Correction

| | |
|---|---|
| Chemical choice: | Sulfuric acid |
| Dosage: | 72.39ppm 100% $H_2SO_4$ |

# APPENDIX C – REVERSE OSMOSIS PERFORMANCE PROJECTIONS

Reverse Osmosis System Analysis for FILMTEC™ Membranes
Project: UWCD South Oxnard Desal Feasibility Study
Brandon C. Yallaly, Carollo Engineers, Inc.

ROSA 9.1 ConfigDB u399339_282
Case: 2
5/6/2014

**Project Information:**

**Case-specific:** Design Water Quality

**System Details**

| | | | | | |
|---|---|---|---|---|---|
| Feed Flow to Stage 1 | 1545.04 gpm | Pass 1 Permeate Flow | 1236.08 gpm | Osmotic Pressure: | |
| Raw Water Flow to System | 1545.04 gpm | Pass 1 Recovery | 80.00 % | Feed | 55.98 psig |
| Feed Pressure | 263.30 psig | Feed Temperature | 18.9 C | Concentrate | 268.00 psig |
| Flow Factor | 0.85 | Feed TDS | 6556.75 mg/l | Average | 161.99 psig |
| Chem. Dose (100% H2SO4) | 43.87 mg/l | Number of Elements | 336 | Average NDP | 190.52 psig |
| Total Active Area | 134400.00 ft² | Average Pass 1 Flux | 13.24 gfd | Power | 299.60 kW |
| Water Classification: Well Water SDI < 3 | | | | Specific Energy | 4.04 kWh/kgal |

| Stage | Element | #PV | #Ele | Feed Flow (gpm) | Feed Press (psig) | Recirc Flow (gpm) | Conc Flow (gpm) | Conc Press (psig) | Perm Flow (gpm) | Avg Flux (gfd) | Perm Press (psig) | Boost Press (psig) | Perm TDS (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BW30XFR-400/34i | 32 | 7 | 1545.04 | 258.30 | 0.00 | 720.44 | 246.47 | 824.60 | 13.25 | 20.00 | 0.00 | 48.39 |
| 2 | SW30ULE-400i | 16 | 7 | 720.44 | 441.47 | 0.00 | 308.96 | 418.12 | 411.48 | 13.23 | 20.00 | 200.00 | 55.71 |

Pass Streams
(mg/l as Ion)

| Name | Feed | Adjusted Feed | Concentrate | | Permeate | | |
|---|---|---|---|---|---|---|---|
| | | | Stage 1 | Stage 2 | Stage 1 | Stage 2 | Total |
| NH4+ + NH3 | 1.89 | 1.90 | 4.02 | 9.28 | 0.06 | 0.08 | 0.07 |
| K | 19.10 | 19.10 | 40.64 | 94.29 | 0.28 | 0.36 | 0.31 |
| Na | 1077.00 | 1077.00 | 2297.60 | 5337.74 | 10.58 | 14.93 | 12.03 |
| Mg | 303.00 | 303.00 | 648.01 | 1509.50 | 1.57 | 1.17 | 1.43 |
| Ca | 810.00 | 810.00 | 1732.43 | 4035.68 | 4.08 | 3.06 | 3.74 |
| Sr | 4.80 | 4.80 | 10.27 | 23.92 | 0.02 | 0.02 | 0.02 |
| Ba | 0.04 | 0.04 | 0.08 | 0.19 | 0.00 | 0.00 | 0.00 |
| CO3 | 0.80 | 0.14 | 0.99 | 8.97 | 0.00 | 0.00 | 0.00 |
| HCO3 | 246.00 | 192.72 | 408.45 | 934.97 | 3.55 | 3.49 | 3.53 |
| NO3 | 1.20 | 1.20 | 2.48 | 5.56 | 0.08 | 0.16 | 0.11 |
| Cl | 3257.38 | 3257.40 | 6957.26 | 16183.66 | 24.88 | 29.67 | 26.48 |
| F | 0.40 | 0.40 | 0.85 | 1.97 | 0.01 | 0.01 | 0.01 |
| SO4 | 812.00 | 854.97 | 1830.75 | 4267.51 | 2.44 | 1.13 | 2.01 |
| SiO2 | 31.70 | 31.70 | 67.90 | 157.39 | 0.07 | 0.72 | 0.28 |
| Boron | 0.42 | 0.41 | 0.74 | 1.50 | 0.13 | 0.16 | 0.14 |
| CO2 | 16.07 | 54.93 | 55.35 | 59.11 | 54.63 | 55.79 | 55.01 |
| TDS | 6567.69 | 6556.75 | 14005.96 | 32579.22 | 48.39 | 55.71 | 50.83 |
| pH | 7.14 | 6.50 | 6.73 | 6.95 | 5.03 | 5.02 | 5.03 |

*Permeate Flux reported by ROSA is calculated based on ACTIVE membrane area. DISCLAIMER: NO WARRANTY, EXPRESSED OR IMPLIED, AND NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, IS GIVEN. Neither FilmTec Corporation nor The Dow Chemical Company assume any obligation or liability for results obtained or damages incurred from the application of this information. Because use conditions and applicable laws may differ from one location to another and may change with time, customer is responsible for determining whether products are appropriate for customer's use. FilmTec Corporation and The Dow Chemical Company assume no liability, if, as a result of customer's use of the ROSA membrane design software, the customer should be sued for alleged infringement of any patent not owned or controlled by the FilmTec Corporation nor The Dow Chemical Company.

Reverse Osmosis System Analysis for FILMTEC™ Membranes ROSA 9.1 ConfigDB u399339_282
Project: UWCD South Oxnard Desal Feasibility Study Case: 2
Brandon C. Yallaly, Carollo Engineers, Inc. 5/6/2014

**Design Warnings**

-None-

**Solubility Warnings**

Langelier Saturation Index > 0
Stiff & Davis Stability Index > 0
CaSO4 (% Saturation) > 100%
BaSO4 (% Saturation) > 100%
CaF2 (% Saturation) > 100%
SiO2 (% Saturation) > 100%
Antiscalants may be required. Consult your antiscalant manufacturer for dosing and maximum allowable system recovery.

**Stage Details**

| Stage 1 Element | Recovery | Perm Flow (gpm) | Perm TDS (mg/l) | Feed Flow (gpm) | Feed TDS (mg/l) | Feed Press (psig) |
|---|---|---|---|---|---|---|
| 1 | 0.09 | 4.54 | 25.70 | 48.28 | 6556.75 | 258.30 |
| 2 | 0.10 | 4.29 | 30.57 | 43.74 | 7235.04 | 255.82 |
| 3 | 0.10 | 4.01 | 36.96 | 39.45 | 8017.87 | 253.65 |
| 4 | 0.11 | 3.72 | 45.50 | 35.44 | 8921.93 | 251.76 |
| 5 | 0.11 | 3.41 | 57.16 | 31.72 | 9963.56 | 250.13 |
| 6 | 0.11 | 3.07 | 73.38 | 28.31 | 11156.18 | 248.72 |
| 7 | 0.11 | 2.72 | 96.35 | 25.24 | 12505.96 | 247.51 |

| Stage 2 Element | Recovery | Perm Flow (gpm) | Perm TDS (mg/l) | Feed Flow (gpm) | Feed TDS (mg/l) | Feed Press (psig) |
|---|---|---|---|---|---|---|
| 1 | 0.11 | 5.14 | 28.27 | 45.03 | 14005.96 | 441.47 |
| 2 | 0.12 | 4.70 | 34.49 | 39.88 | 15808.82 | 436.17 |
| 3 | 0.12 | 4.23 | 42.90 | 35.18 | 17917.93 | 431.70 |
| 4 | 0.12 | 3.71 | 54.51 | 30.95 | 20358.20 | 427.97 |
| 5 | 0.12 | 3.18 | 70.80 | 27.24 | 23125.32 | 424.85 |
| 6 | 0.11 | 2.64 | 94.02 | 24.06 | 26168.21 | 422.23 |
| 7 | 0.10 | 2.12 | 127.49 | 21.43 | 29374.65 | 420.02 |

**Scaling Calculations**

| | Raw Water | Adjusted Feed | Concentrate |
|---|---|---|---|
| pH | 7.14 | 6.50 | 6.95 |
| Langelier Saturation Index | 0.64 | -0.11 | 1.69 |
| Stiff & Davis Stability Index | 0.26 | -0.49 | 0.69 |
| Ionic Strength (Molal) | 0.16 | 0.16 | 0.79 |
| TDS (mg/l) | 6567.69 | 6556.75 | 32579.22 |
| HCO3 | 246.00 | 192.72 | 934.97 |
| CO2 | 16.07 | 54.92 | 59.09 |
| CO3 | 0.80 | 0.14 | 8.97 |
| CaSO4 (% Saturation) | 41.53 | 43.63 | 284.05 |
| BaSO4 (% Saturation) | 163.06 | 171.21 | 945.20 |
| SrSO4 (% Saturation) | 10.21 | 10.73 | 66.45 |
| CaF2 (% Saturation) | 17.23 | 17.23 | 2088.41 |
| SiO2 (% Saturation) | 28.10 | 26.45 | 138.52 |
| Mg(OH)2 (% Saturation) | 0.00 | 0.00 | 0.00 |

To balance: 0.00 mg/l Na added to feed.

Reverse Osmosis System Analysis for FILMTEC™ Membranes ROSA 9.1 ConfigDB u399339_282
Project: UWCD South Oxnard Desal Feasibility Study Case: 1
Brandon C. Yallaly, Carollo Engineers, Inc. 4/24/2014

**Project Information:**

**Case-specific:** Worst Case Water Quality

**System Details**

| | | | | | |
|---|---|---|---|---|---|
| Feed Flow to Stage 1 | 1716.39 gpm | Pass 1 Permeate Flow | 1235.56 gpm | Osmotic Pressure: | |
| Raw Water Flow to System | 1716.39 gpm | Pass 1 Recovery | 71.99 % | Feed | 82.71 psig |
| Feed Pressure | 308.80 psig | Feed Temperature | 18.9 C | Concentrate | 287.47 psig |
| Flow Factor | 0.85 | Feed TDS | 9836.29 mg/l | Average | 185.09 psig |
| Chem. Dose (100% H2SO4) | 61.25 mg/l | Number of Elements | 336 | Average NDP | 200.47 psig |
| Total Active Area | 134400.00 ft² | Average Pass 1 Flux | 13.24 gfd | Power | 384.87 kW |
| Water Classification: Well Water SDI < 3 | | | | Specific Energy | 5.19 kWh/kgal |

| Stage | Element | #PV | #Ele | Feed Flow (gpm) | Feed Press (psig) | Recirc Flow (gpm) | Conc Flow (gpm) | Conc Press (psig) | Perm Flow (gpm) | Avg Flux (gfd) | Perm Press (psig) | Boost Press (psig) | Perm TDS (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BW30XFR-400/34i | 32 | 7 | 1716.39 | 303.80 | 0.00 | 888.32 | 289.53 | 828.07 | 13.31 | 20.00 | 0.00 | 79.69 |
| 2 | SW30ULE-400i | 16 | 7 | 888.32 | 484.53 | 0.00 | 480.82 | 448.63 | 407.50 | 13.10 | 20.00 | 200.00 | 65.65 |

Pass Streams
(mg/l as Ion)

| Name | Feed | Adjusted Feed | Concentrate | | Permeate | | |
|---|---|---|---|---|---|---|---|
| | | | Stage 1 | Stage 2 | Stage 1 | Stage 2 | Total |
| NH4+ + NH3 | 2.89 | 2.90 | 5.53 | 10.14 | 0.11 | 0.09 | 0.10 |
| K | 28.60 | 28.60 | 54.82 | 100.92 | 0.47 | 0.43 | 0.46 |
| Na | 1615.00 | 1615.02 | 3104.12 | 5719.93 | 17.57 | 17.59 | 17.58 |
| Mg | 454.00 | 454.00 | 874.79 | 1615.02 | 2.59 | 1.36 | 2.18 |
| Ca | 1216.00 | 1216.00 | 2343.21 | 4326.03 | 6.77 | 3.59 | 5.72 |
| Sr | 7.20 | 7.20 | 13.87 | 25.61 | 0.04 | 0.02 | 0.03 |
| Ba | 0.06 | 0.06 | 0.11 | 0.21 | 0.00 | 0.00 | 0.00 |
| CO3 | 1.64 | 0.30 | 1.71 | 8.35 | 0.00 | 0.00 | 0.00 |
| HCO3 | 369.00 | 295.47 | 563.84 | 1028.15 | 5.56 | 4.15 | 5.09 |
| NO3 | 2.00 | 2.00 | 3.72 | 6.70 | 0.15 | 0.22 | 0.17 |
| Cl | 4885.05 | 4885.08 | 9400.38 | 17337.55 | 41.25 | 34.90 | 39.15 |
| F | 0.60 | 0.60 | 1.15 | 2.12 | 0.01 | 0.01 | 0.01 |
| SO4 | 1218.00 | 1278.00 | 2465.59 | 4554.05 | 4.01 | 1.31 | 3.12 |
| SiO2 | 47.50 | 47.50 | 91.69 | 168.68 | 0.10 | 0.84 | 0.34 |
| Boron | 0.62 | 0.62 | 1.03 | 1.72 | 0.19 | 0.20 | 0.19 |
| CO2 | 21.64 | 75.59 | 76.28 | 79.36 | 75.40 | 76.69 | 75.82 |
| TDS | 9851.10 | 9836.29 | 18930.40 | 34913.28 | 79.69 | 65.65 | 75.05 |
| pH | 7.14 | 6.50 | 6.69 | 6.86 | 5.08 | 4.95 | 5.04 |

*Permeate Flux reported by ROSA is calculated based on ACTIVE membrane area. DISCLAIMER: NO WARRANTY, EXPRESSED OR IMPLIED, AND NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, IS GIVEN. Neither FilmTec Corporation nor The Dow Chemical Company assume any obligation or liability for results obtained or damages incurred from the application of this information. Because use conditions and applicable laws may differ from one location to another and may change with time, customer is responsible for determining whether products are appropriate for customer's use. FilmTec Corporation and The Dow Chemical Company assume no liability, if, as a result of customer's use of the ROSA membrane design software, the customer should be sued for alleged infringement of any patent not owned or controlled by the FilmTec Corporation nor The Dow Chemical Company.

Reverse Osmosis System Analysis for FILMTEC™ Membranes ROSA 9.1 ConfigDB u399339_282
Project: UWCD South Oxnard Desal Feasibility Study Case: 1
Brandon C. Yallaly, Carollo Engineers, Inc. 4/24/2014

**Design Warnings**

-None-

**Solubility Warnings**

Langelier Saturation Index > 0
Stiff & Davis Stability Index > 0
CaSO4 (% Saturation) > 100%
BaSO4 (% Saturation) > 100%
CaF2 (% Saturation) > 100%
SiO2 (% Saturation) > 100%
Antiscalants may be required. Consult your antiscalant manufacturer for dosing and maximum allowable system recovery.

**Stage Details**

| Stage 1 Element | Recovery | Perm Flow (gpm) | Perm TDS (mg/l) | Feed Flow (gpm) | Feed TDS (mg/l) | Feed Press (psig) |
|---|---|---|---|---|---|---|
| 1 | 0.09 | 4.70 | 41.59 | 53.64 | 9836.29 | 303.80 |
| 2 | 0.09 | 4.39 | 50.10 | 48.94 | 10776.70 | 300.92 |
| 3 | 0.09 | 4.06 | 61.26 | 44.55 | 11832.71 | 298.38 |
| 4 | 0.09 | 3.72 | 76.07 | 40.49 | 13012.56 | 296.14 |
| 5 | 0.09 | 3.37 | 96.01 | 36.78 | 14320.40 | 294.16 |
| 6 | 0.09 | 3.01 | 123.12 | 33.41 | 15752.95 | 292.42 |
| 7 | 0.09 | 2.65 | 160.24 | 30.41 | 17297.51 | 290.89 |

| Stage 2 Element | Recovery | Perm Flow (gpm) | Perm TDS (mg/l) | Feed Flow (gpm) | Feed TDS (mg/l) | Feed Press (psig) |
|---|---|---|---|---|---|---|
| 1 | 0.09 | 5.01 | 37.66 | 55.52 | 18930.40 | 484.53 |
| 2 | 0.09 | 4.56 | 44.81 | 50.51 | 20802.30 | 477.23 |
| 3 | 0.09 | 4.10 | 53.92 | 45.96 | 22861.05 | 470.84 |
| 4 | 0.09 | 3.63 | 65.64 | 41.86 | 25094.80 | 465.24 |
| 5 | 0.08 | 3.17 | 80.89 | 38.22 | 27474.39 | 460.32 |
| 6 | 0.08 | 2.72 | 100.83 | 35.05 | 29950.53 | 455.97 |
| 7 | 0.07 | 2.28 | 127.16 | 32.34 | 32456.79 | 452.11 |

Permeate Flux reported by ROSA is calculated based on ACTIVE membrane area.

**Scaling Calculations**

| | Raw Water | Adjusted Feed | Concentrate |
|---|---|---|---|
| pH | 7.14 | 6.50 | 6.86 |
| Langelier Saturation Index | 0.98 | 0.25 | 1.67 |
| Stiff & Davis Stability Index | 0.44 | -0.29 | 0.65 |
| Ionic Strength (Molal) | 0.23 | 0.23 | 0.85 |
| TDS (mg/l) | 9851.10 | 9836.29 | 34913.28 |
| HCO3 | 369.00 | 295.47 | 1028.15 |
| CO2 | 21.64 | 75.58 | 79.34 |
| CO3 | 1.64 | 0.30 | 8.35 |
| CaSO4 (% Saturation) | 67.32 | 70.49 | 307.34 |
| BaSO4 (% Saturation) | 248.26 | 259.84 | 1028.90 |
| SrSO4 (% Saturation) | 15.77 | 16.50 | 72.43 |
| CaF2 (% Saturation) | 58.19 | 58.19 | 2574.52 |
| SiO2 (% Saturation) | 42.11 | 39.63 | 146.85 |
| Mg(OH)2 (% Saturation) | 0.00 | 0.00 | 0.00 |

To balance: 0.02 mg/l Na added to feed.

# APPENDIX D – DETAILED O&M ESTIMATE

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 10,000 AFY - Design Water

| | |
|---|---|
| *Unit Costs* | |
| Power ($/kWh): | $0.125 |
| Lime (slaked) ($/lb): | $0.20 |
| Sulfuric Acid ($/lb): | $0.03 |
| Scale Inhibitor ($/lb): | $0.95 |
| Sodium Hypochlorite ($/lb): | $0.35 |
| Membrane Elements - 8 inch diameter($/element): | $500.00 |
| Cartridge Filters ($/filter): | $12.00 |
| Step 1 Cleaning Chemical Cost ($/lb): | $2.82 |
| Step 2 Cleaning Chemical Cost ($/lb): | $3.16 |
| Step 3 Cleaning Chemical Cost ($/lb): | $2.00 |
| Plant Operating Factor: | 0.98 |
| *Well 1* | |
| Flowrate (gpm): | 1931 |
| Discharge Head (ft): | 226 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 156.3 |
| Power (kW): | 116.6 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 1000848 |
| *Well 2* | |
| Flowrate (gpm): | 1931 |
| Discharge Head (ft): | 200 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 138.4 |
| Power (kW): | 103.2 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 885706 |
| *Well 3* | |
| Flowrate (gpm): | 1931 |
| Discharge Head (ft): | 188 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 130.1 |
| Power (kW): | 97.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 832564 |
| *Well 4* | |
| Flowrate (gpm): | 1931 |
| Discharge Head (ft): | 194 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 134.2 |
| Power (kW): | 100.1 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 859135 |
| *Well 5* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |

| | |
|---|---|
| *Well 6* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 7* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 8* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 9* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 10* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 11* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 12* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 10,000 AFY - Design Water

| | |
|---|---|
| *RO Feed Pumps* | |
| Number of Pumps: | 5.0 |
| Flowrate Per Pump (gpm): | 1545 |
| Discharge Head (ft): | 538 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 297.9 |
| Power (kW): | 222.1 |
| Operational Factor: | 0.98 |
| Yearly Power Usage Per Pump - Existing (kWh/yr): | 1906855 |
| Total Yearly Power Usage (kWh/yr): | 9534273 |
| *Primary RO Stage 2 Boost Pumps* | |
| Number of Pumps: | 5.0 |
| Flowrate Per Pump (gpm): | 720 |
| Discharge Head (ft): | 462 |
| Pump Efficiency (%): | 74.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 120.8 |
| Power (kW): | 90.1 |
| Operational Factor: | 0.98 |
| Yearly Power Usage Per Pump (kWh/yr): | 773061 |
| Total Yearly Power Usage (kWh/yr): | 3865307 |
| *Procuct Water Pumps* | |
| Total Number of Pumps: | 2.0 |
| Flowrate Per Pump (gpm): | 3090 |
| Discharge Head (ft): | 155 |
| Pump Efficiency (%): | 84.0% |
| Motor Efficiency (%): | 92.5% |
| Power (hp): | 155.7 |
| Power (kW): | 116.1 |
| Operational Factor: | 0.98 |
| Total Yearly Power Usage (kWh/yr): | 1993010 |
| | |
| *Chemical Usage* | |
| Lime | |
| Post Treatment (lbs/day): | 4320.0 |
| Operating Factor: | 0.98 |
| Total Lime Usage (lbs/yr): | 1545247 |
| Sulfuric Acid | |
| Primary Desal Usage (lb/day): | 4082.4 |
| Operating Factor: | 0.98 |
| Total Sodium Hypochlorite Usage (lb/yr): | 1460285 |
| Scale Inhibitor | |
| Primary Desal Usage (lbs/day): | 278.3 |
| Operating Factor: | 0.98 |
| Total Scale Inhibitor Usage (lbs/yr): | 99565 |
| Sodium Hypochlorite | |
| Finished Water Usage (lb/day): | 371.1 |
| Operating Factor: | 0.98 |
| Total Sodium Hypochlorite Usage (lb/yr): | 132753 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 10,000 AFY - Design Water

| | |
|---|---|
| *Cartridge Filters* | |
| Number of Primary Desal Cartridge Filter Elements: | 552 |
| Replacement Events per Year: | 3 |
| Number of Filters Replaced Per Year: | 1655 |
| *Membranes* | |
| Primary Desal Flux Rate (gfd): | 13.2 |
| Membrane Area per Element (ft2): | 400 |
| Number of Primary Desal Membrane Elements: | 1681 |
| Replacement Events per Year: | 0.2 |
| Number of 8-in Membrane Elements Replaced Per Year: | 336 |
| *Chemical Cleanings* | |
| Primary RO | |
| Number of Trains to Clean Per Cleaning Event: | 5.0 |
| Number of Cleaning Steps Per Train: | 3.0 |
| Step 1 Solution Volume (gal): | 3000 |
| Step 1 Cleaning Solution Strength (% by wt.): | 8.0% |
| Step 1 Cleaning Chemical Requirement (lbs): | 2001.6 |
| Step 2 Solution Volume (gal): | 3000 |
| Step 2 Cleaning Solution Strength (% by wt.): | 4.0% |
| Step 2 Cleaning Chemical Requirement (lbs): | 1000.8 |
| Step 3 Solution Volume (gal): | 3000 |
| Step 3 Cleaning Solution Strength (% by wt.): | 4.0% |
| Step 3 Cleaning Chemical Requirement (lbs): | 1000.8 |
| Step 1 Cleaning Solution Usage Per Cleaning Event (lbs/cleaning): | 10008.0 |
| Step 2 Cleaning Solution Usage Per Cleaning Event (lbs/cleaning): | 5004.0 |
| Step 3 Cleaning Solution Usage Per Cleaning Event (lbs/cleaning): | 5004.0 |
| Number of Step 1 Cleaning Events Per Year: | 3.0 |
| Number of Step 2 Cleaning Events Per Year: | 3.0 |
| Number of Step 3 Cleaning Events Per Year: | 4.0 |
| Step 1 Cleaning Chemical Requirement Per Year (lbs): | 30024 |
| Step 2 Cleaning Chemical Requirement Per Year (lbs): | 15012 |
| Step 3 Cleaning Chemical Requirement Per Year (lbs): | 20016 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 10,000 AFY - Design Water

| | |
|---|---|
| *Maintenance Costs* | |
| Miscellaneous Equipment and Building Maintenance ($/yr): | $150,000 |
| Annual Well Maintenance ($/yr): | $300,000 |
| *Laboratory Costs* | |
| Sample Analysis ($/yr): | $50,000 |
| *Concentrate Disposal Costs* | |
| Usage @ $750/AF ($/yr): | $1,831,980 |
| Estimated Annual Concentrate Flow Measurement Station Costs ($/yr): | $45,000 |
| *Labor Cost* | |
| Number of Grade T2 Operators (No.): | 3 |
| Annual T2 Operator Salary ($/yr): | $72,696 |
| Number of Grade T1 Operators (No.): | 2 |
| Annual T1 Operator Salary ($/yr): | $59,821 |
| Total Raw Salary ($/yr): | $337,730 |
| Fringe Percentage (%): | 40% |
| Administrative Cost Percentage (%): | 55% |
| Total Labor Cost Per Year ($/yr): | $732,874 |
| *O&M Cost Summary:* | |
| *Power* | |
| Percentage Adder for Misc Power (%): | 2% |
| Total Power Cost ($/yr): | $2,418,782 |
| *Chemicals* | |
| Lime | $309,049 |
| Sulfuric Acid | $43,809 |
| Scale Inhibitor | $94,587 |
| Sodium Hypochlorite | $46,464 |
| Step 1 Cleaning | $84,668 |
| Step 2 Cleaning | $47,438 |
| Step 3 Cleaning | $40,032 |
| *Membranes* | $168,100 |
| *Cartridge Filters* | $19,865 |
| *Maintenance Costs* | $450,000 |
| *Labotatory Costs* | $50,000 |
| *Concentrate Disposal Costs* | $1,876,980 |
| *Labor* | $732,874 |
| Annual O&M Cost ($/yr): | $6,382,647 |
| Annual O&M Cost ($/kgal): | $2.005 |
| Annual O&M Cost ($/AF): | $653 |
| *Amortized Capital Cost* | |
| Capital Cost ($): | $85,137,023 |
| Interest (%): | 3.22% |
| Life Span of Investment (yrs): | 30 |
| Amortized Capital Cost ($/yr): | $4,468,057 |
| Annual O&M Cost with Capital Recovery ($/yr): | $10,850,705 |
| Annual O&M Cost with Capital Recovery ($/kgal): | $3.408 |
| Annual O&M Cost with Capital Recovery ($/AF): | $1,111 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 20,000 AFY - Design Water

| | |
|---|---|
| *Unit Costs* | |
| Power ($/kWh): | $0.125 |
| Lime (slaked) ($/lb): | $0.20 |
| Sulfuric Acid ($/lb): | $0.03 |
| Scale Inhibitor ($/lb): | $0.95 |
| Sodium Hypochlorite ($/lb): | $0.35 |
| Membrane Elements - 8 inch diameter($/element): | $500.00 |
| Cartridge Filters ($/filter): | $12.00 |
| Step 1 Cleaning Chemical Cost ($/lb): | $2.82 |
| Step 2 Cleaning Chemical Cost ($/lb): | $3.16 |
| Step 3 Cleaning Chemical Cost ($/lb): | $2.00 |
| Plant Operating Factor: | 0.98 |
| *Well 1* | |
| Flowrate (gpm): | 1931 |
| Discharge Head (ft): | 226 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 156.3 |
| Power (kW): | 116.6 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 1000848 |
| *Well 2* | |
| Flowrate (gpm): | 1931 |
| Discharge Head (ft): | 200 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 138.4 |
| Power (kW): | 103.2 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 885706 |
| *Well 3* | |
| Flowrate (gpm): | 1931 |
| Discharge Head (ft): | 188 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 130.1 |
| Power (kW): | 97.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 832564 |
| *Well 4* | |
| Flowrate (gpm): | 1931 |
| Discharge Head (ft): | 194 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 134.2 |
| Power (kW): | 100.1 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 859135 |
| *Well 5* | |
| Flowrate (gpm): | 1931 |
| Discharge Head (ft): | 211 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 146.0 |
| Power (kW): | 108.8 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 934420 |

| | |
|---|---|
| *Well 6* | |
| Flowrate (gpm): | 1931 |
| Discharge Head (ft): | 213 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 147.3 |
| Power (kW): | 109.9 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 943277 |
| *Well 7* | |
| Flowrate (gpm): | 1931 |
| Discharge Head (ft): | 191 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 132.1 |
| Power (kW): | 98.5 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 845849 |
| *Well 8* | |
| Flowrate (gpm): | 1931 |
| Discharge Head (ft): | 179 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 123.8 |
| Power (kW): | 92.3 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 792707 |
| *Well 9* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 10* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 11* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 12* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 20,000 AFY - Design Water

| | |
|---|---|
| *RO Feed Pumps* | |
| Number of Pumps: | 10.0 |
| Flowrate Per Pump (gpm): | 1545 |
| Discharge Head (ft): | 552 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 305.5 |
| Power (kW): | 227.8 |
| Operational Factor: | 0.98 |
| Yearly Power Usage Per Pump - Existing (kWh/yr): | 1955958 |
| Total Yearly Power Usage (kWh/yr): | 19559581 |
| *Primary RO Stage 2 Boost Pumps* | |
| Number of Pumps: | 10.0 |
| Flowrate Per Pump (gpm): | 655 |
| Discharge Head (ft): | 508 |
| Pump Efficiency (%): | 74.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 120.8 |
| Power (kW): | 90.1 |
| Operational Factor: | 0.98 |
| Yearly Power Usage Per Pump (kWh/yr): | 773598 |
| Total Yearly Power Usage (kWh/yr): | 7735982 |
| *Procuct Water Pumps* | |
| Total Number of Pumps: | 4.0 |
| Flowrate Per Pump (gpm): | 3090 |
| Discharge Head (ft): | 123 |
| Pump Efficiency (%): | 84.0% |
| Motor Efficiency (%): | 92.5% |
| Power (hp): | 123.5 |
| Power (kW): | 92.1 |
| Operational Factor: | 0.98 |
| Total Yearly Power Usage (kWh/yr): | 3163100 |
| | |
| *Chemical Usage* | |
| Lime | |
| Post Treatment (lbs/day): | 8639.9 |
| Operating Factor: | 0.98 |
| Total Lime Usage (lbs/yr): | 3090495 |
| Sulfuric Acid | |
| Primary Desal Usage (lb/day): | 8164.9 |
| Operating Factor: | 0.98 |
| Total Sodium Hypochlorite Usage (lb/yr): | 2920570 |
| Scale Inhibitor | |
| Primary Desal Usage (lbs/day): | 556.7 |
| Operating Factor: | 0.98 |
| Total Scale Inhibitor Usage (lbs/yr): | 199130 |
| Sodium Hypochlorite | |
| Finished Water Usage (lb/day): | 742.3 |
| Operating Factor: | 0.98 |
| Total Sodium Hypochlorite Usage (lb/yr): | 265506 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 20,000 AFY - Design Water

| | |
|---|---|
| *Cartridge Filters* | |
| Number of Primary Desal Cartridge Filter Elements: | 1104 |
| Replacement Events per Year: | 3 |
| Number of Filters Replaced Per Year: | 3311 |
| *Membranes* | |
| Primary Desal Flux Rate (gfd): | 13.2 |
| Membrane Area per Element (ft2): | 400 |
| Number of Primary Desal Membrane Elements: | 3362 |
| Replacement Events per Year: | 0.2 |
| Number of 8-in Membrane Elements Replaced Per Year: | 672 |
| *Chemical Cleanings* | |
| Primary RO | |
| Number of Trains to Clean Per Cleaning Event: | 10.0 |
| Number of Cleaning Steps Per Train: | 3.0 |
| Step 1 Solution Volume (gal): | 3000 |
| Step 1 Cleaning Solution Strength (% by wt.): | 8.0% |
| Step 1 Cleaning Chemical Requirement (lbs): | 2001.6 |
| Step 2 Solution Volume (gal): | 3000 |
| Step 2 Cleaning Solution Strength (% by wt.): | 4.0% |
| Step 2 Cleaning Chemical Requirement (lbs): | 1000.8 |
| Step 3 Solution Volume (gal): | 3000 |
| Step 3 Cleaning Solution Strength (% by wt.): | 4.0% |
| Step 3 Cleaning Chemical Requirement (lbs): | 1000.8 |
| Step 1 Cleaning Solution Usage Per Cleaning Event (lbs/cleaning): | 20016.0 |
| Step 2 Cleaning Solution Usage Per Cleaning Event (lbs/cleaning): | 10008.0 |
| Step 3 Cleaning Solution Usage Per Cleaning Event (lbs/cleaning): | 10008.0 |
| Number of Step 1 Cleaning Events Per Year: | 3.0 |
| Number of Step 2 Cleaning Events Per Year: | 3.0 |
| Number of Step 3 Cleaning Events Per Year: | 4.0 |
| Step 1 Cleaning Chemical Requirement Per Year (lbs): | 60048 |
| Step 2 Cleaning Chemical Requirement Per Year (lbs): | 30024 |
| Step 3 Cleaning Chemical Requirement Per Year (lbs): | 40032 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 20,000 AFY - Design Water

| | |
|---|---|
| *Maintenance Costs* | |
| Miscellaneous Equipment and Building Maintenance ($/yr): | $150,000 |
| Annual Well Maintenance ($/yr): | $600,000 |
| *Laboratory Costs* | |
| Sample Analysis ($/yr): | $50,000 |
| *Concentrate Disposal Costs* | |
| Usage @ $750/AF ($/yr): | $3,663,960 |
| Estimated Annual Concentrate Flow Measurement Station Costs ($/yr): | $45,000 |
| *Labor Cost* | |
| Number of Grade T2 Operators (No.): | 3 |
| Annual T2 Operator Salary ($/yr): | $72,696 |
| Number of Grade T1 Operators (No.): | 2 |
| Annual T1 Operator Salary ($/yr): | $59,821 |
| Total Raw Salary ($/yr): | $337,730 |
| Fringe Percentage (%): | 40% |
| Administrative Cost Percentage (%): | 55% |
| Total Labor Cost Per Year ($/yr): | $732,874 |
| *O&M Cost Summary:* | |
| *Power* | |
| Percentage Adder for Misc Power (%): | 2% |
| Total Power Cost ($/yr): | $4,788,029 |
| *Chemicals* | |
| Lime | $618,099 |
| Sulfuric Acid | $87,617 |
| Scale Inhibitor | $189,173 |
| Sodium Hypochlorite | $92,927 |
| Step 1 Cleaning | $169,335 |
| Step 2 Cleaning | $94,876 |
| Step 3 Cleaning | $80,064 |
| *Membranes* | $336,200 |
| *Cartridge Filters* | $39,730 |
| *Maintenance Costs* | $750,000 |
| *Labotatory Costs* | $50,000 |
| *Concentrate Disposal Costs* | $3,708,960 |
| *Labor* | $732,874 |
| Annual O&M Cost ($/yr): | $11,737,885 |
| Annual O&M Cost ($/kgal): | $1.844 |
| Annual O&M Cost ($/AF): | $601 |
| *Amortized Capital Cost* | |
| Capital Cost ($): | $147,965,936 |
| Interest (%): | 3.22% |
| Life Span of Investment (yrs): | 30 |
| Amortized Capital Cost ($/yr): | $7,765,368 |
| Annual O&M Cost with Capital Recovery ($/yr): | $19,503,252 |
| Annual O&M Cost with Capital Recovery ($/kgal): | $3.063 |
| Annual O&M Cost with Capital Recovery ($/AF): | $998 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 10,000 AFY - Worst Case Water

| | |
|---|---|
| *Unit Costs* | |
| Power ($/kWh): | $0.125 |
| Lime (slaked) ($/lb): | $0.20 |
| Sulfuric Acid ($/lb): | $0.03 |
| Scale Inhibitor ($/lb): | $0.95 |
| Sodium Hypochlorite ($/lb): | $0.35 |
| Membrane Elements - 8 inch diameter($/element): | $500.00 |
| Cartridge Filters ($/filter): | $12.00 |
| Step 1 Cleaning Chemical Cost ($/lb): | $2.82 |
| Step 2 Cleaning Chemical Cost ($/lb): | $3.16 |
| Step 3 Cleaning Chemical Cost ($/lb): | $2.00 |
| Plant Operating Factor: | 0.98 |
| *Well 1* | |
| Flowrate (gpm): | 1717 |
| Discharge Head (ft): | 217 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 133.4 |
| Power (kW): | 99.5 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 854214 |
| *Well 2* | |
| Flowrate (gpm): | 1717 |
| Discharge Head (ft): | 196 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 120.5 |
| Power (kW): | 89.9 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 771549 |
| *Well 3* | |
| Flowrate (gpm): | 1717 |
| Discharge Head (ft): | 187 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 115.0 |
| Power (kW): | 85.7 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 736120 |
| *Well 4* | |
| Flowrate (gpm): | 1717 |
| Discharge Head (ft): | 179 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 110.1 |
| Power (kW): | 82.1 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 704628 |
| *Well 5* | |
| Flowrate (gpm): | 1717 |
| Discharge Head (ft): | 190 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 116.8 |
| Power (kW): | 87.1 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 747930 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 10,000 AFY - Worst Case Water

| | |
|---|---|
| *Well 6* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 140 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 7* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 8* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 9* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 10* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 11* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 12* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 10,000 AFY - Worst Case Water

| | | |
|---|---|---|
| *RO Feed Pumps* | | |
| | Number of Pumps: | 5.0 |
| | Flowrate Per Pump (gpm): | 1717 |
| | Discharge Head (ft): | 644 |
| | Pump Efficiency (%): | 80.0% |
| | Motor Efficiency (%): | 94.0% |
| | Power (hp): | 371.5 |
| | Power (kW): | 277.1 |
| | Operational Factor: | 0.98 |
| | Yearly Power Usage Per Pump - Existing (kWh/yr): | 2378453 |
| | Total Yearly Power Usage (kWh/yr): | 11892266 |
| *Primary RO Stage 2 Boost Pumps* | | |
| | Number of Pumps: | 5.0 |
| | Flowrate Per Pump (gpm): | 888 |
| | Discharge Head (ft): | 462 |
| | Pump Efficiency (%): | 74.0% |
| | Motor Efficiency (%): | 94.0% |
| | Power (hp): | 148.9 |
| | Power (kW): | 111.1 |
| | Operational Factor: | 0.98 |
| | Yearly Power Usage Per Pump (kWh/yr): | 953442 |
| | Total Yearly Power Usage (kWh/yr): | 4767212 |
| *Procuct Water Pumps* | | |
| | Total Number of Pumps: | 2.0 |
| | Flowrate Per Pump (gpm): | 3090 |
| | Discharge Head (ft): | 155 |
| | Pump Efficiency (%): | 82.0% |
| | Motor Efficiency (%): | 94.0% |
| | Power (hp): | 156.9 |
| | Power (kW): | 117.0 |
| | Operational Factor: | 0.98 |
| | Total Yearly Power Usage (kWh/yr): | 2009041 |
| | | |
| *Chemical Usage* | | |
| Lime | | |
| | Post Treatment (lbs/day): | 5418.5 |
| | Operating Factor: | 0.98 |
| | Total Lime Usage (lbs/yr): | 1938197 |
| Sulfuric Acid | | |
| | Primary Desal Usage (lb/day): | 4536.0 |
| | Operating Factor: | 0.98 |
| | Total Sodium Hypochlorite Usage (lb/yr): | 1622539 |
| Scale Inhibitor | | |
| | Primary Desal Usage (lbs/day): | 536.1 |
| | Operating Factor: | 0.98 |
| | Total Scale Inhibitor Usage (lbs/yr): | 191755 |
| Sodium Hypochlorite | | |
| | Finished Water Usage (lb/day): | 371.1 |
| | Operating Factor: | 0.98 |
| | Total Sodium Hypochlorite Usage (lb/yr): | 132753 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 10,000 AFY - Worst Case Water

| | |
|---|---|
| *Cartidge Filters* | |
| Number of Primary Desal Cartridge Filter Elements: | 613 |
| Replacement Events per Year: | 3 |
| Number of Filters Replaced Per Year: | 1839 |
| *Membranes* | |
| Primary Desal Flux Rate (gfd): | 13.2 |
| Membrane Area per Element (ft2): | 400 |
| Number of Primary Desal Membrane Elements: | 1681 |
| Replacement Events per Year: | 0.2 |
| Number of 8-in Membrane Elements Replaced Per Year: | 336 |
| *Chemical Cleanings* | |
| Primary RO | |
| Number of Trains to Clean Per Cleaning Event: | 5.0 |
| Number of Cleaning Steps Per Train: | 3.0 |
| Step 1 Solution Volume (gal): | 3000 |
| Step 1 Cleaning Solution Strength (% by wt.): | 8.0% |
| Step 1 Cleaning Chemical Requirement (lbs): | 2001.6 |
| Step 2 Solution Volume (gal): | 3000 |
| Step 2 Cleaning Solution Strength (% by wt.): | 4.0% |
| Step 2 Cleaning Chemical Requirement (lbs): | 1000.8 |
| Step 3 Solution Volume (gal): | 3000 |
| Step 3 Cleaning Solution Strength (% by wt.): | 4.0% |
| Step 3 Cleaning Chemical Requirement (lbs): | 1000.8 |
| Step 1 Cleaning Solution Usage Per Cleaning Event (lbs/cleaning): | 10008.0 |
| Step 2 Cleaning Solution Usage Per Cleaning Event (lbs/cleaning): | 5004.0 |
| Step 3 Cleaning Solution Usage Per Cleaning Event (lbs/cleaning): | 5004.0 |
| Number of Step 1 Cleaning Events Per Year: | 3.0 |
| Number of Step 2 Cleaning Events Per Year: | 3.0 |
| Number of Step 3 Cleaning Events Per Year: | 4.0 |
| Step 1 Cleaning Chemical Requirement Per Year (lbs): | 30024 |
| Step 2 Cleaning Chemical Requirement Per Year (lbs): | 15012 |
| Step 3 Cleaning Chemical Requirement Per Year (lbs): | 20016 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 10,000 AFY - Worst Case Water

| | |
|---|---|
| *Maintenance Costs* | |
| Miscellaneous Equipment and Building Maintenance ($/yr): | $150,000 |
| Annual Well Maintenance ($/yr): | $300,000 |
| *Laboratory Costs* | |
| Sample Analysis ($/yr): | $50,000 |
| *Concentrate Disposal Costs* | |
| Usage @ $750/AF ($/yr): | $2,849,747 |
| Estimated Annual Concentrate Flow Measurement Station Costs ($/yr): | $45,000 |
| *Labor Cost* | |
| Number of Grade T2 Operators (No.): | 3 |
| Annual T2 Operator Salary ($/yr): | $72,696 |
| Number of Grade T1 Operators (No.): | 2 |
| Annual T1 Operator Salary ($/yr): | $59,821 |
| Total Raw Salary ($/yr): | $337,730 |
| Fringe Percentage (%): | 40% |
| Administrative Cost Percentage (%): | 55% |
| Total Labor Cost Per Year ($/yr): | $732,874 |
| *O&M Cost Summary:* | |
| *Power* | |
| Percentage Adder for Misc Power (%): | 2% |
| Total Power Cost ($/yr): | $2,866,577 |
| *Chemicals* | |
| Lime | $387,639 |
| Sulfuric Acid | $48,676 |
| Scale Inhibitor | $182,167 |
| Sodium Hypochlorite | $46,464 |
| Step 1 Cleaning | $84,668 |
| Step 2 Cleaning | $47,438 |
| Step 3 Cleaning | $40,032 |
| *Membranes* | $168,100 |
| *Cartridge Filters* | $22,072 |
| *Maintenance Costs* | $450,000 |
| *Labotatory Costs* | $50,000 |
| *Concentrate Disposal Costs* | $2,894,747 |
| *Labor* | $732,874 |
| Annual O&M Cost ($/yr): | $8,021,454 |
| Annual O&M Cost ($/kgal): | $2.520 |
| Annual O&M Cost ($/AF): | $821 |
| *Amortized Capital Cost* | |
| Capital Cost ($): | $85,137,023 |
| Interest (%): | 3.22% |
| Life Span of Investment (yrs): | 30 |
| Amortized Capital Cost ($/yr): | $4,468,057 |
| Annual O&M Cost with Capital Recovery ($/yr): | $12,489,511 |
| Annual O&M Cost with Capital Recovery ($/kgal): | $3.923 |
| Annual O&M Cost with Capital Recovery ($/AF): | $1,278 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 20,000 AFY - Worst Case Water

| | |
|---|---|
| *Unit Costs* | |
| Power ($/kWh): | $0.125 |
| Lime (slaked) ($/lb): | $0.20 |
| Sulfuric Acid ($/lb): | $0.03 |
| Scale Inhibitor ($/lb): | $0.95 |
| Sodium Hypochlorite ($/lb): | $0.35 |
| Membrane Elements - 8 inch diameter($/element): | $500.00 |
| Cartridge Filters ($/filter): | $12.00 |
| Step 1 Cleaning Chemical Cost ($/lb): | $2.82 |
| Step 2 Cleaning Chemical Cost ($/lb): | $3.16 |
| Step 3 Cleaning Chemical Cost ($/lb): | $2.00 |
| Plant Operating Factor: | 0.98 |
| *Well 1* | |
| Flowrate (gpm): | 1907 |
| Discharge Head (ft): | 226 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 154.4 |
| Power (kW): | 115.1 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 988492 |
| *Well 2* | |
| Flowrate (gpm): | 1907 |
| Discharge Head (ft): | 201 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 137.3 |
| Power (kW): | 102.4 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 879145 |
| *Well 3* | |
| Flowrate (gpm): | 1907 |
| Discharge Head (ft): | 190 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 129.8 |
| Power (kW): | 96.8 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 831033 |
| *Well 4* | |
| Flowrate (gpm): | 1907 |
| Discharge Head (ft): | 180 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 123.0 |
| Power (kW): | 91.7 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 787294 |
| *Well 5* | |
| Flowrate (gpm): | 1907 |
| Discharge Head (ft): | 194 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 132.5 |
| Power (kW): | 98.8 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 848528 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 20,000 AFY - Worst Case Water

| | |
|---|---|
| *Well 6* | |
| Flowrate (gpm): | 1907 |
| Discharge Head (ft): | 210 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 143.5 |
| Power (kW): | 107.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 918510 |
| *Well 7* | |
| Flowrate (gpm): | 1907 |
| Discharge Head (ft): | 212 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 144.8 |
| Power (kW): | 108.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 927258 |
| *Well 8* | |
| Flowrate (gpm): | 1907 |
| Discharge Head (ft): | 191 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 130.5 |
| Power (kW): | 97.3 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 835407 |
| *Well 9* | |
| Flowrate (gpm): | 1907 |
| Discharge Head (ft): | 179 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 122.3 |
| Power (kW): | 91.2 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 782921 |
| *Well 10* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 11* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |
| *Well 12* | |
| Flowrate (gpm): | 0 |
| Discharge Head (ft): | 250 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 0.0 |
| Power (kW): | 0.0 |
| Operational Factor: | 0.98 |
| Yearly Power Usage (kWh/yr): | 0 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 20,000 AFY - Worst Case Water

| | |
|---|---|
| *RO Feed Pumps* | |
| Number of Pumps: | 10.0 |
| Flowrate Per Pump (gpm): | 1717 |
| Discharge Head (ft): | 552 |
| Pump Efficiency (%): | 75.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 339.5 |
| Power (kW): | 253.2 |
| Operational Factor: | 0.98 |
| Yearly Power Usage Per Pump - Existing (kWh/yr): | 2173287 |
| Total Yearly Power Usage (kWh/yr): | 21732868 |
| *Primary RO Stage 2 Boost Pumps* | |
| Number of Pumps: | 10.0 |
| Flowrate Per Pump (gpm): | 655 |
| Discharge Head (ft): | 508 |
| Pump Efficiency (%): | 74.0% |
| Motor Efficiency (%): | 94.0% |
| Power (hp): | 120.8 |
| Power (kW): | 90.1 |
| Operational Factor: | 0.98 |
| Yearly Power Usage Per Pump (kWh/yr): | 773598 |
| Total Yearly Power Usage (kWh/yr): | 7735982 |
| *Procuct Water Pumps* | |
| Total Number of Pumps: | 4.0 |
| Flowrate Per Pump (gpm): | 3090 |
| Discharge Head (ft): | 118 |
| Pump Efficiency (%): | 84.0% |
| Motor Efficiency (%): | 92.5% |
| Power (hp): | 118.5 |
| Power (kW): | 88.4 |
| Operational Factor: | 0.98 |
| Total Yearly Power Usage (kWh/yr): | 3034518 |
| | |
| *Chemical Usage* | |
| Lime | |
| Post Treatment (lbs/day): | 10837.0 |
| Operating Factor: | 0.98 |
| Total Lime Usage (lbs/yr): | 3876393 |
| Sulfuric Acid | |
| Primary Desal Usage (lb/day): | 9072.1 |
| Operating Factor: | 0.98 |
| Total Sodium Hypochlorite Usage (lb/yr): | 3245078 |
| Scale Inhibitor | |
| Primary Desal Usage (lbs/day): | 618.6 |
| Operating Factor: | 0.98 |
| Total Scale Inhibitor Usage (lbs/yr): | 221255 |
| Sodium Hypochlorite | |
| Finished Water Usage (lb/day): | 742.3 |
| Operating Factor: | 0.98 |
| Total Sodium Hypochlorite Usage (lb/yr): | 265506 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 20,000 AFY - Worst Case Water

| | |
|---|---|
| *Cartidge Filters* | |
| Number of Primary Desal Cartridge Filter Elements: | 1226 |
| Replacement Events per Year: | 3 |
| Number of Filters Replaced Per Year: | 3679 |
| *Membranes* | |
| Primary Desal Flux Rate (gfd): | 13.2 |
| Membrane Area per Element (ft2): | 400 |
| Number of Primary Desal Membrane Elements: | 3362 |
| Replacement Events per Year: | 0.2 |
| Number of 8-in Membrane Elements Replaced Per Year: | 672 |
| *Chemical Cleanings* | |
| Primary RO | |
| Number of Trains to Clean Per Cleaning Event: | 10.0 |
| Number of Cleaning Steps Per Train: | 3.0 |
| Step 1 Solution Volume (gal): | 3000 |
| Step 1 Cleaning Solution Strength (% by wt.): | 8.0% |
| Step 1 Cleaning Chemical Requirement (lbs): | 2001.6 |
| Step 2 Solution Volume (gal): | 3000 |
| Step 2 Cleaning Solution Strength (% by wt.): | 4.0% |
| Step 2 Cleaning Chemical Requirement (lbs): | 1000.8 |
| Step 3 Solution Volume (gal): | 3000 |
| Step 3 Cleaning Solution Strength (% by wt.): | 4.0% |
| Step 3 Cleaning Chemical Requirement (lbs): | 1000.8 |
| Step 1 Cleaning Solution Usage Per Cleaning Event (lbs/cleaning): | 20016.0 |
| Step 2 Cleaning Solution Usage Per Cleaning Event (lbs/cleaning): | 10008.0 |
| Step 3 Cleaning Solution Usage Per Cleaning Event (lbs/cleaning): | 10008.0 |
| Number of Step 1 Cleaning Events Per Year: | 3.0 |
| Number of Step 2 Cleaning Events Per Year: | 3.0 |
| Number of Step 3 Cleaning Events Per Year: | 4.0 |
| Step 1 Cleaning Chemical Requirement Per Year (lbs): | 60048 |
| Step 2 Cleaning Chemical Requirement Per Year (lbs): | 30024 |
| Step 3 Cleaning Chemical Requirement Per Year (lbs): | 40032 |

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 20,000 AFY - Worst Case Water

| | |
|---|---|
| *Maintenance Costs* | |
| Miscellaneous Equipment and Building Maintenance ($/yr): | $150,000 |
| Annual Well Maintenance ($/yr): | $600,000 |
| *Laboratory Costs* | |
| Sample Analysis ($/yr): | $50,000 |
| *Concentrate Disposal Costs* | |
| Usage @ $750/AF ($/yr): | $5,699,494 |
| Estimated Annual Concentrate Flow Measurement Station Costs ($/yr): | $45,000 |
| *Labor Cost* | |
| Number of Grade T2 Operators (No.): | 3 |
| Annual T2 Operator Salary ($/yr): | $72,696 |
| Number of Grade T1 Operators (No.): | 2 |
| Annual T1 Operator Salary ($/yr): | $59,821 |
| Total Raw Salary ($/yr): | $337,730 |
| Fringe Percentage (%): | 40% |
| Administrative Cost Percentage (%): | 55% |
| Total Labor Cost Per Year ($/yr): | $732,874 |
| *O&M Cost Summary:* | |
| *Power* | |
| Percentage Adder for Misc Power (%): | 2% |
| Total Power Cost ($/yr): | $5,138,500 |
| *Chemicals* | |
| Lime | $775,279 |
| Sulfuric Acid | $97,352 |
| Scale Inhibitor | $210,193 |
| Sodium Hypochlorite | $92,927 |
| Step 1 Cleaning | $169,335 |
| Step 2 Cleaning | $94,876 |
| Step 3 Cleaning | $80,064 |
| *Membranes* | $336,200 |
| *Cartridge Filters* | $44,144 |
| *Maintenance Costs* | $750,000 |
| *Labotatory Costs* | $50,000 |
| *Concentrate Disposal Costs* | $5,744,494 |
| *Labor* | $732,874 |
| Annual O&M Cost ($/yr): | $14,316,237 |
| Annual O&M Cost ($/kgal): | $2.248 |
| Annual O&M Cost ($/AF): | $733 |
| *Amortized Capital Cost* | |
| Capital Cost ($): | $147,965,936 |
| Interest (%): | 3.22% |
| Life Span of Investment (yrs): | 30 |
| Amortized Capital Cost ($/yr): | $7,765,368 |
| Annual O&M Cost with Capital Recovery ($/yr): | $22,081,605 |
| Annual O&M Cost with Capital Recovery ($/kgal): | $3.468 |
| Annual O&M Cost with Capital Recovery ($/AF): | $1,130 |

# APPENDIX E – DETAILED CAPITAL COST ESTIMATE

Carollo Engineers, Inc.

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 10,000 AFY - Worst Case Water

| | Units | Unit Costs | Quantity | Cost |
|---|---|---|---|---|
| Drilled and Equipped Wells[1] | EA | $2,500,000 | 6 | $15,000,000 |
| North Wellfield Pipelines | | | | |
| 12" HDPE | LF | $79 | 4550 | $359,450 |
| 20" HDPE | LF | $136 | 3150 | $428,400 |
| 24" HDPE | LF | $167 | 2700 | $450,900 |
| 30" HDPE | LF | $229 | 1350 | $309,150 |
| 36" HDPE | LF | $253 | 1400 | $354,200 |
| South Wellfield Pipelines | | | | |
| 12" HDPE | LF | $79 | 0 | $0 |
| 20" HDPE | LF | $136 | 0 | $0 |
| 24" HDPE | LF | $167 | 0 | $0 |
| 30" HDPE | LF | $229 | 0 | $0 |
| 36" HDPE | LF | $253 | 0 | $0 |
| Sand Separators | EA | $88,550 | 2 | $177,100 |
| Cartridge Filters | EA | $46,000 | 3 | $138,000 |
| RO Feed Pumps | EA | $275,000 | 5 | $1,375,000 |
| RO Systems | GPD | $0.45 | 8900000 | $4,005,000 |
| RO CIP System | EA | $155,000 | 1 | $155,000 |
| RO Flush/Plant Water Pumps | EA | $35,000 | 4 | $140,000 |
| RO Flush Tank | EA | $150,000.00 | 1 | $150,000 |
| Product Water Storage Tank | gal | $1.00 | 1990000 | $1,990,000 |
| Finished Water Pumps | EA | $175,000 | 3 | $525,000 |
| Product Water Pipeline | LF | $304 | 30530 | $9,281,120 |
| Concentrate Pipeline | LF | $106 | 1400 | $148,400 |
| SMP Connection Station | EA | $300,000 | 1 | $300,000 |
| Lime Feed System | EA | $747,500 | 1 | $747,500 |
| Sodium Hypochlorite Feed System | EA | $67,500 | 1 | $67,500 |
| Scale Inhibior Storage and Feed | EA | $67,500 | 1 | $67,500 |
| Building, Non-Process Area [2] | $FT^2$ | $250 | 4048 | $1,012,000 |
| Building, Process Area [2] | $FT^2$ | $200 | 7850 | $1,570,000 |
| Covered Chemical Storage | $FT^2$ | $75 | 2200 | $165,000 |
| | | | | |
| Sitework[3] | % | 5% | | $614,230 |
| Electrical & I/C [4] | % | 30% | | $3,685,380 |
| Mechanical[5] | % | 25% | | $2,384,400 |
| | | | | |
| Direct Cost Subtotal | | | | $45,600,230 |
| Contingency | % | 25% | | $11,400,058 |
| Subtotal | | | | $57,000,288 |
| Sales Tax[6] | % | 9% | | $2,565,013 |
| Subtotal | | | | $59,565,300 |
| Contractor General Conditions | % | 6% | | $3,573,918 |
| Subtotal | | | | $63,139,218 |
| Contractor Overhead and Profit | % | 12% | | $7,576,706 |
| Subtotal | | | | $70,715,925 |
| Escalation to Midpoint[7] | % | 2.9% | | $2,050,762 |
| | | | | |
| TOTAL CONSTRUCTION COSTS | | | | $72,766,686 |
| Engineering and Contract Administration (20%) | % | 17% | | $12,370,337 |
| TOTAL PROJECT COST[12] | | | | $85,137,023 |

1. Based on CDA Phase III Expansion well costs
2. Includes general building HVAC and plumbing.
3. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements. Excludes pipelines and wells.
4. Electrical for desalter site facilities only and does not include backup power. Well electrical costs included in well equipment unit cos
5. Estimate for onsite piping, valves, supports, etc. HVAC and plumbing included in building per square foot cost.
6. Estimated as sales tax*(0.5*direct cost+contingency)
7. Assumes 18 month construction schedule.

Project: South Oxnard Plain Feasibility Study
Client: UWCD
Option: 20,000 AFY - Worst Case Water

| | Units | Unit Costs | Quantity | Cost |
|---|---|---|---|---|
| Drilled and Equipped Wells[1] | EA | $2,500,000 | 12 | $30,000,000 |
| North Wellfield Pipelines | | | | |
| 12" HDPE | LF | $79 | 4550 | $359,450 |
| 20" HDPE | LF | $136 | 3150 | $428,400 |
| 24" HDPE | LF | $167 | 2700 | $450,900 |
| 30" HDPE | LF | $229 | 1350 | $309,150 |
| 36" HDPE | LF | $253 | 1400 | $354,200 |
| South Wellfield Pipelines | | | | |
| 12" HDPE | LF | $79 | 3075 | $242,925 |
| 20" HDPE | LF | $136 | 1600 | $217,600 |
| 24" HDPE | LF | $167 | 3100 | $517,700 |
| 30" HDPE | LF | $229 | 0 | $0 |
| 36" HDPE | LF | $253 | 3950 | $999,350 |
| Sand Separators | EA | $88,550 | 4 | $354,200 |
| Cartridge Filters | EA | $46,000 | 6 | $276,000 |
| RO Feed Pumps | EA | $275,000 | 10 | $2,750,000 |
| RO Systems | GPD | $0.45 | 17800000 | $8,010,000 |
| RO CIP System | EA | $155,000 | 1 | $155,000 |
| RO Flush/Plant Water Pumps | EA | $35,000 | 4 | $140,000 |
| RO Flush Tank | EA | $150,000.00 | 1 | $150,000 |
| Product Water Storage Tank | gal | $1.00 | 4010000 | $4,010,000 |
| Finished Water Pumps | EA | $175,000 | 5 | $875,000 |
| Product Water Pipeline | LF | $425 | 30530 | $12,975,250 |
| Concentrate Pipeline | LF | $136 | 1400 | $190,400 |
| SMP Connection Station | EA | $300,000 | 1 | $300,000 |
| Lime Feed System | EA | $747,500 | 1 | $747,500 |
| Sodium Hypochlorite Feed System | EA | $67,500 | 1 | $67,500 |
| Scale Inhibior Storage and Feed | EA | $67,500 | 1 | $67,500 |
| Building, Non-Process Area [2] | $FT^2$ | $250 | 4048 | $1,012,000 |
| Building, Process Area [2] | $FT^2$ | $200 | 15700 | $3,140,000 |
| Covered Chemical Storage | $FT^2$ | $75 | 2200 | $165,000 |
| | | | | |
| Sitework[3] | % | 5% | | $1,095,985 |
| Electrical & I/C [4] | % | 30% | | $6,575,910 |
| Mechanical[5] | % | 25% | | $4,400,675 |
| | | | | |
| Direct Cost Subtotal | | | | $81,337,595 |
| Contingency | % | 25% | | $20,334,399 |
| Subtotal | | | | $101,671,994 |
| Sales Tax[6] | % | 9% | | $4,575,240 |
| Subtotal | | | | $106,247,233 |
| Contractor General Conditions | % | 6% | | $6,374,834 |
| Subtotal | | | | $112,622,067 |
| Contractor Overhead and Profit | % | 12% | | $13,514,648 |
| Subtotal | | | | $126,136,716 |
| Escalation to Midpoint[7] | % | 2.9% | | $3,657,965 |
| | | | | |
| TOTAL CONSTRUCTION COSTS | | | | $129,794,680 |
| Engineering and Contract Administration (20%) | % | 14% | | $18,171,255 |
| TOTAL PROJECT COST[12] | | | | $147,965,936 |

1. Based on CDA Phase III Expansion well costs
2. Includes general building HVAC and plumbing.
3. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements. Excludes pipelines and wells.
4. Electrical for desalter site facilities only and does not include backup power. Well electrical costs included in well equipment unit cos
5. Estimate for onsite piping, valves, supports, etc. HVAC and plumbing included in building per square foot cost.
6. Estimated as sales tax*(0.5*direct cost+contingency)
7. Assumes 18 month construction schedule.