PURE WATER PROJECT
LAS VIRGENES-TRIUNFO

Bringing Our Water Full Circle

Tapia Water Reclamation Facility and Advanced Water Purification Facility Flow Equalization Analysis

Prepared by

Jacobs

Las Virgenes-Triunfo Joint Powers Authority

February 2023

Executive Summary

Background

The Las Virgenes-Triunfo Joint Powers Authority (JPA) owns and operates the Tapia Water Reclamation Facility (Tapia WRF), located in the Santa Monica Mountains. The Tapia WRF has a permitted capacity of 12 million gallons per day (MGD) and treats wastewater from primarily domestic sources in western Los Angeles and eastern Ventura counties to recycled water quality for use as landscape irrigation. All of the recycled water produced at the Tapia WRF is used for irrigation during summer months; however, surplus recycled water is discharged to Malibu Creek in winter months. Demand for recycled water varies seasonally, with summertime demand significantly higher than typical winter, spring, and fall demands.

Under the Pure Water Project Las Virgenes-Triunfo (PWP), the JPA will construct an Advanced Water Purification Facility (AWPF) to provide further treatment of the recycled water for indirect potable reuse, both to address new stringent regulatory requirements and to create a new source of potable water in a region that now imports nearly all potable water through the State Water Project.

The influent flow to Tapia WRF varies due to a diurnal flow pattern and can experience a significant increase because of infiltration and inflow (I&I) during wet weather events. Tapia WRF experiences seasonal variations and wet weather events when the influent flow to the plant can be as much as three times the average annual rated capacity. Current operations of the facility capture the smaller storms through the Balancing Pond and typically can return to daily fluctuations in flow within hours. Operations has reported that during large storms, high flows through secondary treatment result in solids washout and treatment process upsets that require time to recover. The secondary clarifiers have a relatively shallow side water depth, and the tertiary filtration process capacity is limited to the dry weather peak flow rate.

Study Purpose

This evaluation assessed the equalization (EQ) storage volume requirements to manage flows from both diurnal variation and wet weather events, with the objectives to reduce the peak flow on the secondary treatment and tertiary filtration processes, and to stabilize overall treatment performance at Tapia WRF. The tertiary recycled water produced by Tapia WRF will be a source water for the new AWPF. In anticipation of the PWP, this evaluation also investigated the recycled water system improvements and EQ storage volume requirement at the AWPF to provide a more stable flow for optimal operation of the new advanced treatment processes.

Seasonal demands and flow variations due to precipitation and irrigation demands will determine the available flow for the AWPF and highlights the need for proactive management throughout the recycled water system. Currently, the recycled water system operates in a reactive state, as operations are dictated by recycled water demands and unpredictable, seasonal storms. This reactive process makes it challenging to balance the changing flow demands in the system, which will become more complex with the addition of the AWPF as the highest recycled water user.

This report summarizes the modeling efforts and recommendations for flow EQ at Tapia WRF and the AWPF, improvements to the recycled water system, and operational strategies to enhance performance at the new AWPF.

Basis of Analysis

A comprehensive flow balance model was developed using 5 years of historical flow data for Tapia WRF and the recycled water system demands from 2017 through 2021 to simulate EQ needs at Tapia WRF and the AWPF under various flow scenarios. The modeling efforts were organized into two main components: the flow analysis at Tapia WRF, and analysis of the recycled water system to incorporate the new AWPF as a user.

Flow Scenarios

The following three Tapia WRF flow scenarios were modeled to assess the sizing of a primary effluent EQ basin at Tapia WRF, sizing of an influent EQ basin at the new AWPF, and the impact of integrating the new AWPF into the recycled water system:

1) **Historical Flow Scenario:** The current Tapia WRF average annual daily influent flow ranges from 7.3 to 8.1 MGD (2017 to 2021). This scenario assessed impacts using historical Tapia WRF flows and irrigation demands.
2) **Design Capacity Flow Scenario:** The rated Tapia WRF design capacity is 12 MGD, on an average annual daily flow basis. This scenario assessed the impacts using historical flows for Tapia WRF adjusted to represent the rated design capacity and historical irrigation demands.
3) **Reduced I&I Flow Scenario:** Based on repair efforts, Las Virgenes Municipal Water District (LVMWD) is projecting a reduction in flow to the Tapia WRF of at least 1 MGD. This scenario assessed the impacts using historical flows for Tapia WRF adjusted by a reduction of 1 MGD and historical irrigation demands.

The associated diurnal patterns and peaking factors were incorporated into the model runs for these scenarios.

Summary of Recommendations

The JPA service area has historically experienced wet weather seasons of increased rainfall and higher influent flows during the winter and spring months (December to April). Rainfall-dependent I&I can heavily affect the volume required for EQ. The duration of a typical storm ranged from a few hours to 1 day, and extreme storms often exceeded 2 days of precipitation. I&I during and following seasonal storms, most notably in the winter months, impacted the flow to Tapia WRF. For the 5 years of historical flow data from 2017 to 2021, 2017 was the most extreme wet weather year, with the two largest storm events. As observed in February 2017, the highest peak hour flow to Tapia WRF reached 36 MGD during the largest wet weather event, which is almost 5 times the current average daily flow. During the peak storm in 2017, Malibu Creek discharge flow increased to 26 MGD and was sustained for 9.5 hours.

This evaluation assesses the EQ storage volumes required to manage variable diurnal flows and wet weather events for Tapia WRF, while also investigating the recycled water system improvements and EQ storage volume needed at the AWPF to provide a stable flow for optimal operation of the new advanced facility. Additional storage at Tapia WRF and the new AWPF, and improvements to the recycled water pumping systems, will promote more proactive management of the recycled water system.

Tapia Water Reclamation Facility

The recommended solutions for Tapia WRF include:

- Building an onsite primary effluent EQ basin to ease seasonal demand differences and improve operations at Tapia WRF for the following reasons:
  - A 1.0-MG EQ basin would be sufficient storage to accommodate typical diurnal flows, targeting two flow changes per day.
  - A 2.0-MG EQ basin would be required to accommodate typical diurnal flows, targeting one flow change per day.
  - Expanding the daily flows to the wet weather events, a 3.0-MG basin would attenuate flows from most historical wet weather events and provide greater operational flexibility. For design capacity scenarios, a 3.0-MG basin would provide sufficient storage to capture most of the peak storms

when used with the Balancing Pond. If more sustained peaks were to be experienced, greater use of the primary effluent EQ volume over the Balancing Pond would be beneficial to stay within the peak capacity of the secondary treatment process.

  - To capture the peak flow seen in the February 2017 storm, a 5.0-MG EQ basin would be required based on historical flows. Using the design flow scenario, the required EQ volume would increase to 9.42 MG if Tapia WRF were operating at 12 MGD. However, constructing an EQ basin of this size is not feasible due to physical site constraints, and this size storm has had a historical frequency of once every 5 years.

- Implementing a flow control strategy to promote stable flow through the treatment facility. This operational strategy can be achieved with the addition of primary effluent EQ. A larger EQ volume would be required to achieve one flow change per day, versus two flow changes per day.
- Evaluating the secondary treatment capacity for alternatives to improve the activated sludge settleability during seasonal transition months to optimize secondary clarifier capacity.
- Improving the Tapia WRF Effluent Pump Station by upgrading the pumps to operate on variable frequency drives (VFDs). The addition of VFDs will reduce the overall pump station demand and produce a more consistent effluent flow into the recycled water distribution system. Currently, the capacity is below the rating for the tertiary filters and should be aligned.

Recycled Water System Improvements

The recommended solutions for the recycled water system include:

- Upgrading the Recycled Water Pump Station (RWPS) East and West pumps to operate on VFDs. This improvement will allow the pump stations to more easily meet a variety of flows and demands, leading to lower storage requirements, optimized pump station capacity, and a reduction in wear and tear on equipment. Ultimately, this will promote less flow fluctuations in the distribution system.
- Improving the operational level control of the storage tanks, such as Reservoir 2 and Indian Hills Tank, to use a larger percentage of the usable storage capacity. This refinement promotes a more forecasted level control and allows the existing storage to be used to support the operation of the new AWPF.
- Implementing the flow control strategy to use the previous day's flow data and current flow data to improve system responsiveness. This operational strategy promotes proactive management of the recycled water distribution system.
- Coordinating irrigation demand schedules with the largest users, such as golf courses and parks, to aid in proactive management of the supply and demand of the recycled water distribution system.

Advanced Water Purification Facility

The benefits from the overall improvements at Tapia WRF and throughout the recycled water system will be observed as well at the new AWPF. The recommended solutions for the new AWPF include:

- Building an onsite influent 0.5-MG EQ basin for daily diurnal flows at the new AWPF. This will help provide a more consistent flow to the sensitive unit processes, specifically reverse osmosis (RO), in the new AWPF. This sizing recommendation is dependent on using the existing storage in the recycled water distribution system and the addition of VFDs at RWPS East and West.
- Implementing a flow control strategy to target a maximum of two fundamental flow changes per day. In addition to this target, the operational strategy of using the influent flow conditions to determine operating scenarios for process equipment (such as RO skids) will help reduce the wear and tear on the equipment. These improvements promote stable flow through the treatment facility, preserve the process equipment, and is achievable with the addition of the influent EQ basin.

Tapia Water Reclamation Facility Equalization Cost Summary

A volume of 1.0 MG can be accommodated by retrofitting existing tank infrastructure, but greater volumes require a new tank. Table ES-1 provides the opinion of probable construction cost for the Tapia WRF EQ basin options, in August 2022 dollars.

Table ES-1. Construction Cost Estimate for Tapia Water Reclamation Facility Equalization[a]

Option	EQ Size (MG)	Estimated Capital Cost ($ millions)	Low Range -30% ($ millions)	High Range + 50% ($ millions)
Option 1 - Retrofit	1	6.0	4.2	9.0
Option 2 - New	3	10.6	7.4	15.9

[a] AACE International Class 5 estimate with an accuracy range of -15 to -30% on the low side and +20 to +50% on the high side.

Contents

Appendices

Tables

Figures

Acronyms and Abbreviations

AF	acre-foot (feet)
AWPF	Advanced Water Purification Facility
CCR	California Code of Regulations
cfs	cubic foot (feet) per second
EPA	U.S. Environmental Protection Agency
EQ	equalization
ft^2	square foot (feet)
gpm	gallon(s) per minute
gpm/ft^2	gallon(s) per minute per square foot
HLR	hydraulic loading rate
hp	horsepower
I&I	infiltration and inflow
IDF	intensity, duration, and frequency
Jacobs	Jacobs Engineering Group, Inc.
JPA	Las Virgenes - Triunfo Joint Powers Authority
$lb\text{-}TSS/\ ft^2/d$	pound(s) of total suspended solids per square foot per day
LVMWD	Las Virgenes Municipal Water District
MG	million gallons
mg/L	milligram(s) per liter
mg-TSS/L	milligram(s) total suspended solids per liter
MGD	million gallons per day
mL/g	milliliter(s) per gram
MLSS	mixed liquor suspended solids
No.	number
NPDES	National Pollutant Discharge Elimination System
PWP	Pure Water Project Las Virgenes-Triunfo
RAS	return activated sludge
Regional Board	Los Angeles Regional Water Quality Control Board
RO	reverse osmosis
RWPS	Recycled Water Pump Station
SLR	solids loading rate
SVI	settled volume index
Tapia WRF	Tapia Water Reclamation Facility
TDH	total dynamic head
TMDL	total maximum daily load

Triunfo WSD	Triunfo Water & Sanitation District
VFD	variable frequency drive
WDR	Waste Discharge Requirements

1. Introduction

This report describes the Tapia Water Reclamation Facility and Advanced Water Purification Facility Flow Equalization Analysis Jacobs Engineering Group, Inc. (Jacobs) completed for the Las Virgenes-Triunfo Joint Powers Authority (JPA) Pure Water Project (PWP).

1.1 Project Background

The JPA is a partnership between Las Virgenes Municipal Water District (LVMWD) and Triunfo Water & Sanitation District (Triunfo WSD) that was established in 1964 to cooperatively treat wastewater for these two neighboring districts within the Malibu Creek watershed. The JPA collects, conveys, and treats wastewater from residents in western Los Angeles and eastern Ventura counties, including the cities of Agoura Hills, Calabasas, Hidden Hills, Oak Park, Thousand Oaks, and Westlake Village. LVMWD serves as the administering agent for the JPA facilities.

The Las Virgenes-Triunfo JPA owns and operates the Tapia Water Reclamation Facility (Tapia WRF), located in the Santa Monica Mountains along Malibu Canyon Road. The Tapia WRF has a permitted capacity of 12 million gallons per day (MGD) for average daily flow and treats wastewater from primarily domestic sources (CA RWQCB Los Angeles Region 2017). The current average annual flow is approximately 7.5 MGD.

The facility treats wastewater to *California Code of Regulations* (CCR), Title 22 standards[1] for recycled water, primarily for nonresidential landscape irrigation, such as roadway medians, school yards, and golf courses within Calabasas, Agoura Hills, and Westlake Village and some residential landscape irrigation. Excess recycled water is either discharged to Malibu Creek, used in nearby spray fields, or sent to the Los Angeles River. All of the recycled water produced at the Tapia WRF is used for irrigation during summer months; however, surplus recycled water is discharged to Malibu Creek in winter months.

The Tapia WRF operates pursuant to a federal National Pollutant Discharge Elimination System (NPDES) permit and state Waste Discharge Requirements (WDRs). Collectively, the Los Angeles Regional Water Quality Control Board (Regional Board) adopted the WDRs and NPDES Permit CA0056014/Order R4-2017-0124 on June 1, 2017. The NPDES waste discharge permit for Tapia WRF prohibits discharge to Malibu Creek from April 15 to November 15, except under an operational emergency or qualifying storm event, for protection of habitats in Malibu Creek and Malibu Lagoon. The NPDES permit also requires discharge from the Tapia WRF to Malibu Creek to maintain a minimum stream flow of 2.5 cubic feet per second (cfs) to help support steelhead habitat.

Regional Board Resolution Number (No.) R16-009 (May 16, 2017) amended the Water Quality Control Plan for the Los Angeles Region (*Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties* [Regional Board 2020]) to incorporate more stringent seasonal nitrogen and phosphorus total maximum daily loads (TMDLs) for discharge to Malibu Creek. This amendment addressed benthic community impairments to comply with U.S. Environmental Protection Agency (EPA) established *Malibu Creek and Lagoon Sedimentation and Nutrients TMDL to Address Benthic Community Impairments* (EPA 2013).

To address these stringent EPA water quality standards, while beneficially using surplus recycled water to improve regional water supply reliability and drought resilience, the fundamental plan for the PWP is to build an Advanced Water Purification Facility (AWPF) to treat tertiary effluent from the Tapia WRF for indirect potable reuse, and convey purified water to the Las Virgenes Reservoir, where it will be blended with LVMWD supply. The water from the Las Virgenes Reservoir will then be treated at the Westlake Filtration Plant prior to distribution.

[1] Title 22, Social Security, Division 4 Environmental Health

The recycled water distribution system includes:

- 3 open reservoirs
- 3 storage tanks
- 4 pump stations
- 62 miles of pipelines serving 661 individual connections

Demand for recycled water varies seasonally, with summertime demand significantly higher than typical winter, spring, and fall demands. For this reason, the recycled water system is supplemented by the drinking water system and by the groundwater wells that discharge into the sewer system for treatment at Tapia WRF (Kennedy Jenks 2014).

1.2 Purpose

The influent flow to Tapia WRF varies due to a diurnal flow pattern and can experience a significant increase because of infiltration and inflow (I&I) during wet weather events. This evaluation assessed the equalization (EQ) storage volume requirements to manage flows from both diurnal variation and wet weather events, with the objectives to reduce the peak flow on the secondary treatment and tertiary filtration processes, and to stabilize overall treatment performance at Tapia WRF. In anticipation of the PWP, this evaluation also investigated the recycled water system improvements and EQ storage volume requirement at the AWPF to provide a more stable flow for optimal operation of the new advanced treatment processes. Currently, the recycled water system operates in a reactive state, and operations are dictated by recycled water demands and seasonal storms. The existing system is controlled by the storage tank level set points that signal constant speed pumps to turn on and off. This reactive process makes it challenging to balance the changing flow demands in the system, which will become more complex with the addition of the AWPF as the highest recycled water user. This report summarizes the historical flows, modeling efforts, and recommendations resulting from this EQ flow analysis.

1.3 Basis of Analysis

A comprehensive flow balance model was developed using nearly 5 years of historical flow data for Tapia WRF and the recycled water system demands from 2017 through 2021 provided by LVMWD to simulate EQ needs at Tapia WRF and the AWPF under various flow scenarios. Hydraulic analysis of the recycled water system is being performed by Woodard & Curran as part of the PWP pipeline alignment study and is not part of this effort.

The modeling efforts were organized into two main components: the flow analysis at Tapia WRF, and analysis of the recycled water system to incorporate the new AWPF as a user. The primary objectives are:

Tapia WRF

- Identify the flow EQ volumes and pumping needs to attenuate peak flows for the diurnal and wet weather storm events
- Provide the construction cost estimate for the recommended improvements

AWPF

- Summarize the overall system improvements for the recycled water system to integrate the new AWPF as a recycled water user
- Identify the flow EQ volume needs at the new AWPF

This report summarizes recommendations for flow EQ at Tapia WRF and the AWPF, improvements to the recycled water system, and operational strategies to enhance performance at the new AWPF.

2. Historical Data

This section provides a summary of historical data received from LVMWD. LVMWD provided 5 years of historical data from 2017 to 2021 at 1-minute intervals for the following parameters:

- Tapia WRF influent flow
- Tapia WRF effluent flow
- Malibu Creek discharge flow
- Pepperdine recycled water demand flow
- Rancho Pump Station recycled water demand flow
- Potable water supplemental flow
- Recycled Water Pump Station (RWPS) East flow
- RWPS West flow
- Reservoir 2 level
- Indian Hills Tank level

At times, analysis of the data set revealed null values, which represent a loss in communication with the historian. These values were replaced with the previous timestep value. The values for significant periods exceeding 24 hours with no data were excluded from the evaluation. The cleansed data set for 2017 to 2021 was entered into the simulation model.

2.1 Tapia Water Reclamation Facility Historical Data

This section summarizes the Tapia WRF historical flow data.

2.1.1 Tapia Water Reclamation Facility Flow

Figure 2-1 shows the average daily influent flow to Tapia WRF over the last 19 years. Influent flow has decreased due to conservation, but appears to have stabilized over the last 7 years.

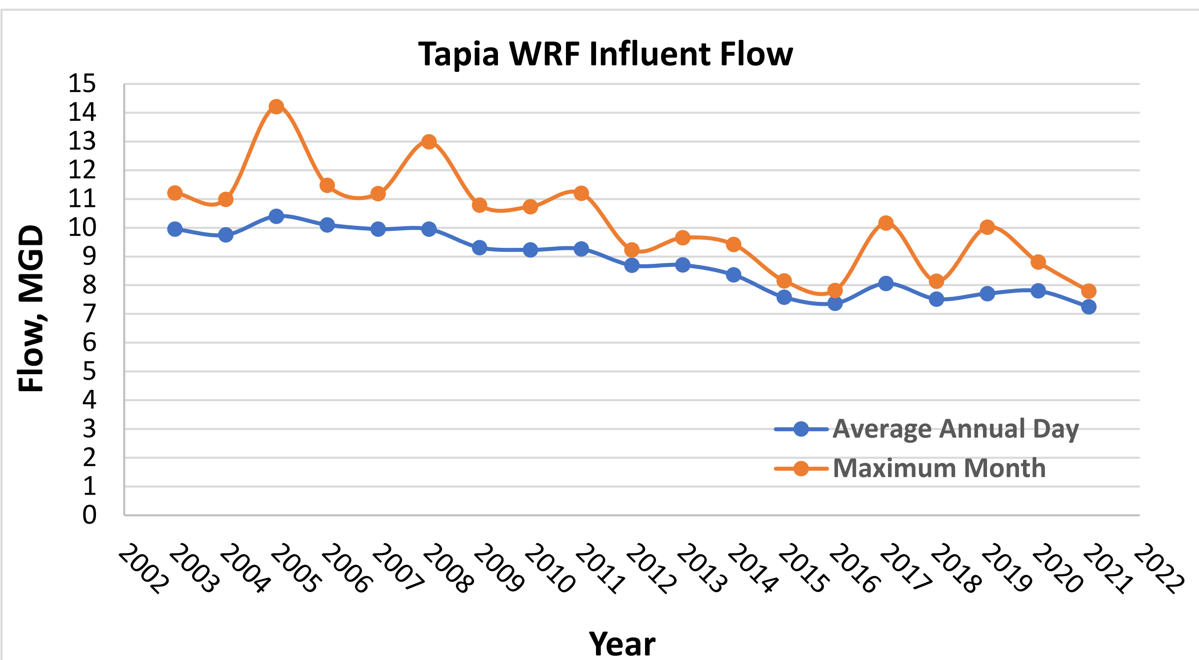


Figure 2-1. Tapia Water Reclamation Facility Daily Average Influent Flow, 2003 to 2021

The 2017 to 2021 historical flow data at Tapia WRF were used as the baseline data for the modeling analysis. The average daily influent flow to Tapia WRF ranged from approximately 7 to 8 MGD. Percentile distributions of the hourly data by year were used to characterize Tapia WRF's influent flow and effluent flow sent to the recycled water system, which are summarized in Tables 2-1 and 2-2, respectively.

Table 2-1. Tapia Water Reclamation Facility Influent Average Hour Flow, 2017 to 2021

Year	Influent Flow Percentile Distribution (MGD)						
	10%	25%	50%	75%	95%	99%	100%
2017	4.5	6.5	8.2	9.5	11.7	14.0	36.0
2018	4.3	6.0	7.8	8.8	10.7	11.8	22.3
2019	4.0	5.8	7.8	9.3	11.8	13.9	25.1
2020	4.0	5.6	8.1	9.5	12.0	12.9	15.3
2021	3.5	5.2	7.7	9.1	11.8	13.7	30.1

Table 2-2. Tapia Water Reclamation Facility Effluent Average Hour Flow to Recycled Water System, 2017 to 2021

Year	Effluent Flow Percentile Distribution (MGD)						
	10%	25%	50%	75%	95%	99%	100%
2017	0.1	1.9	7.4	8.1	10.8	13.8	15.7
2018	0.1	0.6	6.6	7.9	9.8	13.2	16.7
2019	0.1	0.6	7.1	8.1	10.4	13.4	16.5
2020	0.3	1.9	7.5	8.1	12.3	14.7	16.2
2021	0.1	0.8	7.5	7.9	9.9	15.3	16.6

Peak wet weather events experienced at Tapia WRF were identified to further assess EQ needs. The duration of a typical storm ranged from a few hours to 1 day, and extreme storms often exceeded 2 days of precipitation. I&I during and following seasonal storms, most notably in the winter months, impacted the flow to Tapia WRF. For the 5 years of historical flow data from 2017 to 2021, 2017 was the most extreme wet weather year with the two largest storm events. As observed in February 2017, the highest peak hour flow to Tapia WRF reached 36 MGD during the largest wet weather event, which is almost 5 times the current average daily flow.

During periods of high precipitation and lower recycled water usage during the winter months, Tapia WRF currently discharges excess flow to Malibu Creek. Figure 2-2 shows the historical discharges to Malibu Creek for 2017, and Appendix A provides similar plots for 2018 through 2021. During the peak storm in 2017, Malibu Creek discharge flow increased to 26 MGD and was sustained for 9.5 hours. The AWPF will aim to treat most of this excess flow. However, there will be conditions in the winter months where the excess flow will exceed the capacity of the AWPF and other recycled water use and discharge locations, and will need to be discharged to Malibu Creek. Discharges shown during the prohibition period of April 15 to November 15 represent low flow periods where effluent flow from Tapia WRF was supplemented to maintain the minimum instream flow of 2.5 cfs in Malibu Creek.

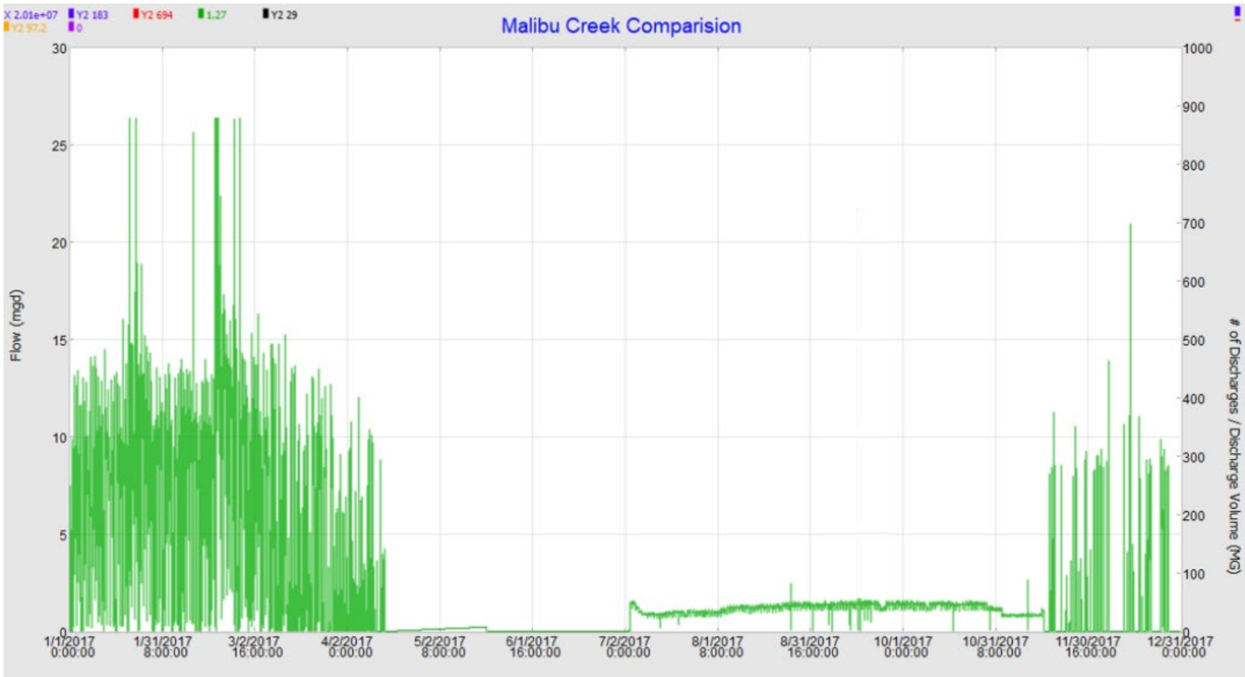


Figure 2-2. Tapia Water Reclamation Facility Historical Discharges to Malibu Creek, 2017

In addition, the JPA is currently building a summertime flow augmentation project, consisting of a new pipeline with breakpoint chlorination treatment. This pipeline will convey water into Malibu Creek from a nearby LVMWD Potable System Pipeline after additional treatment at the existing Tapia WRF overflow structure (Stantec 2019). This new pipeline will comply with new water quality requirements and maintain minimum instream flows in Malibu Creek during the summer, and will support maintaining the instream flow requirements once the more stringent limitations to summertime flow augmentation are in effect and the AWPF is operational.

2.1.2 Historical Storm Characterization

The JPA service area has historically experienced wet weather seasons of increased rainfall and higher influent flows during the winter and spring months (December to April). Rainfall dependent I&I can heavily affect the volume required for EQ. Jacobs attempted to characterize the historical storms that occurred within the watershed draining to the Tapia WRF by reviewing the availability of data from:

- Precipitation gages: Source of precipitation data for historical storms
- Intensity, duration, and frequency (IDF) stations: Source of IDF curves used to characterize the size of a storm

Data demonstrated that precipitation is stratified in the region due to the canyons. There was significantly more influent flow during the storm periods than average flow conditions, yet the available precipitation gage data indicated the storms contributing to rainfall I&I had low intensity. This suggests that there are not enough rain gages to capture the storms that fell over the watershed. In addition, LVMWD does not have a sewer model for the collection system that conveys wastewater to the Tapia WRF, as the District only owns and maintains the main trunk lines, while the collector lines are owned by others. Due to lack of rain gages and no existing model, Jacobs was unable to characterize the storm events that were modeled during the 2017 to 2021 period. Instead of this approach, the available flow data to Tapia WRF were reviewed to assess the high flow wet weather events. This approach is valid if there are no collection system overflows, which would be captured and contribute additional flow if system improvements were made.

2.2 Recycled Water System Historical Data

Seasonal demands and flow variations due to precipitation and irrigation demands will determine the available flow for the AWPF and highlights the need for proactive management throughout the recycled water system. Pairing the historical flow data for the RWPS East and West, the additional irrigation demands from Rancho Pump Station and Pepperdine, and the level data for Reservoir 2 and Indian Hills Tank offers insight on how the recycled water system currently functions.

The historical irrigation demand patterns are erratic and inconsistent, as they are based on unpredictable precipitation and atmospheric conditions. There are more demands over the summer months and fewer in the winter, although some irrigation demand still occurs in the winter. Prior to Reservoir 2, Pepperdine and Rancho Pump Station receive recycled water year-round with seasonal variations in demand. After Reservoir 2, RWPS West and East supply recycled water to meet the irrigation demands in the western and eastern distribution systems, respectively. These pump stations and downstream storage tanks fluctuate daily to meet irrigation demands. Percentile distributions were used to characterize flow throughout the recycled water system, which are summarized in Appendix A.

The tertiary recycled water produced by Tapia WRF will be the source water for the new AWPF. The recycled water demands will take priority over the AWPF, so the historical flow that would have been available to the AWPF was calculated as the difference between the Tapia WRF effluent flow and the recycled water demands. All of the recycled water produced at the Tapia WRF is used for irrigation during summer months, with minor discharges to the spray fields and Los Angeles River. The facility is intended to operate primarily during the winter months when the irrigation water demand is low, and the seasonal precipitation is high.

Percentile distributions of the daily flow data were used to characterize Tapia WRF's effluent flow sent to the recycled water system and Malibu Creek, which are summarized in Table 2-3. The effluent flow that was discharged to the creek represents the flow that would have been available for the AWPF.

Table 2-3. Tapia Water Reclamation Facility Effluent Average Day Flow, 2017 to 2021

Year	Effluent Flow Percentile Distribution (MGD)						
	10%	25%	50%	75%	95%	99%	100%
To Recycled Water System							
2017	0.64	3.54	5.88	7.51	8.78	9.51	10.0
2018	1.11	2.95	5.43	7.29	8.84	9.52	10.0
2019	0.47	1.19	5.31	6.94	7.94	8.36	9.17
2020	1.22	3.33	5.54	7.40	8.43	8.79	9.64
2021[a]	1.33	3.45	5.79	7.45	8.73	9.29	9.64
To Malibu Creek							
2017	0.00	0.18	1.22	2.43	8.89	12.1	22.3
2018	0.00	0.69	1.21	3.13	6.68	8.17	9.90
2019	0.00	0.00	0.43	5.68	8.85	11.6	14.0
2020	0.00	0.00	0.02	3.12	7.40	8.97	11.8
2021[a]	0.00	0.00	0.00	2.33	5.88	8.74	24.1

3. Modeling Data and Assumptions

This section summarizes the modeling data and assumptions used to build the model.

3.1 Overview

Jacobs used their proprietary hydraulics and process optimization platform Replica™ to evaluate the flow EQ needs for Tapia WRF and the new AWPF, and the impacts to the recycled water system. Replica is a suite of models and object libraries Jacobs developed for dynamic simulation and optimization of water and wastewater systems. Replica models are assembled from libraries of intelligent objects and can be used to simulate numerous aspects of a system, including hydraulics, operations and controls, energy use, and chemical consumption.

An extensive flow balance was built in the model to evaluate the dedicated flow EQ needs at Tapia WRF and the new AWPF, as well as to better understand the potential recycled water system impacts from adding the new AWPF as a high-demand user. Historical data (2017 through 2021) for the recycled water system was entered into the model. Control logic was established in the model, and the system performance was calibrated to the historical data providing confidence that the model represents an accurate depiction of the recycled water system.

Figure 3-1 provides an overview of the system Replica model configuration. The model configuration can be reviewed in two fundamental and interconnected systems: the Tapia WRF, and the recycled water and AWPF system. Appendix B provides a detailed description of the model boundaries, defined variables, and custom logic and operation rules.

3.2 Basis of Modeling

This section describes how the model was derived. Appendix B provides a detailed description of how the parameters were integrated into the model logic.

3.2.1 Flow Scenarios

The following three Tapia WRF flow scenarios were modeled to assess the sizing of a primary effluent EQ basin at Tapia WRF, sizing of an influent EQ basin at the new AWPF, and the impact of integrating the new AWPF into the recycled water system:

4) **Historical Flow Scenario:** The current Tapia WRF average annual daily influent flow ranges from 7.3 to 8.1 MGD (2017 to 2021). This scenario assessed impacts using historical Tapia WRF flows and irrigation demands.
5) **Design Capacity Flow Scenario:** The rated Tapia WRF design capacity is 12 MGD, on an average annual daily flow basis. This scenario assessed the impacts using historical flows for Tapia WRF adjusted to represent the rated design capacity and historical irrigation demands.
6) **Reduced I&I Flow Scenario:** Based on repair efforts, LVMWD is projecting a reduction in flow to the Tapia WRF of at least 1 MGD. This scenario assessed the impacts using historical flows for Tapia WRF adjusted by a reduction of 1 MGD and historical irrigation demands.

The associated diurnal patterns and peaking factors were incorporated into the model runs for these scenarios. The configuration data in the following sections represent the defined variables and model boundaries for the system flow balance model. The data are organized by modeling efforts for EQ at Tapia WRF and at the new AWPF.

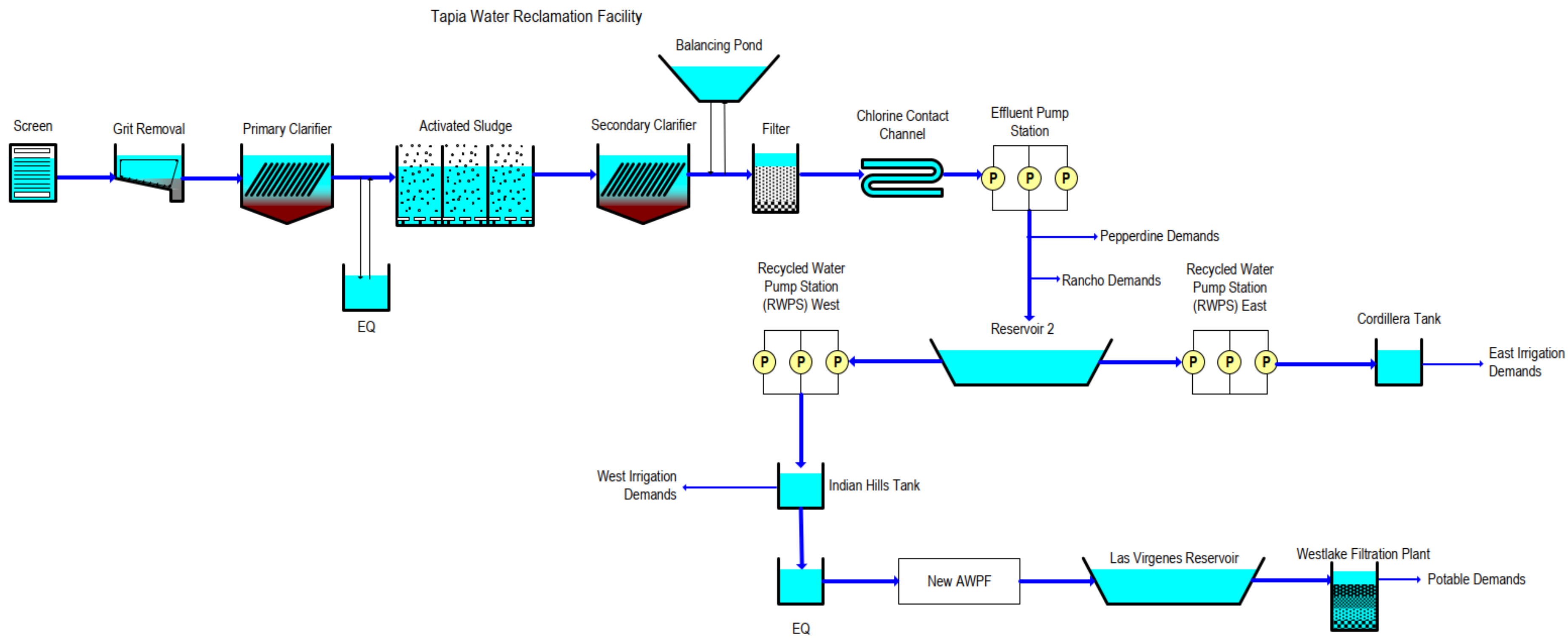


Figure 3-1. Tapia Water Reclamation Facility and Recycled Water System Replica Model Configuration

3.2.2 Tapia Water Reclamation Facility Configuration Parameters

This section summarizes the defined process variables and model boundaries for the Tapia WRF EQ assessment. The Tapia WRF model parameters included:

- Influent flow
- Primary effluent flow EQ
- Secondary and tertiary treatment peak capacities
- Balancing Pond storage
- Tertiary treated effluent flow
- Effluent Pump Station capacity
- Discharge flow to Malibu Creek

3.2.2.1 Flow

The historical Tapia WRF influent flows from 2017 to 2021 were entered into the model at 1-minute timesteps for influent, tertiary effluent, and discharge to Malibu Creek.

3.2.2.2 Plant Capacity

Tapia WRF is currently rated for the design flow conditions provided in Table 3-1 and has a high wet weather peaking factor. Primary effluent EQ is being evaluated to reduce the peak on the secondary treatment facilities. The existing Balancing Pond (2.5 million gallons [MG]) reduces the peak on the tertiary treatment facilities.

Table 3-1. Tapia Water Reclamation Facility Design and Current Condition Flows

Parameter	Influent Flow (MGD)	Peaking Factor
***Design*[a]**		
Average Dry Weather[a]	12	1.0
Peak Dry Weather[b]	18.2	1.5
Peak Wet Weather[c]	36	3.0
***Current Condition*[d]**		
Average Annual Day	7.6	1.0
Peak Hour Wet Weather	36	4.7

[a] Biological Nutrient Removal Project (AECOM 2011)

[b] Title 22 Engineering Report (LVMWD 2004)

[c] Influent capacity; Tapia WRF Headworks Rehabilitation (ASL Consulting Engineers 2001)

[d] 2017 to 2021

3.2.2.3 Secondary Treatment Capacity

The Tapia WRF employs a conventional biological nutrient removal activated sludge process with secondary rectangular clarifiers. The average dry weather capacity was rerated from 16 MGD to 12 MGD based on revised flow projections and conversion to nutrient removal (MWH 2005). Previous design reports do not identify the maximum week, maximum day, or peak hour conditions for the secondary treatment process.

Operations reported that during large storms, high flows through secondary treatment result in solids washout and treatment process upsets that require time to recover. The Tapia WRF secondary clarifier capacity was assessed through a desktop evaluation of the solids loading rate (SLR) and subsequent state point analysis using the Daigger correlations to the measured settled volume index (SVI) (Daigger and Roper 1985). The Tapia WRF includes 10 rectangular secondary clarifiers that are 150 feet long (ft) by 20 feet wide for a per clarifier surface area of 3,000 square feet (ft^2). The secondary clarifiers have a relatively shallow side water depth of approximately 10 feet. The geometry and shallow depth of the Tapia WRF's secondary clarifiers likely result in reduced SLR capacity in comparison to deeper clarifiers with flocculating inlets. Site-specific stress testing and settling column assessments could be used to refine capacity assumptions.

Data from 2018 through 2021 were evaluated to better understand the Tapia WRF specific settling considerations. During this period, the aeration basins had an average mixed liquor suspended solids (MLSS) concentration of 1,980 milligrams total suspended solids per liter (mg-TSS/L) and a maximum 30-day MLSS of 2,200 mg-TSS/L. The median observed SVI was 91 milliliters per gram (mL/g), and the 95th percentile SVI was 231 mL/g. The median SVI of 91 mL/g suggests that under normal operating conditions, the Tapia WRF has good settling sludge, resulting in improved clarifier capacity. The Tapia WRF, however, does experience significant increases in SVI that impact the reliable capacity of the secondary clarifiers.

The maximum allowable SLR was calculated with the Tapia WRF experiencing poor settling conditions, which is represented by the 95th percentile SVI of 231 mL/g. At this condition, the SLR was estimated to be approximately 26 pounds of total suspended solids per square foot per day (lb-TSS/ ft^2/d). At the maximum 30-day MLSS concentration of 2,200 mg-TSS/L under current conditions, the allowable peak secondary flow was calculated to be approximately 24 MGD with one clarifier out of service. For a 30-day MLSS concentration of 3,000 mg-TSS/L under design conditions (AECOM 2011), the allowable peak secondary flow was calculated to be approximately 20 MGD with all clarifiers in service. These flow values were used to establish the maximum peaks under wet weather conditions in the model.

3.2.2.4 Tertiary Treatment Capacity

The tertiary process capacity was assessed through a desktop evaluation by examining the applied hydraulic loading rate (HLR) to the filters. The tertiary process consists of 12 dual-media filters, each filter with a filtration surface area of 253 ft^2. At the current average flow of 8 MGD, the filters are operating at an HLR of 2.5 gallons per minute per square foot (gpm/ft^2) with one unit out of service. The filtration process was originally designed at a peak HLR of 5 gpm/ft^2 to maintain consistency with Title 22 requirements (LVMWD 2004). Considering managing flows produced by the backwash process, the resulting peak influent flow capacity is 18.2 MGD with one filter out of service and 16.4 MGD with two filters out of service. These flow values were used to establish the peak conditions in the model.

3.2.2.5 Storage

The existing onsite storage includes a 2.5-MG Balancing Pond used to attenuate flow to the tertiary filters. Current operation passively conveys secondary effluent to the Balancing Pond via a weir when the tertiary filter influent flow is greater than 18.2 MGD. Diverted flow is then recycled back to tertiary treatment during lower flow conditions. When the Balancing Pond is full, there is no additional storage capacity available at Tapia WRF if the facility were to experience an operational or seasonal challenge. Historically, under extreme wet weather events (February 2017), flow has bypassed the filters through the chlorine contact channel when the Balancing Pond was full and the secondary effluent flow exceeded 18.2 MGD.

To balance out daily operations and provide additional buffer capacity at Tapia WRF, the model incorporated an EQ basin upstream of secondary treatment to equalize primary effluent. The objective was to use the EQ basin to store typical diurnal flows and capture some of the excess flow from the wet weather events. The existing storage at the Balancing Pond was used to help minimize the required EQ volume needed for these storms.

For daily operations, the model targeted an EQ volume of 1.0 MG after initial evaluation. For wet weather events, no size limitations were set, and the model simulated the volume needed to capture elevated flow. The model incorporated storage logic for the EQ basin and Balancing Pond and showed how maintaining two designated storage volumes in tandem can lead to treatment improvements at Tapia WRF.

3.2.2.6 Effluent Pump Station

The Effluent Pump Station contains a total of three constant speed pumps with a combined nominal capacity of 13.5 MGD (9,400 gallons per minute [gpm]). A current design project will equip one of the pumps with a variable frequency drive (VFD). The Effluent Pump Station operates based on the level in Reservoir 2 in the winter and the level in the clear well at Tapia WRF in the summer.

The model assessed constant speed pumps to understand the existing conditions of the system compared to pumping operations with VFDs. The assessment found that VFDs were beneficial; therefore, the model was set up such that all pumps were on VFDs. While the results and recommendations in this report are based on all pumps using VFDs, a minimum conversion of at least 50% is possible. A focused evaluation would be required to identify the pump locations that would result in the overall, optimal benefit if not all pumps were to be provided with VFDs. The model does not account for any storage in the Effluent Pump Station wet well.

3.2.3 Recycled Water System Expansion Configuration Parameters

This section summarizes the defined process variables and model boundaries for the AWPF EQ assessment. The recycled water system model parameters for the new AWPF included:

- Tapia WRF effluent flow
- Pepperdine demand flow
- Rancho Pump Station demand flow
- Supplemental Potable Water flow
- RWPS West flow
- RWPS East flow
- Reservoir 2 level
- Indian Hills Tank level

The major unit processes of interest in the flow model included reverse osmosis (RO), the most flow sensitive process at the new AWPF due to limited turndown, and the pump stations in the recycled water system. The new AWPF will have a rated feed flow capacity of 7.5 MGD and is expected to operate seasonally when there is available flow. The purified water production capacity is 6.0 MGD based on a recovery rate of 80%.

3.2.3.1 Flow

The historical flows from 2017 to 2021 were entered into the model at 1-minute timesteps. Pepperdine demand flow and Rancho Pump Station demand flow are met using Tapia WRF treated effluent. The demand flows leave the recycled water system upstream of Reservoir 2 and are year-round with seasonal variations.

The Reservoir 2 effluent flow is the combined RWPS East and RWPS West flows. RWPS East flow is pumped from Reservoir 2 to the Cordillera Tank to supply the eastern irrigation system. The historical flow data for RWPS East was used for the flow leaving the Cordillera Tank, which represents the eastern system irrigation demand.

The RWPS West flow is pumped from Reservoir 2 to Indian Hills Tank to supply the western irrigation system, including the new AWPF. The historical flow data for the RWPS West flow was used for the western irrigation demand and closely represents the irrigation demand flow pattern that currently leaves the Indian Hills Tank. The available flow to the new AWPF was based on the remaining volume after the irrigation demands are met.

3.2.3.2 Reverse Osmosis

Frequent changes within AWPF unit processes, particularly RO, can be difficult to manage. Variations in AWPF feed flow would result in shutdowns of individual RO skids. Extended shutdowns (longer than 48 hours) require membrane preservation (that is, pickling) to prevent biological growth. For short-term shutdowns that extend 1 to 2 days, RO membranes can be flushed with RO permeate. Flushing can also be performed daily to allow for daily cycling between two RO skids to avoid membrane preservation.

LVMWD wants to minimize flow changes to a target of two per day within the new AWPF to promote consistent RO process operation. A flow change refers to the number of times the treatment process experiences a diurnal spike, and the plant is required to adjust the operational capacity to handle varying flow conditions over the course of one day. This design criterion of two flow changes per day emphasizes the importance of upstream EQ at the new AWPF. Jacobs strategized five RO operating scenarios based on the AWPF's rated capacity. The operating scenarios presented are based on the conceptual design, which includes three different permeate capacity size RO skids operating to treat flows associated with the AWPF feed flow range of 1.0 to 7.5 MGD (Table 3-2).

Table 3-2. Model Configuration Data for Reverse Osmosis Operation

Scenario	AWPF Flow (MGD)	Description of Operation
Offline	< 1.0	No skids
Scenario 1	1.0–1.9	Cycle operation between 2 small RO skids
Scenario 2	1.9–3.5	Cycle operation between 2 small RO skids and 1 medium RO skid
Scenario 3	3.5–5.1	Cycle operation between 2 small RO skids and 2 medium RO skids
Scenario 4	5.1–6.5	Cycle operation between 2 small RO skids, 1 medium RO skid, 1 large RO skid
Scenario 5	> 6.5	All duty skids online with 1 large RO skid (or 2 medium RO skids) in standby

< = less than

> = greater than

3.2.3.3 Pump Stations

The three pump stations of interest related to the new AWPF include Tapia WRF Effluent Pump Station, RWPS West, and RWPS East. The model assessed constant speed pumps to understand the existing conditions of the system compared to pumping operations with VFDs. The assessment found that VFDs were beneficial; therefore, the model setup was changed to include VFDs for all of these pumps.

RWPS West comprises three constant speed pumps with a nominal rated capacity of 7.7 MGD (5,400 gpm) (Boyle Engineering Corporation 1987). Whether the pumps turn on or off is controlled by the water level in Indian Hills Tank. Normal operations include up to three pumps online. Operation of RWPS West and Indian Hills Tank directly impacts performance at the AWPF.

RWPS East operates three constant speed pumps with a reported nominal rated capacity of 6.5 MGD (4,500 gpm) (HDR 2014). Whether the pumps turn on or off is controlled by the water level in Cordillera Tank. Normal operations include up to two pumps online.

Simultaneous operation of both RWPS West and RWPS East at their current rated capacities would result in a high velocity in the suction pipeline, due to limitations at the 16-inch diameter size.

3.2.3.4 Storage

The existing storage within the recycled water system that was modeled includes Reservoir 2, Indian Hills Tank, and Cordillera Tank. The model demonstrates that improving reservoir and storage tank operations can lead to more stable operation of the recycled water system. Operations of Reservoir 2 and Indian Hills Tank directly impact the onsite EQ storage volume necessary at the new AWPF. Cordillera Tank is independent of the new AWPF, but was included in the evaluation to highlight overall system improvements to the recycled water system.

Reservoir 2 stores 14.7 MG of recycled water and is located downstream of Tapia WRF and upstream of Indian Hills Tank. Reservoir 2 currently operates between a level of 10 and 24 feet. The overflow weir is set at an elevation of 795 feet, with an operating level of 25 feet so that at least 1 foot of freeboard is maintained. The water level in Reservoir 2 controls the Effluent Pump Station flow rate at Tapia WRF by determining when the pumps cycle on and off.

Indian Hills Tank is a 2.5-MG storage tank located downstream of RWPS West and upstream of the new AWPF. The water level in Indian Hills Storage Tank controls the RWPS West flow rate.

Cordillera Tank is a 3.0-MG tank located downstream of RWPS East and upstream of the eastern distribution system. The water level in Cordillera Tank controls the RWPS East flow rate.

3.2.4 Logical Data

Table 3-3 lists the global set points used in the flow balance model to evaluate EQ at Tapia WRF and the new AWPF. Appendix B provides details about the model parameters and logical data.

Table 3-3. Model Configuration Data

Parameter	Units	Value
Tapia Water Reclamation Facility		
Headworks Capacity Average Dry Weather[a] Peak Dry Weather[b] Peak Wet Weather[c]	MGD	 12 18.2 36
Secondary Treatment Peak Wet Weather Capacity[d] Design MLSS of 3,000 mg/L (all clarifiers in service) Current MLSS of 2,200 mg/L (one clarifier out of service)	MGD	 20 24
Secondary Treatment Peak Dry Weather Capacity[e]	MGD	18.2
Tertiary Filtration Peak Capacity[e] Two filters out of service One filter out of service	MGD	 16.4 18.2
Effluent Pump Station Nominal Capacity	MGD	13.5
Balancing Pond Volume	MG	2.5
Maximum Number of Flow Changes per Day	No.	2
Recycled Water System and Advanced Water Purification Facility		
RWPS East Nominal Capacity[e]	MGD	6.5
RWPS West Nominal Capacity[f]	MGD	7.7
AWPF Capacity Minimum Maximum	MGD	 1.0 7.5
Reservoir 2 Low Level	feet	10
Reservoir 2 High Level	feet	24
Reservoir 2 Volume	MG	14.7
Indian Hills Tank Volume	MG	2.5
Cordillera Tank Volume	MG	3
Maximum Number of Flow Changes per Day	No.	2
RO Skid Capacities	MGD	1–7

[a] Biological Nutrient Removal Project (AECOM 2011)
[b] Title 22 Engineering Report (LVMWD 2004)
[c] Tapia WRF Headworks Rehabilitation (ASL Consulting Engineers 2001)
[d] Desktop evaluation, recommend field testing to confirm
[e] Title 22 Engineering Report (LVMWD 2004)
[f] Boyle Engineering Corporation 1987
mg/L = milligram(s) per liter
MGD = million gallons per day

4. Tapia Water Reclamation Facility Flow Equalization

This section presents the analysis for primary effluent flow EQ at Tapia WRF. The model provides a comparison between historical and simulated data and supports recommendations to improve operations at Tapia WRF.

4.1 Daily Operational Flow Equalization

Tapia WRF is currently functioning in a reactive state, and plant operations are controlled by the influent diurnal flow patterns. The typical diurnal flow ranges from 4 to 15 MGD. The addition of primary effluent flow EQ would help stabilize daily operations and performance at Tapia WRF and to the recycled water system. On a typical dry weather day, approximately 1.0 MG of storage is required to attenuate the current diurnal flow through Tapia WRF. This would balance out operations by allowing for two flow changes per day with typical flow set points ranging from approximately 7 to 8 MGD. If operations at Tapia WRF were to target one flow change per day, a larger EQ basin up to 2.0 MG would be needed to attenuate the primary effluent. Appendix C contains plots highlighting the response to one flow change per day. Figure 4-1 shows the model output for a representative 10-day period of typical flow and operation in March 2017 when the average daily influent flow was 8.2 MGD.

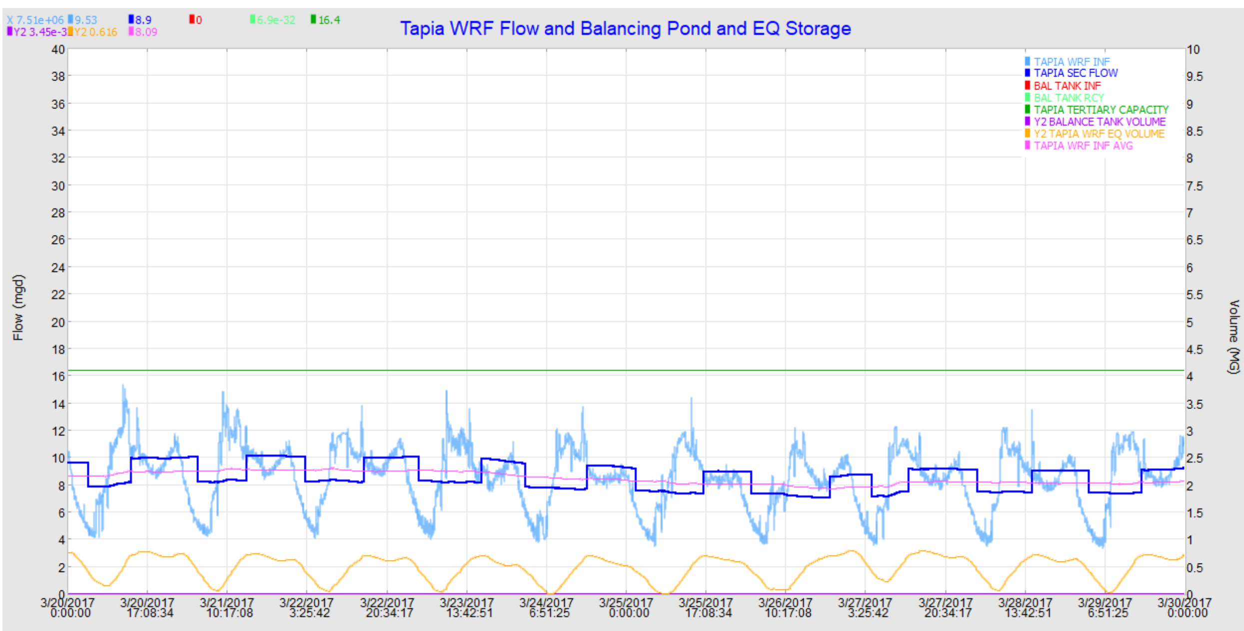


Figure 4-1. Tapia Water Reclamation Facility Typical Daily Operations for 10 Days in 2017

Notes: Average influent flow of 8.2 MGD, secondary treatment capacity of 20 MGD, and tertiary treatment capacity of 16.4 MGD

On Figure 4-1, the date is shown across the x-axis and ranges from March 20 to 30, 2017. The parameters captured on the primary y-axis include:

- Influent flow to Tapia WRF shown in light blue, with a diurnal pattern ranging from 4 to 15 MGD
- Running daily average influent flow shown in magenta, ranging between 8 and 9 MGD
- Secondary treatment flow shown in dark blue, with a stepped pattern between 7 and 10 MGD
- Tertiary treatment capacity shown in green, at 16.4 MGD

The EQ volume at Tapia WRF shown in yellow (ranging from 0 to <1 MG) and the Balancing Pond volume shown in purple (constant at 0 MG) are both on the secondary y-axis.

The model shows a stepped operation that mimics two flow changes per day that typically occur in the early morning and late afternoon. For this time period, 1.0 MG of EQ volume is needed to equalize primary effluent flow, and the Balancing Pond (purple line shown on 0 MG) is not used. This trend for typical daily operation using 1.0 MG of EQ volume and no flow captured and stored in the Balancing Pond is representative of all 5 years investigated (2017 to 2021). Appendix C provides the 1-year simulation plots for EQ storage at Tapia WRF from 2017 to 2021.

Percent capture was used as a key performance indicator to correlate the amount of flow captured in the respective EQ basin volume during the year. This metric was used to select the appropriate size of the EQ basin based on the three modeled flow scenarios at Tapia WRF, which are summarized in Table 4-1.

Table 4-1. Equalization Basin Percent Capture Summary

Year	Average Influent Flow to Tapia WRF (MGD)[a]	Secondary Treatment Capacity (MGD)	Tertiary Treatment Capacity (MGD)	Percent Capture of EQ Volume (%)				
				1 MG	2 MG	3 MG	5 MG	10 MG
2017	7 (I&I)	20	16.4	99.4	99.5	99.9	100	100
	7 (I&I)	24	18.2	99.4	99.7	100	100	100
	8.2	20	16.4	99.0	99.3	99.4	100	100
	8.2	24	18.2	99.3	99.4	99.8	100	100
	12 (DC)	20	16.4	97.9	98.3	98.4	98.7	100
	12 (DC)	24	18.2	98.8	98.9	99.1	99.6	100
2018	7 (I&I)	20	16.4	99.9	100	100	100	100
	6.5 (I&I)	24	18.2	99.9	100	100	100	100
	7.8	20	16.4	99.9	100	100	100	100
	7.8	24	18.2	99.9	100	100	100	100
	12 (DC)	20	16.4	99.9	100	100	100	100
	12 (DC)	24	18.2	99.9	100	100	100	100
2019	7.8	20	16.4	99.8	100	100	100	100
	7.8	24	18.2	99.8	100	100	100	100
	12 (DC)	20	16.4	98.9	99.8	100	100	100
	12 (DC)	24	18.2	99.8	100	100	100	100
2020	8.1	20	16.4	99.9	100	100	100	100
	8.1	24	18.2	99.9	100	100	100	100
	12 (DC)	20	16.4	99.9	100	100	100	100
	12 (DC)	24	18.2	99.9	100	100	100	100
2021	7.7	20	16.4	99.9	100	100	100	100
	7.7	24	18.2	99.9	100	100	100	100
	12 (DC)	20	16.4	99.9	100	100	100	100
	12 (DC)	24	18.2	100	100	100	100	100

[a] (I&I) denotes adjusted average influent flow, where the historical data were adjusted to achieve the potential reduced flow from collection system repairs to address I&I. (DC) denotes adjusted average influent flow, where the historical data were adjusted to achieve the rated design capacity of 12 MGD at Tapia WRF.

Over the 5 years of focus and the three modeled flow scenarios, an EQ basin volume of 1.0 MG achieved a flow capture rate of 97% or more. This signifies that 1.0 MG is sufficient to capture the regular, diurnal flows at Tapia WRF in addition to continued utilization of the Balancing Pond. Therefore, it is recommended to provide a 1.0-MG primary effluent EQ basin volume coupled with two flow changes per day to mitigate the daily operational peak flows at Tapia WRF.

4.2 Storm Flow Equalization

Tapia WRF experiences seasonal variations and wet weather events when the influent flow to the plant can be as much as three times the average annual rated capacity. Current operations of the facility capture the smaller magnitude storms through the Balancing Pond and typically can return to daily fluctuations in flow within hours. This analysis consisted of modeling the three flow scenarios (historical flow, design capacity flow, and reduced I&I flow) with the two peak secondary treatment and tertiary treatment capacities to assess the level of storage needed to attenuate the peak storms. Figure 4-2 and Figure 4-3 show two typical wet weather events with similar outcomes that occurred in January 2017 and 2019, respectively, both showing a 10-day period with historical influent flow. A 1.0-MG primary effluent EQ basin volume and storage in the Balancing Pond provided enough buffer capacity during these regular storms for Tapia WRF.

On Figure 4-2, the date is shown across the x-axis and ranges from January 19 to 30, 2017. The parameters captured on the primary y-axis include:

- Influent flow to Tapia shown in light blue, with a flow ranging from 4 to 26 MGD
- Running daily average influent flow shown in magenta, ranging from 8 to 15 MGD
- Secondary treatment flow shown in dark blue, with a maximum flow of 20 MGD
- Tertiary treatment capacity shown in dark green, at 16.4 MGD
- Influent flow to the Balancing Pond in red
- Recycled flow from the Balancing Pond in lime green

The EQ volume at Tapia WRF shown in yellow (ranging from 0 to 1 MG), and Balancing Pond volume shown in purple (ranging from 0 to 1 MG) are both reflected on the secondary y-axis.

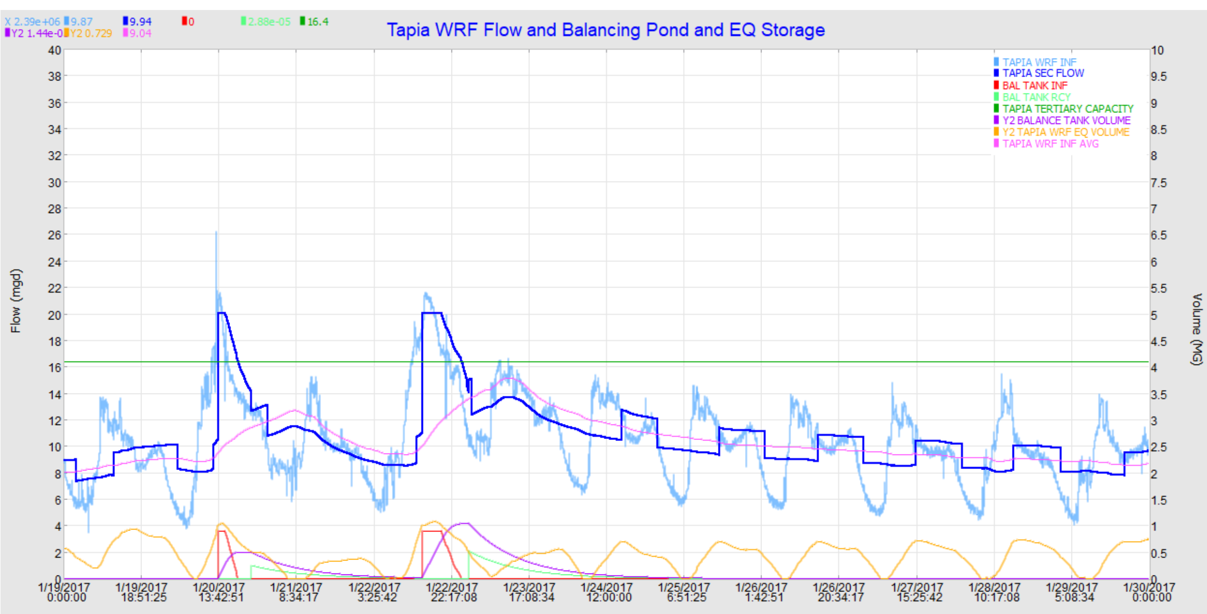


Figure 4-2. Tapia Water Reclamation Facility Response to Two Typical Storms in January 2017

Notes: Historical average annual influent flow of 8.2 MGD, secondary treatment capacity of 20 MGD, and tertiary treatment capacity of 16.4 MGD

On Figure 4-3, the date is shown across the x-axis and ranges from January 13 to 24, 2019. The parameters captured on the primary y-axis include:

- Influent flow to Tapia shown in light blue, with a flow ranging from 4 to 21 MGD
- Running daily average influent flow shown in magenta, ranging from 8 to 13.5 MGD
- Secondary treatment flow shown in dark blue, with a maximum flow of 24 MGD
- Tertiary treatment capacity shown in dark green, at 18.2 MGD
- Influent flow to the Balancing Pond in red
- Recycled flow from the Balancing Pond in lime green

The EQ volume at Tapia WRF shown in yellow (ranging from 0 to 1 MG), and Balancing Pond volume shown in purple (ranging from 0 to 1.5 MG) are both reflected on the secondary y-axis.

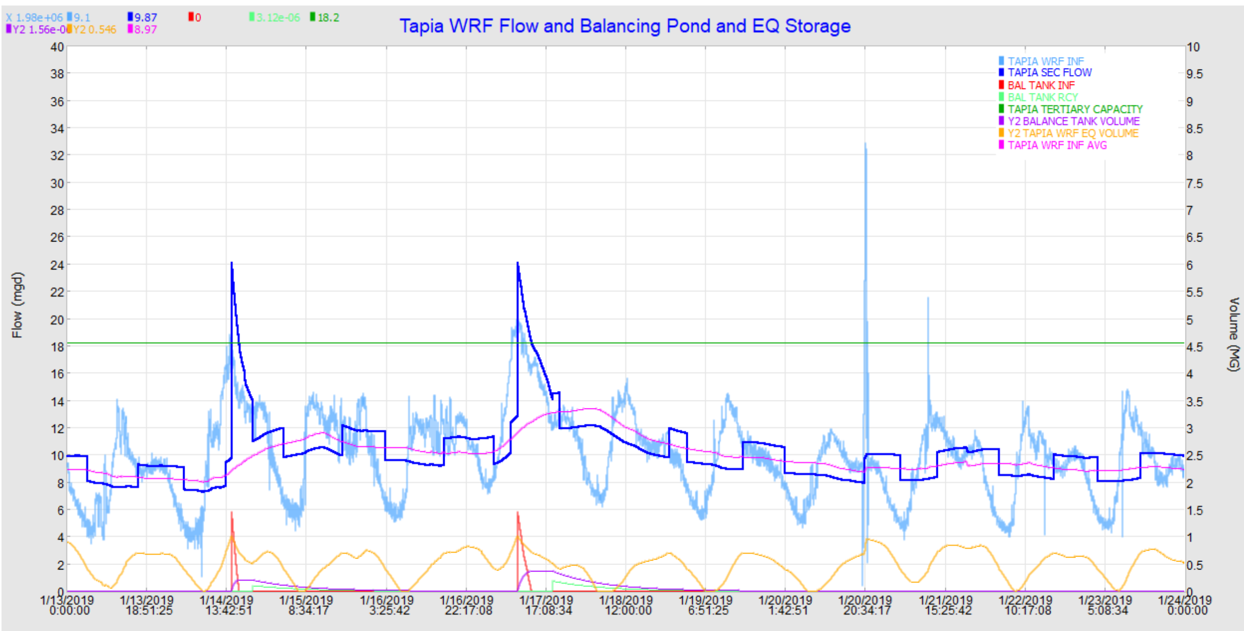


Figure 4-3. Tapia Water Reclamation Facility Response to Two Typical Storms in January 2019

Notes: Average annual influent flow of 7.8 MGD, secondary treatment capacity of 20 MGD, and tertiary treatment capacity of 18.2 MGD

Over the 5-year period of historical data for Tapia WRF, the largest storm events occurred in 2017 and 2019. The most significant storm event took place on February 17, 2017, as shown on Figures 4-4 through 4-7. During this storm, all of the tanks at Tapia WRF were in service, and the Balancing Pond was full, so secondary effluent bypassed the filters to the chlorine contact channel for ultimate discharge to Malibu Creek. Figures 4-4 and 4-5 show the model outputs for the historical flow scenarios with an average annual influent flow of 8.2 MGD, and Figures 4-6 and 4-7 show when the design capacity flow scenario was used with an average annual influent flow adjusted to 12 MGD.

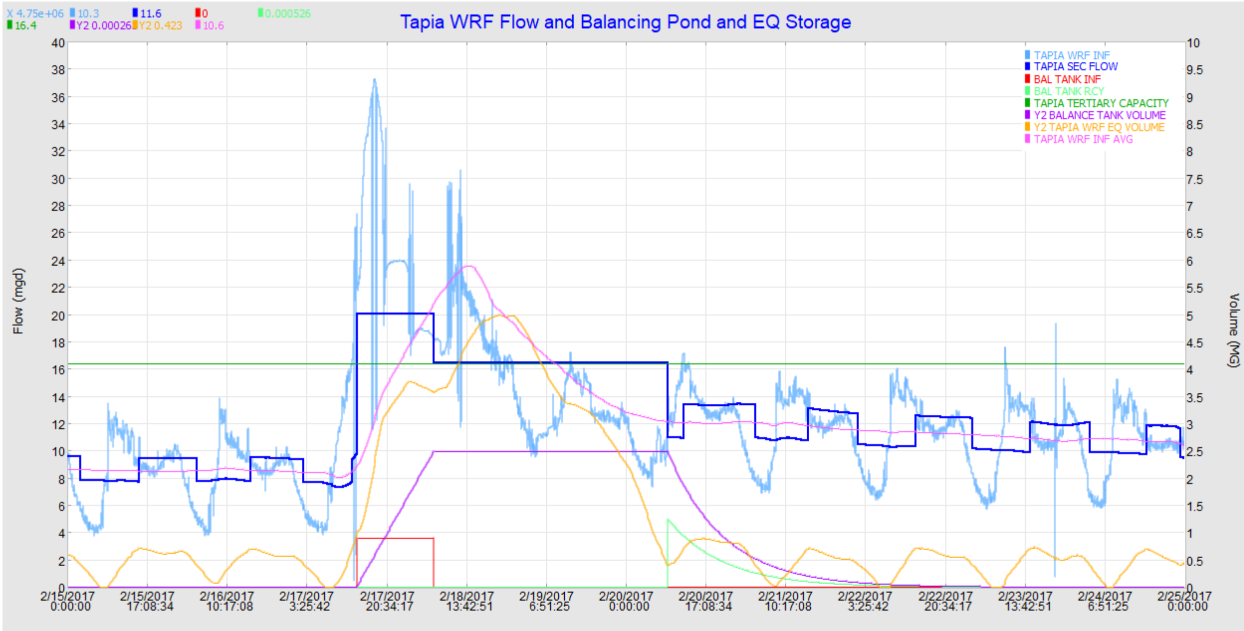


Figure 4-4. Tapia Water Reclamation Facility Response to Historical February 2017 Storm, EQ 1
Notes: Historical average annual influent flow of 8.2 MGD, secondary treatment capacity of 20 MGD, tertiary treatment capacity of 16.4 MGD, and EQ volume shown on secondary y-axis

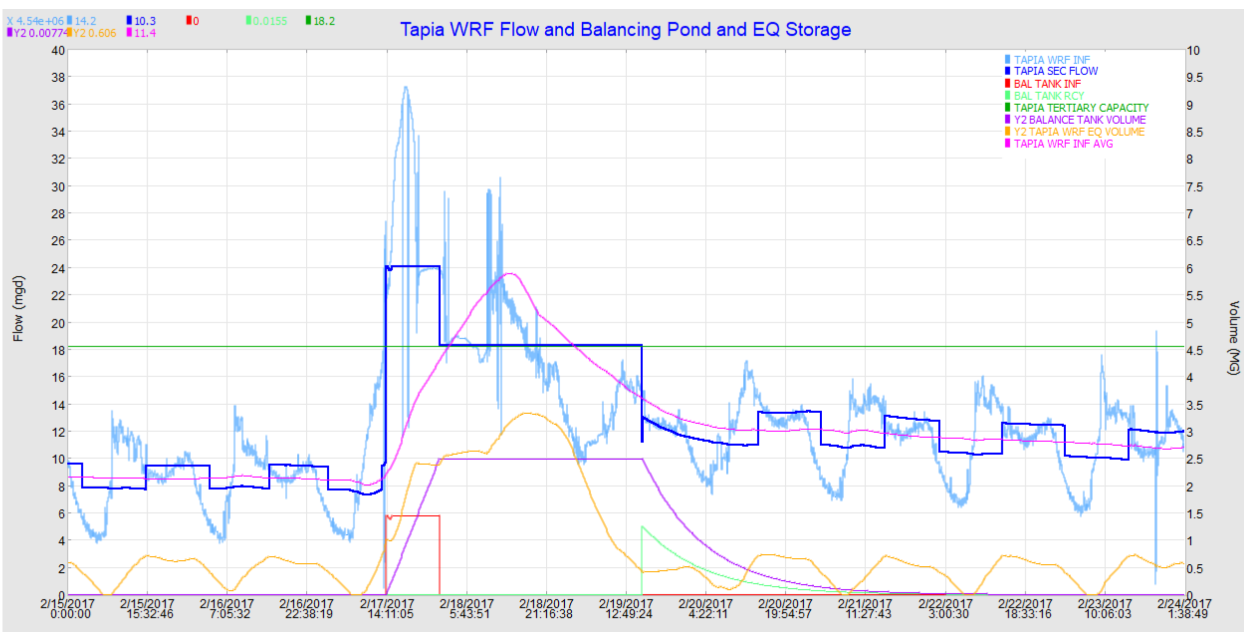


Figure 4-5. Tapia Water Reclamation Facility Response to Historical February 2017 Storm, EQ 2
Notes: Historical average annual influent flow of 8.2 MGD, secondary treatment capacity of 24 MGD, tertiary treatment capacity of 18.2 MGD, and EQ volume shown on secondary y-axis

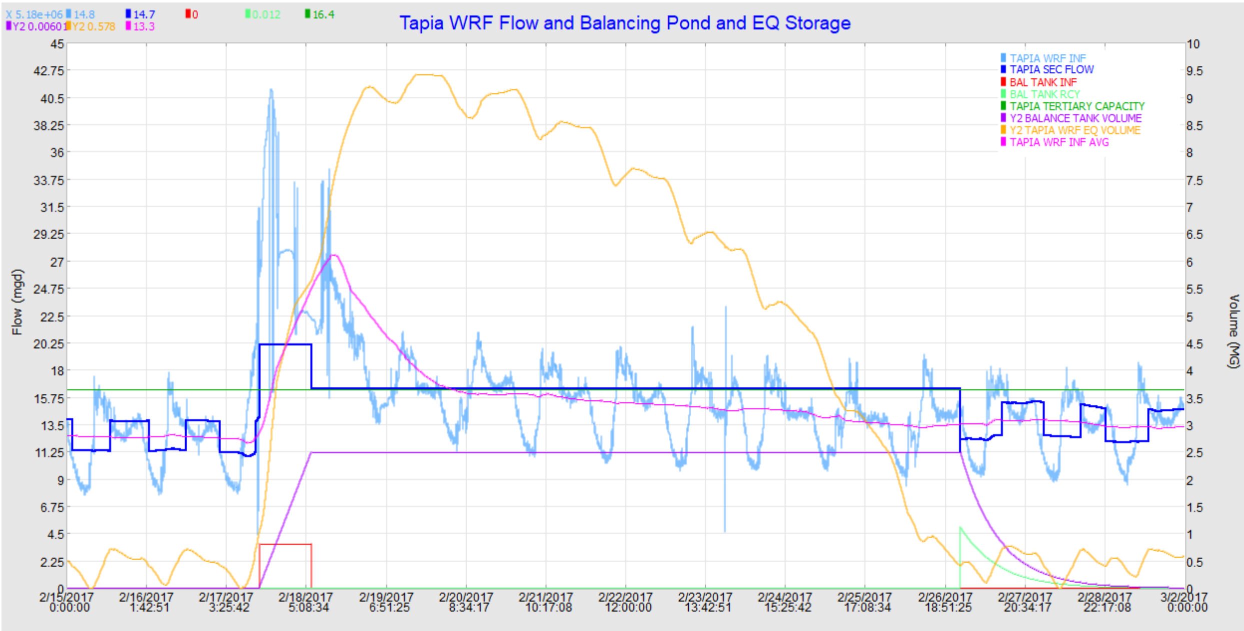


Figure 4-6. Tapia Water Reclamation Facility Response to February 2017 Storm Adjusted to Design Capacity, EQ 1

Notes: Adjusted average annual influent flow to 12 MGD, secondary treatment capacity of 20 MGD, tertiary treatment capacity of 16.4 MGD, and EQ volume shown on secondary y-axis

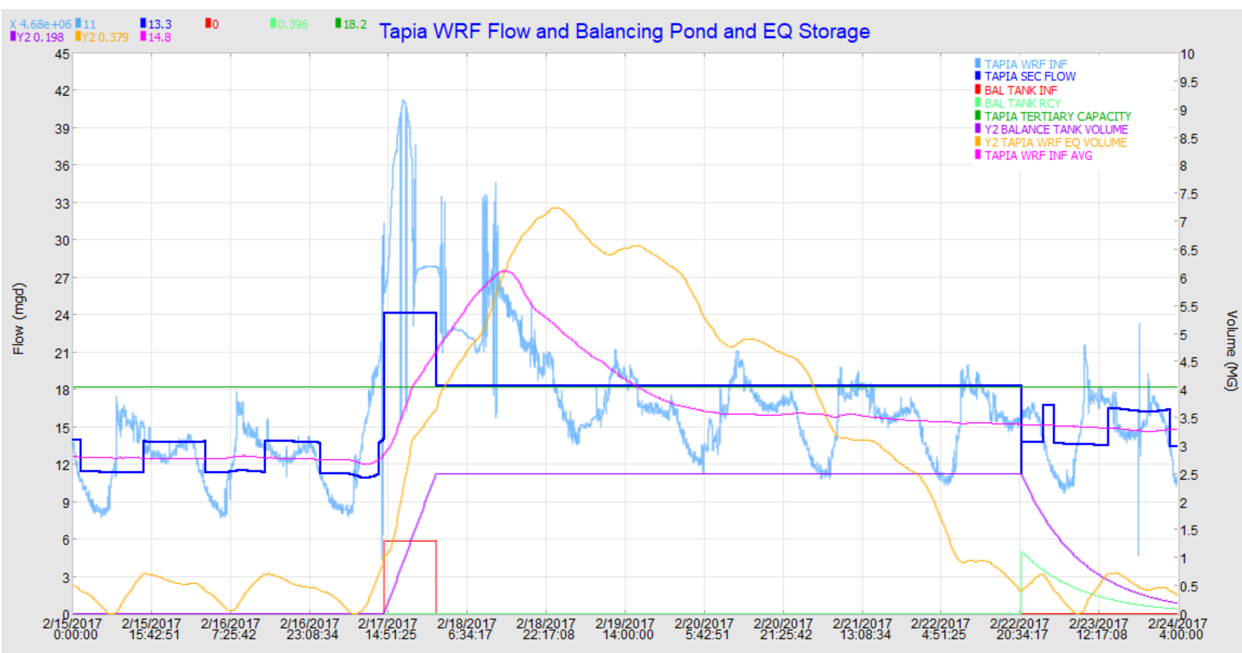


Figure 4-7. Tapia Water Reclamation Facility Response to February 2017 Storm Adjusted to Design Capacity, EQ 2

Notes: Adjusted average annual influent flow to 12 MGD, secondary treatment capacity of 24 MGD, tertiary treatment capacity of 18.2 MGD, and EQ volume shown on secondary y-axis

As observed in the historical flow scenario plots, the influent peak hour flow reached 36 MGD. For both secondary treatment capacity scenarios, the full storage capacity of 2.5 MG in the Balancing Pond (purple line) was used to attenuate the storm in addition to the primary effluent EQ storage. To handle the large influx of flow, Tapia WRF would have run at a sustained maximum day flow of 18.2 MGD (dark green line) for nearly 3 days.

Tables 4-2 through 4-4 summarize the modeling efforts completed for select peak storms and the maximum storage needed to capture the flows based on the modeled scenarios from 2017 to 2020. Year 2021 was excluded due to an incomplete data set for November and December and the absence of intense storms during the remaining portion of the year. The scenarios determined the amount of onsite storage that would have been required to attenuate storms at Tapia WRF for historical flow scenarios, design capacity flow scenarios, and reduced I&I flow scenarios. The more typical storms are represented in the full year model outputs in Appendix C. The model outputs show the tradeoff between the influent flow and process capacities, and how they influence the required storage needed to capture the peak storms. The EQ volumes are shown for primary effluent, Balancing Pond and total. As the duration of the peak flows at 20 and 24 MGD increases, more primary effluent EQ approaching the total volume would be beneficial to maintain a maximum day flow of 18.2 MGD. Appendix D provides the associated model plots for the remainder of the scenarios noted in Tables 4-2 through 4-4.

Table 4-2. EQ Storage for Historical Flow Scenarios in 2017 to 2020 Storms Events

Year	Average Influent Flow (MGD)	Secondary Treatment Capacity (MGD)	Tertiary Treatment Capacity (MGD)	Storm Date	Storm Peak Hour Flow (MGD)	Primary Effluent EQ Volume (MG)	Balancing Pond Volume (MG)	Total EQ Volume (MG)
2017	8.2	20	16.4	1/20/17	21.2	1.03	0.49	1.52
	8.2	24	18.2	1/20/17	21.2	1.00	0.40	1.40
	8.2	20	16.4	1/22/17	21.2	1.07	1.03	1.10
	8.2	24	18.2	1/22/17	21.2	1.00	0.69	1.69
	8.2	20	16.4	2/17/17	36.0	5.00	2.50	7.50
	8.2	24	18.2	2/17/17	36.0	3.33	2.50	5.83
2018	7.8	20	16.4	9/13/18	22.3	1.14	0.06	1.20
	7.8	24	18.2	9/13/18	22.3	1.09	0.09	1.18
	7.8	20	16.4	12/6/18	17.5	1.00	0.20	1.20
	7.8	24	18.2	12/6/18	17.5	1.00	0.19	1.19
2019	7.8	20	16.4	1/14/19	16.8	1.00	0.22	1.22
	7.8	24	18.2	1/14/19	16.8	1.00	0.20	1.20
	7.8	20	16.4	1/17/19	19.5	1.00	0.55	1.55
	7.8	24	18.2	1/17/19	19.5	1.00	0.36	1.36
	7.8	20	16.4	2/2/19	25.1	1.28	1.12	2.40
	7.8	24	18.2	2/2/19	25.1	1.06	0.89	1.95
	7.8	20	16.4	2/14/19	18.4	1.00	0.24	1.24
	7.8	24	18.2	2/14/19	18.4	1.00	0.20	1.20
2020	8.1	20	16.4	4/10/20	15.0	1.29	0.00	1.29
	8.1	24	18.2	4/10/20	15.0	1.29	0.00	1.29

Table 4-3. EQ Storage for Design Capacity Flow Scenarios in 2017 to 2020 Storms Events

Year	Average Influent Flow (MGD)[a]	Secondary Treatment Capacity (MGD)	Tertiary Treatment Capacity (MGD)	Storm Date	Storm Peak Hour Flow (MGD)	Primary Effluent EQ Volume (MG)	Balancing Pond Volume (MG)	Total EQ Volume (MG)
2017	12 (DC)	20	16.4	1/20/17	25.1	1.23	1.40	2.63
	12 (DC)	24	18.2	1/20/17	25.1	1.27	0.90	2.17
	12 (DC)	20	16.4	1/22/17	25.1	1.68	2.50	4.18
	12 (DC)	24	18.2	1/22/17	25.1	1.04	2.12	3.16
	12 (DC)	20	16.4	2/17/17	39.9	9.42	2.50	11.9
	12 (DC)	24	18.2	2/17/17	39.9	7.23	2.50	9.73
2018	12 (DC)	20	16.4	9/13/18	26.8	1.03	0.03	1.06
	12 (DC)	24	18.2	9/13/18	26.8	1.00	0.05	1.05
	12 (DC)	20	16.4	12/6/18	22.0	1.00	0.53	1.53
	12 (DC)	24	18.2	12/6/18	22.0	1.00	0.40	1.40
2019	12 (DC)	20	16.4	1/14/19	21.2	1.26	0.95	2.21
	12 (DC)	24	18.2	1/14/19	21.2	1.00	0.50	1.50
	12 (DC)	20	16.4	1/17/19	23.9	1.31	1.92	3.23
	12 (DC)	24	18.2	1/17/19	23.9	1.00	1.18	2.18
	12 (DC)	20	16.4	2/2/19	29.4	2.50	2.50	5.00
	12 (DC)	24	18.2	2/2/19	29.4	1.33	2.50	3.83
	12 (DC)	20	16.4	2/14/19	22.7	1.04	1.36	1.40
	12 (DC)	24	18.2	2/14/19	22.7	1.00	0.56	1.56
2020	12 (DC)	20	16.4	4/10/20	19.2	1.00	0.55	1.55
	12 (DC)	24	18.2	4/10/20	19.2	1.00	0.30	1.30

[a] (DC) denotes adjusted average influent flow, where the historical data were adjusted to achieve the rated design capacity of 12 MGD at Tapia WRF.

Table 4-4. EQ Storage for Reduced Inflow and Infiltration Flow Scenarios in 2017 to 2018 Storm Events

Year[a]	Average Influent Flow (MGD)[b]	Secondary Treatment Capacity (MGD)	Tertiary Treatment Capacity (MGD)	Storm Date	Storm Peak Hour Flow (MGD)	Primary Effluent EQ Volume (MG)	Balancing Pond Volume (MG)	Total EQ Volume (MG)
2017	7 (I&I)	24	18.2	1/20/17	20.2	1.00	0.31	1.31
	7 (I&I)	24	18.2	1/22/17	20.1	1.00	0.59	1.59
	7 (I&I)	24	18.2	2/17/17	34.9	2.26	2.50	4.76
2018	6.5 (I&I)	24	18.2	9/13/18	21.8	1.12	0.06	1.18

[a] These years were selected to represent the highest precipitation year (2017) and a typical year (2018) over the 5 years of data.

[b] (I&I) denotes adjusted average influent flow, where the historical data were adjusted to achieve the potential reduced flow from collection system repairs to address I&I.

The tradeoff between average influent flow and treatment capacity is important to determine the size of EQ storage and how the selected storage impacts facility operations. Based on the storm analysis, an EQ basin of 3.0 MG, in addition to using the Balancing Pond, provides sufficient storage to capture most of the peak storms at Tapia WRF. An excessively large EQ basin would be required to capture all of the peak flow for the most extreme storm that was experienced in February 2017. This is not a feasible option at Tapia WRF based on cost, operational, and site constraints. The addition of primary effluent EQ allows for the Balancing Pond to be used as additional buffer capacity during these storms.

4.3 Malibu Creek Discharges

The new AWPF will maximize treatment of the surplus recycled water for indirect potable reuse that is currently discharged from Tapia WRF to Malibu Creek. When the storage throughout the recycled water system is full and the AWPF is operating at capacity, Tapia WRF will continue to discharge the remaining flow to Malibu Creek under an operational emergency or qualifying storm event.

Table 4-5 provides a comparison between the historical discharges to Malibu Creek and the simulated discharges to Malibu Creek with the AWPF operational, based on historical data from 2017 to 2021. The simulation indicates the number of events and discharge volume to Malibu Creek will decrease significantly with the addition of EQ storage at Tapia WRF, continued utilization of the Balancing Pond, the new AWPF, and optimization of system storage and operation.

Table 4-5. Malibu Creek Discharge Comparison, 2017 to 2021

Year	Historical	Historical		Simulation[a]	
	Annual Average Influent Flow (MGD)	No. of Discharge Days	Total Discharge Volume (MG)	No. of Discharge Days	Total Discharge Volume (MG)
2017	8.2	89	849	42	110
2018	7.8	86	750	15	15
2019	7.8	76	915	34	118
2020	8.1	53	664	26	39
2021	7.7	79	298	9	11

[a] With AWPF in operation.

4.4 Recommendations

This evaluation used Replica to assess the EQ storage volumes required to manage variable diurnal flows and wet weather events, with the objectives to attenuate the peak flow on the secondary treatment and tertiary filtration processes, and to stabilize overall treatment performance at Tapia WRF. The recommendations for Tapia WRF process improvements and flow EQ needs are summarized in this section.

4.4.1 Process Improvements

In addition to EQ, there are additional approaches that could improve the secondary treatment capacity, as shown in Table 4-6.

Table 4-6. Potential Methods to Improve Tapia Water Reclamation Facility Secondary Treatment Capacity

Approach	Methods	Considerations
Reducing SLR	Step-feed to reduce MLSS concentration in clarifier feed	Effective tool, but impacts on water quality and reuse goals would need to be considered
	Increase clarifier area	Expensive and requires significant site space
Reducing SVI	Incorporate anaerobic selector zones	Will promote biological phosphorus removal, but may reduce nitrogen removal efficiency
	Confirm full anaerobic and anoxic utilization of soluble carbon	Requires detailed process monitoring and modeling to verify limited soluble carbon bleed through to aerobic zones
	Incorporate hydrocyclones	Relatively new approach with promising results from early installations
Improving Clarifier Characteristics	Improve sludge removal and clarifier inlet (currently included in the Capital Improvement Plan)	Commonly implemented when rehabilitating clarifiers

Another option is to consider increasing the tertiary treatment capacity to match secondary treatment capacity so that the Balancing Pond could be used for additional storage at Tapia WRF. An extensive evaluation could be completed to understand whether the filters could hydraulically handle an increase in loading through improvements. This was outside of the scope of this evaluation; however, this would not increase the secondary treatment capacity, which is a limiting factor as well.

Additionally, the outcomes of the modeling efforts show that restricting the plant to two flow changes per day leads to a more consistent flow through the treatment facility, which benefits the overall processes. This improvement stabilizes flows at Tapia WRF and will distribute a more stable water quality and flow into the recycled water system for use at the future AWPF.

4.4.2 Flow Equalization

The model provided a means to compare historical operations to simulated operations with the addition of a primary effluent EQ basin at Tapia WRF. To attenuate variable diurnal flows at Tapia WRF, a 1.0-MG EQ tank provides sufficient storage, captures some of the minor storm events, and improves process performance by stabilizing flow when targeting two flow changes per day. A 1.0-MG EQ basin was sized based on the 97% or higher percent capture rate over the modeled flow scenarios and the 5 years of historical data. A 1.5-MG EQ tank would be required when targeting one flow change per day.

Expanding the daily flows to the wet weather events at Tapia WRF, a 3.0-MG EQ basin would provide sufficient storage to capture most of the peak storms when used with the Balancing Pond. If more sustained peaks were to be experienced, greater use of the primary effluent EQ volume over the Balancing Pond would be beneficial to stay within the peak capacity of the secondary treatment process. 2017 was the wettest year evaluated and serves as the worst-case scenario of flows. To capture the peak flow seen in the February 2017 storm, a 5.0-MG EQ basin would be required based on historical flows. Using the design flow scenario, the required EQ volume would increase to 9.42 MG if Tapia WRF were operating at 12 MGD. However, constructing an EQ basin of this size is not feasible due to physical site constraints and functionality of use once every 5 or more years.

Operations reported that during large storms, high flows through secondary treatment result in solids washout and treatment process upsets that require time to recover. Sufficient EQ storage is required to attenuate flows to secondary treatment during storms, given the shallow clarifiers and high influent peaking factor at Tapia WRF. The initial assessment investigated the use of volume in the EQ basin and the Balancing Pond to use existing infrastructure, based on peak flows of 20 and 24 MGD to secondary treatment and 16.4 and 18.2 MGD to tertiary treatment. The analysis concluded that for short peaking durations, continued use of the Balancing Pond can attenuate flow. For longer storm durations with high peaking factors, additional storage is required to capture primary effluent prior to secondary treatment. As the storm durations increase, the flows need to decrease to the process facilities.

Operational strategies, such as allowing the secondary and tertiary treatment processes to run at maximum capacities within acceptable durations, can reduce the overall EQ volume needed to capture the peak storms at Tapia WRF. Using the primary effluent EQ basin allows for the Balancing Pond to maintain flow to the tertiary filters at the design capacity, while also providing buffer capacity for wet weather events or operation and maintenance needs. With a larger EQ basin, there are fewer impacts from seasonal variations and wet weather, and the increased storage leads to a more consistent flow to the recycled water system and eventually to the new AWPF.

5. Recycled Water System and Advanced Water Purification Facility Flow Equalization

This section presents the analysis for flow management within the recycled water system and EQ at the AWPF. The model provides a comparison between historical and simulated data and supports recommendations for recycled water system improvements and EQ at the new AWPF for proactive flow management.

The historical operation of the recycled water system storage tanks and pump stations are dependent on one another. The existing pump stations operate on constant speed pumps controlled by the levels in the system's downstream storage tanks. This control approach results in an erratic operation as pumps are continually reacting to meet the irrigation flow demands and changing levels within the distribution system. System improvements to the operation of the pumps and the overall level set points were investigated. The correlation between flow, level, and operational strategies are described for the trends referred to throughout this section.

5.1 Tapia Water Reclamation Facility Effluent Pump Station

The tertiary treated effluent flow from Tapia WRF is the first component of the recycled water system that will ultimately feed the new AWPF. The Tapia WRF system improvements and operational management described in Section 4 will benefit the overall performance of the recycled water system, in addition to improving Tapia WRF performance.

Current operation of the Tapia WRF Effluent Pump Station is controlled by the level in Reservoir 2 and is variable and erratic. The existing pumps are constant speed and data show to have an operating range from 6 to 15 MGD, affected by the level in Reservoir 2. The model was used to assess the impact of VFDs, in conjunction with EQ, on the overall pump station capacity and effluent flow conveyance for the new AWPF. The assessment found that VFDs were beneficial; therefore, the model was set up such that all pumps were on VFDs. While the results and recommendations in this report are based on all pumps using VFDs, a minimum conversion of at least 50% could be viable. A focused evaluation would be required to identify the pump locations that would result in the overall, optimal benefit if not all pumps were to be provided with VFDs. The model does not account for any storage in the Effluent Pump Station wet well, which is a conservative assumption.

Figure 5-1 provides a representative comparison between historical operations with constant speed pumps and simulated operations with VFDs for a 1-month period in 2017. The date is shown across the x-axis, and the flow is shown on the primary y-axis. The light orange line represents the historical flow through the Effluent Pump Station, and the red line represents operation with VFDs. The figure shows the daily flow fluctuations due to recycled water demands.

The addition of VFDs lowers the overall required operating range and pumping capacity for the Effluent Pump Station. The three pumps with VFDs would need to convey a maximum range of 10 MGD, as opposed to a 15-MGD maximum range flow with constant speed pumps, for the historical flow conditions for 2017 to 2021. More of the pump station capacity would be required if average flows increased in the future.

The addition of VFDs would not only improve the stability of the pumped flow into the recycled water system but would also optimize the overall pump station capacity. The pump station would operate in a less reactive state. Less variation in the effluent flow would reduce the flow fluctuations in the distribution system, leading to more efficient operations of the new AWPF.

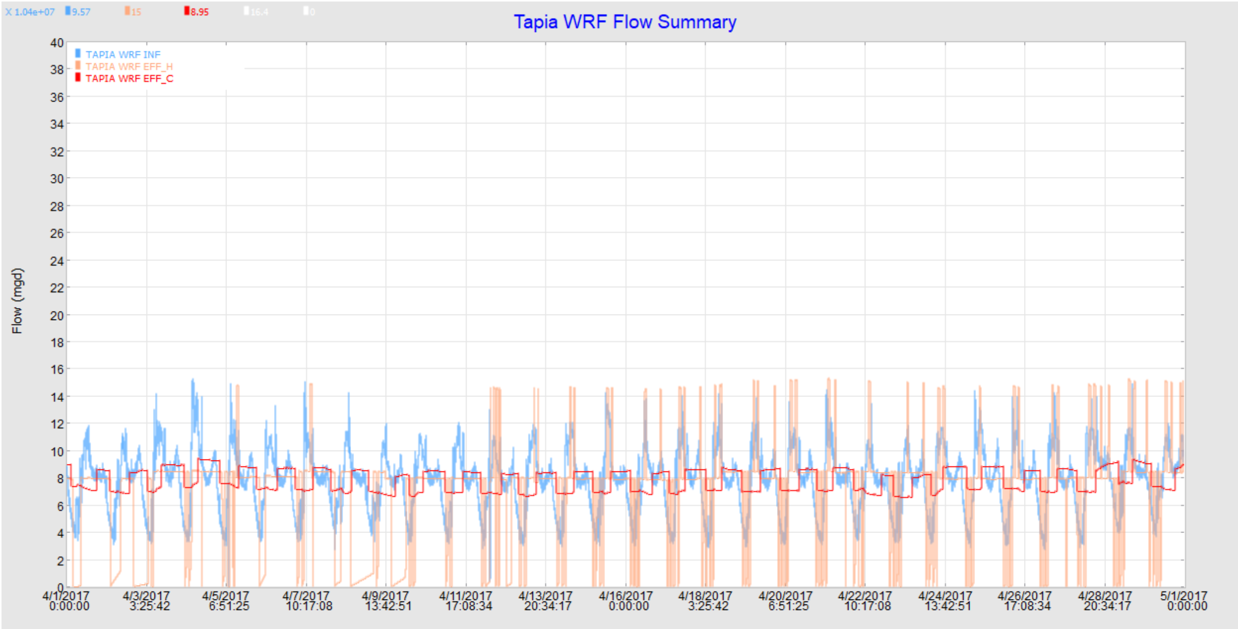


Figure 5-1. Tapia Water Reclamation Facility Effluent Pump Station Historical vs. Simulated Operations, 1 Month in 2017

5.2 Recycled Water System

Reservoir 2 provides 14.7 MG of storage and is a vital component in the recycled water system's operation. Management of Reservoir 2 water levels and the RWPS East and RWPS West flows will dictate the variability in the available flow to the new AWPF, while meeting irrigation demands. Changes to one element of the system ripple through to the other components.

5.2.1 Reservoir 2 Operation and Storage

The Tapia WRF Effluent Pump Station conveys tertiary effluent to Reservoir 2. The current daily level in Reservoir 2 is cyclical, given the network of distribution pump stations use constant speed pumps. The modeling analysis revealed that in addition to the recommended EQ and VFD modifications at Tapia WRF, VFDs for RWPS East and RWPS West would enhance the flow and level management in Reservoir 2.

Figure 5-2 provides a representative comparison between the historical and simulated levels in Reservoir 2 over a 1-month period in 2017. The simulated levels show the additional proposed upgrades to run the RWPS East and West pumps on VFDs.

The date is plotted on the x-axis and ranges from April 1 to May 1, 2017. The secondary y-axis represents both volume and level in Reservoir 2. Also, of note on the figure:

- The historical level in Reservoir 2 is shown in light pink
- The simulated Reservoir 2 level is shown in purple
- The Reservoir 2 volume is shown in yellow and is associated with the simulated Reservoir 2 level

The historical level in Reservoir 2 shows the varying irrigation demands supplied by the RWPS and reactive nature of the recycled water system. For this 1-month period in 2017, the historical operating level in Reservoir 2 varies between 5 to 21 feet, with daily peaks and valleys. In contrast, the simulated level in Reservoir 2 (shown in purple) fluctuates between a smaller operating band of 11 to 21 feet over several days during this 1-month period for a smoother operation. The simulated required Reservoir 2 volume (shown in yellow) follows the same pattern and ranges from 3 to 9 MG of storage. Over the course of 2017, the historical level in Reservoir 2 ranged from 3 to 23 ft, the simulated level in Reservoir 2 varies from 10 to 24 ft, and the volume in Reservoir 2 changes from 3 to 11 MG.

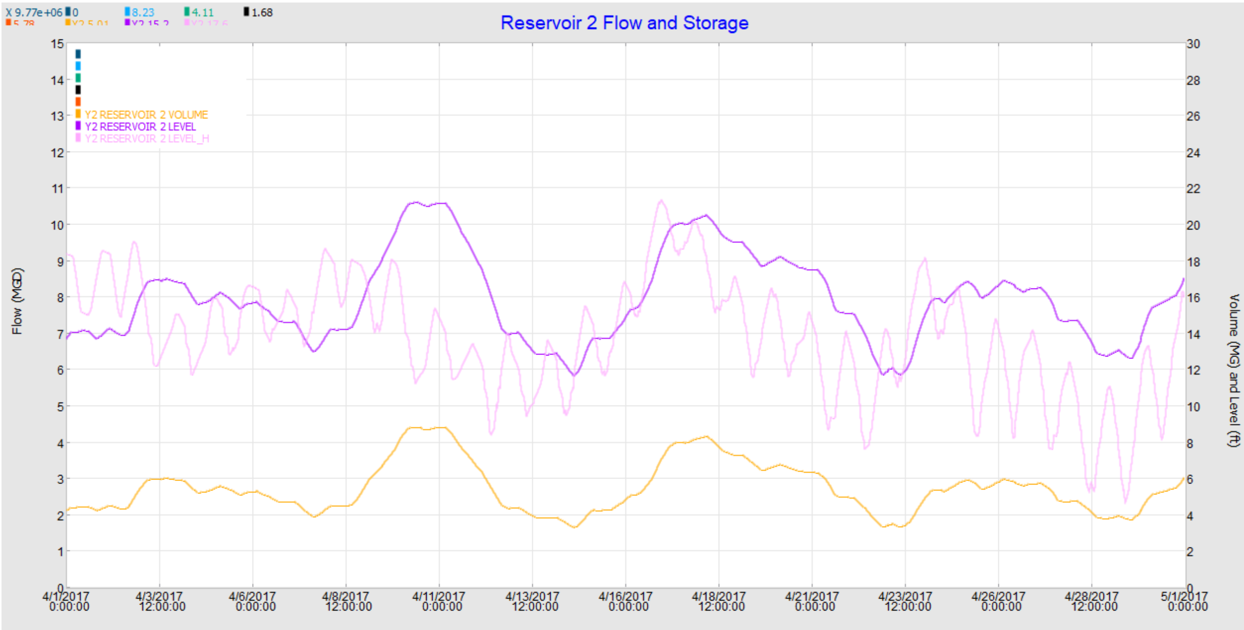


Figure 5-2. Reservoir 2 Historical vs. Simulated Operations with Variable Frequency Drives, 2017

The outcomes of this analysis emphasize how changes to Tapia WRF and the VFDs added to the Effluent Pump Station, RWPS East, and RWPS West would provide a more predictable influent flow to Reservoir 2 and more stable effluent flow out of Reservoir 2 to meet irrigation demands. In turn, this would promote a more forecasted control of Reservoir 2 because the level would not be fluctuating as drastically every day. These proposed changes would make operation of Reservoir 2 less variable and more predictable, facilitating an improved proactive management of the recycled water system.

5.2.2 Recycled Water Pump Station West Operations

The RWPS West pumps flow from Reservoir 2 to Indian Hills Tank (2.5 MG) for distribution through the western recycled water pipeline network to serve irrigation demands. RWPS West will provide source water to the new AWPF through Indian Hills Tank.

The model logic for RWPS West operates based on the level in Indian Hills Tank, which is dictated by the irrigation demands in the western distribution system. RWPS West includes three constant speed pumps, with a documented total capacity of 7.7 MGD (Boyle 1987). The pumps currently start and stop daily to meet irrigation demands, resulting in erratic operation of the system.

Figure 5-3 shows a representative snapshot of the 2017 historical operation of RWPS West with constant speed pumps. In comparison, Figure 5-4 shows the simulated 2017 operation of RWPS West with VFDs on the pumps. RWPS West is required to meet the erratic, diurnal irrigation demand; the addition of VFDs would allow the pump station (shown in the teal line) to operate with less frequent and severe peaks and valleys in flow. This promotes a proactive and balanced operation of the pump station to support a steadier flow pumped to the downstream to the AWPF.

The date is plotted across the x-axis and ranges from January 1 to December 31, 2017. The parameters captured on the primary y-axis include:

- RWPS West effluent flow shown in teal, with peak flow up to 12 MGD (Figure 5-3) and 10 MGD (Figure 5-4)
- Western irrigation demand shown in light green, with a flow ranging from 2 to 7.5 MGD
- AWPF demand flow shown in dark purple, with a flow ranging from 0 to 7.5 MGD

The volume at Indian Hills Tank is shown in dark brown on the secondary y-axis.

This model is also set up such that the Indian Hills Tank volume is held constant, as the flows entering and leaving the tank are the same. This provides a conservative assumption because the additional tank volume could act as buffer to balance flows and demands through the system.

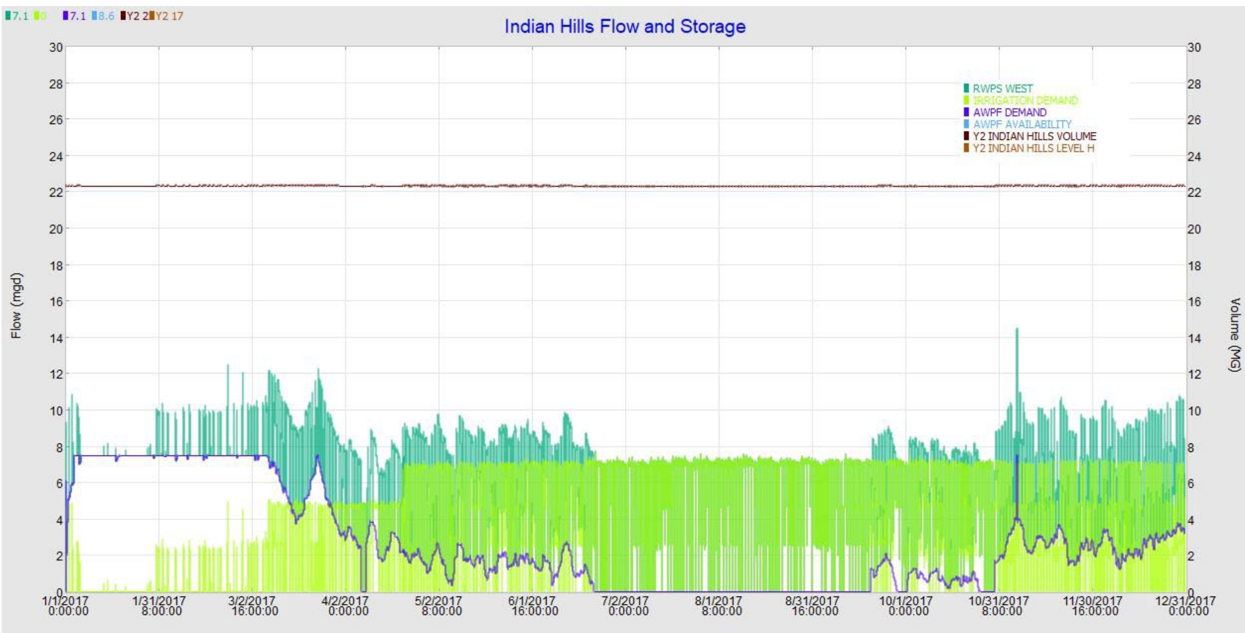


Figure 5-3. Historical Operations of Recycled Water Pump Station West with Constant Speed Pumps, 2017

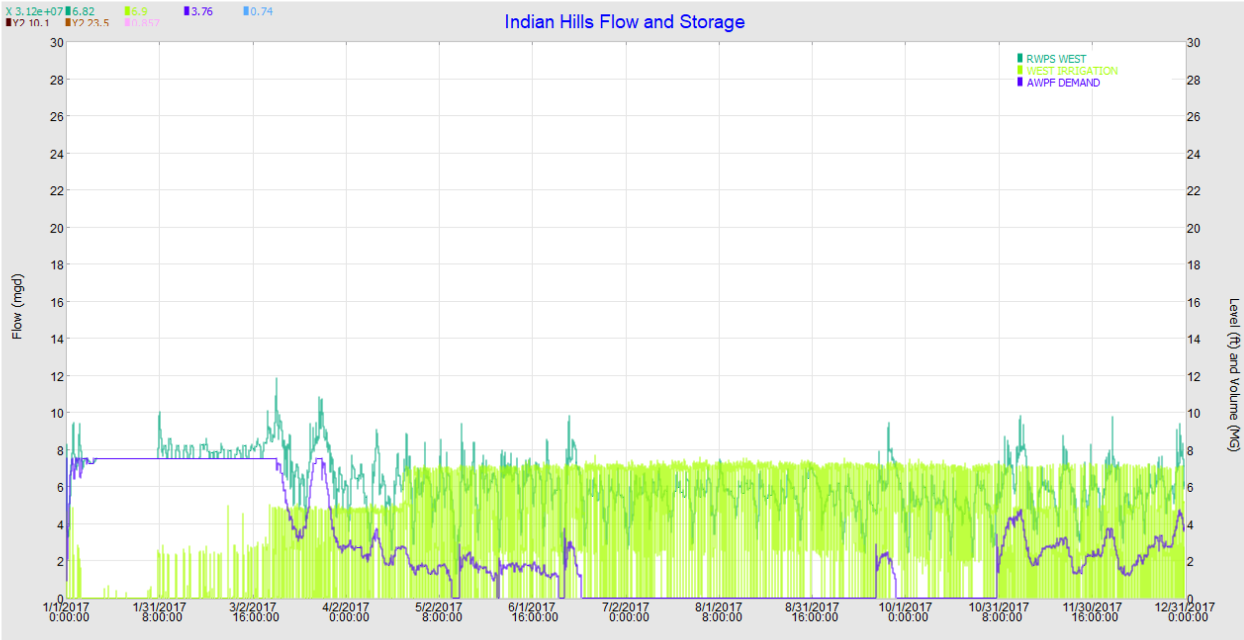


Figure 5-4. Simulated Operations of Recycled Water Pump Station West with Pumps on Variable Frequency Drives, 2017

There are instances where the AWPF demand decreases from the historical operations to the simulated operations because of the improvements in flow stability. The available flow for the AWPF is being captured upstream in the recycled water system from the operational improvements made such as EQ at Tapia WRF, leveraging more usable storage in Reservoir 2, and pumping upgrades.

Table 5-1 summarizes the resulting average and peak flows for RWPS West with constant speed pumps and pumps with VFDs. The use of VFDs reduces the required peak.

Table 5-1. Recycled Water Pump Station West Flow Comparison

Parameter	Units	Historical Pumping Operations (Constant Speed Pumps)	Simulated Pumping Operations (Pumps on VFDs)
Pump Station Peak Flow	MGD	12	10
Winter Irrigation Demands	MGD	0-2.2	
Summer Irrigation Demands	MGD	0-7	

The RWPS West pumping operation is only one component of the flow balance to the AWPF. The operation of Indian Hills Tank and the nature of the western irrigation demands are important to management of the new AWPF. As shown on Figures 5-3 and 5-4, the irrigation demands (light green line) create an additional challenge for balancing flow to the western distribution system. The demands range from 0 to 7 MGD, which is based on the actual irrigation demands matching the RWPS West historical flow data.

Figure 5-5 shows a simulated 10-day period in 2017 of flows leaving Reservoir 2 and the RWPS West operational requirements to meet the irrigation demands.

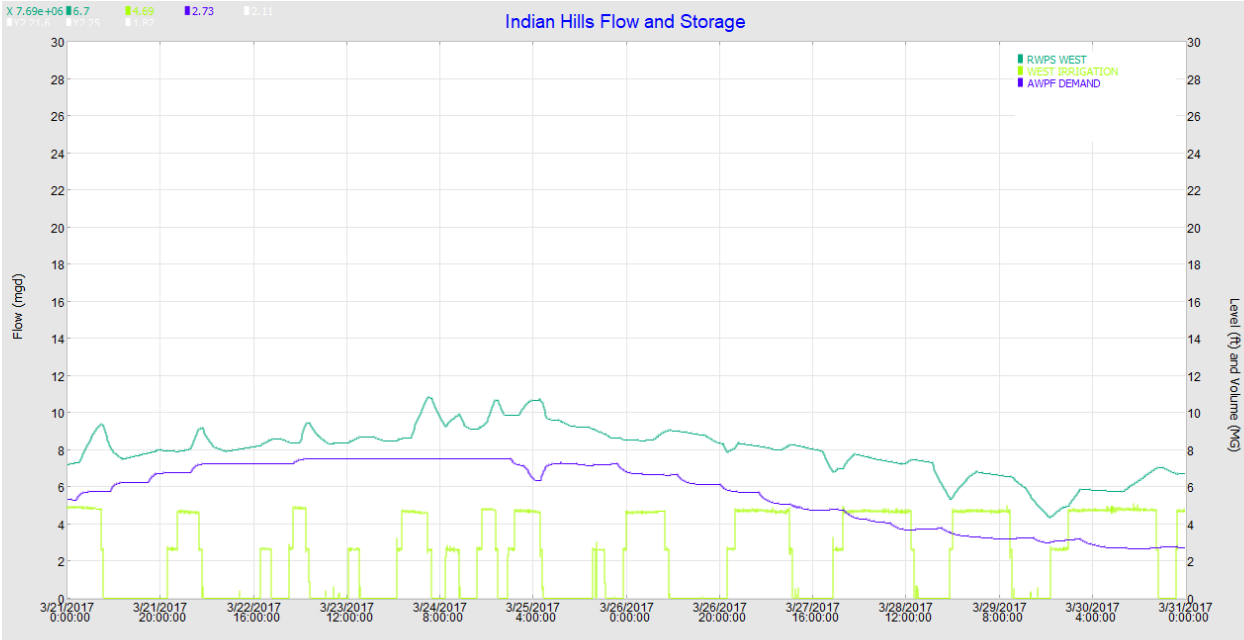


Figure 5-5. Recycled Water Pump Station West Simulated Irrigation Demands, 10 Days in 2017

The trend emphasizes the irregular nature of the irrigation demands (light green line), generally showing the highest demand in the early hours of the day. However, some days, the irrigation demand persists throughout the whole day or extends for significantly longer periods than other days. If the irrigation customers could be placed on a schedule for water, this would help balance operation and lessen the flow fluctuations within the distribution system. During this 10-day period, RWPS West supplies between 5 to 11 MGD of flow. Peaks of 11 MGD only occurred a few times within the year.

Figure 5-6 shows how RWPS West operations impact Indian Hills Tank storage over 1 month in 2017. The first 10 days are the same time period as on Figure 5-5.

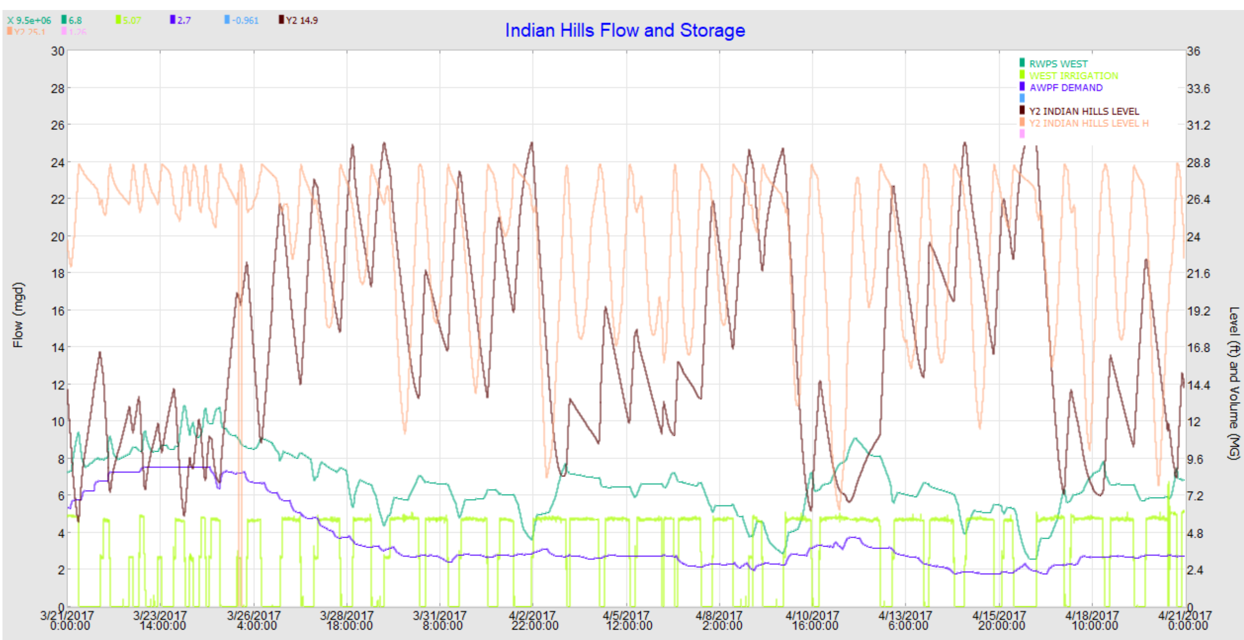


Figure 5-6. Historical vs. Simulated Storage of the Indian Hills Tank, 1 Month in 2017

The historical level in Indian Hills Tank is in light orange, and the simulated level is in brown and plotted on the secondary y-axis. The constant speed pumps at RWPS West are controlled based on the level in Indian Hills Tank, so daily fluctuations in pumping are shown (light orange line), as well as the on and off operation of the pumps represented by the western irrigation demand (light green; the actual RWPS West pumped flow).

When the pumps start and the effluent flow from RWPS West increases (light green line), the historical level in Indian Hills Tank starts to rise. Switching to VFDs would reduce the drastic level swings in Indian Hills Tank (brown line) while still using the full storage capacity. Simulated operations of Indian Hills Tank show that the storage can gradually increase and gradually decrease over several days and still balance flow to the AWPF and irrigation demands. The simulation uses the volume in Indian Hills Tank as EQ for the new AWPF, ultimately reducing the required volume of the onsite EQ at the AWPF.

Improved operations of RWPS West together with using storage in Indian Hills Tank and coordinating customer irrigation demands would deliver more stable flow through the western distribution system and to the new AWPF. The addition of VFDs would reduce the overall required pump station capacity and lessen the flow fluctuations within the distribution system. This proactive management approach for RWPS West would optimize delivery of flow to the new AWPF and operations of the system, while minimizing EQ at the AWPF.

5.2.3 Recycled Water Pump Station East Operations

Flow leaving Reservoir 2 can also be conveyed to RWPS East before it is pumped to Cordillera Tank and delivered into the eastern distribution system. Current operations of RWPS East are determined by irrigation demands, which fluctuate daily. Historical irrigation flow patterns from RWPS East mimic the same type of pattern as the historical irrigation demands leaving RWPS West. Figure 5-7 shows the simulated output of how the system would perform if VFDs were added to the pumps at RWPS East, similar to the recommended improvements for RWPS West.

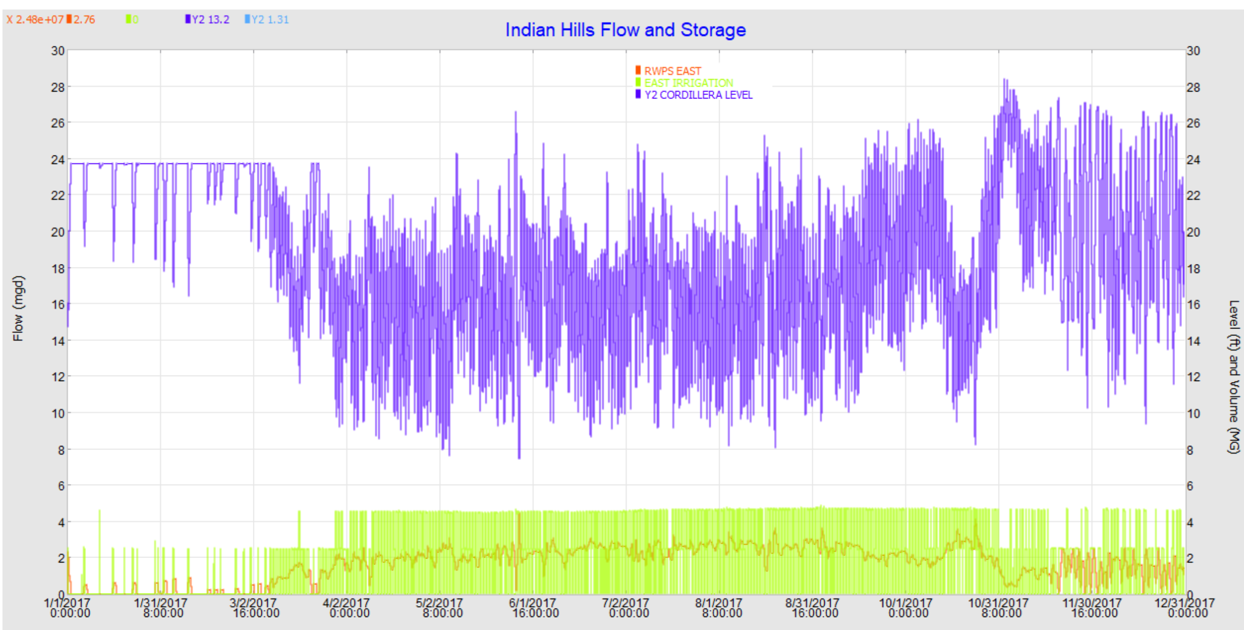


Figure 5-7. Simulated 2017 Operations of Recycled Water Pump Station East with Pumps on Variable Frequency Drives

The date is plotted across the x-axis and ranges from January 1 to December 31, 2017. The parameters captured on the primary y-axis include:

- RWPS East effluent flow shown in orange, with a flow up to 4.5 MGD
- Eastern irrigation demand shown in light green, with a flow ranging from 0 to 3 MGD

The Cordillera Tank level is shown in purple on the secondary y-axis

The model does not include operation logic for Cordillera Tank; instead, it passes flow through the system to meet the eastern distribution system irrigations demands.

The trend shows the range of irrigation demands (light green) to the eastern distribution system ranging from 0 to 4.5 MGD. In this condition, the RWPS East pumps with VFDs assumed are able to use the current storage in Cordillera Tank to smooth out pump station operations and flow to the eastern distribution system. Ultimately, with the addition of VFDs, the overall RWPS East capacity could be reduced to an average of 2 MGD, with peak flows rarely reaching 4 MGD. The level in Cordillera Tank oscillates to regulate the pressure in the eastern distribution system.

Overall improvements can be made to RWPS East, such as adding VFDs and coordinating irrigation demands with customers to help smooth out operations to the recycled water system. Reducing the overall RWPS East capacity requirements reduces hydraulic concerns regarding suction piping leaving Reservoir 2 to the two downstream pump stations.

5.3 Advanced Water Purification Facility Flow and Equalization

The flow to the AWPF will be directly connected to the management of:

- Tapia WRF
- Reservoir 2
- RWPS West
- Indian Hills Tank
- Western distribution system irrigation demands

Improved operations of these assets within the recycled water system will provide an integrated system and beneficially impact operations of the new AWPF. The model logic determines the available flow to the new AWPF by considering the effluent flow leaving Tapia WRF, the operating level in Reservoir 2, and the downstream recycled water users. The flow to the new AWPF will influence the sizing of the EQ basin used to attenuate daily flows for optimal process performance. The model logic for the AWPF demand incorporates a 3-day rolling average of the AWPF available flow to minimize flow changes at the AWPF.

The model was used to compare how the flow EQ would be impacted at the new AWPF if the proposed changes, described in Section 4 and Sections 5.1 and 5.2, were made to the recycled water system. The model assumes that the effluent flow from Indian Hills Tank will be sent to an EQ basin connected to the new AWPF. The cause-and-effect nature of the system is best seen through operational trends at Reservoir 2.

Figure 5-8 shows the trends for simulated operations of the recycled water system with variable speed pumps and the impact on the AWPF feed flow for 2017. Appendix E provides the 1-year simulation plots for 2018 to 2021.

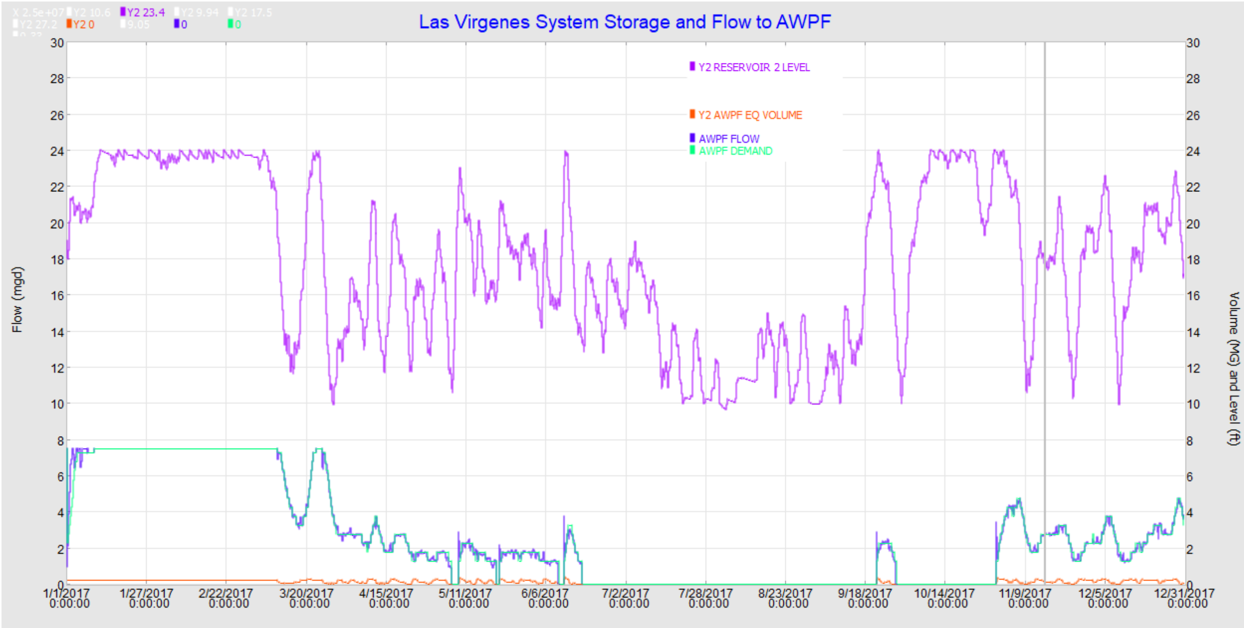


Figure 5-8. Advanced Water Purification Facility Simulated Feed Flow for 2017

The date is plotted across the x-axis and ranges from January 1 to December 31, 2017. The parameters captured on the primary y-axis include:

- AWPF available flow shown in overlapping dark purple/lime green, ranging from 0 to 7.5 MGD

The secondary y-axis includes:

- Reservoir 2 level shown in purple, ranging from 10 to 24 feet
- AWPF EQ basin volume shown in orange, up to 0.5 MG

The AWPF would have reached its peak flow of 7.5 MGD through part of March 2017. The available flow remains limited to the AWPF over the spring, fall, and summer months as the available recycled water is used for irrigation demands. In general, the AWPF demand and AWPF flow pattern allows for two daily flow changes at the AWPF while using less than 0.5 MG of EQ at the AWPF.

The level in Reservoir 2 would fluctuate between 10 and 24 feet as a result of the VFDs on the RWPS West pumps and the operational logic calculations for determining flow set points. Reservoir 2 would operate between the local peaks and valleys over several days as opposed to historical operations when the volume shifted daily. This pumping adjustment would not only stabilize operations at Reservoir 2, but would smooth out the RWPS West effluent flow to Indian Hills Tank on the way to the new AWPF. The ripple effect promotes proactive management for easing the flow fluctuations on the western distribution system.

The recycled water operational improvements would affect the required EQ storage capacity, but not eliminate the overall need at the new AWPF. Per LVMWD, the AWPF will receive the surplus flow after irrigation demands have been met and thus onsite EQ at the AWPF will be used to absorb fluctuations in flow based on the selected location for recycled water delivery. The orange line on Figure 5-8 shows the trend of AWPF EQ volume as it varies based on available flow and demand. During the winter months when the AWPF is intended to run, the EQ storage reaches a maximum of 0.5 MG. If operations at the new AWPF were to target one flow change per day, a larger EQ basin would be needed to attenuate flow. The AWPF can use existing storage throughout the recycled water system if VFDs are added to the pumps at RWPS West. The EQ basin will provide a steadier flow to the AWPF to promote operational stability for the treatment processes, specifically RO.

5.4 Recommendations

The recommendations for recycled water system improvements and flow EQ needs at the new AWPF are summarized in this section.

5.4.1 System Improvements

Historical operations of the pump stations of interest as they relate to the AWPF, notably Tapia WRF Effluent Pump Station and RWPS East and West, have traditionally operated on constant speed pumps controlled by levels in distribution system storage tanks. The pump stations' flow patterns mimic the erratic nature of the irrigation demands. Upgrading the pump stations to operate on VFDs balance out the erratic nature and can reduce the overall required pumping capacity while still meeting the demand.

Additionally, coordinating customer irrigation demands would deliver more stable flow through the distribution system. The pump stations would operate in a less reactive state, and less variation in the recycled water flow would reduce the flow fluctuations in the distribution system, leading to more efficient operations of the new AWPF.

The addition of VFDs on the pump stations are linked to operation of the storage tanks in the recycled water system. If the system can better meet a variety of flows and demands, there will be fewer storage requirements, and less wear and tear on equipment. The operational strategies promote more forecasted control of the level in these storage tanks, specifically Reservoir 2, where the level isn't fluctuating as drastically every day. These proposed changes make the Reservoir 2 operations less variable and more predictable, improving proactive management of the recycled water system.

5.4.2 Flow Equalization

The recommended improvements at Tapia WRF and the recycled water system benefit the future operation of the new AWPF. Fewer flow fluctuations through the distribution system promote proactive operation of the AWPF. Frequent changes within the unit processes, particularly RO, can be difficult to manage; thus, it is favorable to provide a constant flow through the treatment facility and limit the number of flow changes per day.

This design criteria of two flow changes per day emphasizes the importance of upstream EQ at the new AWPF. The modeling results show that an influent flow EQ of 0.5 MG provides adequate storage to buffer the daily variations in flow while supplying sufficient flow to the AWPF processes, using existing upstream storage within the recycled water system. Coupling the EQ storage with the process operational strategies allow for smoother operation of the new AWPF.

6. Equalization Basin Concept Design

This section presents the conceptual design criteria for the Tapia WRF and AWPF EQ.

6.1 Tapia Water Reclamation Facility Equalization

This section describes the conceptual design criteria and locations for the Tapia WRF EQ alternatives.

6.1.1 Preliminary Considerations

Based on the modeling analysis presented in Section 4.1, approximately 1.0 MG of storage volume is sufficient to attenuate the regular diurnal flows through Tapia WRF and capture the smaller magnitude storm events in tandem with the Balancing Pond with two flow changes per day, based on historical flow data from 2017 to 2021. Up to 2.0 MG of storage volume would be needed if one flow change per day is targeted. If the design intent is to capture up to the peak storm recorded in February 2017, the required storage volume increases to 9.42 MG, assuming an equalized average influent flow of 12 MGD and a peak secondary treatment capacity of 24 MGD. This is not a feasible option for onsite equalization given site footprint constraints. Instead, a lower EQ volume of 3.0 MG would cover all of the other historical storms and provide some attenuation during a similar extreme event.

This section evaluates the location of the EQ for these two options, which are summarized in Table 6-1. Figure 6-1 shows the considered locations of the EQ tank for Option 1 and Option 2.

Table 6-1. Equalization Tank Sizing Summary

Parameter	Option 1	Option 2
Design Basis	Regular diurnal flows and some smaller storms, with two flow changes per day	Regular diurnal flows and all storms except February 2017 peak storm, with two flow changes per day
EQ Volume	1 MG[a]	3 MG
Pumping Capacity	12 MGD	12 MGD

[a] Up to 2 MG would be required to maintain one flow change per day.

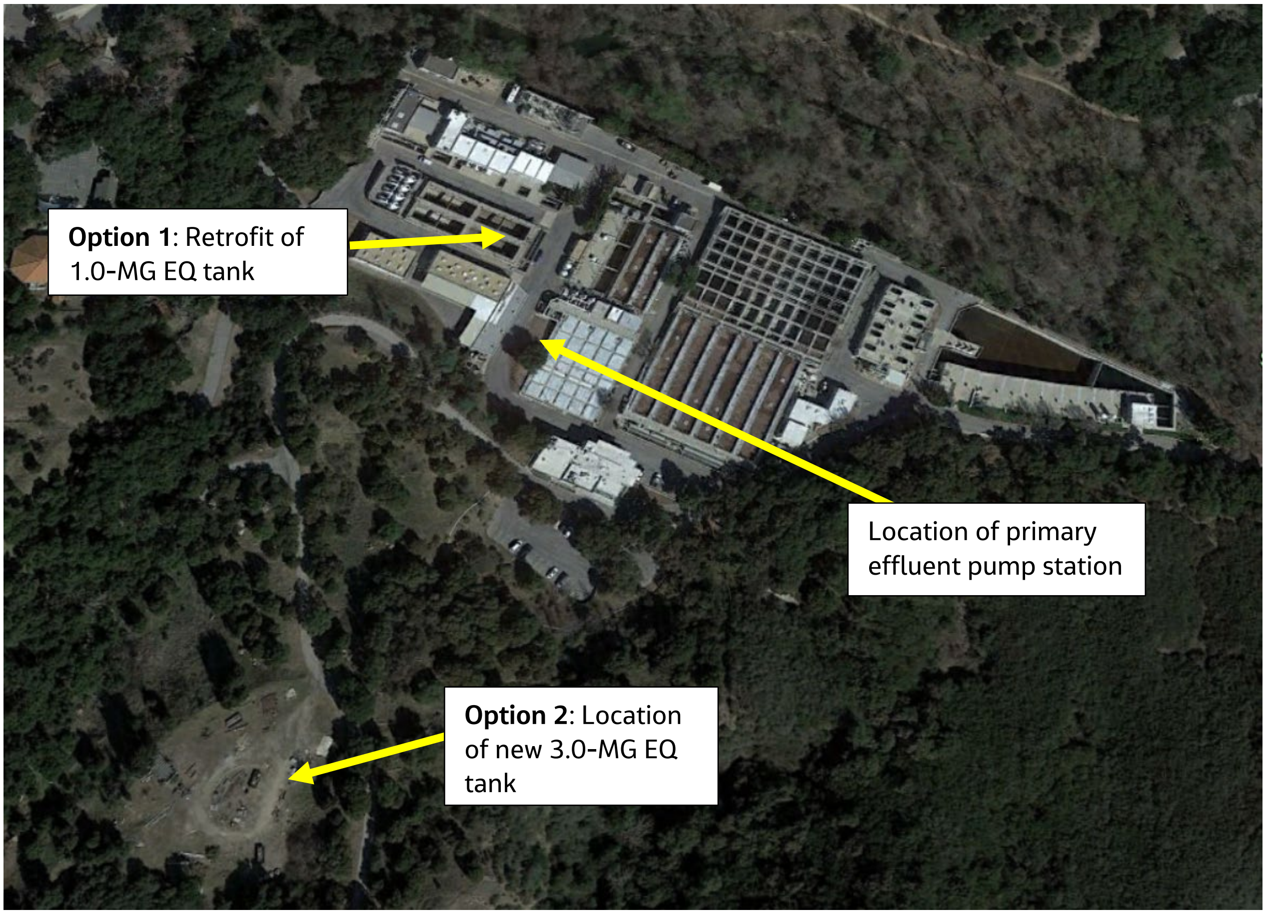


Figure 6-1. Options 1 and 2 Equalization Tank Locations
Source: Esri World Imagery, 2021

6.1.2 Infrastructure and Pumping Considerations

This section describes infrastructure and pumping considerations.

6.1.2.1 Option 1, 1-MG Tank

In Option 1, the existing digester tank would be retrofitted to serve as an EQ tank with a storage volume of 1.0 MG, with a pump station and odor control (Figure 6-2). This option was investigated to reuse existing infrastructure. A conditions assessment of the tanks was not conducted as part of this effort. Table 6-2 summarizes the design criteria. Given that the EQ tank water surface elevation would be 2.5 feet lower than the water surface elevation in the primary sedimentation tanks, primary effluent would be diverted from the primary effluent channel and conveyed to the EQ tank by gravity flow. The equalized flow would then be pumped back to the primary effluent channel from the EQ tank using submersible pumps.

Table 6-2. Option 1 Design Criteria

Parameter	Units	Design Criteria
Pumping Flow Range	gpm MGD	700-8,400 1–12
Pump Type	--	Submersible
Small Pumps		
Quantity	No.	3
Capacity, each	gpm MGD	700–1,400 (with VFD) 1–2
TDH	feet	25
Power	hp	14
Large Pumps		
Quantity	No.	2
Capacity, each	gpm MGD	2,000–4,200 (with VFD) 2.9–6
TDH	feet	20
Power	hp	35
Odor Control		
Type	--	Biofilter
Foul Air Flow[a]	cfm	5,500

[a] Based on containment.

- = not applicable

hp = horsepower

TDH = total dynamic head

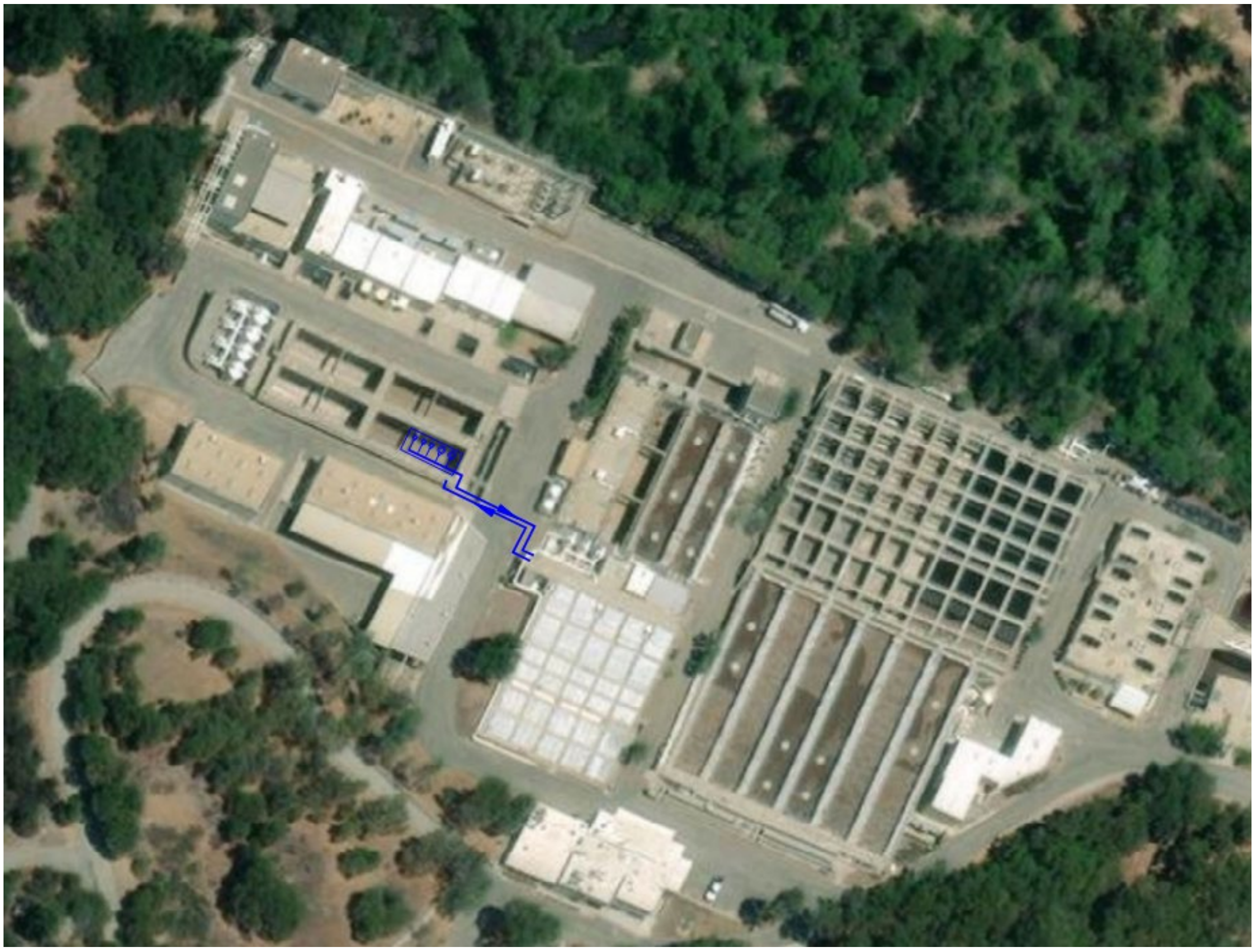


Figure 6-2. Option 1, Retrofit of the Existing Digester Tanks
Source: Esri World Imagery, 2021

6.1.2.2 Option 2, 3-MG Tank

In Option 2, a new 3.0-MG EQ tank would be provided with a pump station and odor control with the design criteria in Table 6-3. The tank would be installed in the flat area approximately 122 feet above the grade level of the treatment plant, as shown on Figure 6-3. A pump station would be constructed next to the primary effluent channel to divert and lift flow to the EQ tank. The equalized flow would return to the primary effluent channel by gravity.

Table 6-3. Option 2 Pump Station Design Criteria

Parameter	Units	Design Criteria
Pumping Flow Range	gpm MGD	700-8,400 1–12
Pump Type	--	Submersible
Small Pumps		
Quantity	No.	3
Capacity, each	gpm MGD	700–1,400 (with VFD) 1–2
TDH	feet	165
Power	hp	105
Large Pumps		
Quantity	No.	2
Capacity, each	gpm MGD	2,000–4,200 (with VFD) 2.9–6
TDH	feet	165
Power	hp	250
Odor Control		
Type	--	Biofilter
Foul Air Flow[a]	cfm	2,000

[a] Based on fill rate, considering minimal hatches.

- = not applicable

hp = horsepower

TDH = total dynamic head

6.1.3 Construction Cost

Construction cost estimates were prepared for the two primary equalization options in accordance with the AACE International Class 5 standards and are presented in August 2022 dollars. These estimates were prepared based on limited information, with engineering from 1 to 15% complete and based on plant capacity, block schematics, process flow diagrams for main process systems, and preliminary engineered process and utility equipment lists. End usage of these costs includes detailed strategic planning, project screening at more developed stages, alternative scheme analysis, confirmation of economic and technical feasibility, and preliminary budget approval. The expected accuracy range for this estimate is -15 to -30% on the low side and +20 to +50% on the high side. Table 6-4 provides a summary and Appendix F provides the detailed estimates.

Table 6-4. Construction Cost Estimate for Tapia Water Reclamation Facility Equalization

Option	EQ Size (MG)	Estimated Capital Cost ($ M)	Low Range -30% ($ M)	High Range + 50% ($ M)
Option 1 - retrofit	1	6.0	4.2	9.0
Option 2 - new	3	10.6	7.4	15.9

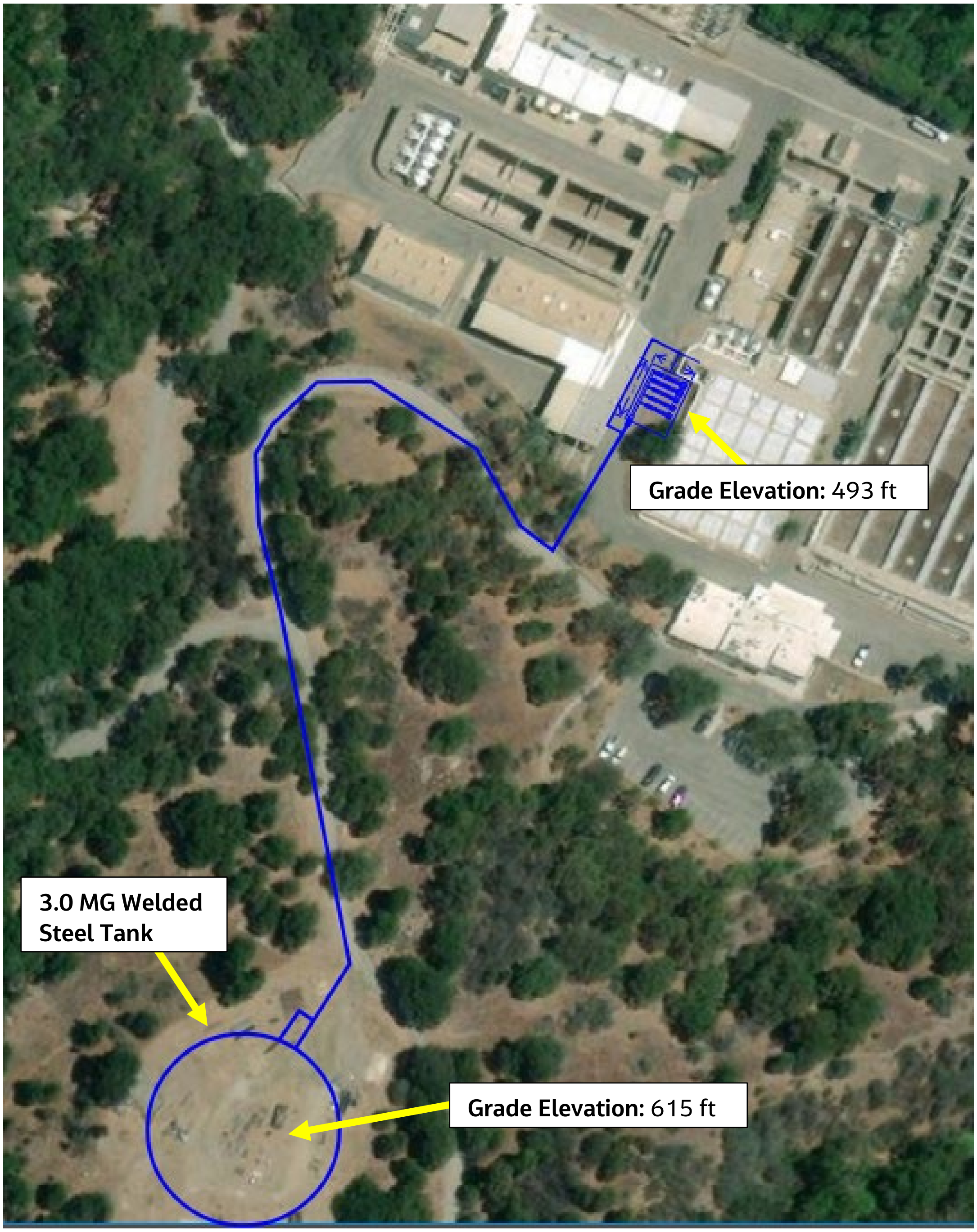


Figure 6-3. Option 2, Proposed Construction of a New Tank
Source: Esri World Imagery, 2021

6.2 Advanced Water Purification Facility Equalization

Based on the modeling analysis, approximately 0.5 MG of storage volume would be sufficient to attenuate the flows to the AWPF in conjunction with the other proposed improvements at Tapia WRF and the recycled water system and will be incorporated as part of the membrane filtration feed pump station. This infrastructure will be addressed in the AWPF conceptual design.

7. Summary of Recommendations

This evaluation assessed the EQ storage volumes required to manage variable diurnal flows and wet weather events for Tapia WRF. In anticipation of the PWP, this evaluation also investigated the recycled water system improvements and EQ storage volume needed at the AWPF to provide a stable flow for optimal operation of the new advanced facility. Additional storage at Tapia WRF and the new AWPF, and improvements to the recycled water pumping systems, will promote more proactive management of the recycled water system.

7.1 Tapia Water Reclamation Facility

A series of flow scenarios and operating conditions were assessed to size the primary effluent EQ basin at Tapia WRF. Replica was used to compare historical operations to simulated operations with the identified system improvements. The recommended solutions for Tapia WRF include:

- Building an onsite primary effluent EQ basin to ease seasonal demand differences and improve operations at Tapia WRF.
    - A 1.0-MG EQ basin would be sufficient storage to accommodate typical diurnal flows, targeting two flow changes per day.
    - A 2.0-MG EQ basin would be required to accommodate typical diurnal flows, targeting one flow change per day.
    - Expanding the daily flows to the wet weather events, a 3.0-MG basin would attenuate flows from most historical wet weather events and provide greater operational flexibility. For design capacity scenarios, a 3.0-MG basin would provide sufficient storage to capture most of the peak storms when used with the Balancing Pond. If more sustained peaks were to be experienced, greater use of the primary effluent EQ volume over the Balancing Pond would be beneficial to stay within the peak capacity of the secondary treatment process.
    - To capture the peak flow seen in the February 2017 storm, a 5.0-MG EQ basin would be required based on historical flows. Using the design flow scenario, the required EQ volume would increase to 9.42 MG if Tapia WRF were operating at 12 MGD. However, constructing an EQ basin of this size is not feasible due to physical site constraints, with an expected occurrence once every 5 years.
- Implementing a flow control strategy to promote stable flow through the treatment facility. This operational strategy can be achieved with the addition of primary effluent EQ. A larger EQ volume would be required to achieve one flow change per day, versus two flow changes per day.
- Evaluating the secondary treatment capacity for alternatives to improve the activated sludge settleability during seasonal transition months to optimize secondary clarifier capacity.
- Improving the Tapia WRF Effluent Pump Station by upgrading the pumps to operate on VFDs. The addition of VFDs will reduce the overall pump station demand and produce a more consistent effluent flow into the recycled water distribution system. Currently, the capacity is below the rating for the tertiary filters and should be aligned.

7.2 Recycled Water System Improvements

The recycled water system operates in a reactive state where operations of pump stations and storage tanks are dictated by seasonal storms and recycled water demands. A thorough flow balance model was developed in Replica to identify system improvements throughout the recycled water system as they relate to the new AWPF. The recommended solutions for the recycled water system include:

- Upgrading the RWPS East and West pumps to operate on VFDs. This improvement will allow the pump stations to more easily meet a variety of flows and demands, leading to lower storage requirements, optimized pump station capacity, and a reduction in wear and tear on equipment. Ultimately, this will promote less flow fluctuations in the distribution system.

- Improving the operational level control of the storage tanks, such as Reservoir 2 and Indian Hills, to use a larger percentage of the usable storage capacity. This refinement promotes a more forecasted level control and allows the existing storage to be used to support the operation of the new AWPF.
- Implementing the flow control strategy to use the previous day's flow data and current flow data to improve system responsiveness. This operational strategy promotes proactive management of the recycled water distribution system.
- Coordinating irrigation demand schedules with the largest users, such as golf courses and parks, to aid in proactive management of the supply and demand of the recycled water distribution system.

7.3 Advanced Water Purification Facility

The benefits from the overall improvements at Tapia WRF and throughout the recycled water system will be observed as well at the new AWPF. The recommended solutions for the new AWPF include:

- Building an onsite influent 0.5-MG EQ basin for daily diurnal flows at the new AWPF. This will help provide a more consistent flow to the sensitive unit processes, specifically RO, in the new AWPF. This sizing recommendation is dependent on using the existing storage in the recycled water distribution system and the addition of VFDs at RWPS East and West.
- Implementing a flow control strategy to target a maximum of two fundamental flow changes per day. In addition to this target, the operational strategy of using the influent flow conditions to determine operating scenarios for process equipment (such as RO skids) will help reduce the wear and tear on the equipment. These improvements promote stable flow through the treatment facility, preserves the process equipment, and is achievable with the addition of the influent EQ basin.

8. References

AACE International (AACE). 2020. *18R-97, Cost Estimate Classification System – As applied in Engineering, Procurement, and Construction for the Process Industries*. August 7.

AECOM. 2011. *Biological Nutrient Removal Project for Las Virgenes Municipal Water District.* August.

ASL Consulting Engineers. 2001. *Las Virgenes Municipal Water District & Triunfo Sanitation District Construction Drawings for the Tapia Water Reclamation Facility Headworks Rehabilitation*. September.

Boyle Engineering Corporation.1987. *Western Reclaimed Water Distribution System Phase 2 – Headquarters West Pumping Station.* February.

California Regional Water Quality Control Board Los Angeles Region (Regional Board). 2017. *Waste Discharge Requirements for the Las Virgenes Municipal Water District Tapia Water Reclamation Facility, Order R4-2017-0124, NPDES N0. CA0056014*. June 1.

Daigger, G.T., and R.E. Roper Jr. 1985. "The relationship between SVI and activated sludge settling characteristics." *Journal*. Water Pollution Control Federation. Vol. 57. No. 8. WPCF Conference Preview Issue. August. https://www.jstor.org/stable/25042720.

Kennedy/Jenks Consultants. 2014. *Recycled Water Master Plan Update.* Prepared by HDR. June.

Las Virgenes Municipal Water District (LVMWD). 2004. *Engineering Report for Distribution and Use of Recycled Water in the Las Virgenes Municipal Water District Use Area* (*Title 22 Engineering Report)*. Revision No. 1, March.

Los Angeles Regional Water Quality Control Board (Los Angeles Regional Board). 2020. *Water Quality Control Plan: Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties*. Basin Plan | Los Angeles Regional Water Quality Control Board (ca.gov).

MWH. 2005. *Tapia Water Reclamation Facility Nutrient Reduction Master Plan Update*. April 1.

Peerless Pump, a Sterling Company. 1986. *Certified Pump Curve for Recycled Water Pump Station West Pumps*. May 14.

Stantec. 2019. *Preliminary Design Report: Summer Flow Augmentation of Malibu Creek.* Prepared by for Las Virgenes-Triunfo Joint Powers Authority. January 18. p. 15. https://www.lvmwd.com/home/showdocument?id=11712.

U.S. Environmental Protection Agency (EPA). 2013. *Malibu Creek and Lagoon Sedimentation and Nutrients TMDL to Address Benthic Community Impairments*. Region IX. July 2. Final Malibu Creek & Lagoon TMDL for Sedimentation and Nutrients to Address Benthic Community Impairments - Signed - 07/02/2013 (ca.gov).

Appendix A
Historical Data

Appendix A. Historical Data

Appendix A contains the historical data (LVMWD 2021) for parameters used in the modeling efforts for both Tapia Water Reclamation Facility (Tapia WRF) and the recycled water system to the Advanced Water Purification Facility (AWPF). The parameters include:

- Malibu Creek flow
- Pepperdine flow
- Rancho Pump Station flow
- Supplemental Potable Water flow
- Recycled Water Pump Station (RWPS) East flow
- RWPS West flow
- Irrigation Demand flow
- Reservoir 2 level
- Indian Hills Tank level

Figures A-1 through A-4 show the historical discharge events at 1-minute increments from Tapia WRF to Malibu Creek from 2018 to 2021.

Tables A-1 through A-8 summarize the percentile distributions of the historical daily average flow data for the recycled water system from 2017 to 2021.

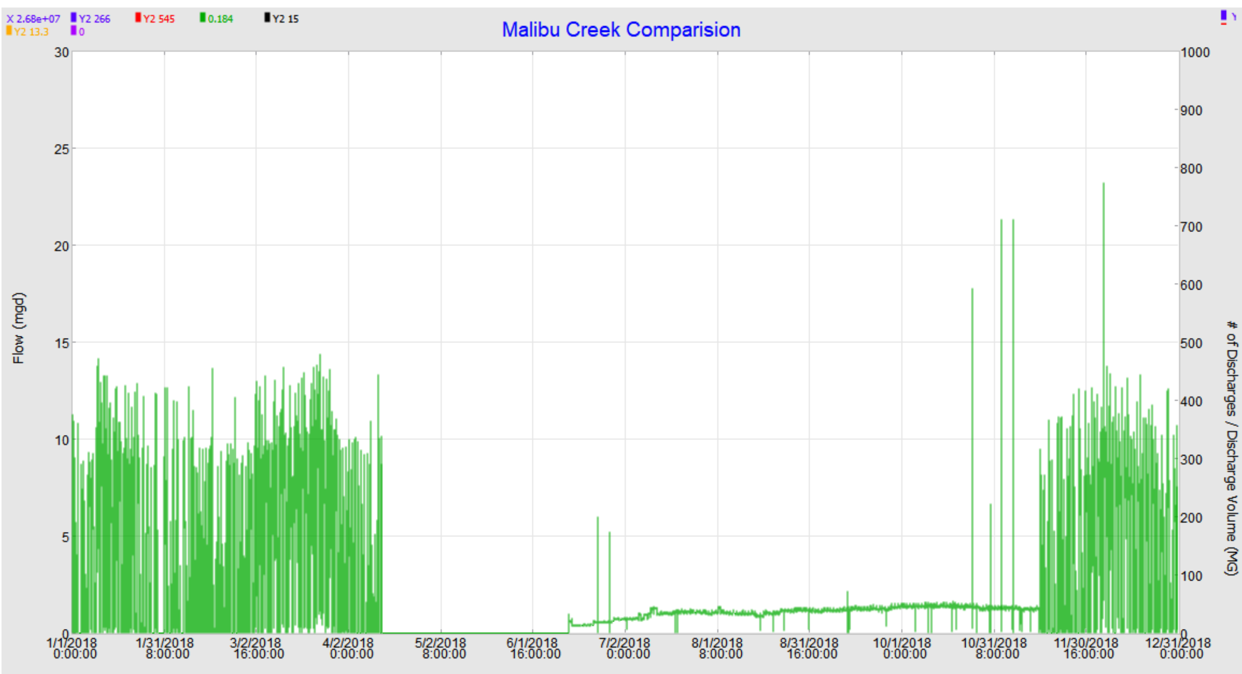


Figure A-1. Historical Discharges to Malibu Creek in 2018

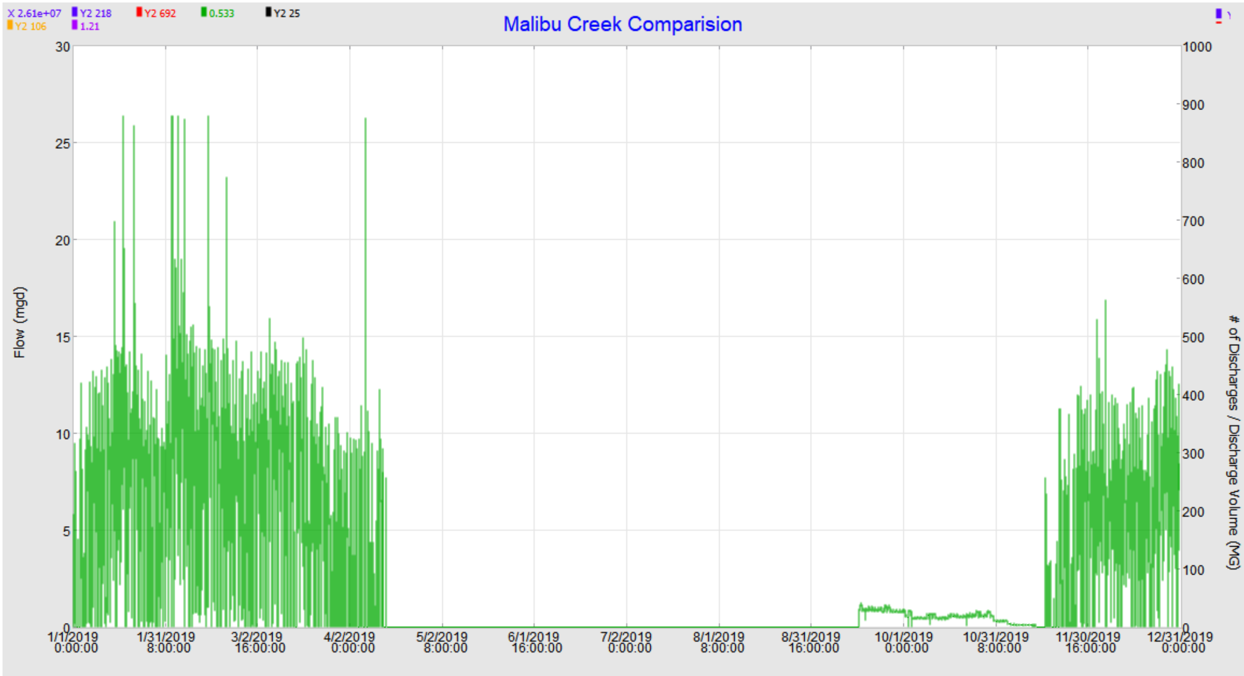


Figure A-2. Historical Discharges to Malibu Creek in 2019

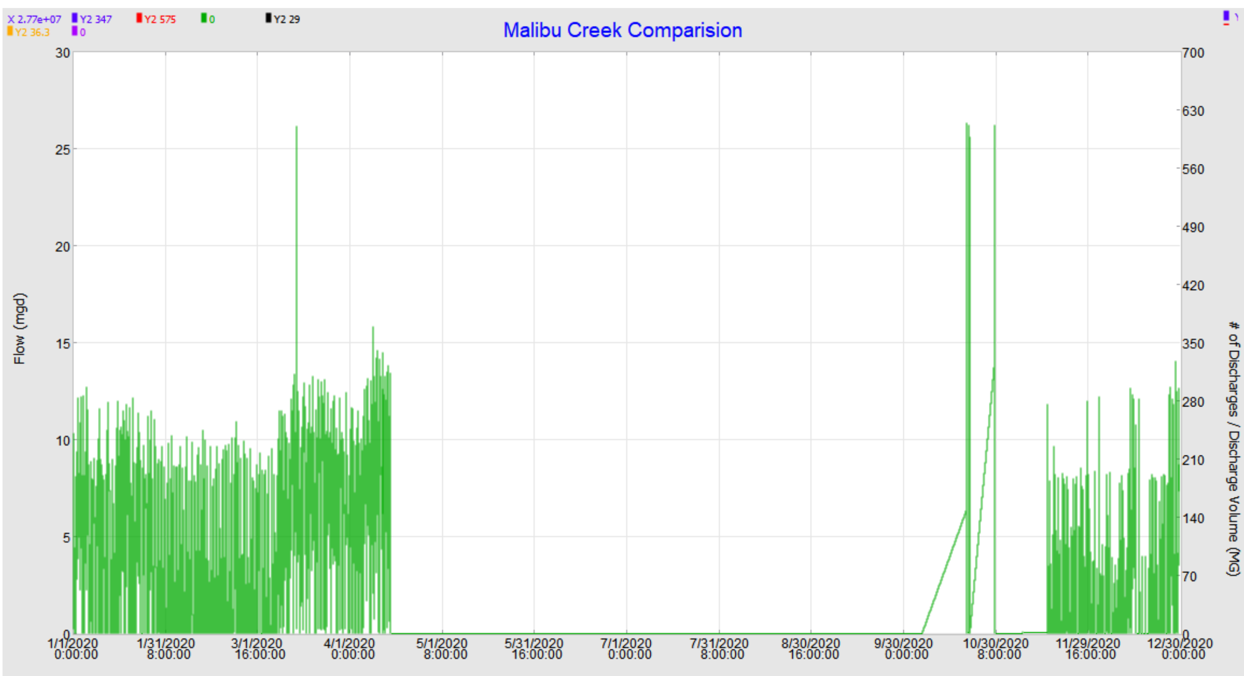


Figure A-3. Historical Discharges to Malibu Creek in 2020

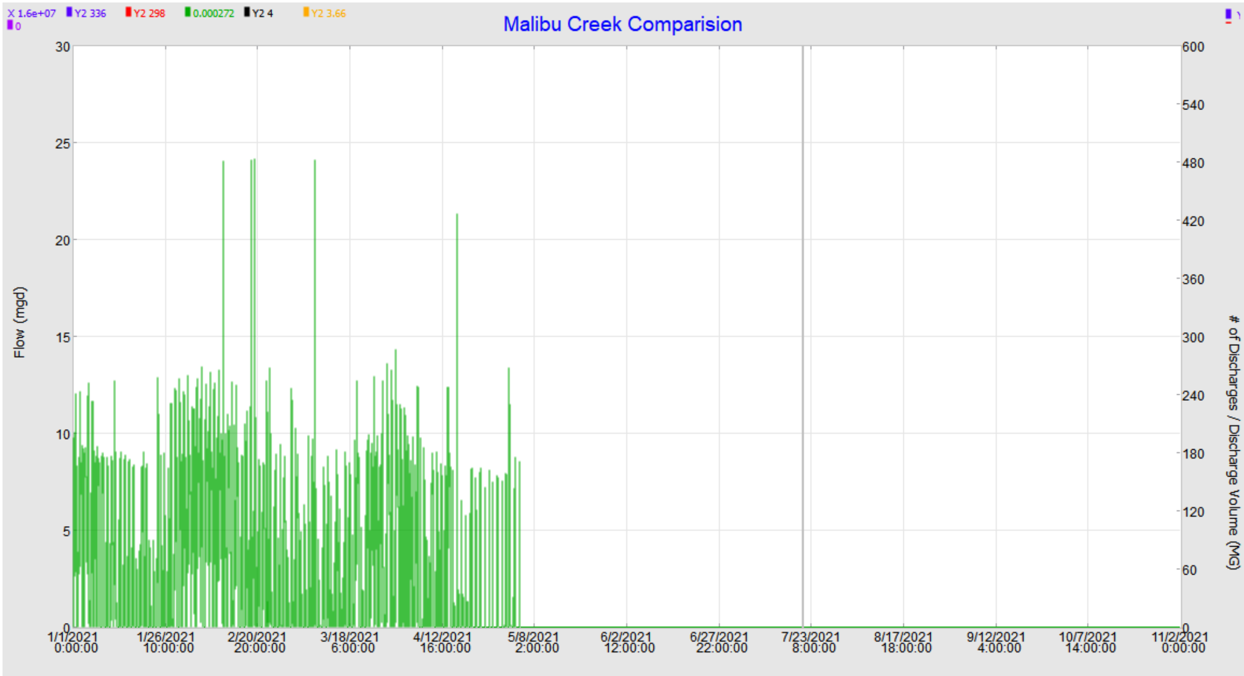


Figure A-4. Historical Discharges to Malibu Creek in 2021

Table A-1. Daily Average Pepperdine Flow from 2017 to 2021

Year	Percentile Distribution of Pepperdine Flow (gpm)						
	10%	25%	50%	75%	95%	99%	100%
2017	0	10	17	34	125	159	165
2018	6	9	18	32	49	62	74
2019	8	11	19	31	53	95	121
2020	3	5	8	11	32	39	45
2021	4	9	13	19	37	44	48

gpm = gallons per minute

Table A-2. Daily Average Rancho Pump Station Flow from 2017 to 2021

Year	Percentile Distribution of Rancho Pump Station Flow (gpm)						
	10%	25%	50%	75%	95%	99%	100%
2017	10.5	10.8	11.7	12.5	13.3	14.8	17.9
2018	8.5	10.9	13.3	14.2	15.6	15.9	15.9
2019	10.0	10.2	10.7	11.0	12.5	13.3	13.4
2020	0.0	8.7	9.2	9.5	11.9	13.1	13.6
2021	8.6	8.8	9.0	9.7	10.1	10.5	10.6

gpm = gallons per minute

Table A-3. Daily Average Supplemental Potable Water Flow from 2017 to 2021

Year	Percentile Distribution of Supplemental Potable Water Flow (MGD)						
	10%	25%	50%	75%	95%	99%	100%
2017	0.00	0.00	0.00	1.77	2.80	3.25	3.26
2018	0.00	0.00	0.00	1.65	2.96	3.74	4.20
2019	0.00	0.00	0.00	0.64	1.74	2.25	2.85
2020	0.00	0.00	0.00	0.00	1.63	1.89	2.17
2021	0.00	0.00	0.00	1.45	2.60	2.87	2.89

MGD = million gallons per day

Table A-4. Daily Average Recycled Water Pump Station East Flow from 2017 to 2021

Year	Percentile Distribution of Recycled Water Pump Station East Flow (MGD)						
	10%	25%	50%	75%	95%	99%	100%
2017	0.00	0.93	1.85	2.39	2.84	3.10	3.31
2018	0.00	0.96	1.74	2.26	2.79	3.02	3.33
2019	0.00	0.55	1.71	2.42	3.00	4.53	4.55
2020	0.39	1.08	1.81	2.50	3.00	4.47	4.48
2021	0.40	1.11	1.93	2.54	3.01	3.80	4.45

MGD = million gallons per day

Table A-5. Daily Average Recycled Water Pump Station West Flow from 2017 to 2021

Year	Percentile Distribution of Recycled Water Pump Station West Flow (MGD)						
	10%	25%	50%	75%	95%	99%	100%
2017	0.18	2.40	3.90	5.22	6.02	6.58	6.97
2018	0.75	1.93	3.71	4.98	6.18	6.99	7.24
2019	0.35	0.83	3.19	4.53	5.30	5.57	6.01
2020	0.86	2.01	3.59	4.88	5.73	6.01	6.18
2021	0.99	2.20	3.66	4.80	5.88	6.17	6.44

MGD = million gallons per day

Table A-6. Percentile Distribution of Daily Average Reservoir 2 Level from 2017 to 2021

Year	Percentile Distribution of Reservoir 2 Level (feet)						
	10%	25%	50%	75%	95%	99%	100%
2017	9.41	12.0	15.1	17.5	20.6	21.5	22.6
2018	9.98	12.94	16.2	18.6	20.5	21.3	21.8
2019	9.52	11.3	15.0	17.3	19.6	20.2	22.4
2020	11.1	13.3	16.1	17.8	18.9	19.8	21.0
2021	8.47	11.3	14.3	17.7	20.1	21.6	22.1

Table A-7. Percentile Distribution of Daily Average Indian Hills Tank Level from 2017 to 2021

Year	Percentile Distribution of Indian Hills Tank Level (feet)						
	10%	25%	50%	75%	95%	99%	100%
2017	17.3	20.2	23.0	25.7	26.9	27.2	27.4
2018	19.5	21.7	23.9	26.2	27.5	27.6	27.6
2019	21.3	22.4	24.4	26.0	27.0	27.5	27.6
2020	19.8	21.3	23.0	24.8	26.4	26.8	27.3
2021	18.3	20.0	22.9	25.3	26.6	26.9	27.0

Appendix B
Detailed Model Description

Appendix B. Detailed Model Description

Appendix B contains a detailed description of the model boundaries, parameters, and control logic for the equalization (EQ) analysis at Tapia Water Reclamation Facility (Tapia WRF) and improvements to the recycled water distribution system. Jacobs used their proprietary hydraulics and process optimization platform Replica™ to evaluate the flow EQ needs for Tapia WRF and the new AWPF, and the impacts to the recycled water system. An extensive flow balance was built in the model to evaluate the dedicated flow EQ needs at Tapia WRF and the new AWPF, as well as to better understand the potential recycled water system impacts from adding the new AWPF as a high-demand user. The description is organized by Tapia WRF and the recycled water system. Figure B-1 provides an overview of the Replica model.

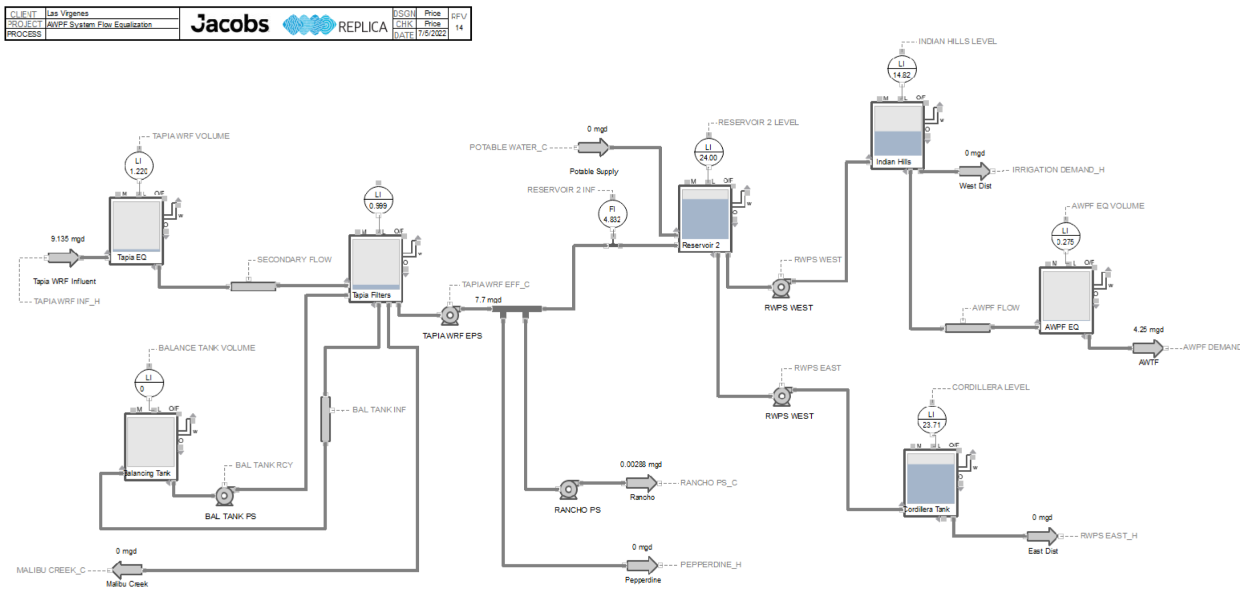


Figure B-1. Las Virgenes Recycled Water System Replica Model Configuration

B.1 Configuration Data

This section describes the configuration data for the model.

B.1.1 Tapia Water Reclamation Facility Parameters

The Tapia WRF model parameters included:

- Influent flow
- Primary effluent flow EQ
- Secondary and tertiary treatment
- Balancing Pond storage
- Tertiary treated effluent flow
- Effluent Pump Station capacity
- Discharge flow to Malibu Creek

This section summarizes the defined process variables and model boundaries for the Tapia WRF. Section B.2 provides descriptions about how the parameters are integrated into the model logic.

B.1.1.1 Flow

The annual historical flows were entered into the model at 1-minute timesteps. The influent flow to Tapia WRF was the main parameter that influenced the model for the Tapia WRF EQ analysis. The historical flow data were used to assess how the influent flow impacts the potential sizing of an EQ basin at Tapia WRF.

Current flow through secondary and tertiary treatment at Tapia WRF typically ranges from 4 to 15 MGD, with a typical average of 7 to 9 MGD. To assess how the EQ requirements vary based on treatment capacity, three flow scenarios were evaluated:

1) **Historical Flow Scenario:** The current Tapia WRF average daily influent flow ranges from 7.7 to 8.2 MGD. This scenario assessed impacts using historical flows for Tapia WRF and historical irrigation demands.
2) **Design Capacity Flow Scenario:** The rated Tapia WRF design capacity is 12 MGD on an average daily flow basis. This scenario assessed the impacts using historical flows for Tapia WRF adjusted to represent the rated design capacity and historical irrigation demands.
3) **Reduced Inflow and Infiltration (I&I) Flow Scenario:** Based on repair efforts, Las Virgenes Municipal Water District (LVMWD) is projecting a reduction in flow to the Tapia WRF of at least 1 MGD. This scenario assessed the impacts using historical flows for Tapia WRF adjusted by a reduction of 1 MGD and irrigation demands.

In addition to the constant adjusted influent flow calculation, the model independently used the historical influent flow and performed a time-weighted daily average calculation to determine the running daily average. This calculation was used to balance out the daily flows at Tapia WRF and serves as the main input parameter for the Tapia WRF secondary treatment flow set point. This time-weighted daily average was closely connected to the model logic for Tapia WRF and the new AWPF operations.

B.1.1.2 Unit Process Capacities

This section describes the unit process capacities.

Secondary Clarifier Capacity

Tapia WRF's secondary clarifier capacity was assessed through a desktop evaluation of the solids loading rate (SLR). The SLR was assessed using the Daigger correlations to the measured settled volume index (SVI) (Daigger and Roper 1985). The correlation used in the analysis is defined as:

$$G_L = V_0 e^{-kC_i} * \frac{Q_R}{SA} * C_i$$

Where: G_L = Limiting mass flux (pounds of total suspended solids per square foot per day [lb-TSS/ft^2/d])
V_0 = Maximum Vesilind settling velocity (meters per hour [m/h]); equal to 6.49 in the Daigger SVI correlation
k = Vesilind hindered zone settling parameter (liters per gram [L/g]); calculated as *0.6146 + 0.001586*SVI*
C_i = Estimated thick blanket suspended solids concentration (grams per liter [g/L])
Q_R = Returned activated sludge (RAS) rate
SA = Clarifier surface area

The maximum theoretical limiting solids flux (G_{Lmax}) is then determined by finding (iteratively) the point on the flux curve where the current RAS line intersects the flux curve line (G_L). G_{Lmax} is derated to account for practical limitations of the clarifiers (for example, clarifier depth and the nonideality of sludge-removal mechanisms, flocculation well design, and incorporation of energy-dissipating inlets). Older, shallower clarifiers often are assigned a 20% derating (or 80% G_{Lmax}), whereas more modern designed clarifiers with deep side water depth (SWD) and energy-dissipating inlets typically are assigned a 10% derating (or 90% of G_{Lmax}).

The Tapia WRF includes 10 rectangular secondary clarifiers that are 150 feet long by 20 feet wide for a per-clarifier surface area of 3,000 square feet (ft^2). The secondary clarifiers have relatively shallow SWDs of approximately 10 feet. The geometry and shallow depth of the Tapia WRF's secondary clarifiers likely result in the clarifiers operating at a 20% derating of G_{Lmax} (or 80% G_{Lmax}). Site-specific stress testing and settling column assessments could be used to refine capacity assumptions if the predicted capacity is less than Tapia WRF operational experience indicates.

Data from 2018 through 2021 (LVMWD 2021) were evaluated to better understand Tapia WRF specific settling considerations. During this period, the aeration basins had an average mixed liquor suspended solids (MLSS) concentration of 1,980 milligrams total suspended solids per liter (mg-TSS/L) and a maximum 30-day MLSS of 2,200 mg-TSS/L.

Figure B-1 summarizes cumulative frequency for the observed SVI. The median observed SVI was 91 milliliters per gram (mL/g), and the 95th percentile SVI was 231 mL/g. The median SVI of 91 mL/g suggests that under normal operating conditions, the Tapia WRF has well-settling sludge, resulting in improved clarifier capacity. The Tapia WRF, however, does experience significant increases in SVI that impact the reliable capacity of the secondary clarifiers.

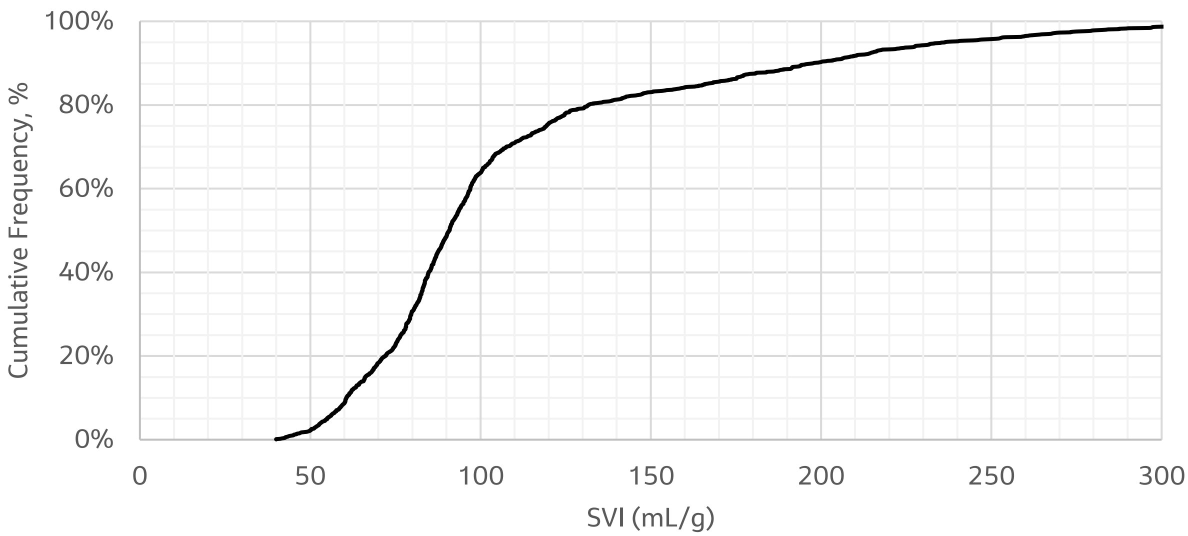


Figure B-1. Tapia Water Reclamation Facility Settled Volume Index Cumulative Frequency Distribution from 2018 to 2021

The maximum allowable SLR (80% G_{Lmax}) was calculated with the Tapia WRF experiencing poor settling conditions, which is represented by the 95th percentile SVI of 231 mL/g. The analysis also assumed that the RAS capacity of the system was nonlimiting, with the Tapia WRF RAS pump capacity exceeding the maximum beneficial RAS rate of 14 MGD. The allowable SLR was calculated to be approximately 26 lb-TSS/ft^2/d. At the maximum 30-day MLSS concentration of 2,200 mg-TSS/L, with one clarifier out of service, the allowable peak secondary flow is calculated to be approximately 24 MGD.

Tertiary Treatment Capacity

The tertiary process capacity was assessed through a desktop evaluation by examining the applied hydraulic loading rate (HLR) to the filters. The Tapia WRF tertiary process consists of 12 dual-media filters, each filter with a filtration area of 253 ft^2. At the current average flow of 8 MGD, the filters are operating at an HLR of 2.5 gallons per minute per square foot (gpm/ft^2) with one unit out of service. The filtration process was originally designed at a peak HLR of 5 gpm/ft^2 to maintain consistency with Title 22[1] requirements (LVMWD 2004). Considering managing flows produced by the backwash process, the

[1] Title 22, Social Security, Division 4 Environmental Health

resulting peak influent flow capacity is 18.2 MGD with one filter out of service and 16.4 MGD with two filters out of service. Additional peak flow capacity may be obtained if backwash waste could be diverted from the process during peak flows and returned during lower-flow periods.

While the original basis of design considered 5 gpm/ft^{2}to maintain consistency with Title 22 requirements, advancements in tertiary filter design consisting of improved filtration components and revised media selection, and alleviating hydraulic bottlenecks have the potential to achieve HLRs up to 8 gpm/ft^2. HLRs greater than 5 gpm/ft^2 likely require pilot or demonstration testing to obtain approval from the California Environmental Protection Agency.

Figure 3-3 provides an overview showing the potential capacity of the Tapia WRF filters to increase hydraulic loading rates. For every gallon per minute increase in the allowable HLR, the filtration process could experience an approximate 3.5-MGD increase in peak capacity. For this evaluation, tertiary capacity was set to the existing capacity based on 5 gpm/ft^2, but future evaluations could consider approaches to alleviate capacity restrictions, impacts to filter run time, and backwash sequencing within the tertiary process.

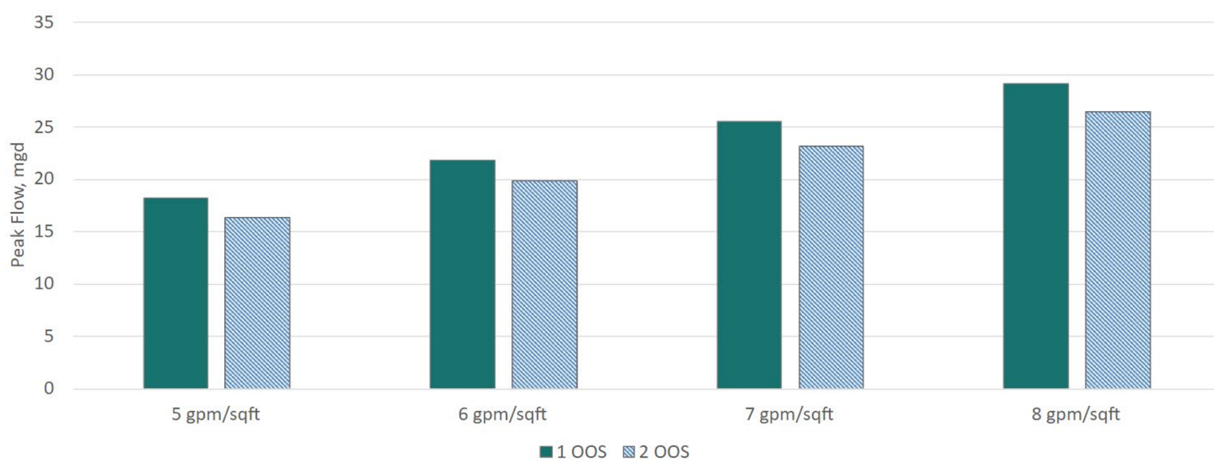


Figure B-2. Tapia Water Reclamation Facility Filtration Capacity at Increasing Hydraulic Loading Rates

Effluent Pump Station Evaluation

The Effluent Pump Station at Tapia WRF contains a total of three pumps with a combined nominal capacity of 13.5 MGD (9,400 gallons per minute [gpm]). The existing equipment includes two constant speed pumps, and one pump that was upgraded to a variable frequency drive (VFD) in 2022. Typical operation of the pump station does not require the use of all three pumps. The Tapia WRF Effluent Pump Station operates based on the level in Reservoir 2 in the winter and the level in the clear-well at Tapia WRF in the summer. The Replica model was set up such that all pumps are on VFDs, and the model does not account for any storage in the Effluent Pump Station wet well.

B.1.1.3 Storage

The existing onsite storage at Tapia WRF includes a 2.5-million-gallon (MG) Balancing Pond that is used to attenuate flows to the tertiary filters. Current operations send secondary effluent to the Balancing Pond when the tertiary filter influent flow is greater than 16 MGD and then recycles the flow back to tertiary treatment. When the Balancing Pond is full, there is no additional storage capacity available at Tapia WRF if the facility were to experience an operational or seasonal challenge. In the past when the Balancing Pond was full and the tertiary influent flow exceeded 16 MGD, treatment operations bypassed the filters through the chlorine contact channel.

To balance daily operations and provide additional buffer capacity at Tapia WRF, an EQ basin was assumed upstream of secondary treatment. The objective was to use the EQ basin to store daily flows and capture some of the excess flow from the wet weather events. The existing storage at the Balancing Pond was used to help minimize the required EQ volume needed for these storms.

The model targeted a 1.0-MG EQ basin for daily operations at Tapia WRF. There were no size limits set on the EQ basin; instead, the model was allowed to simulate the volume needed to capture the wet weather events. The model incorporated storage logic for the EQ basin and Balancing Pond and shows how maintaining two designated storage volumes in tandem can lead to treatment improvements at Tapia WRF.

B.1.2 Recycled Water System Parameters

The recycled water model parameters for the new AWPF included the following:

- Tapia WRF effluent flow
- Rancho Pump Station flow
- Pepperdine Demand flow
- Supplemental Potable Water Supply flow
- RWPS West flow
- RWPS East flow
- Reservoir 2 level
- Indian Hills Tank level

This section summarizes the defined process variables and model boundaries for the Recycled Water System. Section B.2 provides descriptions about how the parameters are integrated into the model logic.

B.1.2.1 Flow

The following annual historical flows were entered into the model at 1-minute timesteps:

- Malibu Creek
- Pepperdine Demand
- Rancho Pump Station Demand
- RWPS East
- RWPS West
- Supplemental Potable Water Supply

Malibu Creek, Supplemental Potable Water Supply, and RWPS West and East flows were adjusted in the model, while the Pepperdine Demand and Rancho Pump Station where not changed in the model.

Pepperdine Demand flow and Rancho Pump Station flow are met using Tapia WRF tertiary treated effluent. The demand flows leave the recycled water system upstream of Reservoir 2. Pepperdine Demand and Rancho Pump Station flows represent relatively minor users of recycled water and receive flow year-round with seasonal variations.

The Reservoir 2 influent flow is the pumped effluent from Tapia WRF with the Pepperdine and Rancho Pump Station demands removed. Supplemental Potable Water Supply also supplies Reservoir 2 and is needed during periods of high irrigation demands, typically in the summer months, when Tapia WRF effluent cannot meet the demands.

The Reservoir 2 effluent flow is the combined RWPS East and RWPS West flows. RWPS East flow is pulled out of Reservoir 2 and is pumped to the Cordillera Tank to supply the eastern irrigation system. The historical flow data for RWPS East was used for the flow leaving the Cordillera Tank, which represents the eastern system irrigation demand.

The RWPS West flow is pumped from Reservoir 2 to Indian Hills Tank, where the western irrigation demand and new AWPF flows are pulled from the tank. Currently, the historical RWPS West flow is assumed to be the western irrigation demand and closely represents the irrigation demand flow pattern that leaves the Indian Hills Tank. The available flow to the new AWPF is the remaining quantity after the irrigation demands are met.

B.1.2.2 Unit Process Capacities

The major unit processes of interest in the flow model included reverse osmosis (RO), the most flow-sensitive process at the new AWPF, and the pump stations in the recycled water system. The new AWPF will have a rated feed flow capacity of 7.5 MGD and is intended to operate seasonally when there is available flow. The design recovery of the AWPF is 80%; therefore, the rated purified water production capacity is 6.0 MGD.

Frequent changes within AWPF unit processes, particularly RO, can be difficult to manage. Variations in AWPF feed flow would result in shutdowns of individual RO skids. Extended shutdowns (longer than 48 hours) require membrane preservation (i.e., pickling) to prevent biological growth. Prior to preservation, membranes are also typically required to be cleaned in place. To minimize RO shutdowns, the target goal for pickling a given RO skid is no more than once per month. For short-term shutdowns that extend 1 to 2 days, RO membranes can be flushed with RO permeate. Flushing can also be performed daily to allow for daily cycling between two RO skids to avoid membrane preservation.

Initial discussions with LVMWD identified the desire to minimize the flow changes per day to a target of two within the new AWPF to promote consistent RO process operation. A flow change refers to the number of times the treatment process experiences a diurnal spike, and the plant is required to adjust the operational capacity to handle varying flow conditions over the course of one day. This design criterion of two flow changes per day emphasizes the importance of upstream EQ at the new AWPF. Jacobs strategized five RO operating scenarios based on rated capacity of the AWPF, which is presented as RO permeate production capacity in Figure B-3. The operating scenarios presented are based on the conceptual design, which includes three different permeate capacity size RO skids operating to treat flows associated with the AWPF feed flow range of 1.0 to 7.5 MGD.

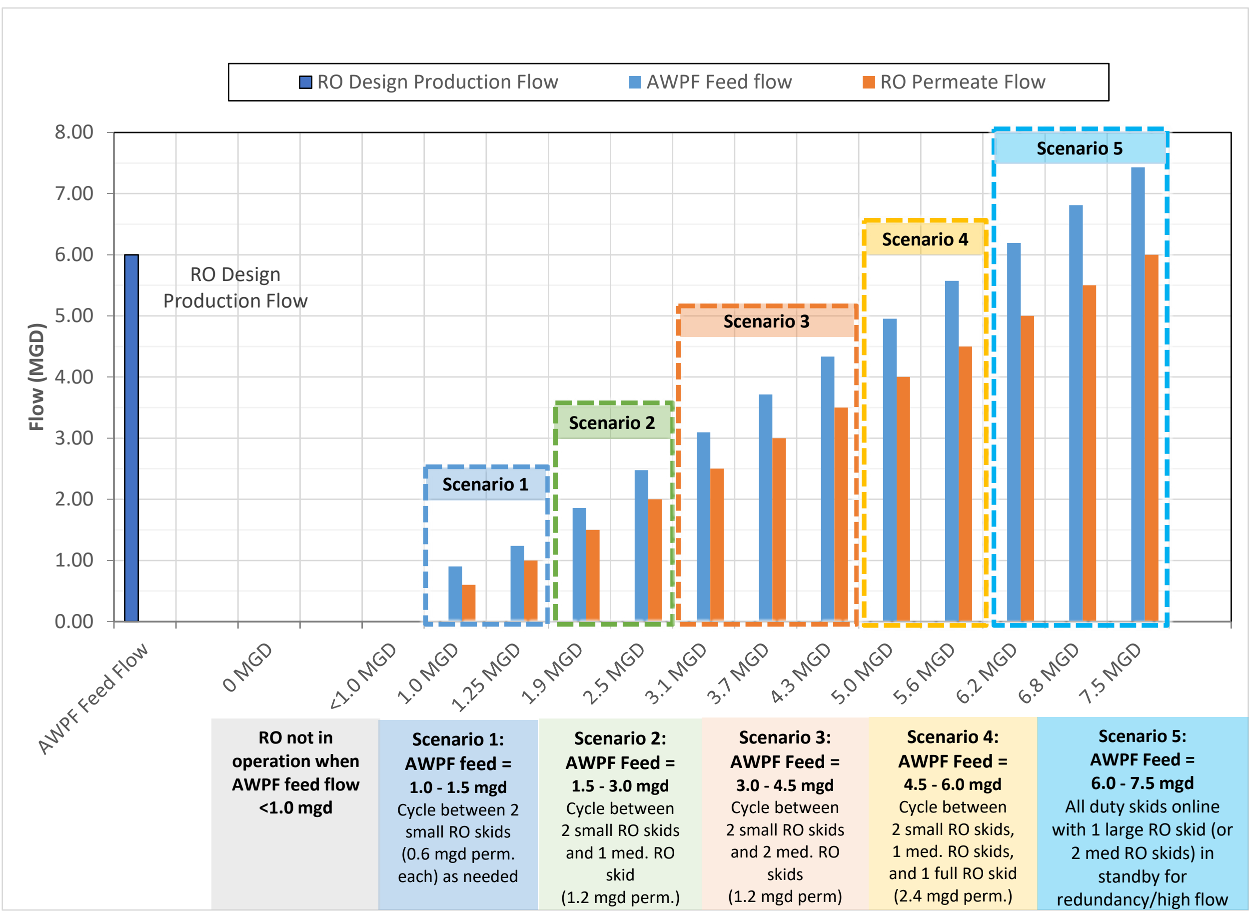


Figure B-3. Advanced Water Purification Facility Reverse Osmosis Skid Operating Scenarios

The three pump stations of interest related to the new AWPF include Tapia WRF Effluent Pump Station, RWPS West, and RWPS East. The Replica model assessed constant speed pumps to understand the existing conditions of the system compared to pumping operations with VFDs. The assessment found that VFDs were beneficial; therefore, the Replica model was set up such that all pumps were on VFDs.

RWPS West comprises three constant speed pumps with a combined nominal rated capacity of 7.7 MGD (5,400 gpm). Initiation to turn on and off the pumps is controlled by the water level in the Indian Hills Tank. Operation of RWPS West and the Indian Hills Tank directly impacts AWPF performance.

RWPS East operates three constant speed pumps with a combined nominal rated capacity of 6.5 MGD (4,500 gpm). Initiation to turn on and off the pumps is controlled by the water level in the Cordillera Tank. Normal operations include two pumps online. It is important to note that it is not possible to simultaneously run both the RWPS West and RWPS East at their rated capacities due to limitations in the size of the suction pipeline.

B.1.2.3 Storage

The existing storage within the recycled water system includes Reservoir 2, Indian Hills Tank, and Cordillera Tank. Improving system operations of the reservoir and storage tanks can lead to more stable treatment operations of the recycled water system as shown through the modeling efforts. Operations of Reservoir 2 and Indian Hills Tank directly impact the onsite EQ storage volume necessary at the new AWPF. Cordillera Tank is independent of the new AWPF but was included in the evaluation to highlight overall system improvements to the recycled water system.

Reservoir 2 stores 14.7 MG of recycled water and is located downstream of Tapia WRF and upstream of the Indian Hills Tank. Reservoir 2 currently operates between a low level of 10 and a maximum level of 24 feet. The overflow weir is set at an elevation of 795 feet, with an operating level of 25 feet so that at least 1 foot of freeboard is maintained. The water level in Reservoir 2 controls the Effluent Pump Station flow rate at Tapia WRF (i.e., dictate when the pumps cycle on and off).

Indian Hills Tank is a 2.5-MG storage tank located downstream of RWPS West and upstream of the new AWPF. Cordillera Tank is a 3.0-MG tank located downstream of RWPS East and upstream of the eastern distribution system.

B.2 Logical Data

The section discusses the operating logic used in the flow balance model to evaluate EQ at Tapia WRF and the new AWPF. The logic was configured so that the model can use past data to provide future operational set points.

B.2.1 Tapia Water Reclamation Facility System Flow and Volume Setpoints

This section describes the model logic used to operate and control flow and EQ at Tapia WRF. The model logic that controls flow through Tapia WRF included the following parameters:

- Tapia WRF influent adjusted flow set points
- Secondary treatment flow set point
- Balancing Pond flow set point
- Tertiary treatment flow set point
- Malibu Creek flow
- Effluent Pump Station flow set point

The model logic that controls level operations through Tapia WRF include the following parameters:

- Tapia WRF EQ level set points
- Tapia WRF EQ storm set points
- Malibu Creek discharges

Tapia Water Reclamation Facility Secondary Treatment Flow Setpoints

The secondary treatment flow logic in the model determined the primary effluent flow that was sent to secondary treatment from the new EQ basin at Tapia WRF. This logic was used to aid in maintaining an operating band in the potential new Tapia EQ by adjusting the secondary treatment flow set point based on the volume stored in the potential Tapia EQ.

The model used the running daily average to set the flow, whereas the flow set point was adjusted and maintained based on the EQ volume. The model targeted an EQ volume of 1.0 MG for daily operations at Tapia WRF. The EQ storage logic included three set points:

1) Tapia EQ low volume
2) Tapia EQ high volume
3) Tapia EQ storm volume

The Tapia EQ low-volume set point was initially set at 0.4 MG. The Tapia EQ high-volume set point was initially set at 0.7 MG. Both set points are intended to be operator adjustable.

If the EQ volume was less than 0.4 MG (Tapia EQ low-volume trigger), the model logic adjusted the time-weighted daily average influent flow, decreasing it by 10% to create the Tapia WRF adjusted low-flow set point. The model logic used hysteresis to step up the volume in the EQ basin until it reached 0.7 MG.

Conversely, if the EQ volume was greater than 0.7 MG (Tapia EQ high-volume trigger), the model logic adjusted the time-weighted daily average influent flow, increasing it by 10% to create the Tapia WRF adjusted high-flow set point. These set points could be used as inputs for the Tapia WRF secondary treatment flow set point. The model logic used hysteresis to step down the volume in the EQ basin until it reached 0.4 MG.

The Tapia WRF storm volume set point was initially set at 1.0 MG and was intended to be operator adjustable. When this value is exceeded, the system enters storm operation. The model logic was developed such that as more EQ volume is stored, the secondary treatment flow set point increased linearly. The current logic calculates a secondary treatment storm flow set point between 0 and 24 MGD by interpolating between 0 and 10 MG of EQ storage. These variations in flow and model logic allowed for simulation of different treatment strategies for managing flows and EQ storage at Tapia WRF.

The system stays in storm mode until there is less than 0.5 MG of storage. A lookup table was used in Replica to simulate treatment plant operations at Tapia WRF during storm events. The table lists a series of EQ volumes, ranging from 0 to 10 MG, and the associated secondary treatment storm flow set point, ranging from 0 to 24 MGD, that would be needed to mitigate the magnitude of the storm. The model interpolates between the two parameters and sets the Tapia WRF storm capacity set point, which is an input for the Tapia WRF secondary treatment flow set point.

Balancing Pond Flow Setpoints

To determine when flow needs to be sent to the Balancing Pond or recycled back to the plant, the model logic uses:

- Secondary treatment flow
- Tapia WRF tertiary treatment rated capacity
- EQ basin volume
- Balancing Pond volume

The first step in the model logic determines whether the secondary treatment flow exceeds the tertiary treatment rated capacity at Tapia WRF.

When the secondary treatment flow is greater than the tertiary treatment rated capacity at Tapia WRF, and the Balancing Pond is not completely full (that is, volume of 2.5 MG), then the difference between those two flows is conveyed to the Balancing Pond. If the secondary treatment flow is less than the tertiary treatment rated capacity, flow is not sent to the Balancing Pond.

When the secondary treatment flow is less than the tertiary treatment rated capacity of 14 MGD, and the Balancing Pond has stored volume (that is, volume is greater than 0 MG), the Balancing Pond returns flow to tertiary treatment. The Balancing Pond recycle flow set point is calculated by multiplying the current Balancing Pond volume by a factor of 2 until the stored volume decreases to 0 MG. The factor of 2 was selected because it recycles the water back into the system in a reasonable time and does not exceed the filter capacity. Operations staff can adjust the rate at which flow is recycled back to the plant.

Effluent Pump Station Flow Setpoint

The Effluent Pump Station flow logic determines the tertiary treated effluent flow leaving Tapia WRF. The flow balance calculation includes two steps. The first part determines the flow to tertiary treatment at Tapia WRF by adding the secondary treatment flow with the Balancing Pond recycle flow. The second part subtracts out the Malibu Creek calculated flow set point from the tertiary treated flow to obtain the calculated Effluent Pump Station flow set point.

B.2.2 Recycled Water System Setpoints

This section describes the model logic used to control flow through the recycled water system to the new APWF.

B.2.2.1 Flow Setpoints

The model logic that controls flow through the recycled water system to the new AWPF includes the following parameters:

- Malibu Creek flow set point
- Pepperdine flow set point
- Rancho Pump Station flow set point
- Supplemental Potable Water Supply flow set point
- RWPS East set point
- RWPS West flow set point
- AWPF flow set points

Malibu Creek Flow Setpoint

The model calculates the volume of discharges and the number of discharge events to Malibu Creek for both the historical data and the Malibu Creek calculated flow set point data. This functionality allows for comparison between historical and simulated discharges to the creek.

When the Reservoir 2 level exceeds the maximum operating level, the excess flow is directed to Malibu Creek. To avoid a surge of flows to the creek when Reservoir 2 fills, a Malibu Creek flow setpoint is established that begins sending flow to the creek as Reservoir 2 approaches its maximum level. The difference between the influent and effluent flow into Reservoir 2 is multiplied by the ratio of the current level in Reservoir 2 to the maximum operating level in Reservoir 2. The outcome of this logic is used as the Malibu Creek flow setpoint.

Rancho Pump Station Flow Setpoint

The Rancho Pump Station logic selects the flow parameter to simulate operations. The model can either use the historical operating data for Rancho Pump Station demands, or it assumes no flow to simulate that the Rancho Pump Station demand is being supplied by the Supplemental Potable Water Supply system. The outcome of this selection defines the Rancho Pump Station flow set point.

Supplemental Potable Water Supply Flow Setpoint

The Supplemental Potable Water Supply to the recycled water system is used to fill in the gaps in supply when the Tapia WRF effluent cannot meet the summer irrigation demands. The Supplemental Potable Water Supply flow setpoint is calculated by subtracting the Reservoir 2 effluent from the Tapia WRF Effluent Pump Station flow set point and is only allowed when the operating level in Reservoir 2 is below 10 feet.

Recycled Water Pump Station East Flow Setpoint

The model assumes that RWPS East is upgraded to include VFDs and can operate more consistently. The historical demands are based on constant speed pumps, so a 24-hour time-weighted average was calculated to simulate the demands after VFDs were added. To manage the Cordillera Tank level, a level trim factor was applied to the time-weighted historical flows. The historical RWPS East flow data are used in the model as the eastern irrigation demand.

Recycled Water Pump Station West Flow Setpoint

Similarly, it was assumed that RWPS West is upgraded to included VFDs, and a 24-hour time-weighted average flow was calculated using the historical flows. The RWPS West flow setpoint is equal to the average flow multiplied by a trim factor that manages the level in the Indian Hills Tank. Because the future AWPF will be supplied by RWPS West, the calculated AWPF flow was added to the historical RWPS West demand before creating the 24-hour time-weighted average. The historical RWPS West flow data are used in the model as the west irrigation demand.

Advanced Water Purification Facility Flow Setpoints

The AWPF flow system is configured in the model through a multitiered approach with four different flow set points. A flow balance is calculated to determine the available instantaneous flow for the AWPF, referred to as AWPF Availability. This logic uses the tertiary treatment flow and then subtracts all of the demands that leave the recycled water system prior to the new AWPF. These demands include:

- Pepperdine
- Rancho Pump Station
- West irrigation system
- Eastern irrigation system

This series of flow calculations defines the AWPF Availability flow.

To determine the flow supplying the AWPF, the logic in the model calculates a 4-day running average of AWPF Availability. This calculation is then used as the AWPF daily flow set point to supply flow to the AWPF. The AWPF daily flow set point is further manipulated in the model to replicate operations at the AWPF.

The AWPF is intended to operate seasonally in the winter months when there is available flow and storage throughout the recycled water system. There are two rules of operations to determine when the AWPF goes offline, and they are controlled by the AWPF daily flow set point and the level in Reservoir 2. For the AWPF to be online, the AWPF daily flow set point must be greater than 1.0 MGD. When this condition is not met, the logic sets the AWPF flow to 0 MGD, and the facility is then turned off. This rule is implemented to preserve and maintain the equipment used in the AWPF treatment processes.

The AWPF can also be turned off when the Reservoir 2 average level is beneath the Reservoir 2 minimum operating level. The Reservoir 2 operational level that triggers when the AWPF comes back online can be adjusted. This rule signifies that the AWPF will only operate when there is enough supply in the recycled water system.

The AWPF daily flow set point is also trimmed to maintain sufficient volume in Reservoir 2. The logic uses a lookup table that correlates a water level in Reservoir 2 to a multiplier that is applied to the AWPF daily flow set point. When the level in Reservoir 2 is high, there is enough recycled water in the system to operate the AWPF; thus, the model increases the available flow to the AWPF. There is also low-level trim for the instances when the Reservoir 2 level is low and the available flow to the AWPF is reduced.

The AWPF's rated capacity is 7.5 MGD. If the AWPF flow set point exceeds the AWPF treatment capacity, the logic sets the AWPF flow set point to the AWPF treatment capacity. This rule ensures that the AWPF only accepts the flow it can treat. For all other instances when the available flow is less than the rated capacity, the AWPF flow set point is passed through the model to the AWPF.

The AWPF flow set point is adjusted to create a AWPF demand that minimizes flow changes. The logic use a 2-day running average of the AWPF flow set point and a lookup table based on the RO skid capacities to set a daily flow for the AWPF. The logic is intended to minimize the daily flow changes and to use the operational storage provided by an EQ basin at the AWPF.

The logic for the AWPF EQ volume uses a lookup table to adjust the AWPF flow set point based on the level in the AWPF EQ basin to maintain a desired band of operation. The selected value from the lookup table applies a multiplier to set the AWPF flow. The model also includes logic so that flow is not sent to the AWPF EQ basin when the AWPF is offline.

Reverse Osmosis Skid Scenarios

The AWPF operating scenarios include three different permeate capacity size RO skids designed to treat flows associated with the AWPF feed flow ranging from 1.0 to 7.5 MGD, consisting of two small-size, two medium, and two full-size RO skids. The model assigned scenarios based on the influent flow to the AWPF and the associated number of skids that need to be online to accommodate the flow. The logic was used to evaluate how frequently the RO skids need to turn on and off. Table B-1 summarizes the RO skid operating scenarios for the AWPF.

Table B-1. Advanced Water Purification Facility Reverse Osmosis Skid Operating Scenarios

Scenario	AWPF Flow (MGD)	Number of RO Skids Online
Offline	< 1.0	No skids
Scenario 1	1.0–1.9	Cycle operation between 2 small RO skids
Scenario 2	1.9–3.5	Cycle operation between 2 small RO skids and 1 medium RO skid
Scenario 3	3.5–5.1	Cycle operation between 2 small RO skids and 2 medium RO skids
Scenario 4	5.1–6.5	Cycle operation between 2 small RO skids, 1 medium RO skid, 1 large RO skid
Scenario 5	> 6.5	All duty skids online with 1 large RO skid (or 2 medium RO skids) in standby

< = less than

> = greater than

B.2.2.2 Volume and Level Setpoints

The model logic that calculates volume and level set points are used for the following storage components within the new AWPF system:

- Reservoir 2
- Indian Hills Tank
- Cordillera Tank

Reservoir 2 Volume and Level Setpoints

The operating levels for Reservoir 2 are used for various controls within the recycled water system. The influent and effluent flows from Reservoir 2 are used in the model to determine the volume of water entering and exiting Reservoir 2. The model also uses simulated data from Reservoir 2 operations to calculate the storage and level within the reservoir throughout the 1-year simulation.

The Reservoir 2 level is used as an input for various flow set point calculations within the recycled water system, such as:

- Malibu Creek
- Supplemental Potable Water Supply
- AWPF flow

The model logic calculates a 1-day running average of the Reservoir 2 level and Reservoir 2 average level, which is used to shut down the AWPF if the level drops too low.

The Reservoir 2 level is included in the Malibu Creek flow set point calculations. When the Reservoir 2 level exceeds the maximum set point of 24 feet, flow to Malibu Creek is allowed and will remain until the Reservoir 2 level drops below a set point of 23.5 feet.

In a similar manner but a different operational direction for storage, the Reservoir 2 level is used in the Supplemental Potable Water Supply flow set point calculations. The model uses hysteresis when the level in Reservoir 2 drops below the minimum operating level. The Supplemental Potable Water Supply flow will remain in operation until the level in Reservoir 2 reaches 12 feet, just above the minimum operating level.

Appendix C
Operational Flow at Tapia Water Reclamation Facility

Appendix C. Operational Flow at Tapia Water Reclamation Facility

Appendix C contains the Replica model 1-year simulation plots for equalization (EQ) storage at Tapia Water Reclamation Facility (WRF) from 2017 to 2021.

There are two plots for each year, highlighting the operational impact with historical flows and with the flows adjusted to the design capacity of 12 MGD.

Figures C-1 through C-9 show the simulation plots for the historical flows from 2017 to 2021, targeting one and two flow changes per day.

Figures C-10 through C-14 show the simulation plots for the design capacity flows from 2017 to 2021, targeting two flow changes per day.

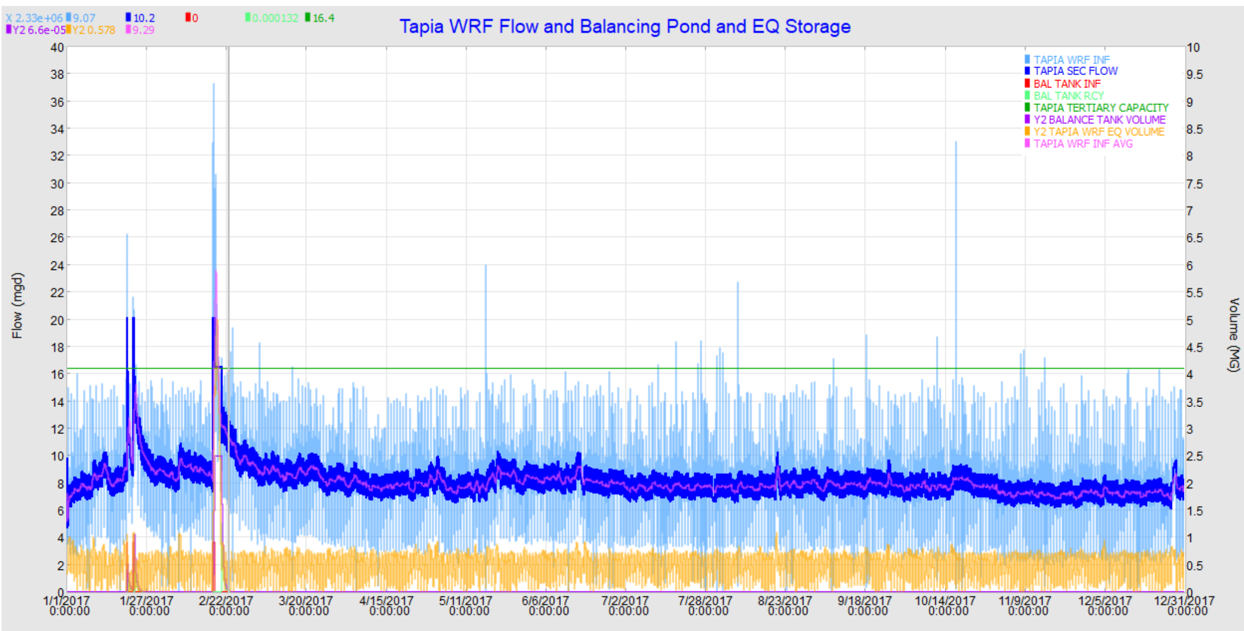


Figure C-1. Tapia Water Reclamation Facility 2017 Historical Flows, with an Average Influent Flow of 8.2 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD, Targeting Two Flow Changes Per Day

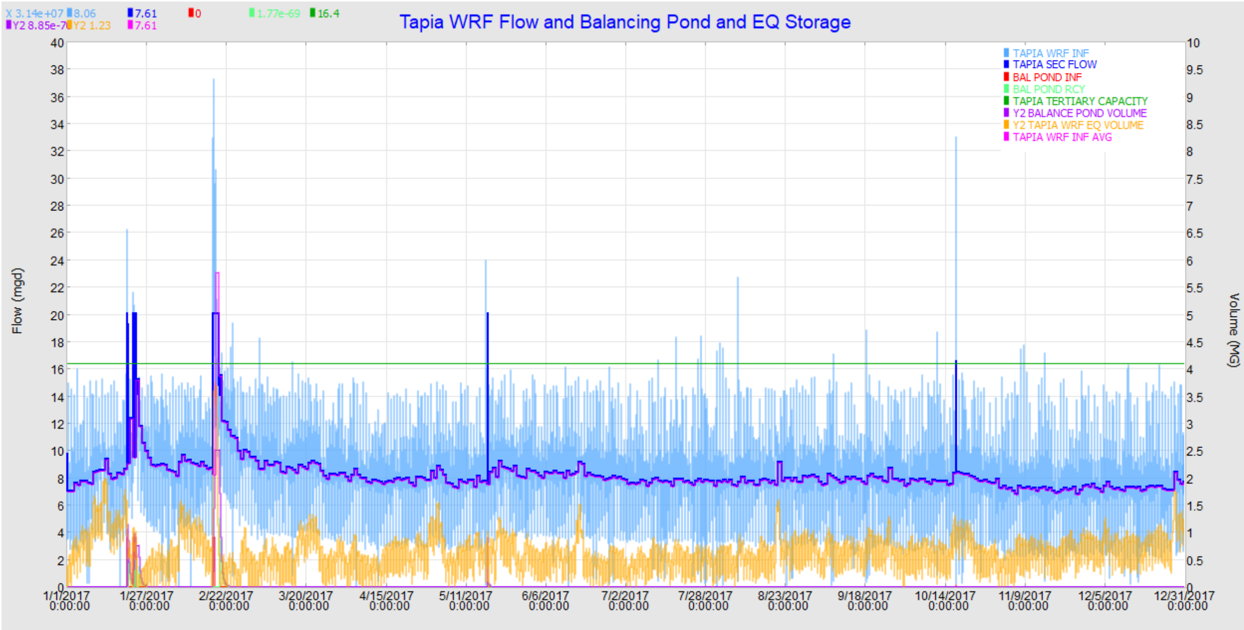


Figure C-2. Tapia Water Reclamation Facility 2017 Historical Flows, with an Average Influent Flow of 8.2 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD, Targeting One Flow Change Per Day

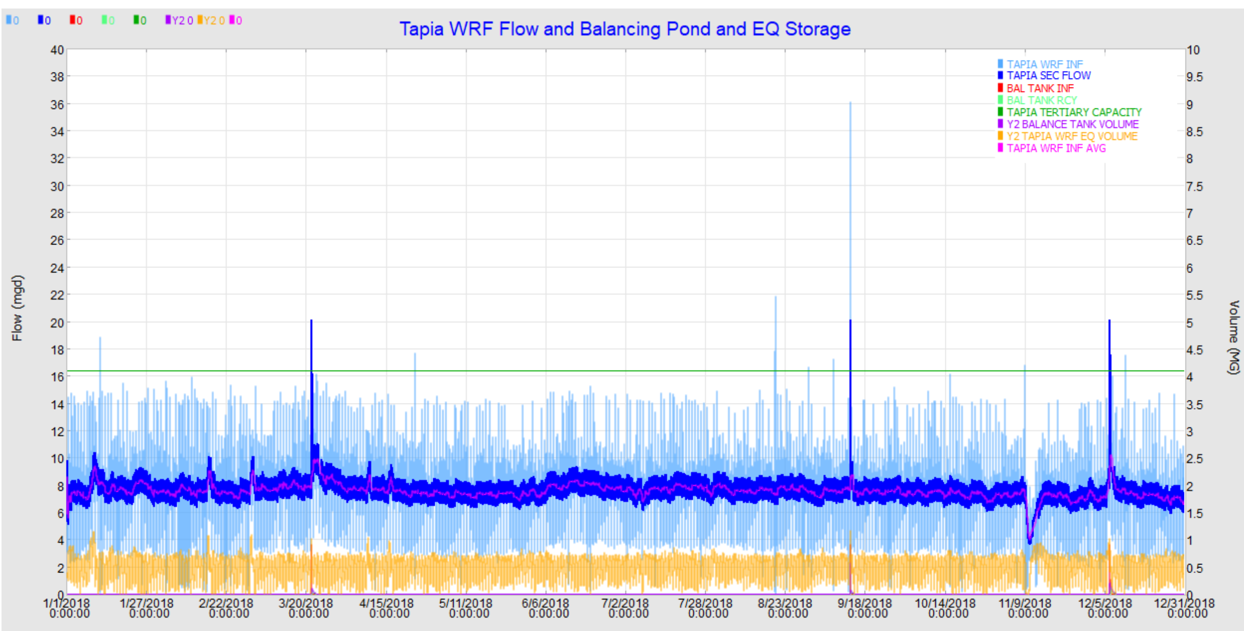


Figure C-3. Tapia Water Reclamation Facility 2018 Historical Flows, with an Average Influent Flow of 7.8 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD, Targeting Two Flow Changes Per Day

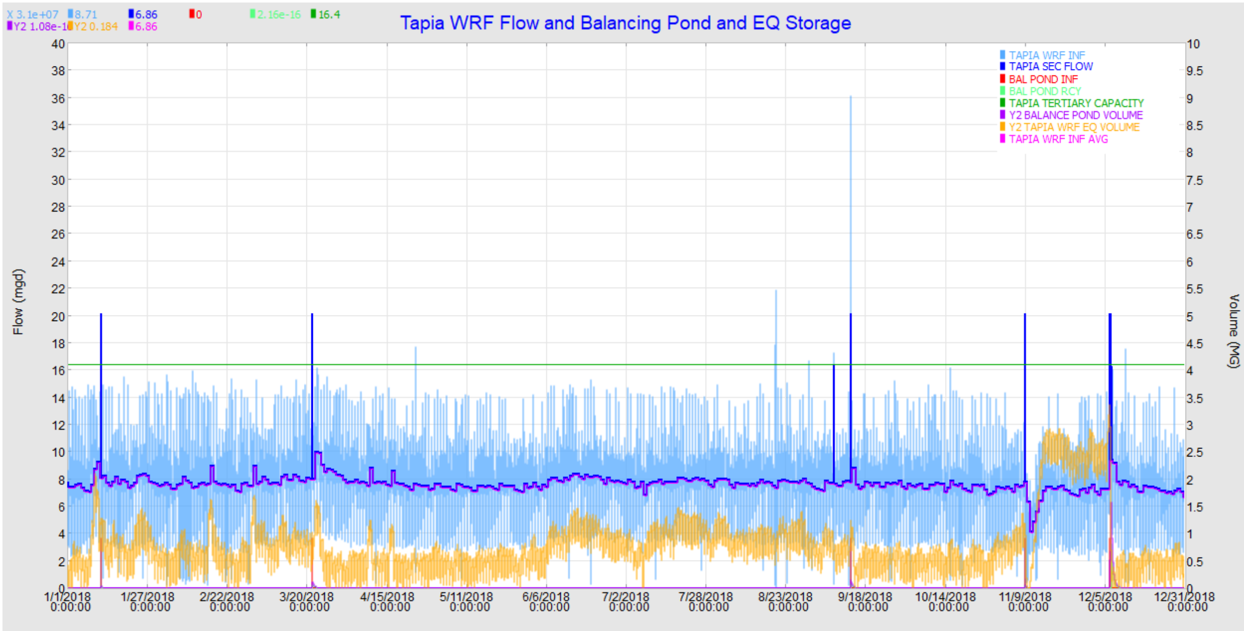


Figure C-4. Tapia Water Reclamation Facility 2018 Historical Flows, with an Average Influent Flow of 7.8 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD, Targeting One Flow Change Per Day

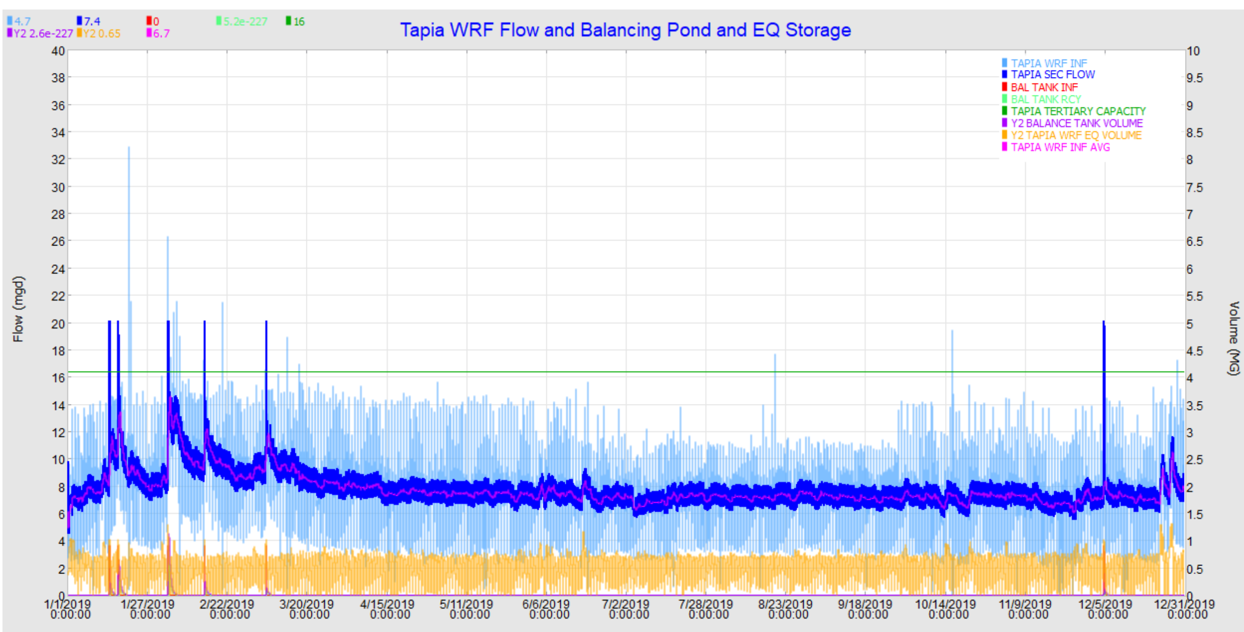


Figure C-5. Tapia Water Reclamation Facility 2019 Historical Flows, with an Average Influent Flow of 7.8 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD, Targeting Two Flow Changes per Day

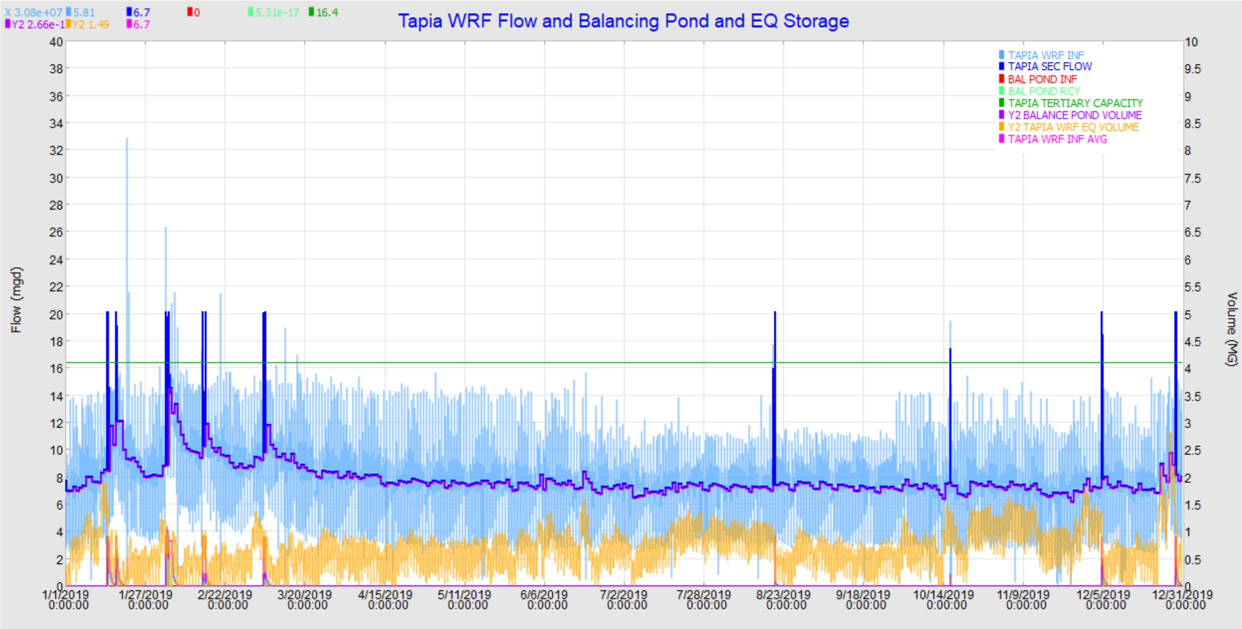


Figure C-6. Tapia Water Reclamation Facility 2019 Historical Flows, with an Average Influent Flow of 7.8 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD, Targeting One Flow Change per Day

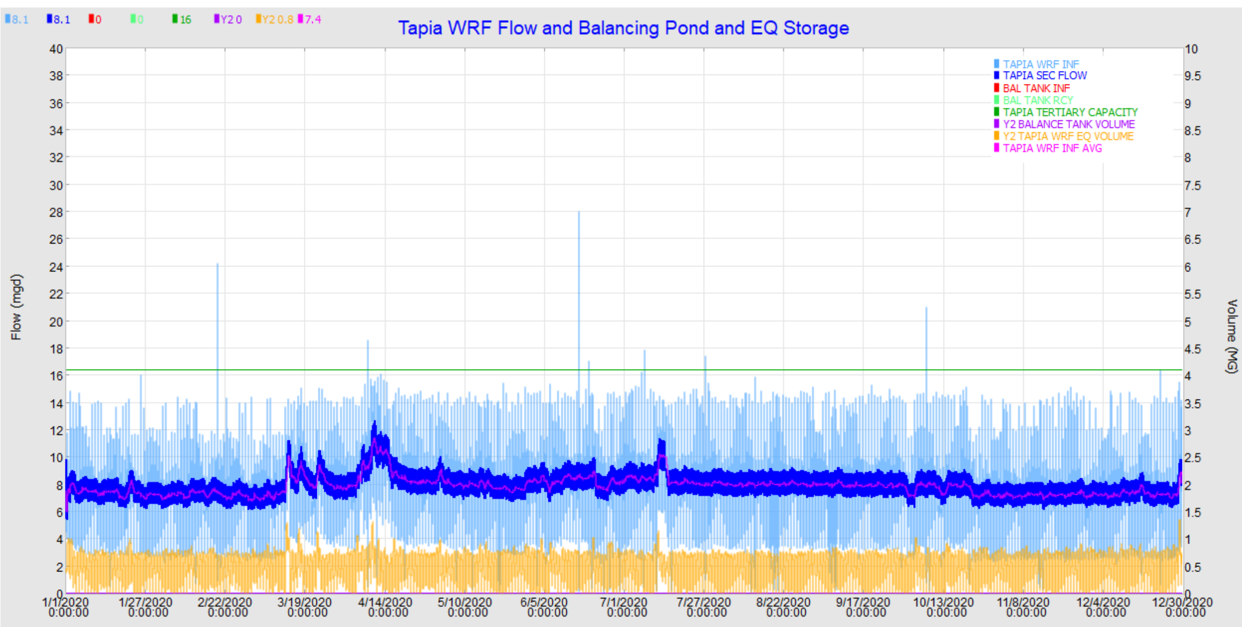


Figure C-7. Tapia Water Reclamation Facility 2020 Historical Flows, with an Average Influent Flow of 8.1 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD, Targeting Two Flow Changes per Day

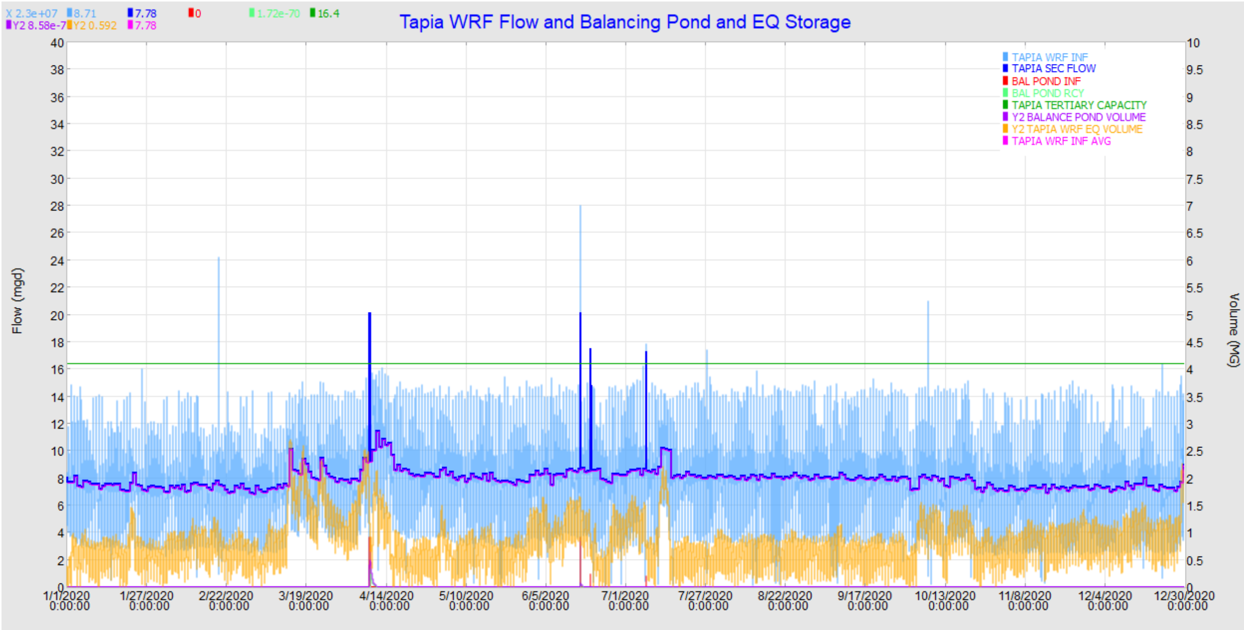


Figure C-8. Tapia Water Reclamation Facility 2020 Historical Flows, with an Average Influent Flow of 8.1 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD, Targeting One Flow Change per Day

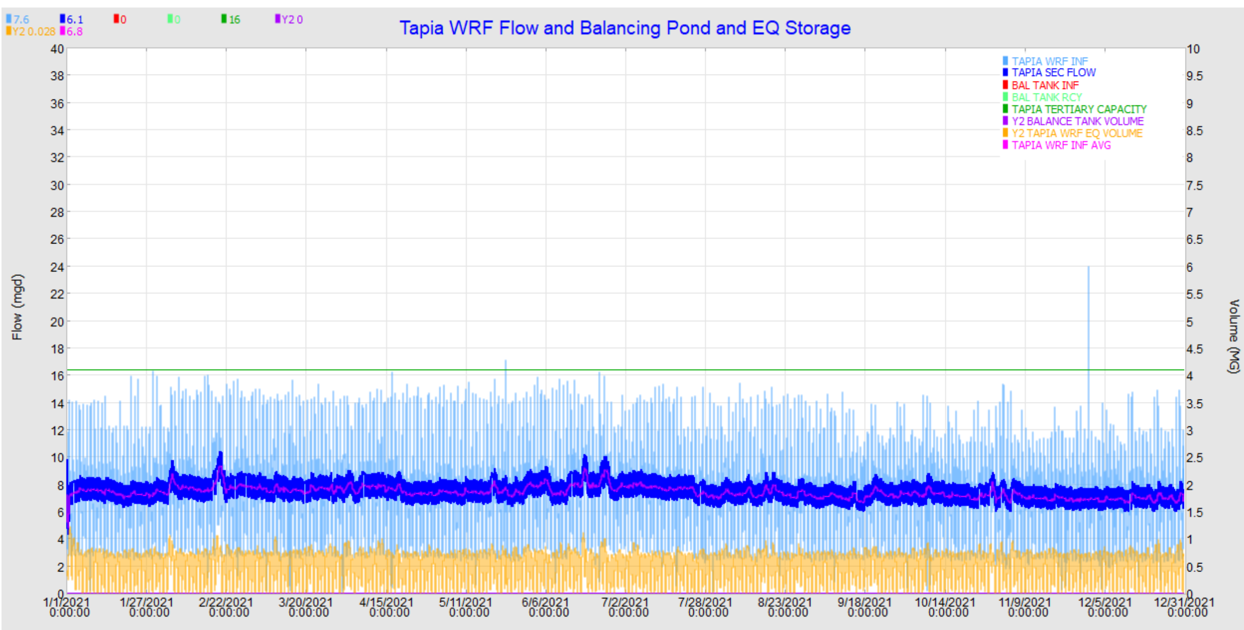


Figure C-9. Tapia Water Reclamation Facility 2021 Historical Flows, with an Average Influent Flow of 7.7 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD, Targeting Two Flow Changes per Day

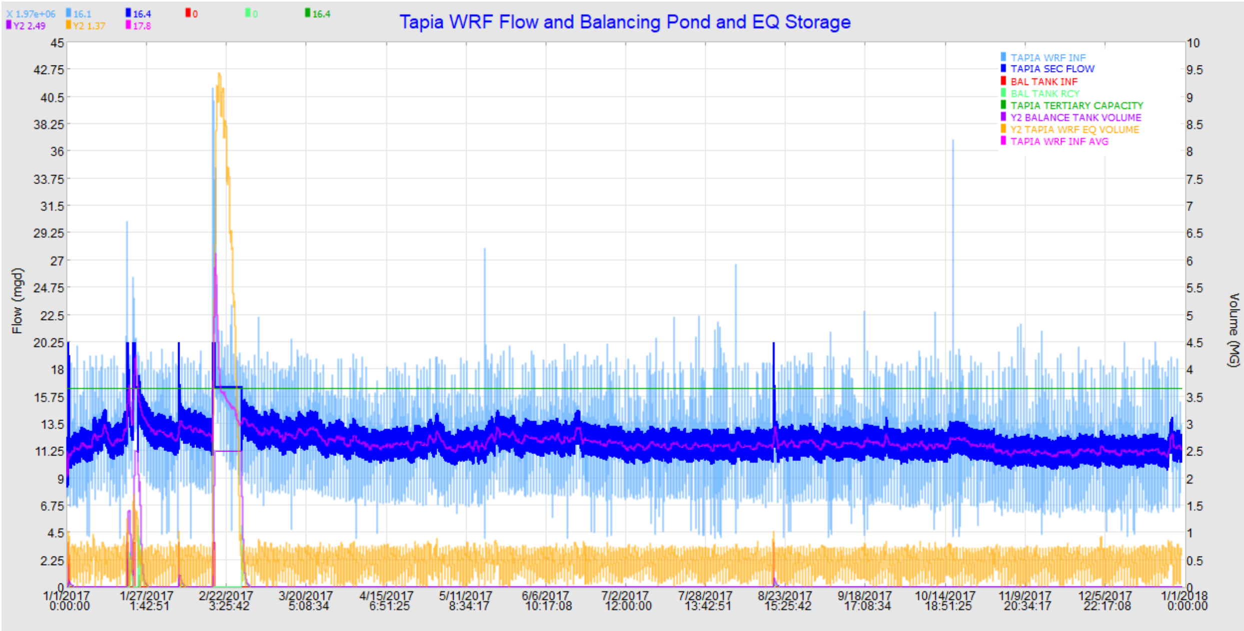


Figure C-10. Tapia Water Reclamation Facility 2017 Flows Adjusted to Design Capacity, with an Average Influent Flow of 12 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD

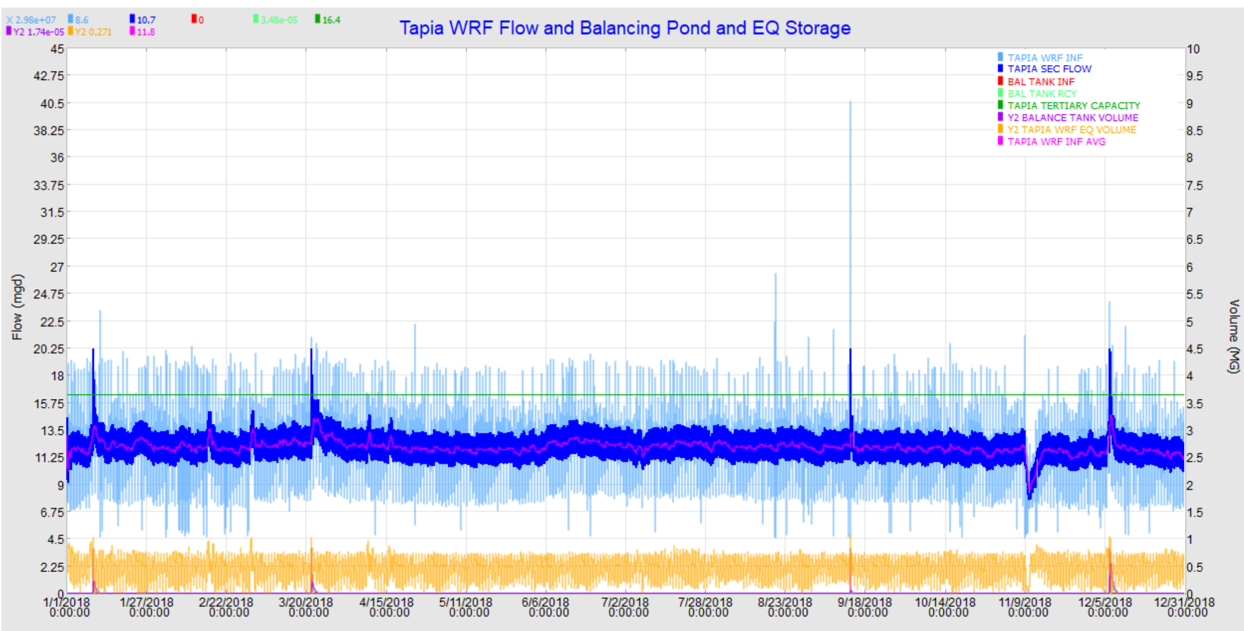


Figure C-11. Tapia Water Reclamation Facility 2018 Flows Adjusted to Design Capacity, with an Average Influent Flow of 12 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD

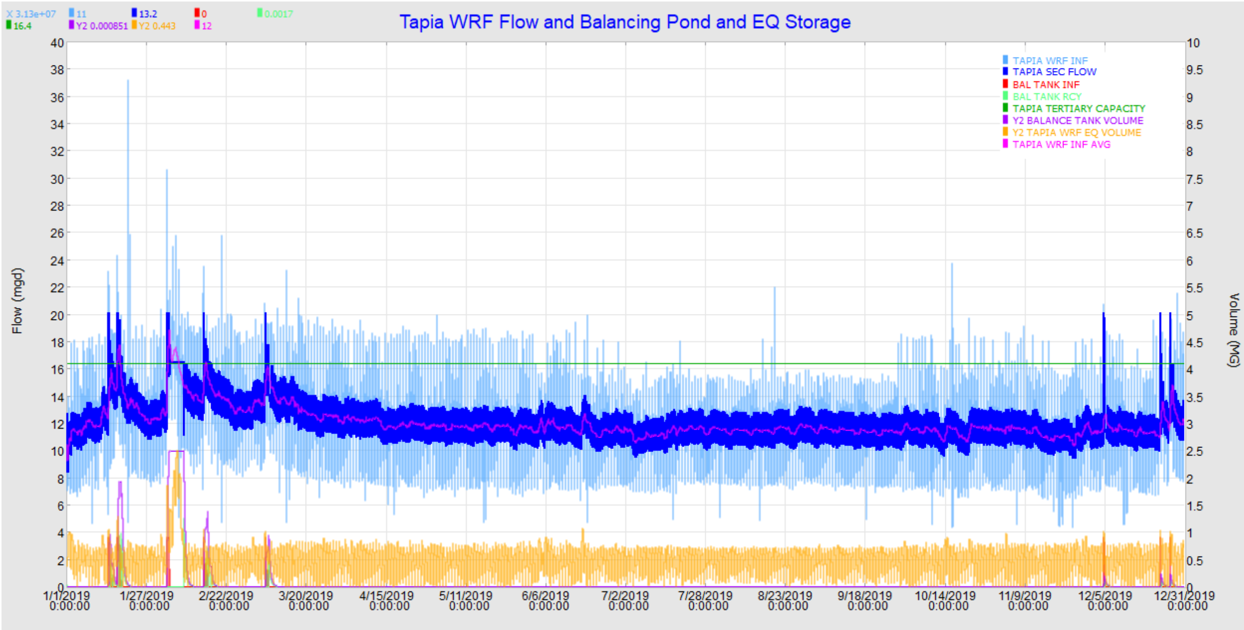


Figure C-12. Tapia Water Reclamation Facility 2019 Flows Adjusted to Design Capacity, with an Average Influent Flow of 12 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD

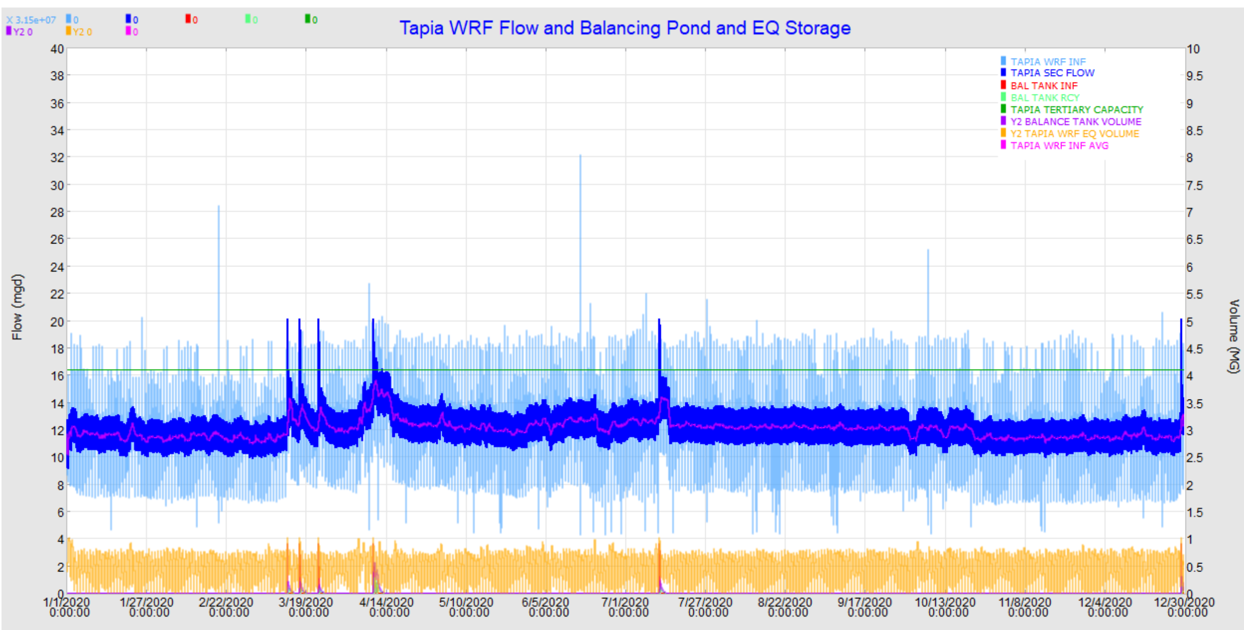


Figure C-13. Tapia Water Reclamation Facility 2020 Flows Adjusted to Design Capacity, with an Average Influent Flow of 12 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD

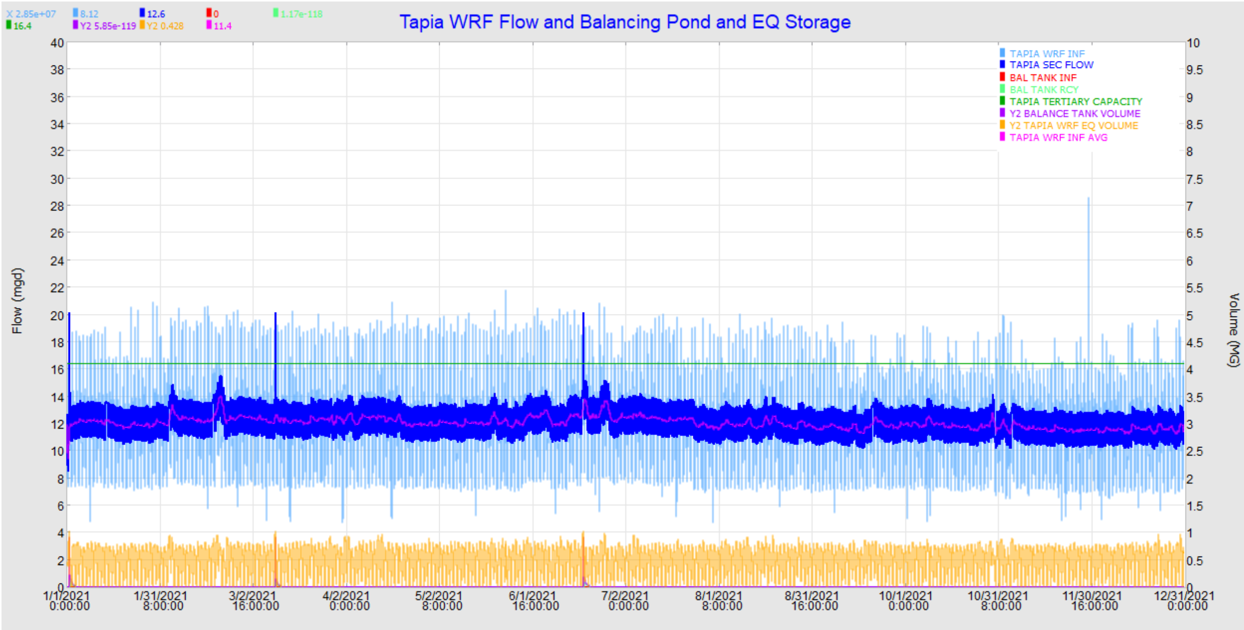


Figure C-14. Tapia Water Reclamation Facility 2021 Flows Adjusted to Design Capacity, with an Average Influent Flow of 12 MGD, Secondary Treatment Capacity of 20 MGD, and Tertiary Treatment Capacity of 16.4 MGD

Appendix D
Storm Events at Tapia Water Reclamation Facility

Appendix D. Storm Events at Tapia Water Reclamation Facility

Figures D-1 through D-32 contain the Replica scenarios used to analyze the peak storm events that occurred from 2017 to 2021 and show the different response strategies at Tapia Water Reclamation Facility (WRF). Table D-1 summarizes the flow scenarios, treatment capacities, and storm dates.

Table D-1. Tapia Water Reclamation Facility Storm Event Modeling Scenarios

Parameter	Value
Secondary Treatment Wet Weather Peak Capacity[a]	
Design MLSS of 3,000 mg/L (all clarifiers in service)	20
Current MLSS of 2,200 mg/L (one clarifier out of service)	24
Tapia WRF Tertiary Filtration Capacity[b]	
Two filters out of service	16.4
One filter out of service	18.2
Flow Scenarios	Historical Flow Design Capacity Flow Reduced I&I Flow
Years	2017-2020
Storm Events	
2017	January 20 and 22 February 17
2018	September 13 December 6
2019	January 14-17 February 2 and 14
2020	April 10

I&I infiltration and inflow

MGD = million gallons per day

[a] Desktop evaluation, recommend field testing to confirm

[b] Title 22 Engineering Report (LVMWD 2004)

The model outputs use the same color scheme for the Tapia WRF system. The date is plotted across the x-axis. The parameters captured on the primary y-axis include:

- Influent flow to Tapia WRF shown in light blue
- Secondary treatment flow shown in dark blue
- Treatment capacity shown in green
- Daily average influent flow shown in magenta
- Influent flow to the Balancing Pond in red
- Recycled flow from the Balancing Pond in lime green

The EQ volume at Tapia WRF is shown in yellow, and the Balancing Pond volume is shown in purple, both reflected on the secondary y-axis.

Figures D-1 through D-4 show two of the three peak storm events that occurred at Tapia WRF in 2017:

- January 20, 2017
- January 22, 2017
- February 17, 2017 (in report)

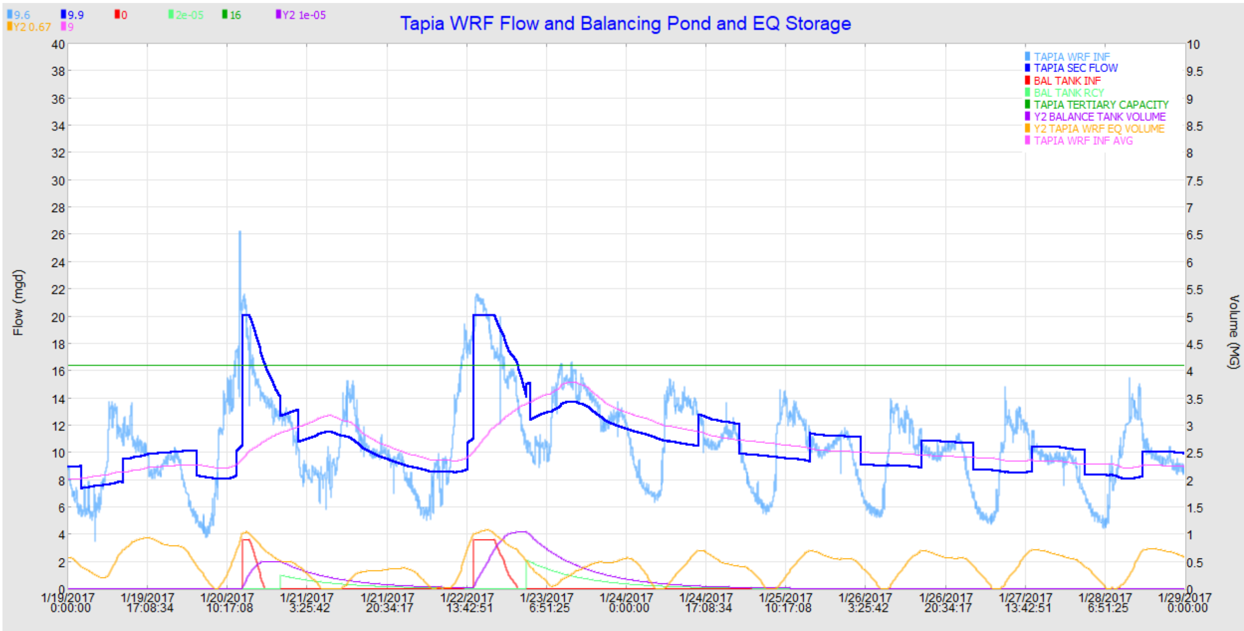


Figure D-1. January 2017 Storm Events at Tapia Water Reclamation Facility, with Historical Average Influent Flow of 8.2 MGD and Secondary Treatment Capacity of 20 MGD

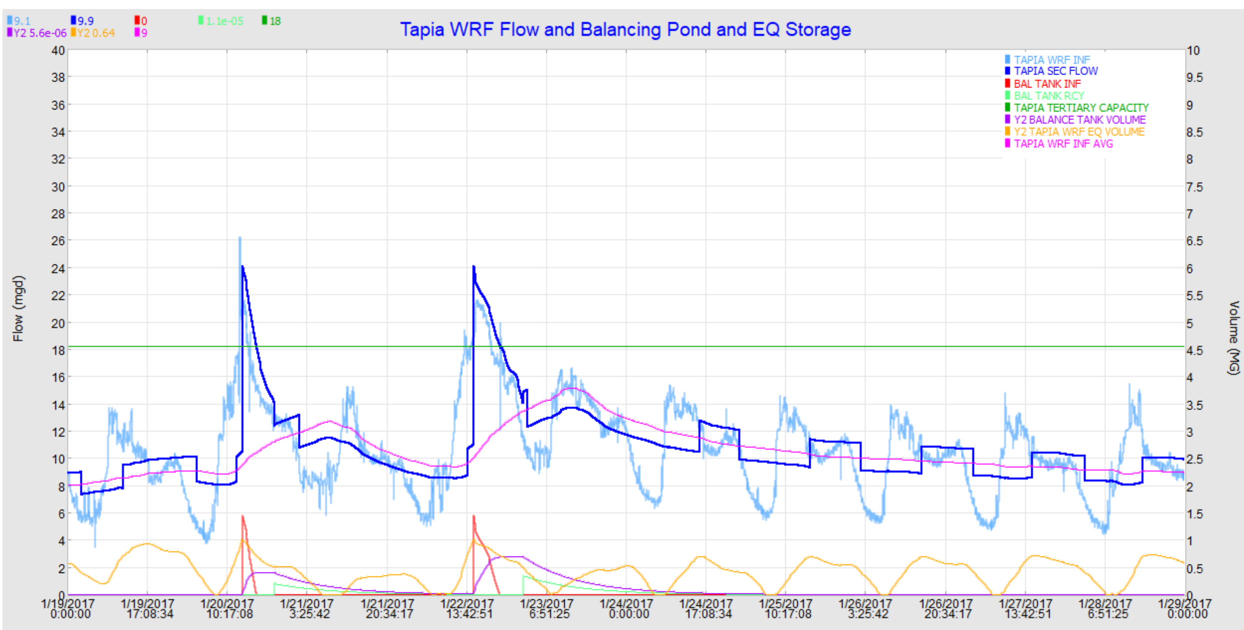


Figure D-2. January 2017 Storm Events at Tapia Water Reclamation Facility, with Historical Average Influent Flow of 8.2 MGD and Secondary Treatment Capacity of 24 MGD

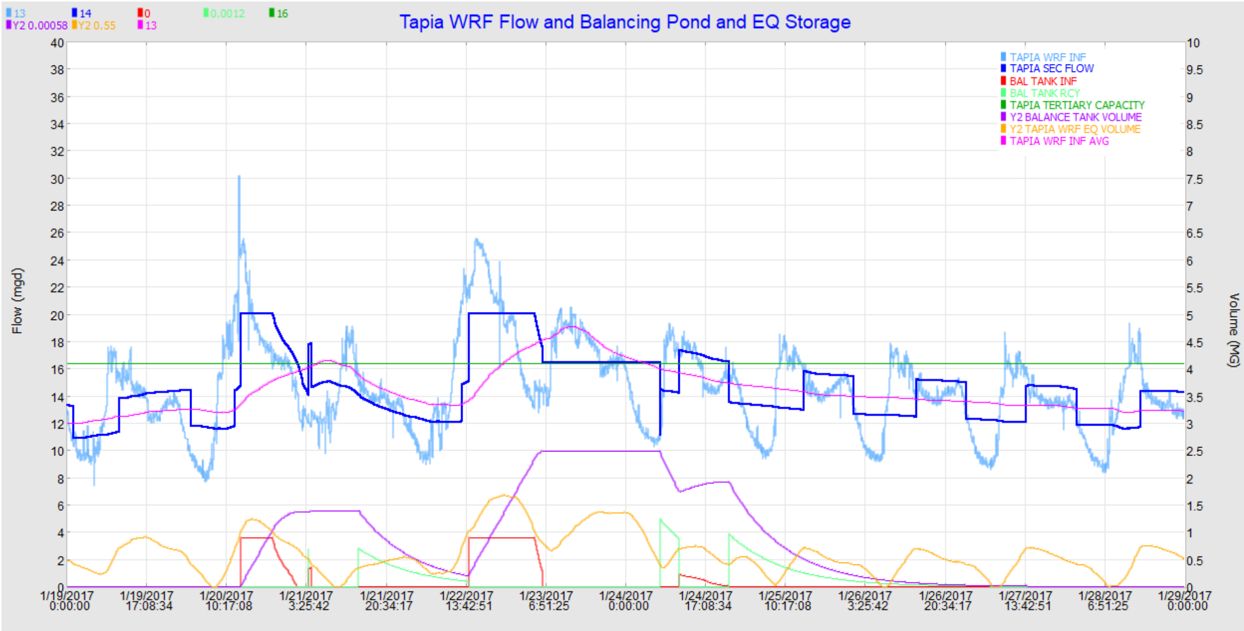


Figure D-3. January 2017 Storm Events at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 20 MGD

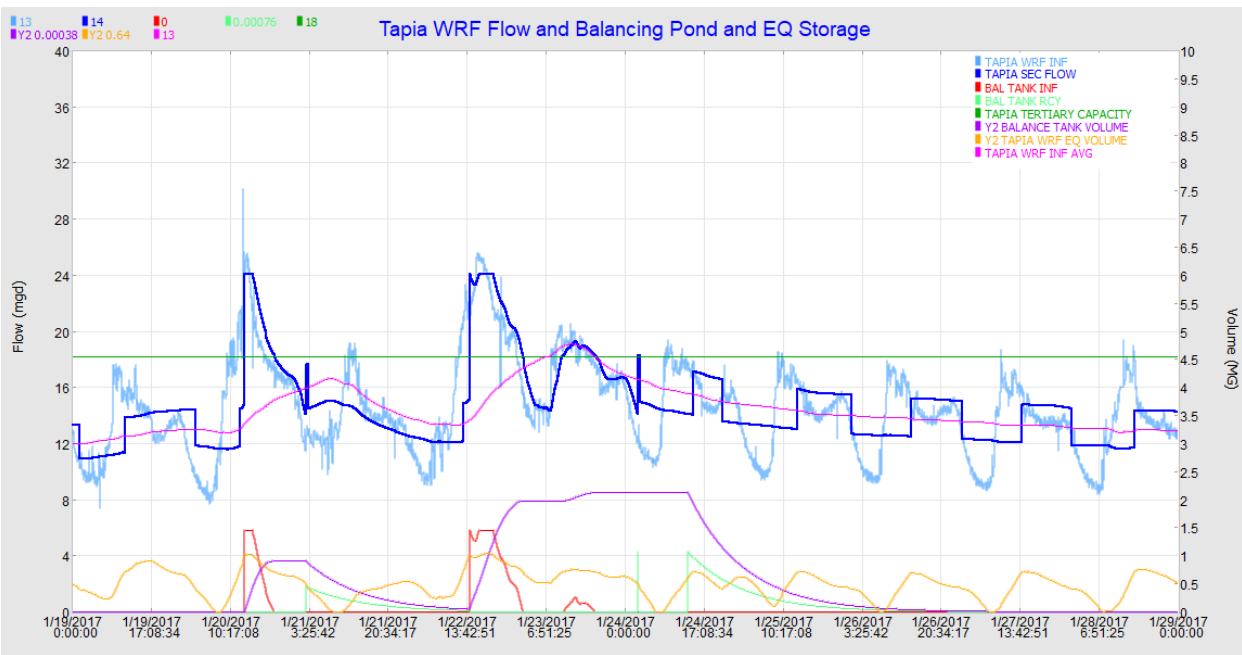


Figure D-4. January 2017 Storm Events at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 24 MGD

Figures D-5 through D-14 show peak storm events that occurred at Tapia WRF in 2018:

- September 13, 2018
- December 6, 2018

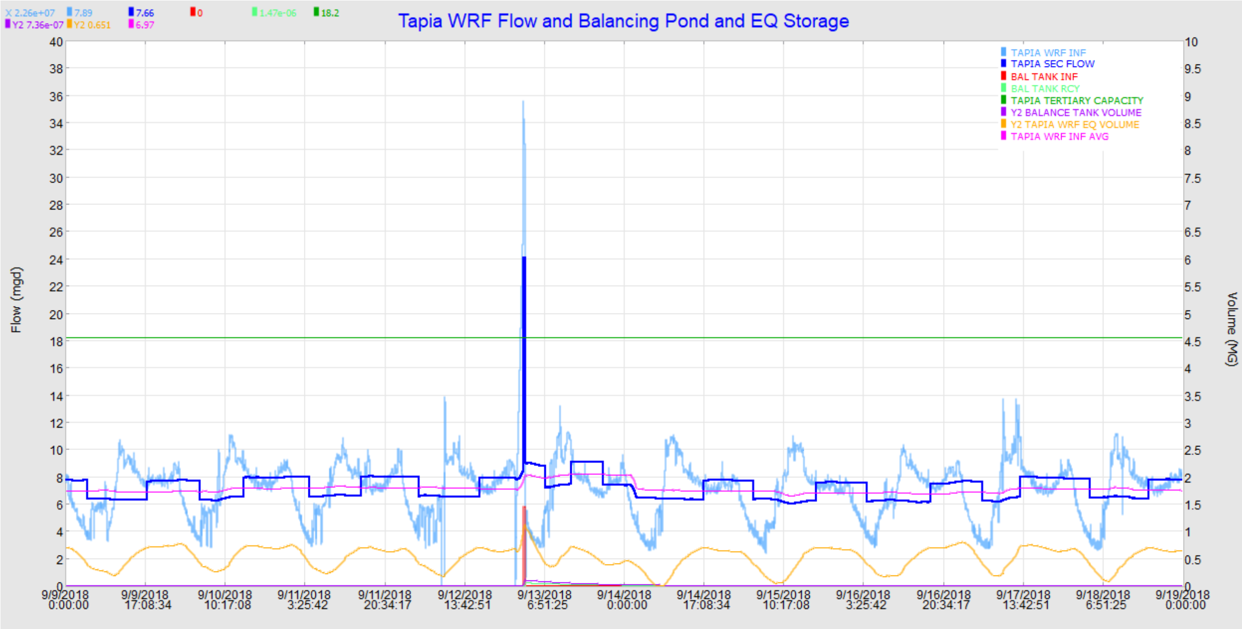


Figure D-5. September 2018 Storm Event at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 6.5 MGD and Secondary Treatment Capacity of 24 MGD

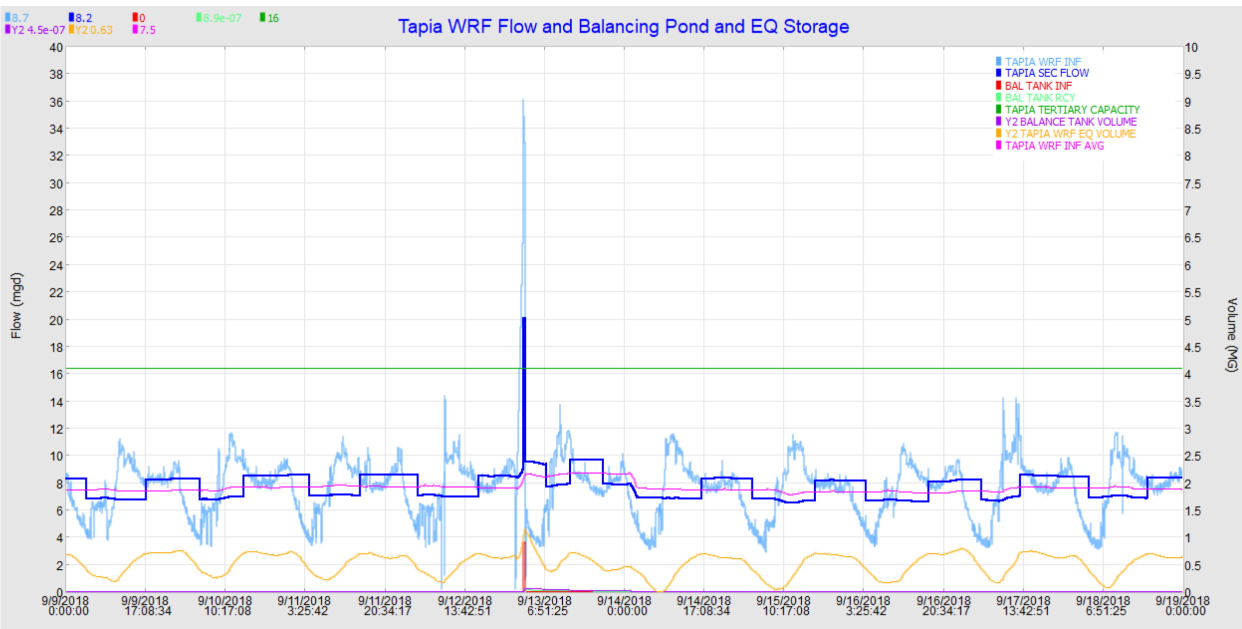


Figure D-6. September 2018 Storm Event at Tapia Water Reclamation Facility, with Historical Average Influent Flow of 7.8 MGD and Secondary Treatment Capacity of 20 MGD

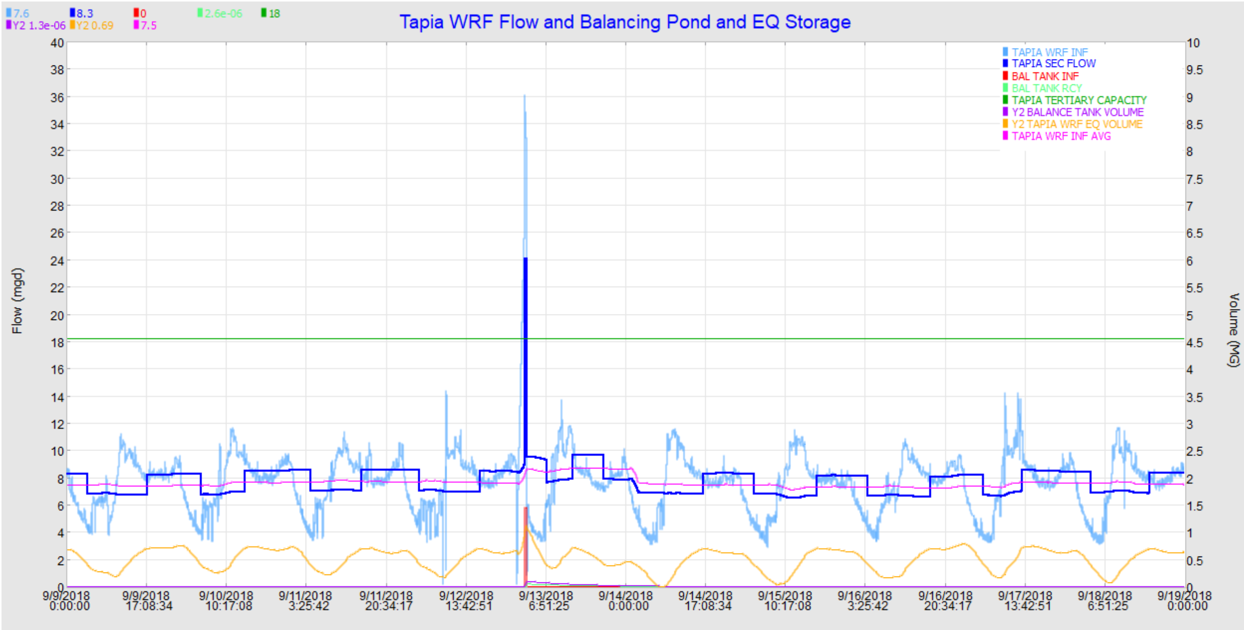


Figure D-7. September 2018 Storm Event at Tapia Water Reclamation Facility, with Historical Average Influent Flow of 7.8 MGD and Secondary Treatment Capacity of 24 MGD

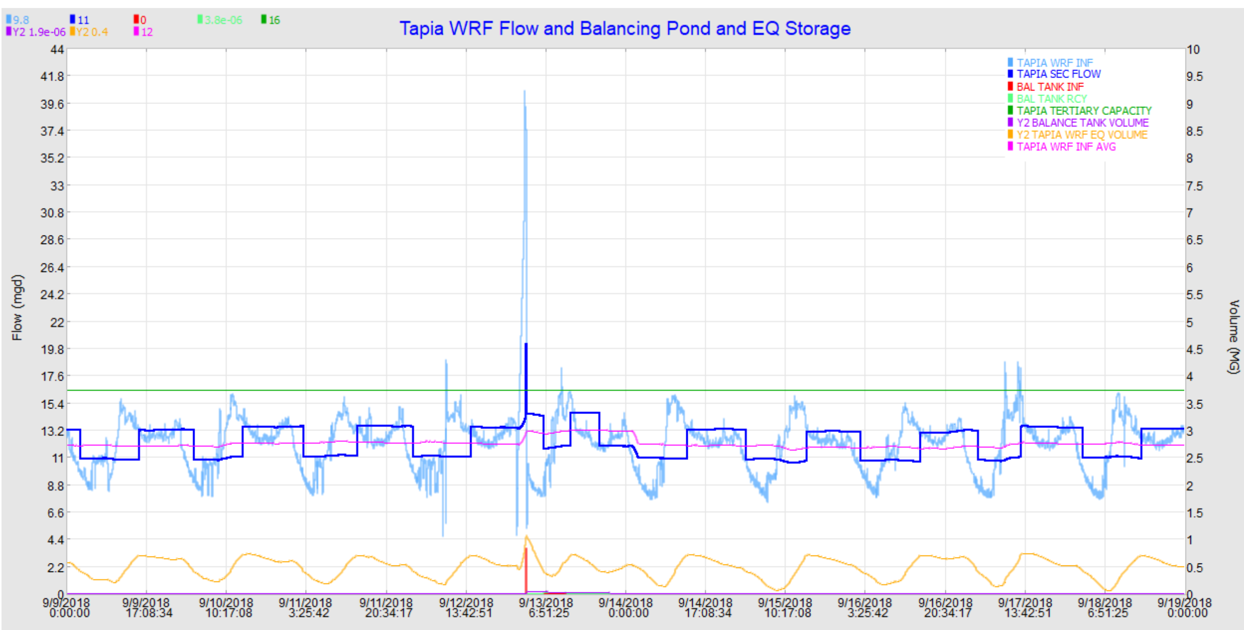


Figure D-8. September 2018 Storm Event at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 20 MGD

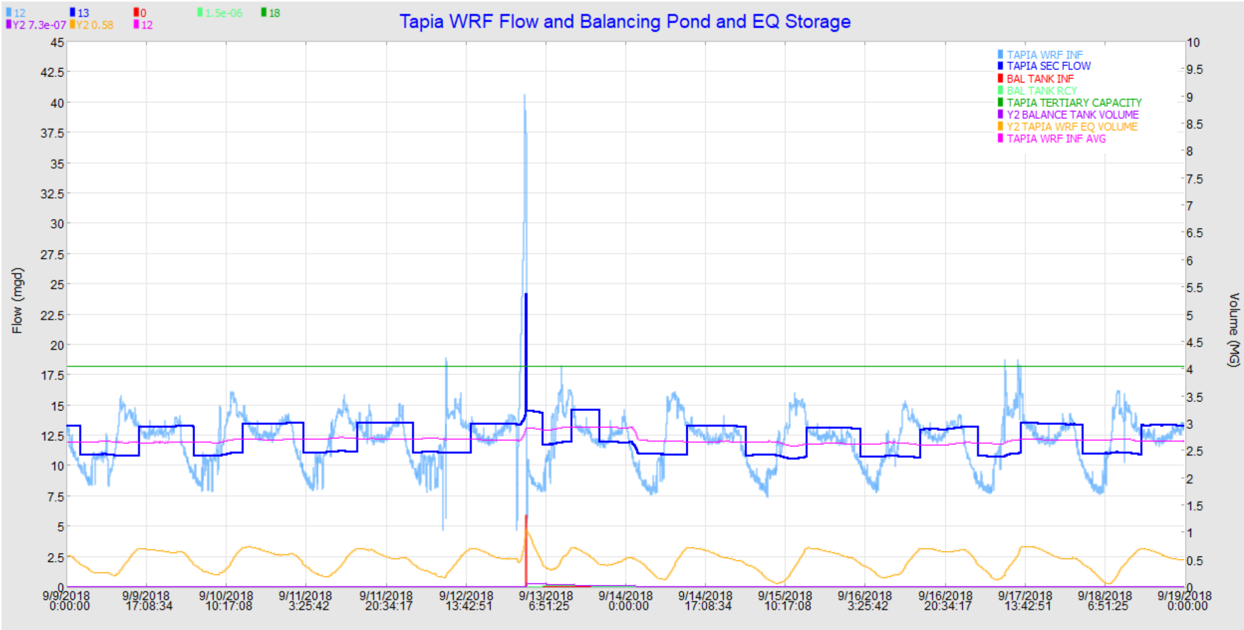


Figure D-9. September 2018 Storm Event at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 24 MGD

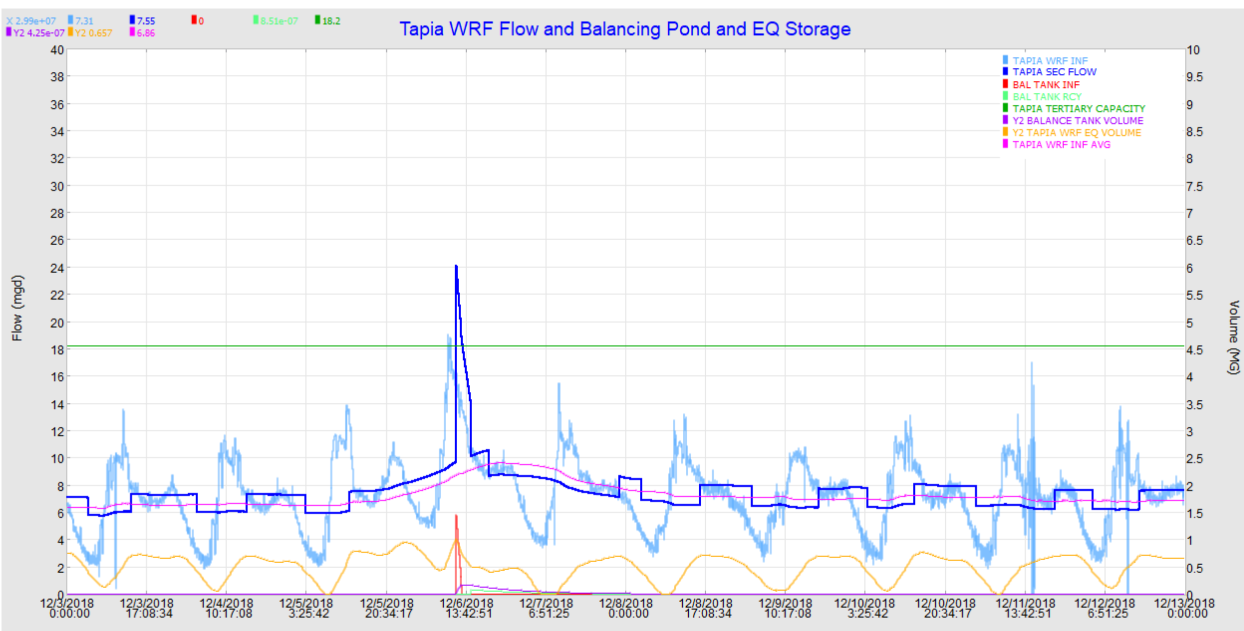


Figure D-10. December 2018 Storm Event at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 6.5 MGD and Secondary Treatment Capacity of 24 MGD

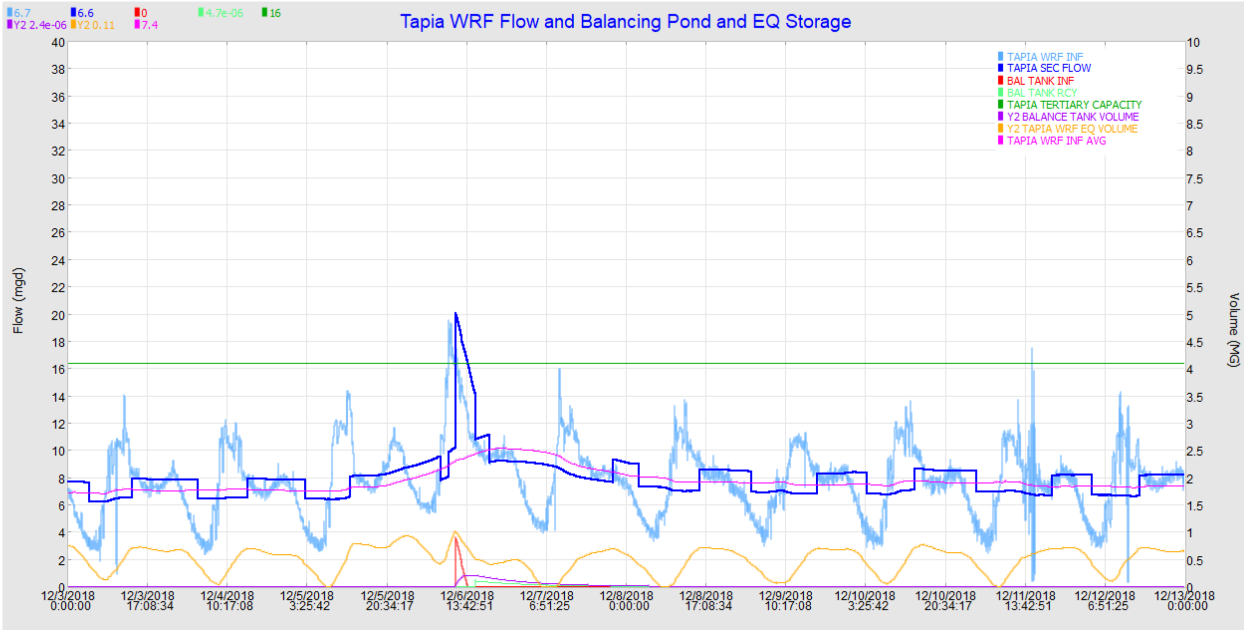


Figure D-11. December 2018 Storm Event at Tapia Water Reclamation Facility, with Historical Average Influent Flow of 7.8 MGD and Secondary Treatment Capacity of 20 MGD

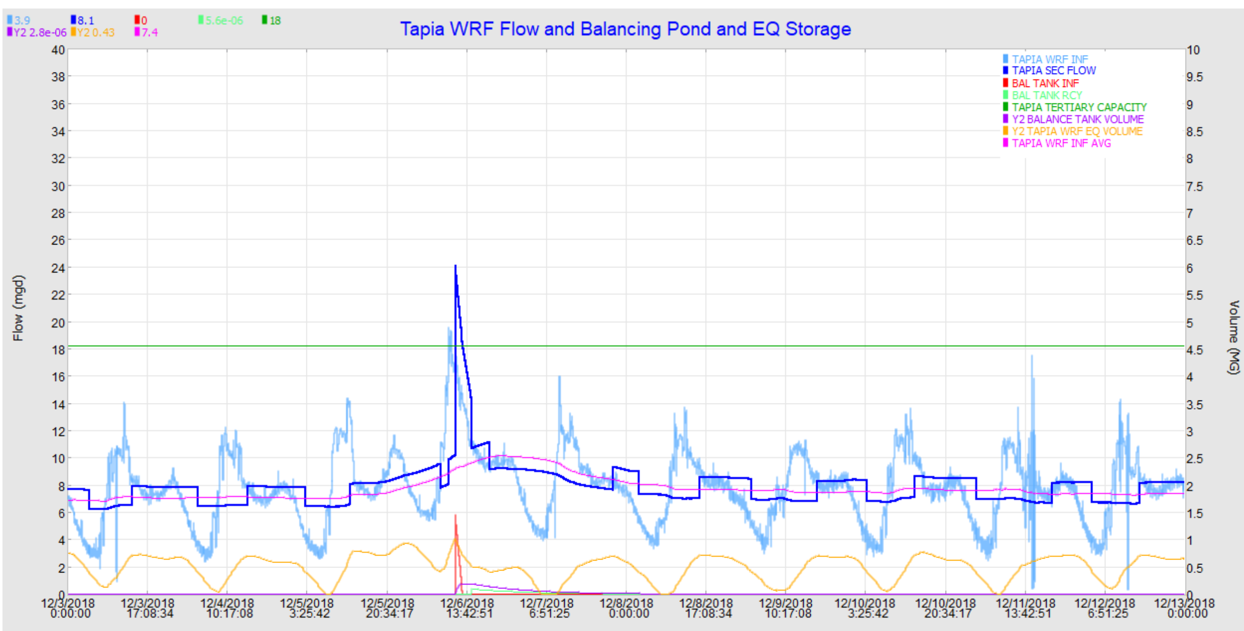


Figure D-12. December 2018 Storm Event at Tapia Water Reclamation Facility, with Historical Average Influent Flow of 7.8 MGD and Secondary Treatment Capacity of 24 MGD

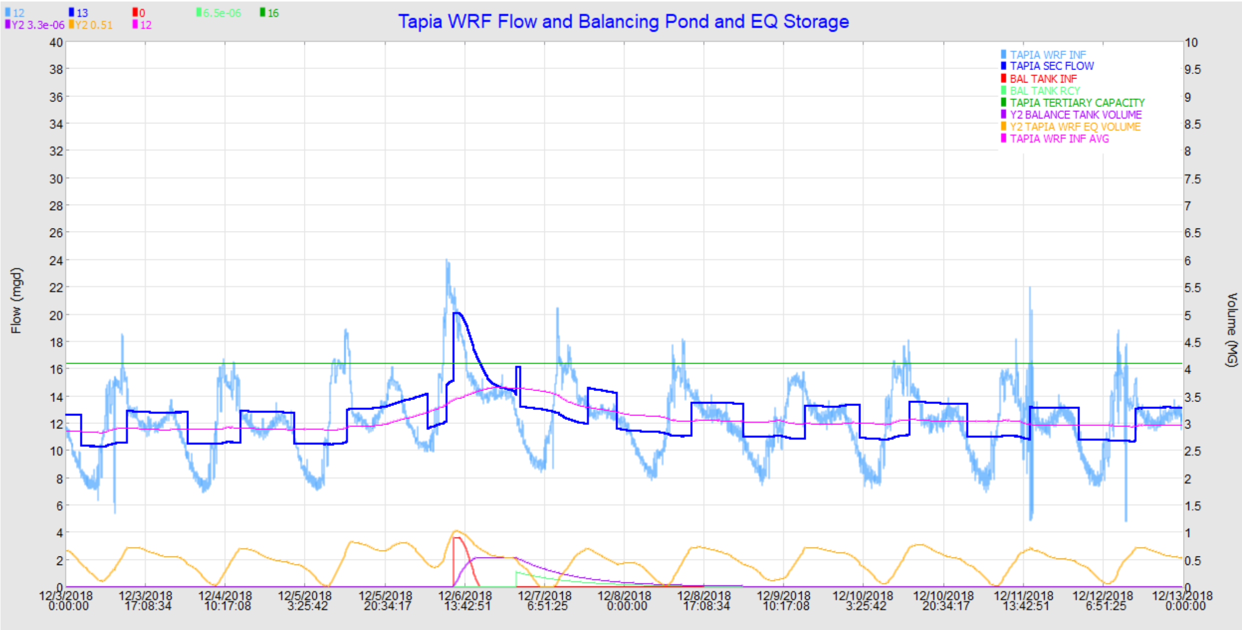


Figure D-13. December 2018 Storm Event at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 20 MGD

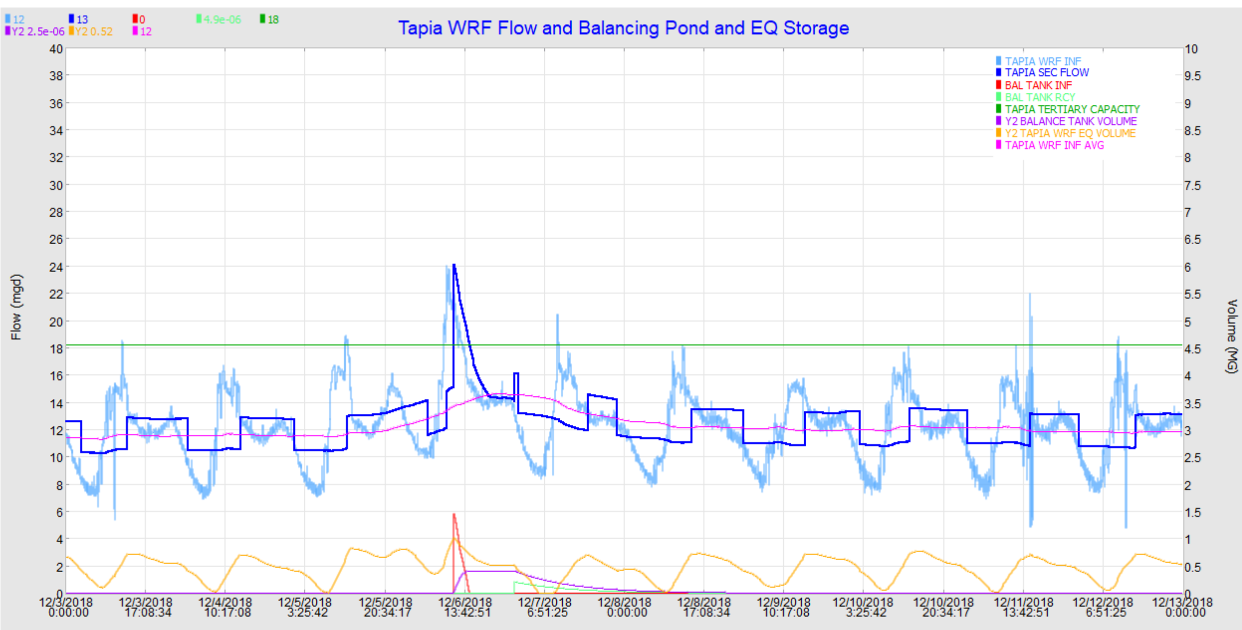


Figure D-14. December 2018 Storm Event at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 24 MGD

Figures D-15 through D-27 show four peak storm events that occurred at Tapia WRF in 2019:

- January 14, 2019
- January 17, 2019
- February 2, 2019
- February 14, 2019 (peak storm)

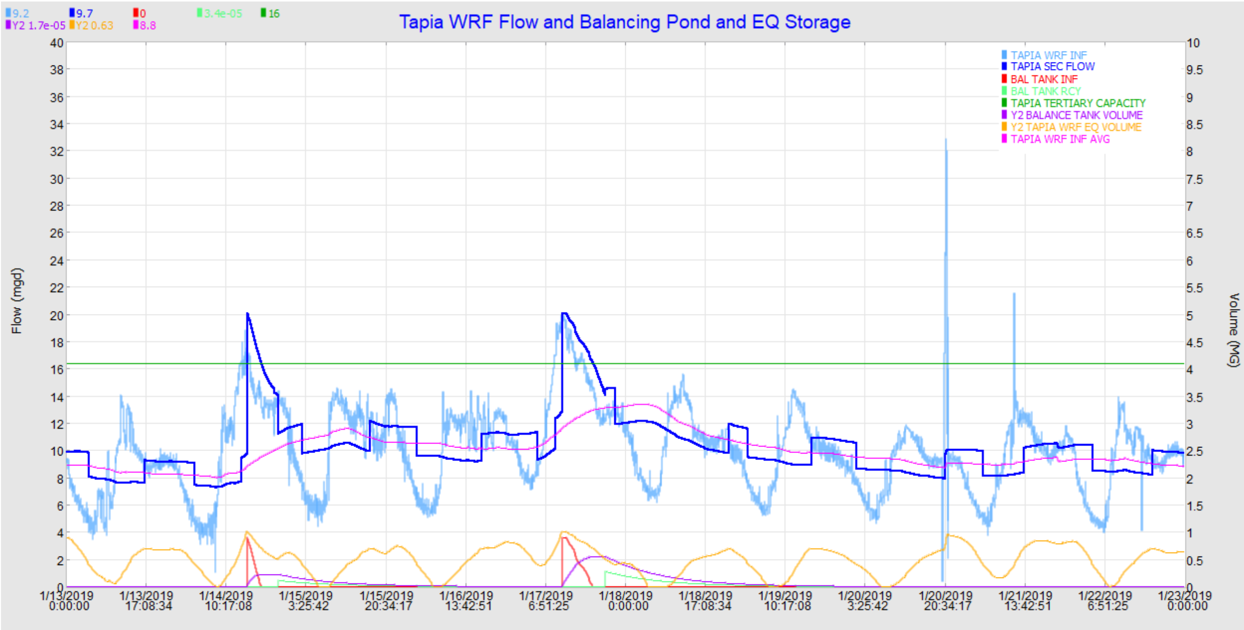


Figure D-15. January 2019 Storm Events at Tapia Water Reclamation Facility, with Historical Average Influent Flow of 7.8 MGD and Secondary Treatment Capacity of 20 MGD

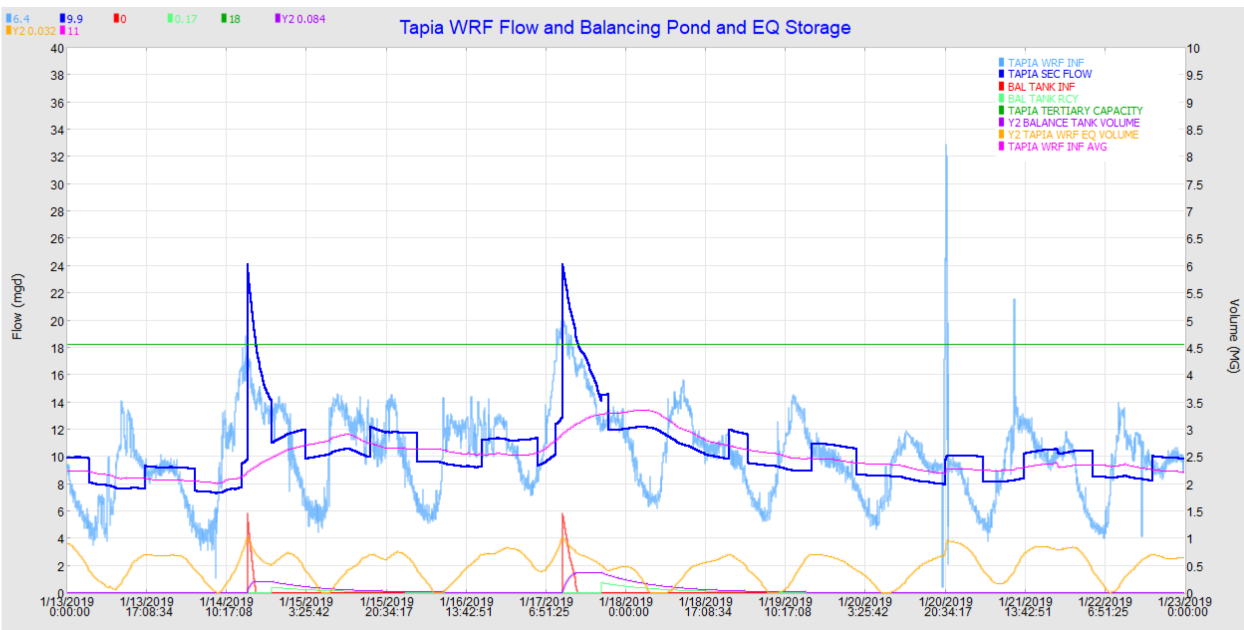


Figure D-16. January 2019 Storm Events at Tapia Water Reclamation Facility, with Historical Average Influent Flow of 7.8 MGD and Secondary Treatment Capacity of 24 MGD

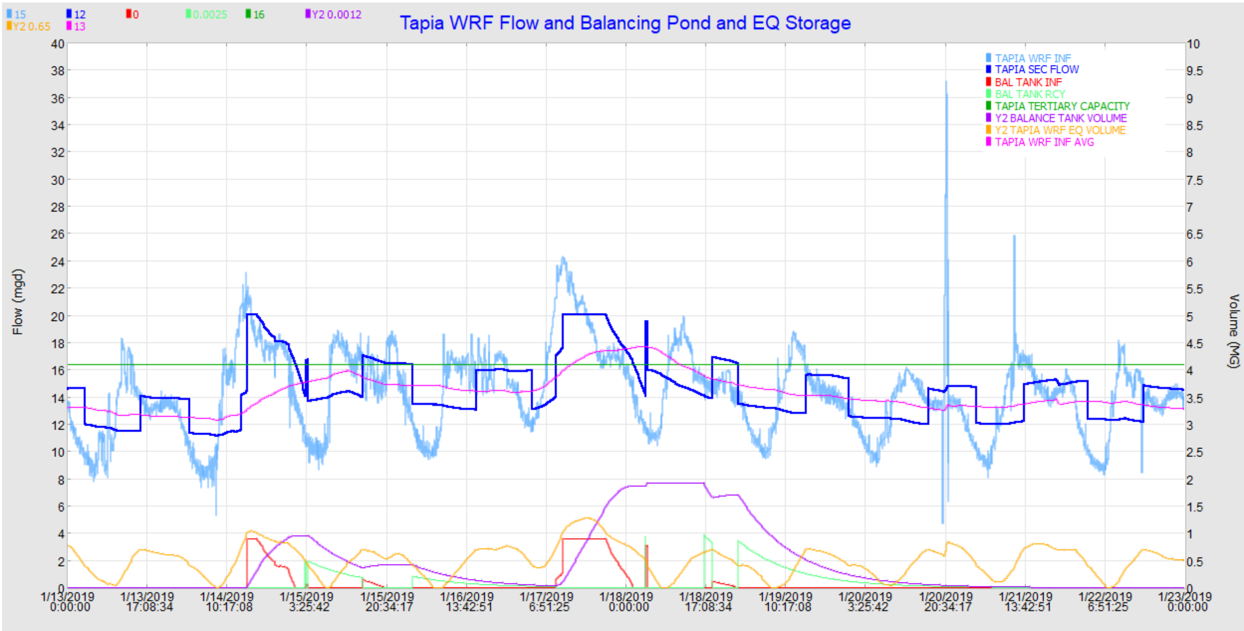


Figure D-17. January 2019 Storm Events at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 20 MGD

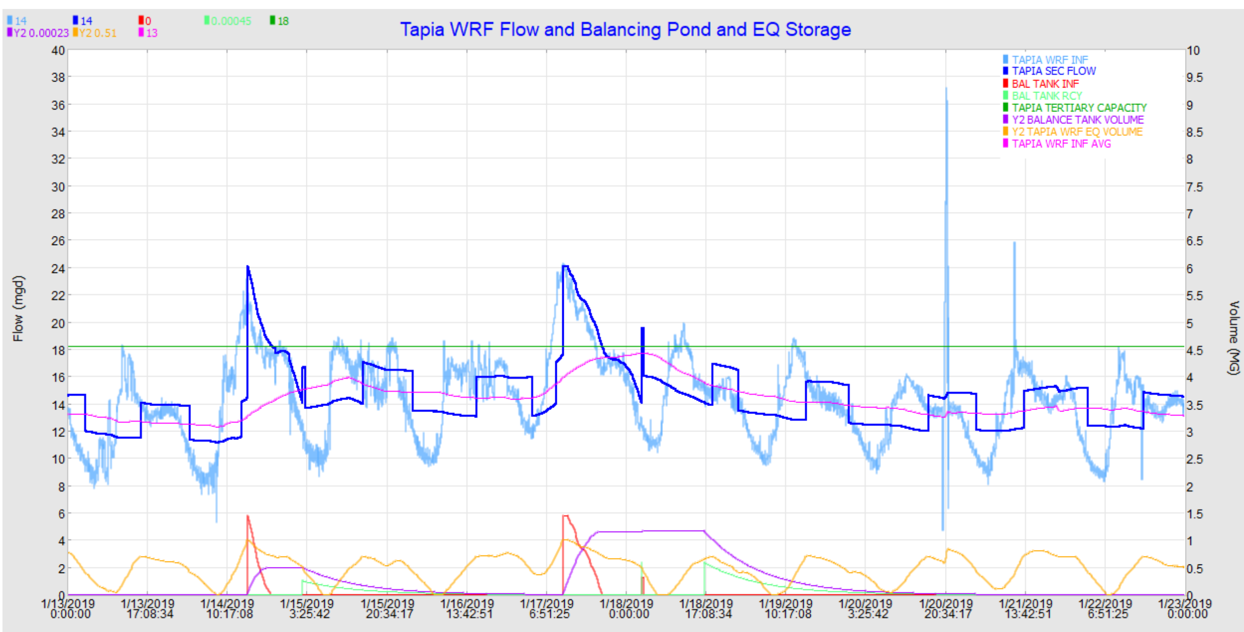


Figure D-18. January 2019 Storm Events at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 24 MGD

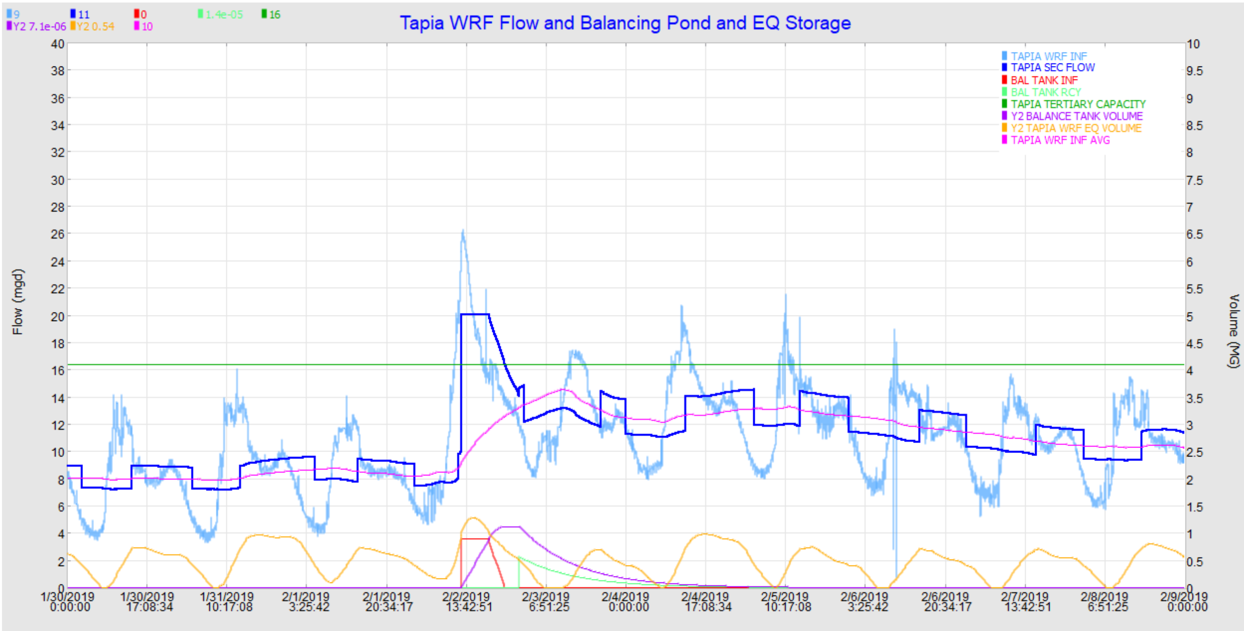


Figure D-19. February 2, 2019 Storm Event at Tapia Water Reclamation Facility, with Historical Average Influent Flow of 7.8 MGD and Secondary Treatment Capacity of 20 MGD

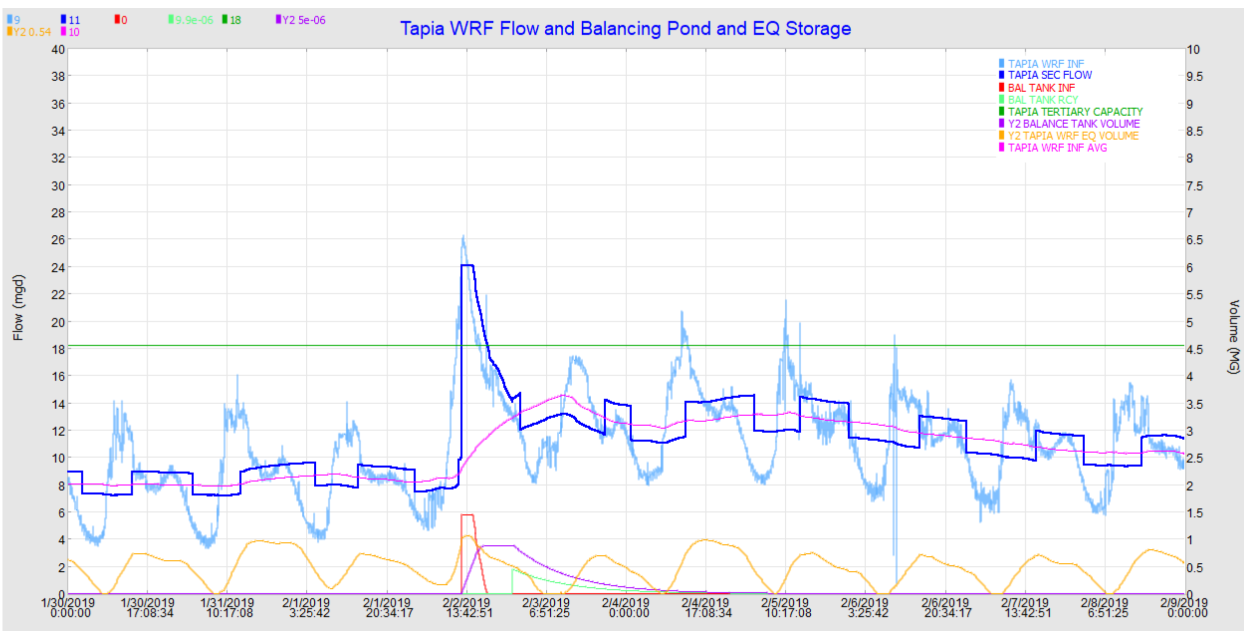


Figure D-20. February 2, 2019 Storm Event at Tapia Water Reclamation Facility, with Historical Average Influent Flow of 7.8 MGD and Secondary Treatment Capacity of 24 MGD

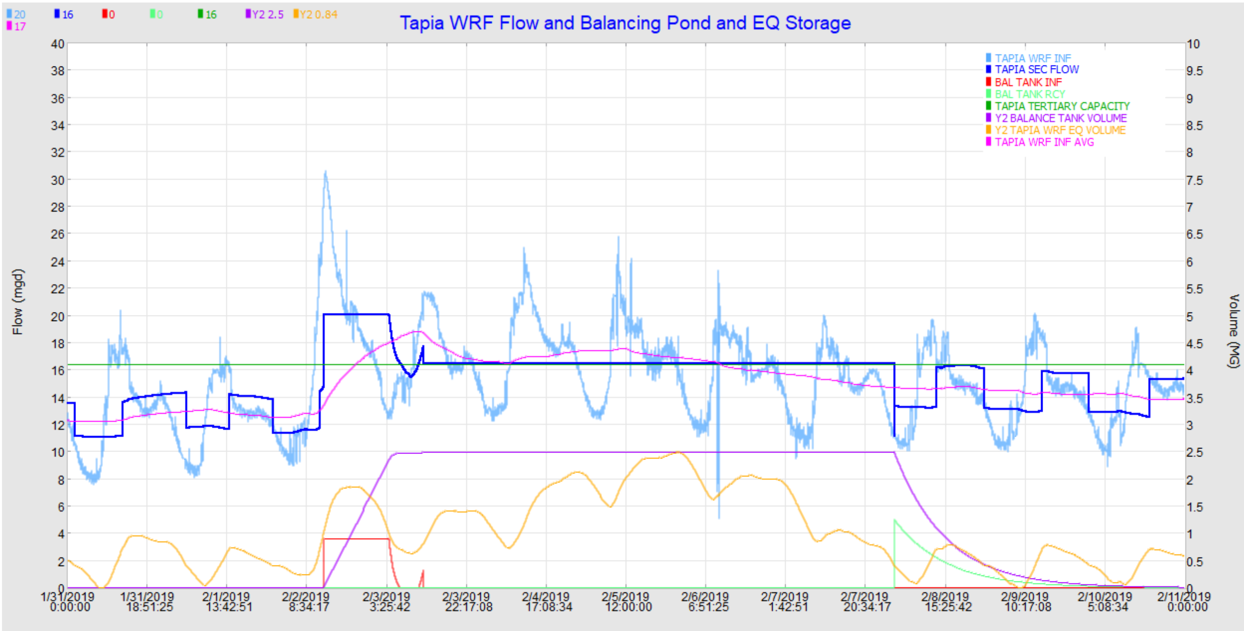


Figure D-21. February 2, 2019 Storm Event at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 20 MGD

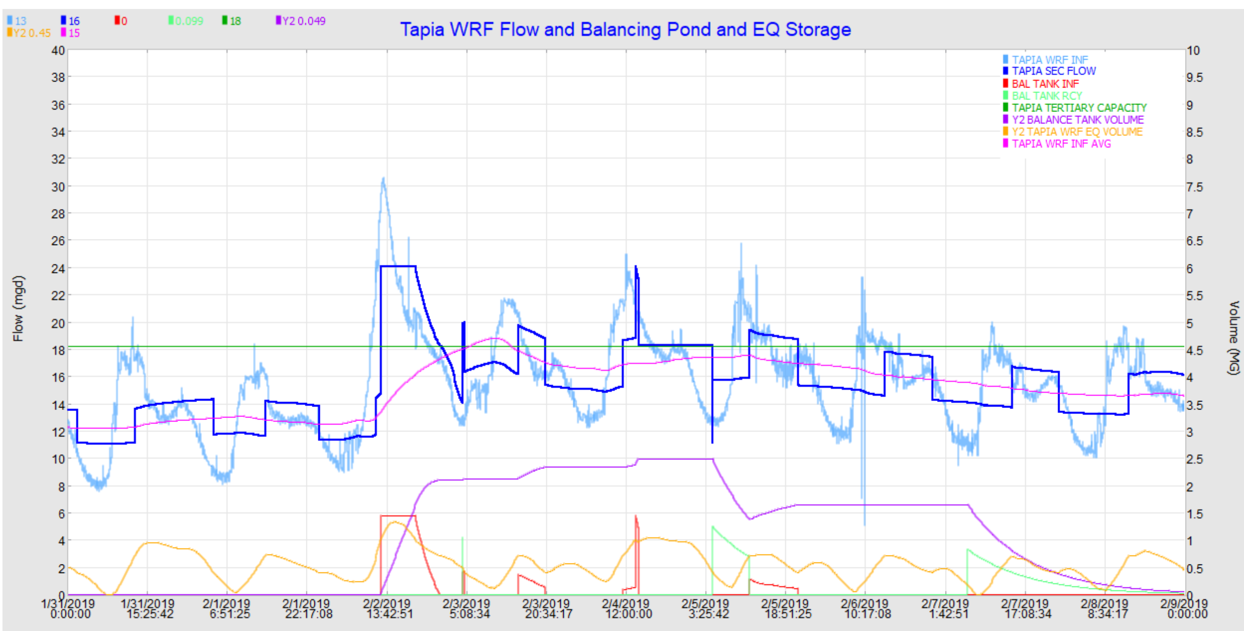


Figure D-22. February 2, 2019 Storm Event at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 24 MGD

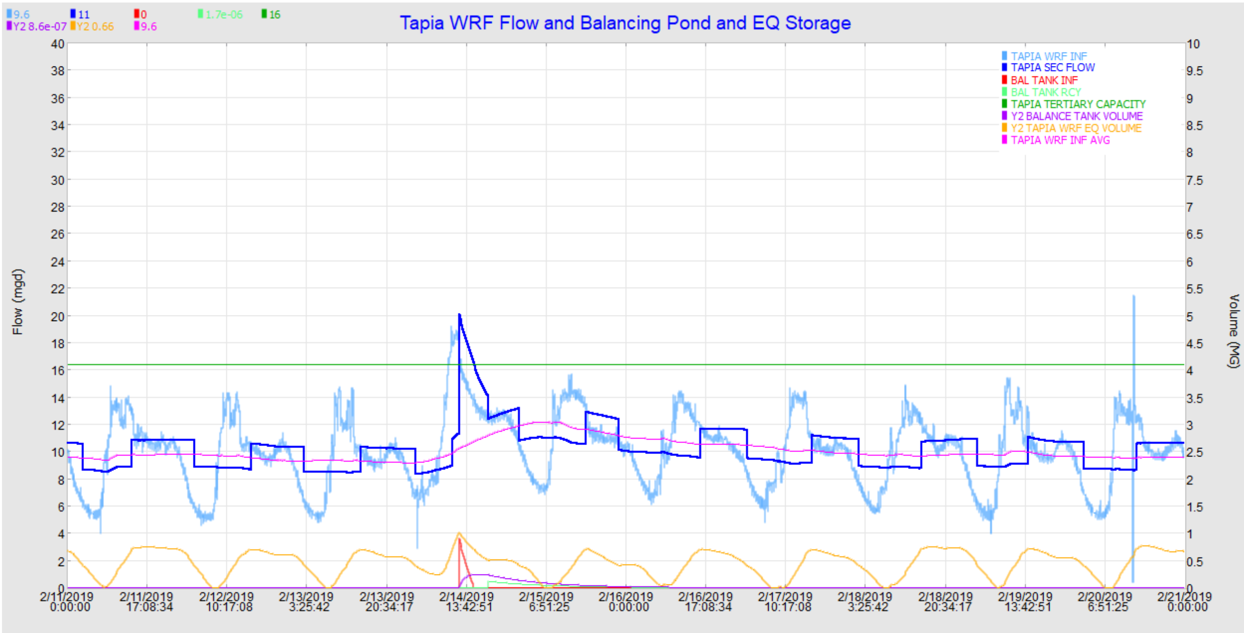


Figure D-23. February 14, 2019 Storm Event at Tapia Water Reclamation Facility, with Historical Average Influent Flow of 7.8 MGD and Secondary Treatment Capacity of 20 MGD

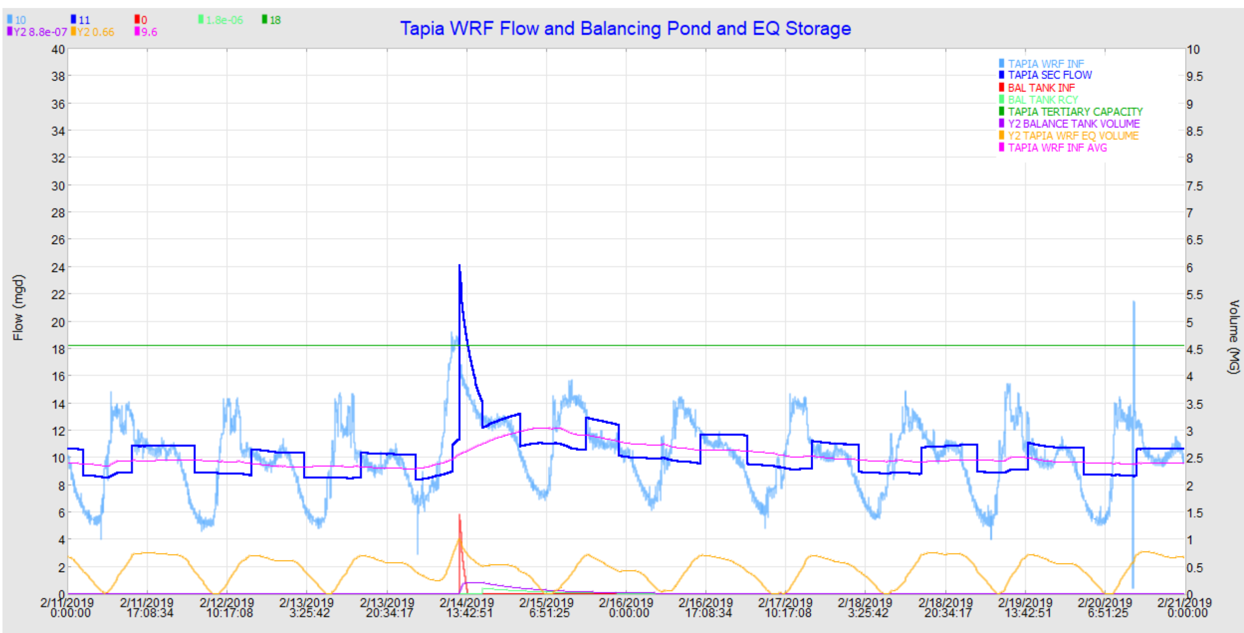


Figure D-24. February 14, 2019 Storm Event at Tapia Water Reclamation Facility, with Historical Average Influent Flow of 7.8 MGD and Secondary Treatment Capacity of 24 MGD

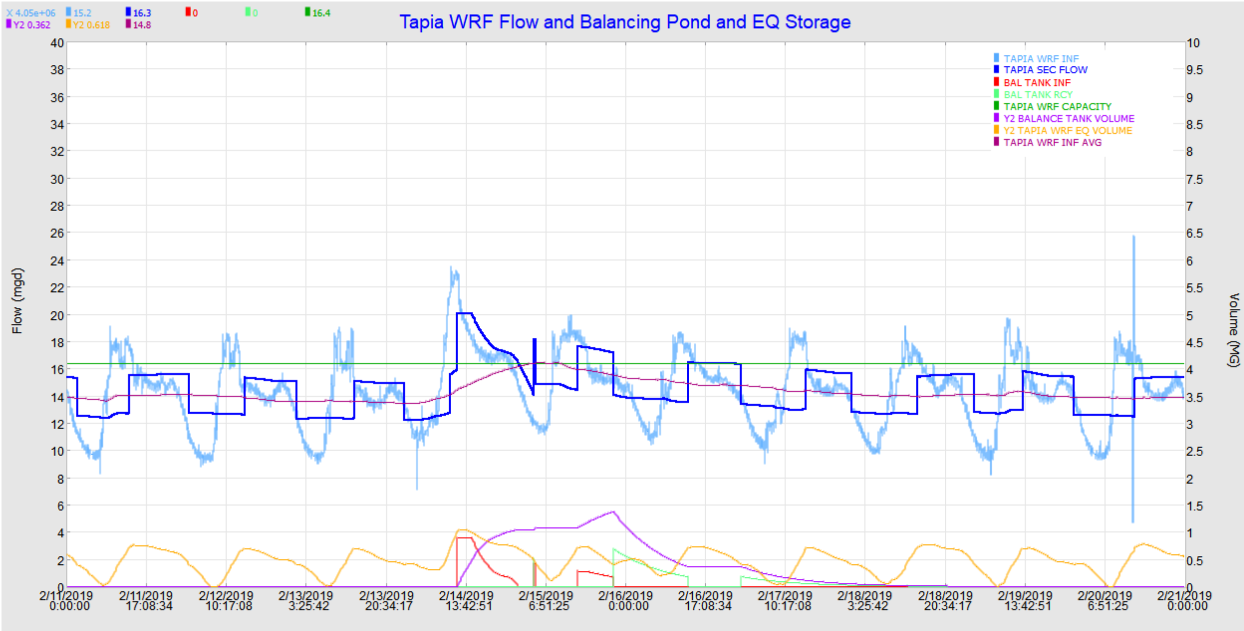


Figure D-25. February 14, 2019 Storm Event at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 20 MGD

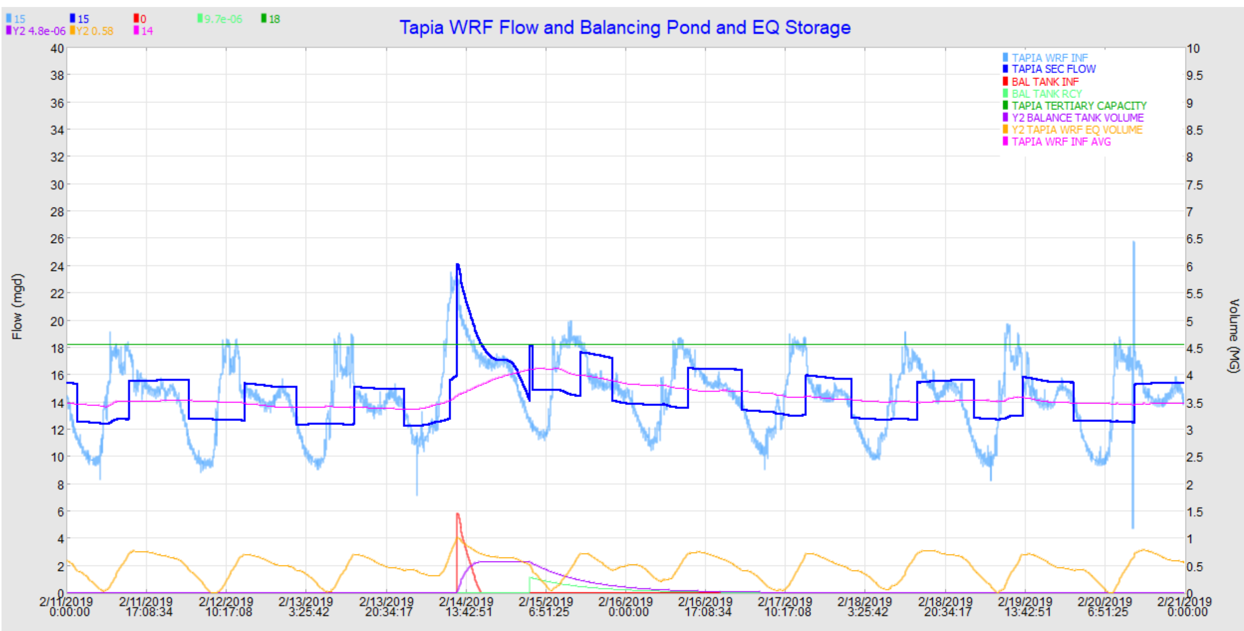


Figure D-27. February 14, 2019 Storm Event at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 24 MGD

Figures D-28 through D-30 show one peak storm event that occurred at Tapia WRF in 2020 on April 10, 2020.

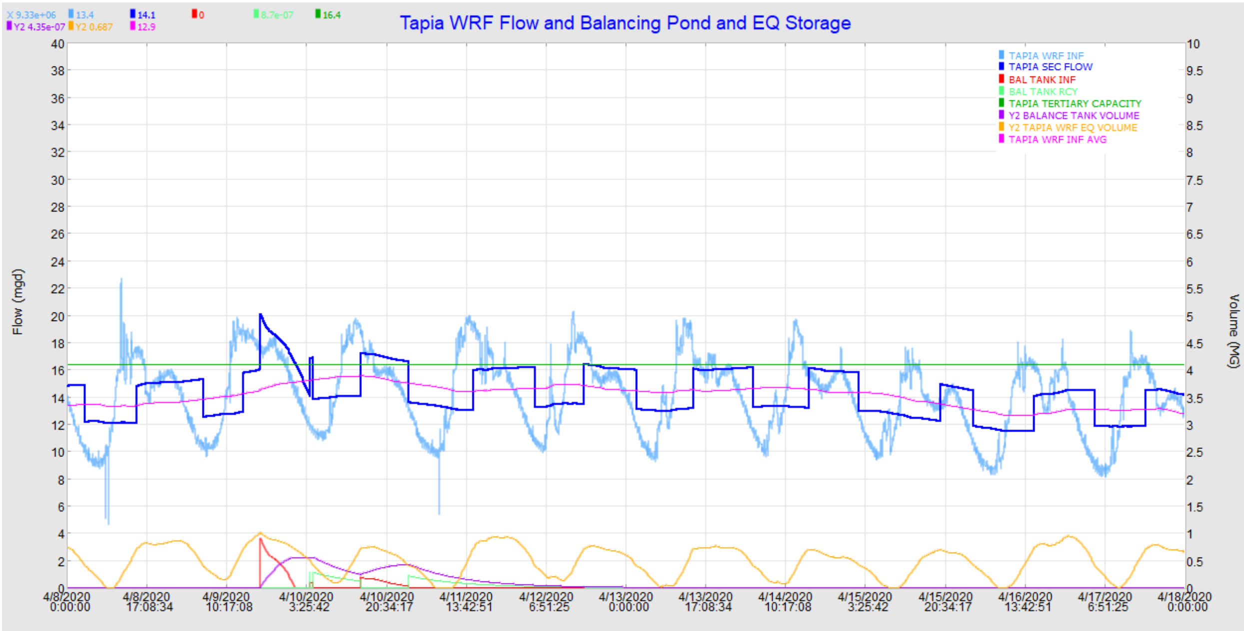


Figure D-28. April 2020 Storm Event at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 20 MGD

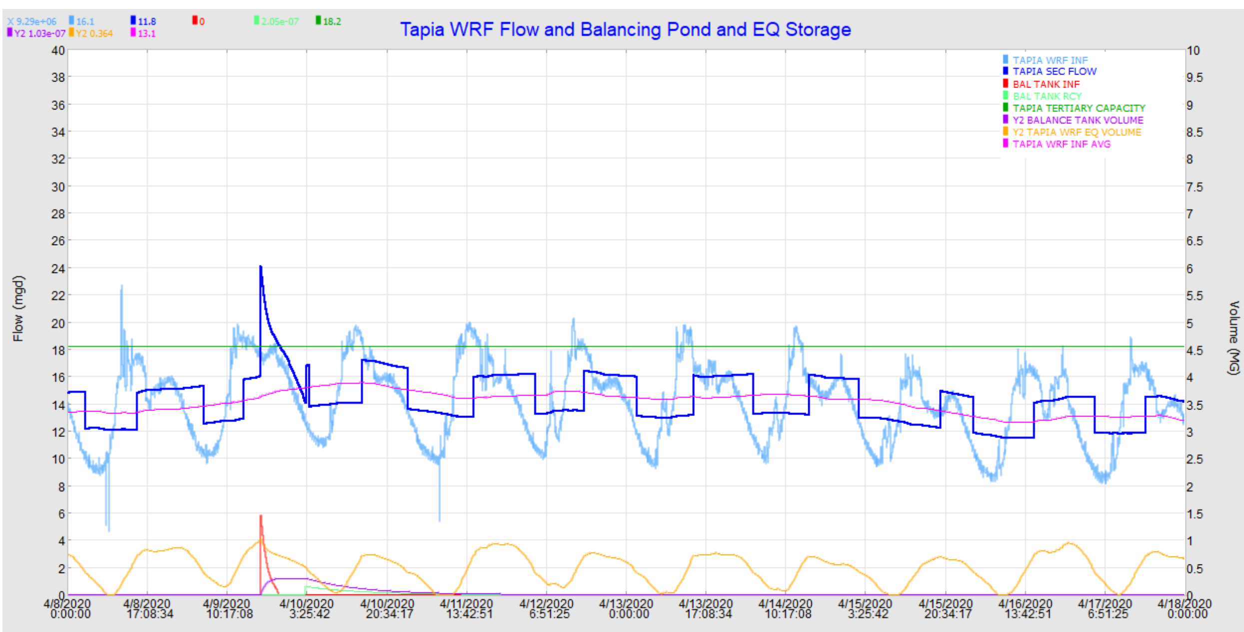


Figure D-29. April 2020 Storm Event at Tapia Water Reclamation Facility, with Adjusted Average Influent Flow of 12 MGD and Secondary Treatment Capacity of 24 MGD

Appendix E
Simulated Operation of the Advanced Water Purification Facility

Appendix E. Simulated Operation of the Advanced Water Purification Facility

Appendix E shows the trends for simulated operations of the recycled water system and the impact they have on the AWPF available flow and AWPF demand for 2018 through 2021 in Figures E-1 through E-4. Additionally, the reduced I&I flow scenarios for 2017 and 2018 are captured in Figures E-5 and E-6 to highlight the impact on available flow to the AWPF. The date is plotted across the x-axis. The parameters captured on the primary y-axis include AWPF available flow shown in overlapping dark purple/lime green. The secondary y-axis includes Reservoir 2 level shown in purple and AWPF EQ basin volume shown in orange.

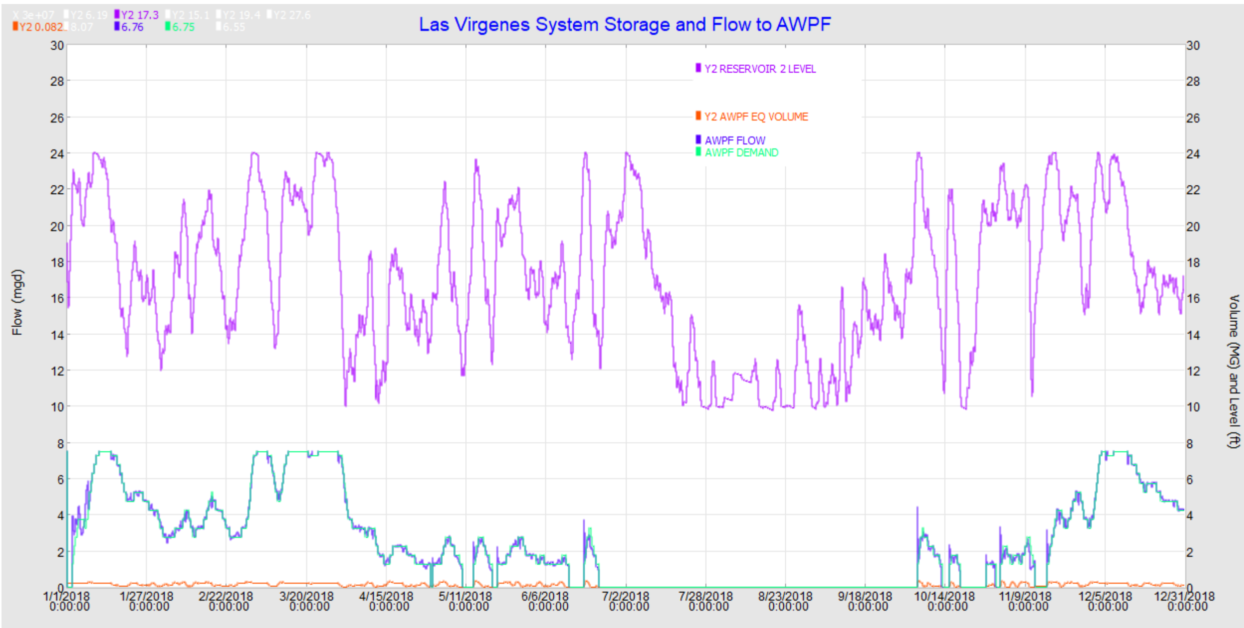


Figure E-1. Recycled Water System Simulated Operations with Variable Speed Pumps Impact on Advanced Water Purification Facility Flow for 2018

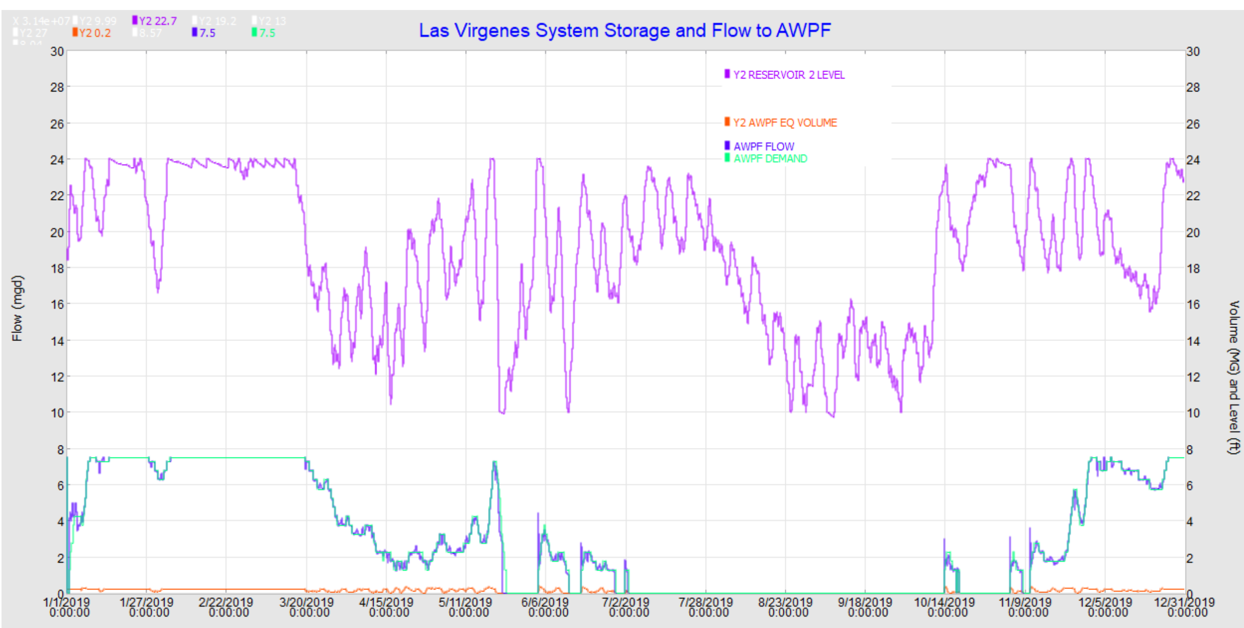


Figure E-2. Recycled Water System Simulated Operations with Variable Speed Pumps Impact on Advanced Water Purification Facility Flow for 2019

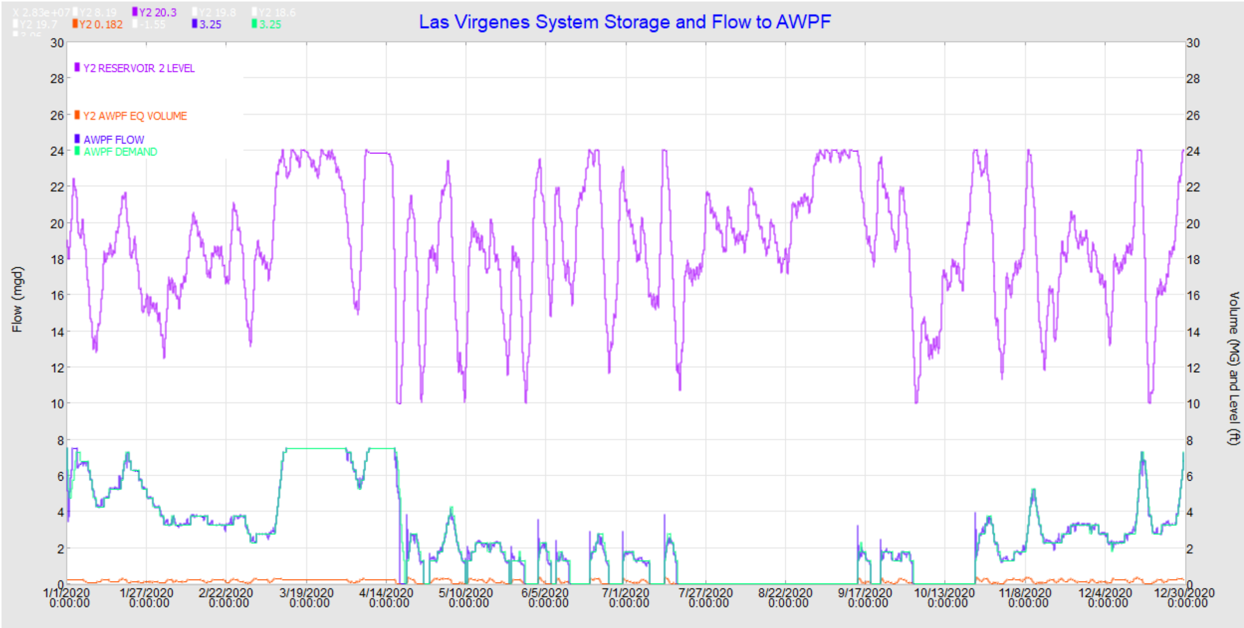


Figure E-3. Recycled Water System Simulated Operations with Variable Speed Pumps Impact on Advanced Water Purification Facility Flow for 2020

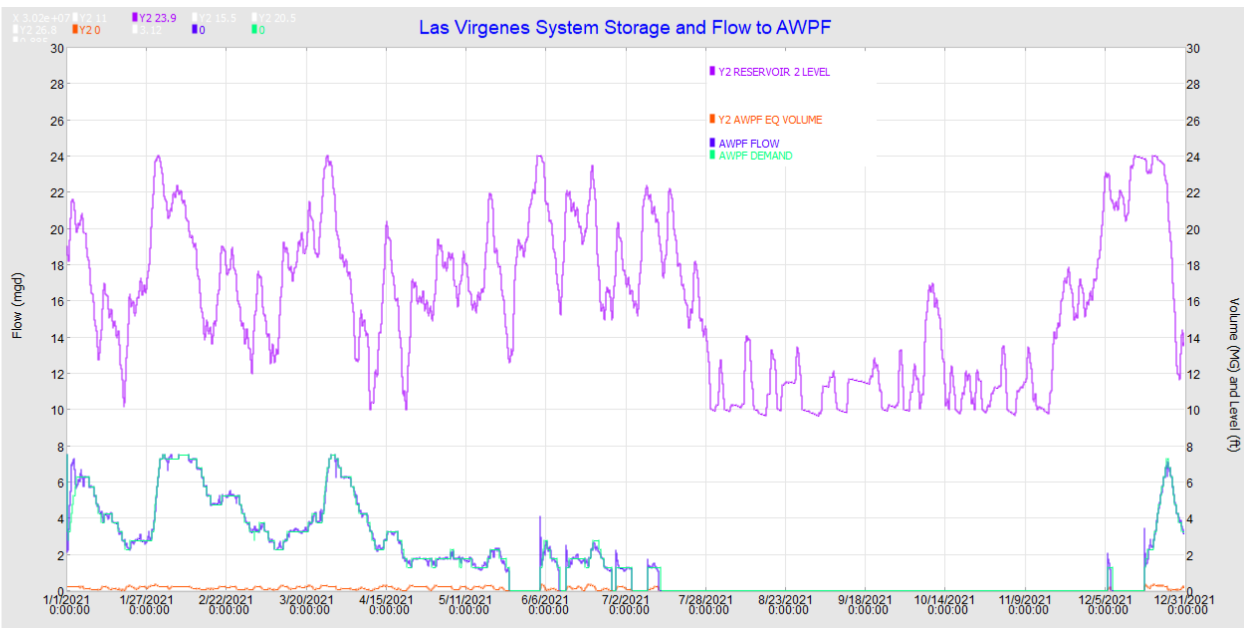


Figure E-4. Recycled Water System Simulated Operations with Variable Speed Pumps Impact on Advanced Water Purification Facility Flow for 2021

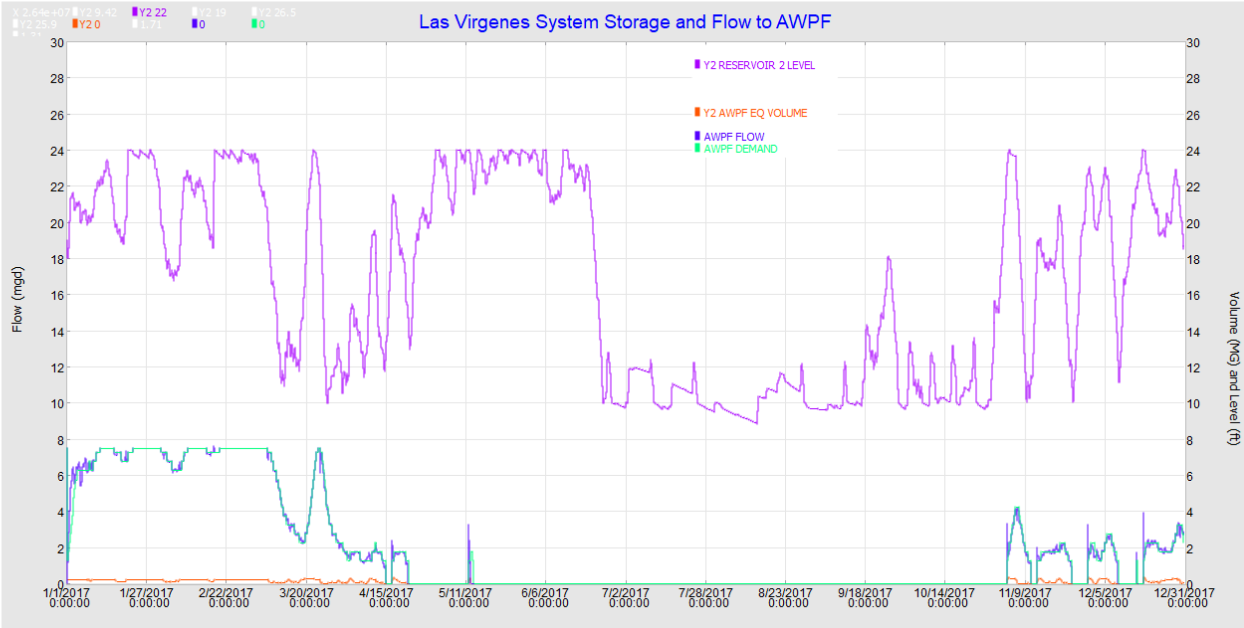


Figure E-5. Recycled Water System Simulated Operations with Variable Speed Pumps Impact and Reduced I&I Flow on Advanced Water Purification Facility Flow for 2017

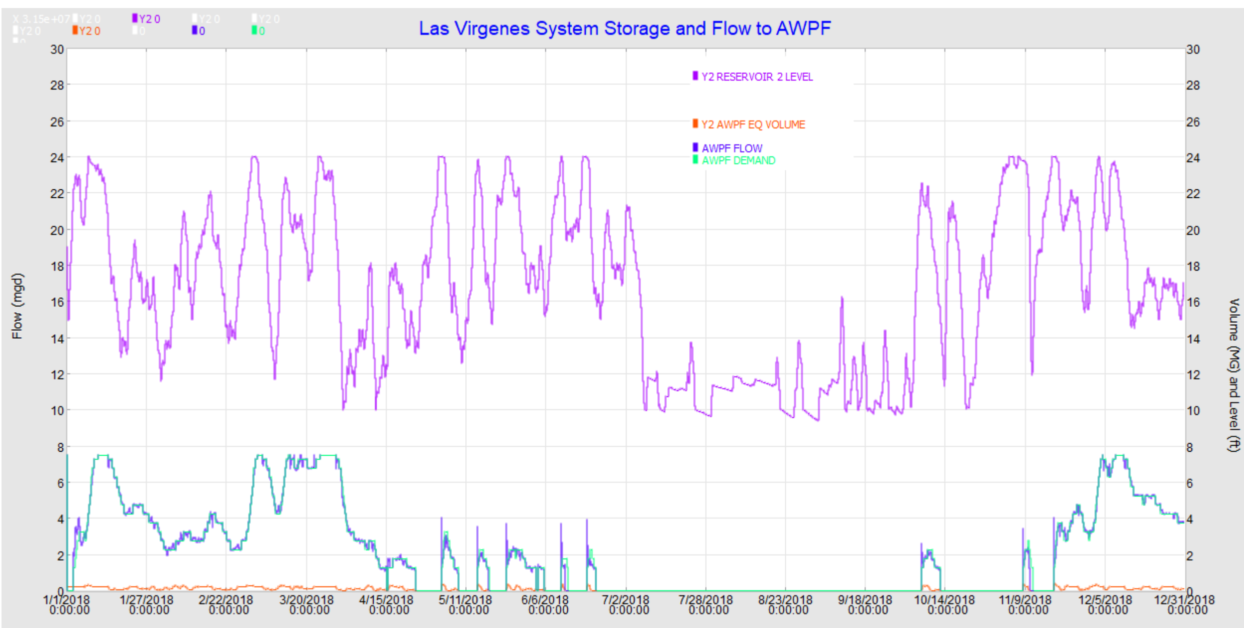


Figure E-6. Recycled Water System Simulated Operations with Variable Speed Pumps Impact and Reduced I&I Flow on Advanced Water Purification Facility Flow for 2018

Appendix F
Tapia Water Reclamation Facility Equalization Cost Estimate

SUMMARY REPORT

Project type:
Job Size:
Duration:

Project Name: Tapia WRF EQ and Pumping Alt Selection Rev 0
Project Number: W9Y31200
Design Stage: 5% to 10%

Estimator: Nick Cavalleri/RDD
Revision/Date: 0 / Aug 9, 2022
Estimate Class: 5

Area	Facility	Work Pkg	Description	Takeoff Quantity	Labor Cost/Unit	Equip Cost/Unit	Material Cost/Unit	Sub Cost/Unit	Direct Total Cost/Unit	Direct Total	Grand Total Price	Grand Total with Markups
01			***Option 1: Retrofit Existing Concrete Tanks***									
	01		**EQ Pump Station**									
		02.0	*Existing Conditions*	1.00 LS	9,256.48 /LS	1,400.00 /LS	15,000.00 /LS	/LS	25,656.48 /LS	25,656	57,270.00 /LS	57,270
		03.0	*Concrete*	1.00 CY	/CY	/CY	/CY	220,400.00 /CY	220,400.00 /CY	220,400	463,929.74 /CY	463,930
		05.0	*Metals*	1.00 LS	7,908.91 /LS	334.46 /LS	10,000.00 /LS	/LS	18,243.37 /LS	18,243	41,766.60 /LS	41,767
		08.0	*Openings*	5.00 EA	522.92 /EA	/EA	3,500.00 /EA	/EA	4,022.92 /EA	20,115	8,953.74 /EA	44,769
		09.0	*Finishes*	1.00 LS	4,782.48 /LS	600.00 /LS	5,000.00 /LS	/LS	10,382.48 /LS	10,382	23,906.62 /LS	23,907
		26.0	*Electrical Work*	1.00 LS	39,670.98 /LS	3,000.00 /LS	64,625.00 /LS	/LS	107,295.98 /LS	107,296	249,858.86 /LS	249,859
		40.0	*Process Pipe*	1.00 LS	/LS	/LS	/LS	350,000.00 /LS	350,000.00 /LS	350,000	666,730.57 /LS	666,731
		40.9	*Instrumentation & Controls*	1.00 LS	15,067.78 /LS	1,600.00 /LS	15,000.00 /LS	/LS	31,667.78 /LS	31,668	72,334.21 /LS	72,334
		46.0	*Water and Wastewater Equipment*	5.00 EA	4,792.21 /EA	/EA	32,415.00 /EA	/EA	37,207.21 /EA	186,036	75,361.20 /EA	376,806
			01 EQ Pump Station	**1.00 LS**	**103,262.28 /LS**	**6,934.46 /LS**	**289,200.00 /LS**	**570,400.00 /LS**	**969,796.74 /LS**	**969,797**	**1,997,371.34 /LS**	**1,997,371**
	03		**Yard Piping**									
		33.0	*Yard Piping*	360.00 LF	/LF	/LF	/LF	350.00 /LF	350.00 /LF	126,000	736.73 /LF	265,223
			03 Yard Piping	**1.00 LS**	**/LS**	**/LS**	**/LS**	**126,000.00 /LS**	**126,000.00 /LS**	**126,000**	**265,222.98 /LS**	**265,223**
	04		**Sitework**									
		02.0	*Existing Conditions*	1.00 LS	4,456.61 /LS	1,800.00 /LS	5,000.00 /LS	/LS	11,256.61 /LS	11,257	25,439.90 /LS	25,440
		32.0	*Exterior Improvements*	1.00 LS	14,855.36 /LS	3,539.52 /LS	15,000.00 /LS	/LS	33,394.88 /LS	33,395	75,439.33 /LS	75,439
			04 Sitework	**2.00 LS**	**9,655.99 /LS**	**2,669.76 /LS**	**10,000.00 /LS**	**/LS**	**22,325.74 /LS**	**44,651**	**50,439.61 /LS**	**100,879**
	05		**Primary Effluent Equalization**									
		02.0	*Existing Conditions*	1.00 LS	37,025.92 /LS	5,600.00 /LS	40,000.00 /LS	/LS	82,625.92 /LS	82,626	186,081.07 /LS	186,081
		03.0	*Concrete*	1.00 CY	42,764.35 /CY	7,799.99 /CY	52,320.00 /CY	/CY	102,884.34 /CY	102,884	236,351.59 /CY	236,352
		05.0	*Metals*	1.00 LS	92,955.28 /LS	29,786.09 /LS	181,960.00 /LS	/LS	304,701.37 /LS	304,701	694,628.87 /LS	694,629
		09.0	*Finishes*	1.00 LS	38,259.84 /LS	4,800.00 /LS	60,000.00 /LS	/LS	103,059.84 /LS	103,060	235,251.79 /LS	235,252
		26.0	*Electrical Work*	1.00 LS	18,834.72 /LS	2,000.00 /LS	25,000.00 /LS	/LS	45,834.72 /LS	45,835	107,250.84 /LS	107,251
		40.0	*Process Pipe*	1.00 LS	37,639.04 /LS	10,400.00 /LS	75,000.00 /LS	/LS	123,039.04 /LS	123,039	255,582.97 /LS	255,583
		40.9	*Instrumentation & Controls*	1.00 LS	6,278.24 /LS	1,000.00 /LS	10,000.00 /LS	/LS	17,278.24 /LS	17,278	39,106.69 /LS	39,107
		46.0	*Water and Wastewater Equipment*	1.00 EA	75,278.08 /EA	14,400.00 /EA	150,000.00 /EA	/EA	239,678.08 /EA	239,678	497,099.11 /EA	497,099
			05 Primary Effluent Equalization	**1.00 LS**	**349,035.47 /LS**	**75,786.08 /LS**	**594,280.00 /LS**	**/LS**	**1,019,101.55 /LS**	**1,019,102**	**2,251,352.93 /LS**	**2,251,353**
			01 Option 1: Retrofit Existing Concrete Tanks	***1.00 LS***	***471,609.72 /LS***	***88,060.06 /LS***	***903,480.00 /LS***	***696,400.00 /LS***	***2,159,549.78 /LS***	***2,159,550***	***4,614,826.48 /LS***	***4,614,826***

Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	1,102,737		6,541.502 hrs	
Material	1,910,422			
Subcontract	1,395,883			
Equipment	205,784		1,792.000 hrs	
Subtotal W/ Contingency	**4,614,826**	**4,614,826**		
Non Markup Items				
Total Construction Cost		**4,614,826**		

Jacobs

DETAIL REPORT

Project type:
Job Size:
Duration:

Project Name: Tapia WRF EQ and Pumping Alt Selection Rev 0
Project Number: W9Y31200
Design Stage: 5% to 10%

Estimator: Nick Cavalleri/RDD
Revision/Date: 0 / Aug 9, 2022
Estimate Class: 5

Area	Facility	Work Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Cost/Unit	Equip Cost/Unit	Material Cost/Unit	Sub Cost/Unit	Other Cost/Unit	Direct Total Cost/Unit	Direct Total	Grand Total Price	Grand Total with Markups
01					***Option 1: Retrofit Existing Concrete Tanks***										
	01				**EQ Pump Station**										
		02.0			*Existing Conditions*										
			02.90.000		*Pump Station Concrete*										
				02.90.00.00	*Existing Conditions, Other*										
					Clean and Prepare Existing Aerobic Digester for Pump Station Construction	1.00 LS	9,256.48 /LS	1,400.00 /LS	15,000.00 /LS	-	-	25,656.48 /LS	25,656	57,270.00 /LS	57,270
					02.90.00.00 Existing Conditions, Other	*1.00 LS*	*9,256.48 /LS*	*1,400.00 /LS*	*15,000.00 /LS*	*/LS*	*/LS*	*25,656.48 /LS*	*25,656*	*57,270.00 /LS*	*57,270*
					02.90.000 Pump Station Concrete	*1.00 LS*	*9,256.48 /LS*	*1,400.00 /LS*	*15,000.00 /LS*	*/LS*	*/LS*	*25,656.48 /LS*	*25,656*	*57,270.00 /LS*	*57,270*
					02.0 Existing Conditions	*1.00 LS*	*9,256.48 /LS*	*1,400.00 /LS*	*15,000.00 /LS*	*/LS*	*/LS*	*25,656.48 /LS*	*25,656*	*57,270.00 /LS*	*57,270*
		03.0			*Concrete*										
			03.00.010		*Pump Station Concrete*										
				03.00.99.00	*Concrete, Other*										
					Pump Station Structural Concrete Allowance	290.00 CY		-		760.00 /CY	-	760.00 /CY	220,400	1,599.76 /CY	463,930
					03.00.99.00 Concrete, Other	*290.00 CY*	*/CY*	*/CY*	*/CY*	*760.00 /CY*	*/CY*	*760.00 /CY*	*220,400*	*1,599.76 /CY*	*463,930*
					03.00.010 Pump Station Concrete	*290.00 CY*	*/CY*	*/CY*	*/CY*	*760.00 /CY*	*/CY*	*760.00 /CY*	*220,400*	*1,599.76 /CY*	*463,930*
					03.0 Concrete	***1.00** CY*	*/CY*	*/CY*	*/CY*	*220,400.00 /CY*	*/CY*	*220,400.00 /CY*	*220,400*	*463,929.74 /CY*	*463,930*
		05.0			*Metals*										
			05.00.000		*Pump Station Metals*										
				05.00.99.00	*Metals, Other*										
					Pump Station Metals Allowance	1.00 LS	7,908.91 /LS	334.46 /LS	10,000.00 /LS	-	-	18,243.37 /LS	18,243	41,766.60 /LS	41,767
					05.00.99.00 Metals, Other	*1.00 LS*	*7,908.91 /LS*	*334.46 /LS*	*10,000.00 /LS*	*/LS*	*/LS*	*18,243.37 /LS*	*18,243*	*41,766.60 /LS*	*41,767*
					05.00.000 Pump Station Metals	*1.00 LS*	*7,908.91 /LS*	*334.46 /LS*	*10,000.00 /LS*	*/LS*	*/LS*	*18,243.37 /LS*	*18,243*	*41,766.60 /LS*	*41,767*
					05.0 Metals	*1.00 LS*	*7,908.91 /LS*	*334.46 /LS*	*10,000.00 /LS*	*/LS*	*/LS*	*18,243.37 /LS*	*18,243*	*41,766.60 /LS*	*41,767*
		08.0			*Openings*										
			08.00.000		*Pump Station Pump Access Hatch*										
				08.30.01.10	*Specialty Doors and Frames, Access Doors*										
					Doors, specialty, access, floor, industrial, aluminum, double leaf, 4' x 4'	5.00 EA	522.92 /EA	-	3,500.00 /EA	-	-	4,022.92 /EA	20,115	8,953.74 /EA	44,769
					08.30.01.10 Specialty Doors and Frames, Access Doors	*5.00 EA*	*522.92 /EA*	*/EA*	*3,500.00 /EA*	*/EA*	*/EA*	*4,022.92 /EA*	*20,115*	*8,953.74 /EA*	*44,769*
					08.00.000 Pump Station Pump Access Hatch	*5.00 EA*	*522.92 /EA*	*/EA*	*3,500.00 /EA*	*/EA*	*/EA*	*4,022.92 /EA*	*20,115*	*8,953.74 /EA*	*44,769*
					08.0 Openings	*5.00 EA*	*522.92 /EA*	*/EA*	*3,500.00 /EA*	*/EA*	*/EA*	*4,022.92 /EA*	*20,115*	*8,953.74 /EA*	*44,769*
		09.0			*Finishes*										
			09.00.000		*Pump Station Paintings and Coatings*										
				09.00.99.00	*Finishes, Other*										
					Paintings and Coatings Allowance	1.00 LS	4,782.48 /LS	600.00 /LS	5,000.00 /LS	-	-	10,382.48 /LS	10,382	23,906.62 /LS	23,907
					09.00.99.00 Finishes, Other	*1.00 LS*	*4,782.48 /LS*	*600.00 /LS*	*5,000.00 /LS*	*/LS*	*/LS*	*10,382.48 /LS*	*10,382*	*23,906.62 /LS*	*23,907*
					09.00.000 Pump Station Paintings and Coatings	*1.00 LS*	*4,782.48 /LS*	*600.00 /LS*	*5,000.00 /LS*	*/LS*	*/LS*	*10,382.48 /LS*	*10,382*	*23,906.62 /LS*	*23,907*
					09.0 Finishes	*1.00 LS*	*4,782.48 /LS*	*600.00 /LS*	*5,000.00 /LS*	*/LS*	*/LS*	*10,382.48 /LS*	*10,382*	*23,906.62 /LS*	*23,907*
		26.0			*Electrical Work*										
			26.00.000		*Pump Station Electrical*										
				26.00.99.00	*Electrical, Other*										
					Pump Station Electrical Fitout Allowance	1.00 LS	28,252.08 /LS	3,000.00 /LS	35,000.00 /LS	-	-	66,252.08 /LS	66,252	155,251.42 /LS	155,251
					Variable frequency drives, custom-engineered, 460 volt, 15 HP motor size	3.00 ea	2,025.24 /ea	-	4,925.00 /ea	-	-	6,950.24 /ea	20,851	16,038.65 /ea	48,116
					Variable frequency drives, custom-engineered, 460 volt, 35 HP motor size	2.00 ea	2,671.59 /ea	-	7,425.00 /ea	-	-	10,096.59 /ea	20,193	23,245.74 /ea	46,491
					26.00.99.00 Electrical, Other	*1.00 LS*	*39,670.98 /LS*	*3,000.00 /LS*	*64,625.00 /LS*	*/LS*	*/LS*	*107,295.98 /LS*	*107,296*	*249,858.86 /LS*	*249,859*
					26.00.000 Pump Station Electrical	*1.00 LS*	*39,670.98 /LS*	*3,000.00 /LS*	*64,625.00 /LS*	*/LS*	*/LS*	*107,295.98 /LS*	*107,296*	*249,858.86 /LS*	*249,859*
					26.0 Electrical Work	*1.00 LS*	*39,670.98 /LS*	*3,000.00 /LS*	*64,625.00 /LS*	*/LS*	*/LS*	*107,295.98 /LS*	*107,296*	*249,858.86 /LS*	*249,859*
		40.0			*Process Pipe*										
			40.00.000		*Pump Station Process Piping*										
				40.00.99.01	*Process Pipe, Other*										
					Process Piping and Valving Allowance	1.00 LS		-		350,000.00 /LS	-	350,000.00 /LS	350,000	666,730.57 /LS	666,731
					40.00.99.01 Process Pipe, Other	*1.00 LS*	*/LS*	*/LS*	*/LS*	*350,000.00 /LS*	*/LS*	*350,000.00 /LS*	*350,000*	*666,730.57 /LS*	*666,731*
					40.00.000 Pump Station Process Piping	*1.00 LS*	*/LS*	*/LS*	*/LS*	*350,000.00 /LS*	*/LS*	*350,000.00 /LS*	*350,000*	*666,730.57 /LS*	*666,731*
					40.0 Process Pipe	*1.00 LS*	*/LS*	*/LS*	*/LS*	*350,000.00 /LS*	*/LS*	*350,000.00 /LS*	*350,000*	*666,730.57 /LS*	*666,731*
		40.9			*Instrumentation & Controls*										
			40.90.000		*Pump Station I&C*										
				40.90.99.01	*I&C, Other*										
					Pump Station I&C Allowance	1.00 LS	15,067.78 /LS	1,600.00 /LS	15,000.00 /LS	-	-	31,667.78 /LS	31,668	72,334.21 /LS	72,334
					40.90.99.01 I&C, Other	*1.00 LS*	*15,067.78 /LS*	*1,600.00 /LS*	*15,000.00 /LS*	*/LS*	*/LS*	*31,667.78 /LS*	*31,668*	*72,334.21 /LS*	*72,334*
					40.90.000 Pump Station I&C	*1.00 LS*	*15,067.78 /LS*	*1,600.00 /LS*	*15,000.00 /LS*	*/LS*	*/LS*	*31,667.78 /LS*	*31,668*	*72,334.21 /LS*	*72,334*
					40.9 Instrumentation & Controls	*1.00 LS*	*15,067.78 /LS*	*1,600.00 /LS*	*15,000.00 /LS*	*/LS*	*/LS*	*31,667.78 /LS*	*31,668*	*72,334.21 /LS*	*72,334*
		46.0			*Water and Wastewater Equipment*										
			44.00.000		*Pump Station Submersible Pumps, Large*										
				44.05.49.02	*Submersible Pump: 21hp-50hp*										
					Functional Testing, Submersible Pumps, 21 - 50 hp	2.00 ea	263.31 /ea	-	50.00 /ea	-	-	313.31 /ea	627	678.73 /ea	1,357
					Sleeved anchor bolts - Medium	16.00 ea	23.04 /ea	-	21.00 /ea	-	-	44.04 /ea	705	92.64 /ea	1,482
					Non-Shrink Machine Grout	16.00 cuft	62.54 /cuft	-	74.00 /cuft	-	-	136.54 /cuft	2,185	285.45 /cuft	4,567
					Grease, Oil, and Lube Pumps, 21-50 hp	2.00 ea	131.66 /ea	-	75.00 /ea	-	-	206.66 /ea	413	439.36 /ea	879
					FURNISH Submersible Pump, 35 hp Quotye Price plus 20% Contingency	2.00 EA	-	-	42,250.00 /EA	-	-	42,250.00 /EA	84,500	84,497.66 /EA	168,995
					Set pump assembly, 21 - 50 hp	2.00 ea	2,369.77 /ea	-	50.00 /ea	-	-	2,419.77 /ea	4,840	5,308.61 /ea	10,617
					44.05.49.02 Submersible Pump: 21hp-50hp	*2.00 EA*	*3,449.34 /EA*	*/EA*	*43,185.00 /EA*	*/EA*	*/EA*	*46,634.33 /EA*	*93,269*	*93,949.04 /EA*	*187,898*
					44.00.000 Pump Station Submersible Pumps, Large	*2.00 EA*	*3,449.34 /EA*	*/EA*	*43,185.00 /EA*	*/EA*	*/EA*	*46,634.33 /EA*	*93,269*	*93,949.04 /EA*	*187,898*
			44.00.002		*Pump Station Submersible Pumps, Small*										
				44.05.49.01	*Submersible Pump: 6hp-20hp*										
					Functional Testing, Submersible Pumps, 101 - 250 hp	3.00 ea	526.62 /ea	-	100.00 /ea	-	-	626.62 /ea	1,880	1,357.46 /ea	4,072
					Sleeved anchor bolts - Medium	24.00 ea	23.04 /ea	-	21.00 /ea	-	-	44.04 /ea	1,057	92.64 /ea	2,223
					Non-Shrink Machine Grout	24.00 cuft	62.54 /cuft	-	74.00 /cuft	-	-	136.54 /cuft	3,277	285.45 /cuft	6,851
					Grease, Oil, and Lube Pumps, 101-250 hp	3.00 ea	263.31 /ea	-	75.00 /ea	-	-	338.31 /ea	1,015	728.72 /ea	2,186
					FURNISH Submersible Pump, 14 hp Quotye Price plus 20% Contingency	3.00 EA	-	-	24,200.00 /EA	-	-	24,200.00 /EA	72,600	48,398.66 /EA	145,196
					Set pump assembly, 101 - 250 hp	3.00 ea	4,212.93 /ea	-	100.00 /ea	-	-	4,312.93 /ea	12,939	9,459.78 /ea	28,379
					44.05.49.01 Submersible Pump: 6hp-20hp	*3.00 EA*	*5,687.45 /EA*	*/EA*	*25,235.00 /EA*	*/EA*	*/EA*	*30,922.45 /EA*	*92,767*	*62,969.31 /EA*	*188,908*
					44.00.002 Pump Station Submersible Pumps, Small	*3.00 EA*	*5,687.45 /EA*	*/EA*	*25,235.00 /EA*	*/EA*	*/EA*	*30,922.45 /EA*	*92,767*	*62,969.31 /EA*	*188,908*
					46.0 Water and Wastewater Equipment	*5.00 EA*	*4,792.21 /EA*	*/EA*	*32,415.00 /EA*	*/EA*	*/EA*	*37,207.21 /EA*	*186,036*	*75,361.20 /EA*	*376,806*
					01 EQ Pump Station	**1.00 LS**	**103,262.28 /LS**	**6,934.46 /LS**	**289,200.00 /LS**	**570,400.00 /LS**	**/LS**	**969,796.74 /LS**	**969,797**	**1,997,371.34 /LS**	**1,997,371**
	03				**Yard Piping**										
		33.0			*Yard Piping*										
			33.00.010		*Yard Piping*										
				40.00.99.01	*Process Pipe, Other*										
					Yard Piping Allowance	360.00 LF		-		350.00 /LF	-	350.00 /LF	126,000	736.73 /LF	265,223
					40.00.99.01 Process Pipe, Other	***1.00** LS*	*/LS*	*/LS*	*/LS*	*126,000.00 /LS*	*/LS*	*126,000.00 /LS*	*126,000*	*265,222.98 /LS*	*265,223*
					33.00.010 Yard Piping	*360.00 LF*	*/LF*	*/LF*	*/LF*	*350.00 /LF*	*/LF*	*350.00 /LF*	*126,000*	*736.73 /LF*	*265,223*
					33.0 Yard Piping	*360.00 LF*	*/LF*	*/LF*	*/LF*	*350.00 /LF*	*/LF*	*350.00 /LF*	*126,000*	*736.73 /LF*	*265,223*
					03 Yard Piping	**1.00 LS**	**/LS**	**/LS**	**/LS**	**126,000.00 /LS**	**/LS**	**126,000.00 /LS**	**126,000**	**265,222.98 /LS**	**265,223**
	04				**Sitework**										
		02.0			*Existing Conditions*										
			02.00.000		*Demolition*										
				02.01.01.00	*General Site Demolition*										
					Site Demolitions and Preperation for Construction of Yard Piping and Sitework	1.00 LS	4,456.61 /LS	1,800.00 /LS	5,000.00 /LS	-	-	11,256.61 /LS	11,257	25,439.90 /LS	25,440

DETAIL REPORT

Project type:
Job Size:
Duration:

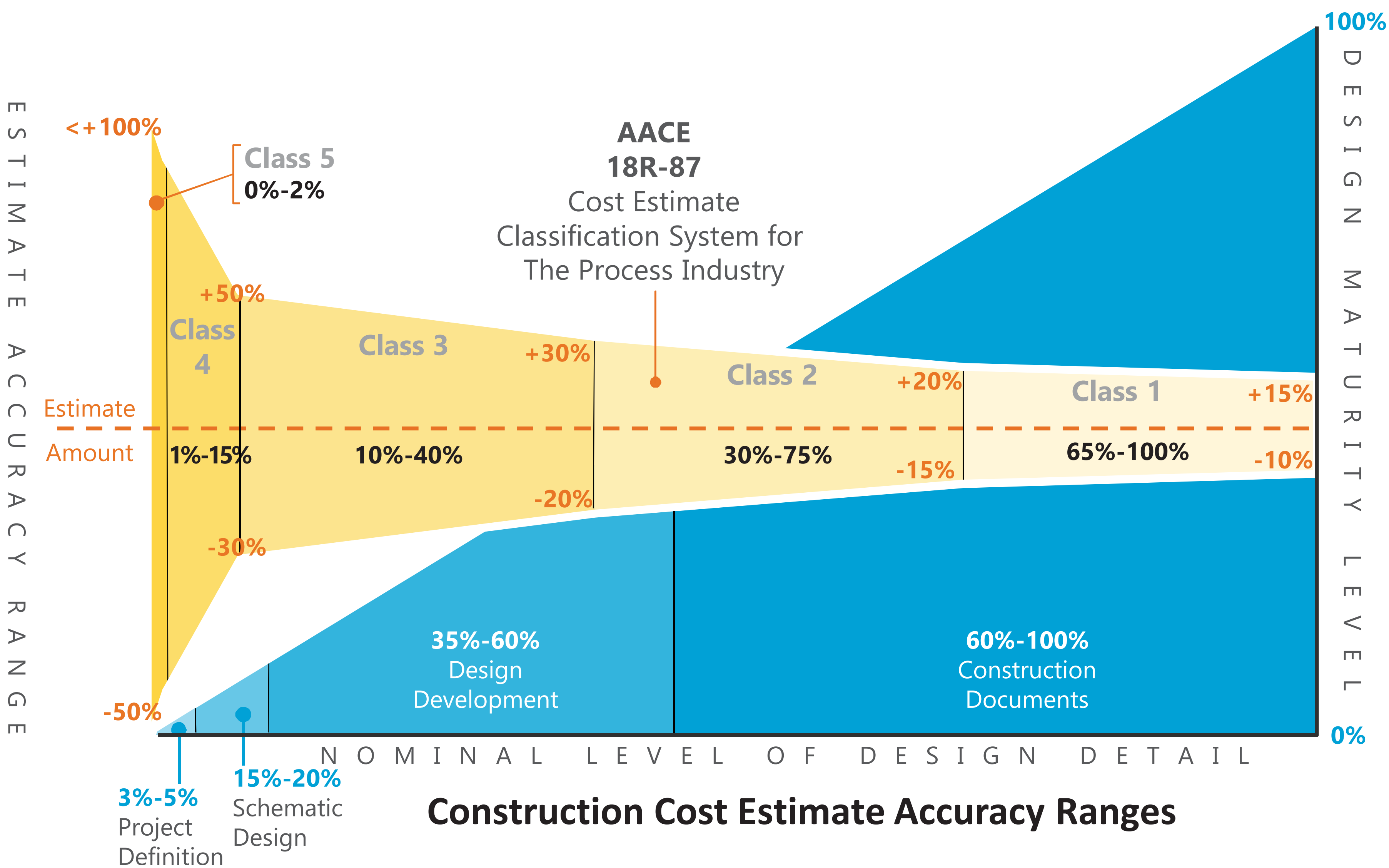
Project Name: Tapia WRF EQ and Pumping Alt Selection Rev 0
Project Number: W9Y31200
Design Stage: 5% to 10%

Estimator: Nick Cavalleri/RDD
Revision/Date: 0 / Aug 9, 2022
Estimate Class: 5

Area	Facility	Work Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Cost/Unit	Equip Cost/Unit	Material Cost/Unit	Sub Cost/Unit	Other Cost/Unit	Direct Total Cost/Unit	Direct Total	Grand Total Price	Grand Total with Markups
					02.01.01.00 General Site Demolition	1.00 LS	4,456.61 /LS	1,800.00 /LS	5,000.00 /LS	/LS	/LS	11,256.61 /LS	11,257	25,439.90 /LS	25,440
					02.00.000 Demolition	1.00 LS	4,456.61 /LS	1,800.00 /LS	5,000.00 /LS	/LS	/LS	11,256.61 /LS	11,257	25,439.90 /LS	25,440
					02.0 Existing Conditions	1.00 LS	4,456.61 /LS	1,800.00 /LS	5,000.00 /LS	/LS	/LS	11,256.61 /LS	11,257	25,439.90 /LS	25,440
		32.0			Exterior Improvements										
			32.50.000		Site Improvements and Surface Restorations										
				32.50.06.00	Site Improvements, Other										
					Surface Restorations and Site Improvements Allowance	1.00 LS	14,855.36 /LS	3,539.52 /LS	15,000.00 /LS	-	-	33,394.88 /LS	33,395	75,439.33 /LS	75,439
					32.50.06.00 Site Improvements, Other	1.00 LS	14,855.36 /LS	3,539.52 /LS	15,000.00 /LS	/LS	/LS	33,394.88 /LS	33,395	75,439.33 /LS	75,439
					32.50.000 Site Improvements and Surface Restorations	1.00 LS	14,855.36 /LS	3,539.52 /LS	15,000.00 /LS	/LS	/LS	33,394.88 /LS	33,395	75,439.33 /LS	75,439
					32.0 Exterior Improvements	1.00 LS	14,855.36 /LS	3,539.52 /LS	15,000.00 /LS	/LS	/LS	33,394.88 /LS	33,395	75,439.33 /LS	75,439
					04 Sitework	**2.00 LS**	**9,655.99 /LS**	**2,669.76 /LS**	**10,000.00 /LS**	**/LS**	**/LS**	**22,325.74 /LS**	**44,651**	**50,439.61 /LS**	**100,879**
	05				**Primary Effluent Equalization**										
		02.0			Existing Conditions										
			02.90.002		Prepare Existing Aerobic Digester for Modification										
				02.90.00.00	Existing Conditions, Other										
					Clean and Prepare Existing Aerobic Digester for Tank Construction	1.00 LS	37,025.92 /LS	5,600.00 /LS	40,000.00 /LS	-	-	82,625.92 /LS	82,626	186,081.07 /LS	186,081
					02.90.00.00 Existing Conditions, Other	1.00 LS	37,025.92 /LS	5,600.00 /LS	40,000.00 /LS	/LS	/LS	82,625.92 /LS	82,626	186,081.07 /LS	186,081
					02.90.002 Prepare Existing Aerobic Digester for Modification	1.00 LS	37,025.92 /LS	5,600.00 /LS	40,000.00 /LS	/LS	/LS	82,625.92 /LS	82,626	186,081.07 /LS	186,081
					02.0 Existing Conditions	1.00 LS	37,025.92 /LS	5,600.00 /LS	40,000.00 /LS	/LS	/LS	82,625.92 /LS	82,626	186,081.07 /LS	186,081
		03.0			Concrete										
			03.90.000		Existing Concrete Patching and Crack Injection										
				03.00.99.02	Concrete, Other										
					Concrete Patching and Crack Injection	3,488.00 SF	12.26 /SF	2.24 /SF	15.00 /SF	-	-	29.50 /SF	102,884	67.76 /SF	236,352
					03.00.99.02 Concrete, Other	3,488.00 SF	12.26 /SF	2.24 /SF	15.00 /SF	/SF	/SF	29.50 /SF	102,884	67.76 /SF	236,352
					03.90.000 Existing Concrete Patching and Crack Injection	3,488.00 SF	12.26 /SF	2.24 /SF	15.00 /SF	/SF	/SF	29.50 /SF	102,884	67.76 /SF	236,352
					03.0 Concrete	**1.00** CY	42,764.35 /CY	7,799.99 /CY	52,320.00 /CY	/CY	/CY	102,884.34 /CY	102,884	236,351.59 /CY	236,352
		05.0			Metals										
			05.90.000		Metal Cover										
				05.00.99.00	Metals, Other										
					Metal Cover Allowance	3,488.00 SF	19.09 /SF	8.22 /SF	45.00 /SF	-	-	72.31 /SF	252,223	164.49 /SF	573,740
					Miscellaneous Metal Allowance	1.00 ls	26,363.04 /ls	1,114.88 /ls	25,000.00 /ls	-	-	52,477.92 /ls	52,478	120,889.13 /ls	120,889
					05.00.99.00 Metals, Other	**1.00** LS	92,955.28 /LS	29,786.09 /LS	181,960.00 /LS	/LS	/LS	304,701.37 /LS	304,701	694,628.87 /LS	694,629
					05.90.000 Metal Cover	3,488.00 SF	26.65 /SF	8.54 /SF	52.17 /SF	/SF	/SF	87.36 /SF	304,701	199.15 /SF	694,629
					05.0 Metals	**1.00** LS	92,955.28 /LS	29,786.09 /LS	181,960.00 /LS	/LS	/LS	304,701.37 /LS	304,701	694,628.87 /LS	694,629
		09.0			Finishes										
			09.00.002		Primary Effluent Equalization Paintings and Coatings										
				09.00.99.00	Finishes, Other										
					Paintings and Coatings Allowance	1.00 LS	38,259.84 /LS	4,800.00 /LS	60,000.00 /LS	-	-	103,059.84 /LS	103,060	235,251.79 /LS	235,252
					09.00.99.00 Finishes, Other	1.00 LS	38,259.84 /LS	4,800.00 /LS	60,000.00 /LS	/LS	/LS	103,059.84 /LS	103,060	235,251.79 /LS	235,252
					09.00.002 Primary Effluent Equalization Paintings and Coatings	1.00 LS	38,259.84 /LS	4,800.00 /LS	60,000.00 /LS	/LS	/LS	103,059.84 /LS	103,060	235,251.79 /LS	235,252
					09.0 Finishes	1.00 LS	38,259.84 /LS	4,800.00 /LS	60,000.00 /LS	/LS	/LS	103,059.84 /LS	103,060	235,251.79 /LS	235,252
		26.0			Electrical Work										
			26.00.004		Electrical										
				26.00.99.00	Electrical, Other										
					Electrical Fitout Allowance	1.00 LS	18,834.72 /LS	2,000.00 /LS	25,000.00 /LS	-	-	45,834.72 /LS	45,835	107,250.84 /LS	107,251
					26.00.99.00 Electrical, Other	1.00 LS	18,834.72 /LS	2,000.00 /LS	25,000.00 /LS	/LS	/LS	45,834.72 /LS	45,835	107,250.84 /LS	107,251
					26.00.004 Electrical	1.00 LS	18,834.72 /LS	2,000.00 /LS	25,000.00 /LS	/LS	/LS	45,834.72 /LS	45,835	107,250.84 /LS	107,251
					26.0 Electrical Work	1.00 LS	18,834.72 /LS	2,000.00 /LS	25,000.00 /LS	/LS	/LS	45,834.72 /LS	45,835	107,250.84 /LS	107,251
		40.0			Process Pipe										
			40.00.002		Primary Effluent Equalization Process Piping										
				40.00.99.01	Process Pipe, Other										
					Process Piping, Valves, Gates and Appurtenances Allowance	1.00 LS	37,639.04 /LS	10,400.00 /LS	75,000.00 /LS	-	-	123,039.04 /LS	123,039	255,582.97 /LS	255,583
					40.00.99.01 Process Pipe, Other	1.00 LS	37,639.04 /LS	10,400.00 /LS	75,000.00 /LS	/LS	/LS	123,039.04 /LS	123,039	255,582.97 /LS	255,583
					40.00.002 Primary Effluent Equalization Process Piping	1.00 LS	37,639.04 /LS	10,400.00 /LS	75,000.00 /LS	/LS	/LS	123,039.04 /LS	123,039	255,582.97 /LS	255,583
					40.0 Process Pipe	1.00 LS	37,639.04 /LS	10,400.00 /LS	75,000.00 /LS	/LS	/LS	123,039.04 /LS	123,039	255,582.97 /LS	255,583
		40.9			Instrumentation & Controls										
			40.90.002		I&C										
				40.90.99.01	I&C, Other										
					I&C Allowance	1.00 LS	6,278.24 /LS	1,000.00 /LS	10,000.00 /LS	-	-	17,278.24 /LS	17,278	39,106.69 /LS	39,107
					40.90.99.01 I&C, Other	1.00 LS	6,278.24 /LS	1,000.00 /LS	10,000.00 /LS	/LS	/LS	17,278.24 /LS	17,278	39,106.69 /LS	39,107
					40.90.002 I&C	1.00 LS	6,278.24 /LS	1,000.00 /LS	10,000.00 /LS	/LS	/LS	17,278.24 /LS	17,278	39,106.69 /LS	39,107
					40.9 Instrumentation & Controls	1.00 LS	6,278.24 /LS	1,000.00 /LS	10,000.00 /LS	/LS	/LS	17,278.24 /LS	17,278	39,106.69 /LS	39,107
		46.0			Water and Wastewater Equipment										
			44.00.004		Odor Control										
				44.05.04.00	Odor Control Equipment										
					Odor Control System Allowance	1.00 LS	75,278.08 /LS	14,400.00 /LS	150,000.00 /LS	-	-	239,678.08 /LS	239,678	497,099.11 /LS	497,099
					44.05.04.00 Odor Control Equipment	**1.00** EA	75,278.08 /EA	14,400.00 /EA	150,000.00 /EA	/EA	/EA	239,678.08 /EA	239,678	497,099.11 /EA	497,099
					44.00.004 Odor Control	1.00 LS	75,278.08 /LS	14,400.00 /LS	150,000.00 /LS	/LS	/LS	239,678.08 /LS	239,678	497,099.11 /LS	497,099
					46.0 Water and Wastewater Equipment	**1.00** EA	75,278.08 /EA	14,400.00 /EA	150,000.00 /EA	/EA	/EA	239,678.08 /EA	239,678	497,099.11 /EA	497,099
					05 Primary Effluent Equalization	**1.00 LS**	**349,035.47 /LS**	**75,786.08 /LS**	**594,280.00 /LS**	**/LS**	**/LS**	**1,019,101.55 /LS**	**1,019,102**	**2,251,352.93 /LS**	**2,251,353**
					01 Option 1: Retrofit Existing Concrete Tanks	***1.00 LS***	***471,609.72 /LS***	***88,060.06 /LS***	***903,480.00 /LS***	***696,400.00 /LS***	***/LS***	***2,159,549.78 /LS***	***2,159,550***	***4,614,826.48 /LS***	***4,614,826***

Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	471,610		6,541.502 hrs	
Material	903,480			
Subcontract	696,400			
Equipment	88,060		1,792.000 hrs	
Subtotal Direct Costs	**2,159,550**	**2,159,550**		
Material Sales Tax Agoura Hills Ca	85,831			9.500 %
Subtotal W/ Sales Tax	**85,831**	**2,245,381**		
Location Adj. Factor	163,983			29.300 %
Subtotal W/ Adj. Factors	**163,983**	**2,409,364**		
Existing Conditions I,OH&P	17,931			15.000 %
Concrete Work I,OH&P	64,657			20.000 %
Metals Work I,OH&P	64,589			20.000 %
Architectural (Div 6-12)I,OH&P	26,711			20.000 %
Electrical Work I,OH&P	38,283			25.000 %
Site/Civil I,OH&P	5,009			15.000 %
Buried Piping I,OH&P	25,200			20.000 %
Instruments & Controls I,OH&P	8,810			18.000 %
Subtotal W/ Subcontractor OH&P	**251,190**	**2,660,554**		
General Conditions	319,266			12.000 %
Subtotal W/ General Conditions	**319,266**	**2,979,820**		
Mobilization/Demobilization	119,193			4.000 %
Prime Contractor Overhead	309,901			10.000 %
Prime Contractor Profit	204,535			6.000 %
Bonds & Insurance	78,412			2.170 %
Subtotal W/ Prime Markups	**712,041**	**3,691,861**		
Contingency	922,965			25.000 %
Subtotal W/ Contingency	**922,965**	**4,614,826**		
Non Markup Items				
Subtotal W/ Non Markup Items		**4,614,826**		
Total Construction Cost		**4,614,826**		



Construction Cost Estimate Accuracy Ranges

Estimate Class	Class 5	Class 4	Class 3	Class 2	Class 1
LEVEL OF PROJECT DEFINITION Expressed as a % of complete definition	0% to 2%	1% to 15%	10% to 40%	30% to 70%	50% to 100%
END USAGE Typical Purpose of Estimate	Concept Screening	Study or Feasibility	Budget Authorization, or Control	Control or Bid / Tender	Check Estimate or Bid / Tender
METHODOLOGY Typical estimating method	Capacity Factored, Parametric Models, Judgment, or Analogy	Equipment Factored or Parametric Models	Semi-Detailed Unit Costs with Assembly Level Line Items	Detailed Unit Cost with Forced Detailed Take-Off	Detailed Unit Cost with Detailed Take-Off
EXPECTED ACCURACY RANGE Typical variation in low and high ranges [a]	L: -20% to -50% H: +30% to +100%	L: -15% to -30% H: +20% to +50%	L: -10% to -20% H: +10% to +30%	L: -5% to -15% H: +5% to +20%	L: -3% to -10% H: +3% to +15%
PREPARATION EFFORT Typical degree of effort relative to least cost index of 1 [b]	1	2 to 4	3 to 10	4 to 20	5 to 100
REFINED CLASS DEFINITION	Class 5 estimates are generally prepared based on very limited information, and subsequently have very wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systematic manner. Class 5 estimates, due to the requirements of end use, may be prepared within a very limited amount of time and with very little effort expended - sometimes requiring less than 1 hour to prepare. Often, little more than proposed plant type, location, and capacity are known at the time of estimate preparation.	Class 4 estimates are generally prepared based on very limited information, and subsequently have very wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Typically, engineering is from 1% to 5% complete, and would comprise at a minimum the following: plant capacity, block schematics, indicated layout, process flow diagrams (PFDs) for main process systems and preliminary engineered process and utility equipment lists. Level of Project Definition Required: 1% to 15% of full project definition.	Class 3 estimates are generally prepared to form the basis for budget authorization, appropriation, and/or funding. As such, they typically form the initial control estimate against which all actual costs and resources will be monitored. Typically, engineering is from 10% to 40% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, preliminary piping and instrument diagrams, utility flow diagrams, preliminary piping and instrument diagrams, plot plan, developed layout drawings, and essentially complete engineering process and utility equipment lists. Level Of Project Definition Required: 10% to 40% of full project definition.	Class 2 estimates are generally prepared to form a detailed control baseline against which all project work is monitored in terms of cost and progress control. For contractors, this class of estimate is often used as the "bid" estimate to establish contract value. Typically, engineering is from 30% to 70% complete, and would comprise at a minimum the following: Process flow diagrams, utility flow diagrams, piping and instrument flow diagrams, heat and material balances, final plot plan, final layout drawings, complete engineered process and utility equipment lists, single line diagrams for electrical, electrical equipment and motor schedules, vendor quotations, detailed project execution plans, resourcing and work force plans, etc.	Class 1 estimates are generally prepared for discrete parts or sections of the total project rather than generating this level of detail for the entire project. The parts of the project estimated at this level of detail will typically be used by subcontractors for bids, or by owners for check estimates. The updated estimate is often referred to as the current control estimate and becomes the new baseline for cost/schedule control of the project. Class 1 estimates may be prepared for parts of the project to comprise a fair price estimate or bid check estimate to compare against a contractor's bid estimate, or to evaluate/dispute claims. Typically, engineering is from 50% to 100% complete, and would comprise virtually all engineering and design documentation of the project, and complete project execution and commissioning plans. Level for Project Definition Required: 50% to 100% of full project definition.
END USAGE DEFINED	Class 5 estimates are prepared for any number of strategic business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.	Class 4 estimates are prepared for a number of purposes, such as but not limited to, detailed strategic planning, business development, project screening at more developed stages, alternative scheme analysis, confirmation of economic and/or technical feasibility, and preliminary budget approval or approval to proceed to next stage.	Class 3 estimates are typically prepared to support full project funding requests, and become the first of the project phase "control estimate" against which all actual costs and resources will be monitored for variations to the budget. They are used as the project budget until replaced by more detailed estimates. In many owner organizations, a Class 3 estimate may be the last estimate required and could well form the only basis for cost/schedule control.	Class 2 estimates are typically prepared as the detailed control baseline against which all actual costs an resources will now be monitored for variation to the budget, and form a part of the change/variation control program.	Class 1 estimates are typically prepared to form a current control estimate to be used as the final control baseline against which all actual coasts and resources will now be monitored for variations to the budget, and form a part of the change/variation control program. They may be used to evaluate bid checking, to support vendor/contractor negotiations, or for claim evaluations and dispute resolution.
ESTIMATING METHODS USED	Class 5 estimates virtually always use stochastic estimating methods such as cost/capacity curves and factors, scale of operations factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, and other parametric and modeling techniques.	Class 4 estimates virtually always use stochastic estimating methods such as cost/capacity curves and factors, scale of operations factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, the Miller method, gross unit costs/ratios, and other parametric and modeling techniques.	Class 3 estimates usually involve more deterministic estimating methods that stochastic methods. They usually involve a high degree of unit cost line items, although these may be at an assembly level of detail rather than individual components. Factoring and other stochastic methods may be used to estimate less-significant areas of the project.	Class 2 estimates always involve a high degree of deterministic estimating methods. Class 2 estimates are prepared in great detail, and often involve tens of thousands of unit cost line items. For those areas of the project still undefined, an assumed level of detailed takeoff (forced detail) may be developed to use as line items in the estimate instead of relying on factoring methods.	Class 1 estimates involve the highest degree of deterministic estimating methods, and require a great amount of effort. Class 1 estimates are prepared in great detail, and thus are usually performed on only the most important or critical areas of the project. All items in the estimate are usually unit cost line items based on actual design quantities.
EXPECTED ACCURACY RANGE	Typical accuracy ranges for Class 5 estimates are -20% to -50% on the low side, and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.	Typical accuracy ranges for Class 4 estimates are -15% to -30% on the low side, and +20% to +50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.	Typical accuracy ranges for Class 3 estimates are -10% to -20% on the low side, and +10% to +30% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.	Typical accuracy ranges for Class 2 estimates are -5% to -15% on the low side, and +5% to +20% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.	Typical accuracy ranges for Class 1 estimates are -3% to -10% on the low side, and +3% to +15% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.
EFFORT TO PREPARE (for US$20MM project):	As little as 1 hour or less to prepare to perhaps more than 200 hours, depending on the project and the estimating methodology used.	Typically, as little as 20 hours or less to perhaps more than 300 hours, depending on the project and the estimating methodology used.	Typically, as little as 150 hours or less to perhaps more than 1500 hours, depending on the project and the estimating methodology used.	Typically, as little as 300 hours or less to perhaps more than 3000 hours, depending on the project and the estimating methodology used. Bid Estimates typically require more effort than estimates used for funding or control purposes	Class 1 estimates require the most effort to create, and as such are generally developed for only selected areas of the project, or for bidding purposes. A complete Class 1 estimate may involve as little as 600 hours or less, to perhaps more than 6,000 hours, depending on the project and the estimating methodology used. Bid estimate typically require more effort than estimates used for funding or control purposes.
ANSI Standard Reference Z94.2-1989 name; Alternate Estimate Names, Terms, Expressions, Synonyms:	Order of Magnitude Estimate; Ratio, ballpark, blue sky, seat-of-pants, ROM, idea study, prospect estimate, concession license estimate, guesstimate, rule-of thumb.	Budget Estimate; Screening, top-down, feasibility, authorization, factored, pre-design, pre-study.	Budget Estimate; Budget, scope, sanction, semi-detailed, authorization, preliminary control, concept study, development, basic engineering phase estimate, target estimate.	Definitive Estimate; Detailed Control, forced detail, execution phase, master control, engineering, bid, tender, change order estimate.	Definitive Estimate; Full detail, release, fall-out, tender, firm price, bottoms-up, final, detailed control, forced detail, execution phase, master control, fair price, definitive, change order estimate.

Estimate Class	Class 5	Class 4	Class 3	Class 2	Class 1
Estimate Input Checklist and Maturity Index	Class 5	Class 4	Class 3	Class 2	Class 1
GENERAL PROJECT DATA					
Project Scope Description	General	Preliminary	Defined	Defined	Defined
Plant Production / Facility Capacity	Assumed	Preliminary	Defined	Defined	Defined
Plant Location	General	Approximate	Specific	Specific	Specific
Soils & Hydrology	None	Preliminary	Defined	Defined	Defined
Integrated Project Plan	None	Preliminary	Defined	Defined	Defined
Project Master Schedule	None	Preliminary	Defined	Defined	Defined
Escalation Strategy	None	Preliminary	Defined	Defined	Defined
Work Breakdown Structure	None	Preliminary	Defined	Defined	Defined
Project Code of Accounts	None	Preliminary	Defined	Defined	Defined
Contracting Strategy	Assumed	Assumed	Preliminary	Defined	Defined

ENGINEERING DELIVERABLES:	Class 5	Class 4	Class 3	Class 2	Class 1
Block Flow Diagrams	Started / Preliminary	Preliminary / Complete	Complete	Complete	Complete
Plot Plans		Started	Preliminary / Complete	Complete	Complete
Process Flow Diagrams (PFDs)		Started / Preliminary	Preliminary / Complete	Complete	Complete
Utility Flow Diagrams (UFDs)		Started / Preliminary	Preliminary / Complete	Complete	Complete
Piping & Instrument Diagrams (P&IDS)		Started	Preliminary / Complete	Complete	Complete
Heat and Material Balances		Started	Preliminary / Complete	Complete	Complete
Process Equipment List		Started / Preliminary	Preliminary / Complete	Complete	Complete
Utility Equipment List		Started / Preliminary	Preliminary / Complete	Complete	Complete
Electrical One Line Drawings		Started / Preliminary	Preliminary / Complete	Complete	Complete
Specifications and Datasheets		Started	Preliminary / Complete	Complete	Complete
General Equipment Arrangement Drawings		Started	Preliminary / Complete	Complete	Complete
Spare Parts Lists			Started / Preliminary	Preliminary	Complete
Architectural Details / Schedules		Started	Preliminary / Complete	Complete	Complete
Structural Details		Started	Preliminary / Complete	Complete	Complete
Mechanical Discipline Drawings			Started	Preliminary	Preliminary / Complete
Electrical Discipline Drawings			Started	Preliminary	Preliminary / Complete
System Discipline Drawings			Started	Preliminary	Preliminary / Complete
Civil/Site Discipline Drawings			Started	Preliminary	Preliminary / Complete
Demolition Details		Started	Preliminary / Complete	Complete	Complete

SUMMARY REPORT

Project type:
Job Size:
Duration:

Project Name: Tapia WRF EQ and Pumping Alt Selection Rev 0
Project Number: W9Y31200
Design Stage: 5% to 10%

Estimator: Nick Cavalleri/RDD
Revision/Date: 0 / Aug 9, 2022
Estimate Class: 5

Area	Facility	Work Pkg	Description	Takeoff Quantity	Labor Cost/Unit	Equip Cost/Unit	Material Cost/Unit	Sub Cost/Unit	Direct Total Cost/Unit	Direct Total	Grand Total Price	Grand Total with Markups
02			***Option 2: New Primary Effluent Equalization***									
	01		**EQ Pump Station**									
		03.0	*Concrete*	***442.00*** *CY*	*288.50 /CY*	*8.28 /CY*	*339.32 /CY*	*15.84 /CY*	*651.93 /CY*	*288,153*	*1,492.27 /CY*	*659,585*
		05.0	*Metals*	*1.00 LS*	*7,908.91 /LS*	*334.46 /LS*	*10,000.00 /LS*	*/LS*	*18,243.37 /LS*	*18,243*	*41,789.18 /LS*	*41,789*
		08.0	*Openings*	*5.00 EA*	*522.92 /EA*	*/EA*	*3,500.00 /EA*	*/EA*	*4,022.92 /EA*	*20,115*	*8,958.74 /EA*	*44,794*
		09.0	*Finishes*	*1.00 LS*	*2,869.49 /LS*	*360.00 /LS*	*3,500.00 /LS*	*/LS*	*6,729.49 /LS*	*6,729*	*15,452.28 /LS*	*15,452*
		26.0	*Electrical Work*	*1.00 LS*	*52,545.16 /LS*	*5,269.90 /LS*	*146,900.00 /LS*	*/LS*	*204,715.06 /LS*	*204,715*	*472,298.61 /LS*	*472,299*
		31.0	*Earthwork*	***1.00*** *LS*	*20,822.28 /LS*	*19,433.21 /LS*	*9,792.60 /LS*	*138,040.00 /LS*	*188,088.09 /LS*	*188,088*	*399,468.83 /LS*	*399,469*
		40.0	*Process Pipe*	*1.00 LS*	*/LS*	*/LS*	*/LS*	*510,000.00 /LS*	*510,000.00 /LS*	*510,000*	*972,153.72 /LS*	*972,154*
		40.9	*Instrumentation & Controls*	*1.00 LS*	*18,834.72 /LS*	*2,000.00 /LS*	*25,000.00 /LS*	*/LS*	*45,834.72 /LS*	*45,835*	*104,099.23 /LS*	*104,099*
		46.0	*Water and Wastewater Equipment*	*5.00 EA*	*5,687.45 /EA*	*/EA*	*78,735.00 /EA*	*/EA*	*84,422.45 /EA*	*422,112*	*170,070.96 /EA*	*850,355*
			01 EQ Pump Station	***1.00*** **LS**	**261,550.12 /LS**	**31,055.18 /LS**	**756,344.94 /LS**	**655,040.00 /LS**	**1,703,990.24 /LS**	**1,703,990**	**3,559,994.92 /LS**	**3,559,995**
	02		**Welded Steel Tanl, 3 MG**									
		99.1	*Non Markups Items*	***1.00*** *LS*	*/LS*	*/LS*	*/LS*	*/LS*	*4,032,000.00 /LS*	*4,032,000*	*4,032,000.00 /LS*	*4,032,000*
			02 Welded Steel Tanl, 3 MG	***3.00*** **MG**	**/MG**	**/MG**	**/MG**	**/MG**	**1,344,000.00 /MG**	**4,032,000**	**1,344,000.00 /MG**	**4,032,000**
	03		**Yard Piping**									
		33.0	*Yard Piping*	***1,090.00*** *LF*	*71.10 /LF*	*21.52 /LF*	*200.38 /LF*	*15.00 /LF*	*307.99 /LF*	*335,710*	*694.86 /LF*	*757,393*
		33.2	*Yard Piping Structures*	*2.00 EA*	*21,074.85 /EA*	*9,197.77 /EA*	*120,050.00 /EA*	*25,000.00 /EA*	*175,322.62 /EA*	*350,645*	*389,536.28 /EA*	*779,073*
			03 Yard Piping	***1.00*** **LS**	**119,643.38 /LS**	**41,848.70 /LS**	**458,512.76 /LS**	**66,350.00 /LS**	**686,354.84 /LS**	**686,355**	**1,536,465.33 /LS**	**1,536,465**
	04		**Sitework**									
		02.0	*Existing Conditions*	*1.00 LS*	*14,855.36 /LS*	*6,000.00 /LS*	*15,000.00 /LS*	*/LS*	*35,855.36 /LS*	*35,855*	*81,260.83 /LS*	*81,261*
		26.0	*Electrical Work*	*1.00 LS*	*9,417.36 /LS*	*1,400.00 /LS*	*20,000.00 /LS*	*150,000.00 /LS*	*180,817.36 /LS*	*180,817*	*394,944.95 /LS*	*394,945*
		32.0	*Exterior Improvements*	*1.00 LS*	*22,283.04 /LS*	*5,309.28 /LS*	*20,000.00 /LS*	*/LS*	*47,592.32 /LS*	*47,592*	*107,843.10 /LS*	*107,843*
			04 Sitework	***1.00*** **LS**	**46,555.76 /LS**	**12,709.28 /LS**	**55,000.00 /LS**	**150,000.00 /LS**	**264,265.04 /LS**	**264,265**	**584,048.88 /LS**	**584,049**
			02 Option 2: New Primary Effluent Equalization	***1.00 LS***	***427,749.26 /LS***	***85,613.16 /LS***	***1,269,857.70 /LS***	***871,390.00 /LS***	***6,686,610.12 /LS***	***6,686,610***	***9,712,509.13 /LS***	***9,712,509***

Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	1,020,385		5,797.895 hrs	
Material	2,722,060			
Subcontract	1,733,905			
Equipment	204,158		1,474.718 hrs	
Subtotal W/ Contingency	**5,680,508**	**5,680,508**		
Non Markup Items	4,032,000			
Total Construction Cost	**4,032,000**	**9,712,508**		

Jacobs

DETAIL REPORT

Project type:	Project Name: Tapia WRF EQ and Pumping Alt Selection Rev 0	Estimator: Nick Cavalleri/RDD
Job Size:	Project Number: W9Y31200	Revision/Date: 0 / Aug 9, 2022
Duration:	Design Stage: 5% to 10%	Estimate Class: 5

Area	Facility	Work Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Cost/Unit	Equip Cost/Unit	Material Cost/Unit	Sub Cost/Unit	Other Cost/Unit	Direct Total Cost/Unit	Direct Total	Grand Total Price	Grand Total with Markups
02					*Option 2: New Primary Effluent Equalization*										
	01				EQ Pump Station										
		03.0			*Concrete*										
			03.00.000		*Pump Station Foundation Slab*										
				03.10.05.24	*Cast-In-Place Concrete, Slabs on Grade, 24" thick*										
					C.I.P. concrete forms, slab on grade, edge, wood, over 12", 4 use, includes erecting, bracing, stripping and cleaning	364.00 sfca	5.97 /sfca	-	1.43 /sfca	-	-	7.40 /sfca	2,694	17.47 /sfca	6,360
					Reinforcing Steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	13.25 ton	1,200.62 /ton	-	1,500.00 /ton	-	-	2,700.62 /ton	35,783	6,182.29 /ton	81,915
					Reinforcing in place, unloading & sorting, add to above - slabs	13.25 ton	41.72 /ton	6.69 /ton	-	-	-	48.41 /ton	641	116.14 /ton	1,539
					Reinforcing in place, crane cost for handling, add to above, slabs	13.25 ton	45.34 /ton	7.27 /ton	-	-	-	52.62 /ton	697	126.24 /ton	1,673
					Struct concrete,ready mix,normal wt,4500 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives and treatments	156.00 cy	-	-	133.00 /cy	-	-	133.00 /cy	20,748	292.76 /cy	45,670
					Structural concrete, placing, slab on grade, pumped, over 6" thick, includes strike off & consolidation, excludes material	151.00 CY	21.18 /CY	5.71 /CY	-	-	-	26.89 /CY	4,061	64.52 /CY	9,742
					Cfnsh,flrs,for spcf rndm accs flrs aci clss 1,2,3 and 4,achv a cmps ovrl flr fltn&lvln val f35/25,bull flt,mchn flt&stl trwl (wlk-bhn),excl plcn,strkn	2,028.00 sf	0.88 /sf	0.03 /sf	-	-	-	0.91 /sf	1,844	2.18 /sf	4,425
					Curing, sprayed membrane curing compound	20.28 csf	9.74 /csf	-	12.20 /csf	-	-	21.94 /csf	445	50.23 /csf	1,019
					Fine grading, fine grade for slab on grade, hand grading	225.33 sy	2.01 /sy	0.07 /sy	-	-	-	2.08 /sy	468	4.99 /sy	1,124
					03.10.05.24 Cast-In-Place Concrete, Slabs on Grade, 24" thick	*151.00 CY*	*164.72 /CY*	*7.40 /CY*	*274.11 /CY*	*/CY*	*/CY*	*446.24 /CY*	*67,382*	*1,016.34 /CY*	*153,467*
					03.00.000 Pump Station Foundation Slab	*151.00 CY*	*164.72 /CY*	*7.40 /CY*	*274.11 /CY*	*/CY*	*/CY*	*446.24 /CY*	*67,382*	*1,016.34 /CY*	*153,467*
			03.00.002		*Pump Station Perimeter Walls*										
				03.10.06.18	*Cast-In-Place Concrete, Straight Walls, 18" thick*										
					Forms in place, wall, steel framed plywood, to 16' high, 3 use/month	4,480.00 sfca	6.35 /sfca	-	5.40 /sfca	-	-	11.75 /sfca	52,648	27.13 /sfca	121,523
					Form oil, coverage varies greatly, maximum, includes material only	11.95 gal	-	-	21.50 /gal	-	-	21.50 /gal	257	47.32 /gal	565
					Reinforcing Steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	11.00 ton	1,200.62 /ton	-	1,500.00 /ton	-	-	2,700.62 /ton	29,707	6,182.29 /ton	68,005
					Reinforcing in place, unloading & sorting, add - walls, cols, beams	11.00 ton	41.71 /ton	6.69 /ton	-	-	-	48.41 /ton	532	116.14 /ton	1,278
					Reinforcing, crane cost for handling, add to above, walls, cols, beams	11.00 ton	45.34 /ton	7.27 /ton	-	-	-	52.62 /ton	579	126.24 /ton	1,389
					Struct concrete,ready mix,normal wt,4500 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives and treatments	129.00 cy	-	-	133.00 /cy	-	-	133.00 /cy	17,157	292.76 /cy	37,766
					Structural concrete, placing, walls, pumped, 15" thick, includes strike off & consolidation, excludes material	125.00 CY	32.65 /CY	8.81 /CY	-	-	-	41.46 /CY	5,182	99.46 /CY	12,433
					Concrete finishing, walls, burlap rub with grout, includes breaking ties and patching voids	4,480.00 sf	1.17 /sf	-	0.04 /sf	-	-	1.21 /sf	5,406	2.89 /sf	12,935
					03.10.06.18 Cast-In-Place Concrete, Straight Walls, 18" thick	*125.00 CY*	*415.43 /CY*	*10.04 /CY*	*466.28 /CY*	*/CY*	*/CY*	*891.75 /CY*	*111,469*	*2,047.15 /CY*	*255,893*
					03.00.002 Pump Station Perimeter Walls	*125.00 CY*	*415.43 /CY*	*10.04 /CY*	*466.28 /CY*	*/CY*	*/CY*	*891.75 /CY*	*111,469*	*2,047.15 /CY*	*255,893*
			03.00.004		*Pump Station Baffle Walls*										
				03.10.06.12	*Cast-In-Place Concrete, Straight Walls, 12" thick*										
					Forms in place, wall, steel framed plywood, to 16' high, 3 use/month	1,120.00 sfca	6.35 /sfca	-	5.40 /sfca	-	-	11.75 /sfca	13,162	27.13 /sfca	30,381
					Form oil, coverage varies greatly, maximum, includes material only	3.00 gal	-	-	21.50 /gal	-	-	21.50 /gal	65	47.33 /gal	142
					Reinforcing Steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	7.30 ton	1,200.63 /ton	-	1,500.00 /ton	-	-	2,700.62 /ton	19,715	6,182.29 /ton	45,131
					Reinforcing in place, unloading & sorting, add - walls, cols, beams	7.30 ton	41.72 /ton	6.69 /ton	-	-	-	48.41 /ton	353	116.14 /ton	848
					Reinforcing, crane cost for handling, add to above, walls, cols, beams	7.30 ton	45.34 /ton	7.27 /ton	-	-	-	52.62 /ton	384	126.24 /ton	922
					Struct concrete,ready mix,normal wt,4500 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives and treatments	86.00 cy	-	-	133.00 /cy	-	-	133.00 /cy	11,438	292.76 /cy	25,177
					Structural concrete, placing, walls, pumped, 15" thick, includes strike off & consolidation, excludes material	83.00 CY	32.65 /CY	8.81 /CY	-	-	-	41.46 /CY	3,441	99.46 /CY	8,256
					Concrete finishing, walls, burlap rub with grout, includes breaking ties and patching voids	1,120.00 sf	1.17 /sf	-	0.04 /sf	-	-	1.21 /sf	1,352	2.89 /sf	3,234
					03.10.06.12 Cast-In-Place Concrete, Straight Walls, 12" thick	*83.00 CY*	*247.36 /CY*	*10.04 /CY*	*343.92 /CY*	*/CY*	*/CY*	*601.31 /CY*	*49,909*	*1,374.57 /CY*	*114,089*
					03.00.004 Pump Station Baffle Walls	*83.00 CY*	*247.36 /CY*	*10.04 /CY*	*343.92 /CY*	*/CY*	*/CY*	*601.31 /CY*	*49,909*	*1,374.57 /CY*	*114,089*
			03.00.006		*Pump Station Elevated Slab*										
				03.10.10.12	*Cast-In-Place Concrete, Elevated Decks, 12" thick*										
					Slab shoring	23,520.00 cf	0.47 /cf	-	0.05 /cf	-	-	0.52 /cf	12,146	1.23 /cf	28,908
					C.I.P. concrete forms, elevated slab, flat plate, plywood, to 15' high, 4 use, includes shoring, erecting, bracing, stripping and cleaning	1,680.00 sf	4.34 /sf	-	1.87 /sf	-	-	6.21 /sf	10,436	14.53 /sf	24,416
					Cip concrete forms,elevated slab,box-out for shallow slab openings,over 10 sf (use perimeter),includes shoring,erecting,bracing,stripping and cleaning	80.00 lf	5.56 /lf	-	2.56 /lf	-	-	8.12 /lf	649	18.97 /lf	1,518
					C.I.P. concrete forms, elevated slab, edge forms, 7" to 12" high, 3 use, includes shoring, erecting, bracing, stripping and cleaning	166.00 sfca	9.79 /sfca	-	0.78 /sfca	-	-	10.57 /sfca	1,755	25.21 /sfca	4,184
					Reinforcing Steel, in place, elevated slabs, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	5.50 ton	1,200.62 /ton	-	1,500.00 /ton	-	-	2,700.62 /ton	14,853	6,182.29 /ton	34,003
					Reinforcing in place, unloading & sorting, add to above - decks	5.50 ton	41.72 /ton	6.69 /ton	-	-	-	48.41 /ton	266	116.14 /ton	639
					Struct concrete,ready mix,normal wt,4500 psi,includes local aggregate,sand,portland cement and water,delivered,excludes all additives and treatments	65.00 cy	-	-	133.00 /cy	-	-	133.00 /cy	8,645	292.76 /cy	19,029
					Structural concrete, placing, elevated slab, pumped, over 10" thick, includes strike off & consolidation, excludes material	63.00 CY	21.77 /CY	5.87 /CY	-	-	-	27.64 /CY	1,741	66.31 /CY	4,177
					Finishing elev. slabs, manual screed, bull float, machine float & trowel	1,680.00 sf	0.88 /sf	0.03 /sf	-	-	-	0.91 /sf	1,528	2.18 /sf	3,665
					Curing, sprayed membrane curing compound, elevated decks	16.80 csf	9.74 /csf	-	12.45 /csf	-	-	22.19 /csf	373	50.78 /csf	853
					03.10.10.12 Cast-In-Place Concrete, Elevated Decks, 12" thick	*63.00 CY*	*479.12 /CY*	*7.18 /CY*	*345.33 /CY*	*/CY*	*/CY*	*831.63 /CY*	*52,393*	*1,926.86 /CY*	*121,392*
					03.00.006 Pump Station Elevated Slab	*63.00 CY*	*479.12 /CY*	*7.18 /CY*	*345.33 /CY*	*/CY*	*/CY*	*831.63 /CY*	*52,393*	*1,926.86 /CY*	*121,392*
			03.00.008		*Pump Station Equipment Pads and Sloped Fill*										
				03.00.99.00	*Concrete, Other*										
					Concrete Equipment Pads and Sloped Concrete Fill	20.00 CY		-		350.00 /CY	-	350.00 /CY	7,000	737.16 /CY	14,743
					03.00.99.00 Concrete, Other	*20.00 CY*	*/CY*	*/CY*	*/CY*	*350.00 /CY*	*/CY*	*350.00 /CY*	*7,000*	*737.16 /CY*	*14,743*
					03.00.008 Pump Station Equipment Pads and Sloped Fill	*20.00 CY*	*/CY*	*/CY*	*/CY*	*350.00 /CY*	*/CY*	*350.00 /CY*	*7,000*	*737.16 /CY*	*14,743*
					03.0 Concrete	***442.00*** *CY*	*288.50 /CY*	*8.28 /CY*	*339.32 /CY*	*15.84 /CY*	*/CY*	*651.93 /CY*	*288,153*	*1,492.27 /CY*	*659,585*
		05.0			*Metals*										
			05.00.000		*Pump Station Metals*										
				05.00.99.00	*Metals, Other*										
					Pump Station Metals Allowance	1.00 LS	7,908.91 /LS	334.46 /LS	10,000.00 /LS	-	-	18,243.37 /LS	18,243	41,789.18 /LS	41,789
					05.00.99.00 Metals, Other	*1.00 LS*	*7,908.91 /LS*	*334.46 /LS*	*10,000.00 /LS*	*/LS*	*/LS*	*18,243.37 /LS*	*18,243*	*41,789.18 /LS*	*41,789*
					05.00.000 Pump Station Metals	*1.00 LS*	*7,908.91 /LS*	*334.46 /LS*	*10,000.00 /LS*	*/LS*	*/LS*	*18,243.37 /LS*	*18,243*	*41,789.18 /LS*	*41,789*
					05.0 Metals	*1.00 LS*	*7,908.91 /LS*	*334.46 /LS*	*10,000.00 /LS*	*/LS*	*/LS*	*18,243.37 /LS*	*18,243*	*41,789.18 /LS*	*41,789*
		08.0			*Openings*										
			08.00.000		*Pump Station Pump Access Hatch*										
				08.30.01.10	*Specialty Doors and Frames, Access Doors*										

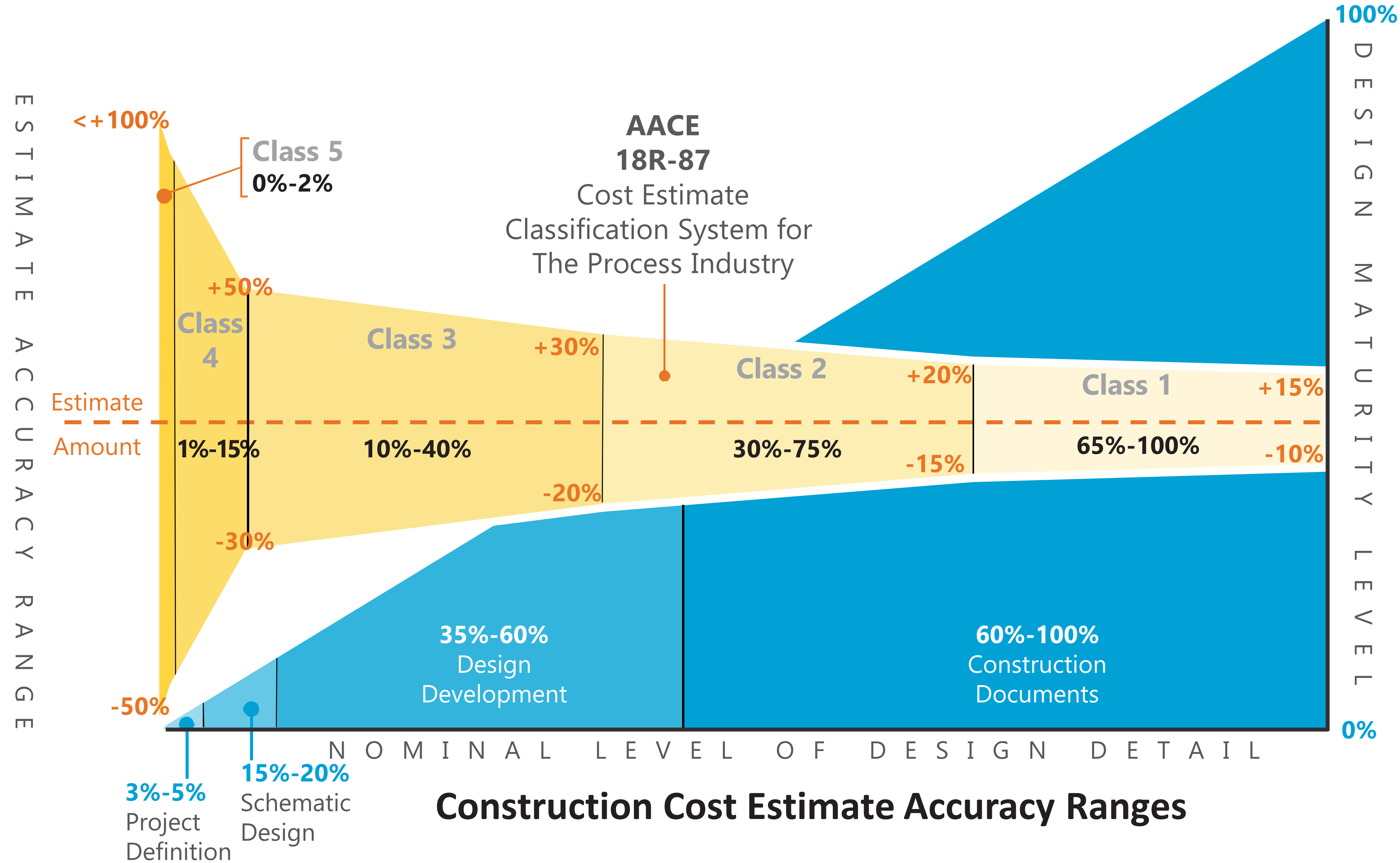
Area	Facility	Work Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Cost/Unit	Equip Cost/Unit	Material Cost/Unit	Sub Cost/Unit	Other Cost/Unit	Direct Total Cost/Unit	Direct Total	Grand Total Price	Grand Total with Markups
				08.30.01.10	Specialty Doors and Frames, Access Doors										
					Doors, specialty, access, floor, industrial, aluminum, double leaf, 4' x 4'	5.00 EA	522.92 /EA	-	3,500.00 /EA	-	-	4,022.92 /EA	20,115	8,958.74 /EA	44,794
					08.30.01.10 Specialty Doors and Frames, Access Doors	5.00 EA	522.92 /EA	/EA	3,500.00 /EA	/EA	/EA	4,022.92 /EA	20,115	8,958.74 /EA	44,794
					08.00.000 Pump Station Pump Access Hatch	5.00 EA	522.92 /EA	/EA	3,500.00 /EA	/EA	/EA	4,022.92 /EA	20,115	8,958.74 /EA	44,794
					08.0 Openings	5.00 EA	522.92 /EA	/EA	3,500.00 /EA	/EA	/EA	4,022.92 /EA	20,115	8,958.74 /EA	44,794
		09.0			Finishes										
			09.00.000		Pump Station Paintings and Coatings										
				09.00.99.00	Finishes, Other										
					Paintings and Coatings Allowance	1.00 LS	2,869.49 /LS	360.00 /LS	3,500.00 /LS	-	-	6,729.49 /LS	6,729	15,452.28 /LS	15,452
					09.00.99.00 Finishes, Other	1.00 LS	2,869.49 /LS	360.00 /LS	3,500.00 /LS	/LS	/LS	6,729.49 /LS	6,729	15,452.28 /LS	15,452
					09.00.000 Pump Station Paintings and Coatings	1.00 LS	2,869.49 /LS	360.00 /LS	3,500.00 /LS	/LS	/LS	6,729.49 /LS	6,729	15,452.28 /LS	15,452
					09.0 Finishes	1.00 LS	2,869.49 /LS	360.00 /LS	3,500.00 /LS	/LS	/LS	6,729.49 /LS	6,729	15,452.28 /LS	15,452
		26.0			Electrical Work										
			26.00.000		Pump Station Electrical										
				26.00.99.00	Electrical, Other										
					Pump Station Electrical Fitout Allowance	1.00 LS	28,252.08 /LS	3,000.00 /LS	35,000.00 /LS	-	-	66,252.08 /LS	66,252	155,333.52 /LS	155,334
					Variable frequency drives, custom-engineered, 460 volt, 105 HP motor size	3.00 ea	4,487.26 /ea	419.28 /ea	19,300.00 /ea	-	-	24,206.54 /ea	72,620	55,464.86 /ea	166,395
					Variable frequency drives, custom-engineered, 460 volt, 250 HP motor size	2.00 ea	5,415.66 /ea	506.03 /ea	27,000.00 /ea	-	-	32,921.68 /ea	65,843	75,285.26 /ea	150,571
					26.00.99.00 Electrical, Other	1.00 LS	52,545.16 /LS	5,269.90 /LS	146,900.00 /LS	/LS	/LS	204,715.06 /LS	204,715	472,298.61 /LS	472,299
					26.00.000 Pump Station Electrical	1.00 LS	52,545.16 /LS	5,269.90 /LS	146,900.00 /LS	/LS	/LS	204,715.06 /LS	204,715	472,298.61 /LS	472,299
					26.0 Electrical Work	1.00 LS	52,545.16 /LS	5,269.90 /LS	146,900.00 /LS	/LS	/LS	204,715.06 /LS	204,715	472,298.61 /LS	472,299
		31.0			Earthwork										
			31.00.000		Pump Station Earthwork										
				31.16.01.00	Earthworks, Sheeting and Shoring										
					Excavation Shoring Allowance, Shoring Three Sides of Excavation Area	2,576.00 SF		-		40.00 /SF	-	40.00 /SF	103,040	82.25 /SF	211,869
					31.16.01.00 Earthworks, Sheeting and Shoring	2,576.00 SF	/SF	/SF	/SF	40.00 /SF	/SF	40.00 /SF	103,040	82.25 /SF	211,869
				31.19.03.20	Site Preparation, Dewatering										
					Dewatering Allowance	1.00 MO	0.00 /MO	-	0.00 /MO	35,000.00 /MO	-	35,000.00 /MO	35,000	71,966.43 /MO	71,966
					31.19.03.20 Site Preparation, Dewatering	1.00 MO	/MO	/MO	/MO	35,000.00 /MO	/MO	35,000.00 /MO	35,000	71,966.43 /MO	71,966
				31.25.01.00	Earthworks, Structural, Excavation										
					Excavating, trench or continuous footing, common earth, 1/2 C.Y. excavator, truck mounted, 6' to 10' deep, excludes sheeting or dewatering	1,760.00 CY	3.24 /CY	3.54 /CY	-	-	-	6.78 /CY	11,930	15.92 /CY	28,026
					31.25.01.00 Earthworks, Structural, Excavation	1,760.00 CY	3.24 /CY	3.54 /CY	/CY	/CY	/CY	6.78 /CY	11,930	15.92 /CY	28,026
				31.25.02.00	Earthworks, Structural, Import Aggregates (Slab)										
					Fill, gravel fill, compacted, under floor slabs, alternate pricing method, 6" deep	44.00 CY	30.16 /CY	3.57 /CY	32.00 /CY	-	-	65.72 /CY	2,892	148.06 /CY	6,515
					31.25.02.00 Earthworks, Structural, Import Aggregates (Slab)	44.00 CY	30.16 /CY	3.57 /CY	32.00 /CY	/CY	/CY	65.72 /CY	2,892	148.06 /CY	6,515
				31.25.03.00	Earthworks, Structural, Backfill										
					Fill, Native Fill, dumped material, excludes compaction	710.00 CY	3.09 /CY	0.98 /CY	0.00 /CY	-	-	4.06 /CY	2,885	9.55 /CY	6,778
					31.25.03.00 Earthworks, Structural, Backfill	710.00 CY	3.09 /CY	0.98 /CY	/CY	/CY	/CY	4.06 /CY	2,885	9.55 /CY	6,778
				31.25.03.10	Earthworks, Structural, Compaction										
					Compaction, 4 passes, 13" to 18", 8" lifts, rammer tamper	710.00 CY	0.96 /CY	0.16 /CY	-	-	-	1.12 /CY	796	2.63 /CY	1,871
					Compaction, water for, 3000 gallon truck, 3 mile haul	710.00 cy	0.52 /cy	0.56 /cy	1.20 /cy	-	-	2.28 /cy	1,621	5.13 /cy	3,639
					31.25.03.10 Earthworks, Structural, Compaction	710.00 CY	1.48 /CY	0.72 /CY	1.20 /CY	/CY	/CY	3.40 /CY	2,417	7.76 /CY	5,509
				31.25.05.00	Earthworks, Structural, Hauling and Dump Fees										
					Load Excavated Spoils	1,050.00 cy	3.24 /cy	2.21 /cy	2.17 /cy	-	-	7.62 /cy	8,005	17.48 /cy	18,353
					Hauling and disposal of excavated spoils, 20 mile round trip, 0.5 loads/hour, 20 C.Y. dump trailer, highway haulers, excludes loading	1,050.00 CY	6.81 /CY	9.06 /CY	5.00 /CY	-	-	20.88 /CY	21,919	48.05 /CY	50,452
					31.25.05.00 Earthworks, Structural, Hauling and Dump Fees	1,050.00 CY	10.05 /CY	11.27 /CY	7.17 /CY	/CY	/CY	28.50 /CY	29,924	65.53 /CY	68,806
					31.00.000 Pump Station Earthwork	4,274.00 CY	4.87 /CY	4.55 /CY	2.29 /CY	32.30 /CY	/CY	44.01 /CY	188,088	93.46 /CY	399,469
					31.0 Earthwork	**1.00** LS	20,822.28 /LS	19,433.21 /LS	9,792.60 /LS	138,040.00 /LS	/LS	188,088.09 /LS	188,088	399,468.83 /LS	399,469
		40.0			Process Pipe										
			40.00.000		Pump Station Process Piping										
				40.00.99.01	Process Pipe, Other										
					Process Piping and Valving Allowance	1.00 LS		-		510,000.00 /LS	-	510,000.00 /LS	510,000	972,153.72 /LS	972,154
					40.00.99.01 Process Pipe, Other	1.00 LS	/LS	/LS	/LS	510,000.00 /LS	/LS	510,000.00 /LS	510,000	972,153.72 /LS	972,154
					40.00.000 Pump Station Process Piping	1.00 LS	/LS	/LS	/LS	510,000.00 /LS	/LS	510,000.00 /LS	510,000	972,153.72 /LS	972,154
					40.0 Process Pipe	1.00 LS	/LS	/LS	/LS	510,000.00 /LS	/LS	510,000.00 /LS	510,000	972,153.72 /LS	972,154
		40.9			Instrumentation & Controls										
			40.90.000		Pump Station I&C										
				40.90.99.01	I&C, Other										
					Pump Station I&C Allowance	1.00 LS	18,834.72 /LS	2,000.00 /LS	25,000.00 /LS	-	-	45,834.72 /LS	45,835	104,099.23 /LS	104,099
					40.90.99.01 I&C, Other	1.00 LS	18,834.72 /LS	2,000.00 /LS	25,000.00 /LS	/LS	/LS	45,834.72 /LS	45,835	104,099.23 /LS	104,099
					40.90.000 Pump Station I&C	1.00 LS	18,834.72 /LS	2,000.00 /LS	25,000.00 /LS	/LS	/LS	45,834.72 /LS	45,835	104,099.23 /LS	104,099
					40.9 Instrumentation & Controls	1.00 LS	18,834.72 /LS	2,000.00 /LS	25,000.00 /LS	/LS	/LS	45,834.72 /LS	45,835	104,099.23 /LS	104,099
		46.0			Water and Wastewater Equipment										
			44.00.000		Pump Station Submersible Pumps, Large										
				44.05.49.04	Submersible Pump: 101hp-250hp										
					Functional Testing, Submersible Pumps, 101 - 250 hp	2.00 ea	526.62 /ea	-	100.00 /ea	-	-	626.62 /ea	1,253	1,358.24 /ea	2,716
					Sleeved anchor bolts - Medium	16.00 ea	23.04 /ea	-	21.00 /ea	-	-	44.04 /ea	705	92.69 /ea	1,483
					Non-Shrink Machine Grout	16.00 cuft	62.54 /cuft	-	74.00 /cuft	-	-	136.54 /cuft	2,185	285.62 /cuft	4,570
					Grease, Oil, and Lube Pumps, 101-250 hp	2.00 ea	263.31 /ea	-	75.00 /ea	-	-	338.31 /ea	677	729.15 /ea	1,458
					FURNISH Submersible Propeller Pump, 250 hp Quotye Price plus 20% Contingency	2.00 EA	-	-	91,500.00 /EA	-	-	91,500.00 /EA	183,000	183,108.33 /EA	366,217
					Set pump assembly, 101 - 250 hp	2.00 ea	4,212.93 /ea	-	100.00 /ea	-	-	4,312.93 /ea	8,626	9,465.12 /ea	18,930
					44.05.49.04 Submersible Pump: 101hp-250hp	2.00 EA	5,687.46 /EA	/EA	92,535.00 /EA	/EA	/EA	98,222.46 /EA	196,445	197,687.30 /EA	395,375
					44.00.000 Pump Station Submersible Pumps, Large	2.00 EA	5,687.46 /EA	/EA	92,535.00 /EA	/EA	/EA	98,222.46 /EA	196,445	197,687.30 /EA	395,375
			44.00.002		Pump Station Submersible Pumps, Small										
				44.05.49.04	Submersible Pump: 101hp-250hp										
					Functional Testing, Submersible Pumps, 101 - 250 hp	3.00 ea	526.62 /ea	-	100.00 /ea	-	-	626.62 /ea	1,880	1,358.25 /ea	4,075
					Sleeved anchor bolts - Medium	24.00 ea	23.04 /ea	-	21.00 /ea	-	-	44.04 /ea	1,057	92.69 /ea	2,225
					Non-Shrink Machine Grout	24.00 cuft	62.54 /cuft	-	74.00 /cuft	-	-	136.54 /cuft	3,277	285.62 /cuft	6,855
					Grease, Oil, and Lube Pumps, 101-250 hp	3.00 ea	263.31 /ea	-	75.00 /ea	-	-	338.31 /ea	1,015	729.15 /ea	2,187
					FURNISH Submersible Propeller Pump, 105 hp Quotye Price plus 20% Contingency	3.00 EA	-	-	68,500.00 /EA	-	-	68,500.00 /EA	205,500	137,081.09 /EA	411,243
					Set pump assembly, 101 - 250 hp	3.00 ea	4,212.93 /ea	-	100.00 /ea	-	-	4,312.93 /ea	12,939	9,465.12 /ea	28,395
					44.05.49.04 Submersible Pump: 101hp-250hp	3.00 EA	5,687.45 /EA	/EA	69,535.00 /EA	/EA	/EA	75,222.45 /EA	225,667	151,660.07 /EA	454,980
					44.00.002 Pump Station Submersible Pumps, Small	3.00 EA	5,687.45 /EA	/EA	69,535.00 /EA	/EA	/EA	75,222.45 /EA	225,667	151,660.07 /EA	454,980
					46.0 Water and Wastewater Equipment	5.00 EA	5,687.45 /EA	/EA	78,735.00 /EA	/EA	/EA	84,422.45 /EA	422,112	170,070.96 /EA	850,355
					01 EQ Pump Station	**1.00 LS**	**261,550.12 /LS**	**31,055.18 /LS**	**756,344.94 /LS**	**655,040.00 /LS**	**/LS**	**1,703,990.24 /LS**	**1,703,990**	**3,559,994.92 /LS**	**3,559,995**
	02				**Welded Steel Tanl, 3 MG**										
		99.1			Non Markups Items										
			33.00.000		3 MG Welded Steel Tank										
				33.90.01.01	Tanks, Welded Steel										
					Furnish and Install 3 MG Coned Roof Welded Steel Tank, CB&I Email Quote 7/26/2022	1.00 ls		-		-	2,500,000.00 /ls	2,500,000.00 /ls	2,500,000	2,500,000.00 /ls	2,500,000
					Furnish and Install 3 MG Welded Steel Tank Ring Wall Foundation, CB&I Email Quote 7/26/2022	1.00 ls		-		-	600,000.00 /ls	600,000.00 /ls	600,000	600,000.00 /ls	600,000

Area	Facility	Work Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Cost/Unit	Equip Cost/Unit	Material Cost/Unit	Sub Cost/Unit	Other Cost/Unit	Direct Total Cost/Unit	Direct Total	Grand Total Price	Grand Total with Markups
				33.90.01.01	*Tanks, Welded Steel*										
					Furnish and Install 3 MG Welded Steel Tank Field Coatings, CB&I Email Quote 7/26/2022	1.00 ls		-		-	500,000.00 /ls	500,000.00 /ls	500,000	500,000.00 /ls	500,000
					Prime Contractor Markups on Welded Steel Tank for Overheads and Insurances 7%	1.00 ls		-		-	252,000.00 /ls	252,000.00 /ls	252,000	252,000.00 /ls	252,000
					Prime Contractor Markups on Welded Steel Tank for Contingency 5%	1.00 ls		-		-	180,000.00 /ls	180,000.00 /ls	180,000	180,000.00 /ls	180,000
					33.90.01.01 Tanks, Welded Steel	*3.00 MG*	*/MG*	*/MG*	*/MG*	*/MG*	*1,344,000.00 /MG*	*1,344,000.00 /MG*	*4,032,000*	*1,344,000.00 /MG*	*4,032,000*
					33.00.000 3 MG Welded Steel Tank	*3.00 MG*	*/MG*	*/MG*	*/MG*	*/MG*	*1,344,000.00 /MG*	*1,344,000.00 /MG*	*4,032,000*	*1,344,000.00 /MG*	*4,032,000*
					99.1 Non Markups Items	*1.00 LS*	*/LS*	*/LS*	*/LS*	*/LS*	*4,032,000.00 /LS*	*4,032,000.00 /LS*	*4,032,000*	*4,032,000.00 /LS*	*4,032,000*
					02 Welded Steel Tanl, 3 MG	**3.00 MG**	**/MG**	**/MG**	**/MG**	**/MG**	**1,344,000.00 /MG**	**1,344,000.00 /MG**	**4,032,000**	**1,344,000.00 /MG**	**4,032,000**
	03				**Yard Piping**										
		33.0			*Yard Piping*										
			33.00.002		*24" Dia CLDI Pipeline*										
				33.00.04.24	*Buried Pipe, Ductile Iron, 24"*										
					Excavating, trench, common earth, 1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	1,430.00 cy	3.31 /cy	1.36 /cy	-	-	-	4.67 /cy	6,677	11.20 /cy	16,021
					Fill Native Material	726.00 cy	3.37 /cy	1.39 /cy		-	-	4.77 /cy	3,460	11.43 /cy	8,302
					Fill bedding and pipe zone, for pipe, crushed or screened bank run gravel, excludes compaction	721.00 cy	9.90 /cy	2.36 /cy	35.00 /cy	-	-	47.26 /cy	34,077	106.46 /cy	76,760
					Haul and Disposal of Excavated Spoils	704.00 cy	2.73 /cy	3.62 /cy	-	-	-	6.35 /cy	4,471	15.24 /cy	10,726
					Load Excavated Spoils for Haul Off	704.00 cy	0.62 /cy	0.44 /cy		-	-	1.06 /cy	747	2.55 /cy	1,793
					Compaction, 4 passes, 18" wide, 12" lifts, walk behind, vibrating plate	121.00 cy	1.65 /cy	0.16 /cy	-	-	-	1.82 /cy	220	4.36 /cy	528
					Compaction, 4 passes, 13" to 18", 8" lifts, rammer tamper	1,326.00 cy	1.19 /cy	0.15 /cy	-	-	-	1.34 /cy	1,774	3.21 /cy	4,256
					Compaction, water for, 3000 gallon truck, 3 mile haul	1,447.00 cy	0.60 /cy	0.48 /cy	1.23 /cy	-	-	2.31 /cy	3,341	5.30 /cy	7,662
					Piping,ductile iron pipe,cement lined,mechanical joint,fittings,18'lengths,24"diameter,class 50,excludes excavation backfill	990.00 lf	39.23 /lf	3.12 /lf	157.00 /lf	-	-	199.35 /lf	197,355	447.19 /lf	442,716
					Pipe Fitting Allowance	1.00 ls	10,000.00 /ls	5,000.00 /ls	15,000.00 /ls	-	-	30,000.00 /ls	30,000	69,005.51 /ls	69,006
					Dewatering Allowance	5.94 msf				2,500.00 /msf		2,500.00 /msf	14,850	5,265.46 /msf	31,277
					33.00.04.24 Buried Pipe, Ductile Iron, 24"	*990.00 LF*	*68.84 /LF*	*16.70 /LF*	*199.44 /LF*	*15.00 /LF*	*/LF*	*299.97 /LF*	*296,972*	*675.80 /LF*	*669,045*
					33.00.002 24" Dia CLDI Pipeline	*990.00 LF*	*68.84 /LF*	*16.70 /LF*	*199.44 /LF*	*15.00 /LF*	*/LF*	*299.97 /LF*	*296,972*	*675.80 /LF*	*669,045*
			33.00.008		*30" Dia Overflow Drain*										
				33.00.09.30	*Buried Pipe, HDPE, 30"*										
					Excavating, trench, common earth, 1/2 C.Y. excavator, 4' to 6' deep, excludes sheeting or dewatering	167.00 cy	3.31 /cy	1.36 /cy	-	-	-	4.67 /cy	780	11.20 /cy	1,871
					Fill Native Material	86.00 cy	3.37 /cy	1.39 /cy	0.00 /cy	-	-	4.77 /cy	410	11.43 /cy	983
					Fill bedding and pipe zone, for pipe, crushed or screened bank run gravel, excludes compaction	79.00 cy	9.90 /cy	2.36 /cy	35.00 /cy	-	-	47.26 /cy	3,734	106.46 /cy	8,411
					Haul and Disposal of Excavated Spoils	81.00 cy	2.73 /cy	3.62 /cy	-	-	-	6.35 /cy	514	15.24 /cy	1,234
					Load Excavated Spoils for Haul Off	81.00 cy	0.62 /cy	0.44 /cy	0.00 /cy	-	-	1.06 /cy	86	2.55 /cy	206
					Compaction, 4 passes, 18" wide, 12" lifts, walk behind, vibrating plate	79.00 cy	1.65 /cy	0.16 /cy	-	-	-	1.82 /cy	144	4.36 /cy	344
					Compaction, 4 passes, 13" to 18", 8" lifts, rammer tamper	86.00 cy	1.19 /cy	0.15 /cy	-	-	-	1.34 /cy	115	3.21 /cy	276
					Compaction, water for, 3000 gallon truck, 3 mile haul	165.00 cy	0.60 /cy	0.48 /cy	1.23 /cy	-	-	2.31 /cy	381	5.30 /cy	874
					Pipe Fitting Allowance	1.00 ls	2,000.00 /ls	2,000.00 /ls	4,000.00 /ls	-	-	8,000.00 /ls	8,000	18,401.45 /ls	18,401
					Piping, piping HDPE, butt fusion joints, 40' lengths, 30" diameter, SDR 21	100.00 LF	26.19 /LF	24.55 /LF	90.00 /LF	-	-	140.74 /LF	14,074	319.85 /LF	31,985
					Dewatering Allowance	0.60 msf	0.00 /msf	0.00 /msf	0.00 /msf	2,500.00 /msf	0.00 /msf	2,500.00 /msf	1,500	5,265.45 /msf	3,159
					Drain Basin Allowance	1.00 ls	2,500.00 /ls	1,500.00 /ls	5,000.00 /ls	-		9,000.00 /ls	9,000	20,602.67 /ls	20,603
					33.00.09.30 Buried Pipe, HDPE, 30"	*100.00 LF*	*93.46 /LF*	*69.24 /LF*	*209.68 /LF*	*15.00 /LF*	*/LF*	*387.38 /LF*	*38,738*	*883.48 /LF*	*88,348*
					33.00.008 30" Dia Overflow Drain	*100.00 LF*	*93.46 /LF*	*69.24 /LF*	*209.68 /LF*	*15.00 /LF*	*/LF*	*387.38 /LF*	*38,738*	*883.48 /LF*	*88,348*
					33.0 Yard Piping	*1,090.00 LF*	*71.10 /LF*	*21.52 /LF*	*200.38 /LF*	*15.00 /LF*	*/LF*	*307.99 /LF*	*335,710*	*694.86 /LF*	*757,393*
		33.2			*Yard Piping Structures*										
			33.00.004		*Valve Vault, Tank*										
				33.15.03.04	*Buried Structures, Valve Vault*										
					Install butterfly valve, Flgd, DIP, 24"	2.00 ea	981.33 /ea	271.51 /ea	-	-	-	1,252.83 /ea	2,506	3,005.76 /ea	6,012
					Butterfly valve, iron body, Flgd, MTR OPER, 150#, 24"	2.00 ea	-	-	20,000.00 /ea	-	-	20,000.00 /ea	40,000	44,023.68 /ea	88,047
					Valve Vault Structure, Complete, Includes Earthworks	1.00 EA	7,427.68 /EA	1,769.76 /EA	10,000.00 /EA	22,000.00 /EA	-	41,197.44 /EA	41,197	90,414.24 /EA	90,414
					Pipe and Fittings Allowance	1.00 ls	3,763.90 /ls	720.00 /ls	15,000.00 /ls	-	-	19,483.90 /ls	19,484	43,775.44 /ls	43,775
					Miscellaneous Items and Consumables Allowance	1.00 ls	3,875.00 /ls	3,875.00 /ls	7,750.00 /ls	-	-	15,500.00 /ls	15,500	35,652.85 /ls	35,653
					33.15.03.04 Buried Structures, Valve Vault	*1.00 EA*	*17,029.23 /EA*	*6,907.77 /EA*	*72,750.00 /EA*	*22,000.00 /EA*	*/EA*	*118,687.00 /EA*	*118,687*	*263,901.41 /EA*	*263,901*
					33.00.004 Valve Vault, Tank	*1.00 EA*	*17,029.23 /EA*	*6,907.77 /EA*	*72,750.00 /EA*	*22,000.00 /EA*	*/EA*	*118,687.00 /EA*	*118,687*	*263,901.41 /EA*	*263,901*
			33.00.006		*Valve Vault, Pump Station*										
				33.15.03.04	*Buried Structures, Valve Vault*										
					Install butterfly valve, Flgd, DIP, 24"	2.00 ea	981.33 /ea	271.51 /ea	-	-	-	1,252.83 /ea	2,506	3,005.77 /ea	6,012
					Butterfly valve, iron body, Flgd, MTR OPER, 150#, 24"	2.00 ea	-	-	20,000.00 /ea	-	-	20,000.00 /ea	40,000	44,023.68 /ea	88,047
					18" Dia Flow Control Valve	1.00 ea	1,254.64 /ea	260.00 /ea	55,000.00 /ea	-	-	56,514.64 /ea	56,515	124,699.01 /ea	124,699
					18" Dia Mag Meter	1.00 ea	1,254.64 /ea	260.00 /ea	17,200.00 /ea	-	-	18,714.64 /ea	18,715	41,494.26 /ea	41,494
					Valve Vault Structure, Complete, Includes Earthworks	1.00 EA	7,427.68 /EA	1,769.76 /EA	15,000.00 /EA	28,000.00 /EA	-	52,197.44 /EA	52,197	114,057.27 /EA	114,057
					Pipe and Fittings Allowance	1.00 ls	5,645.86 /ls	1,080.00 /ls	25,000.00 /ls	-	-	31,725.86 /ls	31,726	71,166.14 /ls	71,166
					Miscellaneous Items and Consumables Allowance	1.00 ls	7,575.00 /ls	7,575.00 /ls	15,150.00 /ls	-	-	30,300.00 /ls	30,300	69,695.58 /ls	69,696
					33.15.03.04 Buried Structures, Valve Vault	*1.00 EA*	*25,120.47 /EA*	*11,487.77 /EA*	*167,350.00 /EA*	*28,000.00 /EA*	*/EA*	*231,958.24 /EA*	*231,958*	*515,171.15 /EA*	*515,171*
					33.00.006 Valve Vault, Pump Station	*1.00 EA*	*25,120.47 /EA*	*11,487.77 /EA*	*167,350.00 /EA*	*28,000.00 /EA*	*/EA*	*231,958.24 /EA*	*231,958*	*515,171.15 /EA*	*515,171*
					33.2 Yard Piping Structures	*2.00 EA*	*21,074.85 /EA*	*9,197.77 /EA*	*120,050.00 /EA*	*25,000.00 /EA*	*/EA*	*175,322.62 /EA*	*350,645*	*389,536.28 /EA*	*779,073*
					03 Yard Piping	**1.00 LS**	**119,643.38 /LS**	**41,848.70 /LS**	**458,512.76 /LS**	**66,350.00 /LS**	**/LS**	**686,354.84 /LS**	**686,355**	**1,536,465.33 /LS**	**1,536,465**
	04				**Sitework**										
		02.0			*Existing Conditions*										
			02.00.000		*Demolition*										
				02.01.01.00	*General Site Demolition*										
					Site Demolitions and Preperation for Construction of Pump Station, EQ Tank, and Sitework	1.00 LS	14,855.36 /LS	6,000.00 /LS	15,000.00 /LS	-	-	35,855.36 /LS	35,855	81,260.83 /LS	81,261
					02.01.01.00 General Site Demolition	*1.00 LS*	*14,855.36 /LS*	*6,000.00 /LS*	*15,000.00 /LS*	*/LS*	*/LS*	*35,855.36 /LS*	*35,855*	*81,260.83 /LS*	*81,261*
					02.00.000 Demolition	*1.00 LS*	*14,855.36 /LS*	*6,000.00 /LS*	*15,000.00 /LS*	*/LS*	*/LS*	*35,855.36 /LS*	*35,855*	*81,260.83 /LS*	*81,261*
					02.0 Existing Conditions	*1.00 LS*	*14,855.36 /LS*	*6,000.00 /LS*	*15,000.00 /LS*	*/LS*	*/LS*	*35,855.36 /LS*	*35,855*	*81,260.83 /LS*	*81,261*
		26.0			*Electrical Work*										
			26.00.002		*Site Electrical*										
				26.00.99.00	*Electrical, Other*										
					Site Electrical, Includes Ductbanks for Electrical and I&C, and Site Electrical Allowance	1.00 LS	9,417.36 /LS	1,400.00 /LS	20,000.00 /LS	150,000.00 /LS	-	180,817.36 /LS	180,817	394,944.95 /LS	394,945
					26.00.99.00 Electrical, Other	*1.00 LS*	*9,417.36 /LS*	*1,400.00 /LS*	*20,000.00 /LS*	*150,000.00 /LS*	*/LS*	*180,817.36 /LS*	*180,817*	*394,944.95 /LS*	*394,945*
					26.00.002 Site Electrical	*1.00 LS*	*9,417.36 /LS*	*1,400.00 /LS*	*20,000.00 /LS*	*150,000.00 /LS*	*/LS*	*180,817.36 /LS*	*180,817*	*394,944.95 /LS*	*394,945*
					26.0 Electrical Work	*1.00 LS*	*9,417.36 /LS*	*1,400.00 /LS*	*20,000.00 /LS*	*150,000.00 /LS*	*/LS*	*180,817.36 /LS*	*180,817*	*394,944.95 /LS*	*394,945*
		32.0			*Exterior Improvements*										
			32.50.000		*Site Improvements and Surface Restorations*										
				32.50.06.00	*Site Improvements, Other*										
					Surface Restorations and Site Improvements Allowance	1.00 LS	22,283.04 /LS	5,309.28 /LS	20,000.00 /LS	-	-	47,592.32 /LS	47,592	107,843.10 /LS	107,843

Area	Facility	Work Pkg	WorkActiv	Unit Price	Description	Takeoff Quantity	Labor Cost/Unit	Equip Cost/Unit	Material Cost/Unit	Sub Cost/Unit	Other Cost/Unit	Direct Total Cost/Unit	Direct Total	Grand Total Price	Grand Total with Markups
					32.50.06.00 Site Improvements, Other	*1.00 LS*	*22,283.04 /LS*	*5,309.28 /LS*	*20,000.00 /LS*	*/LS*	*/LS*	*47,592.32 /LS*	*47,592*	*107,843.10 /LS*	*107,843*
					32.50.000 Site Improvements and Surface Restorations	*1.00 LS*	*22,283.04 /LS*	*5,309.28 /LS*	*20,000.00 /LS*	*/LS*	*/LS*	*47,592.32 /LS*	*47,592*	*107,843.10 /LS*	*107,843*
					32.0 Exterior Improvements	*1.00 LS*	*22,283.04 /LS*	*5,309.28 /LS*	*20,000.00 /LS*	*/LS*	*/LS*	*47,592.32 /LS*	*47,592*	*107,843.10 /LS*	*107,843*
					04 Sitework	**1.00 LS**	**46,555.76 /LS**	**12,709.28 /LS**	**55,000.00 /LS**	**150,000.00 /LS**	**/LS**	**264,265.04 /LS**	**264,265**	**584,048.88 /LS**	**584,049**
					02 Option 2: New Primary Effluent Equalization	***1.00 LS***	***427,749.26 /LS***	***85,613.16 /LS***	***1,269,857.70 /LS***	***871,390.00 /LS***	***4,032,000.00 /LS***	***6,686,610.12 /LS***	***6,686,610***	***9,712,509.13 /LS***	***9,712,509***

Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	427,749		5,797.895 hrs	
Material	1,269,858			
Subcontract	871,390			
Equipment	85,613		1,474.718 hrs	
Subtotal Direct Costs	**2,654,610**	**2,654,610**		
Material Sales Tax Agoura Hills Ca	120,636			9.500 %
Subtotal W/ Sales Tax	**120,636**	**2,775,246**		
Location Adj. Factor	150,415			29.300 %
Subtotal W/ Adj. Factors	**150,415**	**2,925,661**		
Existing Conditions I,OH&P	5,378			15.000 %
Concrete Work I,OH&P	57,631			20.000 %
Metals Work I,OH&P	3,649			20.000 %
Architectural (Div 6-12)I,OH&P	5,369			20.000 %
Electrical Work I,OH&P	96,383			25.000 %
Site/Civil I,OH&P	35,352			15.000 %
Buried Piping I,OH&P	137,271			20.000 %
Instruments & Controls I,OH&P	8,250			18.000 %
Subtotal W/ Subcontractor OH&P	**349,283**	**3,274,944**		
General Conditions	392,993			12.000 %
Subtotal W/ General Conditions	**392,993**	**3,667,937**		
Mobilization/Demobilization	146,718			4.000 %
Prime Contractor Overhead	381,466			10.000 %
Prime Contractor Profit	251,767			6.000 %
Bonds & Insurance	96,519			2.170 %
Subtotal W/ Prime Markups	**876,470**	**4,544,407**		
Contingency	1,136,102			25.000 %
Subtotal W/ Contingency	**1,136,102**	**5,680,509**		
Non Markup Items	4,032,000			
Subtotal W/ Non Markup Items	**4,032,000**	**9,712,509**		
Total Construction Cost		**9,712,509**		



Construction Cost Estimate Accuracy Ranges

Estimate Class	Class 5	Class 4	Class 3	Class 2	Class 1
LEVEL OF PROJECT DEFINITION Expressed as a % of complete definition	**0% to 2%**	**1% to 15%**	**10% to 40%**	**30% to 70%**	**50% to 100%**
END USAGE Typical Purpose of Estimate	**Concept Screening**	**Study or Feasibility**	**Budget Authorization, or Control**	**Control or Bid / Tender**	**Check Estimate or Bid / Tender**
METHODOLOGY Typical estimating method	**Capacity Factored, Parametric Models, Judgment, or Analogy**	**Equipment Factored or Parametric Models**	**Semi-Detailed Unit Costs with Assembly Level Line Items**	**Detailed Unit Cost with Forced Detailed Take-Off**	**Detailed Unit Cost with Detailed Take-Off**
EXPECTED ACCURACY RANGE Typical variation in low and high ranges [a]	**L: -20% to -50%** **H: +30% to +100%**	**L: -15% to -30%** **H: +20% to +50%**	**L: -10% to -20%** **H: +10% to +30%**	**L: -5% to -15%** **H: +5% to +20%**	**L: -3% to -10%** **H: +3% to +15%**
PREPARATION EFFORT Typical degree of effort relative to least cost index of 1 [b]	**1**	**2 to 4**	**3 to 10**	**4 to 20**	**5 to 100**
REFINED CLASS DEFINITION	Class 5 estimates are generally prepared based on very limited information, and subsequently have very wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systematic manner. Class 5 estimates, due to the requirements of end use, may be prepared within a very limited amount of time and with very little effort expended - sometimes requiring less than 1 hour to prepare. Often, little more than proposed plant type, location, and capacity are known at the time of estimate preparation.	Class 4 estimates are generally prepared based on very limited information, and subsequently have very wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Typically, engineering is from 1% to 5% complete, and would comprise at a minimum the following: plant capacity, block schematics, indicated layout, process flow diagrams (PFDs) for main process systems and preliminary engineered process and utility equipment lists. Level of Project Definition Required: 1% to 15% of full project definition.	Class 3 estimates are generally prepared to form the basis for budget authorization, appropriation, and/or funding. As such, they typically form the initial control estimate against which all actual costs and resources will be monitored. Typically, engineering is from 10% to 40% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, preliminary piping and instrument diagrams, utility flow diagrams, preliminary piping and instrument diagrams, plot plan, developed layout drawings, and essentially complete engineering process and utility equipment lists. Level Of Project Definition Required: 10% to 40% of full project definition.	Class 2 estimates are generally prepared to form a detailed control baseline against which all project work is monitored in terms of cost and progress control. For contractors, this class of estimate is often used as the "bid" estimate to establish contract value. Typically, engineering is from 30% to 70% complete, and would comprise at a minimum the following: Process flow diagrams, utility flow diagrams, piping and instrument flow diagrams, heat and material balances, final plot plan, final layout drawings, complete engineered process and utility equipment lists, single line diagrams for electrical, electrical equipment and motor schedules, vendor quotations, detailed project execution plans, resourcing and work force plans, etc.	Class 1 estimates are generally prepared for discrete parts or sections of the total project rather than generating this level of detail for the entire project. The parts of the project estimated at this level of detail will typically be used by subcontractors for bids, or by owners for check estimates. The updated estimate is often referred to as the current control estimate and becomes the new baseline for cost/schedule control of the project. Class 1 estimates may be prepared for parts of the project to comprise a fair price estimate or bid check estimate to compare against a contractor's bid estimate, or to evaluate/dispute claims. Typically, engineering is from 50% to 100% complete, and would comprise virtually all engineering and design documentation of the project, and complete project execution and commissioning plans. Level for Project Definition Required: 50% to 100% of full project definition.
END USAGE DEFINED	Class 5 estimates are prepared for any number of strategic business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.	Class 4 estimates are prepared for a number of purposes, such as but not limited to, detailed strategic planning, business development, project screening at more developed stages, alternative scheme analysis, confirmation of economic and/or technical feasibility, and preliminary budget approval or approval to proceed to next stage.	Class 3 estimates are typically prepared to support full project funding requests, and become the first of the project phase "control estimate" against which all actual costs and resources will be monitored for variations to the budget. They are used as the project budget until replaced by more detailed estimates. In many owner organizations, a Class 3 estimate may be the last estimate required and could well form the only basis for cost/schedule control.	Class 2 estimates are typically prepared as the detailed control baseline against which all actual costs an resources will now be monitored for variation to the budget, and form a part of the change/variation control program.	Class 1 estimates are typically prepared to form a current control estimate to be used as the final control baseline against which all actual coasts and resources will now be monitored for variations to the budget, and form a part of the change/variation control program. They may be used to evaluate bid checking, to support vendor/contractor negotiations, or for claim evaluations and dispute resolution.
ESTIMATING METHODS USED	Class 5 estimates virtually always use stochastic estimating methods such as cost/capacity curves and factors, scale of operations factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, and other parametric and modeling techniques.	Class 4 estimates virtually always use stochastic estimating methods such as cost/capacity curves and factors, scale of operations factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, the Miller method, gross unit costs/ratios, and other parametric and modeling techniques.	Class 3 estimates usually involve more deterministic estimating methods that stochastic methods. They usually involve a high degree of unit cost line items, although these may be at an assembly level of detail rather than individual components. Factoring and other stochastic methods may be used to estimate less-significant areas of the project.	Class 2 estimates always involve a high degree of deterministic estimating methods. Class 2 estimates are prepared in great detail, and often involve tens of thousands of unit cost line items. For those areas of the project still undefined, an assumed level of detailed takeoff (forced detail) may be developed to use as line items in the estimate instead of relying on factoring methods.	Class 1 estimates involve the highest degree of deterministic estimating methods, and require a great amount of effort. Class 1 estimates are prepared in great detail, and thus are usually performed on only the most important or critical areas of the project. All items in the estimate are usually unit cost line items based on actual design quantities.
EXPECTED ACCURACY RANGE	Typical accuracy ranges for Class 5 estimates are -20% to -50% on the low side, and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.	Typical accuracy ranges for Class 4 estimates are -15% to -30% on the low side, and +20% to +50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.	Typical accuracy ranges for Class 3 estimates are -10% to -20% on the low side, and +10% to +30% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.	Typical accuracy ranges for Class 2 estimates are -5% to -15% on the low side, and +5% to +20% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.	Typical accuracy ranges for Class 1 estimates are -3% to -10% on the low side, and +3% to +15% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.
EFFORT TO PREPARE (for US$20MM project):	As little as 1 hour or less to prepare to perhaps more than 200 hours, depending on the project and the estimating methodology used.	Typically, as little as 20 hours or less to perhaps more than 300 hours, depending on the project and the estimating methodology used.	Typically, as little as 150 hours or less to perhaps more than 1500 hours, depending on the project and the estimating methodology used.	Typically, as little as 300 hours or less to perhaps more than 3000 hours, depending on the project and the estimating methodology used. Bid Estimates typically require more effort than estimates used for funding or control purposes	Class 1 estimates require the most effort to create, and as such are generally developed for only selected areas of the project, or for bidding purposes. A complete Class 1 estimate may involve as little as 600 hours or less, to perhaps more than 6,000 hours, depending on the project and the estimating methodology used. Bid estimate typically require more effort than estimates used for funding or control purposes.
ANSI Standard Reference Z94.2-1989 name; Alternate Estimate Names, Terms, Expressions, Synonyms:	Order of Magnitude Estimate; Ratio, ballpark, blue sky, seat-of-pants, ROM, idea study, prospect estimate, concession license estimate, guesstimate, rule-of thumb.	Budget Estimate; Screening, top-down, feasibility, authorization, factored, pre-design, pre-study.	Budget Estimate; Budget, scope, sanction, semi-detailed, authorization, preliminary control, concept study, development, basic engineering phase estimate, target estimate.	Definitive Estimate; Detailed Control, forced detail, execution phase, master control, engineering, bid, tender, change order estimate.	Definitive Estimate; Full detail, release, fall-out, tender, firm price, bottoms-up, final, detailed control, forced detail, execution phase, master control, fair price, definitive, change order estimate.

Estimate Class	Class 5	Class 4	Class 3	Class 2	Class 1
Estimate Input Checklist and Maturity Index	Class 5	Class 4	Class 3	Class 2	Class 1
GENERAL PROJECT DATA					
Project Scope Description	General	Preliminary	Defined	Defined	Defined
Plant Production / Facility Capacity	Assumed	Preliminary	Defined	Defined	Defined
Plant Location	General	Approximate	Specific	Specific	Specific
Soils & Hydrology	None	Preliminary	Defined	Defined	Defined
Integrated Project Plan	None	Preliminary	Defined	Defined	Defined
Project Master Schedule	None	Preliminary	Defined	Defined	Defined
Escalation Strategy	None	Preliminary	Defined	Defined	Defined
Work Breakdown Structure	None	Preliminary	Defined	Defined	Defined
Project Code of Accounts	None	Preliminary	Defined	Defined	Defined
Contracting Strategy	Assumed	Assumed	Preliminary	Defined	Defined

ENGINEERING DELIVERABLES:	Class 5	Class 4	Class 3	Class 2	Class 1
Block Flow Diagrams	Started / Preliminary	Preliminary / Complete	Complete	Complete	Complete
Plot Plans		Started	Preliminary / Complete	Complete	Complete
Process Flow Diagrams (PFDs)		Started / Preliminary	Preliminary / Complete	Complete	Complete
Utility Flow Diagrams (UFDs)		Started / Preliminary	Preliminary / Complete	Complete	Complete
Piping & Instrument Diagrams (P&IDS)		Started	Preliminary / Complete	Complete	Complete
Heat and Material Balances		Started	Preliminary / Complete	Complete	Complete
Process Equipment List		Started / Preliminary	Preliminary / Complete	Complete	Complete
Utility Equipment List		Started / Preliminary	Preliminary / Complete	Complete	Complete
Electrical One Line Drawings		Started / Preliminary	Preliminary / Complete	Complete	Complete
Specifications and Datasheets		Started	Preliminary / Complete	Complete	Complete
General Equipment Arrangement Drawings		Started	Preliminary / Complete	Complete	Complete
Spare Parts Lists			Started / Preliminary	Preliminary	Complete
Architectural Details / Schedules		Started	Preliminary / Complete	Complete	Complete
Structural Details		Started	Preliminary / Complete	Complete	Complete
Mechanical Discipline Drawings			Started	Preliminary	Preliminary / Complete
Electrical Discipline Drawings			Started	Preliminary	Preliminary / Complete
System Discipline Drawings			Started	Preliminary	Preliminary / Complete
Civil/Site Discipline Drawings			Started	Preliminary	Preliminary / Complete
Demolition Details		Started	Preliminary / Complete	Complete	Complete