Diurnal Flow Equalization
Business Case Evaluation

Sacramento Regional County Sanitation District

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1.0 Introduction

As part of the EchoWater Project facilities, a new secondary treatment facility, the Biological Nutrient Removal (BNR) structure, will be constructed directly north of the Carbonaceous Oxygenation (CO) tanks. The BNR will replace the CO Tanks as Regional San’s secondary treatment process. The purpose of this Business Case Evaluation (BCE) is to evaluate conversion of the CO Tanks for diurnal flow equalization.

1.1 Opportunity Statement

After the new BNR is operational, the existing CO Tanks will be removed from service and will be available for other uses. Implementation of diurnal flow equalization using the CO tanks could reduce energy and chemical use, thereby reducing annual operating costs as well as providing operational flexibility. The potential savings include:

1. Reduced energy for pumps that are flow paced and blowers that respond to carbonaceous and nitrogenous dissolved oxygen (DO) demand.
2. Reduced chlorine use for breakpoint chlorination to ensure compliance with the Alternative Title 22 Treatment Technology selection of free chlorine disinfection.
3. Reduced use of ESBs for diurnal primary effluent equalization storage needed for limiting summer flows to less than 217 mgd (tertiary filtration capacity) and, therefore, lower odor footprint and lower liquid phase chemical needs.
4. Reduced acetic acid chemical use for denitrification when carbon:nitrogen ratios are unfavorable.

In addition to the noted operating cost savings, using the CO tanks for diurnal flow equalization will be beneficial for operation of the Primary Effluent Pumping Station (PEPS). As it is currently designed, the water surface elevation in the primary effluent (PE) channel will be subject to rapid variations based upon the Sacramento Regional Wastewater Treatment Plant (SRWTP) influent flow rates. There is a risk that sudden high flows could cause the PE channel to rapidly rise, triggering the operation of the PE diversion gates to ESB-A, if the PEPS pumps cannot adjust quickly enough. To mitigate this risk, the PEPS pumps would need to include a sensitive control system that allow them to instantaneously ramp up/down to accommodate current flows. Such a control system would be difficult to implement with pumps of this size and would be expensive and it is not currently included in the design. If diurnal flow equalization is utilized, PE could be diverted from the PE channel to the CO tanks during high flows and pumped back into the PE channel when the peak flow has subsided to avoid rapid variations in the water surface elevation in the PE channel. This would reduce the risk of overflow in the PE channel and, thus, the need for the pumps to instantaneously adjust to flowrate changes.
2.0 Diurnal Flow Equalization Analysis

2.1.1 Diurnal Flow Variation Analysis

Actual 2008 through 2011 hourly influent flows for April through October were averaged for each hour to generate an average diurnal influent flow profile. The annual average flow (AAF) was determined to be 152 mgd. This profile was used to determine how much primary effluent storage capacity is required to conduct diurnal flow equalization.

The historic 2008 through 2011 average diurnal profile was scaled up to the expected 181-mgd dry weather capacity. The method simply up-scaled hourly flows using the ratio of 181 mgd:152 mgd to estimate the future and average hourly flows. This method relies on the raw influent diurnal flow pattern to the wastewater treatment plant remaining similar as currently experienced.

2.1.2 Diurnal Flow Patterns With and Without Equalization

Two alternatives exist for diurnal flow equalization: full equalization and limited equalization. Figure 1 provides a graph showing a 152-mgd ADWF with no, limited, and full diurnal flow equalization. Limited diurnal flow equalization refers to the use of the existing 27-mgd pumping station (Sump 404), whereas full diurnal flow equalization is based on adding a new pumping station such that there are no pumping limitations. This BCE is based on achieving partial diurnal flow equalization, thus no alternatives will include costs to upgrade Sump 404 to 60 mgd. Figure 2 provides a similar graph showing the flows at 181 ADWF.

![Figure 1. 152 ADWF Average Diurnal Flow Pattern April through October](image-url)
The volume required for limited diurnal flow equalization at 152-mgd ADWF is calculated to be 10 MG (or 5 CO Tanks), whereas 11 MG (6 CO tanks) will be required at 181-mgd ADWF. For full flow equalization, storage requirement would increase to 11 and 13 MG (6 and 7 CO Tanks), respectively.

2.1.3 Flows in and out of CO Tanks

With full diurnal flow equalization, the flows to and from the CO Tanks can range from 0 to 42 mgd at 152-mgd AAF. At buildout flows (196-mgd AAF), the flows to and from the CO Tanks will range from 0 to 56 mgd.

With limited diurnal flow equalization, the flows from the CO Tanks would be restricted to a maximum of approximately 27 mgd due to the capacity of the existing pumps in Sump 404. The headloss from Sump 404 to the PE Channel is expected to range from 0.5 foot to 38.0 feet due to the static head difference.

2.1.4 Equalization Constraints

For full equalization, the existing Sump 404 and CO Tank drains must drain and pump an instantaneous flow of up to 60 mgd from 7 CO Tanks. The drains, however, are not sized for this purpose and Sump 404 is not Hydraulic Institute (HI) compliant. Currently, the south CO Tanks are drained by a 30-inch line (two tanks per line); each 30-inch line connects to a 36-inch drain line to Sump 404. The north CO Tanks are individually drained via 30-inch pipelines connected to a main 36-inch drain to Sump 404. These drain lines can process the limited diurnal equalization return flow of 27 mgd.

Increased equalization can be realized by using an additional CO Tank (for a total of 7) and increasing the total PE return pumping capacity to 60 mgd. The PE return pumping may be
increased to 60 mgd in one of two ways: construct a 60-mgd pumping station or continue using Sump 404 and install a parallel 33-mgd pumping station. This BCE is based on achieving partial equalization. Neither alternative will include costs for upsizing the pump station to 60 mgd. Reference Appendix A for preliminary costs associated with upsizing Sump 404.

2.1.5 Controls

The flow in and out of the CO Tanks will be set to match the modeled flow pattern shown in Figures 1 and 2. The logic control with the PEPS pumps, PE Diversion gates, primary sedimentation tank (PST) gates, and PE channel level will also be required to maintain a set level in the PSTs.

2.1.6 Benefits

Primary effluent diurnal equalization would provide the following benefits:

2.1.6.1 Energy Savings

There are two types of energy savings; one is due to the peak energy demand period overlapping with the daily high flow periods and the other occurs when increased oxygen transfer rate occurs as a result of a lower peak daily flow. The first type of energy savings occurs by reallocating some flow from peak energy demand periods to off-peak periods.

The second type of energy savings occurs due to a more efficient aeration system. This is due to the air supply for operating at an equalized flow rate. As flow and, therefore, load increases, more dissolved oxygen is required, so additional blowers have to be started or higher blower speeds have to be operated to provide the necessary amount of air. This results in higher energy costs. In addition, aeration diffusers are more efficient at lower aeration flux (cfm/sqft diffuser). Equalizing the diurnal flow will reduce the aeration flux and thus improves energy use.

At the diurnal low flow, air flow is reduced to the minimum specified by the type of aeration diffuser or demand. At the startup condition (2020 flows), and the new diffusers installed, it is common that the low flow condition results in air demands that are less than the minimum required by the aeration diffusers and sometimes less than the aeration required for the minimum mixing criterion. This results in over-aeration of the MLSS and DO concentrations that are higher than setpoint. MLSS with higher DO concentrations are recycled to the anoxic zone and higher DO will reduce denitrification efficiency. Diurnal flow equalization would reduce or resolve this over-aeration issue during the starting condition as the low flows would be equalized. An estimate of the savings has been made based upon Figure 3.

The BNR pilot was operated for a short trial period with a simulated equalized flow beginning the afternoon of October 28, 2014. Aeration demand reduced as a result of the change to equalized influent flow as seen in Figure 3. Based on this data, the air flow rate was reduced by approximately 10 to 12 percent.
Chemical savings will be realized due to the decreased sodium hypochlorite requirements for disinfection. This occurs due to less fluctuating flows (due to the lower peak flows as shown in Figure 2), which then reduces the ammonia in the secondary effluent. The equalized flow reduces the chlorine demand as shown in Figure 4 and it reduces the acetic acid demand as shown in Figure 5.

A BioWin™ model was used to simulate the impacts of diurnal versus equalized flow on ammonia bleed through and breakpoint chlorination. The BioWin™ simulation model was based on the Pilot Phase II primary effluent feed characteristics and the projected diurnal flow at 181 mgd. A dynamic simulation was run and during the dynamic simulation the calculations were interrupted and the influent was converted from a diurnal flow pattern to a continuous 181-mgd flow pattern. For both cases, the hourly influent concentrations were taken as identical. This is an appropriate condition as higher flows typically carry higher loads that would produce a larger difference between equalized and diurnal flow operation.
Figure 4. 181-mgd BioWin™ Simulation of Equalized versus Diurnal Flow Chlorine Demand due to Breakpoint Chlorination

Figure 5. Pilot Operation in Diurnal and Equalized Flow – NO3-N Concentrations and Acetic Acid Pump Runtime
The difference in chlorine used for residual ammonia removal through breakpoint chlorination is approximately 1,000 pounds per day (lbs/d) but, as mentioned, this is based on a perfect model. In reality, the variable ammonia and TKN load will increase this chlorine requirement and, therefore, 2,000 lbs/d of additional chlorine at 181 mgd has been estimated for the purposes of the BCE (1.3 mg/L increased average dose).

Acetic acid used for carbon addition will also decrease with an equalized primary effluent. The BNR pilot acetic acid demand reduced during the short trial period mentioned previously with a simulated equalized primary effluent flow, as seen by the acetic acid pump run-time in Figure 5. Based on the data in Figure 5, the acetic acid dose was reduced by approximately 35 percent. Because influent conditions are never exactly the same, a value of 10 percent reduction (2mg/L) was used in the lifecycle cost analysis.

2.1.6.3 Non-Economic Benefits
Several non-cost impacts and potential savings are not considered in the life cycle cost analysis due to difficulties in quantifying and relative unknowns. These impacts are as follows:

- Operational reliability increases due to operators not needing to turn on/off equipment as flow varies on a daily basis.
- There are maintenance savings associated with reduced frequency of starting and stopping as each start causes peak loading of motor, starter, contactor and contacts. Although overloading lasts for only a few seconds, it reduces life of the equipment. Maintenance costs decreases due to a lowered on/off cycling of equipment.
- Lower risk of violations or diversions to ESBs due to increased hydraulic retention times in the secondary and tertiary treatment systems. Increased hydraulic retention time occurs due to lowered peak flows.
- Reduction of future diversion flows to ESB-A when dry weather peak flows exceed 217 mgd. This may occur in the summer when plant staff conduct maintenance work, which requires diversion to the ESBs. Flows may increase above 217 mgd when the stored water is returned through the plant.

In addition, an unquantified economic benefit of the diurnal equalization system is improved operation of the filters. In Figure 6, the number of filters required to be in operation for an un-equalized system is 17 (blue line) to process diurnal peak flows at the design dry weather filter loading rate of 6.3 gpm/sq.ft, while only 12 (red line) are required if flows are equalized. Operating 17 filters during dry weather periods is not preferred.

- If filter backwash is on a time based schedule, filtration efficiency (measured as: (product water ((product plus backwash water))) will be poor resulting in unnecessary flows through the PSTs and BNR processes.
Diurnal Flow Equalization
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- If filter headloss is used as the criteria to trigger a backwash, there will be problems with excess biological growth on filter media, media compression, and mud balls (the Easterly WWTP at Vacaville experienced similar problems with too many filters on-line and infrequent backwashing).

![Comparison of Number of Filters Required to Operate with and without Equalization](image)

**Figure 6: Number of Filters Required with and without Equalization**

Furthermore, the CO Tank Project is critical to achieving the NPDES NO. CA0077682 limits for disinfection byproducts and in particular Bromodichloromethane. Formation of disinfection byproducts is not well understood. However, what is known is that elevated free chlorine residual in combination with long residence times in the chlorine contact basin produces very high DBPs. As an example, in Figure 7, the Vacaville Easterly WWTP effluent Bromodichloromethane concentration for the past 5 years is plotted against the Regional San Average Month Effluent Limit (AMEL) and Maximum Day Effluent Limit (MDEL). The Easterly WWTP is a BNR facility that fully nitrifies ammonia and disinfects using sodium hypochlorite. In addition, the facility produces a conventional Title 22 effluent operating at a minimum 450 mg/L.min CT and minimum 5 mg/L Cl2 residual. (This facility has been used historically as a local example for projecting Regional San effluent quality for CEQA and other purposes). As seen from
the chart, this facility seldom produces effluent that would meet the Regional San AMEL or MDEL concentrations.

Without CO Tank equalization, 3 or ALL chlorine contact basins must be operated at all times to provide sufficient CT for the hourly maximum dry weather flows. With CO Tank equalization, a reduced number of chlorine contact tanks will be operated to optimize CT and reduce the potential of bromodichloromethane exceedances. Without CO Tank equalization, it is very likely that the Regional San effluent will exceed MDEL.

![Vacaville Easterly WWTP Bromodichloromethane (ug/L) and Regional San Limits](image)

**Figure 7: Vacaville Easterly WWTP Bromodichloromethane and Regional San Limits**

A final benefit of diurnal flow equalization is improving the ability to meet demands for the South County Ag Program. The South County Ag Program C-PMO is current evaluating the South County Ag Pumping Station (SCAPS) capacity. The anticipated peak pumping capacity range is between 75 MGD and 105 MGD. The SCAPS will deliver recycled water from the Sacramento Regional Wastewater Treatment (SRWTP) to farmers in Southern Sacramento County.

Based on a cursory review of SRWTP diurnal flows, the minimum diurnal flows are lower than the SCAPS pumping capacity range. Compounding this deficit is the need to
retain some plant effluent flow for internal plant needs. The minimum diurnal flows also correspond to the time period where there is peak demand when the farmers would need the flow during irrigation season (between 5 am and 10 am).

Based on this difference in supply and demand, the SCAPS pumping capacity would be restricted in the morning hours. The restriction would prevent the SCAPS from delivering between 15 and 45 million gallons per day during this time period depending on the size of the SCAPS. If there is PE flow equalization, this shortcoming can be eliminated by increasing the minimum diurnal flows and eliminating the flow deficit. All of these non-economic benefits would favor repurposing the CO Tanks for diurnal PE equalization.

3.0 Existing Equipment

Use of the CO Tanks would require mixing, odor control, and return pumping. Some of the existing equipment assets can be repurposed to fulfill these requirements.

3.1 Mixers

The stored volume in the CO Tanks should be mixed to re-suspend settled solids before transfer to the primary effluent channel. The existing mixers in each CO tank are oversized at 75 horsepower (hp) each, but these mixers could be operated intermittently (if acceptable), which is expected to be sufficient for proper functionality and be less expensive than removal and replacement. Alternatively, smaller mixers could be purchased and installed.

3.2 Odor Control

The existing secondary odor control tower (ORT) is located west of the site and is not in service. In lieu of this ORT, Regional San currently uses a mobile ventilation unit (MVU). The MVU uses activated carbon and is regularly recharged. However, the MVU is not appropriate for PE equalized storage tanks due to the headspace volume and moisture content of the odor from primary effluent (PE) storage.

The odor in the air space above the CO Tanks will be controlled by a vapor phase odor control method. The generation of vapor-phase H2S and liquid-phase sulfides in anaerobic conditions is a function of BOD5, temperature, pH and time. BOD5 will be lower than the influent BOD5 and, therefore, less likely to produce sulfides, but temperature and pH will be approximately the same as the influent, so sulfides may form. The time sewage remains in the basin is also equivalent to the liquid level or storage volume. Therefore, the highest H2S generation will occur when the basins are full and sewage has been stored for the longest time period. The volume of air to be treated under this condition for 6 tanks in operation; 4-foot head space and 3 air changes per hour would require a 12,000-cfm biofilter system. Addition of sidestream
effluent containing nitrate would reduce the need for odor control, but is not considered in this analysis.

Nitrate-rich sidestream injection at the CO Tanks will reduce odor treatment requirements. This savings credit is not used due to the fact that use of sidestream at the CO Tanks will take away nitrate from the plant influent stream and potentially increase odors at the PEPS odor control facility. Detailed analysis would be required to optimize sidestream use.

3.3 Sump 404 Dewatering Pumping Station
Sump 404 currently includes three (3) 100-hp pumps operating at 6,800 gallons per minute (gpm) at 40 feet total dynamic head (TDH). These pumps are single-speed pumps that originally discharged into the OI channel. The discharge of this pumping station has been relocated to the primary effluent channel. (The cost of this work was originally allocated to the CO Tank re-purposing project).

Sump 404 is also used to dewater the secondary sedimentation tanks (SSTs). Therefore, close coordination will be needed when equalizing PE and dewatering an SST.

4.0 Condition Assessment
The CO Tanks require rehabilitation of the structural components. Current assumptions include the repair of approximately 50 percent of the concrete surfaces and a need to coat all concrete surfaces. The actual condition of the concrete, Sump 404, RAS channel, and valves are not well known. Condition assessments have been completed on some of the tanks and repairs have been made. However, further condition assessments are needed to generate an in depth estimate on rehabilitating the CO Tanks.

5.0 Alternatives
The following alternatives were considered for the diurnal flow equalization project. Note: Except when otherwise noted, the costs included in this BCE are to convert all 13 CO tanks for diurnal flow equalization. Although all CO Tanks may not be used, this would allow for more operational flexibility. Costs would be reduced if the District chooses to convert fewer tanks.

5.1 Alternative 0: Decommission CO Tanks and Abandon in Place
This alternative includes decommissioning the CO Tanks.
5.2 Alternative 1: Diurnal Flow Equalization - Full Upgrades

Alternative 1 includes all of the upgrades necessary to permanently use the CO Tanks for diurnal flow equalization. Figure 6 is a schematic of Alternative 1 (and Alternative 2).

5.2.1 Capital Costs

Alternative 1 includes the following capital costs:

- Replace Sump 404 motors, install VFDs, and install instrumentation and controls.
- Install automatic gate(s) at the front of the OI channel to control flow into the CO Tanks. Shown in Figure 6.
- Add new mixers (4 per tank).
- Close CO Tank outlets (Remove 52 outlet gates and fill with concrete). Shown in Figure 6.
- Add level transmitters to CO Tanks 1-8 and 13 (CO Tanks 9-12 currently have level transmitters).
- Add actuators to 15 tank drain gates.
- Modify the inlet into each CO tank to allow ventilation. This requires demolition of the inlet air curtain and opening a hole in the tank wall for odor ventilation.
- Repair and coat concrete walls and cover for 6 CO Tanks. This is the most expensive component of the alternative and may be reduced if the newer CO Tanks 9-13 are used or if only 5 CO Tanks are initially converted (or both). Additional analysis would also
Figure 8. Alternative 1 & 2 Schematic
be required to determine the extent of CO Tank repair required; this may either increase or decrease the capital cost.

- Construct biofilter(s) for odor control located west of CO Tank 13 to be modeled after the Primary Effluent Pumping Station (PEPS) Odor Control Facility.

Programming and other commissioning costs have not been estimated.

5.3 Alternative 2: Diurnal Flow Equalization - Minimum Upgrades

Alternative 2 is a simplified version of Alternative 1. It includes only the minimum upgrades required to achieve diurnal flow equalization, thus reducing the initial capital cost. Alternative 2 is not a permanent solution, but could be used to evaluate the actual benefits of diurnal flow equalization. Since complete upgrades will not be made, there are risks associated with Alternative 2, which will be discussed in Section 5.3.2

5.3.1 Capital Costs

Alternative 2 includes the following capital costs:

- Close outlets for 13 CO Tanks (Remove 20 outlet gates on North CO deck tanks 9-13, the BNR contractor is sealing the outlets for South CO Deck). Shown in Figure 7.

- Install concrete weir wall in the OI Channel (see Jacobs Memorandum recommendation 4/30/2019)

- Add level transmitters to CO Tanks 1-8 and 13 (CO Tanks 9-12 currently have level transmitters).

- Add actuators to 15 tank drain gates.

Programming and other commissioning costs have not been estimated.

5.3.2 Risks

Alternative 2 is subject to the following risks:

- The existing CO Tanks are old and their current condition is unknown. No condition assessment or repair of the tanks will be completed and thus there is a risk of tank failure. Additional tank maintenance will likely be required.

- No new mixing equipment will be installed. The existing mixing equipment will be used to mix the primary effluent and prevent deposition of solids.
• New odor control facilities will not be installed. The PEPS biofilter and PE ORT will maintain slight negative pressure on the equalization tanks. Temporary ventilation will be required to access tanks for maintenance purposes.

6.0 Construction Timing

The CO Tanks Conversion Project is not on the Critical Path. However, potential coordination with the PEPS Designer will be required for the control logic setup. Conversion of the CO Tanks can only occur after the completion of the BNR/PEPS and RAS projects. Therefore, construction would likely occur in 2021. However, planning and design should be completed well before this time.

7.0 Economic Analysis

An economic analysis was performed for the various alternatives. All costs are based on 2021 dollars because that is when construction would likely occur.

7.1 Operations and Maintenance Savings

The O&M Labor costs include additional time to service and maintain new equipment. The chlorine savings are based upon saving approximately 2,000 pounds per day at $0.50/pound. The acetic acid savings are based on saving approximately 2,100 pounds per day at $0.65/pound. The energy cost includes a savings for reducing peak demand and additional costs for added run time of Sump 404. Table 1 shows the estimated annual operations and maintenance costs/savings, which would result from repurposing the CO Tanks for diurnal flow equalization:

<table>
<thead>
<tr>
<th>O&amp;M Labor</th>
<th>Chlorine Usage</th>
<th>Acetic Acid Usage</th>
<th>Energy</th>
<th>Total O&amp;M</th>
</tr>
</thead>
<tbody>
<tr>
<td>$60,000</td>
<td>-$450,000</td>
<td>-$597,000</td>
<td>$58,000</td>
<td>-$929,000</td>
</tr>
</tbody>
</table>

7.2 Lifecycle Cost Analysis

Alternative 0 requires minimal capital cost, but offers no future benefits. All alternatives include the cost of re-routing the Sump 404 discharge piping to the PE Channel. Alternative 1 also includes upgrading the Sump 404 motors and adding VFDs. Additional Sump 404 upgrade alternatives are described in Appendix A. The lifecycle costs for Alternatives 1 and 2 are each based on achieving partial diurnal flow equalization as shown in Figures 1 and 2. Two lifecycle costs were generated for Alternatives 1 and 2; the first assumes no reduction in acetic acid use and the second assumes a 10 percent reduction of acetic acid use. As noted above, it is difficult to quantify the actual reduction in acetic acid use, but based on the pilot testing results (which showed up to a 35 percent reduction of acetic acid), a 10 percent reduction is a conservative estimate. The following general assumptions were used in the lifecycle cost analysis:
• Inflation Rate: 3.0 percent
• Discount Rate: 5.0 percent
• Energy Escalation Rate: 5.0 percent
• Cost of Electricity: $0.09/kWh

Table 2 shows the results of the lifecycle cost analysis:

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Construction Cost</th>
<th>Total Capital Cost</th>
<th>Total Annual O&amp;M</th>
<th>Present Value (60 Year)</th>
<th>Present Value (20 Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – Status Quo: Decommission COTs</td>
<td>$324,000</td>
<td>$441,000</td>
<td>$0</td>
<td>$441,000.00</td>
<td>$441,000.00</td>
</tr>
<tr>
<td>1 – PE Diurnal Flow Equalization: Full Upgrade (No acetic acid reduction)</td>
<td>$16,058,000</td>
<td>$21,839,000</td>
<td>-$332,000</td>
<td>$12,100,000.00</td>
<td>$16,600,000.00</td>
</tr>
<tr>
<td>1 – PE Diurnal Flow Equalization: Full Upgrade (10% acetic acid reduction)</td>
<td>$16,058,000</td>
<td>$21,839,000</td>
<td>-$929,000</td>
<td>$6,600,000.00</td>
<td>$6,600,000.00</td>
</tr>
<tr>
<td>2 – PE Diurnal Flow Equalization: Minimum Upgrade (No acetic acid reduction)</td>
<td>$521,000</td>
<td>$709,000</td>
<td>-$332,000</td>
<td>$(9,100,000.00)</td>
<td>$(4,500,000.00)</td>
</tr>
<tr>
<td>2 – PE Diurnal Flow Equalization: Minimum Upgrade (10% acetic acid reduction)</td>
<td>$521,000</td>
<td>$709,000</td>
<td>-$929,000</td>
<td>$(30,500,000.00)</td>
<td>$(14,600,000.00)</td>
</tr>
</tbody>
</table>

8.0 Recommendation

Based upon the lifecycle cost analysis, it is recommended that the District proceed with Alternative 2 at this time. As previously noted, Alternative 2 is not a permanent solution and additional upgrades may eventually be required. However, Alternative 2 requires a significantly lower capital cost than Alternative 1. Therefore, if Alternative 2 was implemented, studies could be performed to determine the actual savings that result from using the CO Tanks for diurnal flow equalization. If the studies show that Diurnal Flow Equalization is effective, the District could then consider making additional improvements (i.e. repairing CO Tanks, installing new mixers, adding odor control facilities, upgrading Sump 404, etc.) to permanently convert the CO Tanks for diurnal flow equalization. Reference Appendix A for costs associated with upgrading Sump 404. If the studies show that diurnal flow equalization is not effective, the District could then proceed with decommissioning the CO Tanks and would avoid the high capital costs associated with a complete upgrade.
Appendix A

Jacobs Memorandum April 30, 2019
Carbonaceous Oxygen Tanks Conversion to Primary Effluent Equalization - Preliminary Design Memo
Appendix B

Capital Cost Estimate
Appendix C

Lifecycle Cost Analysis