

WASTEWATER TREATMENT PLANT MASTER PLAN

7. DESCRIPTION OF RECOMMENDED PROJECT

This chapter summarizes the recommended projects for upgrading the Napa Sanitation District (District) Wastewater Treatment Plant (WWTP) to address existing deficiencies, improve redundancy of key facilities, and add capacity. Proposed improvements would accommodate growth and both existing and possible future, more stringent discharge requirements. The improvements would also deliver more recycled water when needed to accommodate increased demand.

7.1 Trigger Points for WWTP Improvements or Expansion

To respond appropriately to future changes, such as additional connections or changes in load contributed by existing customers, the District needs to recognize what conditions could require changes such as adding more WWTP components or upgrading existing components. The District must also understand when a project must come online so that sufficient lead time to initiate planning, design and construction can be established. Previous Wastewater Treatment Plant Master Plan (Plan) chapters have defined existing capacity, capacity limitations, and projects that would increase capacity. This section presents and discusses potential triggers for District action. Section 7.2 describes a time range for project implementation. Later sections lay out existing capacities and show triggers for changes. The reader should note that some WWTP improvement projects are not triggered by future events but address current deficiencies identified through master planning.

As stated above, many trigger points in the Plan, such as organic loading treatment or hydraulic transfer, are linked to capacity. To establish a set of trigger dates within the Plan, planning presented herein assumed that growth defined in the City and County General Plans would occur over the next 20 years. If growth is delayed, the District would reach identified triggers at later dates. Conversely, if growth occurs earlier than projected, capacity triggers would be reached earlier. In addition, increasing wastewater strength without growth could also trigger projects earlier. And if the District was to annex new areas with additional demands outside the existing service boundary, the total ultimate required capacity would increase beyond that identified in the Plan. Such a change would require new studies to define extra capacity needs in the WWTP and how best to reach them.

Based on the recommended alternative, District staff and its consultants have identified several potential triggers that require implementing major projects, e.g., new effluent filters. The Plan specifically addresses these triggers, which include:

- Peak hour wet weather flow (PHWWF) capacity deficiencies.
- Increased influent biochemical oxygen demand (BOD) and total suspended solids (TSS) loading.

- Increased WWTP influent flows.
- Increased recycled water demand.
- Possible future regulatory changes to lower ammonia limits.
- Equipment redundancy for risk mitigation and maintenance purposes.
- Improvements to upgrade aging facilities to address equipment wear or deterioration.
- Improvements to enhance operations.
- District acceptance of fats, oils and grease (FOG); and winery wastes at the WWTP (added to either or both the solids systems and oxidation ponds)

District staff and its consultants also recognize that factors beyond those listed above could lead to new projects or new project triggers beyond those shown in the Plan. For example, development not included in the City of Napa and/or Napa County planning documents could lead to additional projects because construction could generate new sewage flows while simultaneously increasing recycled water demands beyond the ultimate capacity defined in the Plan. The District also could decide to accelerate planned projects because it could borrow money at highly competitive rates, or it could take advantage of a favorable bidding climate and/or available special grant funding.

The projected flows and loads developed in Chapter 2 served as the basis for the project trigger charts. Future flow and load projections do not, however, dictate a specific calendar time frame for implementing any portion of the Plan. The District will construct future treatment facilities as needed in incremental stages over the planning period as it realizes or firmly projects actual increases in wastewater flows and loads. Flow and load triggers to start new facilities are established based on the lead time required to design and construct them, the projected growth rate, and existing facilities capacity limitations. The District will track its flows and loads, together with any regulatory changes and increased demands or contracts for delivery of recycled water, and adjust the timing of expansion or upgrade projects accordingly.

Where the District currently has no basis for selecting timing, such as with recycled water demand, capacity serves as a surrogate for calendar dates.

7.2 Implementation Activities

Implementation activities for any project include some or all of the following, with required time as noted:

- **Pre-design Planning.** This activity typically would take three to six months but could extend to 18 months if a project requires pilot testing or full-scale demonstration. Some smaller projects may not require any pre-design activities, with detailed project definition occurring during the design.
- **Design.** For smaller projects the design time could be as short as three months. Typical design time would be nine to 12 months.
- **Bidding and Award.** The bidding and award time will vary depending on project size and District requirements. Bidding typically requires one to two months, as does awarding, depending on District Board schedules. Thus, this activity's overall time frame is two to four months.

- **Construction.** Construction duration reflects construction complexity and lead time required for key equipment. Typical durations range from six months or less for smaller projects without specialty equipment to up to 20 months for a major project, possibly with complicated tie-ins to existing facilities.
- **Commissioning.** Commissioning times vary widely from several weeks to several months. For example, commissioning often includes substantial time for staff training; however, none of the recommended projects defined through master planning include completely new processes for which District staff would need such training.
- **Environmental Review and Permitting.** In general, Plan projects will be completed onsite with little or no offsite impact, so little is expected for environmental review and permitting. If the District determines that a project requires environmental review, related activities could add between three to six months to the project schedule, although a substantial portion of environmental review could occur in parallel with other predesign activities. Most projects will require a negative declaration determination by the District Board, which may require a public comment period of one month and adoption at a subsequent meeting. Permitting will be minimal, though it should be noted that expanding the recycled water system may require updating the Engineer's Report for California Department of Public Health and Regional Water Quality Control Board, San Francisco Bay Region, which may require two to three months to review.

In summary, the District could implement smaller projects in as little as nine months, while the most complex projects could take almost four years if the District needs to carry out detailed environmental review. Preliminary estimated schedules for individual projects are presented later in this chapter.

7.3 Capacity Triggers

Five potential project triggers discussed in Section 7.1 are capacity triggers. Because of the parallel processes at the WWTP, these capacity triggers can require projects in different WWTP areas. This section shows the capacity trigger charts, which indicate when projects must both start and reach completion. Project descriptions in Section 7.4 include discussions of implementation times for each project. The following sections describe each project by WWTP area and include the trigger values to begin design. The District should track WWTP flows and loadings against the trigger charts annually to reassess project timing.

7.3.1 PHWWF Trigger

The influent pump station (IPS) limits WWTP PHWWF capacity. The existing IPS has a reliable (firm) capacity with one pump out of service of 25 million gallons per day (mgd), significantly less than current peak flows as shown in Figure 7-1. Together, the downstream facilities (the headworks and the diversion pipeline to the ponds) have the capacity to convey projected PHWWF. Owing to the current, limited firm capacity, the District needs to initiate this project on an accelerated schedule. The future PHWWF depends on the success of collection system infiltration/inflow (I/I) improvements and capacity improvements. The District should monitor PHWWF and trigger additional IPS projects if PHWWF increases further.

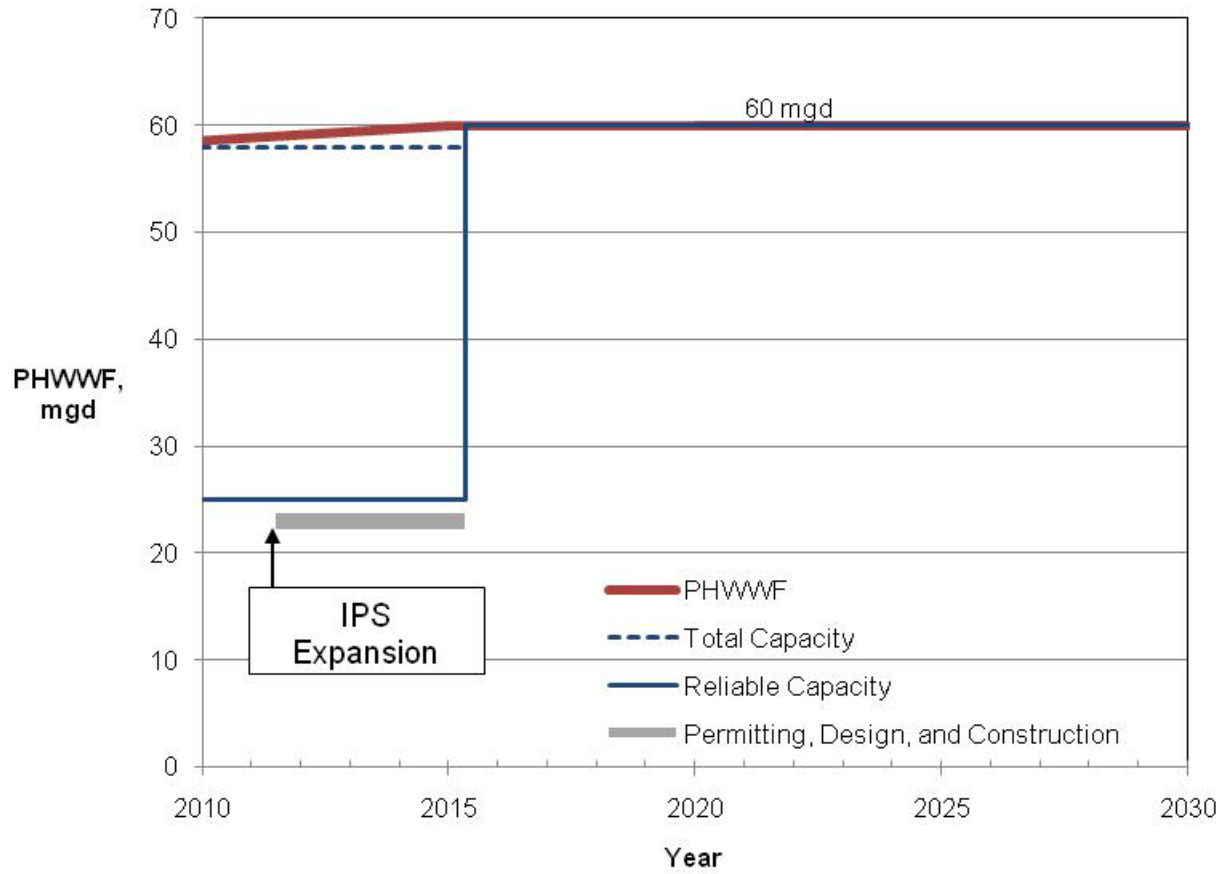


Figure 7-1. Peak Hour Flow Triggers
PHWWF increases trigger projects. Dates shown represent projections.

7.3.2 BOD Loading Trigger

The WWTP BOD capacity is limited by the combined pond and activated sludge capacity. Several BOD loading scenarios were analyzed during the capacity and alternatives analysis, including average dry weather maximum month BOD loading and average wet weather maximum month (AWWMM) BOD loading. AWWMM BOD loading (the running 30-day average of BOD loading) was found to be the limiting parameter. AWWMM BOD loading was converted to average annual (AA) BOD loading using the loading relationships shown in Table 2-13.

As shown in Figure 7-2, BOD loading triggers projects in different areas of the WWTP over the planning period. Converting to step-feed is already underway. The District should monitor AA BOD loading and trigger new projects based on Figure 7-2.

7.3.3 River Discharge Flow Triggers

River discharge flow is limited by flocculating clarifier, activated sludge, Pond 4 pump station, and pond water direct filtration capacities. Analyses also considered secondary effluent pumping and chlorine contact capacity and hydraulics. To control pond levels during wet weather, the required river discharge capacity during wet weather was set to equal the AWWMM flow. Thus whatever wastewater entered the WWTP would be treated and discharged. AWWMM flow was converted to average dry weather flow (ADWF) using the relationships shown in Table 2-13. Available river discharge flow is also shown for low influent flows when the activated sludge flow is limited. Based on water balance results, these river discharge capacities are sufficient.

As shown in Figure 7-3, river discharge flow capacity triggers projects throughout the WWTP. Some of these projects (new filters and aeration basin expansion) are expected to be triggered by other factors (recycled water demand or loading) before river discharge flows would trigger their construction.

7.3.4 Recycled Water Demand Triggers

Recycled water production capacity is limited by several processes, including filtration capacity, disinfection capacity, and available secondary effluent flows. Projected recycled water demands are not related to the growth-based influent flow and loading projections, but depend on District addition of customers. The exact timing of the recycled water demand increases is beyond the scope of the Plan; therefore, the chart shown in Figure 7-4 does not show project timing, but illustrates the total capacity after each project. Figure 7-4 also shows the available recycled water based on current ADWFs. The full capacity of many projects can not be used until ADWFs increase. Latter sections discuss the lead time for each project. Projects that increase capacity are shown in logical increments based on the existing facilities' capacities, although future demands may necessitate different phasing.

The existing filters are at capacity under current peak-day reclamation demands that occur during dry weather (5.1 mgd). Since designing and constructing new filters may take almost four years, an interim project to test whether filtration rates improve when flocculating clarifier effluent is treated in the activated sludge process is shown. This full-scale pilot test only requires some

pipings modifications and has the potential to increase existing filter capacity until new facilities are available. Results could be incorporated into the design of new filter facilities.

Chapter 2 discusses potential recycled water demands, including the peak recycled water demands for various scenarios resulting from the water balance. To maximize water delivery with current ADWF (median yearly supply of 3,700 acre-feet [AF]), a peak filter capacity of 11.0 mgd is required. With increased ADWF, required capacity increases to 12.1 mgd (2020 ADWF; 4,000 AF). Since the District expects to maximize delivery as soon as possible, the Phase 1 recycled water project is expected to be implemented immediately. Timing of the Phase 2 project will depend on recycled water demand.

7.3.5 Solids Handling Demands

Solids handling capacity is limited by the digester. Projected sludge loadings are shown based on influent flow and loading projections. Projected sludge loadings include both primary and waste activated sludge based on process modeling results. Since primary sludge accounts for more than 60 percent of the projected sludge loading, an approximate relationship to AA TSS loading is shown as the trigger for digester expansion. Projected sludge loadings do not include District acceptance of non-traditional wastes. If non-traditional wastes are accepted, digester expansion would be required sooner. Figure 7-5 shows projects triggered by AA TSS loading. Total sludge loading is shown for reference; the Plan recommends that monthly digester loadings be monitored also.

The District expects to add FOG to the digesters to increase gas production and optimize the cogeneration engine operation (HDR Energy Study, 2010). The District's objective would be to add sufficient FOG so that the existing cogeneration system would generate power at its maximum name plate continuous capacity. Existing digestion capacity would allow the District to add about 3,000 pounds per day (lb/day) of volatile solids during maximum month loading conditions.

7.3.6 Sensitivity Analysis

A sensitivity analysis has been performed to clarify the impacts to the recommended capital improvement program (CIP) of development occurring at rates greater than and less than the projected development rate in. The results show how slower or faster growth rates would impact the phasing for major capital projects needed to increase the WWTP capacity and hence the CIP. This sensitivity analysis shows the base scenario that follows the population and growth assumptions developed for the Collection System Master Plan and carried over into the WWTP Plan. It also shows a slow growth scenario—150 fewer equivalent dwelling units (EDUs) each year and a fast growth scenario—150 more EDUs each year. Table 7-1 and Figure 7-6 present the approximate start and completion dates for five major CIP projects for the three growth scenarios. Figure 7-6 also indicates the approximate duration for the major projects, with the duration rounded up to the nearest calendar year. With the slow growth rate the WWTP would reach capacity in about 2036 compared to about 2030 for the Plan growth rate, and about 2026 for the fast growth rate.

Table 7-1. WWTP Improvement Projects for Three Growth Scenarios

	Project	Projected Growth	High Growth (150 EDU per year more than projected)	Low Growth (150 EDU per year less than projected)
A	Floc Clarifier Weirs	2011 – 2012	2011 –2012	2011 –2012
B	Pond Aerators	2011 – 2013	2011 –2013	2017 –2019
C	Phase 1 Filters	2013 –2018	2011 –2016	2017 –2022
D	New Digester	2019 –2023	2017 –2021	2022 –2026
E	Aeration Basin	2021 – 2025	2018 –2022	2025 –2029

Note: Project durations rounded up to whole years. Figure 7-6 shows project durations.

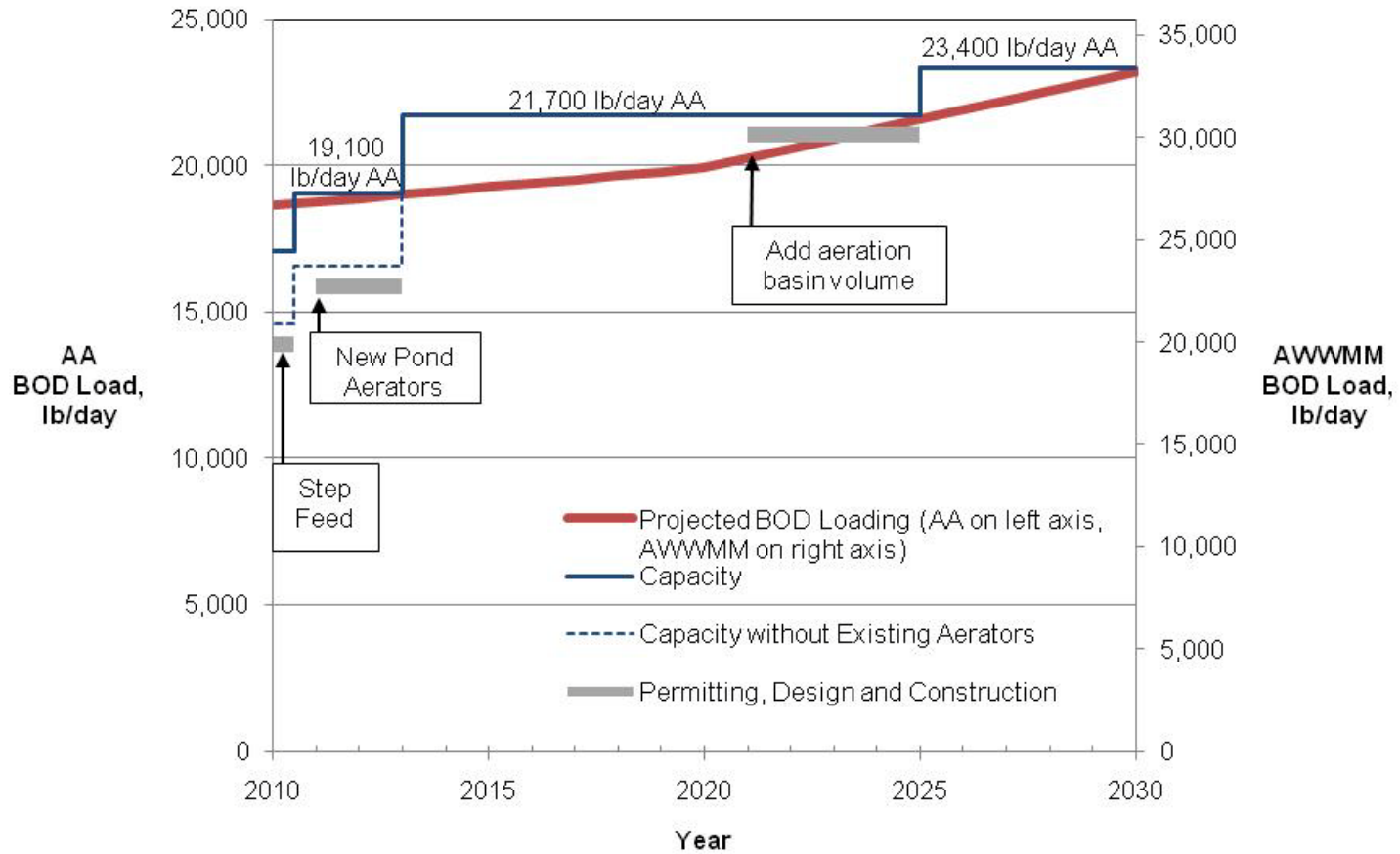


Figure 7-2. BOD Loading Triggers
 AA BOD Load increases trigger projects. Dates shown represent projections.

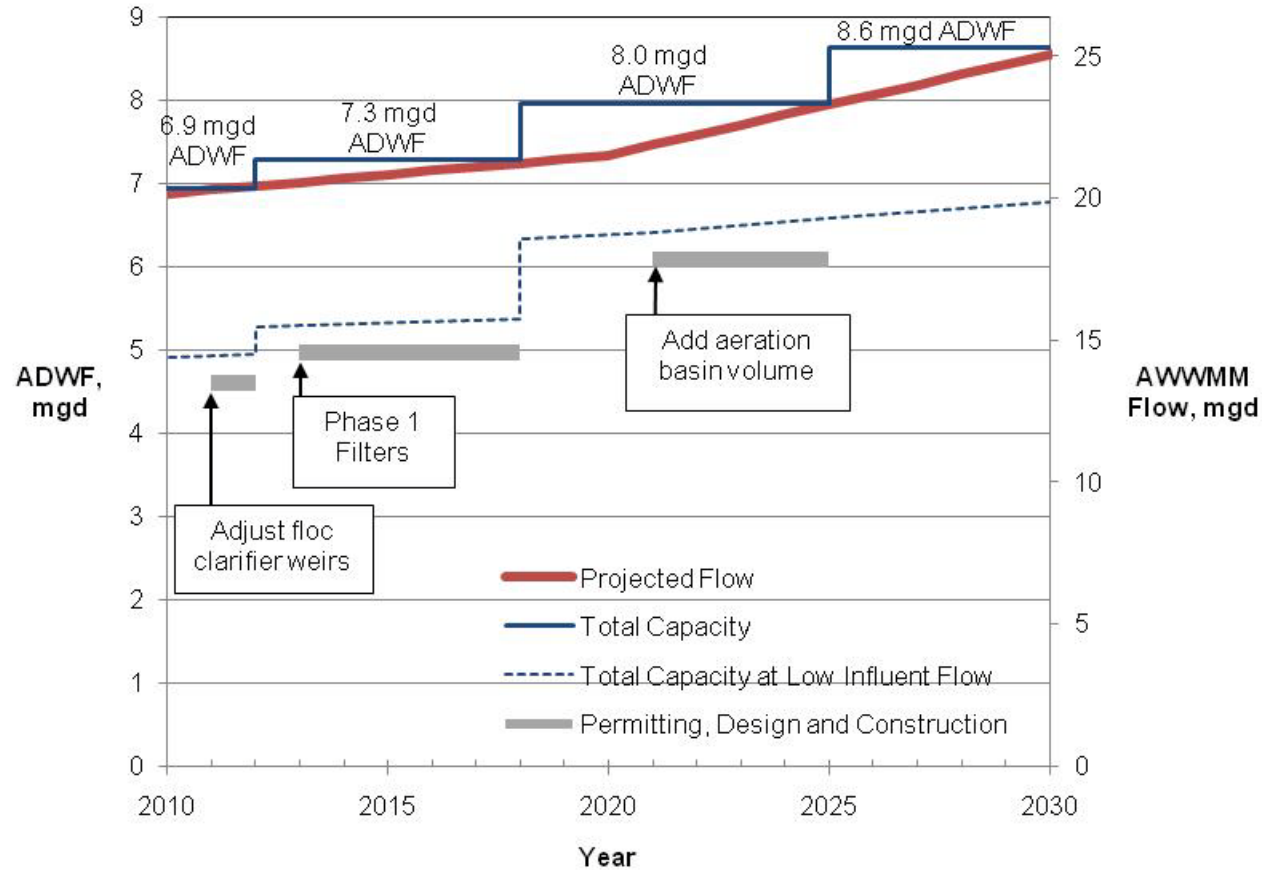


Figure 7-3. River Discharge Flow Triggers

ADWF increases trigger projects. Required river discharge flow is assumed to equal AWWMMF in order to maintain pond levels during a maximum month influent flow. Dates shown represent projections.

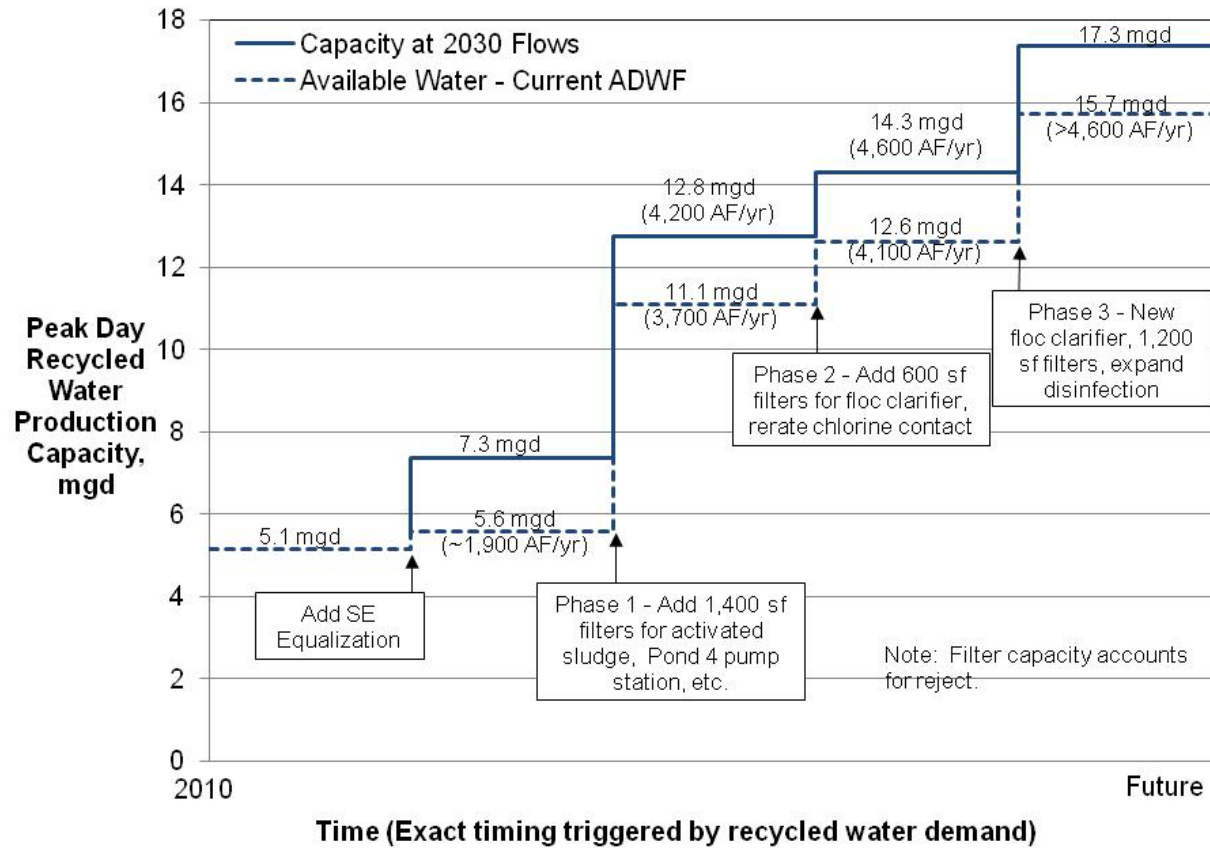


Figure 7-4. Recycled Water Project Capacities

Recycled water from activated sludge is limited to the ADWF into the WWTP.

Available water for current ADWF shows potential recycled water production with current ADWF. Capacity shows the installed capacity, which is equivalent to the available water at the 2030 ADWF.

Average yearly water supply capacity in AF is estimated based on the peak 30-day demand from the water balance model for the 10-year return frequency dry year, without any delivery curtailment.

Further delivery curtailment may be required during peak week demand conditions

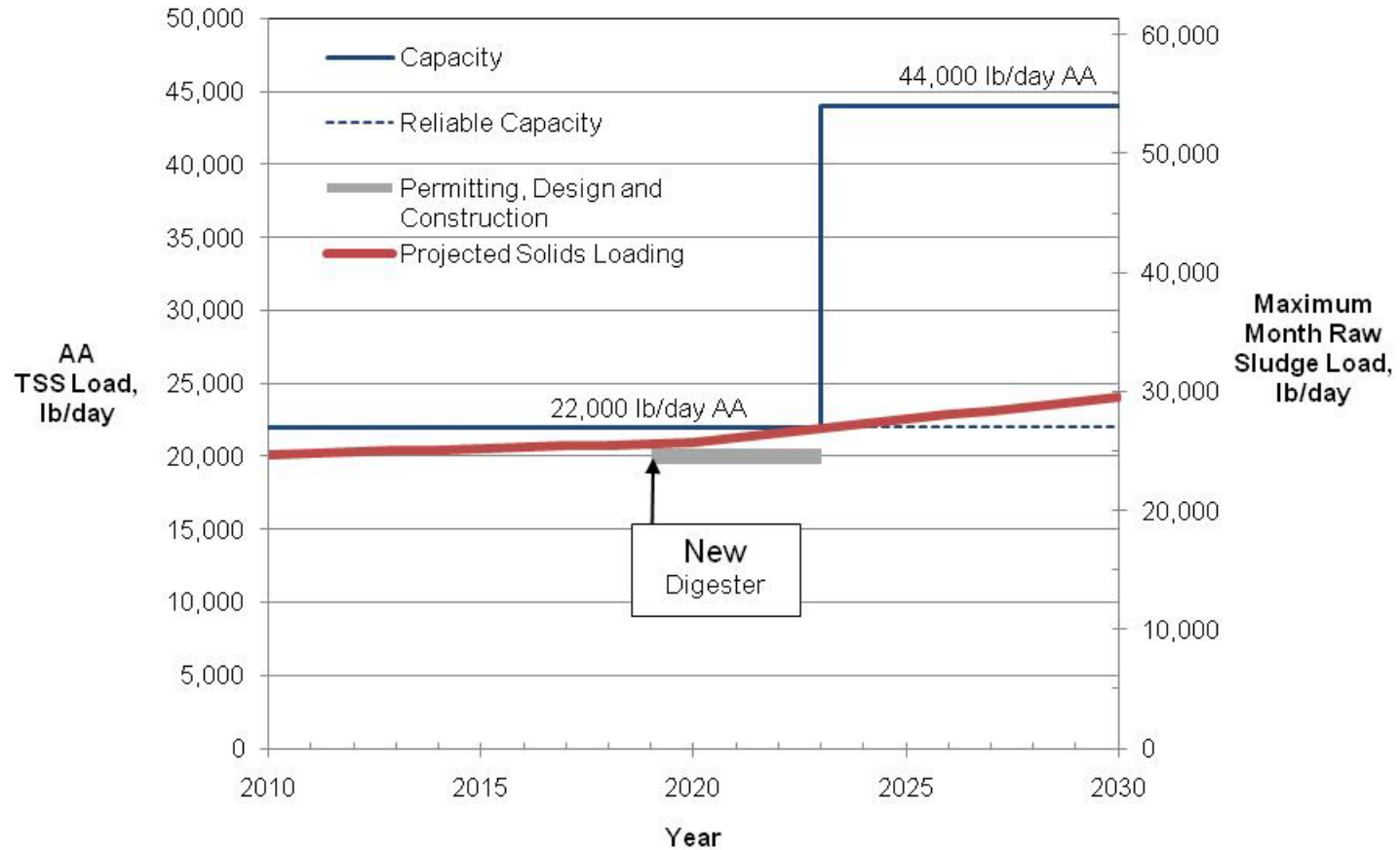


Figure 7-5. Solids Handling Triggers

AA TSS loading triggers projects. AA TSS loading does not include non-traditional wastes. Monitoring monthly raw sludge load to the digester is recommended. Dates shown represent projections.

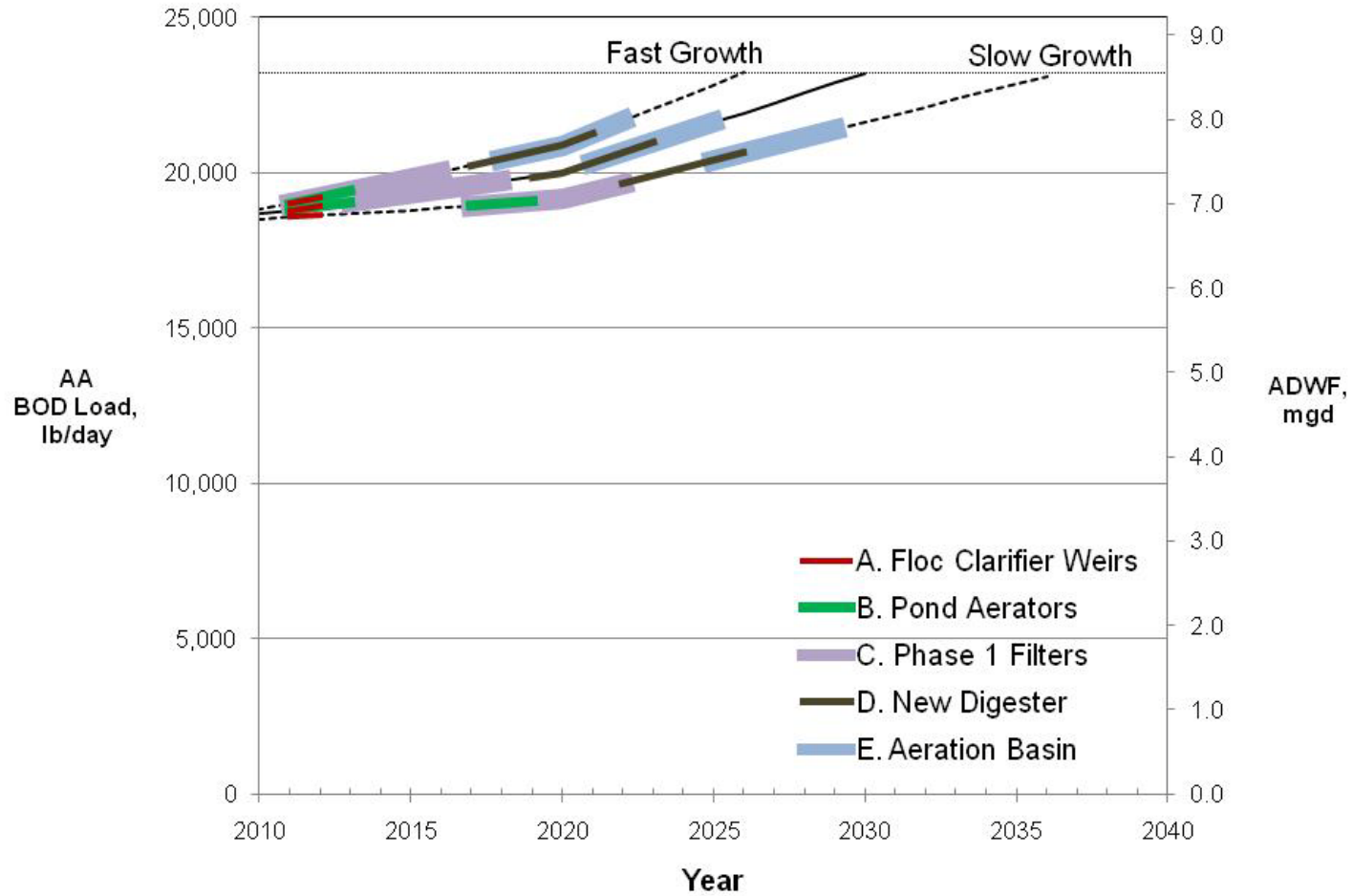


Figure 7-6. WWTP Improvement Projects for Three Growth Scenarios
 The figure shows project durations. Table 7-1 shows project start and completion dates.

7.4 Project Description

This section describes the recommended projects and includes project triggers and implementation time.

7.4.1 Influent Pumping

The IPS evaluation is based on the PHWWF pumping capacity into the WWTP. With one pump out of service, the existing IPS has a reliable capacity of 25 mgd, significantly less than current peak flows. Based on direction from District staff concerning planning for expected peak flows, improvements to the IPS will increase capacity to pump the projected PHWWF through 2030 (60 mgd), as shown in Figure 7-1. The 60-mgd PHWWF depends on the success of collection system I/I improvements and capacity improvements. According to the Collection System Master Plan (Winzler & Kelly, October 2007), the PHWWF could be as high as 90 mgd, if I/I improvements are not successful and collection system conveyance capacity constraints are addressed so the peak flows from a 10-year storm reach the WWTP.

The recommended IPS expansion project includes constructing a new pump station adjacent to the existing IPS with both dry weather flow and wet weather flow pumps. During the preliminary IPS design more detailed analyses will determine whether the existing pump station structure could be salvaged and reused only for pumping dry weather flows, to reduce overall project costs. The project is described in the technical memorandum “IPS Seismic Study and Replacement” (Winzler and Kelly, May 2009). The upgraded IPS would have a firm capacity of 60 mgd.

The IPS design will provide room for expanding the firm capacity to as much as 90 mgd in the future. District staff will monitor how influent flows change as the District implements collection system improvements and decide later whether to increase IPS capacity beyond 60 mgd. Note that if the IPS is expanded beyond 77 mgd, the capacity of the pond diversion pipeline would need to be increased to convey the additional flow.

The IPS project includes programming costs to automate the gate at Manhole 9 so that diversion to Pond 1 during wet weather events can be controlled automatically through the WWTP supervisory control and data acquisition (SCADA) system.

The IPS will require up to 48 months for permitting, design and construction, including:

- Six months for predesign.
- 12 months for design.
- Six months beyond design completion for environmental permitting.
- Four months for bidding and award.
- 20 months for construction and commissioning.

Since the IPS is already operating beyond reliable capacity, the project should begin immediately and be completed by 2015.

7.4.2 Headworks

The headworks improvement project would increase capacity to 20 mgd (existing capacity is 15.1 mgd) and address condition issues. The project includes:

- Replacing grit pumps, grit classifiers and washer compactors.
- Replacing screens.
- Increasing knife gate valve size on headworks hopper and modifying the hopper.
- Raising the headworks overflow weir.

Headworks improvements will require up to 25 months for design and construction, and include:

- Four months for predesign.
- Six months for design.
- Three months beyond design completion for environmental permitting.
- Three months for bidding and award.
- Nine months for construction and commissioning.

This project is triggered by the equipment's age and condition. Based on wastewater industry experience, the equipment is estimated to have a useful life of 15 to 20 years. Since it was installed in 2001 and shows signs of significant wear, predesign should begin in 2014 to achieve completion by 2016.

7.4.3 Primary Treatment

The primary treatment improvements include:

- Modifying the primary scum box piping.
- Lowering the primary diversion structure weir.
- Programming automatic primary scum pumps to shut off when high water levels are reached in the primary clarifiers.

The primary treatment improvements would enhance operation and increase capacity to 20 mgd (existing capacity is 17 mgd) and would require approximately 22 months for design and construction, including:

- Four months for predesign.
- Six months for design.
- Three months beyond design completion for environmental permitting.
- Three months for bidding and award.
- Six months for construction and commissioning.

The primary treatment improvements are needed to improve system operation at high flows and to enhance operation. Since the capacity increase can only be realized when headworks modifications are also completed, predesign should begin in 2014 to achieve completion by 2016. This schedule matches the schedule for headworks improvements.

7.4.4 Activated Sludge

Three different activated sludge projects are included, as described below. Because the activated sludge system has already been converted to step-feed mode, that project is not described.

7.4.4.1 Diffuser Replacement and Programming Improvements

The diffuser replacement project includes:

- Replacing the activated sludge panel diffusers with a new type of diffuser that can transfer more oxygen.
- Automating the air drop leg valves.
- Programming the blower aeration to address surge issues.
- Programming the return activated sludge (RAS) pumping to maintain a minimum RAS flow.
- Adding mixers to aeration basin compartments as required based on additional analyses.

The diffuser replacement project will require approximately 25 months for design and construction, including:

- Four months for predesign to determine best type of diffuser to meet oxygen transfer requirements, especially given ongoing technological improvements.
- Six months for design.
- Three months beyond design completion for environmental permitting.
- Three months for bidding and award.
- Nine months for construction and commissioning.

This project is needed to improve activated sludge operation. A previous study (Carollo Engineers, October 2008) identified the need to replace the existing diffusers with units that can achieve higher flux rates and satisfy aeration demands year round. The process optimization conducted during the Plan has confirmed that the existing panel diffusers are successfully operating above their rated flux in some compartments, even though this mode will decrease the life of the diffusers and reduce oxygen transfer efficiency. In 2008, the District replaced diffuser membranes. The diffusers will reach the end of their useful life in five to seven years, at which time replacement with a new diffuser system rated for a higher flux is recommended. For the diffusers to be in place when the existing membranes reach the end of their useful life, predesign should begin in 2011.

7.4.4.2 Additional Aeration Basin Volume

The aeration basin expansion project includes:

- Constructing a 0.66-million-gallon (MG) aeration tank, equal in size to Compartment No. 6 of the existing aeration basins. The new basin will be designed for future expansion (beyond the planning period) so that it also would function as part of a full third aeration basin.
- Modifying the primary effluent and RAS piping and distribution to configure the activated sludge system to operate in step-feed mode with the new aeration tank.

After completing the aeration basin expansion and projects scheduled for earlier completion (increase pond aeration, adjust flocculating clarifier weirs, expand Pond 4 pump station, and add 1,400 square feet of filters), the WWTP will have an AA BOD loading capacity of 23,400 lb/day (8.6 mgd ADWF, based on flow and loading projections defined for the project) .

The aeration basin project does not include a new blower. The existing system includes two high-speed turbine blowers and one standby multi-stage centrifugal blower. Together, the existing high-speed blowers have sufficient capacity for the expanded aeration basin. The District would continue to use the centrifugal blower as a standby.

The aeration basin project will require up to 40 months for design and construction, including:

- Six months for predesign to confirm that wastewater characterization and loading requirements have not significantly changed since the time of this Plan.
- 12 months for design.
- 12 months for an Initial Study/Project Specific Environmental Impact Report, with six months extending beyond design completion.
- Four months for bidding and award.
- 12 months for construction and commissioning.

Capacity needs would trigger this project. Based on current flow and loading projections, the new aeration basin needs to be on line to accommodate loading increases when AA BOD loading exceeds about 21,700 lb/day (approximately 8.0 mgd ADWF, projected to occur in 2025), or when ADWF exceeds 8.0 mgd to accommodate river discharge capacity requirements (approximately 2025). Thus, the District should track both ADWF and AA BOD loading and their growth trends, since either parameter could trigger the project if future flow and loadings differ from Plan projections.

For the aeration basin to be in service when the capacity is required, design should begin either when AA BOD loading reaches about 20,200 lb/day or when ADWF reaches about 7.5 mgd.

7.4.5 Oxidation Ponds and Flocculating Clarifiers

The recommended project would include four different facultative pond and flocculating clarifier projects, as described below.

7.4.5.1 Pond Improvements

Previous evaluation of the pond system (Brown and Caldwell, July 2008b) identified deficiencies with the existing pond system, including failing or failed inlet structure and Pond 1 distribution piping and transfer structures. Those analyses also defined and developed costs for proposed solutions, which included new piping to allow recycling Pond 4 effluent to the Pond 1 influent before coagulant is added to flow routed to the flocculating clarifier.

The pond improvements project includes:

- Replacing the inflatable plug on the Pond 1 pipeline with an isolation valve.
- Replacing the pond transfer structures.
- Replacing the Pond 1 inlet structure and distribution piping.

- Replacing the existing aerators.

The District likely would divide this work into two phases, the first limited to replacing a couple transfer structures between Ponds 1 and 2 as an immediate need, and the second for all other work listed above.

The transfer structures, constructed of corrugated metal pipe in the late 1960s, no longer have functioning control gates and have released odors caused by decomposing trapped algae. Based on the Brown and Caldwell July 2008b Technical Memorandum, the recommended project includes four new transfer structures between Ponds 1 and 2, and single transfer structures between Ponds 2 and 3 and 3 and 4. Each transfer structure will have a manually set control valve to allow the operators to control pond level. During the predesign for this improvement, the District should explore options for inlet flow distribution and aerator type and locations. The next addition is about 100 horsepower (hp) of replacement aeration capacity.

The pond improvements will require up to 25 months for permitting, design and construction, including:

- Four months for predesign.
- Six months for design.
- Three months beyond design completion for environmental permitting.
- Three months for bidding and award.
- Nine months for construction and commissioning.

The District CIP already includes pond transfer structure replacement scheduled for completion by 2013. The District recently reconditioned the Pond 1 inlet structure. This work should extend its service life by five to 15 years. Thus, the District needs to monitor the inlet structure condition and schedule its design and new inlet facilities construction accordingly.

7.4.5.2 Flocculating Clarifier Weirs

The flocculating clarifier weir project raises the radial and effluent weirs by approximately 3 inches to increase the hydraulic capacity. Emphasis should be placed on confirming that weir placements are accurately leveled during construction to help ensure an even flow split between the clarifiers. The project also includes raising the scum boxes and skimmers.

With the flocculating clarifier weir project completed, the WWTP will have a river discharge capacity of 21.3 mgd (equivalent to an ADWF of 7.3 mgd.)

The flocculating clarifier weir project will require up to 10 months for design and construction, including:

- Four months for design.
- Three months for bidding and award.
- Three months for construction and commissioning.

This project is triggered by river discharge capacity needs. Based on current flows, this project is needed immediately.

7.4.5.3 Increase Pond Aeration

This project adds an additional 125-hp of aeration to the ponds to increase BOD loading capacity.

After the pond aerators are installed, the WWTP will have an AA BOD loading capacity of 19,100 lb/day. The additional aerators increase AA BOD loading capacity by approximately 2,700 lb/day (5,600 equivalent dwelling units).

The pond aeration project will require up to 23 months for permitting, design and construction, including:

- Three months for predesign.
- Five months for design.
- Three months beyond design completion for environmental permitting.
- Three months for bidding and award.
- Nine months for construction and commissioning.

This project is triggered by BOD loading capacity. Based on current loading projections, the new aerators need to be on line when AA BOD loading exceeds about 19,100 lb/day (2014). Design should begin when AA BOD loading reaches about 18,700 lb/day.

7.4.5.4 Phase 3 Recycled Water Expansion

The combined flow from activated sludge and the existing flocculating clarifiers can only produce 12.6 mgd of recycled water. When peak day recycled water demand exceeds 12.6 mgd, an additional flocculating clarifier is needed to produce flocculating clarifier effluent for filtration. The Phase 3 Recycled Water Expansion project includes a third 80-foot-diameter flocculating clarifier. Triggers and implementation for the Phase 3 Recycled Water Expansion are described in Section 7.4.6.6.

7.4.6 Tertiary Treatment and Effluent Disinfection

Seven different projects are included to increase tertiary treatment and effluent disinfection capacity and condition. These projects do not include possibly modifying the effluent diffuser in the river to meet enhanced regulatory requirements, which the District is addressing outside the Plan.

7.4.6.1 Tertiary Treatment Improvements

Tertiary treatment improvements include:

- Adding a motorized valve and associated programming and piping that would allow District staff to select flow routing for secondary effluent.
- Replacing sand and airlifts in existing filters.

Tertiary treatment improvements project will require up to 24 months for design and construction, including:

- Three months for predesign.
- Six months for design.
- Three months beyond design completion for environmental permitting.
- Three months for bidding and award.
- Nine months for construction and commissioning.

Owing to equipment age and condition, the District should schedule this project for early implementation.

7.4.6.2 Full-Scale Testing of Flocculating Clarifier Effluent to Activated Sludge

The existing filters are at capacity treating a blend of flocculating clarifier effluent and activated sludge effluent. Even if the District added new secondary effluent equalization immediately, the available recycled water would still be limited by low raw sewage influent flows. The Plan includes new filters to increase recycled water capacity, but constructing new filters could take about four years. An interim project is included to test whether filtration rates improve when flocculating clarifier effluent is treated in the activated sludge process before filtration. The assumption is that bioflocculation of the flocculating clarifier effluent in the activated sludge system would improve filterability of the combined effluent so that a higher flow can be filtered in the existing filters. This full-scale pilot test requires only piping modifications and has the potential to increase existing filter capacity until new filters and equalization are constructed. Results could also be incorporated into the design of new filter facilities.

The project includes:

- Temporary piping modifications to route a constant flow of flocculating clarifier effluent to the activated sludge system.
- Consultant support to help prepare the testing plan and analyze results

Different flows will be tested throughout the project, starting with a small amount of flocculating clarifier effluent and increasing the quantity with time. Adding a constant flocculating clarifier effluent flow of up to 4 mgd to the constant primary effluent flows of about 4 mgd is potentially feasible. The project would study both the activated sludge system performance with flocculating clarifier effluent and the possible filtration rates.

This project has the potential to increase the recycled water peak day capacity to 7 mgd. The timing of recycled water demand increases is beyond the scope of this Plan, but this project could be implemented in the interim before the Phase 1 filter expansion is on line.

7.4.6.3 Phase 1 Recycled Water Expansion

The Phase 1 Recycled Water Expansion includes:

- A predesign study to optimize filters. The study should include a study of reject rates, chemical doses, and media sieve size analysis.

- Secondary effluent equalization. The pump station included as part of this project also would allow the WWTP staff to route substandard activated sludge effluent to the oxidation ponds.
- 1,400 square feet (sf) of filters.
- A chlorine injection and mixing system for the west chlorine contact basin so that all chlorine contact volume can be used for recycled water production during peak demand periods.
- An adjustable chlorine contact tank weir gate to relieve peak hydraulic limitations during river discharge.
- Piping modifications to allow separate operation of the new filters on activated sludge effluent or combined operation with the existing filters.
- Pond 4 pump station expansion.

The WWTP currently filters a blend of flocculating clarifier and activated sludge effluent at a low loading rate (2.2 gallons per minute per square foot [gpm/sf]). With secondary effluent equalization, the WWTP can filter all of the activated sludge effluent in the summer at a constant rate. Since filter loading rates are higher with activated sludge effluent (4.2 gpm/sf), secondary effluent equalization, followed by separate activated sludge filters, are included. The activated sludge filters (Phase 1 – 1,400 sf) are sized to treat the full 2030 ADWF. At lower raw sewage flows, there will not be sufficient flow to use the full filter capacity. When the Phase 1 filters are completed, the recycled water available will be at least 11.1 mgd, with a maximum capacity of 12.8 mgd, assuming sufficient primary effluent flow is available.

In its current operating mode, the Pond 4 pump station reliable capacity is limited to about 8 mgd. This project rehabilitates and expands the Pond 4 pump station to 16 mgd total capacity/12 mgd firm capacity. Hydraulic limitations in the chlorine contact tank limit capacity to 22.7 mgd during river discharge (approximately 7.7 mgd ADWF) and 10 mgd during reclamation. This project includes adding an adjustable weir gate on the chlorine contact tank effluent to relieve these limitations and to increase capacity to 25.1 mgd during river discharge (approximately 8.6 mgd ADWF), and at least 14.3 mgd during reclamation.

The Phase 1 Recycled Water Expansion project will require up to 50 months for design and construction, including:

- 12 months for predesign.
- 12 months for design.
- Six months beyond design completion for environmental permitting.
- Four months for bidding and award.
- 16 months for construction and commissioning.

Analyses have identified two potential triggers for this project. The project needs to be on line when peak day recycled water demands exceed the existing capacity of 5.1 mgd, although the project could potentially be delayed based on the testing results described in Section 7.4.6.2 until peak day recycled water demands exceed 7 mgd or 8 mgd. Since the District plans to maximize recycled water supply immediately, the Phase 1 Recycled Water Expansion is needed

immediately. The filters will also be used to increase river discharge capacity (triggered by ADWF of 7.1 mgd).

7.4.6.4 Phase 2 Recycled Water Expansion

The Phase 2 Recycled Water Expansion includes:

- 600 sf of filters.
- A chlorine contact basin tracer/re-rating study.

The additional flocculating clarifier effluent filters (Phase 2 – 600 sf) increase filtration capacity to match the existing flocculating clarifier effluent capacity. When the Phase 2 filters are completed, the recycled water available will be at least 12.6 mgd, with a maximum capacity of 14.3 mgd, assuming sufficient primary effluent flow is available.

The Title 22 requirement for modal contact time is 90 minutes. Since field testing has not been performed to determine the actual modal contact time, a conservative theoretical contact time of 120 minutes was used to account for hydraulic inefficiencies and to calculate the chlorine contact tanks' reclamation capacity. A tracer study can determine the effective detention time for the contact tanks and, based on project team experience at similar facilities, the rated capacity is expected to increase. Since the contact tanks have a capacity of 13.2 mgd at 120 minutes theoretical contact time, it is expected that the rerating study can increase capacity to match or exceed the Phase 2 peak capacity of 14.3 mgd.

The Phase 2 Recycled Water Expansion project will require up to 38 months for design and construction, including:

- Four months for predesign.
- 12 months for design.
- Six months beyond design completion for environmental permitting.
- Four months for bidding and award.
- 12 months for construction and commissioning.

This project is triggered by recycled water demands and is not scheduled. The project needs to be online when peak day recycled water demands exceed the Phase 1 Recycled Water Expansion project capacity. This project should be considered when peak day recycled water demands exceed 10.8 mgd.

7.4.6.5 Phase 3 Recycled Water Expansion

The Phase 3 Recycled Water Expansion includes:

- A new flocculating clarifier (see Section 7.4.6.4).
- 1,200 sf of filters.
- Additional disinfection capacity (i.e., a new chlorine contact tank, most likely near the recycled water reservoirs).

This project includes the facilities to expand recycled water capacity beyond the Phase 2 project. The filter and disinfection facilities are sized to match the new flocculating clarifier effluent capacity. The activated sludge filters are sized to treat the full 2030 ADWF, so at lower ADWF, flows will be insufficient to use the full filter capacity. When Phase 3 is completed, the recycled water available will be at least 15.7 mgd with a maximum capacity of 17.4 mgd, assuming sufficient primary effluent flow is available to use the activated sludge filters fully.

The Phase 3 Recycled Water Expansion project will require up to 38 months for design and construction, including:

- Four months for predesign.
- 12 months for design.
- Six months beyond design completion for environmental permitting.
- Four months for bidding and award.
- 12 months for construction and commissioning.

Recycled water demands will trigger this project. The project needs to be on line when peak day recycled water demands exceed the Phase 2 Recycled Water Expansion project capacity. This project should be considered when peak day recycled water demands exceed 12.6 mgd.

7.4.7 Recycled Water Storage and Pumping

The master planning and prior studies identified two needs for the recycled water system within the WWTP boundaries—a jockey pump to deliver recycled water at lower demands and additional recycled water storage.

7.4.7.1 Recycled Water Jockey Pump

A jockey pump study (Brown and Caldwell, May 2005) found that the recycled water system might benefit by adding a 200-hp pump with variable speed control. The proposed pump is considerably smaller than the existing 600-hp pumps. It would provide reliable capacity when recycled water demands are lower. The District initially attempted to address this need by running the existing 600-hp pumps at reduced speed; however, owing to system requirements and limitations of the larger pumps, such operation causes adverse wear. Hence, current conditions justify jockey pump installation.

This project will require up to 24 months for design and construction, including:

- Three months for predesign.
- Six months for design.
- Three months beyond design completion for environmental permitting.
- Three months for bidding and award.
- Nine months for construction and commissioning.

This project is needed to prolong the life and reduce maintenance costs of the existing pumps. This project should begin immediately.

7.4.7.2 Line Recycled Water Reservoir

As designed, the WWTP had two open storage reservoirs for tertiary effluent with a volume of about 6.5 MG/20 AF and a surface area of 53,000 sf. To discourage algae growth and preserve disinfection residual, the District subsequently added membrane covers and raised the height of the side walls to increase storage potential. The covers are successful at maintaining water quality, but to achieve the full storage increase, the reservoirs need membrane liners and minor rework on the pump bases to create tight seals. With the modifications, the reservoirs would have a capacity of 25 AF. This equates to one day of storage at an 8-mgd recycled water demand, which is considered typical storage for a recycled water system.

This project will require up to 23 months for design and construction, including:

- Four months for predesign.
- Four months for design.
- Three months beyond design completion for environmental permitting.
- Three months for bidding and award.
- Nine months for construction and commissioning.

This project is triggered by additional recycled water storage capacity needs.

7.4.8 Solids Treatment

Two projects are recommended for solids handling.

7.4.8.1 Purchase Spare Digester Mixer

The spare digester mixer project includes:

- Purchasing a spare digester mixer to have available for quick installation should the existing mixer fail. Design will include a plan for temporary operation and repair should the existing mixer need to be replaced.

This project will require up to 10 months for design and construction, including:

- Two months for design and plan preparation.
- Eight months for procurement.

The District should purchase the spare mixer immediately to minimize the risk of a digester failure. There is a greater risk of problems with the spare mixer approach than if a redundant digester was constructed. For example, volatile solids reduction during digestion may be less effective when the mixer is offline. Hence, District staff may not have dewatered solids that it could immediately apply to District lands (at least not Class B biosolids). The District would need to hold the dewatered solids for an extended period before land application; however, the District has decided to assume that risk.

7.4.8.2 Complete Egg-shaped Digester

The egg-shaped digester project includes:

- Converting existing half-egg digester to a complete digester.
- Constructing a 0.35-MG digested sludge storage tank.
- Constructing a separate gas storage tank.

This project will require up to 46 months for design and construction, including:

- Six months for predesign.
- 12 months for design.
- Six months beyond design completion for environmental permitting.
- Four months for bidding and award.
- 18 months for construction and commissioning.

This project is triggered by digester solids loading capacity. Based on current loading projections, the new digester needs to be on line when digester solids loading exceeds about 27,000 lb/day (AA influent TSS loading of about 22,000 lb/day, assuming only primary and waste activated sludge). Design should begin when digester solids loading reaches about 24,700 lb/day (AA influent TSS loading of about 20,500 lb/day).

7.4.8.3 Solids Handling Improvements

The solids handling improvements project includes:

- Replacing or upgrading the digester heat exchanger.
- Adding grinders for sludge circulation piping.
- Implementing gas storage volume programming for the Dystor.

This project will require up to 31 months for design and construction, including:

- Four months for predesign.
- Nine months for design.
- Three months beyond design completion for environmental permitting.
- Three months for bidding and award.
- 12 months for construction and commissioning.

This project is needed to enhance operations and should begin immediately.

7.4.8.4 Belt Filter Press Filtrate Equalization

The belt filter press filtrate equalization project includes:

- 0.3-MG filtrate equalization tank.
- 250-gpm filtrate equalization pump station.

The filtrate equalization project will require up to 28 months for design and construction, including:

- Four months for predesign.
- Eight months for design.
- Three months beyond design completion for environmental permitting.
- Four months for bidding and award.
- Nine months for construction and commissioning.

The District would only implement this work if future regulatory changes decreased allowable WWTP effluent ammonia concentrations. This project's objective is to equalize the high-ammonia filtrate and nitrify it in the activated sludge system, which would significantly reduce the pond ammonia loading and, hence, reduce ammonia in the pond effluent. The base Plan projects were selected to meet a monthly average ammonia limit of 45 milligrams per liter (mg/L). Based on historical pond effluent ammonia concentrations, the base project effluent ammonia is expected to be less than 20 mg/L; therefore, an ammonia limit less than 20 mg/L would trigger project consideration. The filtrate equalization system could be operational slightly more than two years after the District receives a reduced ammonia limit.

7.4.9 Support Systems

Two support system projects were identified—maintenance shop and support building.

7.4.9.1 New Maintenance Shop and Support Building

A new maintenance shop and support building is needed to provide space for maintenance staff and facilities.

This project will require up to 36 months for design and construction, including:

- Four months for predesign.
- 12 months for design.
- Six months beyond design completion for environmental permitting.
- Four months for bidding and award.
- 10 months for construction and commissioning.

7.4.9.2 3W System Improvements

The 3W system improvements project includes:

- Replacing and modifying 1W, 2W and 3W system piping to address corrosion and dissimilar piping materials, and to add and/or replace isolation valves.
- Adding a variable frequency drive to second 3W pump.

This project will require up to 24 months for design and construction, including:

- Three months for predesign.
- Six months for design.
- Three months beyond design completion for environmental permitting.

- Three months for bidding and award.
- Nine months for construction and commissioning.

This project is triggered by equipment condition and the need to enhance operations. This project should begin immediately.

7.4.10 Maintenance Items

A number of other maintenance-related items were identified during the Plan. These items are not included in the list of Plan projects. A list of these maintenance recommendations is included in *TM 11 – Alternatives Cost Estimate*.

7.5 Capital Costs

Table 7-2 summarizes the capital costs and implementation details for the base Plan project. More details on capital costs and cost estimating can be found in *TM 11 – Alternatives Cost Estimate*.

Table 7-3 summarizes the add-on projects that are not part of the base project but may occur during the planning period. Dates for these projects are unknown.

Table 7-2. Base Project Implementation Summary

Project	Capital Cost Million \$ ¹	Trigger to Begin Predesign	Permitting, Design and Construction Duration, months	Priority ²	Project Completion Date
Flocculating Clarifier Weirs	0.6	ADWF of 6.8 mgd (2011)	10	A	2012
Full-Scale Testing of Flocculating Clarifier Effluent to Activated Sludge	0.3	Peak day recycled water demand of 5.1 mgd and Phase 1 Recycled Water Expansion not on-line	NA	A	2012 ³
Purchase Spare Digester Mixer	0.4	Redundancy – start in 2011	10	A	2012
Increase Pond Aeration (Add 125 hp)	2.2	AA BOD Load of 18,700 lb/day (2011)	23	A	2013
Recycled Water Jockey Pump	0.2	Reduce maintenance - immediate (2011)	24	A	2013
Activated Sludge Diffuser Replacement	0.9	Condition/age - start in 2011 based on useful life of existing equipment	25	C	2013
Pond Improvements – Phase 1	0.1	Condition/age - immediate (2011)	25	C	2013 ⁴
Pond Improvements – Phase 2	2.8	Condition/age - immediate (2011)	25	A	2013 ⁵
Tertiary Treatment Improvements	1.1	Condition/operational enhancements - immediate (2011)	24	C	2013
3W System Improvements	0.3	Condition/operational enhancement - immediate (2011)	24	C	2013
Solids Handling Improvements	0.8	Operational enhancements – immediate (2011)	31	C	2014
IPS Expansion	15.5	PHWWF of 25.0 mgd (2011)	48	A	2015
Phase 1 Recycled Water Expansion	13.9	Four years before peak day recycled water demand exceeds 5.1 mgd (2011) or ADWF of 7.1 mgd (2014)	50	A	2015
Line Recycled Water Reservoir	0.2	Recycled water storage needs	23	C	2015
Headworks Improvements	1.2	Condition/age - start in 2014 based on useful life of existing equipment	25	C	2016
Primary Treatment Improvements	0.3	Operational enhancements - Start in 2014 in parallel with Headworks Improvements.	22	C	2016
Complete Egg-Shaped Digester	11.4	Maximum month sludge loading of 24,700 lb/day (approximately AA influent TSS loading of 20,500 lb/day) (2019)	46	B	2023
Aeration Basin Expansion	4.2	AA BOD loading of 20,200 lb/day (2021) or ADWF of 7.5 (2021)	40	B	2025 ⁶
Phase 2 Recycled Water Expansion	4.9	Four years before peak day recycled water demand exceeds 11.1 mgd	38	D	- ⁷
Base Project Total	61.3				

¹Costs were determined for April 2010 for Napa, California, using the San Francisco ENRCCI (ENR construction cost index) of 9,730.

²Priority A indicates projects required to accommodate capacity by 2016, projects critical for reliability of WWTP operations, and projects expected to save significant maintenance cost. Priority B projects accommodate capacity increases after 2016. Priority C projects are mainly facilities condition/age related. Priority D projects are unscheduled.

³Testing will take approximately one year, so results could be available by 2012.

⁴Install transfer structures between Ponds 1 and 2.

⁵Install replacement aerators, remaining transfer structures and distribution piping. The District may choose to delay some parts of this project, to reduce early expenditures. Aerator replacement is most important.

⁶Triggered by AA BOD loading increase. River discharge capacity required in 2025.

⁷Project is triggered by peak day recycled water demand based on District plan to maximize recycled water delivery. Project timing will depend on recycled water demand.

Table 7-3. Add-On Project Implementation Summary

Project	Capital Cost (millions)	Trigger to Begin Predesign	Permitting, Design and Construction Duration, months
Belt Filter Press Filtrate Equalization Tank and Pumping	3.3	Regulatory — consider for monthly average ammonia limit less than 20 mg/L	28
Phase 3 Recycled Water Expansion	15.5	Four years before peak day recycled water demand exceeds 12.6 mgd	38
New Maintenance Shop and Support Building	2.0	Space for maintenance	36