Report

Peer Review of the Water Pollution Control Plant Strategic Infrastructure Plan, City of Sunnyvale, California

Prepared for

City of Sunnyvale

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Acronyms and Abbreviations

AACE International	Association for the Advancement of Cost Engineering International (formerly known as the American Association of Cost Engineers)
AFT	air flotation thickener
BOD_5	5-day biochemical oxygen demand
$cBOD_5$	5-day carbonaceous biochemical oxygen demand
CEPT	chemically enhanced primary treatment
Peer Review Team	CH2M HILL Peer Review Team
CIP	capital improvement plan
City	City of Sunnyvale
CPES	CH2M HILL Parametric Cost Estimating System
FGR	fixed-growth reactor
mg/L	milligrams per liter
mgd	million gallons per day
O&M	operation and maintenance
Plant	Sunnyvale Water Pollution Control Plant
Plant Rehabilitation Alternative	Rehabilitate and replace the Plant facilities to retain use of the current treatment process
Plant Replacement Alternative	Rehabilitate and replace the Plant facilities to use a different treatment process that would offer advantages over the current process
SIP	Strategic Infrastructure Plan
SRT	solids retention time
TM	technical memoranda
TPAD	temperature-phased anaerobic digestion
TSS	total suspended solids
WAS	waste-activated sludge
WPCP	Water Pollution Control Plant

Peer Review of the Water Pollution Control Plant Strategic Infrastructure Plan, City of Sunnyvale, California

1.0 Purpose and Background

The City of Sunnyvale (City) and their engineering consultant, Brown and Caldwell, developed the Sunnyvale Water Pollution Control Plant (WPCP or Plant) Strategic Infrastructure Plan (SIP) during the period from 2007 through 2010. Implementing the SIP will be the largest capital expenditure ever undertaken by the City, budgeted in the City's 20-year capital improvement plan (CIP) at $331 million. Because of both the financial commitment and the significant opportunities to benefit the community and environment that result when undertaking a project of this magnitude, the City desired an independent peer review of the SIP. The purpose of this Peer Review is to accomplish the following:

- Confirm that the SIP considered all appropriate treatment process alternatives
- Determine whether the technical alternatives and estimated costs that were considered in the SIP were developed and analyzed correctly
- Develop alternatives not contained in the SIP that may better achieve the City's objectives for the future of the Plant to a level of detail that allows comparison to the SIP alternatives
- Provide the City with confidence that implementing the SIP recommendations can best achieve the City's community, environmental, and financial objectives for the facility

The following individuals were key participants in the Peer Review Project:

- City of Sunnyvale: Lorrie Gervin (SIP and Peer Review Project Manager, WPCP Manager, and Environmental Division Manager), Mark Rogge (Assistant Public Works Director and City Engineer), Chuck Neumayer (Senior Civil Engineer, Public Works Project Administration), Joanna De Sa (WPCP Operations Manager), Dan Hammons (WPCP Maintenance and Facilities Manager), Steve Schmidt (WPCP Laboratory and Pretreatment Manager), Nasser Fakih (Assistant City Engineer, Public Works Project Administration), and Tim Kirby (City Finance Department)
- The City's regulatory and process engineering consultant – EOA, Inc.: Don Eisenberg (Principal) and Ray Goebel (Operations Manager)
- CH2M HILL Peer Review Team (Peer Review Team): Glen Daigger, David Jenkins (UC Berkeley), Dana Rippon, George Tchobanoglous (UC Davis), Susan Dennis (Project Manager), and Kathy Rosinski

This report summarizes the major findings, conclusions, and recommendations of the CH2M HILL Peer Review Team. The project's detailed work products include technical

memoranda (TM) and workshop meeting notes, which are presented in the report appendices. Background information on the Sunnyvale WPCP and SIP is presented in the following subsections to provide context for the reader, followed by a summary of the Peer Review Project methodology, findings, conclusions, and recommendations.

1.1 Sunnyvale Water Pollution Control Plant Description

The Plant was constructed in 1956 as a primary treatment facility with primary clarification, sludge digestion, and disinfection as the only treatment processes. The ponds were purchased in the late 1960s and developed to provide secondary treatment, in large part to address cannery waste loads. Major upgrades to the Plant were constructed in 1970 and 1976, with minor improvements constructed at other times, as required, to address regulatory and aging infrastructure needs. The Plant currently provides tertiary treatment using the original clarifiers and ponds plus fixed-growth reactors, dissolved air flotation, and granular media filters as the main treatment processes. Solids processes include anaerobic digestion and drying beds. The City is currently transitioning to contracted disposal of the digested biosolids. The Plant currently treats an annual average flow of 15 million gallons per day (mgd), derived principally from a residential service population of approximately 136,000 and some high-tech manufacturing. The Plant consistently achieves its permitted discharge limits of the following constituents:

- Five-day carbonaceous biochemical oxygen demand ($cBOD_5$): 10 milligrams per liter (mg/L) average monthly and 20 mg/L maximum daily
- Total suspended solids (TSS): 20 mg/L average monthly and 30 mg/L maximum daily
- Ammonia nitrogen (NH_3-N) Winter: 18 mg L average monthly and 26 NH_3-N mg/L maximum daily
- NH_3-N Summer: 2.0 mg/L average monthly and 5.0 mg/L maximum daily

The Plant has been well maintained, but many of the Plant facilities are at or near the end of their useful life in terms of their reliability, function, and cost-effective operation and maintenance (O&M). The SIP was initiated in recognition of the need to upgrade the Plant facilities to maintain reliable and cost-effective service to the Plant's customers.

1.2 Strategic Infrastructure Plan Recommendations

Brown and Caldwell was tasked to develop two alternatives to upgrade and modernize the aging Plant infrastructure, as follows:

- Rehabilitate the existing Plant facilities to retain use of the current treatment process (Plant Rehabilitation Alternative)
- Replace the existing Plant with new facilities. This alternative was further refined to evaluate use of a different treatment process that would offer advantages over the current process (Plant Replacement Alternative). A constraint of this alternative was that the ponds would not be retained as part of the treatment process.

Options to best accomplish each alternative were selected and evaluated by Brown and Caldwell in collaboration with City staff and the City's regulatory and process engineering consultant, EOA, Inc. The SIP presented two alternatives for final consideration and

provisionally recommended the Plant Rehabilitation Alternative for implementation on the basis of lower cost while meeting the City's non-economic criteria. To confirm the selection of the Plant Rehabilitation Alternative for implementation, it was recommended in the SIP that full-scale Plant performance testing be conducted to confirm the ability of the existing treatment process, with a modified flow pattern, to meet more stringent winter ammonia effluent concentration limits. This testing is ongoing. Should the testing not support selection of the Plant Rehabilitation Alternative, the SIP recommends implementation of the Plant Replacement Alternative.

The SIP Plant Rehabilitation and Plant Replacement Alternatives are summarized as follows:

- **Plant Rehabilitation Alternative.** This alternative retains the existing pond-based treatment process by rehabilitating or replacing existing treatment process units to provide a 30-year future service life, and incorporates new facilities to provide more efficient O&M to optimize the life cycle cost of the facility.
- **The Plant Replacement Alternative.** This alternative would use a conventional activated sludge process, consisting of primary clarification, aeration, and secondary clarification, operating at approximate 10-day solids retention time (SRT).

The key features of each alternative are summarized in Table 1.

TABLE 1
Summary of Key Features of Strategic Infrastructure Plan Plant Rehabilitation and Plant Replacement Alternatives
Peer Review of the Water Pollution Control Plant Strategic Infrastructure Plan, City of Sunnyvale, California

Treatment Process	Plant Rehabilitation Alternative	Plant Replacement Alternative
Preliminary Treatment	New influent pumping and new headworks consisting of mechanical screening and aerated grit chambers	Same as Plant Rehabilitation Alternative
Primary Treatment	New primary clarifiers with new effluent pipeline to the ponds	Same as Plant Rehabilitation Alternative
Secondary Treatment	Rehabilitate pond containment berms Replace pond distribution piping, mechanical aerators, and associated pump stations New, full-scale dredging system to remove settled biosolids from the ponds for dewatering New AFTs	New aeration tanks and circular secondary clarifiers Decommission existing AFTs
Tertiary Treatment	Rehabilitate existing FGR and granular media filters	Rehabilitate existing granular media filters Nitrification achieved by activated sludge process Decommission existing FGRs
Disinfection	New sodium hypochlorite disinfection system and sodium bisulfite system for dechlorination	Same as Plant Rehabilitation Alternative

TABLE 1
Summary of Key Features of Strategic Infrastructure Plan Plant Rehabilitation and Plant Replacement Alternatives
Peer Review of the Water Pollution Control Plant Strategic Infrastructure Plan, City of Sunnyvale, California

Treatment Process	Plant Rehabilitation Alternative	Plant Replacement Alternative
Solids Treatment	Rehabilitate existing anaerobic digesters and continue contracted biosolids disposal Replace sludge drying beds with mechanical dewatering Improve digester gas management and cogeneration	Same as Plant Rehabilitation Alternative, plus the following: New primary solids and WAS thickening Convert to TPAD to produce Class A biosolids
Flow Equalization	Provided by existing ponds	Reconfigure a portion of the ponds to provide separate peak monthly and diuranal flow equalization.
Recycled Water Treatment	New AFTs, granular media filters, and chlorine contact tanks dedicated for recycled water production	Construct new cloth media filtration and chlorine contact tanks dedicated for recycled water production

Notes:
AFT = air flotation thickener
FGR = fixed-growth reactor
TPAD = temperature-phased anaerobic digestion
WAS = waste-activated sludge

2.0 Peer Review Methodology, Findings, and Conclusions

The Peer Review was conducted using the following methodology:

- Confirm the City's objectives for the SIP and the Sunnyvale WPCP and goals for the Peer Review Project.
- Brainstorm other treatment process options to achieve the City's current objectives that may offer superior benefits compared to the SIP recommended alternatives.
- Perform an independent review of the SIP document, focusing on the consistency of the technical elements of the work, and the cost estimates for conformance with estimating standards, accuracy, and completeness.
- Develop additional treatment options to a level of detail to allow comparison with the SIP alternatives on the basis of the City's non-monetary objectives and cost.
- Collaboratively compare the SIP alternatives and Peer Review treatment process options to assist the City in selecting the best strategy for the Plant to carry forward for implementation.

The City directed that the Peer Review Team's work be conducted solely on the basis of the SIP document to provide a truly independent review. As such, Brown and Caldwell was not involved in the Peer Review workshops and was not requested by the Peer Review Team to provide additional information or clarification of the information presented in the SIP with the exception of cost estimate breakdown information.

The project approach included two full-day workshops with key project participants to accomplish the following:

- Confirm project objectives
- Share and discuss the Peer Review Team's findings, conclusions, and recommendations
- Collaboratively develop the recommended path forward to implementation.

Prior to and following each workshop, the Peer Review Team's work was reviewed with City and EOA staff in telephone conferences and in TMs.

The findings and conclusions of the Peer Review Project are summarized in the following sections.

2.1 Objectives for Sunnyvale Water Pollution Control Plant and the Strategic Infrastructure Plan

In a workshop setting, the Peer Review Team confirmed the City's objectives for the future of the Sunnyvale WPCP, as follows:

- Reliability – The Plant should reliably achieve all permit requirements with an industry-standard or superior level of O&M, achieved by selecting the best technology for the future.
- Resource Recovery – Optimize recovery of resources present in the influent wastewater for power generation, nutrient recovery, water reuse, or other beneficial uses, including revenue generation.
- Power Issues – Provide the Plant with a more reliable power supply and, to the extent practical, enhance power reliability for other City users.
- Community Resource – The Plant should provide a benefit to its customers and City residents beyond functioning solely as a wastewater treatment plant, without added costs to rate payers.
- Innovation – Incorporate proven technological advances that have emerged since the Plant was constructed as they may align with the City's other objectives, and allow for flexibility to incorporate future innovations to meet needs as they arise.
- Financial – Achieve the optimal balance of capital and long-term O&M costs (life cycle costs), realizing that a low capital cost can be overshadowed by greater O&M costs over the planning horizon.

These objectives provided greater insight to the Peer Review Team for evaluating the SIP alternatives and to brainstorm additional options. The SIP used many of these concepts in the Triple-Bottom Line Level of Service decision making framework. However, the SIP analysis from applying the framework did not reveal significant differences between the alternatives in terms of non-monetary criteria, and SIP decisions thus appeared to be focused on cost-based criteria. On the basis of initial review of the SIP and the City's stated objectives, the Peer Review Team's opinion was that the SIP alternatives are not equal from a non-monetary perspective.

In regard to the City's financial objective for the project, the City requires that a project budget be established that could be met with a high degree of confidence while implementing the preferred alternative. The ability to phase implementation to manage expenditures and provide

flexibility to adapt to future regulatory requirements and innovation should be provided in the alternatives.

Documentation of the discussion of the City's objectives for the WPCP is contained in the Workshop No. 1 meeting notes, which are provided in Appendix A.

2.2 Brainstorming of Additional Options

During Workshop No. 1, additional options focusing on strategies to achieve the City's objectives for the Plant were brainstormed with City and EOA, Inc. staff. Twelve strategies and several technologies to implement the strategies were identified. Strategy 1 – Energy Recovery was selected for further development to compare with the SIP alternatives. The development of this strategy and comparison with the SIP alternatives is discussed in Section 2.4.

Documentation of the brainstorming session in which additional alternatives were developed is contained in the Workshop No. 1 meeting notes, which are provided in Appendix A.

2.3 Detailed Review of Strategic Infrastructure Plan and Cost Estimates

The SIP Report consists of a series of TMs that document the guiding methodology and assumptions for the SIP, the technical work and its basis, estimated costs, evaluation of the alternatives, and recommendations for implementation. The Peer Review Team performed a review over a 1-week period of the SIP document and supplemental cost estimate information that was obtained from Brown and Caldwell.

The conclusions and recommendations from the review were discussed with City staff and EOA, Inc., staff in the project's second full-day workshop. These discussions are included in the Workshop No. 2 meeting notes, which are provided in Appendix B.

2.3.1 Strategic Infrastructure Plan Technical Memoranda Review

The TM review was focused on the technical elements of the work to provide comments about its logic, consistency, and completeness. The review was conducted by CH2M HILL technical subject matter experts in the specialties of treatment process, operations, structural, electrical, and instrumentation and control.

The reviewers conclude that the SIP document conforms to professional standards, is technically sound, and responds to the City's direction as to the breadth of alternatives to be considered. Specific comments pertaining to each TM are presented in the Task 2 TM included in Appendix C, which also includes a summary of the most significant conclusions and recommendations that could be considered to improve the document. City staff should adjudicate action on the Peer Review Team's comments depending on their decision on which alternative to carry forward for implementation.

2.3.2 Strategic Infrastructure Plan Cost Estimate Review

The cost estimate information included in the SIP and supplemental information provided by Brown and Caldwell was reviewed by a senior CH2M HILL cost estimator to accomplish the following:

- Confirm that the SIP construction estimate components and methodology conform with Association for the Advancement of Cost Engineering International (AACE International)

(formerly known as the American Association of Cost Engineers) standards and estimating practices

- Determine if labor and materials quantities and prices appear accurate
- Determine if allowances for contractor overhead and profit, mobilization, escalation and other indirect costs are properly placed and applied, and are reasonable

The SIP estimates were found to conform to AACE International methodology for developing conceptual cost estimates. Specific comments pertaining to the estimates are presented in the Task 4 TM (Appendix D), which includes a summary of the most significant conclusions and recommendations.

The estimates appear to be accurate for purposes of comparing the relative cost ranking of the SIP alternatives. However, at this stage of project development, the project scope is not sufficient to establish a budget level cost estimate meeting the City's cost control objective, as previously discussed. Consequently, further work is needed to define project scope in greater detail before the City's budget control objective can be met. This work is a natural next step in the development of whichever alternative the City selects to upgrade the Plant treatment process. It is recommended that a budget-level cost estimate be developed as part of the next project phase.

2.4 Development of Strategy 1 – Energy Recovery Alternative

The Strategy 1 – Energy Recovery alternative was developed to focus on achieving greater energy recovery from the influent wastewater and overall less energy consumption than may be provided by the recommended SIP alternatives.

During the first project workshop, the Peer Review Team experts observed that both the flow and waste load estimates that were presented in the SIP vary significantly from published industry per capita values and the professional experience of the of the team experts. Therefore, the Strategy 1 – Energy Recovery alternative was developed in the following two steps:

- Flow and waste load review
- Treatment process alternative development

2.4.1 Flow and Waste Load Review

The flow and waste loads that were presented in the SIP for use in planning the future facilities were compared with industry published values. The details of this review are presented in the Optional Services TM that is included in Appendix D. The key conclusions from the review are as follows:

1. The average per capita mass loadings that are presented in the SIP are as much as 50 percent below industry-published values. The mass loading peaking factors presented in the SIP are above published average values. Maximum month and maximum week mass loadings from the SIP were compared and found to be similar to the textbook values. This comparison suggests that the data used to develop the SIP loads are not accurate and that the raw wastewater sampling was not capturing all of the influent wastewater TSS and 5-day biochemical oxygen demand (BOD_5). Discussions with Plant operating staff indicate that this may have resulted from difficulties with the Plant influent wastewater sample. The location of the sampler intake was recently changed, resulting in changes in reported

influent waste loads, which appear to compare more favorably with industry standard values. Because of the timing of the execution of the SIP, these more recent data were not included in the data analyzed by Brown and Caldwell to develop the waste loads used in the SIP.

The implication of this finding is that the SIP alternatives are appropriately sized for purposes of comparison because sizing is based on maximum month/week loadings. However, the O&M and life cycle costs presented in the SIP are likely to be underestimated because they are typically based on (the low) average annual loads.

The Peer Review Team used published per capita loadings and peaking factors to develop the constituent mass loadings for the purpose of developing the Strategy 1 – Energy Recovery alternative.

2. The Peer Review Team calculated a per capita wastewater flow of 102 gallons per capita per day based on the dry weather flow projections that are presented in the SIP. This value is in agreement with typical published values. Thus, the SIP flow estimates were used for the purpose of developing the Strategy 1 – Energy Recovery alternative. However, with increasing water conservation practices, this value can be expected to decrease significantly in the future. Values as low as 70 gallons per capita per day are being used for planning in some United States cities, and flows of 50 gallons per capita per day are currently observed in Europe.

Both the flow and waste load estimates presented in the SIP should be examined more thoroughly in the next project phase. Accurate estimates of flow and loads are required to correctly size the treatment process units and to properly budget the capital and O&M costs for the Plant.

2.4.2 Alternative Development

Seven liquid process treatment alternatives were modeled with the intent to maximize carbon recovery from the influent wastewater for energy production for current and assumed future effluent discharge requirements. The following two options were identified as being capable of achieving this strategy:

- **Option 5 – Natural Treatment:** Primary clarifiers using chemically enhanced primary treatment (CEPT) to maximize TSS and carbon capture, followed by FGRs to complete organics removal and nitrification, with effluent polishing (final TSS removal) accomplished in treatment wetlands.
- **Option 7 – High-rate Activated Sludge:** Conventional primary clarifiers with high-rate activated sludge to maximize carbon capture, followed by FGRs to accomplish nitrification and filters for effluent polishing.

Both options would retain use of the existing digesters, biosolids handling system, and effluent disinfection and disinfectant removal systems, as proposed in the SIP. Key components of Options 5 and 7 are summarized in Table 2.

TABLE 2
Summary of Key Features of Strategy 1 – Energy Recovery Alternatives: Options 5 and 7
Peer Review of the Water Pollution Control Plant Strategic Infrastructure Plan, City of Sunnyvale, California

Treatment Process	Option 5 – Natural Treatment	Option 7 – High-rate Activated Sludge
Preliminary Treatment	New influent pumping and new headworks consisting of mechanical screening and aerated grit chambers	Same as Option 5
Primary Treatment	New primary clarifiers operated in CEPT mode	New primary clarifiers
Secondary Treatment	Rehabilitate existing FGRs and construct one new FGR to be used for carbon removal and nitrification Decommission AFTs	New high-rate activated sludge treatment system operated at a short (1-day) SRT, consisting of aeration tanks and circular secondary clarifiers for carbon capture Rehabilitate existing FGRs to accomplish nitrification Decommission AFTs
Tertiary Treatment	Conversion of ponds to natural treatment wetlands for effluent polishing	Rehabilitate existing granular media filters for effluent polishing
Disinfection	Same as SIP Rehabilitation Alternative[a]	Same as SIP Replacement Alternative[a]
Solids Treatment	Same as SIP Rehabilitation Alternative[a]	Same as SIP Replacement Alternative[a]
Flow Equalization	Same as SIP Replacement Alternative[a]	Same as SIP Replacement Alternative[a]
Recycled Water Treatment	Rehabilitate granular media filters, and construct new chlorine contact tanks dedicated for recycled water production	New granular media filters and chlorine contact tanks dedicated for recycled water production

[a]Assumption made for the purpose of alternative comparison and costing.

Capital cost estimates were developed for the Strategy 1 – Energy Recovery alternative Options 5 and 7 to allow for comparison with the SIP alternatives. Conceptual level Class 5 cost estimates were developed in a fashion comparable to that used in the SIP for the treatment process elements that were unique to the Strategy 1 – Energy Recovery options (new secondary and tertiary treatment process units). The cost estimates presented in the SIP for the treatment process elements common to all alternatives were used for those elements of the Strategy 1 – Energy Recovery options, thereby providing "apples to apples" estimates for comparison purposes. The result is that the alternatives could then be compared on a relative cost basis. This approach was adopted because developing an independent cost estimate for the entire Strategy 1 – Energy Recovery options were not possible within the scope of the Peer Review project and would have limited value at this time. Likewise, the scope of the Peer Review project did not allow for life cycle cost development. After an alternative is selected, it must be refined and project elements must be identified (as discussed in Section 3.0) to develop a budget-level cost estimate that is suitable for the City to establish a total project budget.

Strategy 1 – Energy Recovery alternative options and estimated costs are presented in the Optional Services TM included in Appendix E. Table 3 presents as summary of the estimated costs for the Strategy 1 – Energy Recovery options. The SIP alternatives cost estimates are also summarized.

TABLE 3
Sunnyvale SIP Peer Review – Capital Cost Comparison of Strategic Infrastructure Plan and Alternative Options for Plant Upgrade
Peer Review of the Water Pollution Control Plant Strategic Infrastructure Plan, City of Sunnyvale, California

	Alternative Capital Cost ($ million)			
Cost	**SIP Plant Rehabilitation[a]**	**Peer Review Option 5: PC + CEPT + FGR + Add'l FGR + Wetland[b]**	**SIP Plant Replacement w/Activated Sludge[a]**	**Peer Review Option 7: PC + High-rate Activated Sludge + FGR + Filtration[b]**
Cost for Facilities Unique to Alternative	**63.4**	**46.4**	**92.7**	**81.7**
Pond Restoration/Flow Equalization[a]	--	0 - 26.0[c]	26.0	0 -26.0[c]
Cost for Common Facilities[a]	140.8	140.8	195.5	195.5
Estimated Total Construction Cost	204.2	187.2 - 213.2	288.2	277.3 - 303.3

[a]Cost estimates obtained from SIP (2010) for alternative costs presented in Plant Rehabilitation Alternative Summary TM and Plant Replacement Alternatives Summary TM. Cost breakdowns were not available in the Business Case Evaluation of Plan Alternatives TM to present costs based on the 'adjusted' alternatives.

[b]Cost estimate based on CH2M HILL Parametric Cost Estimating System (CPES). Cost estimates are based on 2015 project startup date, and include escalation to the mid-point of construction, construction markups (including 30% contingency), taxes, and location adjustment factors. Non-construction costs are not included.

[c]Flow equalization is not required for flow management, as facilities have been sized to accommodate peak flows. The SIP Plant Replacement alternative includes diurnal and peak flow equalization utilizing a portion of the existing ponds to provide operating flexibility. The estimated cost for this offline flow equalization is shown as the upper-range cost to allow comparison of alternatives utilizing a comparable type of flow equalization. The upper-range cost estimates for the Peer Review Options include the cost for basins that are sized to accommodate peak flows plus the cost of offline flow equalization.

2.5 Comparison of the Strategic Infrastructure Plan and Peer Review Alternatives and Selection of the Preferred Alternative

To facilitate comparison, the alternatives were grouped into the following two categories: 1) natural treatment-based alternatives, and 2) activated sludge treatment-based alternatives. Evaluation criteria were developed based on the City's objectives stated in Workshop No. 1 and the Triple-Bottom Line Level of Service criteria used to evaluate the alternatives in the SIP. The Strategy 1 – Energy Recovery alternative options were discussed at length in Workshop No. 2, and the alternatives were compared based on the evaluation criteria. The comparison of alternatives is presented in Table 4.

TABLE 4
Comparison of Alternatives
Peer Review of the Water Pollution Control Plant Strategic Infrastructure Plan, City of Sunnyvale, California

	Natural System		**Activated Sludge**	
Criteria	**SIP Plant Rehabilitation Alternative (Ponds)**	**Peer Review Option 5: PC CEPT + FGRs + Wetland**	**SIP Plant Replacement Alternative (Activated Sludge)**	**Peer Review Option 7: PC + High-rate Activated Sludge + FGRs + Filtration**
Reliability – ability of the system to consistently meet discharge requirements	+	+	+	+
Operational Control – ability to make adjustments to the process to achieve a consistent desired result (effluent quality, energy use, good neighbor)	-	o	+	+
Effluent Quality – future constituents, current and potential future BOD_5/TSS, year-round ammonia, total nitrogen	o (existing limits)	+ + (future total nitrogen, total phosphorous)	+ + (future total nitrogen, total phosphorous)	o (existing limits)
Resource Efficiency – net energy efficiency	o	++	-	o
Pond Land Use – beneficially uses pond acreage at appropriate cost or risk	o (ponds stay ponds)	+ (more attractive use of ponds)	+ (potentially more attractive use of the ponds)	+ (potentially more attractive use of the ponds)
Innovation – advances status quo to achieve superior technical, economic, and social benefits	o	+	-	-
Capital Cost	+	++	-	o
O&M Cost	o	+	-	o

Notes:

++ = provides best performance relative to criteria as compared against other alternatives

+ = provides superior performance relative to criteria as compared against other alternatives

o = neutral performance relative to criteria as compared against other alternatives

- = does not meet the criteria

PC = primary clarification

The comparison was intended to highlight key differences between alternatives to identify if there is a best strategy or a "no-regrets" option that incorporates steps that are beneficial even if future circumstances change.

Given future unknowns in regulations, energy costs, or other factors, the alternatives were compared from the perspective of whether they would present either "no regrets" or offer "significant regrets." The opportunity to construct the alternatives in phases and, thereby, retain the flexibility to adopt future technology innovations to meet future regulations was also

considered. The following key points were considered in evaluating and ranking the alternatives:

- Any alternative in Table 4 that is marked with a "-" does not meet the City's objectives and would not be desired. Alternatives in Table 4 with only a "o" or a "+" are preferred over alternatives with a "-."
- Option 5 has no "-" and, consequently, is the benchmark for comparison. It is referred to as the "no-regrets" alternative. There could, however, be good reasons to use an alternative other than the benchmark. The only potential "regret" of this option would be constructing the wetlands; after they are constructed, the City would be committed to this option for at least a significant time into the future. For the SIP Plant Rehabilitation alternative, construction of the new AFTs would commit the City to this option.
- Option 5 scored lower ("o") on operational control criteria than the activated sludge options ("+"). This reflects the key difference between a natural treatment system and the more engineered activated sludge system.
- An initial step in any option would be to construct new headworks and primary clarifiers. Incorporating CEPT would set the stage for the wetlands option or would offload the ponds and allow the City to determine whether the required ammonia removal can be achieved with the ponds. The decision would then be made on whether to proceed with an additional FGR and the wetlands construction. The main tradeoff between the two natural treatment options is that Option 5 allows removal of the AFTs and filters from the treatment train. The capital costs of upgrading the AFTs would be avoided, and the chemical and energy costs associated with their operation would be eliminated. The existing filters could also be used for recycled water production.
- Likewise, the activated sludge options could be phased to defer the ultimate decision of which activated sludge process is implemented. In general, the main difference between the activated sludge and the high-rate activated sludge options is the number and size of aeration basins and energy use devoted to secondary treatment. High-rate activated sludge could be an initial phase of an activated sludge option. The key impact resulting from selection of the activated sludge strategy is that it abandons the pond technology to achieve greater carbon recovery. Again, the high-rate activated sludge option would meet current discharge standards and could be configured to add more aeration basins (thus moving from high-rate activated sludge to conventional activated sludge) in the future to accommodate more stringent effluent requirements (nutrient removal), should this be necessary.
- For the activated sludge options, the greatest uncertainty may be future use of the abandoned ponds. Potential uses include stormwater polishing, environmental mitigation, or return the land to bay ecosystem. The cost and feasibility of these uses was presented on a conceptual level in the SIP.

On the basis of the Peer Review Team's work and the discussions in Workshop Nos. 1 and 2, the Peer Review Team recommends Option 5, the wetland-based treatment alternative, as the strategy to best achieve the City's objectives for the Sunnyvale WPCP.

3.0 Recommendations for Path Forward

At the conclusion of Workshop No. 2, the Peer Review Team recommended that the City proceed with the following steps to complete the SIP and proceed toward implementation.

3.1 Confirm the Wetlands-based Strategy for Upgrade of the Sunnyvale Water Pollution Control Plant

The City should take the following steps to further assess their desire to proceed with the wetlands-based strategy for the Plant upgrade:

1. City staff will have their SIP consultant, Brown and Caldwell, review the Peer Review Team's recommendations. As was part of the Peer Review Team's mission, this should be done on a fatal-flaw basis, leaving the details of implementation to be determined in the next project phase.
2. The City should then decide how to most cost-effectively finalize the SIP.
3. Converting the ponds to treatment wetlands should be discussed with regulatory agencies to gauge agency support and likely permitting approach, associated costs, and implementation schedule.
4. City staff may also wish to visit plants using wetlands for polishing to become familiar and comfortable with a wetlands-based system and to understand O&M activities associated with this technology. The Peer Review Team can provide a list of representative facilities in California and the Western United States.

If there is a positive outcome of these steps, the City should adopt the wetlands-based strategy and proceed with developing an Implementation Plan.

If the City decides at the end of this process that a wetlands-based strategy does not best meet its objectives, the City should proceed with implementing one of the SIP-recommended alternatives. The results of the full-scale plant performance testing to prove ammonia removal performance should allow the City to select either the Plant Rehabilitation or Plant Replacement alternative for implementation. If the Plant Replacement (activated sludge) alternative is selected, incorporating the HRAS features of Peer Review Option 7 should be explored at that time.

3.2 SIP Team Review of the Peer Review Recommendations

As the initial step in proceeding toward implementation, Brown and Caldwell presented their comments on the Peer Review Team's findings, conclusions, and recommendations on May 4, 2011, in a meeting attended by City of Sunnyvale staff, EOA, Inc., and select Peer Review Team members. A copy of Brown and Caldwell's presentation and documentation of the meeting discussion and conclusions are contained in the May 4, 2011, meeting notes, which are provided in Appendix F.

In the May 4 meeting, Brown and Caldwell provided significant information on the history of the SIP alternatives development, findings, and decisions that were not apparent to the Peer Review Team solely from their review of the SIP document. This shared information and collaborative discussion allowed the meeting participants to better understand the alternatives

put before the City. The group reached consensus on three alternatives that the City should consider for implementation, as follows:

- SIP Plant Rehabilitation Alternative
- SIP Plant Replacement Alternative, possibly incorporating HRAS
- Peer Review Option 7 – Wetlands-based Strategy

Upon completion of the full-scale plant performance testing (to confirm Plant Rehabilitation alternative) and exploring steps 3 and 4 (Section 3.1) (to confirm Wetlands-based Strategy), the City can then evaluate all alternatives on a comparable basis and adopt the preferred alternative for implementation.

3.3 Develop Implementation Plan

Following adoption of the wetlands-based strategy or SIP alternative, it will be critical to develop an Implementation Plan to confirm all project elements, identify construction phasing, and develop budget-level costs. The Implementation Plan should include the following:

- Proceed with California Environmental Quality Act (CEQA) documentation for the project.
- Update wastewater flow and waste load estimates for both current and future conditions
- Refine the selected alternative for updated flows and loads to confirm treatment process elements and design criteria
- Identify the project elements beyond the treatment process train, including a new administration building, Plant power supply and distribution system, including addressing power reliability, SCADA platform, odor control, septage/fat, oil, and grease/food waste receiving facilities, and public education and shoreline access facilities
- Define construction packages
- Develop site layout in consideration of project phasing
- Identify decision points for implementation of future construction projects (timing) and technology decisions
- Develop Plant staffing plan
- Develop budget-level estimates for capital, O&M, and life cycle costs to be used as the basis of the City's overall project budget

3.4 Proceed with Implementation

After the Implementation Plan has been developed, the City should proceed with design and construction of the initial implementation phase. The SIP recommendation to construct new headworks and new primary clarifiers in the initial project phase is sound, and it is expected that these process facilities would be included in the first construction package. The new administration building, Plant power supply and distribution system, SCADA system, and other potential early-out projects should also be considered for inclusion in the initial implementation phase.

4.0 Conclusions

On the basis of an independent review of the SIP, development of the Peer Review additional alternatives, and collaborative discussions with the City's SIP Team, the Peer Review Team concludes that the three alternatives summarized in Section 3.2 (one developed through the Peer Review, one developed in the SIP, and the other a combination of alternatives developed by the Peer Review and SIP Teams) best align with the City's objectives for the Sunnyvale WPCP. The Peer Review Team sees no other options that would be superior or worth pursuing.

Further, the Peer Review Team supports the City's decision to implement any one of these alternatives that, when compared on an equal basis, is determined to best meet the City's current objectives for the Plant.

Appendix A
Meeting Summary – Workshop No. 1

Sunnyvale Review of Strategic Infrastructure Plan – Workshop No. 1

ATTENDEES:	Mark Rogge/City of Sunnyvale	Don Eisenberg/EOA
	Lorrie Gervin/City of Sunnyvale	Ray Goebel/EOA
	Joanna De Sa/City of Sunnyvale	Glen Daigger/CH2M HILL
	Tim Kirby/City of Sunnyvale	George Tchobanoglous/UC Davis
	Dan Hammonds/City of Sunnyvale	Dana Rippon/CH2M HILL
	Steve Schmidt/City of Sunnyvale	David Jenkins/UC Berkley
	Chuck Newmayer/City of Sunnyvale	Susan Dennis/CH2M HILL
		Kathy Rosinski/CH2M HILL
FROM:	CH2M HILL	
DATE:	December 13, 2010	
PROJECT NUMBER:	414083	

Introductions

Susan Dennis led round table introductions.

Review of the Agenda

Susan Dennis outlined the agenda for the meeting.

City's Objectives

Dana Rippon chaired the discussion of City's objectives for the project.

- Lorrie Gervin indicated that the purpose of Peer Review is to review the recommendations of the Strategic Infrastructure Plan (SIP) to ensure that everything was considered in the planning process, and determine whether there are any other potential alternatives or variations of alternatives (family of alternatives) that were not considered.
- Mark Rogge is looking for a greater certainty in the outcome of the SIP and the presented path forward. He is concerned that the proposed recommendations for plant upgrades are based on old technology, and that there may have been a missed opportunity to conduct a broader analysis and identify innovative solutions that best address future wastewater treatment needs and the needs of the surrounding community.
- Mark Rogge views the Sunnyvale treatment plant as a water, energy, and minerals resource. Use of these resources should be maximized as much as possible. Other objectives that should be considered for plant upgrade are as follows: increasing efficiency in terms of personnel use, energy recovery, use of resources, and chemicals;

providing required reliability; and balancing capital and long-term operating cost. Mark does not have confidence that these issues were adequately addressed in the SIP.

- There is a desire for the plant to produce revenues (in terms of energy production and recycled water production) to offset operating cost. Recycled water production could potentially offset cost for planned water supply/distribution system infrastructure improvements.
- Tim Kirby indicated that the City does not have specific financial goals for the plant upgrade. Costs would have to be evaluated in terms of impact on the sewer use rates. Current sewer use rates are $33/month.
- Mark Rogge said that converting the existing ponds to interpretive trails or other beneficial community uses is appealing and desired; however, such conversion must offer gains for the treatment plant and not be a burden to the rate payers.
- Joanna De Sa indicated that the City's power supply from Pacific Gas & Electric (PG&E) is unreliable, which affects the business community. While upgrades to the PG&E infrastructure are needed and, to some degree, are being planned for, the goal for the Plant is to potentially assist with providing reliable power for the City.
- Lorrie Gervin and Mark Rogge explained the original objectives for the SIP project. The scope of the project was limited to the plant site, and an evaluation of rehabilitation or replacement options for the existing facilities. Innovation was not part of the SIP mandate. Also, the study was not tasked with looking at a broader issues associated with recycled water, inflow/infiltration (I&I), potential community benefits, land use alternatives… etc.
- Mark Rogge emphasized that through this Peer Review, the City is looking for an independent opinion on SIP recommendations.

Dana Rippon summarized City's objectives, as follows:

- Reliability
- Resource Recovery
- Power Issues
- Community Resources
- Innovation

Understanding of Recommended SIP

The Peer Review Panel presented their view points on the understanding of the SIP recommendations. The panel indicated that, in general, the recommendations are not well aligned with the City's goals, as follows:

- In trying to understand the broader approach to addressing City's goals, Glen Daigger discussed the overall nutrient and energy flow through the existing treatment process. He explained that the existing ponds, in part, contribute to these inefficiencies. The ponds convert carbon-based energy to algal biomass by fixing carbon and nutrients. However, through anaerobic processes that occur in the bottom sludge, the ponds also release some carbon to the atmosphere in the form of CO_2 and methane, which have

significant greenhouse gas (GHG) contribution. The ponds themselves have a low operating cost; however, the follow-on highly mechanized treatments are energy intensive (power, polymer), offsetting energy gains in the ponds. Also, energy recovery through the digestion of algae biomass is not efficient, because algae do not digest well anaerobically. George Tchobanoglous supported the notion that algae have cellular structure that makes it difficult to digest.

- Glen Daigger concluded that the existing treatment process which uses ponds for primary carbon removal is not efficient in extracting energy present in the influent wastewater. At most, approximately 30 to 50 percent of the available carbon is converted to energy.
- Glen Daigger emphasized that the underlying assumption that ponds are inexpensive to operate is false. The assumption would be true if the effluent were directly discharged; however, at the Sunnyvale Water Pollution Control Plant (WPCP) the follow-on treatment processes negate the cost and energy gains.
- Glen Daigger also mentioned that the effluent quality from the ponds is inconsistent; therefore, the current treatment does not meet the City's goals for reliability. Don Eisenberg and Lorrie Gervin confirmed that the inconsistencies could not be attributed to operating strategies. Also, continued use of the ponds in their current form limits the opportunity to use this land as a community resource.

Mark Rogge indicated that the ponds provide the plant with the ability to buffer flows and loads. Also the solids in the ponds are more fully digested and may be approaching Class A quality. On the other hand, ponds may be contributing H_2S odors, and release methane (GHG).

Peer Review Team Initial Feedback

The Peer Review panel offered the following comments on the initial assumptions used in the SIP evaluation:

- The design solids/organic loadings used in the SIP appear to be underestimated compared to typical industry standards. Review and validation of loadings is recommended as it could lead to different conclusions in terms of alternative approaches to future treatment.
- The influent is relatively high in total dissolved solids, which is likely due to salt water intrusion. This could limit water reuse options at the plant. This presents opportunities for satellite recycled water treatment.
- I&I were prorated into the future based on historical data. Replacing/rehabilitating sewers would likely reduce I&I in the future. Flow estimates should be revised to reflect this.
- Efficiency improvements and water use reductions were not considered in the development of the flows. Initial assumptions need to be corrected.

The Peer Review Panel concluded that the SIP is a good plan for continuing with current treatment processes; however, to meet the objectives outlined by City staff in this meeting

other approaches and/or technologies need to be considered. The Peer Review Panel offered comments on other concepts that could be considered to better align plant upgrades with City's goals, which are summarized as follows:

- The Panel agreed that headworks (screening and grit removal) need to be replaced as proposed in the SIP. The existing screens are not efficient in removing debris, and only cut up larger solids into small pieces and return it back in the treatment process. The following other enhancements to preliminary treatment could be considered:
  - Provide fine screening for influent wastewater to improve the quality of biosolids and provide more valuable product.
  - Improve dewatering screenings to reduce volume/weight energy use for hauling.
- Visual observations made during plant walkthrough indicated that the primary clarifier tanks appear to be in good condition and could be rehabilitated or reused, which could reduce capital costs. Dan Hammonds did not agree with this initial assessment, and suggested that the Peer Review Team review the condition assessment report. The following other enhancements to primary treatment could be considered:
  - Chemically enhanced primary treatment (CEPT), where the addition of coagulant with polymer would achieve removal of finer particulates and increase biochemical oxygen demand (BOD_5) removal to 50 percent, and TSS removal to 80 percent. This approach would provide large amount of well digestable high-energy solids to the digestion process and improve energy recovery.
  - Primary effluent filtration to capture more solids/organics up front
- There are many alternative approaches to secondary treatment that could be considered that meet permit requirements and are better aligned with City's objectives:
  - Use trickling filters downstream of enhanced primary treatment to remove remainder of BOD_5 and provide nitrification followed by polishing by wetlands.
  - Covert existing ponds to engineered natural systems that would provide more predictable effluent quality; this may include engineered ponds, dual energy ponds, or engineered wetlands (opportunity to convert ponds to a community resource).
  - High-rate activated sludge treatment that would operate at a 1-day solids retention time (SRT), capture most of the organic matter; followed by trickling filters and final polishing in a smaller wetland.
  - Covering a small portion of ponds to capture of methane gas to increase energy recovery.
- Other concepts for improvements include the following:
  - Consider low-heat recovery from wastewater; this could also help with stream flow augmentation.
  - Consider enhancements to digestion to enhance energy recovery; change in process or provide pretreatment.

- Add food waste and fat, oil, and grease (FOG) to the digesters to improve gas production and energy recovery.
- Alternative disinfection, including ozone, which can address microconstituents. such as NDMA, trace organics, and enhance water quality, for beneficial reuse.
- There is the desire to produce Class A biosolids to diversify final disposal options; windrow air dried bisolids is a common way to achieve Class A quality, in fact, the existing treatment may already be able to produce this quality of solids, given that approximately 1 year of onsite storage is provided; consider other dewatering options (e.g., belt filter press instead of using the more labor intensive filter beds).

Discussion

- All agreed on the SIP concepts for preliminary/primary treatment: replacement of preliminary treatment (headworks, screenings, grit removal) and improvements to primary treatment.
- The concept of primaries rehabilitation was discussed. Joanna De Sa indicated that there are some design flaws in the current primary treatment tanks design. The primaries were originally built with air pumps for sludge pumping, and after these were replaced with conventional pumps the lateral sludge collection trough is not designed for thickening. The raw sludge typically thickens to only 3 to 5 percent solids. Glen Daigger suggested that, instead of completely abandoning the existing primary tanks, a small primary solids thickener could be added to enhance raw sludge thickening.
- Improvements to increase grit capture may be needed. Mark Roggee indicated that grit may be accumulating in the digested, based on the fact that more grit than anticipated was found during digester cleaning. Joanna De Sa said that typically 2 to 3 dumpsters per week of grit are removed from the plant.
- Options for enhancements to primary treatment were discussed. George Tchobanoglous said that primary filtration will soon be pilot tested at the Roseville WPCP. David Jenkins indicated that CEPT could be tested on full scale at the Sunnyvale plant in a short time frame.
- Options for improvements to disinfection were discussed. Laurie Gervin indicated that use of gaseous chlorine will be discontinued. George Tchobanoglous indicated that the alternative, sodium hypochlorite is widely used, but very corrosive. Joanna De Sa noted that ultraviolet (UV) is an option, even with current effluent quality. UV transmittance for pond based effluent was in the range of 60 percent (green water); however, using UV will likely require more energy to provide adequate treatment.
- The concept of converting existing ponds to wetlands was discussed. Mark Rogge indicated that there may be a sense of fear for conversion from status quo to wetlands. There is also potential for concerns/opposition from environmental groups. This concept was not explored in the SIP, but should be addressed. There are 425 acres available in existing ponds. The SIP proposed about 30 acres of existing ponds to be used for flow equalization. Glen Daigger estimates that approximately 4 acres per 1 million gallons per day (mgd) of effluent would be required for wetlands.

- Land use issues were discussed. The City would be open to the changing existing pond area to community resource / recreational uses / wetlands. However, there is a concern that rate payers may be burdened with additional cost and that the area could become a liability and cost to the City. It was discussed that during the SIP the value of the ponds and future costs associated with them, whether they retain current use or are converted to other uses, were unknown and were excluded from the cost evaluation.[1] Mark Rogge emphasized that the value, as well as cost of converting ponds and maintaining them would need to be defined.
- Joanna De Sa explained that complying with the requirements of Title 5 (air regulations) is time consuming. She explained that the air permit is combined for the plant and the adjacent landfill. The plant serves as an abatement facility for the landfill gas. In addition, based on current agreements with PG&E, the plant has power production obligations.
- Mark Rogge had additional comments on using alternative approaches/technologies. He emphasized the need for phasing and testing process changes before full implementation. He also indicated that while there is the desire to deliver services beyond the permit requirements; however, there is also a risk that this can be met with higher requirements later imposed by the regulatory agencies, which may be a liability to the rate payers. Improvements are only attractive if they can be economically implemented. The completeness and accuracy of cost estimates is also a concern. Contingencies need to be included to reflect the uncertainty associated with the planning phase level of this work.

Other Alternatives

Other alternatives were discussed in view of City's objectives, and with consideration of plant functions. The group identified the following functions of the treatment process:

- Remove carbon from water
- Reduce ammonia from water
- Disinfect effluent/dechlorinate
- Process biosolids
- Reclaim water
- Generate energy
- Remove toxics (permit)
- Remove nutrients
- Meet air regulations

[1] It was subsequently clarified that the SIP does present estimated costs associated with retaining the ponds as treatment units and estimated costs to reconfigure the ponds for alternative uses should they be abandoned as part of the plant treatment process.

- Provide energy (external to the facility, but influences treatment and operation; plant needs two power feeds)

The group the identified ideas/technologies for each of the functions that need to be screened as part of identifying solutions for plant upgrades. The technologies are summarized in Table 1.

Strategies for Facilities Upgrade

The Peer Review Panel emphasized that the design basis for the SIP, including per capita flows and loadings, needs to be reviewed. The panel stipulates that per capita flows will likely be reduced over time, and that per capita loadings (once adjusted) will stay constant.

In view of the elevated TDS in the wastewater, the overall plan for recycled water should consider upstream reclamation satellite facilities to improve recycled water quality and provide opportunity to diversify recycled water users.

Panel emphasized that planning for future must be described in terms of short-term detailed strategies, and long-term with less detail, but allowing for more flexibility to adjust to potential changes.

The panel presented alternative strategies for consideration.

Strategy 1 – Focus on Energy Recovery

- Maximize capture of influent carbon, early in the treatment process, for energy production.
- Upgrades to preliminary treatment as recommended by SIP, with enhancements, if needed.
- Treatment would consist of primary treatment with additional enhancements to achieve higher solids removal. Potential options include CEPT, filtration of primary effluent, high-rate activated sludge, and floatation.
- Use existing fixed-growth reactors (FGR) (trickling filters) and, if needed, add one more unit as a final step in carbon removal process.
- Polishing filtration for effluent from FGRs: conventional granular media filters, wetlands, and existing air floatation tanks (AFT).
- If needed, use portion of the existing ponds for reliability, peak flow attenuation or storm water polishing.
- Continue using anaerobic digestion for solids treatment, with enhancements.
- Reclaimed water would be produced by a parallel process, consisting of tertiary filtration process. There would be no need to switch between production modes.

Advantage of this strategy is increased digester gas generation.

Strategy 2 – Focus on Water

Joanna De Sa indicated that management of energy and issues associated with the air permit are consuming plant operating staff resources. The plant currently blends landfill gas with digester gas and natural gas to power equipment, which limits operating flexibility and poses a number of operational issues and compliance issues. The plant should not be focused on energy management. Furthermore, the landfill gas production is decreasing in quantity and quality, and will become less available as a resource in the future.

This strategy stipulates reduced involvement in energy management/production:

- Discontinue onsite burning of landfill/digester gas. Get out of the air permit business.
- Purify and sell gas to PG&E.
- Implement enhancements to treatment to improve gas quality: addition of iron salts to reduce H_2S; siloxane removal; molecular sieve to remove CO_2.
- Produce alternative biosolids product – improve raw wastewater screening and enhance existing processes to produce Class A biosolids

This strategy would apply in either case. It would fit in the implementation plan.

To Do List

Issues in the SIP document that were identified by the Peer Review Panel as needing an in-depth review/verification are as follows:

- Update SIP flows and loads
- Reconsider rehabilitation of existing primaries
- Complete wastewater characterization

Next Steps

- CH2M HILL to distribute meeting notes
- CH2M HILL to screen presented technologies in a TM
- CH2M HILL to develop Strategy 1 to the level that allows for comparison with alternatives already developed. Comparison must be made based on common assumptions.
- CH2M HILL to submit TM summarizing alternative comparison

TABLE 1
Summary of Technologies for Screening for the Sunnyvale WPCP Upgrades
Sunnyvale Review of Strategic Infrastructure Plan – Workshop No. 1

Treatment Function			
Remove Carbon	**Reduce NH_3**	**Disinfect/Dechlorinate**	**Process Biosolids**
Primary sedimentation CEPT Filtration Activated sludge FGRs Ponds Wetlands Anaerobic treatment FGRs	FGRs Ponds Activated sludge Manage recycle streams Wetlands Breakpoint chlorination Ammonia stripping Urine separation	Chlorine gas Hypochlorite (purchase, on-site generation) SO_2 Sodium bisulfate UV Ozone Peroxide Peracetic acid Pasteurization	Improved primary screening (improve quality) Anaerobic digestion (mesophilic, thermophilic) Dewatering Solar drying (open, enclosed) Thickening Lagooning/long term storage Pasteurization Land application/land filling Combustion Composing Gasification/Pyrolysis Precondition for digestion (hydrolysis)
Reclaim water	**Generate Energy**	**Remove toxics**	**Remove nitrogen**
Treatment at the plant Upstream/satellite facility Conventional filtration MBR Industrial reuse (power plant, stream, cooling towers) Dual plumbing	Combine heat and power (CHP) FOG, food waste, use lower energy processes Heat recovery Solar Wind Conserve heat Thermal combination with energy recovery Use in vehicles Produce and use biosolids Clean and sell gas	Urine separation Remove carbon Enhanced source control Reduce NH_3 Dechlorination Advanced oxidation In-plant chemical selection Don't grow algae Avoid discharge Reverse osmosis Reuse Phytoremediation	Urine separation Grow biomass Nitrify-denitrify Bio-P removal Struvite recovery Ion exchange Recovery from ash

Appendix B
Meeting Summary – Workshop No. 2

Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan – Workshop No. 2

ATTENDEES:

Mark Rogge/City of Sunnyvale
Lorrie Gervin/City of Sunnyvale
Joanna De Sa/City of Sunnyvale
Nasser Fakih/City of Sunnyvale
Dan Hammons/City of Sunnyvale
Steve Schmidt/City of Sunnyvale
Chuck Newmayer/City of Sunnyvale
Don Eisenberg/EOA
Ray Goebel/EOA
Glen Daigger/CH2M HILL
George Tchobanoglous/UC Davis
Dana Rippon/CH2M HILL
David Jenkins/UC Berkeley
Susan Dennis/CH2M HILL
Kathy Rosinski/CH2M HILL

FROM: CH2M HILL

DATE: February 16, 2011

PROJECT NUMBER: 414083

Meeting Objectives and Opening Statements

The meeting purposes are as follows:

- Review findings of Tasks 2 and 4 including review of past primary clarifier condition assessment work
- Describe the Strategy 1 alternatives; discuss the advantages/disadvantages of the alternatives as compared with the Strategic Infrastructure Plan (SIP) recommendations; and present comparative costs
- Discuss the City's path forward to share the Peer Review findings with Brown & Caldwell to select an alternative for implementation, and to develop an implementation strategy
- Confirm the remaining tasks for the Peer Review Project

Summary of Tasks 2 and 4 Conclusions and Recommendations

Summary of Peer Review Task 2 – Detailed Review of Strategic Infrastructure Plan Document

Dana Rippon summarized the findings of the SIP review that were presented in the draft Task 2 Technical Memorandum (TM). The review was conducted by subject matter experts; the large number of comments was screened to present only the comments most significant to the SIP in achieving the City's objectives.

In general, the reviewers found the SIP to be a technically competent document. There are some organizational and editorial challenges, particularly related to decision chronology. The SIP document lacks a clear conclusion and a clear outline of a path forward.
Dana Rippon indicated that some of the comments pertained to future optimization of the

design that may not have been part of the SIP scope, and were made for future consideration. He also acknowledged that he understood that the scope of the SIP was limited to evaluating a plant rehabilitation alternative and a plant replacement alternative and that the SIP team may have been constrained from evaluating other viable alternatives.

Discussion of the draft Task 2 TM follows:

- Mark Rogge and Lorrie Gervin agreed that the SIP document may not present a clear recommendation and a path forward for implementation, and that rationale for many decisions is not included in the SIP even though it does indeed exist.
- The SIP does acknowledge some issues that the SIP project team discussed and that need to be addressed in future project phases. Examples are as follows: the effects of sea level rise (SLR) and their mitigation (Mark Rogge indicated that a design SLR has not been decided), evaluation of potential uses for the existing pond area should their use be discontinued, and methods for meeting possible future effluent limits. Lorrie Gervin indicated that many of these issues were discussed during the project but may not have been captured in the SIP. Mark Rogge added that it is important to document decisions and rationale to be able to defend decisions in the future as memories fade.
- Don Eisenberg stated that he disagreed with the comment that the pond area may be available for constructing treatment structures, support buildings, mechanical facilities, or paved areas. Thus, he agrees with the SIP's focus on limiting new facilities siting and treatment process modifications to the current land-based site (except for pond rehabilitation and/or wetlands construction, which would obviously take place in the current pond area).
- Mark Rogge added that the assumption of land (dry land or ponds) having "zero" value may lead to unequal comparison of alternatives. The work to valuate the land has not yet been completed. However, the footprint and value of land needs to be included in the alternatives comparison.
- Assumed effluent total suspended solids (TSS) limits were discussed. Don Eisenberg explained that current limits for the Sunnyvale plant (average month/maximum day is 20 to 30 milligrams per liter [mg/L] of TSS) are technology-based given the existing pond system. His expectations are that TSS limits would likely be lowered if the plant were converted to an activated sludge (AS) process but that a 10-mg/L of TSS limit or the requirement for filtration is not a certainty. There has been no discussion with the San Francisco Bay Regional Water Quality Control Board (Regional Board) regarding potential future effluent limits. However, based on limits at other plants in the South Bay, he believed that the assumptions made in the SIP are reasonable. Mark Rogge indicated that the assumptions and the rationale for them need to be clearly stated. It was agreed that the SIP needs to clarify discharge assumptions, particularly for the AS alternatives. Also, this issue should be identified as needing resolution in the next project phase.
- Don Eisenberg also discussed issues associated with potential future ammonia limits. He indicated that current limits for ammonia are technology-based (ponds). The Regional Board had proposed interim future limits that were assumed in the SIP. In Don Eisenberg's opinion, future limits for ammonia are not certain and this should be

clearly stated; they may be higher or lower than values used in the SIP (winter limit of 4.5 milligrams of NH_3-N/L).

- Mark Rogge stated that the SIP should explain why a particular discharge limit is considered. It should be clear that the environmental benefits of treatment are important to the City and that cost is not the only driver. He asked whether the City would adopt a more stringent limit if costs were equal. Lorrie Gervin stated that the ability to operate the plant to achieve greater treatment efficiencies versus being required to do so have significantly different implications on operations flexibility and costs. Discharge requirements are water quality-based and achieving greater removal may not have water quality benefits.
- Mark Rogge agreed that the SIP did not state whether "advanced" pond technologies or other uses of the pond area were evaluated in the SIP, but this may be useful to support the SIP recommendation for continued use of the ponds for secondary treatment. Don Eisenberg believes that the existing ponds are better engineered and more effective than what is implied in the TM, and that although other enhancements to the ponds may significantly improve their performance as treatment ponds, such enhancements would not likely eliminate the need for the tertiary treatment facilities. Therefore, it is his opinion that an evaluation of other pond design modifications technologies would probably not change the SIP recommendations.

Strategic Infrastructure Plan Peer Review: Task 4 – Review of Cost Estimate

Dana Rippon summarized the findings of the review of the SIP cost estimate that were presented in the draft Task 4 TM.

In general, the estimated costs conform to Association for the Advancement of Cost Engineering International guidelines. Accurate estimate of sales tax, escalation, and other percentages would increase the precision of the estimate. The major question is whether this level of estimate is appropriate for purposes beyond comparing alternatives; can it be used to establish the budget for project implementation?

- Mark Rogge indicated that he thought that the purposes of the SIP cost estimate were (1) to facilitate a comparison between alternatives on a life-cycle basis; and (2) to establish a budget for future construction and operations budgets. In his opinion, the level of accuracy presented in the SIP is not adequate for the City to set future budgets (for the purpose of setting rate structure, and issuing bonds). For the project to be successful, it is important that the estimate accurately reflects future costs because budget increases will be difficult to justify later.
- George Tchobanoglous and Dana Rippon believe that this level of cost estimate is acceptable to use for alternatives selection but not for project budgeting. While the estimate has a lot of detail, there are many uncertainties about the "design" data that was used to develop the estimate and the details of the facilities to be constructed. After the preferred alternative is defined, a Level 3 estimate should be developed.
- Mark Rogge questioned whether the cost estimate should be targeted to be the low or mid-point of the bids to set appropriate budget expectations. All agreed that

construction bids are still coming in below engineers' estimates but that this trend will change at some point; this should be considered in project phasing.

- Mark Rogge also indicated that assumptions used in the development of the SIP cost estimate need to be clearly stated. Other project costs, such as CEQA and other permitting, temporary construction facilities, and phasing need to be better defined.
- Glen Daigger added that CH2M HILL's design-build experience has led to a risk-based cost estimate approach to account for elements of the project for which there is greater certainty and those with less certainty. This could be considered in the future when budget-level cost estimates are prepared.
- Review of Primary Clarifiers Condition Assessments.

In Workshop 1, the Peer Review Team suggested that, based on their brief visual observations, rehabilitation rather than replacement of the primary clarifies should be considered. Susan Dennis summarized the review of previous primary clarifier condition assessments conducted by Carollo Engineers in 2006, and the recommendations presented in the SIP.

The Carollo condition assessment report evaluated two options based on visual inspections and structural seismic analyses of the clarifier structures: rehabilitation of all 10 clarifiers, or replacement of clarifiers 1 through 6 and rehabilitation of clarifiers 7 through 10. In both options, the analysis focused on providing a minimum additional useful life of 10 years through rehabilitation and 50 years through replacement. It was not stated in the Carollo document or in the SIP whether the existing structures were analyzed to provide a 30-year or greater usable life through rehabilitation or whether use beyond 10 years was possible.

In the SIP, Brown & Caldwell recommended replacing 10 clarifiers. It was not clear whether additional analyses were performed to reach this conclusion. However, the existing condition assessment work offers no basis for refuting the SIP recommendation. In addition, replacement of the clarifiers offers significant long-term advantages including superior sludge collection and in-clarifier thickening, and optimization of chemically enhanced primary treatment (CEPT) if implemented.

- Mark Rogge indicated that the efficiency of building new facilities is appealing. The problems with rehabilitating older structures are well known, and include often unknown condition and technical issues that can lead to higher cost. In general, there is much more uncertainty in rehabilitation than new construction.
- Dana Rippon added that from a process perspective, the existing clarifiers are not well suited for solids thickening, which likely led to the inclusion of separate thickening facilities in the SIP. Additionally, if the clarifiers are constructed in the sludge drying area the impact of construction on plant operation would be minimized as well as providing greater flexibility in the site layout.

Strategy 1 Alternative Development

Glen Daigger summarized the review of the SIP flows and waste loads, the development of the loads that were used to develop the Strategy 1 Alternative, and development of the Strategy 1 Alternative as presented in the draft Optional Services Task TM.

Flow and Waste Loads Review

Glen Daigger summarized the findings of the SIP flow and waste load review as follows:

- The flows presented in the SIP were accepted for the purpose of developing the Strategy 1 alternative.
- The average per capita mass loadings from the SIP were compared to published values; the average values used in the SIP appear to be as much as 50 percent below industry standard average values. Mass loading peaking factors from the SIP were also compared to published data and are above published average values. This comparison suggests that the data used to develop the SIP loads is not accurate and that the raw wastewater sampling is not capturing all of the influent wastewater TSS and BOD. Textbook per capita loadings and peaking factors were used to develop the constituent mass loadings for the purpose of developing the Strategy 1 alternative.
- Maximum month and maximum week mass loadings from the SIP were compared and found to be similar to the textbook values.
- The implication of this finding is that the SIP alternatives are appropriately sized for purposes of comparison because sizing is based on maximum month/week loadings. However, the operation and maintenance (O&M) and life cycle costs presented in the SIP are likely to be underestimated because they are typically based on (the low) average annual loads.

The following issues were discussed by the group:

- It is not known whether the data and resulting loadings were questioned during development of the SIP. Mark Rogge believes that the draft Optional Services Task TM does not clearly state that the historical plant data underestimated the mass loading for the service population. This issue will affect costs and sizing of the plant treatment processes and must be resolved during predesign.
- Steve Schmidt believes that sampling data used in the SIP underestimated the true loadings to the plant. The raw wastewater samplers were replaced and relocated in 2010, and there is now more confidence in the data. These new data were not available during the preparation of the SIP, but more than 1 year of data will be available for preliminary design.
- George Tchobanoglous indicated that future water conservation measures have not been evaluated in development of the SIP flows and could significantly affect the future plant flow. His observation is that cities are now using values of 70 gallons per capita per day (gal/cap/day) or lower, compared to 100 gal/cap/day used in the SIP. Flows as low as 50 gal/cap/day are already common in Europe and could be realized in the United States in the future. Also, in his opinion, more effort is required to characterize the wastewater flows and loads and their impacts to design.
- Steve Schmidt mentioned that non-domestic contribution from groundwater pumping and treatment, which is discharged to the sanitary sewer, could add to higher per capita flows. He indicated that there are wells that contribute 60,000 to 70,000 gallons per day. Infiltration/inflow could also contribute to higher per capita flow.

- Ray Goebel indicated that there are some water-intensive industries that discharge to the sewer. This wastewater is low in TSS and BOD, and should not contribute significant loadings of these constituents to the plant. It was suggested that staff research available industrial user data to ascertain the current impact of these discharges.
- David Jenkins emphasized that having the correct flows and waste loads will be important when deciding the number of basins in each unit process to accommodate the range of expected flows and loads.
- Mark Rogge stated that the reasons for using published data versus the SIP values must be clearly stated in the TM and Peer Review report.

Strategy 1 Alternative Development and Description

Glen Daigger summarized the step-wise approach used to develop the Strategy 1. The objective of exploring this strategy was to maximize the capture of carbon from the influent wastewater for energy production. Two options, Option 5 and Option 7, were identified as viable and were developed in more detail so that they could be compared with the SIP recommendations. The viable options were as follows:

Option 5: Headworks + Primary Clarifiers + CEPT + Existing Fixed Growth Reactors (FGR) + one additional FGR + Treatment Wetland

- The option maximizes TSS and organics capture early in the primary treatment process to maximize energy recovery from the wastewater.
- Three existing FGRs and one additional FGR are needed for removal of organics and ammonia.
- The use of ferric chloride is proposed for enhanced TSS removal in primary treatment with the additional benefits of providing odor control, phosphorus removal (though it cannot be reclaimed), and increased capture of colloidal organics.
- Wetlands will be used for effluent polishing (TSS, ammonia, and total nitrogen removals) with the compliance point based on the wetland effluent. It was assumed that the flow would be pumped back to the land-based plant for disinfection. However, construction of disinfection facilities at the wetland outlet could be explored.
- A parallel 4-million-gallon-per-day (mgd) (or more) recycled water train would use the existing filters and disinfection and disinfectant removal facilities.
- Glen Daigger emphasized that the presented concepts were a strategy suitable for comparison with the SIP alternatives and that refinements would be required to fully develop and cost the alternative. However, the strategy was formulated to provide maximum flexibility for meeting future effluent limits, incorporate a parallel recycled water treatment, and allow for phasing.

The group had the following comments on Option 5:

- Mark Rogge asked for clarification of the assumptions concerning reclaimed water, because in the future these needs might increase. Glen Daigger explained that 4 mgd

was assumed, based on the SIP; however, all of the wetland effluent could be used for recycled water production (with additional filters).

- Lorrie Gervin asked whether disinfection of wetland effluent would be required prior to discharge. Glen Daigger responded that chlorine-based or UV disinfection would be required for the wetland effluent. A UV system installed at the wetland could be explored to eliminate pumping back to the plant.
- Lorrie Gervin asked about construction phasing. Glen Daigger responded that CEPT would be implemented first. At that point, the loading to the ponds would be reduced, and all of the ponds would not be needed for treatment and could be sequentially converted to wetland. If the fourth FGR was included in this initial construction phase, it could also be constructed prior to beginning conversion of the ponds to wetlands.
- George Tchobanoglous indicated that the added benefit of this option was that the wetlands would provide a community resource at no additional cost.

Option 7: Headworks + Primary Clarifiers + High-rate Activated Sludge (HRAS) + Existing FGRs + Filtration

- In this process, HRAS effectively accomplishes carbon capture as CEPT did for Option 5. The HRAS would operate at a solids retention time (SRT) of 1 day or less so that it would capture TSS and organics by producing biomass that would then be anaerobically digested.
- This option has a smaller aeration basin volume and significantly lower energy/aeration cost than a conventional AS system that achieves nitrification.

The group had the following comments on Option 7:

- David Jenkins indicated that in terms of energy capture from the wastewater, Option 5 is similar to Option 7. Where the CEPT captures particulates and colloidal fractions, the HRAS also captures soluble organics, but uses some of these for cellular energy.
- Ray Goebel noted that energy use comparison of alternatives needs to include the cost of pumping to the FGRs.
- Lorrie Gervin asked which option would produce more energy. Glen Daigger believes that Option 7 would produce more energy than Option 5 because some digestible TSS would be produced from soluble BOD. David Jenkins and George Tchobanoglous estimated that both Options 5 and 7 would produce about the same amount of energy.
- Glen Daigger stated that Option 5 would be the easiest to operate as CEPT requires less operator attention that HRAS.

Discussion of Strategy 1 and Strategic Infrastructure Plan Alternatives

Glen Daigger led a discussion comparing relative advantages/disadvantages of the Strategy 1 Alternative (Options 5 and 7) and the recommended SIP alternatives (Plant Rehabilitation and Plant Replacement – AS) based on the City's objectives that were identified in Workshop 1.

To facilitate comparison, he grouped the alternatives into two categories: natural treatment-based alternatives, and AS-based alternatives. Criteria were suggested based on the City's objectives stated in Workshop 1 and the Triple Bottom Line used to evaluate the alternatives in the SIP. A summary of this comparison is presented in Table 1. The comparison is intended to highlight key differences between alternatives to identify if there is a best strategy or a "no-regrets" option that incorporates steps that are beneficial even if future circumstances change.

Given future unknowns in regulations, energy costs, or other factors, Glen Daigger suggested looking at the alternatives from the perspective of whether they would present either "no regrets" or offer "significant regrets." He made the following observations:

- Any alternative in Table 1 that is marked with a "-" does not meet the City's objectives and would not be desired. Alternatives in Table 1 with only a "o" or a "+" are preferred over alternatives with any "-."
- Option 5 is the alternatives with no "-" and thus is the benchmark for comparison. There would need to be good reasons to use an alternative other than the benchmark. The only potential "regret" of this option would be constructing the wetlands; after constructed, the City would be committed to this option. Glen Daigger suggested that Option 5 was the "no-regrets" alternative because it would have superior or equal value for the stated criteria regardless of future changes.
- For the Pond alternative, construction of the air flotation thickeners (AFT) would commit the City to this option.
- Option 5 scored lower ("o") on operational control criteria than the AS options ("+"). This reflects the key difference between a natural treatment system and the more engineered AS system.
- An initial step in any option would be to construct new headworks and primary clarifiers. Incorporating CEPT would set the stage for the wetlands option or offload the ponds and allow the City to determine whether the required ammonia removal can be achieved with the ponds. The decision would then be made on whether to proceed with an additional FGR and the wetlands construction. The main tradeoff between the two natural treatment options is that Option 5 allows removal of the AFTs and filters from the treatment train. The existing filters could be used for recycled water production.
- Likewise, the AS options could be phased to defer the ultimate decision. In general, the main difference between the AS and the HRAS options is the number and size of aeration basins and energy use devoted to secondary treatment. HRAS could be an initial phase of an AS option. The key impact resulting from selection of the AS strategy is that it abandons the pond technology to achieve greater carbon recovery. Again, the HRAS option would meet current discharge standards and can be configured to add more aeration basins (thus moving from HRAS to conventional AS) in the future to accommodate more stringent effluent requirements (nutrient removal) should this be necessary.
- For the AS options the greatest uncertainty may be the future use of the abandoned ponds (e.g., stormwater polishing, mitigation, return the land to bay ecosystem).

TABLE 1
Comparison of Alternatives

	Natural System		AS	
Criteria	**SIP Plant Rehabilitation Alternative (Ponds)**	**Option 5: PC with CEPT + FGRs + Wetland**	**SIP Plant Replacement Alternative (AS)**	**Option 7: PC + HRAS + FGRs + Filtration**
Reliability – ability of the system to consistently meet discharge requirements	+	+	+	+
Operational Control – ability to make adjustments to the process to achieve a consistent desired result (effluent quality, energy utilization, good neighbor)	-	o	+	+
Effluent Quality – future constituents current and potential future BOD/TSS, year round ammonia, total nitrogen)	o (existing limits)	+ + (future total nitrogen, total phosphorous)	+ + (future total nitrogen, total phosphorous)	o (existing limits)
Resource Efficiency – net energy efficiency	o	+ +	-	o
Pond Land Use – beneficially utilizes pond acreage at appropriate cost or risk	o (ponds stay ponds)	+ (more attractive use of ponds)	- (uncertainty use of the ponds)	- (uncertainty use of the ponds)
Innovation – advances status quo to achieve superior technical, economic, and social benefits	o	+	-	-
Capital Cost	+	++	-	o
O&M Cost	o	+	-	o

Notes:

++ = best provides performance relative to criteria as compared against other alternatives

+ = provides superior performance relative to criteria as compared against other alternatives

o = neutral performance relative to criteria as compared against other alternatives

- = does not meet the criteria

PC = primary clarification

The group had the following comments on the comparison of alternatives

- Mark Rogge requested clarification on why wetlands, which are natural systems, can be considered more reliable than ponds. Glen Daigger explained that increased reliability is achieved by limiting wetland treatment to processes that wetlands successfully accomplish, as follows: removing TSS, some nitrification, and some denitrification. The water going to the wetland would be almost fully treated. There will be some seasonal variation in effluent quality but it will be less when compared to that of the ponds. Wetland treatment is more microbial than sunlight-based because the plants shade the sunlight and prevent significant algae growth. Glen Daigger is confident, on the basis of CH2M HILL's experience with this technology, that effluent limits can be achieved.

- Don Eisenberg believes that wetlands and ponds should be rated the same for the Operational Control criteria because operational control of a pond system is greater

when looking at the ponds/FGR/AFT/filters as a complete treatment system, particularly considering that the ponds are upstream of the engineered treatment components. This allows correction of any effluent quality issues from the ponds. Glen Daigger reiterated that the wetland option would achieve nearly full treatment before discharging to the wetland; one could make the case that this mode of operation provides greater control by requiring the wetland to do only what is required, whereas the ponds must achieve secondary treatment.

- Mark Rogge asked what would be an alternative treatment process to the wetlands for Option 5. Glen Daigger explained that the primary purpose of wetlands is TSS removal from the FGR effluent. This can also be accomplished by conventional clarifiers followed by filtration, or other TSS removal technology. The cost of building filters and clarifiers is much higher than wetlands.
- Mark Rogge requested that a narrative be included in the TM or report to describe the operational differences between ponds and wetlands.
- Lorrie Gervin stated that either ponds or wetlands offer a strategic opportunity for community benefit.
- Joanna De Sa commented that for Option 5, the Operational Control rating of "o" (i.e., no change from existing) is not most desirable. The plant currently has limited control of the pond process (recirculation pumps, water level) and no control of its performance. From an operational standpoint, not including cost, Joanna De Sa would prefer the AS plant option because of high level of operational control and predicable response to process adjustments (turn a dial, process responds). Glen Daigger responded that lack of operational control can be mitigated by process design and the fact that the effluent quality discharged to the wetlands is already close to the permit limits.
- Joanna De Sa commented that sustainability, and particularly carbon footprint, is important for evaluation/comparison of alternatives, and should be discussed. Mark Rogge added that the City's new Sustainability Commission goals should be considered. Joanna De Sa added that the plant's Title V permit should be considered; new engines should be in place by the next renewal in 2016.

Mark Rogge asked the Peer Review experts for their expert opinion about which option they would recommend, as follows:

- David Jenkins indicated that the City should proceed with the early execution projects of building new headworks and primary clarifiers, and incorporate CEPT, then determine whether the treatment meets effluent limits, including winter ammonia. He recommends moving away from pond treatment and incorporating wetlands.
- George Tchobanoglous indicated that new preliminary treatment should consider enhanced screening to capture more material upstream and offload the FGRs. In addition to primary sedimentation with CEPT, other primary treatment processes (e.g., Densadeg, lamella settling, and ActiFlo) should be considered because these could attain greater organics removal and allow the FGRs to be used for nitrification only. Wetlands should be used for effluent polishing (lightly loaded), would provide an

amenity to the community, and would not preclude any future treatment process innovations.

- Dana Rippon recommended proceeding with the wetlands option, Option 5. This is driven by Option 5 doing the best job of addressing the City's non-monetary goals for the project and, most importantly, providing a community resource. In particular, he emphasized the need to commit to a decision and proceed with developing an implementation plan. The inability to distinguish between alternatives in terms of non-monetary goals was a key failure of the SIP.
- Glen Daigger reiterated his opinion that the wetlands option is a "no-regrets" option. He emphasized the key approach for the City is to develop a step-wise plan all the way through the treatment process, with decision points identified to allow flexibility to adapt to potential future changes. He sees that uncertainty has become a barrier to effective decision-making. The City does not need to commit to everything now, but needs a road map. The SIP Peer Review Team has defined a treatment strategy. However, specific projects must still be indentified including development of budget-level costs. This must be addressed in the next phase (not in Peer Review Project scope of work).

Mark Rogge asked the reviewers to comment on flexibility of Option 5 to address future treatment/capacity issues. He feels that it is important that the evaluation includes a discussion on the ability of the treatment strategy to adapt to future changes.

- George Tchobanoglous confirmed that wetlands could also be used for stormwater treatment, if needed, in the future. The wetlands could be compartmentalized to provide a separate cell for stormwater treatment.
- George Tchobanoglous also indicated that wetlands could provide treatment for trace constituents and metals, if this is needed in the future. Wetlands do not preclude future treatment innovations.
- Steve Schmidt said that fats, oil, and grease (FOG) treatment has not been discussed in the SIP and that this may be desirable in the future. George Tchobanoglous noted that FOG treatment can be incorporated in the design; a FOG receiving facility would be required and FOG would be fed directly to the digesters.
- Accepting septage can also be incorporated in the future treatment. Storage for septage and pumping could be added, regardless of the treatment strategy.

Other comments from the group follow:

- Lorrie Gervin emphasized that the City must still "manage the gap" while SIP implementation proceeds. They still need to keep the existing facilities operational and given the condition of some equipment, this needs to be addressed in the implementation plan.
- Primary effluent flow equalization was discussed. Glen Daigger indicated that the Strategy 1 options do not include flow equalization. The treatment units were sized to manage peak flows. Don Eisenberg said that during the SIP development, flow equalization was requested by the City for emergency management of flows to maintain

operating flexibility similar to currently available with the ponds. Currently the treatment plant can shut down for a few days and the ponds are used to hold flow. Glen Daigger said that equalization is not a typical design feature but could be beneficial for AS options as it would make a difference from the standpoint of secondary treatment sizing and the number of redundant units. It will not make much difference for the wetlands option. David Jenkins added that equalization is less of an issue if CEPT is implemented because greater removal upstream. Don Eisenberg indicated that for the purpose of cost comparison, equalization should be either included or excluded for all alternatives to enable equal comparison.

- Don Eisenberg suggested that testing of the FGR performance once CEPT or other improved upstream treatment is implemented be considered before moving forward with process changes.
- Mark Rogge further emphasized the need for the comparison of alternatives to be, as much as possible, "apples-to-apples" with the basis of comparison and assumptions, as well as the rationale for assumptions clearly stated. Also, clear recommendations and conclusions must be stated so that readers have a clear understanding of the path forward, not just those who developed the plan but the City Council, members of the public, and other readers.

Conclusions and Path Forward

- City staff concur that the Peer Review Team's wetlands option, Option 5, appears quite viable. The City desires to have their SIP consultant review the Peer Review Team's findings and then make a final decision on the alternative to be implemented. An implementation plan to define a step-wise approach with decision points will then be developed for the selected alternative. Budget-level costs can be developed based on the implementation plan.
- The Peer Review Team will incorporate the City's comments to finalize the draft TMs, prepare meeting notes for Workshop 2, and develop an outline for the Peer Review Report to obtain concurrence on content and presentation.
- The City will provide the Peer Review Team's work products and recommendations to Brown & Caldwell to obtain their input. David Jenkins suggested that this step should not preclude the City from proceeding with their decision. Don Eisenberg added that Brown & Caldwell could be asked why the wetlands option is not better than the ponds; did the Peer Review Team miss something?
- Following Brown & Caldwell's response to the Peer Review Report, the SIP/Peer Review findings and path forward will be presented to City council.

Appendix C
Technical Memorandum – Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan, Task 2 Perform Detailed Review of Strategic Infrastructure Plan Documents

Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan
Task 2 Perform Detailed Review of Strategic Infrastructure Plan Documents

PREPARED FOR: City of Sunnyvale

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DATE: February 1, 2011

PROJECT NUMBER: 414083.SP.02

Background and Purpose

This technical memorandum (TM) presents our review of the Strategic Infrastructure Plan (SIP), focusing on consistency of the technical elements of the work.

The SIP comprises a series of TMs that are listed below in subject matter groupings as provided by Brown and Caldwell in the SIP Technical Memorandums Guide. For ease in referencing the various TMs, we have assigned a sequential numbering system.

Decision Making

- TM 1 – Business Case Evaluation of Plan Alternatives
- TM 2 – Business Case Evaluation Decision Making Methodology
- TM 3 – Level of Service (LOS) Measures

Alternatives Development

- TM 4 – Plant Rehabilitation Alternative Summary
- TM 5 – Plant Replacement Alternatives Goals and Objectives
- TM 6 – Plant Replacement Alternatives Summary

Special Planning

- TM 7 – Early Execution Projects
- TM 8 – Headworks and Primary Sedimentation Upgrades Alternatives Evaluation

Fundamental Information

- TM 9 – Influent Flows and Loads
- TM 10 – Solids Loads
- TM 11 – Regulatory Framework
- TM 12 – Seismic Performance Goals
- TM 13 – Electrical Power System Level of Service
- TM 14 – Condition Assessment

Unit Process Improvement Studies

- TM 15 – Nitrification Process Improvements
- TM 16 – Evaluation of Dewatering Alternatives
- TM 17 – AFT Upgrade Alternatives
- TM 18 – Anaerobic Digestion of Algae Float
- TM 19 – Recycled Water Treatment Alternatives

Comments are not provided for the Decision Making memoranda. Review of TM 1, which summarizes the overall SIP recommendations, will not serve a clear purpose until the City adjudicates the Peer Review Project findings and makes the decision on the preferred alternative. TMs 2 and 3 define the City's decision making methodology and LOS goals; these appear to be appropriate based on a brief review.

Review of the other TMs was assigned to subject matter experts. Dana Rippon provided treatment process review and overall coordination of the comments to ensure appropriate context and to minimize repetition. Our conclusions, recommendations, and comments are presented below.

Conclusions and Recommendations

The SIP was found to generally conform to professional standards and be technically sound. Our overall comments on the document and recommendations that will most significantly affect the City's decisions on implementation, including costs, are summarized below. Specific comments pertaining to each TM follow and include recommendations for resolving those individual comments where appropriate.

- The document requires a thorough editing, including spell check, to enhance readability and clarity.

- An introduction stating the overall methodology and timeline for decisions that were made throughout the SIP process would be useful given the 3-year duration of the SIP project. In particular, this would help to clarify the chronology of the TMs that have some decisions preceding the technical evaluations. Such an overview is attempted in TM 1, but it is not clearly presented.

- Recommendations for odor control, geotechnical investigations, surveying, and establishing architectural standards for the Water Pollution Control Plant (WPCP or Plant) (including LEED design) are not clearly stated. These elements can significantly

affect the cost of implementation and/or community perception of the completed facility and should be included in the Final SIP.

- An implementation plan stating recommendations for packaging and sequencing of construction contracts and expenditures should be provided in the Final SIP. The schedule for completing environmental permitting for the project also should be indicated.
- Design sea level rise (SLR) for the facility should be clearly stated. This can significantly affect costs for rehabilitating the pond levees or other alternatives that may utilize the pond area. In addition, design SLR will need to be considered in evaluating plant discharge schemes and earthwork along the Plant boundary.
- Assumptions for primary clarifier thickener performance require reexamination. The conclusion that separate thickening is needed for adequate primary clarifier performance, especially when proposing to build new primary clarifiers, is unsubstantiated. New primary clarifiers can be designed with deep sludge hoppers with good thickening performance, likely eliminating the need for gravity thickeners. We recommend that the evaluation of new clarifiers considers that the design will provide good sludge thickening performance.
- TM 11 should include Regional Water Board verification of BOD_5 and suspended solids limits if the Plant were to be converted to the activated sludge process. Discussion of activated sludge alternatives, including costs, should be adjusted accordingly.
- When evaluating performance of the existing clarifiers, the wide scatter of the data points to questionable data. Using these data as the basis for conclusions regarding performance of the existing clarifiers should be considered suspect and, therefore, recommended modifications such as separate sludge thickening may be unwarranted (TM 14).
- Regarding the recommendation to replace all primary clarifiers, we find no data to refute that conclusion based on our review of the SIP and Asset Condition Assessment, Final Summary Report, Carollo Engineers, August 2006.
- The SIP should identify at least one nitrification alternative that ensures success in meeting proposed permit limits for ammonia, without the need for performance testing.
- No discussion is included on the emergence of improved pond wastewater treatment technologies and how this would or could apply to the continuation of pond treatment at Sunnyvale. Pond treatment technologies have advanced substantially since the construction of the Sunnyvale ponds, but continuing with the existing configuration is the only alternative considered. We recommend that advancements in pond treatment technologies be considered and evaluated, such as advanced integrated pond systems, phase separation, and multi-power/multi-cellular approaches.
- The SIP should state the objectives of mechanical dewatering, especially percent solids and subsequent disposal (composting, land application, mechanical drying) (TM 16).
- Allowable digester loading of 0.18 $lb/ft^3/day$ for a blend of primary sludge (PS) and algae appears high in light of experience with digester foaming. This loading rate is

likely acceptable for PS only. With a mixture of PS and waste activated sludge (WAS), digester loading should be closer to 0.10 lb/ft^3/day. A 50/50 blend of PS and algae could likely be as difficult to digest as a blend of PS/WAS. No information was presented on foaming potential of algal solids. This is a chief limiting factor when digesting a blend of PS/WAS. If this is not a factor with algae, then loadings listed should be acceptable. This should be discussed and clarified (TM 18).

- The SIP recommends filtration of activated sludge effluent for Bay discharge. This should not be necessary. Activated sludge can meet discharge limits without filtration. Therefore, secondary effluent should go directly to disinfection. This would leave the existing dual-media filters (DMF) completely available for reclaimed water. A new set of recycled water filters would not be necessary (TM 19, Figure 6-2).

Review of Alternatives Development Technical Memoranda (TMs 4 through 6)

Our comments, based on our review of these TMs, are as follows.

TM 4 – Plant Rehabilitation Alternative Summary

This TM is a summary document that draws on work done in almost all supporting TMs (9 through 19). The stated objective of the Plant rehabilitation alternative is *"…existing facilities are retained and rehabilitated wherever possible."* Our comments are as follows:

- The TM states that new construction is recommended where existing structures have aged beyond their useful life or *"…a superior technology has emerged*." No discussion is included, however, on the emergence of improved pond wastewater treatment technologies and how this would or could apply to the continuation of pond treatment at Sunnyvale. Pond treatment technologies have advanced substantially since the construction of the Sunnyvale ponds, but continuing with the existing configuration is the only alternative considered. We recommend that advancements in pond treatment technologies be considered and evaluated such as advanced integrated pond systems, phase separation, and multi-power/multi-cellular approaches.
- Use of separate sludge lagoons to be constructed from existing ponds is discussed under "Oxidation Ponds," but does not logically belong here. We recommend moving this discussion to a more appropriate location.
- The conclusion that separate thickening is needed for adequate primary clarifier performance, especially when proposing to build new primary clarifiers, is unsubstantiated. New primary clarifiers can be designed with deep sludge hoppers with good thickening performance. We recommend that the evaluation of new clarifiers considers that the design will provide good sludge thickening performance.
- The recommendation to use positive displacement pumps for thin-phase sludge pumping and centrifugal pumps for thickened sludge pumping appears to be reversed and is unsupported. This requires explanation.
- Attachment A appears to be a structured approach to documenting findings and recommendations. The format is convenient and is a good vehicle to convey information

not worthy of lengthy text. The attachment could use proof-reading and checking; it currently has the appearance of raw notes.

TM 5 – Plant Replacement Alternatives Goals and Objectives, and Technology Screening Review

The stated purpose of this TM is:

> *"…to establish the goals and objectives of new plant alternatives and to review and screen a range of process technologies that may be candidates for inclusion in specific alternatives for the new plant approach."*

Our comments are as follows:

- The potential value of ponds for other uses is just mentioned in passing. Further discussion of other uses for the ponds appears in TM 6; this could be referenced to aid the reader's understanding of potential value of this large tract of land.
- It is unclear why the decision was made to narrow the alternatives for secondary treatment to the conventional and "compact footprint" alternatives. Because approximately 450 acres of ponds would be retired under Plant replacement, having a compact footprint does not appear to be an issue; please explain.
- The discussion of solids stabilization methods is limited to three options without explanation. Other anaerobic digestion and solids minimization technologies exist, but were not discussed. We recommend presenting the full range of anaerobic digestion and solids minimization technologies and explaining how options were screened to the three discussed.

TM 6 – Plant Replacement Alternatives Summary

This TM summarizes the Plant replacement alternative, including two sub-alternatives: Alternative A, which includes conventional activated sludge for secondary treatment; and Alternative B, which includes a membrane bioreactor for secondary treatment (compact footprint). Our comments are as follows:

- The evaluation of dewatering alternatives states that current sludge dewatering operations are "overly consumptive of valuable Plant site area." This statement does not acknowledge that the Plant replacement alternative frees up the pond area for other uses and land area is no longer a constraint. This does not appear to be consistent with other evaluation criteria.
- Attachment A appears to be a very good method of presenting information, but it appears to be unchecked. For example, no quantity of rotary drum thickeners is given. A 12-inch pipeline proposed for 150 gpm flow of thickened sludge (0.4 fps) appears to be sized incorrectly.
- Layout of facilities appears somewhat awkward (e.g., large separation between aeration tanks and final clarifiers). This separation appears unnecessary in light of the fact that the sewage treatment ponds are to be retired and approximately 450 acres will be freed up for construction. It is unclear why the site layout is constrained to fit within the

existing site proper when there will be considerable land made available by retiring the ponds.

Review of Special Planning Technical Memoranda (7 and 8)

Our comments, based on our review of these TMs, are as follows:

TM 7 – Early Execution Projects

This TM considers projects for early implementation that meet the following tests:

- Result in the WPCP site still being able to accommodate any of the reasonable SIP alternatives
- Included a treatment process function that would be reasonably included in any of the SIP alternatives

Additionally, the TM seeks to achieve the following:

- Identify known high-priority, high-risk process and equipment areas that would be candidates for early-execution renewal projects.
- Consider the impact of early execution on the range of possible outcomes for recommended alternatives in the SIP.
- Recommend projects for early execution and address potential project constraints to allow the early-execution projects to be coordinated with the ultimate facilities recommended by the SIP.

After performing these evaluations, the following recommendations are presented in the TM:

- Repair or replace the headworks, primary sedimentation tanks, grit removal tanks, primary effluent channel, and primary effluent pipe.
- For the primary sedimentation tanks, evaluate in predesign the alternatives of replacement in the current location or replacement in the area currently used for sludge dewatering.
- Provide diesel-fueled standby generators for emergency power.
- Develop a master plan for electric power distribution in order for other early execution design projects to add appropriate components of an ultimate electric power distribution backbone system. This plan should be developed simultaneously with planning for new diesel-fueled standby generators.

The TM also presents a project delivery schedule.

Evaluation of Objectives

The objectives presented appear to be sound. However, they do not consider *non*-process facilities that may present advantages for early implementation. The Administration Building could be a candidate for early implementation and could provide benefits such as the following:

- Improve constructability of all facilities
- Improve operations and operator training
- Increase site security
- Avoid interference between ongoing operations and construction
- Provide public access, education, or safety

We recommend that non-process facilities that meet the first two tests also be considered for early implementation if they present other significant advantages to the City.

Evaluation of Recommendations

The recommendations appear to be appropriate given the stated objectives. However, it appears the power master plan must address two different conditions: rebuild the Plant, and replace the Plant, because these two alternatives will have greatly different electrical loads. The standby generators will also need to provide for these two conditions.

If non-process facilities are considered for early implementation under expanded evaluation criteria, the Administration Building could be a candidate for early implementation. Early implementation of this project could provide the following benefits:

- **Separate operations staff from construction activities.** The existing Administration Building is already overcrowded. Early construction of the new Administration Building would alleviate overcrowding and separate operations staff from construction activities. A training room in the new building would be available to operators as new equipment and processes are brought online. Construction staff could occupy the old Administration Building upon completion of the new Administration Building.
- **Provide public amenities.** The new Administration Building could provide public access to the shoreline, as well as public educational displays about Plant improvements, energy recovery and sustainability features of the WPCP, and the City's vision for shoreline enhancement. A separate public entrance with visitor access control would also increase public safety at the site. The new building could initiate the City's commitment to sustainability at the site through LEED certification.
- **Improve process control and energy management.** Having a new control room available from the beginning of process improvements would allow incremental addition of new process controls. It would also enable control cables to be routed to the new building as each new process is added, rather than routing cables to the old building, then relocating them to the new building at a later date. The new control room would also provide a location to house the new Plant energy management system, which has been identified as a project for early implementation.

Schedule

The implementation elements of the "SIP Schedule with Early Execution Projects" (Figure 5-1) should be shifted at least 2 years and one quarter later on the time line. The start of Early Execution, Stage 1, and Stage 2 Projects needs to be coordinated with the winter nitrification studies to be conducted at the Plant. These studies should also be added to the schedule, as well as the schedule for environmental permitting.

TM 8 – Headworks and Primary Sedimentation Upgrades Alternatives Evaluation

Replacing/refurbishing the headworks and primary sedimentation basins were projects identified for early implementation in TM 7. The stated purpose of TM 8 is to determine the following:

> *"…whether to rebuild the headworks and primary sedimentation processes in the existing locations with existing or new structures or to construct new structures and processes in a new location on the existing WPCP plant site."*

The TM includes a discussion of emergency power and a new main Plant power station, which organizationally, does not seem to belong in this TM. We recommend that this discussion be relocated to the analysis of the electric power system (TM 13).

We concur with the conclusion that the headworks, currently comprising grinding and raw sewage pumping, should be replaced with a new headworks consisting of raw sewage pumping and preliminary treatment (screening and grit removal) at a new location on site. However, as discussed at Workshop No. 1, we recommend that additional alternatives for screening and grit removal be evaluated during preliminary design.

Review of Fundamental Information Technical Memoranda (9 through 14)

Our review comments on this series of TMs are as follows:

TM 9 – Influent Flows and Loads

This TM states that historical Plant influent data from 2004 to 2007 were used as the basis for flow and load projections for the SIP planning period. Based on the 2007 Association of Bay Area Governments (ABAG) population projections (*Projections 2007: Forecasts for the San Francisco Bay Area to Year 2030*), the City's population is projected to increase by approximately 30,000 between 2000 and 2035, with no change to the average persons per household (2.5).

Our comments are as follows:

- Though not expressly stated in this TM, we understand the SIP planning horizon to be year 2035 with the ability to accommodate flows from beyond the current service area. This should be stated.
- The flows and loads analysis was completed based on 4 years of raw wastewater flow and quality data, which is an adequate basis for long term planning (M&E, 2006). In

general, the methodologies used to develop the raw wastewater $cBOD_5$, TSS, and ammonia loadings and peaking factors, as well as flow peaking factors, are consistent with industry methods. However, a more rigorous statistical approach to data analysis could have been adopted to assist in identifying system specific response/behavior patterns, and identify inconsistencies or anomalies in the data set. Analysis should also include plots of data to identify correlations between flows, concentrations, and loadings to further understanding of the system.

- The available historical data are limited to three parameters that are routinely sampled (cBOD, TSS, and ammonia). Analysis for additional constituents ($cBOD_5$, BOD_5, COD, TSS, VSS, NH_3-N, TKN, TP, alkalinity, pH, temperature) should be considered to provide a more complete picture of wastewater characteristics for preliminary design and to eliminate use of default values for process modeling.
- The developed metrics (e.g., per capita loadings, peaking factors, wastewater concentrations) could benefit from a comparison to typical values based on industry experience to identify unique patterns, issues or inconsistencies in the data set. (The Peer Review Team performed this analysis as part of the Additional Alternative evaluation under the Optional Services Task, and is presented in the TM titled *Task Optional Services – Development of Strategy 1 Additional Alternative*.)
- The ADWF:Peak Hour flow factor was assumed to be 3.0 based on one flow event, with a recommendation that this value be verified. Peak hourly flows may not be critical to the hydraulic capacity of the WPCP based on the current treatment configuration, which provides significant hydraulic buffer capacity in the ponds. However, in the future if the role of ponds in the treatment process were to be modified, or these were to be removed from treatment entirely, more rigorous assessment of peak flows is recommended to ensure that sufficient hydraulic capacity is provided.
- Conservative projections for water use based on Urban Water Management Plan (December 2005) and SFPUC Wholesale Customer Water Demand Projections Technical Report (URS, November 2004) were used to develop future wastewater flow projections. Other available wastewater flow projections mentioned in the TM include the City of Sunnyvale Wastewater Collection Master Plan (CH2M HILL, 2002) and EOA analysis. These sources do not predict a net increase in wastewater flow through 2030. There was no analysis to estimate the size/number of future facilities that would be required for the range of flows predicted by the various sources.

TM 10 – Solids Loads

This TM states that the solids loading analysis is based on 5 years of historical Plant data. The following comments are noted:

- Figure 1: Solids Flow Diagram for Sunnyvale WPCP, does not indicate where the return streams from the solids treatment process (digester decant and dewatering filtrate) are directed. These streams should be included to understand the overall mass balance for the Plant and the fate of solids in the treatment system.

- The primary solids analysis (Section 3.1) is based on grab samples and indicates significant TSS removal scatter (Figure 2). Single grab samples are not representative for highly variable influent quality, particularly where high-strength recycle streams may be added intermittently. We recommend installing an automated 24-hour composite sampler to obtain more representative data for preliminary design.
- The analysis of algae/solids production from the existing ponds (Section 3.2) is based on historical pond effluent quality only. The analysis should be based on a mass balance approach that considers both pond influent and effluent quality. This mass balance can be used to estimate empirical parameters such as effluent solids (algae) production and sludge production based on influent characteristics, which can then be used to estimate future solids/algae loadings from the ponds.
- The assumptions made for the removal rates in the primary clarifiers (60 percent TSS removal), and digester solids reduction rates (85 percent VS content, and 70 percent reduction) correlate well with typical values based on industry experience. References for the values/ assumptions made for the digestion efficiencies of algae should be provided.
- Estimate of solids production from FGR should be included in the analysis.
- In addition to SRT, which is discussed in the digested solids historical data analysis (Section 3.3), digester performance is also a function of VS loading and HRT. These parameters should be included when evaluating future digester performance at increased flows and solids loadings.

TM 11 – Regulatory Framework

The stated purpose of this TM is to summarize Level of Service definitions for effluent discharge, biosolids management, and air emissions resulting from the regulatory framework for the Plant. Our comments are as follows:

- The City appears to be facing no significant regulatory issues that require immediate or short-term action other than monitoring at the present time beyond those already addressed in the SIP.
- H_2S exceeds 1,300 ppm in the digester gas, indicating that iron addition is required to reduce dissolved sulfide levels to achieve the Plant's Title V emission limits. The City may wish to consider CEPT, as mentioned elsewhere in our comments, which could provide the required iron. CEPT, including ferric chloride addition at the influent pump station, could potentially provide the following three benefits:

    1. Digester gas H_2S reduction resulting in improved air emissions quality
    2. Odor control for influent pumping through primary treatment processes
    3. Enhanced TSS removal (which was the original context for recommending CEPT)

- Page 21, Section 3.2.1, first paragraph. The term "biosolids" is used inappropriately here, as residuals produced in the Plant must be processed to meet certain standards (defined in this TM) to meet the definition of biosolids. In fact, the difference between "sludge" and "biosolids" is the processing that occurs. The Plant provides one acceptable form of

this processing. So, for example, the material going into the anaerobic digesters is sludge, and that coming out is biosolids. Care should be exercised in using the term biosolids as it has legal meaning. The text should be revised accordingly.

- Page 21, Section 3.2.1, second paragraph, last sentence states that it is **not** clear where Synagro takes biosolids for land application, while on page 25, Section 3.3.1.2, first paragraph, the third sentence states that it **is** clear. This should be resolved. Stating the biosolids disposal location would be useful information to include in the SIP.
- The reported quantity of biosolids produced is quite low for a plant of this size. A plant with complete primary and secondary treatment is expected to produce about 1 dry ton of biosolids/MG of wastewater treated. After digestion, this would be reduced to about 0.65 dry ton of biosolids/MG. Because the Plant Annual Average Flow is about 15 mgd, this is about 10 dry tons/day, or roughly 3,500 dry tons/year. In contrast, the data in Tables 4-4 and 4-5 indicate highly variable biosolids production from year to year, but with all values on the order of about 1,000 dry tons/year or less. This suggests that more than half of the biosolids actually produced by the Plant (whether by primary treatment, treatment in the ponds, or captured in the air flotation units and filters) is being retained and stored in the ponds. This is a significant regulatory issue (as these solids must eventually be properly managed), and also is an LOS issue, as it represents a deferred financial liability, which must be reconciled at some point in time.
- In discussion with EOA and the City, EOA stated that conversion to the activated sludge process could trigger a permit change for both BOD_5 and suspended solids to a limit of 10 mg/L. This should be verified with the Regional Water Board and should be discussed in TM 11. Any changes resulting from Regional Water Board input should be reflected in process sizing and cost of activated sludge alternatives.

TM 12 – Seismic Performance Goals

This TM primarily serves to assign each facility to one of two performance levels (Immediate Occupancy or Life Safety) for each of two earthquake magnitudes (Probable Earthquake or Maximum Credible Earthquake). The TM also discusses future work needed to further evaluate some of the structures for seismic vulnerability as recommended by Beyaz &Patel in their 2006 work, and states what structures are obviously vulnerable to the earthquake scenarios selected. Our comments are as follows:

- Tables 1 and 2 "Performance goals" are very general and it is difficult to see how they specifically affect design and construction cost. Clarification and examples of damage levels would be helpful.
- Table 1 states that, under the Maximum Credible Earthquake scenario, the goal is to "maintain hydraulic flow and disinfection." However, Table 3 designates the LOS for the Chlorine and Sulfur Dioxide Buildings after a Maximum Credible Earthquake to be "Life Safety" rather than "Immediate Occupancy." This appears to be a discrepancy.
- This TM was prepared prior to developing SIP alternatives and it is unclear how it was applied in the SIP, except to identify the headworks and primary sedimentation basins as candidates for replacement.

- There is no "Recommendations" section in this TM. However, the following statement is made on the last page:

  "It is highly recommended that an investigation report be conducted for the whole facility to determine the seismic hazards at the site. Most of the investigation [sic] conducted are relatively old and may not be up to date with current liquefaction and ground shaking mapping."

  This is consistent with our overall observation that the SIP is generally silent on site soil conditions and foundation requirements and how they might affect facility siting and cost.

TM 13 – Electric Power System Level of Service

This TM was written with the stated purpose of evaluating the ability of the existing Plant power system to meet LOS requirements. It preceded the development of SIP alternative, and, therefore, does not address future electrical loads or the SIP alternatives, except to establish desired LOS. SIP cost estimates for electrical work were based on allowances, rather than any specific information contained in this TM. No conclusions are stated as to the sufficiency of the existing power system for future needs or identification of future standby power needs.

TM 14 – Condition Assessment and Unit Process Performance Review

The stated purpose of the TM is "…*to summarize various condition assessment reports*." Our comments are as follows:

- The condition assessment reports that were reviewed should be listed with a brief description of the contents of each. When findings from each report are used, they should be properly footnoted and referenced.
- Table 2-2 lists various "improvements" to Headworks and Grit Removal. This table, should be limited to describing improvements to existing facilities that will be retained in the future. Listing components for new facilities is not in the scope of this TM and confuses the reader; this is a preliminary design function.
- This TM was prepared prior to developing the SIP alternatives. It should be updated to state that the Auxiliary Pump Station is slated for demolition, as a new influent pump station will render it obsolete. Discussion of condition appears irrelevant.
- The wide scatter of data points from primary clarifier performance points to questionable data. In light of this, conclusions regarding performance of the clarifiers should be considered suspect and, therefore, recommended modifications such as separate sludge thickening may be unwarranted.
- The process condition for the primary clarifiers makes the point that they are the "oldest at the WPCP." With respect to concrete structures containing water, age tends to

strengthen the concrete. Age should not be a sole factor in evaluating concrete water-holding structures.

- The recommendation of the SIP is to demolish and replace the primary clarifier complex. In light of this, Table 4-3 is confusing, as it describes "improvements," which in reality are "new facilities." This level of detail for new facilities is unnecessary and inconsistent with other sections of the SIP.
- The recommendation for separate sludge thickening as a means of improving clarifier suspended solids removal performance merits further consideration. Because new clarifiers are recommended, it appears that the limitations of the existing clarifiers can be overcome in the design of the new clarifiers. Many primary clarifiers produce excellent sludge thickening performance, especially if the underflow goal is only 4 percent.
- Oxidation Pond loading criteria appear contradictory (e.g., it is stated that a loading above 30 lb/acre/day may need supplemental aeration, but normal loading for unaerated ponds is 40 to 80 lb/acre/day (p. 12).
- It is then suggested that adding aerators to the ponds to accommodate peak loading conditions may be required. Alternatives to adding aeration, such as CEPT, should be considered.
- Table 7-1 should be titled as Existing DAF Design "Data" rather than "Criteria."
- Table 9-2. From this point forward, the "Specific Improvements" worksheets are extremely brief and incomplete. They give the appearance that the work gets very rushed from this point to the end of the TM.
- Table 10-1 should reference Regional Water Board Order No. 94-069. Information in the table is incomplete and some information is contradictory to the Order. For example, the Dissolved Oxygen value is missing, and the Turbidity values listed are not consistent with the Order.
- Table 11-2. It is not clear what the item, "Algae Thickening and Storage Facility" is; it is not described anywhere in the SIP.
- Dewatering Beds and Solar Drying is recommended for demolition regardless of recommended/selected solids handling alternative. Table 12-2 is unrelated and extremely brief.
- The "Support Systems" section of the TM discusses the electrical and SCADA systems. Table 13-2 is partially populated and the information that is presented is incomplete. We recommend that this discussion be relocated to the analysis of the electric power system (TM 13).

Review of Unit Process Improvement Studies Technical Memoranda (15 through 19)

Our comments, based on our review of these TMs, are as follows:

TM 15 – Nitrification Process Improvements

The TM concentrates on the pond retention alternative and examines methods of removing seasonally varying levels of ammonia from poor-quality wastewater lagoon effluent. A hybrid pond/activated sludge alternative is discussed, as well as conversion to full activated sludge to achieve proposed permit limits. Our comments are as follows:

- A great deal of experimental nitrification performance data (e.g., media effectiveness factor) is presented in terms likely not understood by the ordinary reader of this document. We recommend simplifying this discussion and providing interpretation of results.
- Virtually all results presented are tentative and expressed in terms of probability of success in nitrifying to proposed permit limits. An "iron-clad" solution for nitrification is not presented. We recommend providing at least one solution that is certain of success.
- The hybrid activated sludge alternative does not seem to be competitive with the full activated sludge alternative because all of the pond treatment train is retained. The only potential savings compared to full activated sludge (which would eliminate the pond treatment train) is in somewhat reduced aeration basin capacity. Of the alternatives presented, we recommend that either the fixed-growth reactors (FGR) be demonstrated to work, or the City should switch to full activated sludge. The hybrid alternative does not appear to be viable.

TM 16 – Evaluation of Dewatering Alternatives

This TM is based on solids loading for the Pond Alternative only. A separate analysis will need to be performed for activated sludge should that alternative be selected. Our comments are as follows:

- An introduction should be added to this TM stating the objectives of mechanical dewatering for this project, especially percent solids and subsequent disposal (composting, land application, mechanical drying).
- The analysis confines itself to three typical dewatering technologies. This discussion should begin with a list of all technologies that can meet the dewatering objectives. The list can then be culled to those technologies most appropriate for further analysis, including an explanation of how the technologies were screened.
- Clarify whether single-shift operation is based on 5 or 7 days per week.
- Verify that the number of units proposed, especially in Table 5, will accommodate equipment downtime, required redundancy, and overall scheduled maintenance.
- The basic conclusion is that the three dewatering technologies examined are equivalent, within the accuracy of the analysis. We recommend that Plant staff visit installations for

each technology during preliminary design so that operations staff can determine preferences.

TM 17 – Alternatives for Air Flotation Thickeners

The following is the stated purpose of this TM:

> *"This TM examines the current system of dissolved air flotation, and compares this with other alternative approaches for algae removal from the oxidation pond effluent."*

Algae must be removed from pond effluent to meet turbidity and suspended solids limitations for Bay discharge and also meet turbidity limits for recycled water. Our comments are as follows:

- The TM concludes that there are twice as many existing air flotation thickeners (AFT) as are currently needed, and recommends that all four units be replaced with four rectangular units of smaller size. There is no explanation provided as to why four were originally provided and why only 33 percent of this capacity is required in the future (to be provided in four new units). Reconcile the differences in design criteria between original construction and what is proposed.
- There is inconsistency in loading criteria. Page 3 gives maximum month as the loading basis. Page 5 lists performance at maximum week. This needs correction.
- Page 4 mentions *RMC Improvements Alternatives Technical Memorandum* (December 29, 2008). This should be appended to the TM.
- Improvements to AFT technology appear minor, but process improvement from 3 to 4 percent thickened solids to 4 to 6 percent thickened solids are claimed. This assertion needs to be supported.

TM 18 – Anaerobic Digestion of Algae Float

This TM investigates the viability of co-digestion of algae and primary sludge in the anaerobic digesters. The purpose of digesting algae is to convert it to biogas to be used as an energy source. Our comments are as follows:

- A capacity assessment with the "largest unit out of service" assumes that the secondary digester would be out. Because this is principally a holding tank, this does not appear to represent a "firm capacity" scenario from a digestion standpoint. Firm capacity should be based on two primary digesters, unless mixing and heating are added to the secondary digester.
- Thickened primary sludge concentration of 5 percent contradicts earlier TMs, which state 4 percent as the objective.
- Allowable digester loading of 0.18 lb/ft^3/day for a blend of primary sludge (PS) and algae appears high in light of experience with digester foaming. This loading rate is likely acceptable for PS only. With a mixture of PS and waste activated sludge (WAS), digester loading should be closer to 0.10 lb/ft^3/day. A 50/50 blend of PS and algae could likely be as difficult to digest as a blend of PS/WAS. No information was

presented on foaming potential of algal solids. This is a chief limiting factor when digesting a blend of PS/WAS. If this is not a factor with algae, then loadings listed should be acceptable. This should be discussed and clarified.

- There is no mention of a blend tank for thickened algae and primary sludge prior to distribution to the digesters. If this is a necessary facility, the blend tank should be discussed in the SIP and included in the cost estimate.
- The *Condition Assessment* TM (14) refers to an "Algae Thickening and Storage Facility" as a recommended improvement. This is not included anywhere else in the SIP or in the cost estimate. It would be logical to discuss this facility in TM 18.

TM 19 – Recycled Water Treatment Alternatives

The purpose of this TM "*…is to investigate viable alternatives to increase recycled water production to meet future demand.*" Our comments are as follows:

- This appears to be a reasonable treatment of typically employed filtration alternatives for the two principal scenarios for WPCP upgrade presented: new activated sludge or continued use of the ponds.
- Figure 6-2 illustrates filtration of activated sludge effluent for Bay discharge. This should not be necessary. Activated sludge can meet discharge limits without filtration. Therefore, secondary effluent should go directly to disinfection. This would leave the existing dual-media filters (DMF) completely available for reclaimed water. A new set of recycled water filters would not be necessary.
- An issue not addressed in this TM is the coloration left in the recycled water by algae in the pond effluent. Perhaps this is not currently an issue for irrigation, but aesthetics of the water could become an issue if use of recycled water expands, as it likely will.
- There should be a reference in this TM to "California Regional Water Quality Control Board, San Francisco Bay Region, Order No. 94-069."

Appendix D
Technical Memorandum – Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan, Task 4 Review of Strategic Infrastructure Plan Cost Estimates

Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan
Task 4 Review of Strategic Infrastructure Plan Cost Estimates

PREPARED FOR: City of Sunnyvale

PREPARED BY: Robert Lawson/CH2M HILL

REVIEWED BY: Susan Dennis/CH2M HILL

DATE: January 21, 2011

PROJECT NUMBER: 414083.SP.04

Background and Purpose

This review covers three main components of the SIP cost estimates. The first is a review of the methodology; the second is a review of labor and material quantities and prices; and the third is a review of allowances for other construction costs.

The review was conducted on four cost estimate documents:

1. The Basis of Estimate of Probable Construction Cost
2. The Conceptual Estimate for Rehabilitation of Existing Plant (Task 4)
3. The Conceptual Estimate for Plant Replacement Alternative (Task 5a) – Activated Sludge
4. The Conceptual Estimate for Plant Replacement Alternative (Task 5b) – MBR

The review comments are presented in two categories: the Basis of Estimate (related to document 1 above), and the Detailed Alternative Estimates (related to documents 2, 3, 4 above). Because there is a common theme, and several of the Facilities estimated are included in each of the three estimates, we have combined comments on the Detailed Alternatives Estimates to avoid repetition.

Cost estimating methodology and cost estimates have been reviewed in accordance with the following scope of work:

- Review the SIP construction estimate components and methodology to confirm conformance with AACE standards and estimating practices.
- Examine details of the SIP estimate to determine if labor and material quantities and prices appear accurate.

- Review allowances for other construction costs (contractor overhead, profit, and mobilization) to determine if they are properly placed and applied, and are reasonable and complete.

Conclusions and Recommendations

The estimates reviewed were found to generally conform to AACE International methodology of estimating for conceptual cost estimates.

Our review of labor and materials quantities focused on items included in the cost estimates that we believed would have the greatest impact on estimated project costs for all alternatives. Although many of the items identified may not seem to have a particularly large impact on the subtotal for direct construction cost, project allowances and escalation factors often have the effect of magnifying these impacts so that they are significant. It was not possible in all cases to confirm the allowances used in the estimates.

The most significant of our findings are summarized below. Recommendations for resolution of comments are included throughout the detailed comments that follow.

Basis of Estimate of Probable Construction Cost

- Estimates should use the 2010 edition of *R.S. Means Heavy Construction Cost Data* rather than the 2009 edition.
- It appears that construction dewatering has not been included in the cost estimates. This is a significant cost that likely results in underestimating the cost of each alternative.
- An incorrect percentage (0.25 percent too high) for sales tax has been used. Although the percentage is minor, the total value is significant when costs are rolled up to the total.
- It is difficult to determine what percentages have been used in each estimate for Contractor's overhead and profit. Normally, these markups should be included individually, and should be cumulative. Percentages in the range of 10 percent for overhead and 6 percent for profit would be reasonable for the magnitude of cost and duration of these project alternatives. Without knowing the actual markup percentages used for overhead and profit, it cannot be determined whether costs were overestimated or underestimated.
- The factors used for Escalation to Midpoint of Construction for Labor, Materials, Subcontractors, and Equipment are not apparent or readily reviewable. It does not appear that Equipment has been escalated to the mid-point of construction in any of the alternatives. It would be helpful to have a table showing for each alternative the percentages that have been used for each cost category, each bid package, and the expected timeframe of construction for each bid package. It appears from information presented in the cost estimates that escalation costs may be overestimated.

Plant Alternative Conceptual Cost Estimates (Task 4, Task 5A, and Task 5B)

- It appears that the dump costs resulting from demolition are being understated for all alternatives. This will have the greatest impact on plant replacement alternatives.

- It is not apparent how the cost of electrical work is being estimated. In many instances, Equipment line item costs included in each estimate do not have installation equipment costs included in the makeup of the line item unit costing. Overall, the cost included for this work appears adequate.
- In the schedules provided for the three alternative estimates, a different percentage has been used for labor, equipment, and materials for each Bid Package for the Escalation to Midpoint of Construction calculation. It seems more reasonable at this level that a single Escalation figure should have been used throughout for the Subtotal cost. Overall, it appears that escalation may have been overestimated.

Basis of Estimate of Probable Construction Cost

- In the Indirect Cost Development section, there is a reference to allowing for Contractor's home office expense being included in the overall rate markups, with reference to using the *R.S. Means Heavy Construction Cost Data*, 2009. This estimate was prepared in October 2010, and should have used the 2010 version of Means as a reference, which was available at the beginning of 2010.
- In the Estimating Assumptions section, Note 10 states that Dewatering is not included. We assume this refers to construction dewatering, not process dewatering. Given the proximity of the plant location to the plant ponds and San Francisco Bay, dewatering could be a substantial cost to the project that is not currently included in the estimates for any belowgrade construction (see Attachment 1, Project Location).
- In the Contractor and Other Estimate Markups section, it states that the estimate has used a sales tax rate of 9.50 percent. The California City and County Sales and Use Tax rate for Sunnyvale is listed as 9.25 percent. Although this seems like a minor discrepancy, it results in overestimating costs by various amounts, depending on the alternative selected, after applying all of the subsequent markups. For example, estimated costs are about $237,000 high for Task 4, about $353,000 high for Task 5A, and about $471,000 high for Task 5B. These overestimates would be after applying escalations, contingencies, and project markups using the percentages shown in the current estimate alternatives (see Attachment 2, Sales Tax Calculations).
- In the Contractor and Other Estimate Markups section, it states that the percentage for escalation to mid-point of construction for the Labor, Material, and Subcontractors will vary based on sequencing, and to refer to each estimate for this information. These percentages are shown, but no indication is provided as to what percentage or time frame has been used (a table would be helpful). There should be some designation of what percentage percent per year has been used for escalation, and the timing of the midpoint of construction for each project. It does not appear that Equipment has been escalated to the mid-point of construction in any of the estimate alternatives.
- In the Contractor and Other Estimate Markups section, there does not appear to be specific percentages included for the Contractor's Overhead and Contractor's Profit. The written descriptions of what is included in the markups for Labor, Materials, Equipment, and Subcontractor say that the overheads and profit are included with these allowances. Normally markups for overhead and profit should be included individually,

and should be cumulative; the Contractor should be making profit on its overhead costs. Percentages in the range of 10 percent for overhead and 6 percent for profit would be reasonable for the magnitude of cost and duration of these project alternatives. It is difficult to determine what percentage has been used for overhead and profit by the method used.

- In the Escalation to Midpoint of Construction for Labor, Materials, Subcontractors, and Equipment section, it states that the anticipated construction sequencing is described in the Master Plan report. The schedule for the Plant Rehabilitation Alternative shows the three individual Bid Packages running consecutively for 7.5 years. The schedules for the Plant Replacement Alternatives, and for Alternative A show the four individual Bid Packages running consecutively for 11 years, and Alternative B shows the three individual Bid Packages running consecutively for 13 years.

  It would be helpful to have a table showing for each alternative what percentages have been used for each of the cost categories, for each of the Bid Packages, and the expected timeframe of construction for each Bid Package. Escalation percentages appear to be different for labor, equipment, and materials. We recommend using a single factor covering all of these components, which is appropriate for this level of estimate and facilitates recalculation as the schedule changes (see Attachment 3, Project Schedules). Overall, it appears that escalation factors may be overestimated.

Plant Alternative Conceptual Cost Estimates (Task 4, Task 5A, and Task 5B)

- In Facility 1101 – Raw Sewage Pumping, Item Description 11000 – Equipment, the Influent Pump/Motor/VFD – 5,000 gpm, the unit cost for labor is only $6,000, and there is no cost item for equipment needed for installation.
- In Facility 1101 – Raw Sewage Pumping, Item Description 11000 – Equipment, the Influent Pump/Motor/VFD – 10,000 gpm, the unit cost for labor is only $7,000, and there is no cost item for equipment needed for installation.
- In Facility 1101 – Raw Sewage Pumping, Item Description 11040 – Slide gates, the Slide Gate, 54" x 54" MO, the unit cost for labor is only $554, and the Materials are $95,055, and the installation equipment cost is $237. The labor and installation equipment costs appear to be too low for the size and cost of this gate as compared to other gates used in the estimate that are smaller but have more cost of labor and equipment (see Facilities 1102 and 1103 as examples).
- In Facility 1106 – Primary Sedimentation Tanks, Item Description 11000 – Equipment, the Primary Cross Collectors, the unit labor cost is at about 63 percent of the material cost, which seems disproportionately high for this equipment.
- In Facility 1109 – Demolition of Auxiliary Pump Station, there is a line item for Dump Charge expressed as 410 tons, and there is a Loading and Hauling quantity expressed as 410 cubic yards. It has been our experience that the average weights of a variety of materials when demolished are in the 1.5 to 2.0 tons per cubic yard range. A more realistic conversion quantity would be to allow for 2 tons per cubic yard to allow for the

bulking of materials when they are loaded, which will properly account for them when including the dump charge. This would result in a dump charge applied to 820 tons in this example, rather than 410 tons. This situation is stated as one example, because there are many other locations where this occurs in each of the alternative estimates. It appears that the actual dump costs resulting from demolition are being understated for all estimates. This will have the greatest impact on plant replacement alternatives.

- In Facility 2104 – Oxidation Ponds Recirculation Channel, Item Description 11000 – Equipment, costs are shown for a 144″ x 144″ Sluice Gate that, when compared to a 156″ x 156″ Sluice Gate, are confusing. For the 144″ x 144″ Gate, the labor cost is $61,279, the Material cost is $154,284, and the Equipment cost is $18,444, whereas for the 156″ x 156″ Gate, the labor cost is $104,633, the Material cost is $150,381, and the Equipment cost is $31,493. There could be differences in where and how these are installed that could account for some of the differences, but it should be checked.

- In Facility 2118 – Main Power Distribution Center, Item Description 16300 – Transmission and Distribution, two large Switchgear line items have what appears to be a token amount of equipment cost included. Based on the descriptions provided, there should be more equipment cost included. However, taken in total, costs for electrical work and equipment appear adequate.

- Material unit cost of $106 per cubic yard has been used throughout the estimate for the 4,000 psi concrete. A confirmation phone call was made to a local Redi-mix concrete supplier (Milpitas Materials Co., in Mountain View at 650/969-4401), for a budget quote for concrete furnished to the project location. The cost would vary depending on shrinkage and additive requirements, but a reasonable average cost number would be in the range of $102 to $108 dollars per cubic yard. This cost was based on the need for 30,000 to 40,000 cubic yards, over a period of years. The unit cost used in the estimate appears appropriate.

- There are many instances of Equipment line item costs included in the estimate that do not have installation equipment costs included in the makeup of the line item unit costing. It seems reasonable, given the size and type of these equipment items, that there should be installation equipment included. There are too many instances where this is omitted for detailed itemization. However, these costs could be understated by as much as $5 to $10 million per alternative when rolled up to total project cost.

- Near the end of each of the three alternative estimates are several pages that contain the Sub-total of the Direct Costs and the adders called the Prime Contractor's and Other Estimate Markups. The percentages shown for Labor Markup, Material Markup, Subcontractor Markup, Equipment Markup, Sales Tax, and Material Shipping and Handling appear to be reasonable, except as stated above for the incorrect sales tax percent used.

- The Escalations to Mid-Point of Construction on Labor, Materials, Subcontractors, and Equipment are included in the Summary area of the estimates. The schedules provided for the three alternative estimates indicate that a different percentage number has been used for each Bid Package for calculating Escalation of labor, equipment, and materials. However, it seems more reasonable at this level that the same Escalation percentage

should have been used throughout for the Subtotal cost. Currently, CH2M HILL's Estimating leadership recommends for the first quarter of 2011 that a combined rate of 3.85 percent per year should be used. Attachment 4, Project Escalation Calculations, shows CH2M HILL's escalation calculations for each Project Alternative, for each respective Bid Package, using a percentage that we consider to be more appropriate. The use of the different escalation rates for labor, materials, and equipment in the SIP resulted in overestimation of the costs.

- The last Markups included to the Bid Package Subtotals are to account for Contractor General Conditions at 12.00 percent; Startup, Training, O&M at 2.00 percent; Construction Contingency at 30.00 percent; Building Risk, Liability Auto Insurance at 2.00 percent; and Bonds at 1.50 percent. These are appropriate for the cost magnitude, and the level of design information provided at this stage of the project.

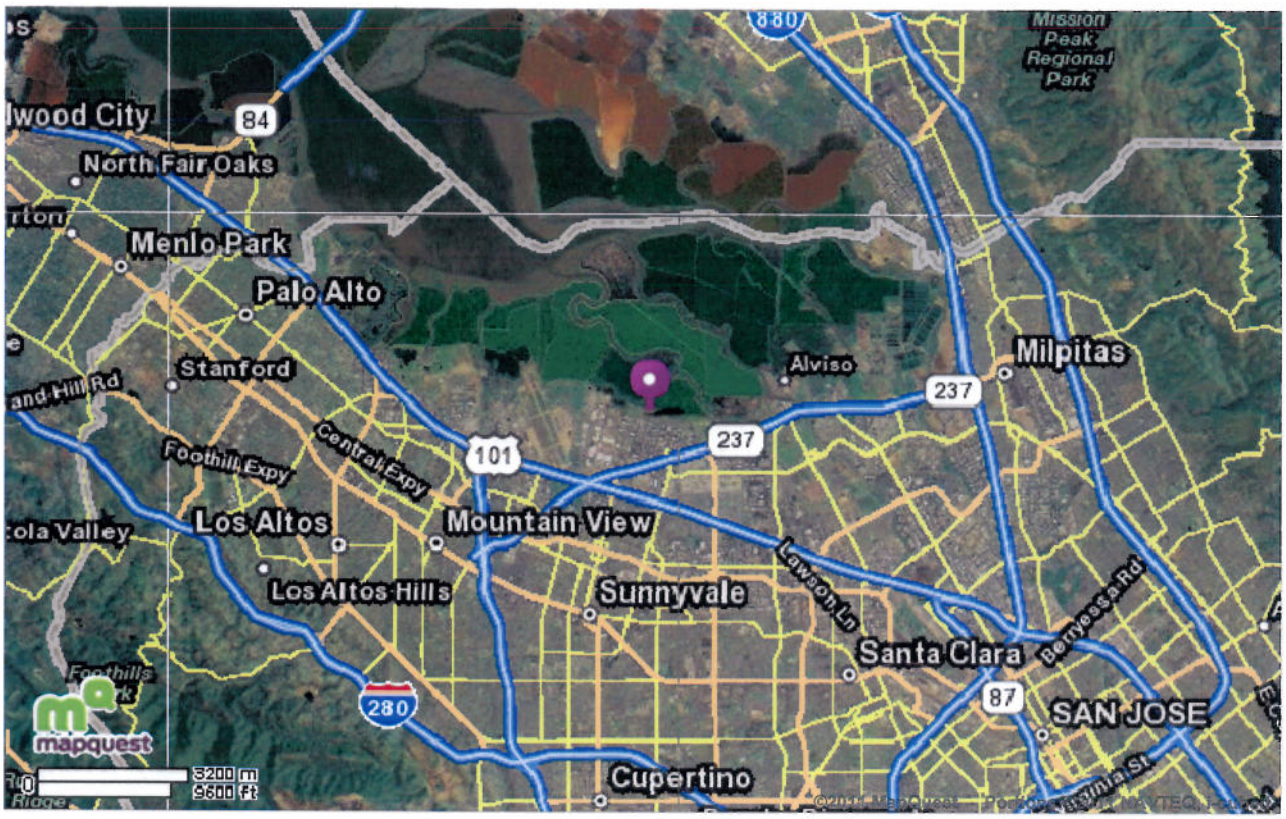
Attachment 1
Project Location

mapquest

Map of:

1444 Borregas Ave
Sunnyvale, CA 94089-1008

Notes



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Attachment 2
Sales Tax Calculations

Cost Estimate - Review - Construction Cost Estimates

Project Name: Sunnyvale SIP

Estimate Date: Oct 29, 2010

Cost Estimator: B & C

Estimate Reviewer Robert Lawson/CH2M HILL

CH2MHILL Estimating Services

Project Alternative		**Task 4**						**Task 4**				
Bid Package No.		**BP 1**	**BP 2**		**BP 3**	**Total**		**BP 1**	**BP 2**		**BP 3**	**Total**
Sales Tax	9.50%	$1,242,390	$1,066,189	$0	$1,591,299	$3,899,878	9.25%	$1,209,696	$1,038,131	$0	$1,549,423	$3,797,250
Esc to Mid-Point on Materials	18.27%	$226,985				$226,985	18.27%	$221,011				$221,011
Esc to Mid-Point on Materials	55.72%		$594,081			$594,081	55.72%		$578,447			$578,447
Esc to Mid-Point on Materials	0.00%			$0		$0	0.00%			$0		$0
Esc to Mid-Point on Materials	86.31%				$1,373,450	$1,373,450	86.31%				$1,337,307	$1,337,307
Subtotal		$1,469,375	$1,660,270	$0	$2,964,749	$6,094,393		$1,430,707	$1,616,578	$0	$2,886,729	$5,934,015
Contractor GCs	12.00%	$176,325	$199,232	$0	$355,770	$731,327	12.00%	$171,685	$193,989	$0	$346,408	$712,082
Startup, Training, O&M	2.00%	$29,387	$33,205	$0	$59,295	$121,888	2.00%	$28,614	$32,332	$0	$57,735	$118,680
Construction Contingency	30.00%	$440,812	$498,081	$0	$889,425	$1,828,318	30.00%	$429,212	$484,973	$0	$866,019	$1,780,204
Bldg Risk, Liability Auto	2.00%	$29,387	$33,205	$0	$59,295	$121,888	2.00%	$28,614	$32,332	$0	$57,735	$118,680
Bonds	1.50%	$22,041	$24,904	$0	$44,471	$91,416	1.50%	$21,461	$24,249	$0	$43,301	$89,010
Total of This Task		$2,167,328	$2,448,898	$0	$4,373,005	$8,989,230		$2,110,293	$2,384,453	$0	$4,257,926	$8,752,671

Project Alternative		**Task 5A**						**Task 5A**				
Bid Package No.		**BP 1**	**BP 2 Phase 1**	**BP 2 Phase 2**	**BP 3**	**Total**		**BP 1**	**BP 2 Phase 1**	**BP 2 Phase 2**	**BP 3**	**Total**
Sales Tax	9.50%	$1,205,118	$874,597	$1,157,736	$1,872,368	$5,109,819	9.25%	$1,173,404	$851,581	$1,127,269	$1,823,095	$4,975,350
Esc to Mid-Point on Materials	18.27%	$220,175				$220,175	18.27%	$214,381				$214,381
Esc to Mid-Point on Materials	52.66%		$460,563			$460,563	52.66%		$448,443			$448,443
Esc to Mid-Point on Materials	79.07%			$915,422		$915,422	79.07%			$891,332		$891,332
Esc to Mid-Point on Materials	127.510%				$2,387,456	$2,387,456	127.510%				$2,324,629	$2,324,629
Subtotal		$1,425,293	$1,335,160	$2,073,158	$4,259,824	$9,093,435		$1,387,785	$1,300,024	$2,018,601	$4,147,724	$8,854,134
Contractor GCs	12.00%	$171,035	$160,219	$248,779	$511,179	$1,091,212	12.00%	$166,534	$156,003	$242,232	$497,727	$1,062,496
Startup, Training, O&M	2.00%	$28,506	$26,703	$41,463	$85,196	$181,869	2.00%	$27,756	$26,000	$40,372	$82,954	$177,083
Construction Contingency	30.00%	$427,588	$400,548	$621,947	$1,277,947	$2,728,031	30.00%	$416,336	$390,007	$605,580	$1,244,317	$2,656,240
Bldg Risk, Liability Auto	2.00%	$28,506	$26,703	$41,463	$85,196	$181,869	2.00%	$27,756	$26,000	$40,372	$82,954	$177,083
Bonds	1.50%	$21,379	$20,027	$31,097	$63,897	$136,402	1.50%	$20,817	$19,500	$30,279	$62,216	$132,812
Total of This Task		$2,102,307	$1,969,361	$3,057,908	$6,283,241	$13,412,817		$2,046,983	$1,917,535	$2,977,437	$6,117,893	$13,059,848

Cost Estimate - Review - Construction Cost Estimates

Project Name: Sunnyvale SIP

Estimate Date: Oct 29, 2010

Cost Estimator: B & C

Estimate Reviewer Robert Lawson/CH2M HILL

Project Alternative			**Task 5B**						**Task 5B**				
Bid Package No.			**BP 1**	**BP 2**		**BP 3**	**Total**		**BP 1**	**BP 2**		**BP 3**	**Total**
Sales Tax		9.50%	$1,204,219	$3,349,191	$0	$1,920,326	$6,473,736	9.25%	$1,172,529	$3,261,054	$0	$1,869,791	$6,303,375
Esc to Mid-Point on Materials		18.27%	$220,011				$220,011	18.27%	$214,221				$214,221
Esc to Mid-Point on Materials		72.07%		$2,413,762			$2,413,762	72.07%		$2,350,242			$2,350,242
Esc to Mid-Point on Materials		0.00%			$0		$0	0.00%			$0		$0
Esc to Mid-Point on Materials		156.41%				$3,003,582	$3,003,582	156.41%				$2,924,540	$2,924,540
Subtotal			$1,424,230	$5,762,953	$0	$4,923,908	$12,111,091		$1,386,750	$5,611,296	$0	$4,794,331	$11,792,378
Contractor GCs		12.00%	$170,908	$691,554	$0	$590,869	$1,453,331	12.00%	$166,410	$673,356	$0	$575,320	$1,415,085
Startup, Training, O&M		2.00%	$28,485	$115,259	$0	$98,478	$242,222	2.00%	$27,735	$112,226	$0	$95,887	$235,848
Construction Contingency		30.00%	$427,269	$1,728,886	$0	$1,477,172	$3,633,327	30.00%	$416,025	$1,683,389	$0	$1,438,299	$3,537,713
Bldg Risk, Liability Auto		2.00%	$28,485	$115,259	$0	$98,478	$242,222	2.00%	$27,735	$112,226	$0	$95,887	$235,848
Bonds		1.50%	$21,363	$86,444	$0	$73,859	$181,666	1.50%	$20,801	$84,169	$0	$71,915	$176,886
Total of This Task			$2,100,739	$8,500,356	$0	$7,262,764	$17,863,859		$2,045,456	$8,276,662	$0	$7,071,639	$17,393,757

Notes:
1. **Cell w/Brown Shading is taken from Summary.**
2. **Cell w/Yellow Shading is calculated.**
3. **Percentages shown are from the provided estimates.**

Attachment 3
Project Schedules

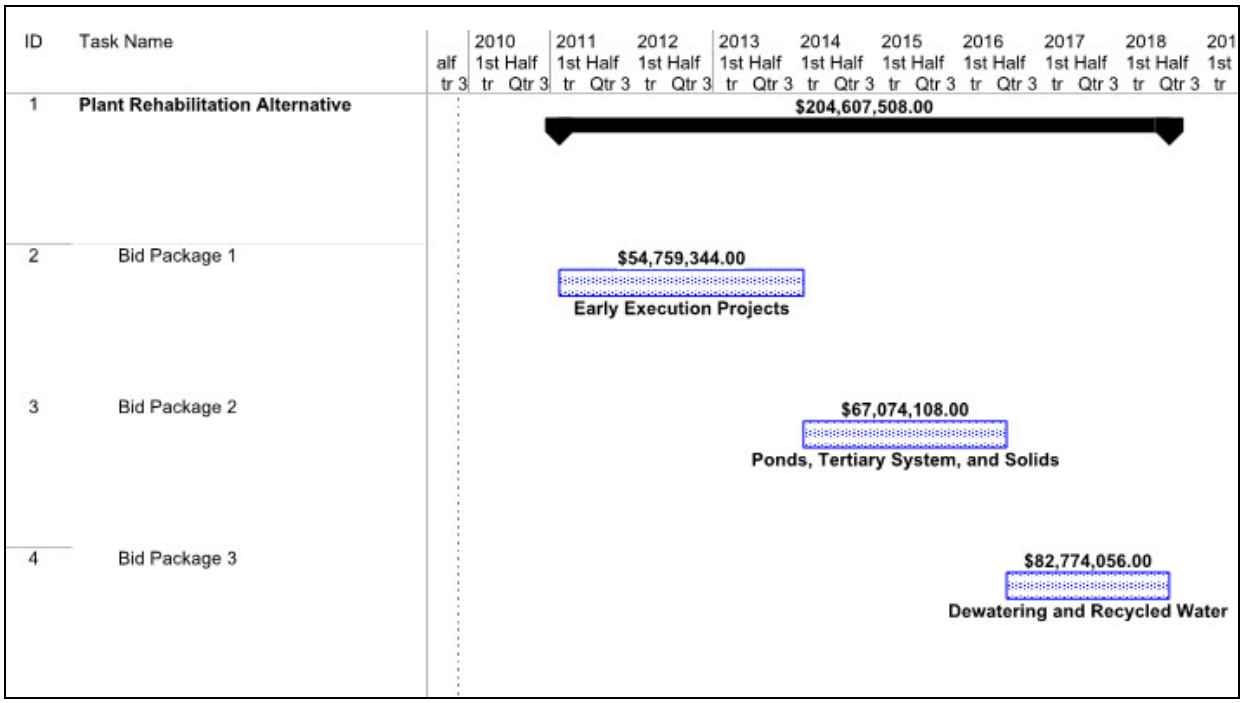

Figure 4-1 Schedule by Bid Package for Plant Rehabilitation Alternative

A summary table of costs by process area and bid package is located in Attachment C.

4.1.2 Operational Cost Summary

Estimates for annual operating costs are summarized in Table 4-2.

The following assumptions are made in the cost estimates:

- Power consumption is presented in total megawatt-hours per year (MW-hr/yr) and power costs are calculated by assuming an electricity cost of $0.20/kW-hr.
- Cost of sodium hypochlorite is $0.71/lb chlorine
- Cost of sodium bisulfite is $803/ton
- Cost of ammonium sulfate is $215/ton
- Cost of caustic soda is $380/ton
- Cost of polymer for dewatering is $1.25/active lb and for DAFT thickening is $5.30/active
- Biosolids hauling cost is $44.69/wet ton
- Sand media replacement cost is $20/ft^3
- Anthracite media replacement cost is $30/ft^3

Table 4-1. Plant Replacement Alternatives Capital Cost Summary (in Millions of Dollars)			
Process Area	Sub-Process	Capital Cost Estimates	
		Alternative A	Alternative B
Electrical Power	Area Substations	15.1	16.0
Electrical Power	Biogas Power Generation	12.3	13.8
Demolition	Demolition of Existing Facilities	21.3	28.2
Civil / Site Work	Activities in Existing Plant Area	2.4	2.9
Community Improvements	Community Improvements	0.4	0.4
	Total Capital Cost Estimate	288.4	355.6

Capital costs have also been broken down into the construction packages presented in layout form in Sections 3.5 and 3.6. The cost estimates for Plant Replacement Alternative A are as follows:

- Construction Package 1 (Early Execution): $52.9 million
- Construction Package 2, Phase 1 (Aeration Basins) $45.4 million
- Construction Package 2, Phase 2 (Secondary Clarifiers): $51.4 million
- Construction Package 3 (Advanced Treatment): $138.7 million

The cost estimates for Plant Replacement Alternative B are as follows:

- Construction Package 1 (Early Execution): $52.9 million
- Construction Package 2 (MBR) $139.7 million
- Construction Package 3 (Advanced Treatment): $163.0 million

These estimates have been incorporated into a projected construction schedule in Figure 4-1.

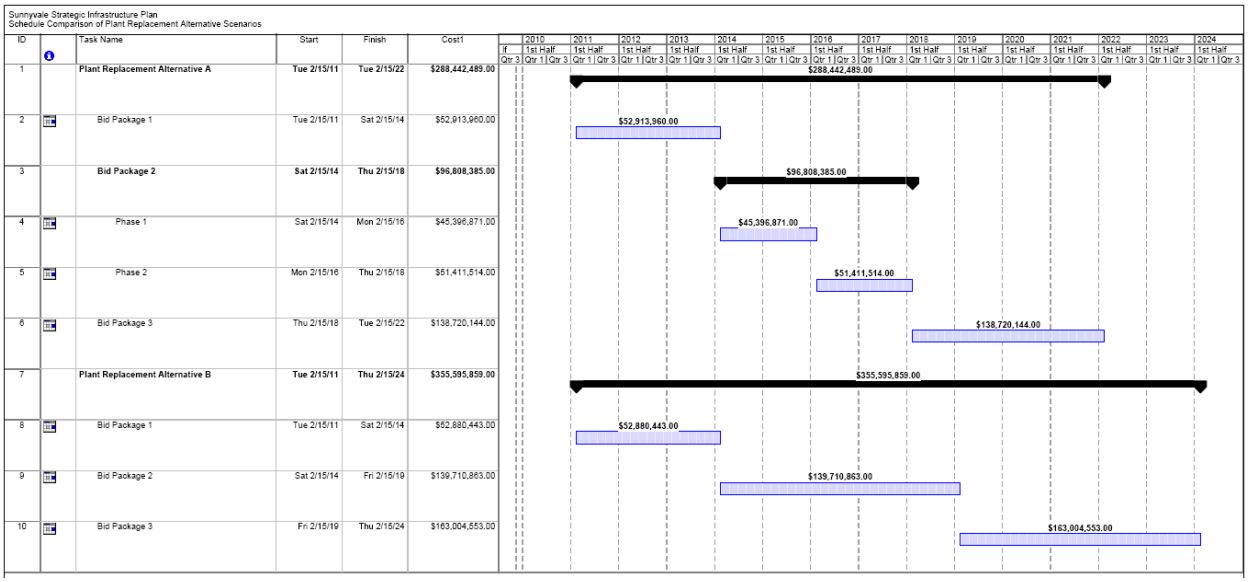

Figure 4-1. Construction schedule and total cost estimates.

Attachment 4
Project Escalation Calculations

CPE Estimating Board issues new Escalation Guidelines

The CPE Estimating Board recommends the following **escalation factors** for the first quarter of 2011:

- *Subcontractors – 4 % per year*
- *Composite rate – 3.85 % per year*
- *Labor – 3 % per year*
- *Materials and Equipment – 4 % per year*
- Diesel Fuel – $3.25 per gallon
- Gasoline – $3.00 per gallon

Note: (*) for those subcontractors that can be broken into the labor and material components, then the appropriate percentages should be applied.

As stated before, it is recommended that the Business Groups engage the Procurement Group for specific commodity pricing.

The CPE Estimating Board will review this on a periodic basis. If there are drastic rises in the above items or their components, the board will make further recommendations to the above list.

For additional information, please contact Lee Lindig/DEN, CPE Director of Estimating.

CH2M Hill - Escalation Calculation

Original Date *January 13, 2011*

Project Name: Sunnyvale Strategic Infrastructure Plan (SIP)

Reprinted Date *January 18, 2011*

Project: Plant Rehabilitation Alternative (Task 4)

Project Reference Numbers: 414083.SP.04

	Type of Contract ===>		*Construction*	*Construction*	*Construction*
	Description		***Bid Package 1***	***Bid Package 2***	***Bid Package 3***
1	**Date of Estimate**		**October 29, 2010**	**October 29, 2010**	**October 29, 2010**
2	**Days from Estimate to NTP**		**123**	**1,219**	**2,134**
3	**Notice to Proceed (NTP)**		**March 1, 2011**	**March 1, 2014**	**September 1, 2016**
4	**Date of Completion**		**March 1, 2014**	**September 1, 2016**	**September 1, 2018**
5	**Project Duration, Days**		**1,096**	**915**	**730**
6	**Project Duration, Years**		**3.0**	**2.5**	**2.0**
7	**Days to Mid-Point from NTP**		**548**	**458**	**365**
8	**Calculated Mid-Point Date**		**August 30, 2012**	**June 2, 2015**	**September 1, 2017**
9	**Total Days for Escalation Calc**		**671**	**1,677**	**2,499**
10	**Total Yrs for Escalation Calc**		**1.838**	**4.595**	**6.847**
11	**Escalation Calculation**		**(1+%^(Days /365) -1 =**	**(1+%^(Days /365) -1 =**	**(1+%^(Days /365) -1 =**
12	**Escalation Percentage to Use**		**7.19%**	**18.95%**	**29.52%**
	Escalation Percentage Used		**3.85%**	**3.85%**	**3.85%**

CH2M Hill - Escalation Calculation

Project Name: Sunnyvale Strategic Infrastructure Plan (SIP)

Project: Plant Replacement Alternative (Task 5A)

Project Reference Numbers: 414083.SP.04

Original Date *January 13, 2011*

Reprinted Date *January 18, 2011*

	Type of Contract ===>		*Construction*	*Construction*	*Construction*	*Construction*
	Description		*Bid Package 1*	*Bid Package 2, Phase 1*	*Bid Package 2, Phase 2*	*Bid Package 3*
1	Date of Estimate		October 29, 2010	October 29, 2010	October 29, 2010	October 29, 2010
2	Days from Estimate to NTP		123	1,219	1,950	1,950
3	Notice to Proceed (NTP)		March 1, 2011	March 1, 2014	March 1, 2016	March 1, 2016
4	Date of Completion		March 1, 2014	March 1, 2016	March 1, 2018	March 1, 2020
5	Project Duration, Days		1,096	731	730	1,461
6	Project Duration, Years		3.0	2.0	2.0	4.0
7	Days to Mid-Point from NTP		548	366	365	731
8	Calculated Mid-Point Date		August 30, 2012	March 2, 2015	March 1, 2017	March 2, 2018
9	Total Days for Escalation Calc		671	1,585	2,315	2,681
10	Total Yrs for Escalation Calc		1.838	4.342	6.342	7.345
11	Escalation Calculation		(1+%^(Days /365) -1 =	(1+%^(Days /365) -1 =	(1+%^(Days /365) -1 =	(1+%^(Days /365) -1 =
12	Escalation Percentage to Use		7.19%	17.83%	27.07%	31.98%
	Escalation Percentage Used		3.85%	3.85%	3.85%	3.85%

CH2M Hill - Escalation Calculation

Project Name: Sunnyvale Strategic Infrastructure Plan (SIF

Project: Plant Replacement Alternative (Task 5B)

Project Reference Numbers: 414083.SP.04

Original Date *January 13, 2011*

Reprinted Date *January 18, 2011*

	Type of Contract ===>		*Construction*	*Construction*	*Construction*
	Description		***Bid Package 1***	***Bid Package 2***	***Bid Package 3***
1	**Date of Estimate**		**October 29, 2010**	**October 29, 2010**	**October 29, 2010**
2	**Days from Estimate to NTP**		**123**	**1,219**	**3,045**
3	**Notice to Proceed (NTP)**		**March 1, 2011**	**March 1, 2014**	**March 1, 2019**
4	**Date of Completion**		**March 1, 2014**	**March 1, 2019**	**March 1, 2024**
5	**Project Duration, Days**		**1,096**	**1,826**	**1,827**
6	**Project Duration, Years**		**3.0**	**5.0**	**5.0**
7	**Days to Mid-Point from NTP**		**548**	**913**	**914**
8	**Calculated Mid-Point Date**		**August 30, 2012**	**August 30, 2016**	**August 31, 2021**
9	**Total Days for Escalation Calc**		**671**	**2,132**	**3,959**
10	**Total Yrs for Escalation Calc**		**1.838**	**5.841**	**10.847**
11	**Escalation Calculation**		**(1+%^(Days /365) -1 =**	**(1+%^(Days /365) -1 =**	**(1+%^(Days /365) -1 =**
12	**Escalation Percentage to Use**		**7.19%**	**24.69%**	**50.64%**
	Escalation Percentage Used		**3.85%**	**3.85%**	**3.85%**

Appendix E
Technical Memorandum – Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan, Task Optional Services – Development of Strategy 1 Additional Alternative

Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan
Task Optional Services – Development of Strategy 1 Additional Alternative

PREPARED FOR: City of Sunnyvale

PREPARED BY: Kathy Rosinski/CH2M HILL
Anne Kernkamp/CH2M HILL
Susan Dennis/CH2M HILL

REVIEWED BY: Glen Daigger/CH2M HILL
David Jenkins/UC Berkeley
George Tchobanoglous/UC Davis
Dana Rippon/CH2M HILL

DATE: March 30, 2011

PROJECT NUMBER: 414083.SP.OS

Background and Purpose

In Workshop 1, the Peer Review Team identified an additional water pollution control plant (WPCP or Plant) treatment strategy that focused on recovering carbon from the influent wastewater for energy production. Advantages of this strategy may include increased digester gas generation, lower in-plant energy usage, and lower chemical usage. Termed Strategy 1, a treatment alternative based on this strategy is as follows:

- Replace preliminary treatment, as recommended by the Strategic Infrastructure Plan (SIP).
- Replace primary clarifiers, possibly with enhancements to clarify or add downstream processes to achieve higher solids removal; options include chemically enhanced primary treatment (CEPT), filtering primary effluent, high-rate activated sludge, and flotation.
- Retain fixed-growth reactors (FGR), potentially requiring additional unit(s) as a final step in carbon removal process.
- Polish effluent from FGRs and achieve N removal; options include conventional granular media filters, wetlands, or existing air floatation tanks (AFT).
- If needed, use a portion of the existing ponds for treatment or peak flow attenuation. If not required for treatment, the City can consider other future uses, such as stormwater polishing or public amenities.

- Retain anaerobic digestion for solids treatment.
- Produce reclaimed water using a parallel treatment process to eliminate the need to switch between Plant operating modes during seasonal production of recycled water. This assumes that all reclamation would be accomplished at the WPCP site.

Additionally, the Peer Review Team identified potential inconsistencies in the per capita waste loads presented in the Draft SIP compared to their professional experience at similar wastewater treatment plants and published per capita values.

This technical memorandum (TM) provides the Team's analysis of the flows and waste loads presented in the Draft SIP, development of the Strategy 1 treatment alternative, estimated construction costs of the alternative, and conclusions and recommendations for further consideration of the Strategy 1 alternative in the City's decision process.

Conclusions and Recommendations

Analysis of the SIP flows and waste loads revealed significant differences between the proposed SIP values, published industry values, and values observed at other plants by the Peer Review Team. The SIP values were adjusted to better align with industry values to develop the Strategy 1 alternative. It is recommended that the SIP flow and waste load values be updated during preliminary design, preferably using additional data from a sampling program. The City should endeavor to collect data from the influent sampler at its new location and daily/weekly/monthly influent data for 5-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), total dissolved solids (TDS), total Kjeldahl-Nitrogen (TKN), and ammonia-nitrogen (NH_3-N) to provide reliable data for preliminary design.

The Strategy 1 treatment alternative was developed to achieve the expected National Pollutant Discharge Elimination System (NPDES) discharge requirement, optimize carbon capture from the influent wastewater, and maximize energy production. Analyses considered both current NPDES discharge limits and probable future treatment requirements, including year-round limits for NH_3. The alternative was developed through several iterations to identify the number and type of process components that would be required to achieve the stated treatment objectives. Seven options were analyzed, and the following two options were found to be candidate treatment trains to achieve the Strategy 1 objectives:

- **Option 5**: New headworks; new primary clarifiers plus CEPT; continued use of existing FGRs **plus one additional FGR**; conversion of the entire pond acreage to treatment wetlands; existing filters for parallel recycled water production; and retain existing solids digestion, effluent disinfection, and disinfectant removal.
- **Option 7**: New headworks; new primary clarifiers; new high-rate activated sludge process operating at 1-day solids retention time (SRT); retain use of all or a portion of the effluent filters for effluent polishing; existing or additional effluent filters for parallel recycled water production; retain existing solids digestion, effluent disinfection, and disinfectant removal.

Cost estimates were developed to compare individual unit processes between the SIP recommended alternatives and Strategy 1 alternative; total estimated construction costs for the Strategy 1 options were not developed. It was assumed that unit processes common to all alternatives would be comparable in cost and, thus, the comparison focused on those processes unique to each alternative. Considering the accuracy of the planning-level estimates developed for this analysis, the Strategy 1 alternative options (Option 5 and Option 7) are comparable in cost to the recommended SIP alternatives or potentially less costly.

The Strategy 1 options were presented and discussed in detail at Peer Review Workshop 2. The Peer Review Team recommends that the City consider the advantages and disadvantages of all alternatives before selecting an alternative for implementation.

Influent Flow and Waste Load Analysis

The SIP-recommended values for influent flow and waste loads to be used in planning the future facilities were compared with industry-published values and are summarized in the following subsections.

Comparison of Per Capita Loadings

The influent loads presented in the SIP were compared to typical values for domestic wastewater published in *Wastewater Engineering Treatment and Reuse* (Metcalf and Eddy, Inc., [M&E], 2003). The Peer Review Team selected this reference as representative of industry data to enable an expedited review of SIP loads. Table 1 compares the calculated SIP per capita loadings with published values. The Peer Review Team's conclusions based on this comparison are as follows:

- The SIP TSS values are underestimated by as much as 50 percent.
- The BOD_5 per capita loading in the SIP appears to be consistent with published values. However, BOD_5 may also be underestimated if the TSS fraction of the wastewater is underestimated.
- The influent NH_3-N data presented in the SIP are within typical range.

Comparison of Peaking Factors

The SIP ratios of peak day, peak week, and peak month loads to the average influent values were evaluated. This peaking factor comparison is presented in Table 2. Our observations are as follows:

- The SIP peaking factors for carbonaceous 5-day BOD ($cBOD_5$) and TKN loads are within the range of published values.
- SIP peak day, peak week, and peak month factors for TSS are significantly higher than published values.

TABLE 1
Comparison of Per Capita Loadings
Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan
Task Optional Services – Development of Strategy 1 Additional Alternative

		Published Values[a]	
Parameter	**Per capita unit loading calculated based on SIP[b] (grams/capita/day)**	**Typical Per Capita Loading Range for Domestic Wastewater (grams/capita/day)**	**Average Per Capita Loading Values (grams/capita/day)**
BOD_5	ND	50 to 120	85
$cBOD_5$	74	40 to 100	72[c]
COD	ND	110 to 295	198
TSS	60.42	60 to 150	95
NH_3- N	9.26	5 to 12	7.8
TKN	ND	9 to 21.7	13.3
Total Phosphorus	ND	2.7 to 4.5	3.3

[a]M&E, 2003.

[b]Per capita loadings calculated based on SIP mass loadings and serviced population for year 2035.

[c]BOD_5 comparison is difficult because only $cBOD_5$ is reported by the Sunnyvale WPCP. The published range of industry values for $cBOD_5$:BOD_5 is 1.0:0.7; 0.85 was assumed to calculate BOD_5 values for this analysis.

Notes:
COD = chemical oxygen demand
ND = no data

TABLE 2
Comparison of Raw Wastewater Loading Peaking Factors
Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan
Task Optional Services – Development of Strategy 1 Additional Alternative

Parameter	Peak Day	Peak Week	Peak Month	Annual Average	Avg Dry Weather
	SIP Peaking Factor Values				
$cBOD_5$[a]	2.38	1.75	1.43	1.06	1.0
TSS	4.6	2.83	1.81	1.19	1.0
TKN-N	1.88	ND	1.43	1.23	1.0
NH_3-N	ND	ND	ND	ND	1.0
P	ND	ND	ND	ND	1.0

TABLE 2
Comparison of Raw Wastewater Loading Peaking Factors
Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan
Task Optional Services – Development of Strategy 1 Additional Alternative

Parameter	Peak Day	Peak Week	Peak Month	Annual Average	Avg Dry Weather
	Published Peaking Factor Values[b]				
BOD_5[a]	2.5	1.5	1.3	1.2	1.0
TSS	2.8	1.5	1.3	1.2	1.0
TKN-N	2.3	1.5	1.3	1.2	1.0
NH_3-N	1.75	1.2	1.3	1.2	1.0
P	2	1.5	1.3	1.2	1.0

[a]The peaking factors for $cBOD_5$ and BOD_5 parameters are assumed to be comparable.

[b]M&E, 2003.

Note:
ND = no data

Possible explanations for the higher TSS load peaking factors estimated in the SIP (which were based on influent sampling data) are that more TSS was captured during higher flows because of greater TSS resuspension at the influent sampling location during high flow. Plant staff corroborated inaccuracies in raw wastewater sampling and relocated the influent sampler location in 2010 to acquire more accurate data. These data were not reviewed for this analysis but should be evaluated during preliminary design, at which time more than a year's worth of data will be available.

Comparison of Mass Loadings

Mass loadings were calculated using the published average per capita loading values (Table 1) and peaking factors. Table 3 presents computed mass loadings, estimated using the 2035 service population of 163,300, industry values for per capita loadings, and published peaking factors. These estimates were then compared to peak month and peak week loading from the SIP. Our observations are as follows:

- The estimated peak month and peak week loadings based on literature are in reasonable agreement with the values presented in the SIP because the higher per capita loadings and lower peaking factors from the literature tend to offset each other.
- The sizing of treatment facilities in the SIP is based on peak month and peak week loadings; therefore, the SIP process sizing developed using these loads appears to be reasonable.
- The average annual loadings are underestimated (based on per capita loadings) and should be adjusted, as these data are used to estimate average TSS production and operation and maintenance costs.

TABLE 3

Comparison of Mass Loadings (2035 design year)

Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan

Task Optional Services – Development of Strategy 1 Additional Alternative

Parameter	Recommended Per Capita Loadings (grams/capita/day)	Avg. Dry Weather Concentration[b] (mg/L)	Estimated Raw Wastewater Loading[a] (lb/day)					SIP (2010) Loadings (lb/day)	
			Avg. Dry Weather	Avg. Annual	Peak Day Load	Peak Week	Peak Month	Peak Week[g]	Peak Month
BOD_5	85[c]	220	30,600	36,700	76,400	45,900	39,700	ND	ND
$CBOD_5$	73[c]	187	26,000	31,200	72,800	39,000	33,800	46,700	38,200
COD	198[c]	511	71,200					ND	ND
TSS	95[c]	245	34,200	41,000	95,700	51,300	44,400	61,500	39,300
VSS	71[d]	184	25,600	30,800	71,800	38,400	33,300	ND	ND
TKN-N	15.5[e]	40	5,600	6,700	12,800	8,300	7,200	ND	ND
NH_3-N	9.3[f]	24	3,300	4,000	5,800	4,000	4,300	ND	3,300
P	3.3[c]	8.3	1,200	1,400	2,300	1,700	1,500	ND	ND

[a]Calculated based on recommended per capita loadings, 2035 service population of 163,300, and published peak factors (see Table 2).

[b]Calculated based on recommended per capita loadings, 2035 service population, and 16.7-mgd average dry weather flow (SIP, 2010).

[c]On the basis of published data (see Table 1).

[d]Assumed VSS is 75 percent of TSS (M&E, 2003).

[e]On the basis of the SIP (see Table 1).

[f]Assumed NH_3-N is 60 percent of TKN (M&E, 2003).

[g]SIP did not present a Peak Week value; instead Peak Day was used.

Notes:

mg/L = milligrams per liter

VSS = volatile suspended solids

Flow Analysis

The per capita wastewater flow estimate was calculated from the SIP dry weather flow projections and the 2035 service population. The calculated 102-gallons-per-capita-per-day (gal/cap/day) flow is in agreement with typical published values, which range from 100 to 120 gal/cap/day for medium-strength wastewater (M&E, 2003). Considering that the per capita flow calculation aligns with published values, the 2035 design flows presented in the SIP, which are summarized in Table 4, were used in this analysis.

TABLE 4

SIP Projected Year 2035 Influent Flows and Flow Peaking Factors
Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan
Task Optional Services – Development of Strategy 1 Additional Alternative

Parameter	Flow (mgd)	Peaking Factors
ADWF	16.7	1.00
AAF	18.0	1.08
AWWF	18.5	1.11
Peak Month	22.4	1.34
Peak Week	24.3	1.46
Peak Day	32	1.92
Peak Hour	50	2.99
Min Daily	10.4	0.62
Min Hourly	5.63	0.34

Notes:
AAF = annual average flow
ADWF = average dry weather flow
AWWF = average wet weather flow

Mass Loadings for Strategy 1 Analysis

Revised waste loads were developed on the basis of the above analysis for the purpose of evaluating the Strategy 1 alternative and are presented in Table 5.

Strategy 1 Alternative Development

The Strategy 1 alternative was developed by sequentially modeling treatment trains using CH2M HILL's Pro2D software. The model uses mass balance and stoichiometric and kinetic parameters to model the transformation of constituents in the wastewater through chemical/physical and biological treatment processes. This proprietary software was used for expediency and will yield results similar to the Biowin software that was used by Brown & Caldwell to perform the SIP analyses.

TABLE 5
Revised Loads Calculated Using Published Values
Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan
Task Optional Services – Development of Strategy 1 Additional Alternative

Parameter	Recommended Per Capita Unit Loading (grams/capita/day)	Raw WW Loading – Calculated Based on 2035 Population (lb/day)	Estimated Raw Wastewater Concentration @ ADWF = 16.7 mgd (mg/L)
BOD_5[a]	85	30,600	220
$cBOD_5$[b]	73	26,000	187
COD[a]	198	71,200	511
TSS[a]	95	34,200	245
NH_3 as N[c]	9.3	3,300	24
TKN as N[d]	15.5	5,600	40
Total Phosphorous[a]	3.3	1,200	8

[a]Typical loading (M&E, 2003).
[b]Assumed 85 percent of BOD_5, typical wastewater.
[c]From SIP, 2010.
[d]NH_3-N:TKN ratio of 0.60 (M&E, 2003).

The analysis was conducted for the discharge limits contained in the Plant NPDES Permit No. CA0037621 and assumed future limits, as follows:

- $cBOD_5$: Monthly average of 10 mg/L and daily maximum of 20 mg/L; future limits were not analyzed.
- TSS: Monthly average of 20 mg/L and daily maximum of 30 mg/L; future limits were not analyzed. However, as discussed in the Peer Review Task 2 TM, the City's NPDES consultant, EOA, Inc., has stated that conversion to an activated sludge process would likely trigger a permit change to a monthly average limit of 10 mg/L or less. A TSS limit of 10 mg/L would necessitate filtration of the wetland effluent prior to disinfection and discharge.
- Ammonia: Summer (June to September) – Monthly average of 2.0 mg/L NH_3-N, and maximum daily average of 5.0 mg/L NH_3-N; winter (October to May) – monthly average of 18.0 mg/L NH_3-N, and maximum daily average of 26.0 mg/L NH_3-N. Additionally, a potential future winter monthly average limit is assumed at 4.5 mg/L NH_3-N, as recommended in the SIP.

Strategy 1 Options

Seven liquid process treatment alternatives were modeled with the goal of meeting the expected future regulatory requirements and maximizing carbon recovery for energy production. These options are summarized in Table 6. All options evaluated would retain use of the existing digesters and solids handling and disinfection systems, as proposed in

TABLE 6
Summary of Additional Alternatives Modeled for Strategy 1
Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan: Task Optional Services – Development of Strategy 1 Additional Alternative

Option	Description	Performance[a]	Recommendation	Advantages	Disadvantages
Option 1 – Headworks + Primary Clarifiers + Existing FGR	Discontinue use of ponds for secondary treatment Use existing FGR for BOD removal and nitrification	Does not meet BOD or ammonia effluent limits	Not viable	--	--
Option 2 – Headworks + CEPT + Existing FGR	Same as Option 1 plus: Implement CEPT – add coagulant to primary treatment to increase capture and removal of solids and organics	Does not meet CURRENT summer ammonia limit of 2 mg NH_3-N/L	Not viable on its own	--	--
Option 3 – Headworks + CEPT + one more FGR	Same as Option 2, plus: Construct one more FGR	Meets CURRENT and potentially more stringent FUTURE summer/winter ammonia limits Requires downstream solids removal treatment	Not viable on its own	--	--
Option 4 – Headworks + CEPT + Existing FGR + Wetland	Same as Option 2, plus: Convert existing ponds to wetlands to achieve additional nitrification in summer and effluent polishing Wetlands would have a small "settling zone" to remove solids (few acres), that would be periodically cleaned	Meets CURRENT winter ammonia limits Requires >1,200-acre wetland to meet summer ammonia limits	Not viable on its own	--	--
Option 5 – Headworks + CEPT + one more FGR + Wetland	Same as Option 4, (with reduced wetland size) plus: Construct one more FGR to increase organics removal and nitrification capacity Wetlands provide effluent polishing for solids removal **Options for Parallel Recycled Water Treatment:** Option A – Filtration (existing filters) of FGR effluent + disinfection Option B – Filtration (existing filters) of wetland effluent + disinfection Option C – Clarification (potentially using existing DAF tanks) of FGR effluent + filtration (existing filters) + disinfection	Meets CURRENT and FUTURE year-round ammonia limits	**Viable option for further evaluation to meet current ammonia effluent limits and potentially more stringent future winter ammonia effluent limits**	• Maximized use of existing facilities (FGR, filters) • Discontinued use of high energy processes (DAF); tanks could be decommissioned or converted to other uses • Improved capture of solids and organics in primary treatment for energy recovery (CEPT) • Secondary benefits of CEPT are H_2S reduction affecting some level of odor control and reduced level of regulated engine emissions • Optimized use of digesters by increasing loading of highly biodegradable primary solids, resulting in increased digester gas production and energy recovery • Wetlands provide treatment and potentially used as a community resource • Recycled water system uses existing facilities • Recycled water system decoupled from the main liquid treatment train, providing operational flexibility and improving overall plant reliability • Improved quality of recycled water (no color) • Stable treatment process with fewer mechanical components and simpler plant operations • Reduced GHG emissions from ponds	• Increased chemical use for CEPT • Limited experience using medium-density FGR media for combined carbon oxidation and nitrification (although successfully used to treat solids-laden pond effluent at Sunnyvale) • Increased solids processing requirements

TABLE 6
Summary of Additional Alternatives Modeled for Strategy 1
Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan: Task Optional Services – Development of Strategy 1 Additional Alternative

Option	Description	Performance[a]	Recommendation	Advantages	Disadvantages
				• Minimized construction within the treatment plant proper frees up a substantial amount of property for other uses • Easy construction phasing • Wetlands could be expanded to provide total Nitrogen removal • Phosphorous removal (though not available for nutrient recovery) • UV is an option for disinfection • Improved biological treatment robustness and redundancy	
Option 6 – Headworks + Primary Clarifiers + High Rate Activated Sludge	Discontinue use of ponds for secondary treatment Operate primary treatment in conventional mode to capture solids and organics Construct new aeration tanks and clarifiers; high-rate activated sludge has short detention time and operates at short SRT (1 day) to capture organic matter (dissolved, colloidal, and particulate) escaping primary treatment	Does not achieve ammonia limits	Not viable on its own	--	--
Option 7 – Headworks + Primary Clarifiers + High-rate Activated Sludge + Existing FGR + Filtration	Same as Option 6 plus: Existing FGR provides nitrification only Use existing filters for all or a portion of FGR effluent polishing or other tertiary effluent polishing options **Options for Parallel Recycled Water Treatment:** Option A – Filtration (existing or new filters) of FGR effluent + disinfection	Meets CURRENT and FUTURE year-round ammonia limits	**Viable option for further evaluation**	• Improved capture of solids and organics in primary and high-rate secondary treatment for energy recovery • Eliminates chemical use associated with CEPT (except for lower dose required for odor and H_2S control) • Robust activated sludge treatment provides BOD removal • Optimized use of energy for secondary treatment (aeration) compared to conventional activated sludge • Maximized use of existing facilities (FGR, filters) • Conventional use of FGRs with medium-density media for nitrification only • Discontinued use of high-energy processes (DAF); tanks could be decommissioned or converted to other uses • Opportunities for other uses for decommissioned ponds (stormwater/peak flow storage) or effluent polishing • Reduced pumping needs (from ponds) • Increased digester gas production and energy recovery	• Energy requirements for activated sludge aeration process • Increased space requirements for bioreactors and secondary clarifiers • Increased solids processing requirements • More mechanized/complex treatment compared to Option 5

TABLE 6
Summary of Additional Alternatives Modeled for Strategy 1
Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan: Task Optional Services – Development of Strategy 1 Additional Alternative

Option	Description	Performance[a]	Recommendation	Advantages	Disadvantages
				• Recycled water system can be decoupled from the main liquid treatment train, providing operational flexibility and improving overall plant reliability • Could convert to nitrification/denitrification system with additional bioreactors • Greater process control • UV is an option for disinfection	

[a]For the purpose of this analysis, current ammonia limits are based on existing NPDES Permit No. CA0037621: summer (June-September): 2.0 mg NH_3-N/L monthly average, and 5.0 mg NH_3-N/L maximum daily; and winter (October–May) 18.0 mg NH_3-N/L monthly average, and 26.0 mg NH_3-N/L maximum daily. Potential future winter limit is assumed to be 4.5 mg NH_3-N/L (based on SIP, 2010). Current annual average/daily maximum TSS and $cBOD_5$ limits are 20/30 mg/L and 10/20 mg/L, respectively.

Notes:
DAF = dissolved air flotation
GHG = greenhouse gases
UV = ultraviolet

the SIP. Of the seven alternatives evaluated, two options were identified as being best able to achieve the Strategy 1 goals. These options are summarized as follows:

- **Option 5:** New Headworks + New Primary Clarifiers utilizing CEPT + Existing FGRs plus one New FGR + New Treatment Wetlands
- **Option 7**: New Headworks + New Primary Clarifiers + High-rate Activated Sludge + Existing FGRs + Exist Effluent Filtration

Option 5 provides an additional FGR to meet current summer NH_3 limits and assumed future year-round NH_3 limits. The existing 425-acre pond area would be converted to constructed wetlands for final effluent polishing. The wetlands would be configured with a small (few acres), deeper influent settling area to remove the FGR solids, which would be periodically dredged. The added benefit of wetland treatment is that it could provide denitrification to meet total nitrogen effluent limits, should stricter limits be imposed in the future.

Option 7 includes new aeration tanks and secondary clarifiers to achieve organics removal, and uses the FGRs to achieve year-round nitrification. The high-rate aeration tanks would have a smaller footprint compared to the conventional activated sludge process that was evaluated in the SIP. Existing filters or new constructed wetlands could be used for effluent filtration. For the purpose of this analysis, it was assumed that the available 425 acres of pond area would be converted to wetlands for final effluent polishing.

A summary of the Pro2D model output (including influent loading, unit process sizes, and predicted effluent quality) for Options 5 and 7 is included in Attachments 1 and 2, respectively.

Discussion of Strategy 1 Options

Advantages and disadvantages of the Strategy 1 options compared with the SIP recommended alternative, Plant Rehabilitation, are presented in Table 6. The key advantages of Options 5 and 7 are summarized as follows:

- Both options eliminate the need for the AFT process, which is mechanically, chemically, and energy intensive.
- Both options provide a robust treatment process with greater controllability and reliability. Therefore, flow equalization is not required.
- New primary clarifiers would be constructed for both options that can be designed to maximize solids capture and sludge thickening.
- Option 5 achieves greater carbon capture through CEPT. CEPT offers the additional benefit of sulfide reduction, which provides some level of odor reduction downstream of the chemical addition site and reduced air emissions from the Plant's cogeneration engines due to reduced H_2S content in the digester gas.
- Option 7 achieves increased carbon capture through a high-rate activated sludge process upstream of the existing FGRs. High-rate activated sludge would reduce energy

consumption compared to conventional activated sludge alternatives and require a smaller footprint.

- Mechanical thickening would be provided to thicken waste activated sludge (WAS) prior to digestion. This treatment approach would require WAS storage, or continuous around-the-clock thickener operation because of the high wasting rate when operating at a 1-day SRT.
- Option 5 uses the existing pond acreage for treatment wetlands for final effluent polishing. The wetlands offer the added benefit as a potential community resource for public trails, wildlife habitat, and education.
- Both options decouple recycled water production from the main treatment train, providing operational flexibility, improved plant reliability, and improved recycled water quality (no color).
- Both options present the opportunity to use UV disinfection, which is not feasible for the SIP-recommended Plant Rehabilitation alternative. UV disinfection would reduce chemical use and the potential for disinfection byproduct formation.
- Discontinuing use of ponds to treat primary effluent will significantly decrease GHG emissions from the WPCP.

Both of these options will be presented and discussed in detail at the upcoming Peer Review Project Workshop 2.

Basis for Cost Comparison

Costs were estimated to compare Strategy 1 Options 5 and 7 with the SIP Plant Rehabilitation and Plant Replacement (activated sludge) alternatives. It was assumed that unit processes common to the Strategy 1 alternatives and SIP alternatives would be comparable in cost and, thus, the comparison focused on the unit processes that differentiate these alternatives.

The cost estimates were prepared in accordance with the guidelines of AACE International, the Association for the Advancement of Cost Engineering, using the CH2M HILL Parametric Cost Estimating (CPES) tool. According to the definitions of AACE International, the Class 5 Estimate is defined as follows:

> This estimate is prepared based on limited information, where little more than proposed plant type, its location, and the capacity are known. Strategic planning purposes include but are not limited to, market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, and long-range capital planning. Examples of estimating methods used would include cost/capacity curves and factors, scale-up factors, and parametric and modeling techniques. Typically, little time is expended in the development of this estimate. The expected accuracy ranges for this class estimate are –20 to –50 percent on the low side and +30 to +100 percent on the high side.

Comparison of Alternative Costs

Table 7 summarizes the cost comparison of treatment process components for Options 5 and 7 with the comparable treatment components for the SIP Plant Rehabilitation and Replacement alternatives.

Considering the accuracy of the planning-level estimates developed for this analysis, Options 5 and 7 and the SIP alternatives are comparable in construction cost.

TABLE 7
Sunnyvale SIP Peer Review – Cost Comparison of SIP and Alternative Options for Plant Upgrade
Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan
Task Optional Services – Development of Strategy 1 Additional Alternative

	Alternative Cost ($ Millions)			
Unit Process	**Option 5: PC + CEPT + FGR + Add'l FGR + Wetland[a]**	**Option 7: PC + High-rate Activated Sludge + FGR + Filtration[a]**	**SIP Plant Rehabilitation[b]**	**SIP Plant Replacement w/AS[b]**
Ponds Rehabilitation/ Conversion to Sludge Lagoons			15.7	
Ponds Rehabilitation/Convert to Wetlands	18.9	18.9		
Ponds Rehabilitation/ Dredging and Levee Rehabilitation	9.1	9.1	7.0	13.9
Ponds Rehabilitation/ Recirculation Channel			4.9	
Pond Restoration/Flow Equalization				26.0
Biological Treatment/Aeration Basins		21.8		27.6
Biological Treatment/ Secondary Clarifiers		20.2		15.7
Fixed Growth Reactors/ Rehabilitation	8.3[b]	8.3[b]	8.3	
Fixed Growth Reactors/ Demolition				4.8
Fixed Growth Reactors/ Additional Facilities	6.7			
Dissolved Air Flotation/New			12.5	
Recycled Water/DAF Filters Disinfection	3.4	3.4	15.0	4.8
Recycled Water/New Disinfection				

TABLE 7
Sunnyvale SIP Peer Review – Cost Comparison of SIP and Alternative Options for Plant Upgrade
Peer Review of the Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan
Task Optional Services – Development of Strategy 1 Additional Alternative

	Alternative Cost ($ Millions)			
Unit Process	**Option 5: PC + CEPT + FGR + Add'l FGR + Wetland[a]**	**Option 7: PC + High-rate Activated Sludge + FGR + Filtration[a]**	**SIP Plant Rehabilitation[b]**	**SIP Plant Replacement w/AS[b]**
Total Cost for Differentiating Facilities	**46.4**	**81.7**	**63.4**	**92.7**

[a]Cost based on CPES.

Cost Estimate Assumptions:

Project duration: 24 months

Project start: March 2015 (consistent with SIP)

Escalation to the midpoint of construction: 1.168

Location adjustment factor (based on San Jose, CA): 117.9

California State Sales Tax: 9.25% (applied to 50% of the of the total cost)

Construction site dewatering cost included for consistency with SIP estimate

Markups: 10% overhead, 5% Profit, 5% Mobilization/Bond/Insurance, 30% Contingency (all are consistent with SIP)

Market adjustment factor: 10%

Non-construction costs are not included: Permitting, engineering, SDC, Legal

[b]Cost estimates obtained from SIP (2010)

Work Cited

Metcalf and Eddy, Inc. (M&E). 2003. *Wastewater Engineering Treatment and Reuse*. Fourth Edition. McGraw-Hill.

Attachment 1

Facility Operating Parameters						Project
Item		**Value**			**Value**	**Notes**
Influent Wastewater	(Metric)	(Metric)	(Metric=US*k)	(US)	(US)	
Flow	m3/day			MG/day		
Design Average		**84,794**	3,785.44		**22.40**	peak month flow
Design Diurnal Peak		**127,191**	3,785.44		**33.60**	
Design Peaking Factor for WW Diurnal flow		1.5	1.00		1.5	equivalent to peak week factor
Design Peaking Factor for WW Diurnal loads		**1.3**	1.00		**1.3**	
Carbonaceous Five-Day Biochemical Oxygen Demand (CBOD5)						
Design Average Concentration	mg/L	181	1.00	mg/L	181	
Design Average Mass Loading	kg/day	**15,331**	0.45	lb/day	**33,800**	peak month loading
Design Diurnal Peak Mass Loading	kg/day	19,931	0.45	lb/day	43,940	
Total Suspended Solids (TSS)						
Design Average Concentration	mg/L	238	1.00	mg/L	238	
Design Average Mass Loading	kg/day	**20,139**	0.45	lb/day	**44,400**	peak month loading
Design Diurnal Peak Mass Loading	kg/day	26,181	0.45	lb/day	57,720	
Volatile Suspended Solids (VSS)						
Percent VSS	%	**75%**	1.00	%	**75%**	assumed
Design Average Concentration	mg/L	178	1.00	mg/L	178	
Design Average Mass Loading	kg/day	15,105	0.45	lb/day	33,300	
Design Diurnal Peak Mass Loading	kg/day	19,636	0.45	lb/day	43,290	
Total Kjeldahl Nitrogen (TKN as N)						
Design Average Concentration	mg/L	39	1.00	mg/L	39	
Design Average Mass Loading	kg/day	**3,275**	0.45	lb/day	**7,220**	peak month loading
Design Diurnal Peak Mass Loading	kg/day	4,257	0.45	lb/day	9,386	
Ammonia-Nitrogen (NH3-N as N)						
Design Average Concentration	mg/L	23	1.00	mg/L	23	
Design Average Mass Loading	kg/day	**1,965**	0.45	lb/day	**4,332**	assumed 60% of TKN
Design Diurnal Peak Mass Loading	kg/day	2,554	0.45	lb/day	5,632	
Total Phosphorus (as P)						
Design Average Concentration	mg/L	8	1.00	mg/L	8	
Design Average Mass Loading	kg/day	**685**	0.45	lb/day	**1,510**	peak month loading
Design Diurnal Peak Mass Loading	kg/day	890	0.45	lb/day	1,963	
Alkalinity (as CaCO3)						
Design Average Concentration	mg/L	250	1.00	mg/L	250	
Design Average Mass Loading	kg/day	**21,197**	0.45	lb/day	**46,732**	pond efluent measured > 250 mg
Design Diurnal Peak Mass Loading	kg/day	27,556	0.45	lb/day	60,752	
Hydrogen Sulfide (H2S)						
Design Average Concentration	mg/L	6	1.00	mg/L	6	
Design Average Mass Loading	kg/day	**509**	0.45	lb/day	**1,122**	assumed, no data available
Design Diurnal Peak Mass Loading	kg/day	661	0.45	lb/day	1,458	
Chemical Addition:						
Select the Metal Salt (if used) **Ferric Chloride**				2		
Wastewater Temperature						
Raw Sewage Temperature	oC	**20**	1.00	oC	**20**	8.8 deg. C - minimum month tem
Plant Elevation	meters	**3**	3.28	feet	**10**	
Ambient Atmospheric Pressure	kPa	101	6.89	psia	14.7	
Is the Temperature Model Used? **No**						confirm this is not needed
N/A	oC	**21**	Special	oF	**70**	
N/A	kph	**8**	0.62	mph	**5**	
N/A	%	**60%**	1.00	%	**60%**	
N/A	%	**50%**	1.00	%	**50%**	
N/A	degrees	**45**	1.00	degrees	**45**	
N/A	Date	**02/09/11**	1.00	Date	**02/09/11**	
Primary Clarifiers: Main						
Primary Clarifiers? **Yes**		TRUE				
Total Area	m2	**1,942**	0.09	ft2	**20,900**	excludes pre-aration
Overflow Rate	m/day		0.04	gpd-sq.ft.		
Average		46	0.04		1,136	1000 gal/sf/day - typical, M&E
Diurnal Peak		70	0.04		1,708	2000-3000 gal/sf/day - typical, M&
Chemical Compound Applied to Primary Influent **Yes**	TRUE	2				
Chemical Formula		FeCl3	1.00		FeCl3	
Chemical Dosage (mg chemical/L treated)	mg/L	**50**	1.00	mg/L	**50**	
Chemical Dosage (as chemical)	kg/day	4,514	0.45	lb/day	9,953	
Molar Ratio of Metal to Phosphate		1.50	1.00		1.50	
Percent of Soluble P that is ortho-P		**100%**	1.00		**100%**	
Percent Removal of Colloidal Matter		**83%**			**83%**	
TSS Removal Efficiency at Average Conditions		**80%**	1.00		**80%**	average removal varied 40-57% (
TSS Removal Efficiency at Diurnal Peak Conditions		**60%**	1.00		**60%**	
Effective TSS Removal with Chemical Addition - Average Conditions(%)		85%	1.00		85%	
Effective TSS Removal with Chemical Addition - Peak Conditions(%)		63%	1.00		63%	
Percent BOD5 Removal		63%	1.00		63%	average removal 23% (2004-2007
Primary Effluent	mg/L			mg/L		
TSS	52				52	
TP	1.96				1.96	
OP	0.56				0.56	
Primary Sludge Concentration	mg/L	**60,000**	1.00	mg/L	**60,000**	in general, weak primary sludge c
Trickling Filter: FGR						
Trickling Filters? **Yes**		TRUE				
Water Temperature	C	20.1	Special	F	68.1	
Coef. "k" in Velz Equation (English Units) =		**0.072**			**0.072**	assumed coeff for 60 deg. Cross
Coef. "n" in Velz Equation =		**0.44**			**0.44**	assumed coeff for 60 deg. Cross
Coef. "Theta" in Velz Equation =		**1.035**			**1.035**	
Media Volume	m3	**14,306**	0.03	ft3	**505,200**	three 92-ft diameter 19-ft media c
Media Depth	m	**5.79**	0.30	ft	**19.00**	
Media Specific surface area	m2/m3	**137.80**	0.30	ft2/ft3	**42.00**	100-150 m2/m3 for plastic media
% Simultaneous Denitrification		**0.1**			**0.1**	
Recirculation Q (used in wetting Q = TF Influent Q+ recirculation)	m3/day	**89,842**	3,785.00	MGD	**23.7**	estimated by the model based on
Biofilm Control Practiced with Distributor? **Yes**		TRUE				
Trickling Filter Loading Rate	kg/m3/d	0.41	0.02	lbs/1000ft3/d	26	
Category of Trickling Filter		Low Rate			Low Rate	
TF Effluent Soluble BOD5	mg/L			mg/L		
Average		5	1.00		5	
Diurnal Peak		8	1.00		8	
TF Effluent NH3-N	mg/L			mg/L		
Average		2	1.00		2	
Diurnal Peak		47	1.00		47	
TF Solids Production in VSS (mg VSS in effluent/mg BOD5 rem)	mg/mg	0	1.00	mg/mg	0	
Trickling Filter Clarifier? **No**		FALSE				
Total Area	m2	**372**	0.09	sq.ft.	**4,000**	
Overflow Rate	m/day			gpd-sq.ft.		

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Average			242	0.04		5,934	
Diurnal Peak			364	0.04		8,925	
Effluent TSS		mg/L			mg/L		
Average			15	1.00		15	
Diurnal Peak			20	1.00		20	
Solids Loading Rate		kg/m2-day		4.88	lb/day-sq.ft.		
Average			N/A	4.88		N/A	
Diurnal Peak			N/A	4.88		N/A	
Underflow Concentration		mg/L			mg/L		
Average			6,000	1.00		6,000	
Diurnal Peak			6,000	1.00		6,000	
Flow Splitter: TF_Eff							
Splitter Influent Flow		m3/day	89,852	3,785	MGD	23.74	
Flow Splits							
TF_Eff Splitter Effluent (SplitE) GMFMain		%	17%		%	17%	
TF_Eff Splitter Effluent (SplitE) WetlandWetland		%	83%		%	83%	83%
		%	0%		%	0%	
		%	0%		%	0%	
		%	0%		%	0%	
		%	0%		%	0%	
		%	0%		%	0%	
		%	0%		%	0%	
		%	0%		%	0%	
Filters: Main							
Filters?	Yes		TRUE				
Total Area		m2	357	0.09	ft2	3,840	four units (30-ft by 32-ft, each)
Hydraulic Loading Rate		m/day		0.04	gpm/ft2		
Average			28	58.67		0.48	
Diurnal Peak			50	58.67		0.84	filters designed for peak rate of 5.
Solids Loading Rate		kg/m2-day			lb/day-sq.ft.		
Average			2.42	0.04		0.10	
Diurnal Peak			6.75	0.04		0.28	
Filter Run Time		hr	48	1.00	hr	48	high solids loading from TF will re
Instantaneous Backwash Rate		m/hr	86	2.44	gpm/ft2	35	max rate is 35 gpm/ft2, based on
Duration of Backwash Flow		minutes	20	1.00	minutes	20	assumed, no data
Backwash Operating Time (%cycle)		%	0.69%	1.00	%	0.69%	
Backwash Flow Rate		m3/day	5,087	3,785.00	MGD	1.34	
Ratio of Backwash Production to Filter Influent		%	33.6%	1.00	%	33.6%	
TSS Removal Efficiency at Average Conditions			90%	1.00		90%	assumed, no data
TSS Removal Efficiency at Diurnal Peak Conditions			85%	1.00		85%	assumed, no data
Effluent TSS at Average Conditions		mg/L	8.6	1.00	mg/L	8.6	
Effluent TSS at Peak Conditions		mg/L	20.4	1.00	mg/L	20.4	
Chemical Compound Applied to Filter Influent	No	FALSE	2				polymer is currently added when
Chemical Formula			FeCl3	1.00		FeCl3	
Chemical Dosage (mg chemical/L treated)		mg/L	10	1.00	mg/L	10	
Chemical Dosage (as chemical)		kg/day	151.42	0.45	lb/day	333.82	
Molar Ratio of Metal to Phosphate			1.45	1.00		1.45	
Percent of Soluble P that is ortho-P			*100%*	1.00		*100%*	
Effective TSS Removal with Chemical Addition - Average Conditions(%)			90%	1.00		90%	
Effective TSS Removal with Chemical Addition - Peak Conditions(%)			85%	1.00		85%	
Backwash Concentration		mg/L	153	1.00	mg/L	153	
Wetlands Node: Wetland							
Is the Wetlands Node in Service?	Yes		TRUE				
Area		ha	159.81	2.4700	acres	394.7	initial pond sizing based on 4 acre
Temperature		oC	15		oC	15	assumed 5 dec C drop compared
Representative Number of Tanks-in-Series		#	5		#	5	assumed
Rate Constants (at 20 C):							parameters are in the bull park bu
BOD		m/yr	34		m/yr	34	default
TSS		m/yr	1,000		m/yr	1,000	default
Organic N		m/yr	17		m/yr	17	default
NH3		m/yr	18		m/yr	18	default
NO3		m/yr	35		m/yr	35	default
TP		m/yr	12		m/yr	12	default
Fraction of Influent Ammonia that can be Nitrified in Wetland		%	1		%	1	confirm. default 1%
% of Nitrogen Removed by Settling		%	0.477041186		%	0.477041186	default
Biodegradeable Fraction of TSS		%	0.5		%	0.5	default
VSS Fraction of TSS		%	0.9		%	0.9	default
ADM Digester Model Meso							
Anaerobic Treatment Type	Digester		TRUE				
Is this Unit Process in Service?	Yes		TRUE				
Total Digester Volume		m3	10,220	3,785.00	MG	2.70	3-55 ft and 1-70 ft digesters, 33-ft
Percent of Volume that is Active		%	0.8	1.00	%	0.8	assumes one small digester
Total HRT		days	19	1.00	days	19	
Total SRT		days	19	1.00	days	19	
Digester Elevation		meters	3	3.28	feet	10	
Digester Digester Feed pH			7.00			7.00	
Volatile Solids Loading - wt VSS/vol-day		kg/m3-day	2.07	16.06	lb/ft3-day	0.13	
Volatile Solids Reduction		%	58%	1.00	%	58%	
Recuperative Thickening Hours/Day of Operation			8	1.00		8	
Recuperative Thickening Days/Week of Operation			7	1.00		7	
Percent P Released that is Precipitated as Struvite		%	0%	1.00	%	0%	
Methane Production		m3/day	5,531	0.03	ft3/day	195,429	
Digester Gas Methane Content		%	55%	1.00	%	55%	
Digester Gas Production		m3/day	10,120	0.03	ft3/day	357,588	
Digester Gas Production (vol/wt volatile solids destroyed)		m3/kg	1.03	0.06	ft3/lb	17	
Dewatering: BFP							
Dewatering?	Yes		TRUE				
Solids Capture		%	85%	1.00	%	85%	
Dewatered Sludge Concentration		%	45%	1.00	%	45%	
Belt Wash Water Flow Rate		m3/hr	0	0.23	gpm	0	
Hours/Day of Operation			5	1.00		5	
Days/Week of Operation			5	1.00		5	

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SIZING INFORMATION Process Components		Schematic Design	Design Development			Schematic Design	Design Development	Design Notes
	(Metric)	(Metric)	(Metric)	(Metric=US*k)	(US)	(US)	(US)	
Power Summary								
Average Power	kW		695	1.34	hp			
Peak Power	kW		1,886	1.34	hp		2,529	
Biosolids Disposal								
Summary								
Total Biosolids to Disposal	kg/day	12,970	12,970	0.45	lbs/day	28,595	28,595	
	m3/day	29	29	264.17	gal/day	7,614	7,614	
Biosolids TSS Percent Solids	%	45	45	1.00	%	45	45	
Observed Overall Solids Yield (Biosolids/Infl BOD5)	kg/kg	0.85	0.85	1.00	lb/lb	0.85	0.85	
Chemical Use Summary (Design mass rate as chemical)								
Metal Salt (Ferric Chloride)	kg/d		4,514	0.45	lbs/day		9,953	
Sodium Hypochlorite (liquid)	kg/d		509	0.45	lbs/day		1,121	
Sodium Hypochlorite (On-Site Generation)	kg/d		0	0.45	lbs/day		0	
Sodium Metabisulfite	kg/d		254	0.45	lbs/day		561	
Polymer	kg/d			0.45	lbs/day		0	
Lime	kg/d			0.45	lbs/day		0	
Caustic (NaOH)	kg/d			0.45	lbs/day		0	
Methanol	kg/d			0.45	lbs/day		0	
Raw Sewage								
Influent Pumping Included? Yes								
Influent Flow Rates								
Average	m3/day	84,794	84,794	3,785.00	MGD	22	22	
Peak Diurnal	m3/day	127,191	127,191	3,785.00	MGD	34	34	
Influent Pump Capacity								
Hours of Operation			24	1.00			24	
Safety Factor on Peak Diurnal			1.50	1.00			1.50	
Number of Duty Units			4	1.00			4	
Capacity Per Unit	m3/hr		1,987	0.23	gpm		8,750	SIP, 4-10,000 gpm +
Number of Standby Units			1	1.00			1	
Total Number of Units			5	1.00			5	
Influent Pump Sizing								
Capacity Per Unit	m3/hr		1,987		gal/min		8,750	
Total Dynamic Head	m		12	3.28	ft		40	no data, estimate
Pump Efficiency			30%	1.00			30%	
RS Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		219.9	1.34	HP		295.1	SIP, 4-100 hp + 1-50
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		244.4		HP		327.9	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			1.00	1.00			1.00	
CPES Life Cycle Average Capacity Per Unit	m3/hr		883	4.40	gal/min		3,889	
CPES Life Cycle Average Power to Motor Per Unit	kW		108.6		HP		145.7	
Influent Pump Station Power								
Average Power	kW		434	1.34	hp		583	
Peak Power	kW		978	1.34	hp		1,311	
Screening								
Screening Included? Yes								
Sizing Information								
Safety Factor on Peak Diurnal		1.00	1.00	1.00		1.00	1.00	
Number of Duty Units		2	2	1.00		2	2	
Number of Standby Units		1	1	1.00		1	1	
Total Number of Units		3	3	1.00		3	3	
Capacity Per Unit	m3/day	63,595	63,595		MGD	16.80	16.80	SIP used 3-17 mgd ea
	m3/s	0.74	0.74		cfs	25.99	25.99	assume by-pass chan
Design Maximum Approach Velocity	m/s	0.91	0.91	0.30	ft/s	3.00	3.00	
Design Depth to Width Ratio		0.80	0.80			0.80	0.80	
Screen Width	m	1.00	1.00	0.30	ft	3.29	3.29	
Approach Velocity at Average	m/s	0.61	0.61		ft/s	2.00	2.00	
Screen Type Mechanical Bar Screen								
Bar Opening	mm		10	25.40	inches		0.375	original value 1/4 in up
Power Input to Motor per Unit	kW		2.2	1.34	HP		3.0	
Motor Type Constant Speed								
Minimum Turndown Capacity			40%	1.00			40%	
Operating Information								
Average Screenings Production Rate	m3/1000 m3	0.08	0.08	0.01	ft3/MG	10	10	SIP used 1.4 cu.ft/mg
Average Screenings Production	m3/d	6.53	6.53		ft3/d	231	231	
	kg/day	6,280	6,280	0.45	lbs/day	13,845	13,845	
Peak Screenings Production Rate	m3/1000 m3	0.16	0.16	0.01	ft3/MG	21	21	
Peak Screenings Production	m3/d	20.1	20.1		ft3/d	709	709	
	kg/day	19,297	19,297	0.45	lbs/day	42,543	42,543	
Washer Compactor Included YES								
Washer Compactor Sizing Information								
Number of Duty Units		2	2	1.00		2	2	
Number of Standby Units		1	1	1.00		1	1	
Peak Screening Throughput per Unit	m3/hr	0.42	0.42		ft3/hr	14.8	14.8	SIP used 4 cu.ft/hr - C
Power Input to Motor per Unit	kW		2.2	1.34	HP		3.0	
Motor Type Constant Speed								
Minimum Turndown Capacity			40%	1.00			40%	
Screening Power								
Average Power Factor			0.75				0.75	
Average Power	kW		6.7	1.34	hp		9.0	
Peak Power	kW		8.9	1.34	hp		12.0	
Grit Removal								
Grit Removal Included? Yes								
Grit Removal System Type Vortex								
Sizing Information								
Safety Factor on Peak Diurnal		1.30	1.50	1.00		1.30	1.50	
Number of Duty Units		2	3	1.00		2	3	
Number of Standby Units		0	1	1.00		0	1	
Total Number of Units		2	4	1.00		2	4	
Capacity Per Unit	m3/day	82,674	63,595	3,785.00	MGD	21.84	16.80	
Operating Information								
Average Grit Production Rate	m3/1000m3	0.019	0.019	133.70	ft3/MG	2.6	2.6	SIP, 2.6 cu.ft per MGD
Average Grit Production	m3/d	1.65	1.65	0.03	ft3/d	58.2	58.2	
	kg/day	2,641	2,641	0.45	lbs/day	5,825	5,825	
Peak Grit Production Rate	m3/1000m3	0.049	0.049	133.70	ft3/MG	7	7	
Peak Grit Production	m3/d	4.0	3.1		ft3/d	142	109	
	kg/day	6,438	4,952		lbs/day	14,198	10,921	
Grit Pump Sizing								
Number of Duty Units			2	1.00			2	SIP, 3-125 gpm
Number of Standby Units			1	1.00			1	
Total Number of Units			3	1.00			3	
Capacity Per Unit	m3/hr		45	0.23	gal/min		200	
Total Dynamic Head	m		18.3	3.28	ft		60	no data, estimate
Pump Efficiency			20%	1.00			20%	
RS Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		11.3	1.34	HP		15.2	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		12.6		HP		16.9	SIP, 3-20 hp pumps
Motor Type Constant Speed								
Minimum Turndown Capacity			40%	1.00			40%	
Grit Removal Power								
Average Power Factor			0.75				0.75	
Average Power	kW		18.9	1.34	hp		25.3	
Peak Power	kW		25.1	1.34	hp		33.7	
Disinfection								
Sizing Information								
Effluent Flow Rates								

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Average	m3/day	84,765	84,765	3,785.00	MGD	22.39	22.39	
Peak Diurnal	m3/day	130,047	130,047	3,785.00	MGD	34.36	34.3586386	
On-Site Sodium Hypochlorite NO								
Sizing Information								
Percent Active Sodium Hypochlorite Generated	%	0.80%	0.80%	1.00	%	0.80%	0.80%	
Generated Sodium Hypochlorite Specific Gravity		1.00	1.00	1.00		1.00	1.00	
Active Chemical Form for Design Basis		Cl_2	Cl_2	1.00		Cl_2	Cl_2	
Active Chemical Concentration, lb/gallon	kg/m3	0.0670	0.0670	1.00	lb/gal	0.0674	0.0674	
Design Chemical Dose	mg/L	6	6	1.00	mg/L	6	6	
CPES Chemical Dose	mg/L	0	0	1.00	mg/L	0	0	
Design Chemical Feed Rate	kg/d	508.59	0.00	0.45	lbs/day	1,121.26	0.00	
Liquid Sodium Hypochlorite D YES								for recycle and discha
Percent Active Chemical	%	12.50%	12.50%		%	12.50%	12.50%	
Bulk Chemical Specific Gravity		1.21	1.21			1.21	1.21	
Active Chemical Form for Dosage Basis		Cl_2	Cl_2			Cl_2	Cl_2	
Active Chemical Concentration	kg/m3	151.16	151.16	119.83	lb/gal	1.26	1.26	
Design Chemical Dose	mg/L	6	6	1.00	mg/L	6	6	no data, estimate
CPES Chemical Dose	mg/L	6	6	1.00	mg/L	6	6	
Design Chemical Feed Rate	kg/d	508.59	508.59	0.45	lbs/day	1,121.26	1,121.26	
Chlorine Gas Disinfection NO								
Sizing Information								
Maximum Temperature of Effluent to be Disinfected	deg-C	20	20	Special	deg-F	68	68	
Maximum pH of Effluent to be Disinfected		7.00	7.00	1.00		7.00	7.00	
Desired Chorine Storage	days	7.00	7.00	1.00		7.00	7.00	
Initial Chlorine Dose	mg/L	10	10	1.00		10	10	
CPES Initial Chlorine Dose	mg/L	0	0	1.00	mg/L	0	0	
Residual Chlorine Dose	mg/L	2	2	1.00	mg/L	2	2	
CPES Residual Chlorine Dose	mg/L	0	0	1.00	mg/L	0	0	
Disinfection Contactor Design Hydraulic Retention Time	min	30.00	30.00	1.00	min	30	30	
Liquid Sodium Bisulfite YES								
Percent Active Chemical	%	38.00%	38.00%		%	38.00%	38.00%	
Bulk Chemical Specific Gravity		1.34	1.34			1.34	1.34	
Active Chemical Form for Dosage Basis		SO_2	SO_2			SO_2	SO_2	
Active Chemical Concentration	kg/m3	508.89	508.89	119.83	lb/gal	4.25	4.25	
Design Chemical Dose	mg/L	3	3	1.00	mg/L	3	3	
CPES Chemical Dose	mg/L	3	3	1.00	mg/L	3	3	
Design Chemical Feed Rate	kg/d	254.30	254.30	0.45	lbs/day	560.63	560.63	
UV Disinfection NO								
Sizing Information								
System Type Closed Vessel								
Design Value of UV Transmittance	%/cm	65%	65%	1.00		65%	65%	
Design Value of UV Absorbance	1/cm	5.00	5.00	1.00		5.00	5.00	
Lamp rating	kW/lamp	0.40	0.40		kW/lamp	0.40	0.40	
Total lamps	lamps	288	288	1.00	lamps	288	288	
Total connected load	kW	115	115		kW	115	115	
Design average flow	m3/day	84,794	84,794		MGD	22.40	22.40	
Design peak flow	m3/day	127,191	127,191		MGD	33.60	33.60	
% of lamps on at average flow	%	67%	67%		%	67%	67%	
Avg. power use	kW	77	77		kW	77	77	
Dosage	mJ/cm2	40	40	1.00	mJ/cm2	40	40	
CPES UV Dose	mg/L	0	0	1.00	mg/L	0	0	
Primary Clarifiers: Main								
Sizing Information								
Total Area	m2	1,942	1,942	0.09	ft2	20,900	20,900	SIP, 5 105 by 20-ft (10
Side Water Depth	m	N/A	5.5	0.30	ft	N/A	18	SIP, 10-ft SWD
Number of duty units		N/A	10	1.00		N/A	10	
Number of Standby units			0	1.00		N/A	0	
Total number of units			10	1.00		N/A	10	
Area per Clarifier	m2		194	0.09	ft2	0	2,090	
Clarifier Configuration Rectangular								
Clarifier Width	m		6.1	0.30	ft	N/A	20	
Clarifier Length	m		31.9		ft	N/A	105	
Clarifier Sludge Collector								
Duty Unit Connected Power, ea	kW		1.5	1.34	hp		2.0	no data, assumed
Average Power Usage Factor			0.75	1.00			0.75	
Average Power Input to Motor per Unit	kW		1.1	1.34	hp		1.5	
Peak Power Usage Factor			0.90	1.00			0.90	
Peak Power Input to Motor per Unit	kW		1.3	1.34	hp		1.8	
Primary Clarification Power								
Average Power	kW		15.7	1.34	hp		21.1	
Peak Power	kW		21.4	1.34	hp		28.7	
Operating Information								
Flow								
Average Design Flow	m3/day	90,289	90,289	3,785.00	MGD	23.85		
Peak Diurnal Design Flow	m3/day	135,676	135,676	3,785.00	MGD	35.85		
Hydraulic Loading Rate								
Average Design Flow	m/day	46	47		gpd/ft2	1,136	1,141	
Peak Diurnal Design Flow	m/day	70	70		gpd/ft2	1,708	1,715	
Chemical Addition System								
Chemical Added		Ferric Chlorid	Ferric Chloride			Ferric Chloride	Ferric Chloride	
Dosage	mg/L	50	50		mg/L	50	50	
CPES Alum Dose	mg/L		0		mg/L		0	
CPES Ferric Chloride Dose	mg/L		50		mg/L		50	
Average Feed Rate	kg/d	4,514	4,514	0.45	lbs/d	9,953	9,953	
	m3/d	8.1	8.1	264.17	gpd	2,130	2,130	
Peak Diurnal Feed Rate	kg/d	6,784	6,784	0.45	lbs/d	14,956	14,956	
	m3/d	12.1	12.1	264.17	gpd	3,200	3,200	
Storage Tank Information								
Storage Time at Average	days		30				30	
Safety Factor on Average Flow			2				1.5	
Number of Tanks			2				2.0	
Minimum Capacity of Tank	m3		181.4		gallons		47,916	
Pump Information								
Safety Factor on Peak Diurnal			1.50				1.50	
Number of Duty Units			2				2	
Number of Standby Units			1				1	
Total Number of Units			3				3	
Capacity per Unit	lph		378.6	3.79	gph		100.0	
Minimum Turndown Capacity	%		20%				20%	
Polymer Addition? No								
Average Dosage	mg/L		1			mg/L	1	
Average Usage	kg/d		90.3	0.45		lbs/d	199.1	
Peak Dosage	mg/L		2			mg/L	2	
Peak Usage	kg/d		271.4	0.45		lbs/d	598.2	
Primary Dilution Polymer Concentration	wt%		0.10%	1.00		wt%	0.10%	
Primary Dilution Water	m3/d		90.2	264.17		gpd	23,828	
Secondary Dilution Polymer Concentration	wt%		0.05%	1.00		wt%	0.05%	
Secondary Dilution Water	m3/d		90.3	264.17		gpd	23,852	
Sludge Pumping								
Primary Sludge Flow								
Average Design Flow	m3/day	436.5	436.5	0.00	GPD	115,332	115,332	
Solids Concentration	mg/L	60,000	60,000	1.00	mg/L	60,000	60,000	
Peak Diurnal Design Flow	m3/day	541.4	541.4	0.00	GPD	143,037	143,037	
Solids Concentration	mg/L	60,000	60,000	1.00	mg/L	60,000	60,000	
Primary Sludge Pump Capacity								
Hours of Operation			8	1.00			8	
Safety Factor on Peak Diurnal			1.50	1.00			1.50	
Number of Duty Units			5	1.00			5	
Capacity Per Unit	m3/hr		20.3	0.00	gal/hr		5,364	
Number of Standby Units			2	1.00			2	
Total Number of Units			7	1.00			7	
Primary Sludge Pump Sizing								
Capacity Per Unit	m3/hr		20.3		gal/min		89	SIP, 8-150 gpm pump
Total Dynamic Head	m		22.9	3.28	ft		75	
Pump Efficiency			30%				30%	
PSD Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	

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Break Horsepower per Unit	kW		4.2		HP		5.7	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		4.7		HP		6.3	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			1.00	1.00			1.00	
CPES Life Cycle Average Capacity Per Unit	m3/hr		3.6	4.40	gal/min		16	
CPES Life Cycle Average Power to Motor Per Unit	kW		0.8		HP		1.1	
Primary Scum Pump Sizing								
Raw Sewage Primary Scum Concentration	mg/L	25	25	1.00		25	25	
Primary Scum Load	kg/d	2,257	2,257	0.45	lbs/d	4,976	4,976	
Primary Scum TS Concentration	mg/L	50,000	50,000	1.00	mg/L	50,000	50,000	
Primary Scum Volume	m3/d	45.1	45.1	0.00	GPD	11,927	11,927	
Pumping Frequency per Day	times/day		2	1.00	times/day		2	
Pumping Drawdown Time	min		10	1.00	min		10	
Pumping Capcity Required	m3/hr		135.4	4.40	gal/min		596	
Total Number of Units			3	1.00			3	SIP, 8-150 hp pumps
Capacity Per Unit	m3/hr		45.1	4.40	gal/min		199	
Total Dynamic Head	m		15	3.28	ft		50	
Pump Efficiency			60%				60%	
PSM Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		3.1	1.34	HP		4.2	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		3.5		HP		4.7	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		1.4	4.40	gal/min		6	
CPES Life Cycle Average Power to Motor Per Unit	kW		0.1		HP		0.1	
Trickling Filter: FGR								
Sizing Information								
Total Area	m2	2,470	618	0.09	ft2	26,590	6,648	
Depth	m	5.79	5.79	0.30	ft	19.0	19.0	
Volume	m3	14,306	3,576	0.03	ft3	505,200	126,304	
Number of duty units		N/A	1	1.00		N/A	1	
Number of Standby units			0	1.00			0	
Total number of units			1	1.00			1	
Area per unit	m2		618	0.09	ft2		6,648	
Unit Diameter	m		28.0	0.30	ft		92	
Trickling Filter Power								
Average Power	kW			1.34	hp			
Peak Power	kW		591.8	1.34	hp		793.7	
Operating Information								
Average Conditions								
Wetting Hydraulic Load (WHL)	m/d	72.8	291.0	58.67	gpm/ft2	1.2	5.0	
Total Organic Load (TOL)	kg/m3/d	0.4	1.6	0.02	lb/1,000 ft3/d	26	102	
Peak Conditions								
Wetting Hydraulic Load (WHL)	m/d	91	364	58.67	gpm/ft2	1.6	6.2	
Total Organic Load (TOL)	kg/m3/d	0.9	3.5	0.02	lb/1,000 ft3/d	55	219	
Recirculation Pumping								
Recirculation Flow								
Average Design Flow	m3/day	89,842		3,785.00	MGD	23.7		this is Q TF + Recirc
Peak Diurnal Design Flow	m3/day	89,842		3,785.00	MGD	23.7		
Recirculation Pump Capacity								
Safety Factor on Peak Diurnal			2.00	1.00			2.00	
Number of Duty Units			4	1.00			4	SIP, 6-16 mgd pumps
Capacity Per Unit	m3/hr		1,871.7	264.17	gal/hr		494,453	
Number of Standby Units			1	1.00			1	
Total Number of Units			5	1.00			5	
Recirculation Pump Sizing								
Capacity Per Unit	m3/hr		1,871.7		gal/min		8,241	
Total Dynamic Head	m		18.3	3.28	ft		60	assumed
Pump Efficiency			70%				70%	
PSD Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		133.2	1.34	HP		178.7	SIP, 6-175 hp pumps
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		148.0		HP		198.5	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
Flow Splitter: TF_Eff								
Operating Information								
Splitter Influent Flow	m3/day	89,852	89,852	3,785	23.74	23.74		
TF_Eff Splitter Effluent (SplitE) GMFMain								
Percent Split		17%	0.168518198			17%		
Flow	m3/day	15,142	15,142	3,785	4.00	4.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.1396	3.2808		0.46		
TF_Eff Splitter Effluent (SplitE) WetlandWetland								
Percent Split		83%	0.831481802			83%		
Flow	m3/day	74,711	0	3,785	19.74	19.74		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.4045	3.2808		1.33		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Filters: Main								
Filter Type Granular Media								
Sizing Information								
Total Area	m2	357	0	0.09	ft2	3,840	0	
Bed Depth	m	N/A	1.22	0.03	inches	N/A	48	anthracite
Number of duty units		N/A	4	1.00		N/A	4	
Number of Standby units			0	1.00		N/A	0	
Total number of units			4.00	1.00		N/A	4	
Area per Filter	m2		0.00	0.09	ft2	0	0	
Filter Bed Width	m		9.14	0.30	ft	N/A	30.00	
Filter Bed Length	m		0.00		ft	N/A	0.00	
Operating Information								

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Flow Rates								
Average Design Flow	m3/day	15,142	15,142	3,785.00	MGD	4.0	4.0	
Peak Diurnal Design Flow	m3/day	22,773	22,773	3,785.00	MGD	6.0	6.0	
Influent TSS								
Average	mg/L	57	57		mg/L	57	57	
Peak	mg/L	106	106		mg/L	106	106	
Hydraulic Load								
Average Design Load	m/day	28	#DIV/0!	58.67	gpd/ft2	0.5	0.0	
Peak Diurnal Design Laod	m/day	50	#DIV/0!	58.67	gpd/ft2	0.8	0.0	designed for 5.8 gal/s
Unit Process Power Usage								
Average Power	kW		24.44	1.34	hp		32.77	
Peak Power	kW		0.00	1.34	hp		0.00	
Chemical Addition System								
Chemical Added		FeCl3				FeCl3		
Dosage	mg/L	0	0		mg/L	0	0	
CPES Alum Dose	mg/L		0		mg/L		0	
CPES Ferric Chloride Dose	mg/L		0		mg/L		0	
Average Feed Rate	kg/d	0	0	0.45	lbs/d	0	0	
	m3/d	0.0	0.0	264.17	gpd	0	0	
Peak Diurnal Feed Rate	kg/d	0	0	0.45	lbs/d	0	0	
	m3/d	0.0	0.0	264.17	gpd	0	0	
Storage Tank Information								
Storage Time at Average	days		30				30	
Safety Factor on Average Flow			1.50				1.50	
Number of Tanks			2				2	
Minimum Capacity of Tank	m3		0		gallons		0	
Pump Inormation								
Safety Factor on Peak Diurnal			1.50				1.50	
Number of Duty Units			2				2	
Number of Standby Units			1				1	
Total Number of Units			3				3	
Capacity per Unit	lph		0.00	3.79	gph		0.00	
Minimum Turndown Capacity	%		20%				20%	
Backwash Pumping								
Backwash Water								
Instantaneous Design Flow	m3/hr	0		0.23	gpm	0		
Solids Concentration	mg/L	153		1.00	mg/L	153		
Average Daily Design Flow	m3/day	5,087		0.00	GPD	1,344,080		
Backwash Pump Capacity								
Daily Operation Time	min		#DIV/0!	1.00	min		#DIV/0!	
Safety Factor on Peak Diurnal			1.00	1.00			1.00	
Number of Duty Units			2	1.00			2	
Capacity Per Unit	m3/hr		0	0.23	gpm		0	
Number of Standby Units			1	1.00			1	
Total Number of Units			3	1.00			3	
Backwash Pump Sizing								
Capacity Per Unit	m3/hr		0.0		gal/min		0.0	
Total Dynamic Head	m		15.24	3.28	ft		50.00	
Pump Efficiency			80%				80%	
Tertiary SD Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		0.00	1.34	HP		0.00	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		0.00		HP		0.00	
Motor Type **Constant Speed**								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Per Unit	m3/hr		212.0	4.40	gal/min		933	
CPES Life Cycle Average Power to Motor Per Unit	kW		12.2		HP		16.4	
Wetlands Node: Wetland								
Operating Information								
Flow								
Average Design Flow	m3/day	74,710.64		3785	MGD	19.74		
Peak Diurnal Design Flow	m3/day	112,362.12		3785	MGD	29.69		
Solids Load								
Average Design Load	kg/day	3,553.77		2.2046	lbs/day	1,611.96		
Peak Diurnal Design Load	kg/day	11,989.66		2.2046	lbs/day	5,438.39		
Wetland Parameters								
Area	ha	159.81		2.4700	acres	394.7		
Percent Open Water	%	40%			%	40%		
Marsh Area Depth	m	0.30		3.2808	feet	1.00		
Deep Area Depth	m	1.52		3.2808	feet	5.00		
Total Volume	m3	1,266,463		0.0003	MG	334.56		
Average Design Hydraulic Loading Rate	cm/d	4.68		2.5400	in/day	1.84		
Average Design Hydraulic Retention Time	days	16.95			days	16.95		
Number of wetland cells	#	1			#	1		
Anaerobic Treatment: Meso								
Sizing Information								
Total Digester Volume	m3	10,219.50	10,220	3,785.00	MG	2.70	0.00	
Straight Wall Sidewater Depth	m		10.06	0.30	ft	N/A	33.00	
Number of duty units			3	1.00		N/A	3	digesters are used
Volume per unit	m3		3,407	3,785.00	MG		0.90	
Diameter per unit	m		20.77	0.30	ft		68.13	
Anaerobic Treatment Power								
Average Power	kW		106.9	1.34	hp	143.4		
Peak Power	kW		106.9	1.34	hp	143.4		
Gas Mixing								
Feed Flow								
Average Design Flow	m3/day	437		0.00	GPD	115,332		
Solids Concentration	mg/L	60,000		1.00	mg/L	60,000		
Peak Diurnal Design Flow	m3/day	541		0.00	GPD	143,037		
Solids Concentration	mg/L	60,000		1.00	mg/L	60,000		
Operating Conditions								
Temperature	oC	35	35.00		oF	95	95.00	
Biogas Production	m3/day	10,120		0.03	ft3/day	357,335		
Digester Gas Mixing System								
Energy	W/m3		6.36	26.48	HP/1000ft3		0.24	
Unit Gas Flow	Nm3/hr per kW		45	2.27	cfm per Hp		20.00	
Safety Factor on Unit Flow Rate			1.00	1.00			1.00	
Number of Duty Units Per Digester			4	1.00			4	
Total Number of Duty Units			12	1.00			12	
Capacity Per Unit	m3/hr		245.21	1.70	cfm		144.31	
Total Number of Standby Units			4	1.00			4	
Biogas Compression For Mixing								
Mixing Gas Flow	Nm3/hr		2,943	1.70	Ncfm		1,732	
Number of Duty Units			3	1.00			3	
Capacity Per Unit	m3/hr		981	1.70	cfm		577	
Number of Standby Units			1	1.00			1	
Total Number of Units			4	1.00			4	
Minimum Turndown Capacity			25%	1.00			25%	
Biogas utilization/flaring capacity								
Peaking Factor on Average Biogas Production			1.50	1.00			1.50	
Utilization/Flaring Capacity	m3/hr		632.48	1.70	cfm		372.22	
Estimated Gas Heat Content					BTU/ft3	525	525	
Biogas Usage Fractions (Average for GHG Calcs)								
Boilers			60%				60%	
Cogeneration			0%				0%	
Drying			0%				0%	
Motors			0%				0%	
Fugitive Emissions, Blow Off Valve			1%				1%	
Fugitive Emissions, Floating Cover Leakage			2%				2%	
Flare			37%				37%	
Mechanical Pumping Mixing System								
Included in Project **Yes**								
Type of Pump **Screw Centrifugal**								
Mechanical Mixing Flow Required								
Number of Tank Turnovers per Day			8	1.00			8	
Digester Mixing Flowrate Required	m3/hr		3,407		gpm		15,000	

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Mixing Pump Capacity								
Number of Duty Units			3	1.00			3	
Capacity Per Unit	m3/hr		1,135.50	0.00	gpm		5,000	
Number of Standby Units			1	1.00			1	
Total Number of Units			4	1.00			4	
Mixing Pump Sizing								
Capacity Per Unit	m3/hr		1,135.50		gal/min		5,000	
Total Dynamic Head	m		6.09	3.28	ft		20	
Pump Efficiency			60%				60%	
Solids Concentration	%		3.50%		%		3.50%	
Specific Gravity of Solids			2.50				2.50	
Sludge Specific Gravity			1.02				1.02	
Sludge Specific Weight	kg/m3		1,021	16.02	lb/ft3		63.7	
Break Horsepower per Unit	kW		32.07	1.34	HP		43.04	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		35.64		HP		47.82	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			1.00	1.00			1.00	
CPES Life Cycle Average Capacity Per Unit	m3/hr		1,136	4.40	gal/min		5,000	
CPES Life Cycle Average Power to Motor Per Unit	kW		35.64		HP		47.81	
Unit Power Calculations								
Actual Operating Unit Power (Brake HP or kW/Digeste	kW/m3		0.01		HP/1000 cf		#DIV/0!	
Operating Information								
SRT	days		18.73		days		18.73	
VSS Loading	kg/m3-day		2.07	16.06	lb/ft3-day		0.13	
VSS Reduction	%		58%		%		58%	
Dewatering: BFP								
Sizing Information								
Dewatering Feed Rates								
Average Design Flow	m3/day	437		0.00	GPD	115,332		
Average Solids Concentration	mg/L	34,956		1.00	mg/L	34,956		
Average Solids Loading	kg/hr ds	636		0.45	lb/hr ds	1,402		
Peak Diurnal Design Flow	m3/day	3,638		0.00	GPD	961,209		
Peak Solids Concentration	mg/L	34,956		1.00	mg/L	34,956		
Peak Solids Loading	kg/hr ds	5,299		0.45	lb/hr ds	11,682		
Feed Sludge Type PSD Only								
Dewatering Equipment								
Type Belt Press								
Hours of Operation			5	1.00			5	
Days Per Week			5	1.00			5	
Safety Factor on Peak Diurnal			2	1.00			1.5	
BFP Dewatering Sizing								
Design (Maximum) Unit Loading								
Hydraulic Loading	m3/hr/m		6.8	4.40	gpm/m		30	
Solids Loading	kg/hr/m		227	0.45	lbs/hr/m		500	
Required Total Belt Width								
Hydraulic Loading Basis	meter		33.37		meter		33.37	
Solids Loading Basis	meter		35.05		meter		35.05	
Select Standard BFP Size	meters		3.00	1.00	meters		3.00	
Number of Duty Units			12	1.00			12	
Number of Standby Units			1	1.00			1	
Total Number of Units			13	1.00			13	
Capacity Per Unit	m3/hr		20	0.00	gpm		90	
	kg DS/hr		680	0.45	lbs DS/hr		1,500	
Belt Press Duty Unit Connected Power, ea	kW		1.5	1.34	hp		2.0	
Average Power Usage Factor			75%	1.00			75%	
Average Power Input to Motor per Unit	kW		1.1	1.34	hp		1.5	
Peak Power Usage Factor			90%	1.00			90%	
Peak Power Input to Motor per Unit	kW		1.3	1.34	hp		1.8	
Centrifuge Dewatering Sizing								
Number of Duty Units			1	1.00			1	
Number of Standby Units			1	1.00			1	
Total Number of Units			2	1.00			2	
Minimum Capacity Per Unit	m3/hr		227.4	0.00	gpm		1,001	
	kg DS/hr		7,948	0.45	lbs DS/hr		17,523	
Maximum Capacity of Unit	m3/hr		341	0.23	gpm		1,502	
	kg DS/hr		11,923	0.45	lbs DS/hr		26,285	
Hydraulic Loading	m3/hr		#N/A		gpm		#N/A	
Solids Loading	kg/hr		#N/A	0.45	lb/hr		#N/A	
Centrifuge Duty Unit Connected Power, ea	kW		15	1.34	hp		20	
Average Power Usage Factor			75%	1.00			75%	
Average Power Input to Motor per Unit	kW		11	1.34	hp		15	
Peak Power Usage Factor			90%	1.00			90%	
Peak Power Input to Motor per Unit	kW		13	1.34	hp		18	
Dewatering Performance								
Dewatered Solids Concentration			45%	1.00			45%	
Solids Capture Efficiency			85%	1.00			85%	
Dewatering Power								
Average Power	kW		11.4	1.34	hp		15.3	
Peak Power	kW		38.7	1.34	hp		51.9	
DEW Feed Sludge Pumping								
Included in Project Yes								
Type of Pump Progressing Cavity								
Feed Sludge Flow								
Average Design Flow	m3/day	437		0.00	GPD	115,332		
Solids Concentration	mg/L	34,956		1.00	mg/L	34,956		
Average Solids Loading	kg/hr ds	636		0.45	lb/hr ds	1,402		
Peak Diurnal Design Flow	m3/day	541		0.00	GPD	143,037		
Solids Concentration	mg/L	34,956		1.00	mg/L	34,956		
Peak Solids Loading	kg/hr ds	789		0.45	lb/hr ds	1,738		
Feed Sludge Pump Capacity								
Hours of Operation			5	1.00			5	
Days per Week			5	1.00			5	
Safety Factor on Peak Diurnal			1.50	1.00			1.50	
Number of Duty Units			12	1.00			12	
Capacity Per Unit	m3/hr		20	0.00	gph		5,401	
Number of Standby Units			1	1.00			1	
Total Number of Units			13	1.00			13	
Feed Sludge Pump Sizing								
Capacity Per Unit	m3/hr		20		gal/min		90	
Total Dynamic Head	m		61	3.28	ft		200	
Pump Efficiency			30%				30%	
Solids Concentration	%		3%		%		3%	
Specific Gravity of Solids			1.50				1.50	
Sludge Specific Gravity			1.01				1.01	
Sludge Specific Weight	kg/m3		1,011	16.02	lb/ft3		63.14	
Break Horsepower per Unit	kW		11.4	1.34	HP		15.3	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		12.7		HP		17.1	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		1.14	4.40	gal/min		5.01	
CPES Life Cycle Average Power to Motor Per Unit	kW		0.71		HP		0.95	
Dewatered Sludge Pumping								
Included in Project No								
Type of Pump Hopper Type Progressing Cavity								
Dewatered Sludge Flow								
Average Design Flow	m3/day	29		0.00	GPD	7,615		
Solids Concentration	mg/L	450,000		1.00		450,000		
Average Solids Loading	kg/day ds	12,970		0.45	lb/day ds	28,595		
Peak Diurnal Design Flow	m3/day	389		0.00	GPD	102,697		
Solids Concentration	mg/L	450,000		1.00		450,000		
Peak Solids Loading	kg/day ds	174,919		0.45	lb/day ds	385,633		
Dewatered Sludge Pump Capacity								
Hours of Operation			5	1.00			5	

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Days per Week			5	1.00			5	
Safety Factor on Peak Diurnal			1	1.00			1	
Number of Duty Units			12	1.00			12	
Capacity Per Unit	m3/hr		9.1	0.00	gph		2,396	
Number of Standby Units			1	1.00			1	
Total Number of Units			13	1.00			13	
Dewatered Sludge Pump Sizing								
Capacity Per Unit	m3/hr		9.1		gal/min		40	
Total Dynamic Head	m		61	3.28	ft		200	
Pump Efficiency			30%				30%	
Solids Concentration	%		45%		%		45%	
Specific Gravity of Solids			1.50				1.50	
Sludge Specific Gravity			1.18				1.18	
Sludge Specific Weight	kg/m3		1,176	16.02	lb/ft3		73	
Break Horsepower per Unit	kW		5.9	1.34	HP		7.9	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		6.6		HP		8.8	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		0.1	4.40	gal/min		0	
CPES Life Cycle Average Power to Motor Per Unit	kW		0.1		HP		0.1	
Dewatered Sludge Conveyance								
Included in Project Yes								
Type of Conveyor Screw								
Sludge Flow								
Average Design Flow	m3/day	29		0.00	GPD	7,615		
Solids Concentration	%	45%		1.00	%	45%		
Peak Diurnal Design Flow	m3/day	2,612		0.00	GPD	690,127		
Solids Concentration	%	45%		1.00	%	45%		
Conveyor Sizing								
Hours of Operation			24	1.00			24	
Days per Week			7	1.00			7	
Safety Factor on Peak Diurnal			1.10	1.00			1.10	
Number of Duty Units - Flat			1	1.00			1	
Number of Duty Units - Inclined			1	1.00			1	
Inclined Conveyor Angle	degree		22	1.00	degree		22	
Break Horsepower per Flat Unit	kW		3.7	1.34	HP		5.0	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Flat Unit	kW		4.1	1.34	HP		5.6	
Break Horsepower per Inclined Unit	kW		3.7	1.34	HP		5.0	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Inclined Unit	kW		4.1		HP		5.6	
Motor Type Constant Speed								
Minimum Turndown Capacity			0%	1.00			0%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		1	4.40	gal/min		4	
CPES Life Cycle Average Power to Motor Per Flat Un	kW		0.0		HP		0.0	
CPES Life Cycle Average Power to Motor Per Inclined	kW		0.0		HP		0.0	
Filtrate Pumping								
Included in Project Yes								
Type of Pump Dry-pit Centrifugal								
Filtrate Flow								
Average Design Flow	m3/day	408		0.00	GPD	107,717		
Solids Concentration	mg/L	5,614		1.00	mg/L	5,614		
Average Solids Loading	kg/hr ds	95		0.45	lb/hr ds	3,394		
Peak Diurnal Design Flow	m3/day	1,540		0.00	GPD	406,748		
Solids Concentration	mg/L	5,614		1.00	mg/L	5,614		
Peak Solids Loading	kg/hr ds	360		0.45	lb/hr ds	794		
Filtrate Pump Capacity								
Hours of Operation			24	1.00			24	
Days per Week			7	1.00			7	
Safety Factor on Peak Diurnal			1.25	1.00			1.25	
Number of Duty Units			1	1.00			1	
Capacity Per Unit	m3/hr		80.2	0.00	gph		21,185	
Number of Standby Units			1	1.00			1	
Total Number of Units			2	1.00			2	
Filtrate Pump Sizing								
Capacity Per Unit	m3/hr		80.2		gal/min		353	
Total Dynamic Head	m		15.2	3.28	ft		50	
Pump Efficiency			70%				70%	
Solids Concentration	%		0		%		0	
Specific Gravity of Solids			2.50				2.50	
Sludge Specific Gravity			1.00				1.00	
Sludge Specific Weight	kg/m3		1,003	16.02	lb/ft3		62.61	
Break Horsepower per Unit	kW		4.8	1.34	HP		6.4	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		5.3		HP		7.1	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		12.7	4.40	gal/min		56	
CPES Life Cycle Average Power to Motor Per Unit	kW		0.8		HP		1.1	
Polymer System								
Polymer Addition? Yes								
Average Dosage	kg/tonne DS		3.0	0.50	lbs/ton DS		6.0	
Average Usage	kg/hr		1.9	0.45	lb/hr		4.2	
Peak Dosage	kg/tonne DS		5.0	0.50	lbs/ton DS		10.0	
Peak Usage	kg/hr		40.8	0.45	lb/hr		90.0	
Primary Dilution Polymer Concentration	wt%		0.10%	1.00	wt%		0.10%	
Average Primary Dilution Water	m3/d		45.7	264.17	gpd		12,081	
Secondary Dilution Polymer Concentration	wt%		0.05%	1.00	wt%		0.05%	
Average Secondary Dilution Water	m3/d		45.8	264.17	gpd		12,093	

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Mass Balance for Average Flow Conditions

Constituent	Raw Wastewater (RW)	Main Recycle Influent (Recyl)	Main Recycled Stream (Recycle)	Main Combined Recycle Effluent (RecyE)	Main Primary Influent (PI)	Main Primary Effluent (PE)	FGR Trickling Filter Influent (TFI)	FGR Trickling Filter Effluent (TFE)	TF_Eff Splitter Influent (SplitI)	TF_Eff Splitter Effluent (SplitE) GMFMain	TF_Eff Splitter Effluent (SplitE) WetlandWetland	Main Granular Media Filter Influent (GMFI)	Main Granular Media Filter Effluent (GMFE)	Wetland Wetland Influent (WI)	Wetland Wetland Effluent (WE)	Plant_Eff Combined Discharge	Plant Effluent (PLE)	Main Primary Sludge (PSD)	Sludge Combined Discharge	Meso Anaerobic Digester Influent (AnDI)	Meso Anaerobic Digester Effluent (AnDE)	BFP Dewatering Influent (DWI)	BFP Dewatered Sludge (DWE)	Biosolids to Disposal	Main Filter Backwash (BW)	BFP Dewatering Recycle (DWR)	Recy Combined Discharge
Flow (gallons/day)	22,400,000	22,400,000	1,451,628	23,851,628	23,851,628	23,736,309	23,736,309	23,736,309	23,736,309	4,000,000	19,736,309	4,000,000	2,656,077	19,736,309	19,736,309	22,392,386	22,392,386	115,319	115,319	115,319	115,319	115,319	7,614	7,614	1,343,923	107,705	1,451,628
Carbonaceous BOD_5 (lbs/day)	33,801	33,801	1,191	34,993	34,993	12,918	12,918	3,807	3,807	642	3,166	642	143	3,166	1,203	1,346	1,346	22,075	22,075	22,075	3,938	3,938	3,251	3,251	504	688	1,191
Particulate	20,504	20,504	581	21,084	21,084	3,912	3,912	39	39	7	33	7	1	33	543	544	544	21,650	21,650	21,650	3,815	3,815	3,242	3,242	8	572	581
Heterotrophs	1	1	449	450	450	69	69	2,862	2,862	482	2,380	482	50	2,380	0	50	50	381	381	381	0	0	0	0	449	0	449
PAOs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filtrate	13,296	13,296	162	13,458	13,458	8,937	8,937	906	906	153	753	153	92	753	660	752	752	43	43	43	124	124	8	8	47	115	162
COD (lbs/day)	74,940	74,940	5,059	79,998	79,998	28,170	28,170	15,046	15,046	2,535	12,510	2,535	656	12,510	3,305	3,961	3,961	51,828	51,828	51,828	19,331	19,331	16,151	16,151	1,879	3,179	5,059
Particulate Bio	36,863	36,863	856	37,719	37,719	7,004	7,004	70	70	12	58	12	1	58	976	978	978	38,765	38,765	38,765	5,635	5,635	4,790	4,790	11	845	856
Particulate Non-Bio	6,876	6,876	2,054	8,930	8,930	1,560	1,560	1,560	1,560	263	1,297	263	26	1,297	976	1,003	1,003	8,632	8,632	8,632	12,116	12,116	10,298	10,298	237	1,817	2,054
Decay Prod Aer/Anx	3,546	3,546	377	3,924	3,924	600	600	2,487	2,487	419	2,068	419	42	2,068	0	42	42	3,323	3,323	3,323	0	0	0	0	377	0	377
Decay Prod Anaerobic	0	0	188	188	188	29	29	29	29	5	24	5	0	24	0	0	0	159	159	159	1,223	1,223	1,039	1,039	4	183	188
Heterotrophs	2	2	810	812	812	124	124	5,341	5,341	900	4,441	900	90	4,441	0	90	90	688	688	688	0	0	0	0	810	0	810
Autotrophs	0	0	201	201	201	31	31	1,322	1,322	223	1,099	223	22	1,099	0	22	22	170	170	170	0	0	0	0	201	0	201
PAOs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soluble Bio	11,474	11,474	82	11,556	11,556	11,501	11,501	1,166	1,166	196	969	196	130	969	569	700	700	56	56	56	17	17	1	1	66	16	82
VFA	2,869	2,869	110	2,978	2,978	2,964	2,964	300	300	51	250	51	34	250	142	176	176	14	14	14	99	99	7	7	17	93	110
Colloidal Bio	9,562	9,562	99	9,661	9,661	1,602	1,602	16	16	3	13	3	2	13	475	476	476	8	8	8	105	105	7	7	1	98	99
Soluble Non-Bio	2,248	2,248	268	2,516	2,516	2,504	2,504	2,504	2,504	422	2,082	422	280	2,082	99	379	379	12	12	12	135	135	9	9	142	126	268
Colloidal Non-Bio	1,499	1,499	14	1,513	1,513	251	251	251	251	42	209	42	28	209	66	94	94	1	1	1	0	0	0	0	14	0	14
TSS (lbs/day)	44,402	44,402	6,761	51,162	51,162	10,232	10,232	11,391	11,391	1,920	9,472	1,920	190	9,472	1,528	1,719	1,719	57,744	57,744	57,744	33,641	33,641	28,595	28,595	1,714	5,046	6,761
Biodegradable	27,750	27,750	645	28,395	28,395	5,273	5,273	55	55	9	46	9	1	46	764	765	765	29,182	29,182	29,182	4,242	4,242	3,606	3,606	8	636	645
Non-Biodegradable	13,875	13,875	3,225	17,100	17,100	2,618	2,618	2,618	2,618	441	2,177	441	44	2,177	764	808	808	15,601	15,601	15,601	18,853	18,853	16,025	16,025	397	2,828	3,225
Decay Prod Aer/Anx	2,775	2,775	295	3,070	3,070	470	470	1,946	1,946	328	1,618	328	33	1,618	0	33	33	2,600	2,600	2,600	0	0	0	0	295	0	295
Decay Prod Anaerobic	0	0	147	147	147	22	22	22	22	4	19	4	0	19	0	0	0	124	124	124	957	957	813	813	3	144	147
Metal Hydroxide	0	0	601	601	601	598	598	598	598	101	497	101	12	497	0	12	12	3,307	3,307	3,307	3,307	3,307	2,811	2,811	105	496	601
Metal Phosphate	0	0	1,087	1,087	1,087	1,135	1,135	1,135	1,135	191	944	191	16	944	0	16	16	6,282	6,282	6,282	6,282	6,282	5,340	5,340	145	942	1,087
Heterotrophs	2	2	634	636	636	97	97	4,179	4,179	704	3,475	704	70	3,475	0	70	70	538	538	538	0	0	0	0	634	0	634
Autotrophs	0	0	127	127	127	19	19	838	838	141	697	141	14	697	0	14	14	108	108	108	0	0	0	0	127	0	127
PAOs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poly-P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VSS (lbs/day)	33,302	33,302	3,540	36,842	36,842	6,755	6,755	7,798	7,798	1,314	6,484	1,314	132	6,484	1,375	1,507	1,507	37,384	37,384	37,384	15,692	15,692	13,338	13,338	1,186	2,354	3,540
Biodegradable	24,975	24,975	580	25,555	25,555	4,746	4,746	49	49	8	41	8	1	41	688	688	688	26,264	26,264	26,264	3,818	3,818	3,245	3,245	7	573	580
Non-Biodegradable	5,828	5,828	1,725	7,553	7,553	1,310	1,310	1,310	1,310	221	1,089	221	22	1,089	688	710	710	7,250	7,250	7,250	10,176	10,176	8,650	8,650	199	1,526	1,725
Decay Prod Aer/Anx	2,498	2,498	266	2,763	2,763	423	423	1,752	1,752	295	1,456	295	30	1,456	0	30	30	2,340	2,340	2,340	0	0	0	0	266	0	266
Decay Prod Anaerobic	0	0	132	132	132	20	20	20	20	3	17	3	0	17	0	0	0	112	112	112	861	861	732	732	3	129	132
Metal Hydroxide	0	0	152	152	152	151	151	151	151	25	126	25	3	126	0	3	3	836	836	836	836	836	711	711	27	125	152
Heterotrophs	2	2	570	572	572	88	88	3,761	3,761	634	3,128	634	63	3,128	0	63	63	484	484	484	0	0	0	0	570	0	570
Autotrophs	0	0	114	114	114	18	18	754	754	127	627	127	13	627	0	13	13	97	97	97	0	0	0	0	114	0	114
PAOs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TKN (lbs/day)	7,220	7,220	1,378	8,598	8,598	6,489	6,489	1,097	1,097	185	912	185	76	912	639	715	715	2,110	2,110	2,110	2,125	2,125	856	856	109	1,269	1,378
NH_3-N (lbs-N/day)	4,332	4,332	1,147	5,479	5,479	5,452	5,452	396	396	67	329	67	44	329	244	288	288	26	26	26	1,204	1,204	79	79	22	1,124	1,147
Particulate Bio Org N	1,358	1,358	45	1,403	1,403	261	261	3	3	0	2	0	0	2	59	59	59	1,447	1,447	1,447	295	295	251	251	0	44	45
Non-Bio Part Org N	317	317	92	409	409	70	70	70	70	12	58	12	1	58	44	45	45	387	387	387	544	544	462	462	11	82	92
Decay Prod Aer/Anx	215	215	5	220	220	34	34	34	34	6	28	6	1	28	0	1	1	186	186	186	0	0	0	0	5	0	5
Decay Prod Anaerobic	0	0	11	11	11	2	2	2	2	0	1	0	0	1	0	0	0	10	10	10	74	74	63	63	0	11	11
Heterotrophs	0	0	49	49	49	8	8	323	323	55	269	55	5	269	0	5	5	42	42	42	0	0	0	0	49	0	49
Autotrophs	0	0	10	10	10	2	2	65	65	11	54	11	1	54	0	1	1	8	8	8	0	0	0	0	10	0	10
PAOs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-Bio Soluble Org. N	135	135	16	151	151	150	150	150	150	25	125	25	17	125	125	141	141	1	1	1	8	8	1	1	8	7	16
Non-Bio Colloidal Org. N	57	57	1	58	58	10	10	10	10	2	8	2	1	8	8	9	9	0	0	0	0	0	0	0	1	0	1
Soluble Bio Org N	439	439	3	443	443	440	440	45	45	8	37	8	5	37	96	101	101	2	2	2	1	1	0	0	3	1	3
Colloidal Bio Org N	366	366	0	366	366	61	61	1	1	0	1	0	0	1	64	64	64	0	0	0	0	0	0	0	0	0	0
NO_3-N (lbs-N/day)	0	0	255	255	255	254	254	4,510	4,510	760	3,750	760	505	3,750	1,273	1,778	1,778	1	1	1	0	0	0	0	255	0	255
TP (lbs-P/day)	1,510	1,510	422	1,932	1,932	389	389	389	389	66	323	66	8	323	164	172	172	1,543	1,543	1,543	1,548	1,548	1,178	1,178	51	370	422
Bio Particulate	250	250	13	262	262	40	40	0	0	0	0	0	0	0	20	20	20	222	222	222	84	84	72	72	0	13	13
Non-Bio Particulate	58	58	15	73	73	11	11	11	11	2	9	2	0	9	7	7	7	62	62	62	87	87	74	74	2	13	15
Decay Prod Aer/Anx	71	71	2	73	73	11	11	11	11	2	9	2	0	9	0	0	0	62	62	62	0	0	0	0	2	0	2
Decay Prod Anaerobic	0	0	4	4	4	1	1	1	1	0	0	0	0	0	0	0	0	3	3	3	24	24	21	21	0	4	4
Metal Phosphate	0	0	204	204	204	213	213	213	213	36	177	36	3	177	0	3	3	1,177	1,177	1,177	1,177	1,177	1,000	1,000	27	177	204
Heterotrophs	0	0	16	16	16	2	2	107	107	18	89	18	2	89	0	2	2	14	14	14	0	0	0	0	16	0	16
Autotrophs	0	0	3	3	3	0	0	21	21	4	18	4	0	18	0	0	0	3	3	3	0	0	0	0	3	0	3
PAOs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poly-P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ortho-PO4	1,131	1,131	166	1,297	1,297	110	110	25	25	4	21	4	3	21	137	140	140	1	1	1	176	176	12	12	1	164	166
Alkalinity (lbs/day as $CaCO_3$)	46,732	46,732	5,661	52,393	52,393	47,504	47,504	22,297	22,297	3,757	18,540	3,757	2,495	18,540	49,912	52,407	52,407	231	231	231	4,710	4,710	311	311	1,262	4,399	5,661
H_2S (lbs/day)	1,122	1,122	45	1,167	1,167	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	48	3	3	0	45	45
Temperature (°C)	20	20	21	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	35	35	35	35	20	35	21
BOD_5 (mg/L)	181	181	98	176	176	65	65	19	19	19	19	19	6	19	7	7	7	22,938	22,938	22,938	4,092	4,092	51,154	51,154	45	765	98
COD (mg/L)	401	401	418	402	402	142	142	76	76	76	76	76	30	76	20	21	21	53,854	53,854	53,854	20,086	20,086	254,174	254,174	168	3,537	418
TSS (mg/L)	238	238	558	257	257	52	52	58	58	58	58	58	9	58	9	9	9	60,000	60,000	60,000	34,956	34,956	450,000	450,000	153	5,614	558
VSS (mg/L)	178	178	292	185	185	34	34	39	39	39	39	39	6	39	8	8	8	38,845	38,845	38,845	16,305	16,305	209,898	209,898	106	2,619	292
TKN (mg-N/L)	38.62	39	114	43	43	33	33	6	6	6	6	6	3	6	4	4	4	2,192	2,192	2,192	2,208	2,208	13,468	13,468	10	1,412	114
NH_3-N (mg-N/L)	23.17	23	95	28	28	28	28	2	2	2	2	2	2	2	1	2	2	28	28	28	1,251	1,251	1,251	1,251	2	1,251	95
NO_3-N (mg-N/L)	0.00	0	21	1	1	1	1	23	23	23	23	23	23	23	8	10	10	1	1	1	0	0	0	0	23	0	21
TP (mg-P/L)	8.08	8	35	10	10	2	2	2	2	2	2	2	0	2	1	1	1	1,603	1,603	1,603	1,609	1,609	18,543	18,543	5	412	35
Alkalinity (mg/L as $CaCO_3$)	250	250	467	263	263	240	240	113	113	113	113	113	113	113	303	280	280	240	240	240	4,894	4,894	4,894	4,894	113	4,894	467
H_2S (mg/L)	6.00	6	4	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	50	50	0	50	4

Mass Balance for Diurnal Peak Flow Conditions

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C H2M HILL P arametric Cost E stimating S ystem (CPES)

FACILITIES DESIGN & CONSTRUCTION COST MODULE

File Version: 1/25/2011

Click for CPES QA/ QC | To Concrete Wall Thickness Help | To Cost Summary Matrix | To Unit Cost Database

Project Name:	City of Sunnyvale SIP Peer Review
Project Number:	414083
Project Manager:	Susan Dennis
Estimator:	Kathy Rosinski
Project Description:	Option 5: CEPT w/Existing TF + 1 w/Wetland
Project Location (City):	San Jose
Project Location (State):	CALIFORNIA
Project Location (Country):	USA
Construction Start (Month):	Jan
Construction Start (Year):	2015
Construction Duration (months):	24
Mid-Point of Construction:	Jan/2016

Roundup to the nearest: $1,000

This Report is for INTERNAL Distributio

This Report is for EXTERNAL Distributio

Item	Is This Facility Included in Project? (Yes or No)	SCOPE OF PROJECT	Cost
	Yes	Submersible IPS: PS_RawInf	$2,959,000
	Yes	Screening and Grit: Headworks	$5,560,000
	Yes	Rect PC: Main	$9,568,000
	No	Flow Splitting: TF_Eff	$0
	No	Filters: Main	$0
	No	Wetlands: Wetland	$0
	Yes	Silo AnDig: Meso	$2,684,000
	No	WWTP BFP: BFP	$0
	Yes	Vertical Turbine PS: PS_TfInf	$4,230,000
	Yes	WPSPS: PS_WtEff	$1,620,000
	Yes	Gravity Pipe: Sewer	$304,000
	Yes	Gravity Pipe: Prim_Eff	$1,393,000
	No	Gravity Pipe: TF_Eff	$0
	Yes	Gravity Pipe: Wtld_Eff	$200,000
	No	UV Disinfection: RecWtr_UV	$0
	Yes	Liquid Chemical: Hypo	$307,000
	No	Oxidant Contactor: RecWtr_Cl	$0
	Yes	Oxidant Contactor: RecWtr_Cl2	$1,381,000
SUBTOTAL - PROJECT COST			$30,206,000
ADDITIONAL PROJECT COSTS:			
Demolition		0%	$0
Overall Sitework		0%	$0
Plant Computer System		0%	$0
Yard Electrical		0%	$0
Yard Piping		0%	$0
UD #1 Default Description		0%	$0
UD #2 Default Description		0%	$0
UD #3 Default Description		0%	$0
SUBTOTAL with Additional Project Costs			$30,206,000

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	A	B	C	D	E
53					
54	CONTRACTOR MARKUPS:				
55	Overhead		10%	$30,206,000	$3,021,000
56	Subtotal				$33,227,000
57	Profit		5%	$33,227,000	$1,662,000
58	Subtotal				$34,889,000
59	Mob/Bonds/Insurance		5%	$34,889,000	$1,745,000
60	Subtotal				$36,634,000
61	Contingency		30%	$36,634,000	$10,991,000
62	SUBTOTAL with Markups				$47,625,000
63					
64	ESCALATION (to Mid-Point of Construction)		16.2%	$47,625,000	$7,716,000
65	SUBTOTAL with Escalation				$55,341,000
66					
67	LOCATION ADJUSTMENT FACTOR		117.9	$55,341,000	$65,248,000
68	SUBTOTAL - with Local Adjustment Factor				$65,248,000
69					
70	RED FLAGS:				
71	1	Rock Excavation			
72	2	Pile Foundations			
73	3	Seismic Foundations			
74	4	Dewatering Conditions			
75	5	Wetlands Mitigation			
76	6	Weather Impacts			
77	7	Depth of Structures			
78	8	Local Building Code Restrictions			
79	9	Coatings or Finishes			
80	10	Building or Architectural Considerations			
81	11	Client Material Preferences			
82	12	Client Equipment Preferences			
83	13	Piping Galleries, Piping Trenches, Piping Racks			
84	14	Yard Piping Complexity			
85	15	Existing Site Utilities (New, Retrofit, and Complexity)			
86	16	I & C Automation (New or Retrofit)			
87	17	Electrical Feed (New or Retrofit)			
88	18	Electrical Distribution			
89	19	Shoring			
90	20	Contamination			
91	21	California State Sales Tax (9.25%)			$3,001,408
92	22	User Defined Red Flag 2			
93	23	User Defined Red Flag 3			
94	24	User Defined Red Flag 4			
95	25	User Defined Red Flag 5			
96	26	User Defined Red Flag 6			
97	27	User Defined Red Flag 7			
98	TOTAL - RED FLAGS				$3,002,000
99					
100	SUBTOTAL - CONSTRUCTION COST with Red Flags				$68,250,000
101					
102	MARKET ADJUSTMENT FACTOR		10%	$68,250,000	$6,825,000
103	SUBTOTAL - CONSTRUCTION COST with Market Adjustment Factor				$75,075,000
104	Your CPES Estimate MUST be reviewed by a Process person AND an Estimator:				
105	Name of Process Reviewer			(None)	Click for Reviewe
106	Name of Estimator Reviewer			(None)	
107	MAXIMUM CONSTRUCTION COST				$105,105,000
108					
109	NON-CONSTRUCTION COSTS:				

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	A	B	C	D	E
110	***Permitting***		**0%**	**$105,105,000**	**$0**
111	***Engineering***		**0%**	**$105,105,000**	**$0**
112	***Services During Construction***		**0%**	**$105,105,000**	**$0**
113	***Commissioning & Startup***		**2%**	**$105,105,000**	**$2,103,000**
114	***Land / ROW***		**0%**	**$105,105,000**	**$0**
115	***Legal / Admin***		**0%**	**$105,105,000**	**$0**
116	***Other Default Description***		**0%**	**$105,105,000**	**$0**
117	***SUBTOTAL - Non-Construction Costs***				**$2,103,000**
118					
119	***TOTAL - CAPITAL COST***				**$107,208,000**
120					
121	***Currency Conversion of TOTAL CAPITAL COST:***				
122		***Currency***	***Unit of Measure***	***Conversion Rate***	***Converted Amount***
123		**None**	**U.S.Dollar**	**1**	**107,208,000**

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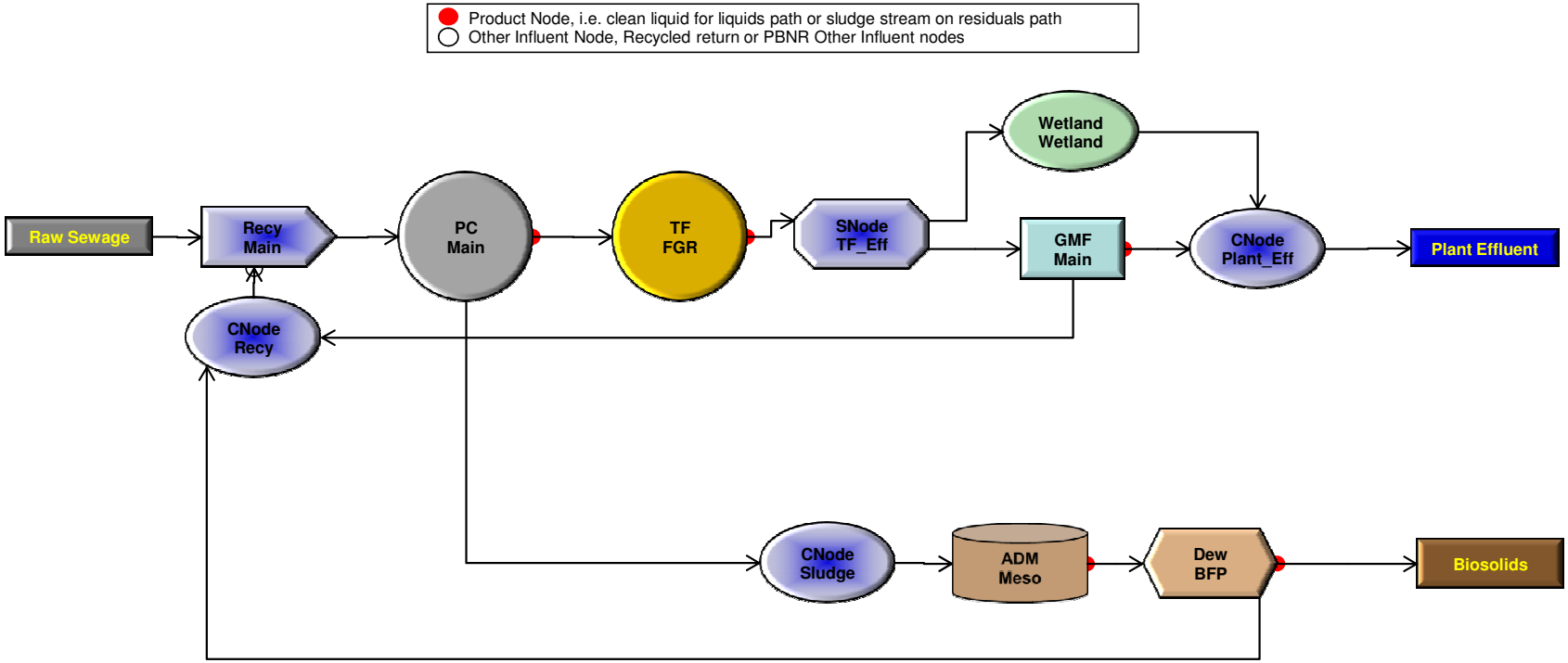

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City of Sunnyvale - SIP Review - Screening of Alternatives

Linked Model Input	Current Run:	Notes	Scenarios: All scenarios are based on Maximum Month Flows and Lo			All scenarios are based on Maximum Month Flows and Loadings			
			Option 1 (PC + TF Existing)	(Option 2 (CEPT + TF Existing)	Option 3 (CEPT + 1 more TF)	Option 4 (CEPT + TF Existing + wetlands for 85% discharge effluent + Filter for 15% Recycled Water) - WINTER	Option 4 (CEPT + TF Existing + wetlands for 85% discharge effluent + Filter for 15% Recycled Water) - SUMMER	Option 5 - (CEPT + 1 more TF + wetlands for 85% discharge effluent + Filter for 15% Recycled Water) - WINTER	Option 5 - (CEPT + 1 more TF + wetlands for 85% discharge effluent + Filter for 15% Recycled Water) - SUMMER
Flow (MGD)	22.40		22.40	22.40	22.40	22.40	22.40	22.40	22.40
Diurnal Flow Peaking Factor	1.5		1.5	1.5	1.5	1.5	1.5	1.5	1.5
CBOD5 (lbs/day)	33,800		33,800	33,800	33,800	33,800	33,800	33,800	33,800
TSS (lbs/day)	44,400		44,400	44,400	44,400	44,400	44,400	44,400	44,400
% VS	75%		75%	75%	75%	75%	75%	75%	75%
Ammonia -N (lbs/day)	4,332		4,332	4,332	4,332	4,332	4,332	4,332	4,332
Total Phosphate - P (lbs/day)	1,510		1,510	1,510	1,510	1,510	1,510	1,510	1,510
Temperature deg.C	20		15	15	15	15	20	15	20
Primary Clarifiers									
Primary Clarifier Area (sqft)	20,900		20,900	20,900	20,900	20,900	20,900	20,900	20,900
Coagulant Applied	Yes		No	Yes	Yes	Yes	Yes	Yes	Yes
Chemical Dosage (mg chemical/L treated) (mg/L)	50		0	50	50	50	50	50	50
Percent Removal of Colloidal Matter (%)	83%		33%	83%	83%	83%	83%	83%	83%
TSS Removal Efficiency	80%		60%	80%	80%	80%	80%	80%	80%
BOD5 Removal Efficiency	63%		44%	65%	65%	65%	65%	65%	63%
TSS Effluent Concentration (mg/L)	52			6507%	6552%	62	62	62	52
BOD5 Effluent Concentration (mg/L)	65			6296%	6282%	69	69	69	65
Primary Sludge Concentration (mg/L)	60,000		30,000	30,000	30,000	30,000	30,000	30,000	60,000
Primary Sludge TSS (lbs/day)	57,692		51,935	78,514	78,943	65,565	65,593	65,610	57,691
Primary Sludge Flow (m3/d)	437		786	1,188	1,195	992	993	993	437
Trickling Filters									
Area (ft2)	26,589			19,942	26,589	19,942	19,942	26,589	26,589
Media Volume (cu.ft)	505,200		379,000	378,900	505,200	378,900	378,900	505,200	505,200
Media Specific surface area (ft2/ft3)	42		30	30	30	42	42	42	42
Hydraulic Loading (m3/m2-d)	#REF!	10-75 High Rate'		57		48.5	48.5	36.4	#REF!
Category of TF	Low Rate			Low Rate	Low Rate	Low Rate	Low Rate	Low Rate	Low Rate
Trickling Filter Organic Loading Rate (lbs/1000ft3/d)	26	40-200 High Rate	76	39	29	36	36	27	26
Recirculation (% of Q Influent)	6%		3%	24%	24%	6%	6%	6%	6%
TF BOD Influent (mg/L)	65			63	63	69	69	69	65
TF NH3-N Influent (mg/L)	28		30	28	26	28	28	27	28
TF TSS Effluent (mg/L)	58			62	64	62	63	63	58
TF BOD5 Effluent (mg/L)	19		97	21	20	22	21	21	19
TF NH3-N Effluent (Average) (mg/L)	**2.0**		**24**	**22**	**13**	**8.8**	**7.1**	**2.0**	**2.0**
TF NH3-N Effluent (Peak Diurnal) (mg/L)	47			92	90	62	63	58	59
Filtration									
Total Filter Surface Area (sf)	3,840			3,840	3,840	3,840	3,840	3,840	3,840
Influent TSS Concentration (mg/L)	58	should be < 30 mg/L for filtration (M&E		62	64	62	63	63	58
Hydraulic Loading Rate (peak) (gpm/sf)	0.84	0		6.41	6.40	0.85	0.85	0.85	0.85
TSS Removal Efficiency at Average Conditions	90%			90%	90%	90%	90%	90%	90%
TSS Removal Efficiency at Diurnal Peak Conditions	85%			85%	85%	85%	85%	85%	85%
Filter Run Time	48			12	12	48	48	48	48
Backwash Flow (mgd)	1.34			5.38	5.38	1.34	1.34	1.34	1.34
Backwash Solids Concentration (mg/L)	153			286	295	165	167	169	153
Backwash Solids Loading (lb TS/day)	1,713			12,816	13,235	1,845	1,874	1,890	1,713
Final Effluent Concentration (Filter)		**Effluent Limits (avg mth / daily max)**							
BOD_5 (mg/L)	6	10 / 20		8	7	9	8	8	6
COD (mg/L)	30			33	31	35	32	33	30
TSS (mg/L)	9	20 / 30		8	8	9	9	9	9
VSS (mg/L)	5.9			5	5	6.2	6.3	6.4	5.9
TKN (mg-N/L)	3.4			24	14	10.3	8.6	3.5	3.4
NH_3-N (mg-N/L)	2.0	4.5 / 18		22	13	8.8	7.1	2.0	2.0
NO_3-N (mg-N/L)	23			7	15	18	19	23	23
TP (mg-P/L)	0			0	0	0	0	0	0
Wetlands									
Wetlant area (acres)	395		0	1	0	395	395	395	395
Temperature (deg. C)	15		10	10	10	10	15	10	15
BOD5 (mg/L)	7		#DIV/0!	8	#DIV/0!	8	8	8	7
COD (mg/L)	20		#DIV/0!	19	#DIV/0!	20	21	20	20
TSS (mg/L)	9		#DIV/0!	7	#DIV/0!	7.1	10	7	9
VSS (mg/L)	8		#DIV/0!	6	#DIV/0!	6.4	9	6	8
TKN (mg-N/L)	4		#DIV/0!	15	#DIV/0!	7.7	6	4	4
NH3-N (mg-N/L)	**1.5**		**#DIV/0!**	**12**	**#DIV/0!**	**5.1**	**3.8**	**1.6**	**1.5**
NO3-N (mg-N/L)	8		#DIV/0!	10	#DIV/0!	11	8	11	8
TP (mg-P/L)	1		#DIV/0!	1	#DIV/0!	1	1	1	1
Alkalinity (mg/L as CaCO3)	303		#DIV/0!	224	#DIV/0!	247	288	260	303
H2S (mg/L)	0		#DIV/0!	0	#DIV/0!	0	0	0	0
Digestion									
Digester Volume (MG)	2.70			2.70	2.70	2.70	2.70	2.70	2.70
Digester Solids IN (lb TSS/d)	57,692			66,737	67,101	55,730	55,754	55,768	57,691
Digester Solids OUT (lb TSS/d)	33,611			42,469	42,701	32,449	32,463	32,470	33,609
Digester Loading (lb VSS/ft3-day)	0.129	0		0.146	0.148	0.125	0.125	0.125	0.129
Volatile Solids Reduction (%)	58%			52%	51%	58%	58%	58%	58%
Digester Gas Production (cuft/day)	357,588			357,205	359,815	345,594	345,845	346,027	357,623
Digester Gas Production (cu.ft/lb VS destroyed)	17			16	16	17	17	17	17
Dewatered Solids Production (lb TSS/day)	28,569			36,099	36,296	27,581	27,594	27,600	28,568
Conclusions			Not able to meet nitrification limit.	Not able to meet nitrification limit.	Some nitrification in TF with the addition of ONE tower. Additional >5mg/L NH3-N needs to be removed. Wetlands??	TF effluent able to meet CURRENT winter ammonia limit of 18 mg/L (monthly average). Wetland would provide polishing (TSS removal).	TF effluent NOT able to meet CURRENT summer ammonia limit of 2 mg/L (monthly average). Wetland would provide AMMONIA REMOVAL and polishing (TSS removal)	TF effluent able to meet FUTURE winter ammonia limit of 4.5 mg/L (monthly average). Wetland would provide polishing (TSS removal).	TF effluent able to meet current summer ammonia limit of 2.0 mg/L (monthly average). Wetland would provide polishing (TSS removal). No separate thickener.

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Attachment 2

Facility Operating Parameters						Project
Item		Value			Value	Notes
Influent Wastewater	(Metric)	(Metric)	(Metric=US*k)	(US)	(US)	
Flow	m3/day			MG/day		
Design Average		84,794	3,785.44		22.40	peak month flow
Design Diurnal Peak		127,191	3,785.44		33.60	
Design Peaking Factor for WW Diurnal flow		1.5	1.00		1.5	equivalent to peak week factor
Design Peaking Factor for WW Diurnal loads		1.3	1.00		1.3	
Carbonaceous Five-Day Biochemical Oxygen Demand (CBOD5)						
Design Average Concentration	mg/L	181	1.00	mg/L	181	
Design Average Mass Loading	kg/day	15,331	0.45	lb/day	33,800	peak month loading
Design Diurnal Peak Mass Loading	kg/day	19,931	0.45	lb/day	43,940	
Total Suspended Solids (TSS)						
Design Average Concentration	mg/L	238	1.00	mg/L	238	
Design Average Mass Loading	kg/day	20,139	0.45	lb/day	44,400	peak month loading
Design Diurnal Peak Mass Loading	kg/day	26,181	0.45	lb/day	57,720	
Volatile Suspended Solids (VSS)						
Percent VSS	%	75%	1.00	%	75%	assumed
Design Average Concentration	mg/L	178	1.00	mg/L	178	
Design Average Mass Loading	kg/day	15,105	0.45	lb/day	33,300	
Design Diurnal Peak Mass Loading	kg/day	19,636	0.45	lb/day	43,290	
Total Kjeldahl Nitrogen (TKN as N)						
Design Average Concentration	mg/L	39	1.00	mg/L	39	
Design Average Mass Loading	kg/day	3,275	0.45	lb/day	7,220	peak month loading
Design Diurnal Peak Mass Loading	kg/day	4,257	0.45	lb/day	9,386	
Ammonia-Nitrogen (NH3-N as N)						
Design Average Concentration	mg/L	23	1.00	mg/L	23	
Design Average Mass Loading	kg/day	1,965	0.45	lb/day	4,332	assumed 60% of TKN
Design Diurnal Peak Mass Loading	kg/day	2,554	0.45	lb/day	5,632	
Total Phosphorus (as P)						
Design Average Concentration	mg/L	8	1.00	mg/L	8	
Design Average Mass Loading	kg/day	685	0.45	lb/day	1,510	peak month loading
Design Diurnal Peak Mass Loading	kg/day	890	0.45	lb/day	1,963	
Alkalinity (as CaCO3)						
Design Average Concentration	mg/L	250	1.00	mg/L	250	
Design Average Mass Loading	kg/day	21,197	0.45	lb/day	46,732	pond efluent measured > 250 mg
Design Diurnal Peak Mass Loading	kg/day	27,556	0.45	lb/day	60,752	
Hydrogen Sulfide (H2S)						
Design Average Concentration	mg/L	6	1.00	mg/L	6	
Design Average Mass Loading	kg/day	509	0.45	lb/day	1,122	assumed, no data available
Design Diurnal Peak Mass Loading	kg/day	661	0.45	lb/day	1,458	
Chemical Addition:						
Select the Metal Salt (if used)	Ferric Chloride			2		
Wastewater Temperature						
Raw Sewage Temperature	oC	15	1.00	oC	15	8.8 deg. C - minimum month tem
Plant Elevation	meters	3	3.28	feet	10	
Ambient Atmospheric Pressure	kPa	101	6.89	psia	14.7	
Is the Temperature Model Used?	No					confirm this is not needed
N/A	oC	21	Special	oF	70	
N/A	kph	8	0.62	mph	5	
N/A	%	60%	1.00	%	60%	
N/A	%	50%	1.00	%	50%	
N/A	degrees	45	1.00	degrees	45	
N/A	Date	02/09/11	1.00	Date	02/09/11	
Primary Clarifiers: Main						
Primary Clarifiers?	Yes	TRUE				
Total Area	m2	1,942	0.09	ft2	20,900	excludes pre-aration
Overflow Rate	m/day		0.04	gpd-sq.ft.		
Average		51	0.04		1,240	1000 gal/sf/day - typical, M&E
Diurnal Peak		81	0.04		1,978	2000-3000 gal/sf/day - typical, M&
Chemical Compound Applied to Primary Influent	No	FALSE	2			
Chemical Formula		FeCl3	1.00		FeCl3	
Chemical Dosage (mg chemical/L treated)	mg/L	50	1.00	mg/L	50	
Chemical Dosage (as chemical)	kg/day	4,931	0.45	lb/day	10,871	
Molar Ratio of Metal to Phosphate		0.03	1.00		0.03	
Percent of Soluble P that is ortho-P		100%	1.00		100%	
Percent Removal of Colloidal Matter		83%			83%	
TSS Removal Efficiency at Average Conditions		60%	1.00		60%	average removal varied 40-57% (2
TSS Removal Efficiency at Diurnal Peak Conditions		55%	1.00		55%	
Effective TSS Removal with Chemical Addition - Average Conditions(%)		60%	1.00		60%	
Effective TSS Removal with Chemical Addition - Peak Conditions(%)		54%	1.00		54%	
Percent BOD5 Removal		39%	1.00		39%	average removal 23% (2004-2007
Primary Effluent	mg/L			mg/L		
TSS	114				114	
TP	8.32				8.32	
OP	7.03				7.03	
Primary Sludge Concentration	mg/L	30,000	1.00	mg/L	30,000	in general, weak primary sludge c
Flow Splitter: PC_Eff						
Splitter Influent Flow	m3/day	98,065	3,785	MGD	25.91	
Flow Splits						
PC_Eff Splitter Effluent (SplitE) PBNRHighRateAS	%	100%		%	100%	
PC_Eff Splitter Effluent (SplitE) CNodePBNR_Eff	%	0%		%	0%	
	%	0%		%	0%	
	%	0%		%	0%	
	%	0%		%	0%	
	%	0%		%	0%	
	%	0%		%	0%	
	%	0%		%	0%	
	%	0%		%	0%	
Biological Process - PBNR: HighRateAS						
Total SRT (anaerobic + anoxic + aerobic)	days	1.00	1.00	days	1.00	
System pH		7.20	1.00		7.20	
Nitrifier Minimum Aerobic SRT (SRT_{min})	days	4.15	1.00	days	4.15	
Aerobic SRT	days	1.00	1.00		1.00	
Nitrification Safety Factor		0.24	1.00		0.24	
DO	mg/L	2.00	1.00	mg/L	2.00	
Temperature in the Biological Process	oC	15	1.00	oC	15	
SVI	mL/g	120	1.00	mL/g	120	
Biosolids Production Rates						
Net Yield (mg TSS/mg BOD_5)	mg/mg	2.52	1.00	lb/lb	2.52	
Volatile Fraction	%	77%	1.00	%	77%	
Active Fraction	%	55%	1.00	%	55%	
Nitrifier Fraction	%	2%	1.00	%	2%	
Nitrogen Content, N/VSS	%	7%	1.00	%	7%	
Phosphorus Content, P/VSS	%	2%	1.00	%	2%	
Process Oxygen Requirements - Minus MBR Tank (if used)						
Carbonaceous AOR/BOD5 - wt/wt	kg/kg	-0.68	1.00	lb/lb	-0.68	
Total AOR/BOD% - wt/wt	kg/kg	1.66	1.00	lb/lb	1.66	
AOR (wt/day)	kg/day			lb/day		
Average		17,918	0.45		39,502	
Diurnal Peak		15,496	0.45		34,162	
AOR	mg/L-hr			mg/L-hr		
Average		66	1.00		66	
Diurnal Peak		57	1.00		57	
Bioreactor	With Secondary Clarifier	1				
Total Bioreactor Volume	m3	11,356	3,785.44	MG	3.00	based on HRT=2h @ ADF (18 mg
HRT	hr	2.79	1.00	hr	2.79	
% non-aerobic	%	0%	1.00		0%	
% aerobic	%	100%	1.00		100%	
Average MLSS Concentration	mg/L	2,520	1.00	mg/L	2,520	should be <1,000 mg/L
No Media Reactors Included	AKI K1					
Bulk Specific Surface Area (Biofilm Active)	m2/m3	No Media	3.28	ft2/ft3	No Media	
Bulk Liquid Volume Displacement	-	No Media	1.00	-	No Media	
Bioreactor Clarifier						
Total Area	m2	3,716	0.09	sq.ft.	40,000	Number of Clarifiers:
Overflow Rate	m/day			gpd-sq.ft.		Clarifier Diameter (ft):
Average		26	0.04		646	
Diurnal Peak		42	0.04		1,033	<-- needs to be based on PF
Effluent TSS	mg/L			mg/L		
Average		15	1.00		15	
Diurnal Peak		20	1.00		20	
Underflow Rate						
Average Flow Ratio	%	150%	1.00		150%	
Average Rate	m/day	39	0.04	gpd-sq.ft.	969	

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Peak Flow Ratio		%	100%	1.00		100%	
Peak Rate		m/day	42	0.04	gpd-sq.ft.	1,033	
Solids Loading Rate		kg/m2-day		4.88	lb/day-sq.ft.		
Average			166	4.88		34	
Diurnal Peak			212	4.88		43	
Limiting Solids Loading Rate		kg/m2-day	238	4.88	lb/day-sq.ft.	49	
Return sludge rate at which limiting solids rate can be achieved							
RAS Flow Rate		m3/day	78,390	3,785.00	MGD	20.71	
Percent of Influent to Bioreactor		%	80%		%	80%	
RAS Concentration		mg/L			mg/L		
Average			4,097	1.00		4,097	
Diurnal Peak			5,039	1.00		5,039	
No Membrane Bioreactor Selected	**GE/Zenon**						
Calculate Based on Flux or # of Modules?	**Flux**	lmh	17	1.70	gph	10	
Design Membrane Net Flux Rate		lmh	17.0	1.70	gfd	10	
Minimum Required Membrane Area		m2	223,667	10.76	ft2	2,407,464	
Membrane Module Area		m2	32	10.76	ft2	340	
Number of Modules			7,081			7,081	
Air Rate per Module		Nm3/hr	20	1.70		11.80	
Percent of Time Membrane Air Scour is on			25%			25%	
Total Membrane Air Scour Rate		Nm3/hr	35,495	1.70	scfm	20,889	
Force MBR DO to Match Air Rate?	**No**						
Effluent TSS		mg/L			mg/L		
Average			1.0	1.00		1.0	
Diurnal Peak			1.0	1.00		1.0	
Chemical Compound Applied before Secondary Clarifier			2				
Chemical Added?	**No**						
Chemical Type			Ferric Chloride	1.00		Ferric Chloride	
Chemical Dosage (as chemical)		kg/day	91	0.45	lb/day	200	
Chemical Dosage (mg chemical/L treated)		mg/L	N/A	1.00	mg/L	N/A	
Molar Ratio Dosage Applied (M+:PO4-P)			0	1.00		N/A	
Effluent PO4-P		kg/day	351	0.45	lb/day	N/A	
Effluent PO4-P		mg/L	3.85	1.00	mg/L	N/A	
Trickling Filter: FGR							
Trickling Filters?	**Yes**		TRUE				
Water Temperature		C	15.1	Special	F	59.2	
Coef. "k" in Velz Equation (English Units) =			0.072			0.072	assumed coeff for 60 deg. Cross
Coef. "n" in Velz Equation =			0.44			0.44	assumed coeff for 60 deg. Cross
Coef. "Theta" in Velz Equation =			1.035			1.035	
Media Volume		m3	10,729	0.03	ft3	378,900	three 92-ft diameter 19-ft media d
Media Depth		m	5.79	0.30	ft	19.00	
Media Specific surface area		m2/m3	137.80	0.30	ft2/ft3	42.00	100-150 m2/m3 for plastic media
% Simultaneous Denitrification			0.1			0.1	
Recirculation Q (used in wetting Q = TF Influent Q+ recirculation)		m3/day	91,220	3,785.00	MGD	24.1	estimated by the model based on
Biofilm Control Practiced with Distributor?	**Yes**		TRUE				
Trickling Filter Loading Rate		kg/m3/d	0.07	0.02	lbs/1000ft3/d	4	
Category of Trickling Filter			Low Rate			Low Rate	
TF Effluent Soluble BOD5		mg/L			mg/L		
Average			0	1.00		0	
Diurnal Peak			0	1.00		0	
TF Effluent NH3-N		mg/L			mg/L		
Average			2	1.00		2	
Diurnal Peak			108	1.00		108	
TF Solids Production in VSS (mg VSS in effluent/mg BOD5 rem)		mg/mg	0	1.00	mg/mg	0	
Trickling Filter Clarifier?	**No**		FALSE				
Total Area		m2	372	0.09	sq.ft.	4,000	
Overflow Rate		m/day			gpd-sq.ft.		
Average			246	0.04		6,025	
Diurnal Peak			392	0.04		9,632	
Effluent TSS		mg/L			mg/L		
Average			15	1.00		15	
Diurnal Peak			20	1.00		20	
Solids Loading Rate		kg/m2-day		4.88	lb/day-sq.ft.		
Average			N/A	4.88		N/A	
Diurnal Peak			N/A	4.88		N/A	
Underflow Concentration		mg/L			mg/L		
Average			6,000	1.00		6,000	
Diurnal Peak			6,000	1.00		6,000	
Flow Splitter: TF_Eff							
Splitter Influent Flow		m3/day	91,231	3,785	MGD	24.10	
Flow Splits							
TF_Eff Splitter Effluent (SplitE) GMFMain		%	100%		%	100%	SIP sized recycled water treatme
TF_Eff Splitter Effluent (SplitE) WetlandWetland		%	0%		%	0%	with wetlands, the recycled water
		%	0%		%	0%	
		%	0%		%	0%	
		%	0%		%	0%	
		%	0%		%	0%	
		%	0%		%	0%	
		%	0%		%	0%	
Filters: Main							
Filters?	**Yes**		TRUE				
Total Area		m2	357	0.09	ft2	3,840	four units (30-ft by 32-ft, each)
Hydraulic Loading Rate		m/day		0.04	gpm/ft2		
Average			227	58.67		3.87	
Diurnal Peak			380	58.67		6.47	filters designed for peak rate of 5.
Solids Loading Rate		kg/m2-day			lb/day-sq.ft.		
Average			3.45	0.04		0.15	
Diurnal Peak			7.91	0.04		0.33	
Filter Run Time		hr	24	1.00	hr	24	high solids loading >30 mg/L from
Instantaneous Backwash Rate		m/hr	86	2.44	gpm/ft2	35	max rate is 35 gpm/ft2, based on
Duration of Backwash Flow		minutes	20	1.00	minutes	20	assumed, no data
Backwash Operating Time (%cycle)		%	1.39%	1.00	%	1.39%	
Backwash Flow Rate		m3/day	10,175	3,785.00	MGD	2.69	
Ratio of Backwash Production to Filter Influent		%	11.2%	1.00	%	11.2%	
TSS Removal Efficiency at Average Conditions			90%	1.00		90%	assumed, no data
TSS Removal Efficiency at Diurnal Peak Conditions			85%	1.00		85%	assumed, no data
Effluent TSS at Average Conditions		mg/L	1.5	1.00	mg/L	1.5	
Effluent TSS at Peak Conditions		mg/L	3.1	1.00	mg/L	3.1	
Chemical Compound Applied to Filter Influent	**No**	FALSE	2				confirm
Chemical Formula			FeCl3	1.00		FeCl3	
Chemical Dosage (mg chemical/L treated)		mg/L	10	1.00	mg/L	10	
Chemical Dosage (as chemical)		kg/day	911.40	0.45	lb/day	2,009.29	
Molar Ratio of Metal to Phosphate			0.01	1.00		0.01	
Percent of Soluble P that is ortho-P			*100%*	1.00		*100%*	
Effective TSS Removal with Chemical Addition - Average Conditions(%)			90%	1.00		90%	
Effective TSS Removal with Chemical Addition - Peak Conditions(%)			85%	1.00		85%	
Backwash Concentration		mg/L	109	1.00	mg/L	109	
Wetlands Node: Wetland							
Is the Wetlands Node in Service?	**Yes**		TRUE				
Area		ha	0.04	2.4700	acres	0.1	initial pond sizing based on 4 acre
Temperature		oC	10		oC	10	assumed 5 dec C drop compared
Representative Number of Tanks-in-Series		#	5		#	5	assumed
Rate Constants (at 20 C):							parameters are in the bull park bu
BOD		m/yr	34		m/yr	34	default
TSS		m/yr	1,000		m/yr	1,000	default
Organic N		m/yr	17		m/yr	17	default
NH3		m/yr	18		m/yr	18	default
NO3		m/yr	35		m/yr	35	default
TP		m/yr	12		m/yr	12	default
Fraction of Influent Ammonia that can be Nitrified in Wetland		%	1		%	1	confirm. default 1%
% of Nitrogen Removed by Settling		%	0.128889125		%	0.128889125	default
Biodegradeable Fraction of TSS		%	0.5		%	0.5	default
VSS Fraction of TSS		%	0.9		%	0.9	default
Primary Sludge Thickening: Gravity							
Primary Sludge Thickener?	**Yes**		TRUE				
Solids Capture		%	85%	1.00	%	85%	
Thickened Sludge Concentration		mg/L	60,000	1.00	mg/L	60,000	
Belt Wash Water Flow Rate		m3/hr	0	0.23	gpm	0	
Hours/Day of Operation			24	1.00		24	
Days/Week of Operation			7	1.00		7	
Fermentation Occurring?	**No**		FALSE				
Conversion Efficiency of VSS to VFAs		kg VFAs/kg V	0.15	1.00	lbs VFAs/lbs V	0.15	
Elutriate VFA Production		kg VFA COD/	0	0.45	lbs VFA COD/	0	
ADM Digester Model Meso							

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Anaerobic Treatment Type	**Digester**		TRUE				
Is this Unit Process in Service?	**Yes**		TRUE				
Total Digester Volume		m3	**10,220**	3,785.00	MG	**2.70**	3-55 ft and 1-70 ft digesters, 33-ft
Percent of Volume that is Active		%	**0.8**	1.00	%	**0.8**	assumes one small digester
Total HRT		days	13	1.00	days	13	
Total SRT		days	13	1.00	days	13	
Digester Elevation		meters	3	3.28	feet	10	
Digester Digester Feed pH			**7.00**			**7.00**	
Volatile Solids Loading - wt VSS/vol-day		kg/m3-day	3.46	16.06	lb/ft3-day	0.22	
Volatile Solids Reduction		%	53%	1.00	%	53%	
Recuperative Thickening Hours/Day of Operation			**8**	1.00		**8**	
Recuperative Thickening Days/Week of Operation			**7**	1.00		**7**	
Percent P Released that is Precipitated as Struvite		%	25%	1.00	%	25%	
Methane Production		m3/day	5,335	0.03	ft3/day	188,503	
Digester Gas Methane Content		%	59%	1.00	%	59%	
Digester Gas Production		m3/day	9,089	0.03	ft3/day	321,174	
Digester Gas Production (vol/wt volatile solids destroyed)		m3/kg	0.60	0.06	ft3/lb	10	
Dewatering: BFP							
Dewatering?	**Yes**		TRUE				
Solids Capture		%	**85%**	1.00	%	**85%**	
Dewatered Sludge Concentration		%	**25%**	1.00	%	**25%**	
Belt Wash Water Flow Rate		m3/hr	**0**	0.23	gpm	**0**	
Hours/Day of Operation			**4**	1.00		**4**	
Days/Week of Operation			**5**	1.00		**5**	

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SIZING INFORMATION Process Components		Schematic Design	Design Development			Schematic Design	Design Development	Design Notes
	(Metric)	(Metric)	(Metric)	(Metric=US*k)	(US)	(US)	(US)	
Power Summary								
Average Power	kW		#REF!	1.34	hp		#REF!	
Peak Power	kW		4,836	1.34	hp		6,485	
Biosolids Disposal								
Summary								
Total Biosolids to Disposal	kg/day	17,869	17,869	0.45	lbs/day	39,394	39,394	
	m3/day	71	71	264.17	gal/day	18,881	18,881	
Biosolids TSS Percent Solids	%	25	25	1.00	%	25	25	
Observed Overall Solids Yield (Biosolids/Infl BOD5)	kg/kg	1.17	1.17	1.00	lb/lb	1.17	1.17	
Chemical Use Summary (Design mass rate as chemical)								
Metal Salt (Ferric Chloride)	kg/d		0	0.45	lbs/day		0	
Sodium Hypochlorite (liquid)	kg/d		486	0.45	lbs/day		1,072	
Sodium Hypochlorite (On-Site Generation)	kg/d		0	0.45	lbs/day		0	
Sodium Metabisulfite	kg/d		243	0.45	lbs/day		536	
Polymer	kg/d			0.45	lbs/day		0	
Lime	kg/d		0	0.45	lbs/day		0	
Caustic (NaOH)	kg/d		0	0.45	lbs/day		0	
Methanol	kg/d		0	0.45	lbs/day		0	
Raw Sewage								
Influent Pumping Included? Yes								
Influent Flow Rates								
Average	m3/day	84,794	84,794	3,785.00	MGD	22	22	
Peak Diurnal	m3/day	127,191	127,191	3,785.00	MGD	34	34	
Influent Pump Capacity								
Hours of Operation			24	1.00			24	
Safety Factor on Peak Diurnal			2.00	1.00			2.00	
Number of Duty Units			4	1.00			4	
Capacity Per Unit	m3/hr		2,650	0.23	gpm		11,667	
Number of Standby Units			1	1.00			1	
Total Number of Units			5	1.00			5	
Influent Pump Sizing								
Capacity Per Unit	m3/hr		2,650		gal/min		11,667	
Total Dynamic Head	m		23	3.28	ft		75	
Pump Efficiency			30%	1.00			30%	
RS Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		549.9	1.34	HP		737.7	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		611.0		HP		819.6	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			1.00	1.00			1.00	
CPES Life Cycle Average Capacity Per Unit	m3/hr		883	4.40	gal/min		3,889	
CPES Life Cycle Average Power to Motor Per Unit	kW		203.7		HP		273.2	
Influent Pump Station Power								
Average Power	kW		815	1.34	hp		1,092	
Peak Power	kW		2,444	1.34	hp		3,277	
Screening								
Screening Included? Yes								
Sizing Information								
Safety Factor on Peak Diurnal		1.25	1.25	1.00		1.25	1.25	
Number of Duty Units		2	2	1.00		2	2	
Number of Standby Units		1	1	1.00		1	1	
Total Number of Units		3	3	1.00		3	3	
Capacity Per Unit	m3/day	79,494	79,494		MGD	21.00	21.00	
	m3/s	0.92	0.92		cfs	32.49	32.49	
Design Maximum Approach Velocity	m/s	0.61	0.61	0.30	ft/s	2.00	2.00	
Design Depth to Width Ratio		0.80	0.80			0.80	0.80	
Screen Width	m	1.37	1.37	0.30	ft	4.51	4.51	
Approach Velocity at Average	m/s	0.33	0.33		ft/s	1.07	1.07	
Screen Type Mechanical Bar Screen								
Bar Opening	mm		6	25.40	inches		0.250	
Power Input to Motor per Unit	kW		2.2	1.34	HP		3.0	
Motor Type Constant Speed								
Minimum Turndown Capacity			40%	1.00			40%	
Operating Information								
Average Screenings Production Rate	m3/1000 m3	0.10	0.10	0.01	ft3/MG	13	13	
Average Screenings Production	m3/d	8.50	8.50		ft3/d	300	300	
	kg/day	8,170	8,170	0.45	lbs/day	18,012	18,012	
Peak Screenings Production Rate	m3/1000 m3	0.21	0.21	0.01	ft3/MG	28	28	
Peak Screenings Production	m3/d	26.5	26.5		ft3/d	934	934	
	kg/day	25,424	25,424	0.45	lbs/day	56,051	56,051	
Washer Compactor Included YES								
Washer Compactor Sizing Information								
Number of Duty Units		2	2	1.00		2	2	
Number of Standby Units		1	1	1.00		1	1	
Peak Screening Throughput per Unit	m3/hr	0.55	0.55		ft3/hr	19.5	19.5	
Power Input to Motor per Unit	kW		2.2	1.34	HP		3.0	
Motor Type Constant Speed								
Minimum Turndown Capacity			40%	1.00			40%	
Screening Power								
Average Power Factor			0.75				0.75	
Average Power	kW		6.7	1.34	hp		9.0	
Peak Power	kW		8.9	1.34	hp		12.0	
Grit Removal								
Grit Removal Included? Yes								
Grit Removal System Type Vortex								
Sizing Information								
Safety Factor on Peak Diurnal		1.30	1.30	1.00		1.30	1.30	
Number of Duty Units		2	2	1.00		2	2	
Number of Standby Units		0	0	1.00		0	0	
Total Number of Units		2	2	1.00		2	2	
Capacity Per Unit	m3/day	82,674	82,674	3,785.00	MGD	21.84	21.84	
Operating Information								
Average Grit Production Rate	m3/1000m3	0.030	0.030	133.70	ft3/MG	4.0	4.0	
Average Grit Production	m3/d	2.54	2.54	0.03	ft3/d	89.6	89.6	
	kg/day	4,063	4,063	0.45	lbs/day	8,961	8,961	
Peak Grit Production Rate	m3/1000m3	0.075	0.075	133.70	ft3/MG	10	10	
Peak Grit Production	m3/d	6.2	6.2		ft3/d	218	218	
	kg/day	9,905	9,905		lbs/day	21,843	21,843	
Grit Pump Sizing								
Number of Duty Units			1	1.00			1	
Number of Standby Units			1	1.00			1	
Total Number of Units			2	1.00			2	
Capacity Per Unit	m3/hr		45	0.23	gal/min		200	
Total Dynamic Head	m		15.2	3.28	ft		50	
Pump Efficiency			30%	1.00			30%	
RS Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		6.3	1.34	HP		8.4	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		7.0		HP		9.4	
Motor Type Constant Speed								
Minimum Turndown Capacity			40%	1.00			40%	
Grit Removal Power								
Average Power Factor			0.75				0.75	
Average Power	kW		5.2	1.34	hp		7.0	
Peak Power	kW		7.0	1.34	hp		9.4	

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Disinfection								
Sizing Information								
Effluent Flow Rates								
Average	m3/day	81,056	81,056	3,785.00	MGD	21.42	21.42	
Peak Diurnal	m3/day	135,666	135,666	3,785.00	MGD	35.84	35.84314331	
On-Site Sodium Hypochlorite NO								
Sizing Information								
Percent Active Sodium Hypochlorite Generated	%	0.80%	0.80%	1.00	%	0.80%	0.80%	
Generated Sodium Hypochlorite Specific Gravity		1.00	1.00	1.00		1.00	1.00	
Active Chemical Form for Design Basis		Cl_2	Cl_2	1.00		Cl_2	Cl_2	
Active Chemical Concentration, lb/gallon	kg/m3	0.0670	0.0670	1.00	lb/gal	0.0674	0.0674	
Design Chemical Dose	mg/L	6	6	1.00	mg/L	6	6	
CPES Chemical Dose	mg/L	0	0	1.00	mg/L	0	0	
Design Chemical Feed Rate	kg/d	486.34	0.00	0.45	lbs/day	1,072.19	0.00	
Liquid Sodium Hypochlorite D YES								
Percent Active Chemical	%	12.50%	12.50%		%	12.50%	12.50%	
Bulk Chemical Specific Gravity		1.21	1.21			1.21	1.21	
Active Chemical Form for Dosage Basis		Cl_2	Cl_2			Cl_2	Cl_2	
Active Chemical Concentration	kg/m3	151.16	151.16	119.83	lb/gal	1.26	1.26	
Design Chemical Dose	mg/L	6	6	1.00	mg/L	6	6	
CPES Chemical Dose	mg/L	6	6	1.00	mg/L	6	6	
Design Chemical Feed Rate	kg/d	486.34	486.34	0.45	lbs/day	1,072.19	1,072.19	
Chlorine Gas Disinfection NO								
Sizing Information								
Maximum Temperature of Effluent to be Disinfected	deg-C	20	20	Special	deg-F	68	68	
Maximum pH of Effluent to be Disinfected		7.00	7.00	1.00		7.00	7.00	
Desired Chorine Storage	days	7.00	7.00	1.00		7.00	7.00	
Initial Chlorine Dose	mg/L	10	10	1.00		10	10	
CPES Initial Chlorine Dose	mg/L	0	0	1.00	mg/L	0	0	
Residual Chlorine Dose	mg/L	2	2	1.00	mg/L	2	2	
CPES Residual Chlorine Dose	mg/L	0	0	1.00	mg/L	0	0	
Disinfection Contactor Design Hydraulic Retention Time	min	30.00	30.00	1.00	min	30	30	
Liquid Sodium Bisulfite YES								
Percent Active Chemical	%	38.00%	38.00%		%	38.00%	38.00%	
Bulk Chemical Specific Gravity		1.34	1.34			1.34	1.34	
Active Chemical Form for Dosage Basis		SO_2	SO_2			SO_2	SO_2	
Active Chemical Concentration	kg/m3	508.89	508.89	119.83	lb/gal	4.25	4.25	
Design Chemical Dose	mg/L	3	3	1.00	mg/L	3	3	
CPES Chemical Dose	mg/L	3	3	1.00	mg/L	3	3	
Design Chemical Feed Rate	kg/d	243.17	243.17	0.45	lbs/day	536.10	536.10	
UV Disinfection NO								
Sizing Information								
System Type Closed Vessel								
Design Value of UV Transmittance	%/cm	65%	65%	1.00		65%	65%	
Design Value of UV Absorbance	1/cm	5.00	5.00	1.00		5.00	5.00	
Lamp rating	kW/lamp	0.40	0.40		kW/lamp	0.40	0.40	
Total lamps	lamps	288	288	1.00	lamps	288	288	
Total connected load	kW	115	115		kW	115	115	
Design average flow	m3/day	84,794	84,794		MGD	22.40	22.40	
Design peak flow	m3/day	127,191	127,191		MGD	33.60	33.60	
% of lamps on at average flow	%	67%	67%		%	67%	67%	
Avg. power use	kW	77	77		kW	77	77	
Dosage	mJ/cm2	40	40	1.00	mJ/cm2	40	40	
CPES UV Dose	mg/L	0	0	1.00	mg/L	0	0	
Primary Clarifiers: Main								
Sizing Information								
Total Area	m2	1,942	1,942	0.09	ft2	20,900	20,900	
Side Water Depth	m	N/A	5.5	0.30	ft	N/A	18	
Number of duty units		N/A	10	1.00		N/A	10	
Number of Standby units			0	1.00		N/A	0	
Total number of units			10	1.00		N/A	10	
Area per Clarifier	m2		194	0.09	ft2	0	2,090	
Clarifier Configuration Rectangular								
Clarifier Width	m		6.1	0.30	ft	N/A	20	
Clarifier Length	m		31.9		ft	N/A	105	
Clarifier Sludge Collector								
Duty Unit Connected Power, ea	kW		1.5	1.34	hp		2.0	
Average Power Usage Factor			0.75	1.00			0.75	
Average Power Input to Motor per Unit	kW		1.1	1.34	hp		1.5	
Peak Power Usage Factor			0.90	1.00			0.90	
Peak Power Input to Motor per Unit	kW		1.3	1.34	hp		1.8	
Primary Clarification Power								
Average Power	kW		16.7	1.34	hp		22.3	
Peak Power	kW		37.6	1.34	hp		50.4	
Operating Information								
Flow								
Average Design Flow	m3/day	98,623	98,623	3,785.00	MGD	26.06		
Peak Diurnal Design Flow	m3/day	158,418	158,418	3,785.00	MGD	41.85		
Hydraulic Loading Rate								
Average Design Flow	m/day	51	51		gpd/ft2	1,240	1,247	
Peak Diurnal Design Flow	m/day	81	82		gpd/ft2	1,978	2,003	
Chemical Addition System								
Chemical Added		Ferric Chloride	Ferric Chloride			Ferric Chloride	Ferric Chloride	
Dosage	mg/L	0	0		mg/L	0	0	
CPES Alum Dose	mg/L		0		mg/L		0	
CPES Ferric Chloride Dose	mg/L		0		mg/L		0	
Average Feed Rate	kg/d	0	0	0.45	lbs/d	0	0	
	m3/d	0.0	0.0	264.17	gpd	0	0	
Peak Diurnal Feed Rate	kg/d	0	0	0.45	lbs/d	0	0	
	m3/d	0.0	0.0	264.17	gpd	0	0	
Storage Tank Information								
Storage Time at Average	days		30				30	
Safety Factor on Average Flow			2				2	
Number of Tanks			2				2	
Minimum Capacity of Tank	m3		0.0		gallons		0	
Pump Information								
Safety Factor on Peak Diurnal			1.50				1.50	
Number of Duty Units			2				2	
Number of Standby Units			1				1	
Total Number of Units			3				3	
Capacity per Unit	lph		0.0	3.79	gph		0.0	
Minimum Turndown Capacity	%		20%				20%	
Polymer Addition? No								
Average Dosage	mg/L		1			mg/L	1	
Average Usage	kg/d		98.6	0.45		lbs/d	217.4	
Peak Dosage	mg/L		2			mg/L	2	
Peak Usage	kg/d		316.8	0.45		lbs/d	698.5	
Primary Dilution Polymer Concentration	wt%		0.10%	1.00		wt%	0.10%	
Primary Dilution Water	m3/d		98.5	264.17		gpd	26,027	
Secondary Dilution Polymer Concentration	wt%		0.05%	1.00		wt%	0.05%	
Secondary Dilution Water	m3/d		98.6	264.17		gpd	26,053	
Sludge Pumping								
Primary Sludge Flow								
Average Design Flow	m3/day	558.1	558.1	0.00	GPD	147,441	147,441	
Solids Concentration	mg/L	30,000	30,000	1.00	mg/L	30,000	30,000	
Peak Diurnal Design Flow	m3/day	1,923.7	1,923.7	0.00	GPD	508,235	508,235	
Solids Concentration	mg/L	30,000	30,000	1.00	mg/L	30,000	30,000	
Primary Sludge Pump Capacity								
Hours of Operation			8	1.00			8	

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Safety Factor on Peak Diurnal			1.30	1.00			1.30	
Number of Duty Units			10	1.00			10	
Capacity Per Unit	m3/hr		31.3	0.00	gal/hr		8,259	
Number of Standby Units			0	1.00			0	
Total Number of Units			10	1.00			10	
Primary Sludge Pump Sizing								
Capacity Per Unit	m3/hr		31.3		gal/min		138	
Total Dynamic Head	m		22.9	3.28	ft		75	
Pump Efficiency			30%				30%	
PSD Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		6.5		HP		8.7	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		7.2		HP		9.7	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			1.00	1.00			1.00	
CPES Life Cycle Average Capacity Per Unit	m3/hr		2.3	4.40	gal/min		10	
CPES Life Cycle Average Power to Motor Per Unit	kW		0.5		HP		0.7	
Primary Scum Pump Sizing								
Raw Sewage Primary Scum Concentration	mg/L	25	25	1.00		25	25	
Primary Scum Load	kg/d	2,466	2,466	0.45	lbs/d	5,436	5,436	
Primary Scum TS Concentration	mg/L	50,000	50,000	1.00	mg/L	50,000	50,000	
Primary Scum Volume	m3/d	49.3	49.3	0.00	GPD	13,028	13,028	
Pumping Frequency per Day	times/day		2	1.00	times/day		2	
Pumping Drawdown Time	min		10	1.00	min		10	
Pumping Capcity Required	m3/hr		147.9	4.40	gal/min		651	
Total Number of Units			1	1.00			1	
Capacity Per Unit	m3/hr		147.9	4.40	gal/min		651	
Total Dynamic Head	m		15	3.28	ft		50	
Pump Efficiency			60%				60%	
PSM Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		10.2	1.34	HP		13.7	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		11.4		HP		15.3	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		1.5	4.40	gal/min		7	
CPES Life Cycle Average Power to Motor Per Unit	kW		0.1		HP		0.2	
Flow Splitter: PC_Eff								
Operating Information								
Splitter Influent Flow	m3/day	98,065	98,065	3,785	25.91	25.91		
PC_Eff Splitter Effluent (SplitE) PBNRHighRateAS								
Percent Split		100%	0.999			100%		
Flow	m3/day	97,967	97,967	3,785	25.88	25.88		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.4845	3.2808		1.59		
PC_Eff Splitter Effluent (SplitE) CNodePBNR_Eff								
Percent Split		0%	0.001			0%		
Flow	m3/day	98	0	3,785	0.03	0.03		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0048	3.2808		0.02		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Biological Process - PBNR: HighRateAS								
Sizing Information								
Total Bioreactor Volume	m3	11,356	11,356	3,785.44	MG	3.00	3.00	
Bioreactor Sidewater Depth	m	6.1	6.10	0.30	ft	20	20.00	
Number of duty Units		N/A	4	1.00		N/A	4	
Number of Standby Units			0	1.00			0	
Total number of Units			4	1.00			4	
Single Tank Information								
Volume per Bioreactor	m3		2,839	3,785.00	MG	0	0.75	
Area per Bioreactor	m2		466		ft2		5,013	
Number of Passes			3	1.00			3	
Pass Width	m		4.57	0.30	ft		15.0	
Pass Length	m		33.95	0.30	ft		111.4	
Number of Bioreactor Zones Separated by Walls			4	1.00			4	
Total Baffle Wall Length	m		13.7		ft		45.0	
Total Pass Wall Length	m		59.0		ft		193.0	
Nitrified Recycle Pump Sizing per Bioreactor								
Included? No								
Type of Recycle Pump? Axial-Flow								
Total Number of Units			2	1.00			2	
Capacity Per Unit	m3/hr		5.68	4.40	gal/min		25	
Total Dynamic Head	m		3.05	3.28	ft		10.00	
Pump Efficiency			60%	1.00			60%	
NR Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		0.08	1.34	HP		0.11	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		0.09		HP		0.12	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		0.0	4.40	gal/min		0	
CPES Life Cycle Average Power to Motor Per Unit	kW		0.0		HP		0.0	
Anoxic Recycle Pump Sizing per Bioreactor								
Included? No								

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Type of Recycle Pump?								
Axial-Flow								
Total Number of Units			2	1			2	
Capacity Per Unit	m3/hr		5.68	4.40	gal/min		25.00	
Total Dynamic Head	m		3.05	3.28	ft		10.00	
Pump Efficiency			60%	1.00			60%	
AR Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		0.1	1.34	HP		0.1	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		0.1		HP		0.1	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		0.0	4.40	gal/min		0	
CPES Life Cycle Average Power to Motor Per Unit	kW		0.0		HP		0.0	
Mixers								
Number of Submersible Mixers per Bioreactor			0	1.00			0	
Motor HP per Mixer	kW		0.00	1.34			0.00	
Biological Process - PBNR Power								
Average Power	kW		1,243	1.34	hp		1,667	
Peak Power	kW		1,181	1.34	hp		1,584	
Operating Information								
Total SRT (Anaerobic + Anoxic + Aerobic)	days		1.0		days		1.0	
Average MLSS Concentration	mg/L		2,520		mg/L		2,520	
Bioreactor Effluent MLSS Concentration	mg/L		2,517		mg/L		2,517	
Observed Net Yield (TSS/BOD_5)	mg/mg		2.52		lb/lb		2.52	
Bioreactor Volume % Aerated	%		100%		%		100%	
Bioreactor Volume % non-aerobic	%		0%		%		0%	
Bioreactor Volume % aerobic	%		100%		%		100%	
Aeration System - NOTE: For MBRs the last Tank's Load is Excluded								
Actual Oxygen Requirement (AOR)								
Average Daily	kg/day O2	17,918		0.45	lb/day O2	39,502		
Peak Diurnal	kg/day O2	15,496		0.45	lb/day O2	34,162		
Standard Oxygen Requirement (SOR)								
Average AOR/SOR		0.28	0.28	1.00		0.28	0.28	
Average Daily	kg/hr O2		2,700	0.45	lb/hr O2		5,953	
Peak Diurnal	kg/hr O2		2,335	0.45	lb/hr O2		5,148	
Standard Oxygen Transfer Efficiency (SOTE) %		25%	25%	1.00		25%	25%	
Blower Capacity - EXCLUDING MBR TANK								
Average air rate	Nm3/hr		39,224	1.70	scfm		23,084	
Peak Diurnal Air Rate	Nm3/hr		33,922	1.70	scfm		19,963	
Safety Factor on Peak Diurnal			1.00	1.00			1.00	
Blower Type?								
Multi-Stage								
Number of Duty Units			4	1.00			4	
Number of Standby Units			1	1.00			1	
Total Number of Units			5	1.00			5	
Capacity Per Unit	Nm3/hr		8,480	1.70	scfm		4,991	
Estimated Discharge Pressure	kPa	73	73.46	6.89	psig	10.65	10.65	
Maximum Ambient Air Temperature	deg-C		37.78	Special	deg-F		100	
Atmospheric Pressure	kPa		100.97	6.89	psia		14.65	
Blower Efficiency	%		70%		%		70%	
Estimated Blower Motor	kW		230	0.75	HP		308	
Motor Type Constant Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			1.00	1.00			1.00	
CPES Life Cycle Average Capacity Per Unit	Nm3/hr		9,806	4.40	scfm		5,771	
CPES Life Cycle Average Power to Motor Per Unit	kW		266	0.75	HP		356	
Fine Bubble Diffuser Aeration System								
Design Condition?			MM				MM	
Est. Diffuser Air Rate	Nm3/hr/diffuser		4.25	1.70	scfm/diffuser		2.50	
Air Rate with all Blowers in Service	Nm3/hr/diffuser		4.17	1.70	scfm/diffuser		2.46	
PBNR air rate	Nm3/hr		39,224	1.70	scfm		23,084	
Safety Factor on PBNR air rate			1.00	1.00			1.00	
Air Rate with Safety Factor	Nm3/hr		39,224	1.70	scfm		23,084	
Est. Total Diffusers (w/ 10% spare)			10,157				10,157	
Diffusers per Bioreactor			2,539				2,539	
Metal Salt Chemical Addition System								
Chemical Added?		No	No			No	No	
Dosage	mg/L	N/A	N/A		mg/L	N/A	N/A	
CPES Alum Dose	mg/L		0.00		mg/L		0.00	
CPES Ferric Chloride Dose	mg/L		N/A		mg/L		N/A	
Average Feed Rate	kg/d	0	0	0.45	lbs/d	0	0	
	m3/d	0	0.00	264.17	gpd	0	0	
Peak Diurnal Feed Rate	kg/d	0	0	0.45	lbs/d	0	0	
	m3/d	0	0.00	264.17	gpd	0	0	
Storage Tank Information								
Storage Time at Average	days		30				30	
Safety Factor on Average Flow			1.5				1.5	
Number of Tanks			2				2	
Minimum Capacity of Tank	m3		0		gallons		0	
Pump Information								
Safety Factor on Peak Diurnal			1.5				1.5	
Number of Duty Units			2				2	
Number of Standby Units			1				1	
Total Number of Units			3				3	
Capacity per Unit	lph		0	3.79	gph		0	
Minimum Turndown Capacity	%		20%				20%	
Alkalinity Addition								
Caustic Included? NO								
Sizing Information								
Percent Active Chemical	%	93%	93%	1.00	%	93%	93%	
Bulk Chemical Specific Gravity		1.83	1.83	1.00		1.83	1.83	
Active Chemical Form for Dosage Basis		NaOH	NaOH	1.00		NaOH	NaOH	
Active Chemical Concentration	kg/m3	1,701	1,701	119.82	lb/gal	14.19	14.19	
Alkalinity Added, mg $CaCO_3$/L per mg/L chem		1.25	1.25	1.00		1.25	1.25	
Alkalinity Required, as $CaCO_3$	mg/L	0	0	1.00	mg/L	0	0	
Design Chemical Dose	mg/L	0	0	1.00	mg/L	0	0	
CPES Chemical Dose	mg/L	0	0	1.00	mg/L	0	0	
Design Chemical Feed Rate	kg/d	0	0	0.45	lbs/day	0	0	
Lime Included? NO								
Sizing Information								
Percent Active Chemical	%	90%	90%	1.00	%	90%	90%	
Active Chemical Form for Dosage Basis		$Ca(OH)_2$	$Ca(OH)_2$	1.00		$Ca(OH)_2$	$Ca(OH)_2$	
Active Chemical Concentration	kg/m3	3,595	3,595	119.82	lb/ft3	30.0	30.0	
Alkalinity Added, mg $CaCO_3$/L per mg/L chem		1.35	1.35	1.00		1.35	1.35	
Alkalinity Required, as $CaCO_3$	mg/L	0	0	1.00	mg/L	0	0	
Design Chemical Dose	mg/L	0	0	1.00	mg/L	0	0	
CPES Chemical Dose	mg/L	0	0	1.00	mg/L	0	0	
Design Chemical Feed Rate	kg/d	0	0	0.45	lbs/day	0	0	
Chemical Oxygen Demand Addition								
Methanol Included? NO								
Sizing Information								
Percent Active Chemical	%	99.85%	99.85%		%	99.85%	99.85%	
Bulk Chemical Specific Gravity		0.79	0.79			0.79	0.79	
Active Chemical Form for Dosage Basis		CH_3OH	CH_3OH			CH_3OH	CH_3OH	
Active Chemical Concentration	kg/m3	789.3	789.3	119.83	lb/gal	6.59	6.59	
Design Chemical Dose	mg/L	0	0	1.00	mg/L	0	0	
CPES Chemical Dose	mg/L	0	0	1.00	mg/L	0	0	
Design Chemical Feed Rate	kg/d	0	0	0.45	lbs/day	0	0	

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Bioreactor Clarifier								
Sizing Information								
Total Area	m2	3,716	**3,716**	0.09	ft2	40,000	**40,000**	
Depth	m	N/A	**5**	0.30	ft	N/A	**16**	
Number of duty Units		N/A	**4**	1.00		N/A	**4**	
Number of Standby Units			**0**	1.00			**0**	
Total number of Units			4	1.00			4	
Area per unit	m2		929	0.09	ft2		10,000	
Clarifier Configuration **Circular**								
Clarifier Width (for rectangular only)	m		**6.10**	0.30	ft		**20.0**	
Clarifier Diameter	m		34.39	0.30	ft		112.8	
Operating Information								
Average Conditions								
Average Flow	m3/d	91,133	91,133	3,785.00	MGD	24.08	24.08	
Overflow Rate	m/d	25	24.5	0.04	gpd/ft2	602	602	
Solids Loading Rate	kg/d/m2	166	165.6	4.88	lbs/d/ft2	33.9	33.9	
Underflow Solids Concentration	mg/L	4,097	4,097	1.00	mg/L	4,097	4,097	
Peak Conditions								
Peak Flow	m3/d	145,684	145,684	3,785.00	MGD	38.49	38.49	
Overflow Rate	m/d	39	39	0.04	gpd/ft2	962	962	
Solids Loading Rate	kg/d/m2	227	227	4.88	lbs/d/ft2	46.5	46.5	
Underflow Solids Concentration	mg/L	5,039	5,039	1.00	mg/L	5,039	5,039	
Secondary Rake Drive								
Motor Size	kW		**0.75**	1.34	hp		**1.00**	
Average Power Usage Factor			**75%**	1.00			**75%**	
Average Power Input to Motor per Unit	kW		0.56	1.34	hp		0.75	
Peak Power Usage Factor			**90%**	1.00			**90%**	
Peak Power Input to Motor per Unit	kW		0.67	1.34	hp		0.90	
Secondary Scum Pump Sizing								
Total Number of Units			**2**	1.00			**2**	
Capacity Per Unit	m3/hr		**23**	4.40	gal/min		**100**	
Total Dynamic Head	m		**9.14**	3.28	ft		**30.00**	
Pump Efficiency			**70%**	1.00			**70%**	
SSM Specific Weight	kg/m3		**1,000**	16.02	lb/ft3		**62.43**	
Break Horsepower per Unit	kW		0.8	1.34	HP		1.1	
Motor Efficiency			**90%**	1.00			**90%**	
Power Input to Motor per Unit	kW		0.9		HP		1.2	
CPES Life Cycle Average Capacity Safety Factor			**75%**	1.00			**75%**	
CPES Life Cycle Average Capacity Per Unit	m3/hr		17	4.40	gal/min		75	
CPES Life Cycle Average Power to Motor Per Unit	kW		0.7		HP		0.9	
Cannibal Information (if used, assumes first tank is IC tank, and screenings are taken from last tank)								
Bioreactor Influent BOD Load	kg/d	10,824	10,824	0.45	lbs/d	23,862	23,862	
Bioreactor Influent Xi Load	kg/d	32,124	32,124	0.45	lbs/d	70,822	70,822	
Interchange Tanks Size	m3	3,407	**3,407**	3,785.44	MG	0.90	**0.90**	
Interchange Tank Feed Rate	m3/d	146,951	**146,951**	3,785.44	MGD	38.82	**38.82**	
Interchange Tank Decant Rate	m3/d	0	**0**	3,785.44	MGD	0.00	**0.00**	
Interchange Tank Concentration	mg/L	2,522	2,522	1.00	MGD	2,522	2,522	
Screenings Production	m3/d	0.0	**0.0**	0.00	gpd	0	**0**	
Screenings Concentration	mg/L	0	**0**	1.00	mg/L	0	**0**	
Membrane Bioreactor	GE/Zenon							
Flow								
Average Design Flow	m3/day	97,967	97,967	3,785.00	MGD	25.9		
Peak Diurnal Design Flow	m3/day	156,337	156,337	3,785.00	MGD	41.3		
Membrane Bioreactor Sidewater Depth	m	6	**2.4**	0.30	ft	20	**8**	
Minimum Water Temperature	oC	15	15		oC	15	15	
Design Membrane Net Flux Rate	lmh		17.0	1.70	gfd		10.0	
Minimum Required Membrane Area	m2		223,667	10.76	ft2		2,407,464	
Membrane Module Area	m2		32	10.76	ft2		340	
Number of Modules			7,081				7,081	
Minimum Percent Spare Modules in a Tank			**10%**				**10%**	
Number of Modules per Cassette/Rack		48	**48**			48	**48**	
Total Number of Cassettes/Racks			163				163	
Number of Duty Membrane Basins			**4**	1.00			**4**	
Number of Standby Membrane Basins			**1**				**1**	
Total Number of Membrane Basins			5				5	
Actual Number of Cassette Slots per Membrane Tank			41				41	
Actual Percent Spare Membrane Area			11%				11%	
Volume Requirement per Cassette/Rack	m3	20	**20.18**	264.17	gallons	5,330	**5,330**	
Estimated Single Membrane Tank Volume	m3		827.23		gallons		218,530	
Air Rate per Module	Nm3/hr		20	1.70			11.80	
Total Membrane Tank Scouring Air Rate	Nm3/hr		35,495	1.70	scfm		20,889	
Permeate Pump Sizing								
MBR Effluent Flow								
Average Design Flow	m3/day	91,133	91,133	3,785.00	MGD	24.08		
Peak Diurnal Design Flow	m3/day	145,684	145,684	3,785.00	MGD	38.49		
Number of Duty Units			**4**	1.00			**4**	
Number of Standby Units			**1**	1.00			**1**	
Total Number of Units			5	1.00			5	
Safety Factor on Peak Diurnal			**1.50**	1.00			**1.50**	
Capacity Per Unit	m3/hr		2,276	0.23	gal/min		10,023	
Trans Membrane Pressue (TMP)	kPa	**34**	**34**	6.89	psi	**5.0**	**5.0**	
Static Discharge Head	m		**1.52**	3.28	ft	**5.0**	**5.0**	
Total Dynamic Head	m		5.05	3.28	ft		16.56	
Pump Efficiency			**80%**	1.00			**80%**	
ML Specific Weight	kg/m3		**1,000**	16.02	lb/ft3		**62.43**	
Break Horsepower per Unit	kW		39.11	1.34	HP		52.47	
Motor Efficiency			**90%**	1.00			**90%**	
Power Input to Motor per Unit	kW		43.45		HP		58.30	
Motor Type **Adjustable-Speed**								
Minimum Turndown Capacity			**40%**	1.00			**40%**	
CPES Life Cycle Average Capacity Safety Factor			**1.00**	1.00			**1.00**	
CPES Life Cycle Average Capacity Per Unit	m3/hr		949	4.40	gal/min		4,180	
CPES Life Cycle Average Power to Motor Per Unit	kW		18.1		HP		24.3	
Air Scour Blower Sizing								
Safety Factor on Peak Diurnal			**1.00**	1.00			**1.00**	
Blower Type?								
Positive-Displacement								
Number of Duty Units			**4**	1.00			**4**	
Number of Standby Units			**1**	1.00			**1**	
Total Number of Units			5	1.00			5	
Capacity Per Unit	Nm3/hr		8,874	1.70	scfm		5,222	
Estimated Discharge Pressure	kPa	38	37.66	6.89	psig	5	5.46	
Maximum Ambient Air Temperature	deg-C		**37.78**	Special	deg-F		**100**	
Atmospheric Pressure	kPa		100.97	6.89	psia		14.65	
Blower Efficiency	%		**70%**		%		**70%**	
Estimated Blower Motor	kW		135	0.75	HP		181	
Motor Type **Constant Speed**								
Minimum Turndown Capacity			**40%**	1.00			**40%**	
CPES Life Cycle Average Capacity Safety Factor			**1.00**	1.00			**1.00**	
CPES Life Cycle Average Capacity Per Unit	Nm3/hr		8,874	4.40	scfm		5,222	
CPES Life Cycle Average Power to Motor Per Unit	kW		135	0.75	HP		181	
Mixed-Liquor Recirculation Flow								
Design MLR Flow	m3/day	#N/A	#N/A	3,785.00	MGD	#N/A	#N/A	
Membrane Tank Design Feed Flow	m3/day	#N/A	#N/A	3,785.00	MGD	#N/A	#N/A	
MLR Maximum Flow Percentage of Design	%	500%	**500%**		%	500%	**500%**	
Peak MLR Flow	m3/day	489,836	489,836	3,785.00	MGD	129.42	129.42	
Peak Membrane Tank Feed Flow	m3/day	646,173	646,173	3,785.00	MGD	170.72	170.72	
MLR Pump Sizing								
MLR Pump Location **Feed**								

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Number of Duty Units			2	1.00			2	
Number of Standby Units			1	1.00			1	
Total Number of Units			3	1.00			3	
Capacity Per Unit	m3/hr		13,462	0.23	gal/min		59,273	
Total Dynamic Head	m		3.05	3.28	ft		10.00	
Pump Efficiency			80%	1.00			80%	
ML Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		139.7	1.34	HP		187.4	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		155.2		HP		208.2	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		#N/A	4.40	gal/min		#N/A	
CPES Life Cycle Average Power to Motor Per Unit	kW		#N/A		HP		#N/A	
Return Activated Sludge (RAS) Pumping								
RAS Flow								
Average Design Flow	m3/day	146,490	146,490	3,785.00	MGD	38.70	38.70	
Solids Concentration	mg/L	4,097	4,097	1.00	mg/L	4,097	4,097	
Peak Diurnal Design Flow	m3/day	156,337	156,337	3,785.00	MGD	41.30	41.30	
Solids Concentration	mg/L	5,039	5,039	1.00	mg/L	5,039	5,039	
RAS Pump Capacity								
Hours of Operation per Day			24.00	1.00			24.00	
Flow Safety Factor on Peak Diurnal			1.00	1.00			1.00	
Number of Duty Units			3	1.00			3	
Number of Standby Units			1	1.00			1	
RAS Pump Sizing								
Total Number of Units			4	1.00			4	
Capacity Per Unit	m3/hr		2,171	0.23	gal/min		9,560	
Total Dynamic Head	m		9.14	3.28	ft		30.00	
Pump Efficiency			75%	1.00			75%	
RAS Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		72.1	1.34	HP		96.7	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		80.1		HP		107.5	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		1,526	4.40	gal/min		6,719	
CPES Life Cycle Average Power to Motor Per Unit	kW		56.3		HP		75.5	
Waste Activated Sludge (WAS) Pumping								
WAS Flow								
Average Design Flow	m3/day	6,650	6,650	0.00	GPD	1,756,945	1,756,945	
Solids Concentration	mg/L	4,097	4,097	1.00	mg/L	4,097	4,097	
Peak Diurnal Design Flow	m3/day	10,653	10,653	0.00	GPD	2,814,502	2,814,502	
Solids Concentration	mg/L	5,039	5,039	1.00	mg/L	5,039	5,039	
WAS Pump Capacity								
Hours of Operation			24.00	1.00			24.00	
Safety Factor on Peak Diurnal			1.00	1.00			1.00	
Number of Duty Units			2	1.00			2	
Number of Standby Units			1	1.00			1	
WAS Pump Sizing								
Total Number of Units			3	1.00			3	
Capacity Per Unit	m3/hr		221.94	0.23	gal/min		977.18	
Total Dynamic Head	m		9.14	3.28	ft		30.00	
Pump Efficiency			70%	1.00			70%	
WAS Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		7.89	1.34	HP		10.59	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		8.77		HP		11.77	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		103.9	4.40	gal/min		457.5	
CPES Life Cycle Average Power to Motor Per Unit	kW		4.1		HP		5.5	
Trickling Filter: FGR								
Sizing Information								
Total Area	m2	1,853	1,853	0.09	ft2	19,943	19,943	
Depth	m	5.79	5.79	0.30	ft	19.0	19.0	
Volume	m3	10,729	10,729	0.03	ft3	378,900	378,912	
Number of duty units		N/A	3	1.00		N/A	3	
Number of Standby units			0	1.00			0	
Total number of units			3	1.00			3	
Area per unit	m2		618	0.09	ft2		6,648	
Unit Diameter	m		28.0	0.30	ft		92	
Trickling Filter Power								
Average Power	kW		#REF!	1.34	hp		#REF!	
Peak Power	kW		17.5	1.34	hp		23.4	
Operating Information								
Average Conditions								
Wetting Hydraulic Load (WHL)	m/d	98.5	98.5	58.67	gpm/ft2	1.7	1.7	
Total Organic Load (TOL)	kg/m3/d	0.1	0.1	0.02	lb/1,000 ft3/d	4	4	
Peak Conditions								
Wetting Hydraulic Load (WHL)	m/d	128	128	58.67	gpm/ft2	2.2	2.2	
Total Organic Load (TOL)	kg/m3/d	0.1	0.1	0.02	lb/1,000 ft3/d	4	4	
Recirculation Pumping								
Recirculation Flow								
Average Design Flow	m3/day	6,367		0.00	MGD	24.1		
Peak Diurnal Design Flow	m3/day	6,367		0.00	MGD	24.1		
Recirculation Pump Capacity								
Safety Factor on Peak Diurnal			2.00	1.00			2.00	
Number of Duty Units			2	1.00			2	
Capacity Per Unit	m3/hr		265.3	0.00	gpm		70,094	
Number of Standby Units			1	1.00			1	
Total Number of Units			3	1.00			3	
Recirculation Pump Sizing								
Capacity Per Unit	m3/hr		265.3		gal/min		1,168	existing pumps are 11
Total Dynamic Head	m		7.6	3.28	ft		25	
Pump Efficiency			70%				70%	
PSD Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		7.9	1.34	HP		10.6	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		8.7		HP		11.7	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
Flow Splitter: TF_Eff								
Operating Information								
Splitter Influent Flow	m3/day	91,231	91,231	3,785	24.10	24.10		
TF_Eff Splitter Effluent (SplitE) GMFMain								
Percent Split		100%	0.999			100%		
Flow	m3/day	91,140	91,140	3,785	24.08	24.08		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.4618	3.2808		1.51		
TF_Eff Splitter Effluent (SplitE) WetlandWetland								
Percent Split		0%	0.001			0%		
Flow	m3/day	91	0	3,785	0.02	0.02		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0046	3.2808		0.02		
Percent Split		0%	0			0%		

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Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Percent Split		0%	0			0%		
Flow	m3/day	0	0	3,785	0.00	0.00		
Flat Weir Width	meters		1.83	3.2808		6.00		
Weir Head	meters		0.0000	3.2808		0.00		
Filters: Main								
Filter Type	**Granular Media**							
Sizing Information								
Total Area	m2	357	357	0.09	ft2	3,840	3,840	
Bed Depth	m	N/A	1.22	0.03	inches	N/A	48	anthracite
Number of duty units		N/A	4	1.00		N/A	4	
Number of Standby units			0	1.00		N/A	0	
Total number of units			4.00	1.00		N/A	4	
Area per Filter	m2		89.18	0.09	ft2	0	960	
Filter Bed Width	m		9.14	0.30	ft	N/A	30.00	
Filter Bed Length	m		9.75		ft	N/A	32.00	
Operating Information								
Flow Rates								
Average Design Flow	m3/day	91,140	91,140	3,785.00	MGD	24.1	24.1	
Peak Diurnal Design Flow	m3/day	145,695	145,695	3,785.00	MGD	38.5	38.5	
Influent TSS								
Average	mg/L	14	14		mg/L	14	14	
Peak	mg/L	19	19		mg/L	19	19	
Hydraulic Load								
Average Design Load	m/day	227	255	58.67	gpd/ft2	3.9	3.9	
Peak Diurnal Design Laod	m/day	380	408	58.67	gpd/ft2	6.5	6.5	designed for 5.8 gal/s
Unit Process Power Usage								
Average Power	kW		48.87	1.34	hp		65.54	
Peak Power	kW		439.87	1.34	hp		589.86	
Chemical Addition System								
Chemical Added		FeCl3				FeCl3		
Dosage	mg/L	0	0		mg/L	0	0	
CPES Alum Dose	mg/L		0		mg/L		0	
CPES Ferric Chloride Dose	mg/L		0		mg/L		0	
Average Feed Rate	kg/d	0	0	0.45	lbs/d	0	0	
	m3/d	0.0	0.0	264.17	gpd	0	0	
Peak Diurnal Feed Rate	kg/d	0	0	0.45	lbs/d	0	0	
	m3/d	0.0	0.0	264.17	gpd	0	0	
Storage Tank Information								
Storage Time at Average	days		30				30	
Safety Factor on Average Flow			1.50				1.50	
Number of Tanks			2				2	
Minimum Capacity of Tank	m3		0		gallons		0	
Pump Inormation								
Safety Factor on Peak Diurnal			1.50				1.50	
Number of Duty Units			2				2	
Number of Standby Units			1				1	
Total Number of Units			3				3	
Capacity per Unit	lph		0.00	3.79	gph		0.00	
Minimum Turndown Capacity	%		20%				20%	
Backwash Pumping								
Backwash Water								
Instantaneous Design Flow	m3/hr	7,631		0.23	gpm	33,598		
Solids Concentration	mg/L	109		1.00	mg/L	109		
Average Daily Design Flow	m3/day	10,175		0.00	GPD	2,688,160		
Backwash Pump Capacity								
Daily Operation Time	min		80	1.00	min		80	
Safety Factor on Peak Diurnal			1.00	1.00			1.00	
Number of Duty Units			2	1.00			2	
Capacity Per Unit	m3/hr		3,816	0.23	gpm		16,799	
Number of Standby Units			1	1.00			1	
Total Number of Units			3	1.00			3	
Backwash Pump Sizing								
Capacity Per Unit	m3/hr		3,815.5		gal/min		16,799.0	
Total Dynamic Head	m		15.24	3.28	ft		50.00	
Pump Efficiency			80%				80%	
Tertiary SD Specific Weight	kg/m3		1,000	16.02	lb/ft3		62.43	
Break Horsepower per Unit	kW		197.94	1.34	HP		265.55	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		219.93		HP		295.05	
Motor Type	**Constant Speed**							
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Per Unit	m3/hr		423.9	4.40	gal/min		1,867	
CPES Life Cycle Average Power to Motor Per Unit	kW		24.4		HP		32.8	
Wetlands Node: Wetland								
Operating Information								
Flow								
Average Design Flow	m3/day	91.23		3785	MGD	0.02		
Peak Diurnal Design Flow	m3/day	145.84		3785	MGD	0.04		
Solids Load								
Average Design Load	kg/day	1.01		2.2046	lbs/day	0.46		
Peak Diurnal Design Load	kg/day	2.73		2.2046	lbs/day	1.24		
Wetland Parameters								
Area	ha	0.04		2.4700	acres	0.1		
Percent Open Water	%	40%			%	40%		
Marsh Area Depth	m	0.30		3.2808	feet	1.00		
Deep Area Depth	m	1.52		3.2808	feet	5.00		
Total Volume	m3	309		0.0003	MG	0.08		
Average Design Hydraulic Loading Rate	cm/d	23.38		2.5400	in/day	9.20		
Average Design Hydraulic Retention Time	days	3.39			days	3.39		
Number of wetland cells	#	1			#	1		

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Primary Sludge Thickening: Gravity								
Sizing Information								
Thickener Feed Rates								
Average Design Flow	m3/day	7,208		0.00	GPD	1,904,387		
Average Solids Concentration	mg/L	6,103		1.00	mg/L	6,103		
Average Solids Loading	kg/hr ds	1,833		0.45	lb/hr ds	4,041		
Peak Diurnal Design Flow	m3/day	12,577		0.00	GPD	3,322,737		
Peak Solids Concentration	mg/L	8,857		1.00	mg/L	8,857		
Peak Solids Loading	kg/hr ds	4,641		0.45	lb/hr ds	10,233		
Thickener Equipment **Gravity Thickener**								
Hours of Operation		24	**24**	1.00		24	**24**	
Days Per Week		7	**7**	1.00		7	**7**	
Safety Factor on Peak Diurnal			**1.50**	1.00			**1.50**	
Number of Duty Units			**1**	1.00			**1**	
Capacity Per Unit	m3/hr	524.02	786.04	0.00	gph	138,447	207,671	
	kg DS/hr	4,641.40	6,962	0.45	lbs DS/hr	10,233	15,349	
Number of Standby Units			**1**	1.00			**1**	
Total Number of Units			2	1.00			2.00	
Diameter	m		**3.05**	3.28	ft		**10**	
Hydraulic Loading	m/hr		107.72		gpd/ft2		63,460	
Solids Loading	kg/hr/m2		954	4.88	lbs/hr/ft2		195	
N/A	kW		**15**	1.34	hp		**20**	
Average Power Usage Factor			**0.75**	1.00			**0.75**	
Average Power Input to Motor per Unit	kW		11.2	1.34	hp		15.0	
Peak Power Usage Factor			**0.90**	1.00			**0.9**	
Peak Power Input to Motor per Unit	kW		13.4	1.34	hp		18.0	
Thickener Performance								
Thickened Solids Concentration		60,000		1.00		60,000		
Solids Capture Efficiency		85%		1.00		85%		
Primary Sludge Fermentation								
Primary Sludge Feed VSS	%	76%	76%			76%	76%	
VFA Yield	kg VFA/kg VSS	0.15	0.15		lbs VFA/lb VSS	0	0.15	
Sludge Detention Time	days		**5**		days	**5**		
Sludge Volume	m3		#N/A	0.00	gallons	#N/A		
Thickener Power								
Average Power	kW		141.0	1.34	hp	189.1		
Peak Power	kW		376.2	1.34	hp	504.4		
Thickener Feed Pumping								
Included in Project **Yes**								
Type of Pump **Centrifugal**								
Feed sludge flow								
Average Design Flow	m3/day	7,208		0.00	GPD	1,904,387		
Solids Concentration	mg/L	6,103		1.00	mg/L	6,103		
Peak Diurnal Design Flow	m3/hr	786		6,340.08	GPD	4,983,525		
Solids Concentration	mg/L	8,857		1.00	mg/L	8,857		
Feed Sludge Pump Capacity								
Hours of Operation			24	1.00			24	
Days per Week			7				7	
Safety Factor on Peak Diurnal			**1.00**	1.00			**1.00**	
Number of Duty Units			**1**	1.00			**1**	
Capacity Per Unit	m3/hr		786.04	0.00	gph		207,671.09	
Number of Standby Units			**1**	1.00			**1**	
Total Number of Units			2	1.00			2.00	
Feed Sludge Pump Sizing								
Capacity Per Unit	m3/hr		786.0351		gal/min		3,461.18	
Total Dynamic Head	m		**30.47**	3.28	ft		**100**	
Pump Efficiency			**30%**				**30%**	
Solids Concentration	%		1%		%		1%	
Specific Gravity of Solids			**2.50**				**2.50**	
Sludge Specific Gravity			1.01				1.01	
Sludge Specific Weight	kg/m3		**1,005**	16.02	lb/ft3		**62.73**	
Break Horsepower per Unit	kW		218.54	1.34	HP		293.22	
Motor Efficiency			**90%**	1.00			**90%**	
Power Input to Motor per Unit	kW		242.82		HP		325.79	
Motor Type **Adjustable-Speed**								
Minimum Turndown Capacity			**40%**	1.00			**40%**	
CPES Life Cycle Average Capacity Safety Factor			**1.00**	1.00			**0.75**	
CPES Life Cycle Average Capacity Per Unit	m3/hr		300.34	4.40	gal/min		1,322.39	
CPES Life Cycle Average Power to Motor Per Unit	kW		92.78		HP		124.47	
Thickened Primary Sludge Pumping								
Thickened sludge flow								
Average Design Flow	m3/day	623		0.00	GPD	164,644		
Solids Concentration	mg/L	60,000		1.00	mg/L	60,000		
Average Solids Loading	kg/hr	1,558		0.45	lbs/hr	3,435		
Peak Diurnal Design Flow	m3/day	1,578		0.00	GPD	416,929		
Solids Concentration	mg/L	60,000		1.00	mg/L	60,000		
Peak Solids Loading	kg/hr	3,945		0.45	lbs/hr	8,698		
Thickened Primary Sludge Pump Capacity								
Hours of Operation			**24**	1.00			**24**	
Days per Week			**7**				**7**	
Safety Factor on Peak Diurnal			**1.50**	1.00			**1.50**	
Number of Duty Units			**1**	1.00			**1**	
Capacity Per Unit	m3/hr		98.63	0.00	gph		26,058.04	
Number of Standby Units			**1**	1.00			**1**	
Total Number of Units			2	1.00			2.00	
Thickened Primary Sludge Pump Sizing								
Capacity Per Unit	m3/hr		98.6		gal/min		434.3	
Total Dynamic Head	m		**60.94**	3.28	ft		**200**	
Pump Efficiency			**30%**				**30%**	
Solids Concentration	%		6%		%		6%	
Specific Gravity of Solids			2.50				2.50	
Sludge Specific Gravity			1.04				1.04	
Sludge Specific Weight	kg/m3		**1,037**	16.02	lb/ft3		**64.73**	
Break Horsepower per Unit	kW		56.59	1.34	HP		75.93	
Motor Efficiency			**90%**	1.00			**90%**	
Power Input to Motor per Unit	kW		62.88		HP		84.36	
Motor Type **Adjustable-Speed**								
Minimum Turndown Capacity			**40%**	1.00			**40%**	
CPES Life Cycle Average Capacity Safety Factor			**1.00**	1.00			**1.00**	
CPES Life Cycle Average Capacity Per Unit	m3/hr		25.97	4.40	gal/min		114.33	
CPES Life Cycle Average Power to Motor Per Unit	kW		16.55		HP		22.21	
Recycle Flow Pumping								
Included in Project **Yes**								
Type of Pump **Submersible**								
Thickener Recycle Flow								
Average Design Flow	m3/day	6,585		0.00	GPD	1,739,742		
Solids Concentration	mg/L	1,002		1.00	mg/L	1,002		
Peak Diurnal Design Flow	m3/day	10,998		0.00	GPD	2,905,809		
Solids Concentration	mg/L	1,519		1.00	mg/L	1,519		
Thickener Recycle Pump Capacity								
Hours of Operation			**24**	1.00			**24**	
Days per Week			**7**	1.00			**7**	
Safety Factor on Peak Diurnal			**1.00**	1.00			**1.00**	
Number of Duty Units			**1**	1.00			**1**	
Capacity Per Unit	m3/hr		458.3	0.00	gph		121,075	
Number of Standby Units			**1**	1.00			**1**	
Total Number of Units			2	1.00			2	
Thickener Recycle Pump Sizing								
Capacity Per Unit	m3/hr		458.3		gal/min		2,018	
Total Dynamic Head	m		**15.24**	3.28	ft		**50**	

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Pump Efficiency			30%				30%	
Solids Concentration	%		0%		%		0%	
Specific Gravity of Solids			2.50				2.50	
Sludge Specific Gravity			1.00				1.00	
Sludge Specific Weight	kg/m3		1,000.44	16.02	lb/ft3		62.46	
Break Horsepower per Unit	kW		63.42	1.34	HP		85.10	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		70.47		HP		94.55	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		205.78	4.40	gal/min		906.04	
CPES Life Cycle Average Power to Motor Per Unit	kW		31.64		HP		42.45	
Polymer System								
Polymer Addition? Yes								
Average Dosage	kg/tonne DS		3.00	0.50	lbs/ton DS		6.00	
Average Usage	kg/hr		5.5	0.45	lb/hr		12.1	
Peak Dosage	kg/tonne DS		5.00	0.50	lbs/ton DS		10.00	
Peak Usage	kg/hr		34.8	0.45	lb/hr		76.7	
Primary Dilution Polymer Concentration	wt%		0.10%	1.00	wt%		0.10%	
Average Primary Dilution Water	m3/d		131.8	264.17	gpd		34,827	
Secondary Dilution Polymer Concentration	wt%		0.05%	1.00	wt%		0.05%	
Average Secondary Dilution Water	m3/d		132.0	264.17	gpd		34,862	
Anaerobic Treatment: Meso								
Sizing Information								
Total Digester Volume	m3	10,219.50	10,220	3,785.00	MG	2.70	2.70	
Straight Wall Sidewater Depth	m		10.06	0.30	ft	N/A	33.00	
Number of duty units			3	1.00		N/A	3	digesters are used
Volume per unit	m3		3,407	3,785.00	MG		0.90	
Diameter per unit	m		20.77	0.30	ft		68.13	
Anaerobic Treatment Power								
Average Power	kW		106.8	1.34	hp	143.3		
Peak Power	kW		106.8	1.34	hp	143.3		
Gas Mixing								
Feed Flow								
Average Design Flow	m3/day	623		0.00	GPD	164,644		
Solids Concentration	mg/L	60,000		1.00	mg/L	60,000		
Peak Diurnal Design Flow	m3/day	1,578		0.00	GPD	416,929		
Solids Concentration	mg/L	60,000		1.00	mg/L	60,000		
Operating Conditions								
Temperature	oC	35	35.00		oF	95	95.00	
Biogas Production	m3/day	9,089		0.03	ft3/day	320,947		
Digester Gas Mixing System								
Energy	W/m3		6.36	26.48	HP/1000ft3		0.24	
Unit Gas Flow	Nm3/hr per kW		45	2.27	cfm per Hp		20.00	
Safety Factor on Unit Flow Rate			1.00	1.00			1.00	
Number of Duty Units Per Digester			4	1.00			4	
Total Number of Duty Units			12	1.00			12	
Capacity Per Unit	m3/hr		245.21	1.70	cfm		144.31	
Total Number of Standby Units			4	1.00			4	
Biogas Compression For Mixing								
Mixing Gas Flow	Nm3/hr		2,943	1.70	Ncfm		1,732	
Number of Duty Units			3	1.00			3	
Capacity Per Unit	m3/hr		981	1.70	cfm		577	
Number of Standby Units			1	1.00			1	
Total Number of Units			4	1.00			4	
Minimum Turndown Capacity			25%	1.00			25%	
Biogas utilization/flaring capacity								
Peaking Factor on Average Biogas Production			1.50	1.00			1.50	
Utilization/Flaring Capacity	m3/hr		568.08	1.70	cfm		334.32	
Estimated Gas Heat Content					BTU/ft3	563	563	
Biogas Usage Fractions (Average for GHG Calcs)								
Boilers			60%				60%	
Cogeneration			0%				0%	
Drying			0%				0%	
Motors			0%				0%	
Fugitive Emissions, Blow Off Valve			1%				1%	
Fugitive Emissions, Floating Cover Leakage			2%				2%	
Flare			37%				37%	
Mechanical Pumping Mixing System								
Included in Project Yes								
Type of Pump Screw Centrifugal								
Mechanical Mixing Flow Required								
Number of Tank Turnovers per Day			8	1.00			8	
Digester Mixing Flowrate Required	m3/hr		3,407		gpm		15,000	
Mixing Pump Capacity								
Number of Duty Units			3	1.00			3	
Capacity Per Unit	m3/hr		1,135.50	0.00	gpm		5,000	
Number of Standby Units			1	1.00			1	
Total Number of Units			4	1.00			4	
Mixing Pump Sizing								
Capacity Per Unit	m3/hr		1,135.50		gal/min		5,000	
Total Dynamic Head	m		6.09	3.28	ft		20	
Pump Efficiency			60%				60%	
Solids Concentration	%		3.37%		%		3.37%	
Specific Gravity of Solids			2.50				2.50	
Sludge Specific Gravity			1.02				1.02	
Sludge Specific Weight	kg/m3		1,020	16.02	lb/ft3		63.7	
Break Horsepower per Unit	kW		32.05	1.34	HP		43.00	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		35.61		HP		47.78	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			1.00	1.00			1.00	
CPES Life Cycle Average Capacity Per Unit	m3/hr		1,136	4.40	gal/min		5,000	
CPES Life Cycle Average Power to Motor Per Unit	kW		35.61		HP		47.78	
Unit Power Calculations								
Actual Operating Unit Power (Brake HP or kW/Digeste	kW/m3		0.01		HP/1000 cf		0.36	
Operating Information								
SRT	days		13.12		days		13.12	
VSS Loading	kg/m3-day		3.46	16.06	lb/ft3-day		0.22	
VSS Reduction	%		53%		%		53%	
Dewatering: BFP								
Sizing Information								
Dewatering Feed Rates								
Average Design Flow	m3/day	623		0.00	GPD	164,644		
Average Solids Concentration	mg/L	33,733		1.00	mg/L	33,733		
Average Solids Loading	kg/hr ds	876		0.45	lb/hr ds	1,931		
Peak Diurnal Design Flow	m3/day	13,256		0.00	GPD	3,502,201		
Peak Solids Concentration	mg/L	33,733		1.00	mg/L	33,733		
Peak Solids Loading	kg/hr ds	18,632		0.45	lb/hr ds	41,076		
Feed Sludge Type PSD & WAS								
Dewatering Equipment								
Type Belt Press								
Hours of Operation			4	1.00			4	
Days Per Week			5	1.00			5	
Safety Factor on Peak Diurnal			2	1.00			2	
BFP Dewatering Sizing								
Design (Maximum) Unit Loading								
Hydraulic Loading	m3/hr/m		6.8	4.40	gpm/m		30	

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Solids Loading	kg/hr/m		227	0.45	lbs/hr/m		500	
Required Total Belt Width								
Hydraulic Loading Basis	meter		121.59		meter		121.59	
Solids Loading Basis	meter		123.23		meter		123.23	
Select Standard BFP Size	meters		2.00	1.00	meters		2.00	
Number of Duty Units			62	1.00			62	
Number of Standby Units			1	1.00			1	
Total Number of Units			63	1.00			63	
Capacity Per Unit	m3/hr		14	0.00	gpm		60	
	kg DS/hr		454	0.45	lbs DS/hr		1,000	
Belt Press Duty Unit Connected Power, ea	kW		1.5	1.34	hp		2.0	
Average Power Usage Factor			75%	1.00			75%	
Average Power Input to Motor per Unit	kW		1.1	1.34	hp		1.5	
Peak Power Usage Factor			90%	1.00			90%	
Peak Power Input to Motor per Unit	kW		1.3	1.34	hp		1.8	
Centrifuge Dewatering Sizing								
Number of Duty Units			1	1.00			1	
Number of Standby Units			1	1.00			1	
Total Number of Units			2	1.00			2	
Minimum Capacity Per Unit	m3/hr		828.5	0.00	gpm		3,648	
	kg DS/hr		27,948	0.45	lbs DS/hr		61,615	
Maximum Capacity of Unit	m3/hr		1,243	0.23	gpm		5,472	
	kg DS/hr		41,922	0.45	lbs DS/hr		92,422	
Hydraulic Loading	m3/hr		#N/A		gpm		#N/A	
Solids Loading	kg/hr		#N/A	0.45	lb/hr		#N/A	
Centrifuge Duty Unit Connected Power, ea	kW		15	1.34	hp		20	
Average Power Usage Factor			75%	1.00			75%	
Average Power Input to Motor per Unit	kW		11	1.34	hp		15	
Peak Power Usage Factor			90%	1.00			90%	
Peak Power Input to Motor per Unit	kW		13	1.34	hp		18	
Dewatering Performance								
Dewatered Solids Concentration			25%	1.00			25%	
Solids Capture Efficiency			85%	1.00			85%	
Dewatering Power								
Average Power	kW		21.5	1.34	hp		28.9	
Peak Power	kW		102.3	1.34	hp		137.2	
DEW Feed Sludge Pumping								
Included in Project **Yes**								
Type of Pump **Progressing Cavity**								
Feed Sludge Flow								
Average Design Flow	m3/day	623		0.00	GPD	164,644		
Solids Concentration	mg/L	33,733		1.00	mg/L	33,733		
Average Solids Loading	kg/hr ds	876		0.45	lb/hr ds	1,931		
Peak Diurnal Design Flow	m3/day	1,578		0.00	GPD	416,929		
Solids Concentration	mg/L	33,733		1.00	mg/L	33,733		
Peak Solids Loading	kg/hr ds	2,218		0.45	lb/hr ds	4,890		
Feed Sludge Pump Capacity								
Hours of Operation			4	1.00			4	
Days per Week			5	1.00			5	
Safety Factor on Peak Diurnal			1.50	1.00			1.50	
Number of Duty Units			62	1.00			62	
Capacity Per Unit	m3/hr		14	0.00	gph		3,600	
Number of Standby Units			1	1.00			1	
Total Number of Units			63	1.00			63	
Feed Sludge Pump Sizing								
Capacity Per Unit	m3/hr		14		gal/min		60	
Total Dynamic Head	m		61	3.28	ft		200	
Pump Efficiency			30%				30%	
Solids Concentration	%		3%		%		3%	
Specific Gravity of Solids			1.50				1.50	
Sludge Specific Gravity			1.01				1.01	
Sludge Specific Weight	kg/m3		1,011	16.02	lb/ft3		63.11	
Break Horsepower per Unit	kW		7.6	1.34	HP		10.2	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		8.5		HP		11.4	
Motor Type **Adjustable-Speed**								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		0.31	4.40	gal/min		1.38	
CPES Life Cycle Average Power to Motor Per Unit	kW		0.20		HP		0.26	
Dewatered Sludge Pumping								
Included in Project **No**								
Type of Pump **Hopper Type Progressing Cavity**								
Dewatered Sludge Flow								
Average Design Flow	m3/day	71		0.00	GPD	18,884		
Solids Concentration	mg/L	250,000		1.00		250,000		
Average Solids Loading	kg/day ds	17,869		0.45	lb/day ds	39,394		
Peak Diurnal Design Flow	m3/day	2,326		0.00	GPD	614,458		
Solids Concentration	mg/L	250,000		1.00		250,000		
Peak Solids Loading	kg/day ds	581,431		0.45	lb/day ds	1,281,843		
Dewatered Sludge Pump Capacity								
Hours of Operation			4	1.00			4	
Days per Week			5	1.00			5	
Safety Factor on Peak Diurnal			1	1.00			1	
Number of Duty Units			62	1.00			62	
Capacity Per Unit	m3/hr		13.1	0.00	gph		3,469	
Number of Standby Units			1	1.00			1	
Total Number of Units			63	1.00			63	
Dewatered Sludge Pump Sizing								
Capacity Per Unit	m3/hr		13.1		gal/min		58	
Total Dynamic Head	m		61	3.28	ft		200	
Pump Efficiency			30%				30%	
Solids Concentration	%		25%		%		25%	
Specific Gravity of Solids			1.50				1.50	
Sludge Specific Gravity			1.09				1.09	
Sludge Specific Weight	kg/m3		1,090	16.02	lb/ft3		68	
Break Horsepower per Unit	kW		7.9	1.34	HP		10.6	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		8.8		HP		11.8	
Motor Type **Adjustable-Speed**								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		0.0	4.40	gal/min		0	
CPES Life Cycle Average Power to Motor Per Unit	kW		0.0		HP		0.0	
Dewatered Sludge Conveyance								
Included in Project **Yes**								
Type of Conveyor **Screw**								
Sludge Flow								
Average Design Flow	m3/day	71		0.00	GPD	18,884		
Solids Concentration	%	25%		1.00	%	25%		
Peak Diurnal Design Flow	m3/day	19,536		0.00	GPD	5,161,450		
Solids Concentration	%	25%		1.00	%	25%		
Conveyor Sizing								
Hours of Operation			24	1.00			24	
Days per Week			7	1.00			7	
Safety Factor on Peak Diurnal			1.10	1.00			1.10	
Number of Duty Units - Flat			1	1.00			1	
Number of Duty Units - Inclined			1	1.00			1	
Inclined Conveyor Angle	degree		22	1.00	degree		22	
Break Horsepower per Flat Unit	kW		3.7	1.34	HP		5.0	

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Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Flat Unit	kW		4.1	1.34	HP		5.6	
Break Horsepower per Inclined Unit	kW		3.7	1.34	HP		5.0	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Inclined Unit	kW		4.1		HP		5.6	
Motor Type Constant Speed								
Minimum Turndown Capacity			0%	1.00			0%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		2	4.40	gal/min		10	
CPES Life Cycle Average Power to Motor Per Flat Uni	kW		0.0		HP		0.0	
CPES Life Cycle Average Power to Motor Per Inclined	kW		0.0		HP		0.0	
Filtrate Pumping								
Included in Project Yes								
Type of Pump Dry-pit Centrifugal								
Filtrate Flow								
Average Design Flow	m3/day	552		0.00	GPD	145,761		
Solids Concentration	mg/L	5,716		1.00	mg/L	5,716		
Average Solids Loading	kg/hr ds	131		0.45	lb/hr ds	13,852		
Peak Diurnal Design Flow	m3/day	6,283		0.00	GPD	1,660,023		
Solids Concentration	mg/L	5,716		1.00	mg/L	5,716		
Peak Solids Loading	kg/hr ds	1,496		0.45	lb/hr ds	3,299		
Filtrate Pump Capacity								
Hours of Operation			24	1.00			24	
Days per Week			7	1.00			7	
Safety Factor on Peak Diurnal			1.25	1.00			1.25	
Number of Duty Units			1	1.00			1	
Capacity Per Unit	m3/hr		327.2	0.00	gph		86,460	
Number of Standby Units			1	1.00			1	
Total Number of Units			2	1.00			2	
Filtrate Pump Sizing								
Capacity Per Unit	m3/hr		327.2		gal/min		1,441	
Total Dynamic Head	m		15.2	3.28	ft		50	
Pump Efficiency			70%				70%	
Solids Concentration	%		0		%		0	
Specific Gravity of Solids			2.50				2.50	
Sludge Specific Gravity			1.00				1.00	
Sludge Specific Weight	kg/m3		1,003	16.02	lb/ft3		62.61	
Break Horsepower per Unit	kW		19.5	1.34	HP		26.1	
Motor Efficiency			90%	1.00			90%	
Power Input to Motor per Unit	kW		21.6		HP		29.0	
Motor Type Adjustable-Speed								
Minimum Turndown Capacity			40%	1.00			40%	
CPES Life Cycle Average Capacity Safety Factor			0.75	1.00			0.75	
CPES Life Cycle Average Capacity Per Unit	m3/hr		17.2	4.40	gal/min		76	
CPES Life Cycle Average Power to Motor Per Unit	kW		1.1		HP		1.5	
Polymer System								
Polymer Addition? Yes								
Average Dosage	kg/tonne DS		3.0	0.50	lbs/ton DS		6.0	
Average Usage	kg/hr		2.6	0.45	lb/hr		5.8	
Peak Dosage	kg/tonne DS		5.0	0.50	lbs/ton DS		10.0	
Peak Usage	kg/hr		140.6	0.45	lb/hr		310.0	
Primary Dilution Polymer Concentration	wt%		0.10%	1.00	wt%		0.10%	
Average Primary Dilution Water	m3/d		63.0	264.17	gpd		16,643	
Secondary Dilution Polymer Concentration	wt%		0.05%	1.00	wt%		0.05%	
Average Secondary Dilution Water	m3/d		63.1	264.17	gpd		16,660	

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Mass Balance for Average Flow Conditions

Constituent	Raw Wastewater (RW)	Main Recycle Influent (RecyI)	Main Recycled Stream (Recycle)	Main Combined Recycle Effluent (RecyE)	Main Primary Influent (PI)	Main Primary Effluent (PE)	PC_Eff Splitter Influent (SplitI)	PC_Eff Splitter Effluent (SplitE) PBNRHighRateAS	PC_Eff Splitter Effluent (SplitE) CNodePBNR_Eff	HighRateAS Bioreactor Influent (BI)	HighRateAS Secondary Clarifier Influent (SI)	HighRateAS Secondary Clarifier Effluent (SE)	PBNR_Eff Combined Discharge	FGR Trickling Filter Influent (TFI)	FGR Trickling Filter Effluent (TFE)	TF_Eff Splitter Influent (SplitI)	TF_Eff Splitter Effluent (SplitE) GMFMain	TF_Eff Splitter Effluent (SplitE) WetlandWetland	Main Granular Media Filter Influent (GMFI)	Main Granular Media Filter Effluent (GMFE)	Wetland Wetland Influent (WI)	Wetland Wetland Effluent (WE)	Plant_Eff Combined Discharge	Plant Effluent (PLE)	Main Primary Sludge (PSD)	HighRateAS WAS	Sludge Combined Discharge
Flow (gallons/day)	22,400,000	22,400,000	4,573,130	26,053,318	26,053,318	25,905,894	25,905,894	25,879,988	25,906	25,879,988	64,578,184	24,074,533	24,100,439	24,100,439	24,100,439	24,100,439	24,076,339	24,100	24,076,339	21,388,492	24,100	24,100	21,412,592	21,412,592	147,424	1,756,741	1,904,165
Carbonaceous BOD_5 (lbs/day)	33,801	33,801	8,230	39,471	39,471	23,886	23,886	23,862	24	23,862	625,005	1,673	1,697	1,697	548	548	547	1	547	99	1	1	99	99	15,584	27,665	43,249
Particulate	20,504	20,504	3,782	23,608	23,608	9,516	9,516	9,506	10	9,506	100,462	223	233	233	2	2	2	0	2	0	0	0	1	1	14,092	4,449	18,541
Heterotrophs	1	1	4,177	2,366	2,366	953	953	953	1	953	522,802	1,162	1,162	1,162	493	493	493	0	493	55	0	0	55	55	1,412	23,152	24,564
PAOs	0	0	9	6	6	2	2	2	0	2	975	2	2	2	2	2	2	0	2	0	0	0	0	0	3	43	47
PHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filtrate	13,296	13,296	263	13,491	13,491	13,415	13,415	13,402	13	13,402	767	286	299	299	50	50	50	0	50	44	0	0	44	44	76	21	97
COD (lbs/day)	74,940	74,940	25,909	93,417	93,417	54,981	54,981	54,926	55	54,926	1,460,366	6,582	6,637	6,637	5,946	5,946	5,940	6	5,940	2,907	6	2	2,909	2,909	38,436	64,518	102,954
Particulate Bio	36,863	36,863	6,453	42,204	42,204	17,011	17,011	16,994	17	16,994	180,614	401	418	418	4	4	4	0	4	0	0	0	1	1	25,193	7,998	33,191
Particulate Non-Bio	6,876	6,876	6,262	11,319	11,319	4,562	4,562	4,558	5	4,558	176,024	391	396	396	396	396	395	0	395	40	0	0	40	40	6,757	7,795	14,552
Decay Prod Aer/Anx	3,546	3,546	1,796	4,943	4,943	1,992	1,992	1,990	2	1,990	120,174	267	269	269	618	618	617	1	617	62	1	0	62	62	2,951	5,322	8,272
Decay Prod Anaerobic	0	0	346	240	240	97	97	97	0	97	2	0	0	0	0	0	0	0	0	0	0	0	0	0	143	0	144
Heterotrophs	2	2	7,537	4,269	4,269	1,721	1,721	1,719	2	1,719	943,424	2,096	2,098	2,098	988	988	987	1	987	99	1	0	99	99	2,548	41,779	44,327
Autotrophs	0	0	1,186	1,121	1,121	452	452	451	0	451	28,426	63	64	64	997	997	996	1	996	100	1	0	100	100	669	1,259	1,928
PAOs	0	0	25	15	15	6	6	6	0	6	2,695	6	6	6	6	6	6	0	6	1	0	0	1	1	9	119	129
PHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soluble Bio	11,474	11,474	121	11,570	11,570	11,504	11,504	11,493	12	11,493	1,243	463	475	475	80	80	80	0	80	71	0	0	71	71	65	34	99
VFA	2,869	2,869	174	2,990	2,990	2,973	2,973	2,970	3	2,970	134	50	53	53	9	9	9	0	9	8	0	0	8	8	17	4	21
Colloidal Bio	9,562	9,562	177	9,696	9,696	9,641	9,641	9,631	10	9,631	1	0	10	10	0	0	0	0	0	0	0	0	0	0	55	0	55
Soluble Non-Bio	2,248	2,248	1,823	3,543	3,543	3,523	3,523	3,519	4	3,519	7,621	2,841	2,845	2,845	2,845	2,845	2,842	3	2,842	2,524	3	0	2,525	2,525	20	207	227
Colloidal Non-Bio	1,499	1,499	8	1,507	1,507	1,498	1,498	1,497	1	1,497	8	3	4	4	4	4	4	0	4	4	0	0	4	4	9	0	9
TSS (lbs/day)	44,402	44,402	23,941	61,477	61,477	24,591	24,591	24,566	25	24,566	1,356,454	3,014	3,038	3,038	2,713	2,713	2,711	3	2,711	271	3	1	272	272	36,910	60,070	96,980
Biodegradable	27,750	27,750	4,858	31,770	31,770	12,806	12,806	12,793	13	12,793	135,964	302	315	315	3	3	3	0	3	0	0	0	1	1	18,965	6,021	24,986
Non-Biodegradable	13,875	13,875	10,400	21,230	21,230	8,359	8,359	8,351	8	8,351	346,732	770	779	779	779	779	778	1	778	78	1	0	78	78	12,871	15,355	28,226
Decay Prod Aer/Anx	2,775	2,775	1,406	3,868	3,868	1,559	1,559	1,557	2	1,557	94,033	209	210	210	483	483	483	0	483	48	0	0	48	48	2,309	4,164	6,473
Decay Prod Anaerobic	0	0	271	188	188	76	76	76	0	76	2	0	0	0	0	0	0	0	0	0	0	0	0	0	112	0	112
Metal Hydroxide	0	0	25	25	25	0	0	0	0	0	1,935	4	4	4	4	4	4	0	4	0	0	0	0	0	0	86	86
Metal Phosphate	0	0	283	318	318	148	148	148	0	148	15,233	34	34	34	34	34	34	0	34	4	0	0	4	4	219	675	894
Heterotrophs	2	2	5,898	3,340	3,340	1,346	1,346	1,345	1	1,345	738,204	1,640	1,641	1,641	773	773	772	1	772	77	1	0	77	77	1,994	32,691	34,685
Autotrophs	0	0	781	725	725	292	292	292	0	292	22,243	49	50	50	632	632	631	1	631	63	1	0	63	63	433	985	1,418
PAOs	0	0	19	12	12	5	5	5	0	5	2,109	5	5	5	5	5	5	0	5	0	0	0	0	0	7	93	101
PHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poly-P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VSS (lbs/day)	33,302	33,302	17,222	45,512	45,512	18,342	18,342	18,323	18	18,323	1,042,950	2,317	2,336	2,336	2,043	2,043	2,041	2	2,041	204	2	1	205	205	27,164	46,187	73,350
Biodegradable	24,975	24,975	4,372	28,593	28,593	11,525	11,525	11,513	12	11,513	122,368	272	283	283	3	3	3	0	3	0	0	0	1	1	17,068	5,419	22,487
Non-Biodegradable	5,828	5,828	5,306	9,592	9,592	3,866	3,866	3,862	4	3,862	149,162	331	335	335	335	335	335	0	335	33	0	0	34	34	5,726	6,606	12,331
Decay Prod Aer/Anx	2,498	2,498	1,265	3,481	3,481	1,403	1,403	1,402	1	1,402	84,629	188	189	189	435	435	435	0	435	43	0	0	43	43	2,078	3,748	5,826
Decay Prod Anaerobic	0	0	244	169	169	68	68	68	0	68	1	0	0	0	0	0	0	0	0	0	0	0	0	0	101	0	101
Metal Hydroxide	0	0	6	6	6	0	0	0	0	0	489	1	1	1	1	1	1	0	1	0	0	0	0	0	0	22	22
Heterotrophs	2	2	5,308	3,006	3,006	1,212	1,212	1,210	1	1,210	664,383	1,476	1,477	1,477	695	695	695	1	695	69	1	0	69	69	1,795	29,422	31,216
Autotrophs	0	0	703	652	652	263	263	263	0	263	20,018	44	45	45	569	569	568	1	568	57	1	0	57	57	389	887	1,276
PAOs	0	0	17	11	11	4	4	4	0	4	1,898	4	4	4	4	4	4	0	4	0	0	0	0	0	6	84	91
PHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TKN (lbs/day)	7,220	7,220	3,598	9,628	9,628	7,966	7,966	7,958	8	7,958	93,106	4,545	4,552	4,552	719	719	718	1	718	524	1	1	525	525	1,661	3,923	5,585
NH_3-N (lbs-N/day)	4,332	4,332	2,281	5,830	5,830	5,797	5,797	5,791	6	5,791	11,204	4,177	4,183	4,183	402	402	402	0	402	357	0	0	357	357	33	305	338
Particulate Bio Org N	1,358	1,358	269	1,577	1,577	635	635	635	1	635	6,808	15	16	16	0	0	0	0	0	0	0	0	0	0	941	301	1,243
Non-Bio Part Org N	317	317	306	533	533	215	215	215	0	215	8,293	18	19	19	19	19	19	0	19	2	0	0	2	2	318	367	686
Decay Prod Aer/Anx	215	215	88	278	278	112	112	112	0	112	7,278	16	16	16	16	16	16	0	16	2	0	0	2	2	166	322	488
Decay Prod Anaerobic	0	0	21	15	15	6	6	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	9
Heterotrophs	0	0	456	259	259	104	104	104	0	104	57,137	127	127	127	60	60	60	0	60	6	0	0	6	6	154	2,530	2,685
Autotrophs	0	0	60	56	56	23	23	23	0	23	1,722	4	4	4	49	49	49	0	49	5	0	0	5	5	33	76	110
PAOs	0	0	1	1	1	0	0	0	0	0	163	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	8
Non-Bio Soluble Org. N	135	135	107	211	211	209	209	209	0	209	453	169	169	169	169	169	169	0	169	150	0	0	150	150	1	12	14
Non-Bio Colloidal Org. N	57	57	0	58	58	57	57	57	0	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soluble Bio Org N	439	439	5	443	443	441	441	440	0	440	48	18	18	18	3	3	3	0	3	3	0	0	3	3	3	1	4
Colloidal Bio Org N	366	366	2	368	368	366	366	366	0	366	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
NO_{2+3}-N (lbs-N/day)	0	0	500	464	464	461	461	460	0	460	2,680	999	999	999	3,862	3,862	3,858	4	3,858	3,427	4	3	3,430	3,430	3	73	76
TP (lbs-P/day)	1,510	1,510	986	2,217	2,217	1,798	1,798	1,796	2	1,796	29,487	834	836	836	836	836	835	1	835	701	1	1	702	702	419	1,270	1,689
Bio Particulate	250	250	57	296	296	119	119	119	0	119	775	2	2	2	0	0	0	0	0	0	0	0	0	0	177	34	211
Non-Bio Particulate	58	58	92	122	122	49	49	49	0	49	1,892	4	4	4	4	4	4	0	4	0	0	0	0	0	73	84	156
Decay Prod Aer/Anx	71	71	29	92	92	37	37	37	0	37	2,403	5	5	5	5	5	5	0	5	1	0	0	1	1	55	106	161
Decay Prod Anaerobic	0	0	7	5	5	2	2	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
Metal Phosphate	0	0	53	60	60	28	28	28	0	28	2,851	6	6	6	6	6	6	0	6	1	0	0	1	1	41	126	167
Heterotrophs	0	0	151	85	85	34	34	34	0	34	18,868	42	42	42	20	20	20	0	20	2	0	0	2	2	51	836	887
Autotrophs	0	0	20	19	19	7	7	7	0	7	569	1	1	1	16	16	16	0	16	2	0	0	2	2	11	25	36
PAOs	0	0	0	0	0	0	0	0	0	0	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3
Poly-P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ortho-PO4	1,131	1,131	576	1,539	1,539	1,521	1,521	1,519	2	1,519	2,074	773	775	775	784	784	783	1	783	695	1	1	696	696	9	56	65
Alkalinity (lbs/day as $CaCO_3$)	46,732	46,732	7,215	52,175	52,175	51,880	51,880	51,828	52	51,828	131,268	48,936	48,988	48,988	33,027	33,027	32,994	33	32,994	29,311	33	42	29,353	29,353	295	3,571	3,866
H_2S (lbs/day)	1,122	1,122	61	1,162	1,162	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	15	15	16	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
BOD_5 (mg/L)	181	181	216	182	182	110	110	110	110	110	1,160	8	8	8	3	3	3	3	3	1	3	3	1	1	12,667	1,887	2,722
COD (mg/L)	401	401	679	430	430	254	254	254	254	254	2,710	33	33	33	30	30	30	30	30	16	30	9	16	16	31,241	4,401	6,479
TSS (mg/L)	238	238	627	283	283	114	114	114	114	114	2,517	15	15	15	13	13	13	13	13	2	13	4	2	2	30,000	4,097	6,103
VSS (mg/L)	178	178	451	209	209	85	85	85	85	85	1,935	12	12	12	10	10	10	10	10	1	10	3	1	1	22,078	3,149	4,616
TKN (mg-N/L)	38.62	39	94	44	44	37	37	37	37	37	173	23	23	23	4	4	4	4	4	3	4	3	3	3	1,350	268	351
NH_3-N (mg-N/L)	23.17	23	60	27	27	27	27	27	27	27	21	21	21	21	2	2	2	2	2	2	2	2	2	2	27	21	21
NO_3-N (mg-N/L)	0.00	0	13	2	2	2	2	2	2	2	5	5	5	5	19	19	19	19	19	19	19	16	19	19	2	5	5
TP (mg-P/L)	8.08	8	26	10	10	8	8	8	8	8	55	4	4	4	4	4	4	4	4	4	4	4	4	4	340	87	106
Alkalinity (mg/L as $CaCO_3$)	250	250	189	240	240	240	240	240	240	240	244	244	244	244	164	164	164	164	164	164	164	209	164	164	240	244	243
H_2S (mg/L)	6.00	6	2	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Mass Balance for Average Flow C

Constituent	Gravity Primary Sludge Thickener Influent (PSTI)	Gravity Thickened Primary Sludge (PST)	T_Sludge Combined Discharge	Meso Anaerobic Digester Influent (AnDI)	Meso Anaerobic Digester Effluent (AnDE)	BFP Dewatering Influent (DWI)	BFP Dewatered Sludge (DWE)	Biosolids to Disposal	Main Filter Backwash (BW)	Gravity Primary Sludge Thickening Recycle (PSTR)	BFP Dewatering Recycle (DWR)	Recy Combined Discharge
Flow (gallons/day)	1,904,165	164,625	164,625	164,625	164,625	164,625	18,881	18,881	2,687,847	1,739,540	145,744	4,573,130
Carbonaceous BOD_5 (lbs/day)	43,249	36,688	36,688	36,688	6,847	6,847	5,680	5,680	502	6,562	1,167	8,230
Particulate	18,541	15,760	15,760	15,760	6,656	6,656	5,658	5,658	2	2,781	998	3,782
Heterotrophs	24,564	20,880	20,880	20,880	0	0	0	0	492	3,685	0	4,177
PAOs	47	40	40	40	0	0	0	0	2	7	0	9
PHA	0	0	0	0	0	0	0	0	0	0	0	0
Filtrate	97	8	8	8	190	190	22	22	5	89	168	263
COD (lbs/day)	102,954	87,197	87,197	87,197	38,599	38,599	31,480	31,480	3,033	15,757	7,119	25,909
Particulate Bio	33,191	28,213	28,213	28,213	9,803	9,803	8,333	8,333	4	4,979	1,470	6,453
Particulate Non-Bio	14,552	12,369	12,369	12,369	24,824	24,824	21,100	21,100	356	2,183	3,724	6,262
Decay Prod Aer/Anx	8,272	7,032	7,032	7,032	0	0	0	0	555	1,241	0	1,796
Decay Prod Anaerobic	144	122	122	122	2,164	2,164	1,840	1,840	0	22	325	346
Heterotrophs	44,327	37,678	37,678	37,678	0	0	0	0	888	6,649	0	7,537
Autotrophs	1,928	1,639	1,639	1,639	0	0	0	0	897	289	0	1,186
PAOs	129	109	109	109	0	0	0	0	5	19	0	25
PHA	0	0	0	0	0	0	0	0	0	0	0	0
Soluble Bio	99	9	9	9	24	24	3	3	9	91	21	121
VFA	21	2	2	2	175	175	20	20	1	19	155	174
Colloidal Bio	55	5	5	5	143	143	16	16	0	50	127	177
Soluble Non-Bio	227	20	20	20	1,466	1,466	168	168	317	208	1,298	1,823
Colloidal Non-Bio	9	1	1	1	0	0	0	0	0	8	0	8
TSS (lbs/day)	96,980	82,433	82,433	82,433	46,346	46,346	39,394	39,394	2,442	14,547	6,952	23,941
Biodegradable	24,986	21,238	21,238	21,238	7,380	7,380	6,273	6,273	3	3,748	1,107	4,858
Non-Biodegradable	28,226	23,992	23,992	23,992	36,440	36,440	30,974	30,974	700	4,234	5,466	10,400
Decay Prod Aer/Anx	6,473	5,502	5,502	5,502	0	0	0	0	435	971	0	1,406
Decay Prod Anaerobic	112	95	95	95	1,694	1,694	1,440	1,440	0	17	254	271
Metal Hydroxide	86	73	73	73	73	73	62	62	1	13	11	25
Metal Phosphate	894	760	760	760	760	760	646	646	35	134	114	283
Heterotrophs	34,685	29,482	29,482	29,482	0	0	0	0	695	5,203	0	5,898
Autotrophs	1,418	1,205	1,205	1,205	0	0	0	0	568	213	0	781
PAOs	101	86	86	86	0	0	0	0	4	15	0	19
PHA	0	0	0	0	0	0	0	0	0	0	0	0
Poly-P	0	0	0	0	0	0	0	0	0	0	0	0
VSS (lbs/day)	73,350	62,348	62,348	62,348	29,220	29,220	24,837	24,837	1,836	11,003	4,383	17,222
Biodegradable	22,487	19,114	19,114	19,114	6,642	6,642	5,645	5,645	3	3,373	996	4,372
Non-Biodegradable	12,331	10,482	10,482	10,482	21,035	21,035	17,880	17,880	301	1,850	3,155	5,306
Decay Prod Aer/Anx	5,826	4,952	4,952	4,952	0	0	0	0	391	874	0	1,265
Decay Prod Anaerobic	101	86	86	86	1,524	1,524	1,296	1,296	0	15	229	244
Metal Hydroxide	22	18	18	18	18	18	16	16	0	3	3	6
Heterotrophs	31,216	26,534	26,534	26,534	0	0	0	0	625	4,682	0	5,308
Autotrophs	1,276	1,085	1,085	1,085	0	0	0	0	511	191	0	703
PAOs	91	77	77	77	0	0	0	0	4	14	0	17
PHA	0	0	0	0	0	0	0	0	0	0	0	0
TKN (lbs/day)	5,585	4,474	4,474	4,474	4,189	4,189	1,896	1,896	194	1,111	2,293	3,598
NH_3-N (lbs-N/day)	338	29	29	29	2,177	2,177	250	250	45	309	1,928	2,281
Particulate Bio Org N	1,243	1,056	1,056	1,056	551	551	468	468	0	186	83	269
Non-Bio Part Org N	686	583	583	583	1,243	1,243	1,057	1,057	17	103	186	306
Decay Prod Aer/Anx	488	415	415	415	0	0	0	0	15	73	0	88
Decay Prod Anaerobic	9	7	7	7	131	131	111	111	0	1	20	21
Heterotrophs	2,685	2,282	2,282	2,282	0	0	0	0	54	403	0	456
Autotrophs	110	93	93	93	0	0	0	0	44	16	0	60
PAOs	8	7	7	7	0	0	0	0	0	1	0	1
Non-Bio Soluble Org. N	14	1	1	1	86	86	10	10	19	12	76	107
Non-Bio Colloidal Org. N	0	0	0	0	0	0	0	0	0	0	0	0
Soluble Bio Org N	4	0	0	0	1	1	0	0	0	3	1	5
Colloidal Bio Org N	2	0	0	0	0	0	0	0	0	2	0	2
NO_3-N (lbs-N/day)	76	7	7	7	0	0	0	0	431	69	0	500
TP (lbs-P/day)	1,689	1,386	1,386	1,386	1,272	1,272	724	724	135	303	548	986
Bio Particulate	211	179	179	179	172	172	146	146	0	32	26	57
Non-Bio Particulate	156	133	133	133	430	430	365	365	4	23	64	92
Decay Prod Aer/Anx	161	137	137	137	0	0	0	0	5	24	0	29
Decay Prod Anaerobic	3	2	2	2	43	43	37	37	0	0	6	7
Metal Phosphate	167	142	142	142	142	142	121	121	7	25	21	53
Heterotrophs	887	754	754	754	0	0	0	0	18	133	0	151
Autotrophs	36	31	31	31	0	0	0	0	15	5	0	20
PAOs	3	2	2	2	0	0	0	0	0	0	0	0
Poly-P	0	0	0	0	0	0	0	0	0	0	0	0
Ortho-PO4	65	6	6	6	485	485	56	56	87	59	430	576
Alkalinity (lbs/day as $CaCO_3$)	3,866	334	334	334	0	0	0	0	3,683	3,532	0	7,215
H_2S (lbs/day)	0	0	0	0	69	69	8	8	0	0	61	61
Temperature (°C)	15	15	15	15	35	35	35	35	15	15	35	16
BOD_5 (mg/L)	2,722	26,704	26,704	26,704	4,983	4,983	36,045	36,045	22	452	959	216
COD (mg/L)	6,479	63,468	63,468	63,468	28,095	28,095	199,774	199,774	135	1,085	5,853	679
TSS (mg/L)	6,103	60,000	60,000	60,000	33,733	33,733	250,000	250,000	109	1,002	5,716	627
VSS (mg/L)	4,616	45,381	45,381	45,381	21,268	21,268	157,617	157,617	82	758	3,603	451
TKN (mg-N/L)	351	3,256	3,256	3,256	3,049	3,049	12,033	12,033	9	77	1,885	94
NH_3-N (mg-N/L)	21	21	21	21	1,585	1,585	1,585	1,585	2	21	1,585	60
NO_3-N (mg-N/L)	5	5	5	5	0	0	0	0	19	5	0	13
TP (mg-P/L)	106	1,009	1,009	1,009	926	926	4,597	4,597	6	21	450	26
Alkalinity (mg/L as $CaCO_3$)	243	243	243	243	0	0	0	0	164	243	0	189
H_2S (mg/L)	0	0	0	0	50	50	50	50	0	0	50	2

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C H2M HILL P arametric Cost E stimating S ystem (CPES)

FACILITIES DESIGN & CONSTRUCTION COST MODULE

File Version: 1/25/2011

Click for CPES QA/ QC | To Concrete Wall Thickness Help | To Cost Summary Matrix | To Unit Cost Database

Project Name:	Sunnyvale SIP Peer Review
Project Number:	414083
Project Manager:	Susan Dennis
Estimator:	Kathy Rosinski
Project Description:	Option 7: Primary Treatment w/ HiRate Activated Sludge w/ existing Trickling Filters
Project Location (City):	San Jose
Project Location (State):	CALIFORNIA
Project Location (Country):	USA
Construction Start (Month):	Mar
Construction Start (Year):	2015
Construction Duration (months):	24
Mid-Point of Construction:	Mar/2016

Roundup to the nearest: $1,000

This Report is for INTERNAL Distributio

This Report is for EXTERNAL Distributio

Item	Is This Facility Included in Project? (Yes or No)	SCOPE OF PROJECT	Cost
	No	Rect PC: Main	$0
	No	Flow Splitting: PC_Eff	$0
	Yes	Aeration Basin: HighRateAS	$5,818,000
	Yes	Blowers: HighRateAS	$2,912,000
	Yes	Round SC: HighRateAS	$5,131,000
	Yes	RAS WAS PS: HighRateAS	$2,940,000
	No	Flow Splitting: TF_Eff	$0
	No	Filters: Main	$0
	No	Wetlands: Wetland	$0
	No	Fermenter: Gravity	$0
	No	Silo AnDig: Meso	$0
	No	WWTP BFP: BFP	$0

SUBTOTAL - PROJECT COST			$16,801,000
ADDITIONAL PROJECT COSTS:			
Demolition	0%		$0
Overall Sitework	0%		$0
Plant Computer System	0%		$0
Yard Electrical	0%		$0
Yard Piping	0%		$0
UD #1 Default Description	0%		$0
UD #2 Default Description	0%		$0
UD #3 Default Description	0%		$0
SUBTOTAL with Additional Project Costs			$16,801,000
CONTRACTOR MARKUPS:			
Overhead	10%	$16,801,000	$1,681,000
Subtotal			$18,482,000
Profit	5%	$18,482,000	$925,000
Subtotal			$19,407,000
Mob/Bonds/Insurance	5%	$19,407,000	$971,000

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	A	B	C	D	E
54	Subtotal				$20,378,000
55	Contingency		30%	$20,378,000	$6,114,000
56	SUBTOTAL with Markups				$26,492,000
57					
58	ESCALATION (to Mid-Point of Construction)		16.8%	$26,492,000	$4,451,000
59	SUBTOTAL with Escalation				$30,943,000
60					
61	LOCATION ADJUSTMENT FACTOR		117.9	$30,943,000	$36,482,000
62	SUBTOTAL - with Local Adjustment Factor				$36,482,000
63					
64	RED FLAGS:				
65	1	Rock Excavation			
66	2	Pile Foundations			
67	3	Seismic Foundations			
68	4	Dewatering Conditions			
69	5	Wetlands Mitigation			
70	6	Weather Impacts			
71	7	Depth of Structures			
72	8	Local Building Code Restrictions			
73	9	Coatings or Finishes			
74	10	Building or Architectural Considerations			
75	11	Client Material Preferences			
76	12	Client Equipment Preferences			
77	13	Piping Galleries, Piping Trenches, Piping Racks			
78	14	Yard Piping Complexity			
79	15	Existing Site Utilities (New, Retrofit, and Complexity)			
80	16	I & C Automation (New or Retrofit)			
81	17	Electrical Feed (New or Retrofit)			
82	18	Electrical Distribution			
83	19	Shoring			
84	20	Contamination			
85	21	California State Sales Tax (9.25%)			$1,678,172
86	22	User Defined Red Flag 2			
87	23	User Defined Red Flag 3			
88	24	User Defined Red Flag 4			
89	25	User Defined Red Flag 5			
90	26	User Defined Red Flag 6			
91	27	User Defined Red Flag 7			
92	TOTAL - RED FLAGS				$1,679,000
93					
94	SUBTOTAL - CONSTRUCTION COST with Red Flags				$38,161,000
95					
96	MARKET ADJUSTMENT FACTOR		10%	$38,161,000	$3,817,000
97	SUBTOTAL - CONSTRUCTION COST with Market Adjustment Factor				$41,978,000
98	Your CPES Estimate MUST be reviewed by a Process person AND an Estimator:				
99	Name of Process Reviewer			(None)	Click for Reviewe
100	Name of Estimator Reviewer			(None)	
101	MAXIMUM CONSTRUCTION COST				$58,770,000
102					
103	NON-CONSTRUCTION COSTS:				
104	Permitting		0%	$58,770,000	$0
105	Engineering		0%	$58,770,000	$0
106	Services During Construction		0%	$58,770,000	$0
107	Commissioning & Startup		2%	$58,770,000	$1,176,000
108	Land / ROW		0%	$58,770,000	$0

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	A	B	C	D	E
109	***Legal / Admin***		**0%**	**$58,770,000**	**$0**
110	***Other Default Description***		**0%**	**$58,770,000**	**$0**
111	***SUBTOTAL - Non-Construction Costs***				**$1,176,000**
112					
113	***TOTAL - CAPITAL COST***				**$59,946,000**
114					
115	***Currency Conversion of TOTAL CAPITAL COST:***				
116		***Currency***	***Unit of Measure***	***Conversion Rate***	***Converted Amount***
117		**None**	**U.S.Dollar**	**1**	**59,946,000**

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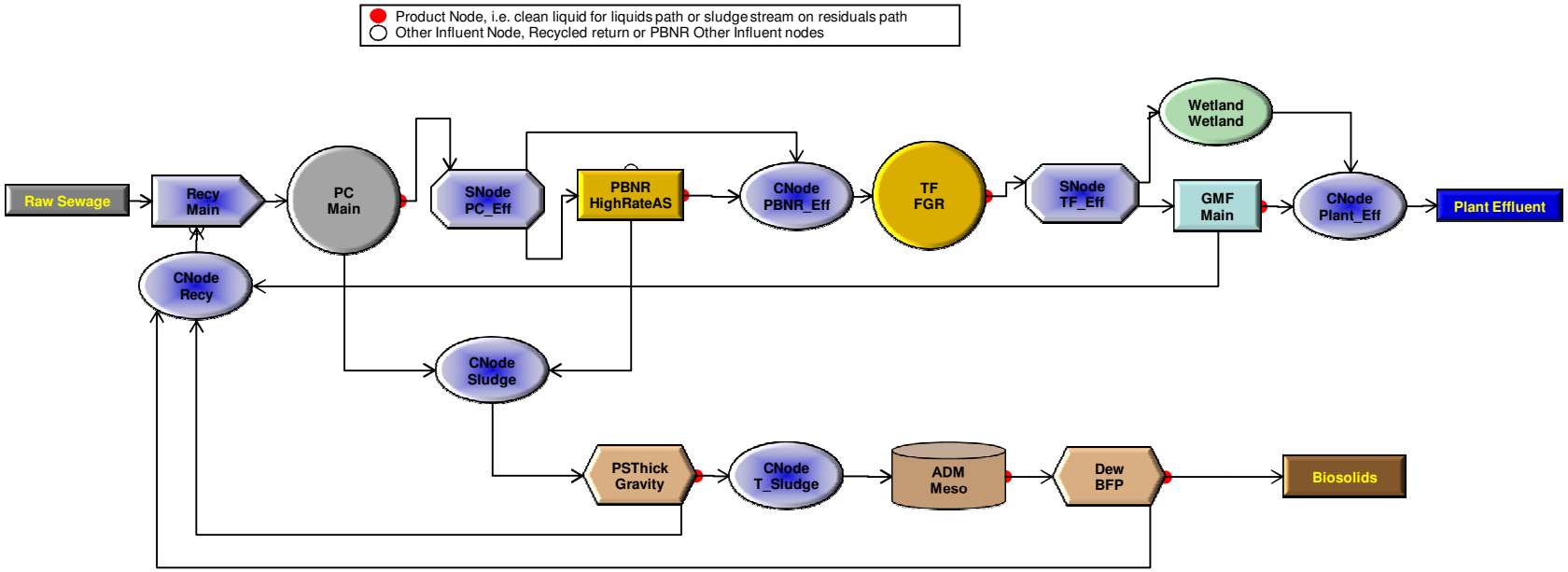

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Use Instructions: See Comment in this cell.

Linked Model Input	Current Run:	Notes	Scenarios - All based on Maximum Mon Option 7 - Primary Treatment + HiRate AS + Existing TF + Filtration - WINTER
Flow (MGD)	22.40		22.40
Diurnal Flow Peaking Factor	1.5		1.5
CBOD5 (lbs/day)	33,800		33,800
TSS (lbs/day)	44,400		44,400
% VS	75%		75%
Ammonia -N (lbs/day)	4,332		4,332
Total Phosphate - P (lbs/day)	1,510		1,510
Temperature deg.C	15		15
Primary Clarifiers			
Primary Clarifier Area (sqft)	20,900		20,900
Coagulant Applied	No		No
Chemical Dosage (mg chemical/L treated) (mg/L)	50		50
Percent Removal of Colloidal Matter (%)	83%		83%
TSS Removal Efficiency	60%		60%
BOD5 Removal Efficiency	39%		39%
TSS Effluent Concentration (mg/L)	114		114
BOD5 Effluent Concentration (mg/L)	110		110
Primary Sludge Concentration (mg/L)	30,000		30,000
Primary Sludge TSS (lbs/day)	36,877		36,877
Primary Sludge Flow (m3/d)	558		558
High Rate Activated Sludge			
Total Bioreactor Volume (MG)	3.0		3
HRT (h)	2.8		3
Aerobic SRT (days)	1.0		1
F/Mv (BOD5/MLVSS) (d-1)	0.579		0.6
Organic Loading (kg BOD5/m3/d)	2.476		2.5
Corresponding Average MLSS (mg/L)	2,517		2,517
Total Process AOR (lbs/day)	39,502		3950202%
Total Required Air Rate (scfm)	23,086		23,086
RAS Recylce Flow (mgd)	39		39
RAS Recycle Flow (% of influent)	173%		2
WAS Concentration (mg/L)	4,097		4,097
WAS (lbs MLSS/day)	63,084		**63,083.7**
AS Effluent TSS (mg/L)	15		15
Total Clarification Area (sf)	40,000		**40,000**
Number of Clarifiers	4		4
Clarifier Diameter, each (ft)	113		113
Secondary Effluent CBOD5 (mg/L)	8		8
Secondary Effluent NH3-N (mg/L)	21		20.79
Trickling Filters			
Area (ft2)	19,942		19,942
TF Media Volume (cu.ft)	378,900		378,900.00
Media Specific surface area (ft2/ft3)	42		42
Hydraulic Loading (m3/m2-d)	49	10-75 High Rate	49
Category of TF	Low Rate		Low Rate
Trickling Filter Loading Rate (lbs/1000ft3/d)	4	40-200 High Rate	4.477458219
Recirculation (% of Q Influent)	8%		0.075912457
TF BOD Influent (mg/L)	110		110
TF NH3-N Influent (mg/L)	21		21
TF TSS Effluent (mg/L)	13		13
TF BOD5 Effluent (mg/L)	2.7		2.7
TF NH3-N Effluent (Average) (mg/L)	**2.0**		2.0
TF NH3-N Effluent (Peak Diurnal) (mg/L)	108		107.8
Filtration			
Total Filter Surface Area (sf)	3,840		3,840
Influent TSS Concentration (mg/L)	13	should be < 30 m	13
Hydraulic Loading Rate (peak) (gpm/sf)	6.47	overloaded	6
TSS Removal Efficiency at Average Conditions	90%		1
TSS Removal Efficiency at Diurnal Peak Conditions	85%		1
Filter Run Time	24		24
Backwash Flow (mgd)	2.69		3
Backwash Solids Concentration (mg/L)	109		109
Backwash Solids Loading (lb TS/day)	2,440		2,440
Plant Effluent		**Effluent Limits (avg mth / daily max)**	
BOD_5 (mg/L)	1	10 / 20	1
COD (mg/L)	16		16
TSS (mg/L)	1.5	20 / 30	2
VSS (mg/L)	1.1		1
TKN (mg-N/L)	2.9		3
NH_3-N (mg-N/L)	2.0	4.5 / 18	2.00
NO_3-N (mg-N/L)	19		19
TP (mg-P/L)	4		4
Wetlands			
Wetlands in Serivce	Yes		Yes
Wetlant area (acres)	0		0
Temperature (deg. C)	10		10
BOD5 (mg/L)	3		3
COD (mg/L)	9		9
TSS (mg/L)	4		4
VSS (mg/L)	3		3
TKN (mg-N/L)	3		3
NH3-N (mg-N/L)	**2**		**2**
NO3-N (mg-N/L)	16		16
TP (mg-P/L)	4		4
Alkalinity (mg/L as CaCO3)	209		209
H2S (mg/L)	0		0
Digestion			
Digester Volume (MG)	2.70		2.70
Digester Solids IN (lb TSS/d)	82,358		82,358
Digester Solids OUT (lb TSS/d)	46,304		46,304
Digester Loading (lb VSS/ft3-day)	0.215	overloaded	0.215
Volatile Solids Reduction (%)	53%		53%
Digester Gas Production (cuft/day)	321,174		321,174
Digester Gas Production (cu.ft/lb VS destroyed)	10		10
Dewatered Solids Production (lb TSS/day)	39,358		39,358
Conclusions			Able to meet Summer and Winter ammonia effluent limits

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Appendix F
Technical Memorandum – Discussion of Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan and Peer Review of the Water Pollution Control Plant Strategic Infrastructure Plan Projects Findings and Recommendations

Discussion of Sunnyvale Water Pollution Control Plant Strategic Infrastructure Plan and Peer Review of the Water Pollution Control Plant Strategic Infrastructure Plan Projects Findings and Recommendations

ATTENDEES:

Lorrie Gervin/City of Sunnyvale
Chuck Neumayer/City of Sunnyvale
Dan Hammons/City of Sunnyvale
Tim Kirby, City of Sunnyvale
Jeff Sorrick/City of Sunnyvale
Nasser Fakih/City of Sunnyvale
Don Eisenberg/EOA
Ray Goebel/EOA
Lloyd Slezak/Brown and Caldwell
Denny Parker/Brown and Caldwell
Ron Crites/Brown and Caldwell
Khalil Abusaba/Brown and Caldwell
Glen Daigger/CH2M HILL
Susan Dennis/CH2M HILL

FROM: Susan Dennis

DATE: May 4, 2011

PROJECT NUMBER: 414083.SP

Meeting Purpose

Lorrie Gervin stated the meeting purpose:

- Exchange information and answer questions to ensure participants understand the final Water Pollution Control Plant (WPCP) treatment alternatives that have been proposed for consideration by the City of Sunnyvale (City). It is understood that there will be some questions that cannot be answered in the meeting, but this should not be the basis to exclude alternatives from further consideration.
- Concur on the alternatives that the City should carry forward for final consideration. These alternatives should enable the City to achieve robust treatment performance and achieve other objectives that have been identified for the WPCP.

The meeting agenda and sign-in sheet are attached.

Conclusions and recommendations from the meeting will be incorporated in City staff's presentation for the May 10 City Council study session. At a study session, the Council cannot take action; staff will ask Council to accept the findings of the draft Strategic Infrastructure Plan (SIP) and draft Peer Review reports, and to direct staff to proceed with the next phase of the project, which includes selection of the alternative for implementation and preparation of the programmatic environmental impact report (EIR).

Brown and Caldwell Comments on Draft Peer Review Report

Lloyd Slezak presented Brown and Caldwell's comments from their review of the draft Peer Review Project report. A copy of the presentation is attached to this Meeting Summary.

Original SIP Goals (Slides 1 and 2)

The scope and objectives of the SIP were summarized to aid in understanding the alternatives that resulted from the SIP projects. The purpose of the SIP was to develop and compare two principal alternatives within the framework of a broad-based master plan, as follows:

- Plant Rehabilitation Alternative: Identify improvements to optimize and rehabilitate the existing treatment process facilities, retaining the oxidation ponds as the principal secondary treatment process.
- Plant Replacement Alternative: Level of service (LOS) constraints were that the replacement technology has proven reliability for full nitrification treatment and the oxidation ponds would not be used as part of the treatment scheme (except for flow equalization). Abandoned ponds would be converted to habitat consistent with Baylands Ecosystem Habitat Goals Report. This conversion could be accomplished independently of the treatment plant improvements so that it would not negatively impact the schedule for plant renewal. However, costs associated with the pond conversion were included in the Plant Replacement alternative cost estimate. A full range of treatment processes were evaluated and resulted in conventional activated sludge (AS) and smaller footprint membrane bioreactors (MBRs) as the plant replacement alternatives that were given final consideration.

Alternatives were screened using a triple bottom line analysis.

Denny Parker presented his comments on the Peer Review alternatives.

Option 5 – Treatment Wetland-based Option (Slides 3 through 8)

Denny Parker considers Option 5 an innovative alternative, which is not consistent with the SIP LOS goals. Each treatment process component has been implemented individually, but he believes it is the cascading impacts of the flow sheet that qualify it as a new and innovative concept. He noted that innovation is defined in Webster's as "the introduction of something new;" he believes that in wastewater engineering, the definition is the same. He is not aware of a prior example and, therefore, he raises concerns for the reliability of this option.

He discussed the merits of each individual component, as follows:

- Chemically enhanced primary treatment (CEPT): used since the 1970s for phosphorous (P) removal in the great lakes; Brown and Caldwell has recent experience for wet weather flow treatment (Slide 4).
- Nitrifying fixed growth reactors (FGRs) following CEPT: This is a more unique application. Brown and Caldwell has implemented this twice, but only for carbon oxidation; thus, there is little experience combining nitrification with carbon oxidation in

trickling filters with medium-density media (42 square feet per cubic foot) following CEPT. Also, prior examples use secondary clarifiers. Pilot testing should be included in the project cost and schedule (Slides 5 and 6).

- The treatment wetlands are a unique application for removing total suspended solids (TSS) downstream of the FGR. He questions whether the four FGRs and approximate 400-acre wetland can accommodate ultimate plant flow (39.6 million gallons per day [mgd]). He emphasized that it's important to recognize that the City desires the flexibility to annex more flow to their system in the future and to not freeze the plant size at 22.4 mgd (Slide 7).
- The assumption that Title 22 regulations for recycled water can be met by direct filtration of wetland effluent requires more study and would have to be pilot tested (Slide 8).

Option 7 – High-rate Activated Sludge Option (Slide 9)

Denny Parker stated that Brown & Caldwell would have screened out this alternative because of insufficient reliability and other considerations, such as the following: high loading results in sludge bulking, it is difficult to maintain the sludge volume index (SVI) at levels consistent with the peer review option, more clarifiers would be required to treat wet weather flows, and other concerns.

Treatment Wetlands (Slides 10 through 13)

Ron Crites presented comments on the treatment wetlands component of Option 5. He is aware of few treatment wetlands as large as 400 acres. He also looked to identify examples of wetlands that are required to achieve nitrification. The City of Stockton treatment wetland is a large wetland, but it is placed between the secondary treatment and nitrification processes. In Stockton, the wetlands remove solids from ponds, but the ponds have variable NH_3 removal, and the nitrifying trickling filters are relied upon for nitrification. He isn't aware of any examples that achieve ammonia removal down to 2 milligrams per liter (mg/L) in climates with winter conditions representative of those in Sunnyvale. He concurs that wetlands can effectively treat TSS and metals, but his greatest concern is ammonia removal.

Khalil Abusaba stated his concern for mosquito control and compatibility with the Bayland Ecosystem Habitat Goals Report. He believes that the risk of mercury conversion to methylmercury in the wetlands is significant. California Environmental Quality Act (CEQA) and South Bayland Mercury Project precedents for monitoring suggest a significant programmatic cost, particularly if response actions are required. He questions how the City would respond if mercury does become an issue.

Engineering Subjects (Slides 14 through 16)

Lloyd Slezak discussed concerns related to the engineering aspects of converting the ponds to wetlands. He questions the feasibility of lowering the pond water surface elevation to support a wetland (relative to San Francisco Bay) and utilizing the existing levees as they were not designed as dams (to withstand a 6-foot water surface differential). Conversely, to raise the pond bottom elevation to support a wetland, he questions the feasibility of

acquiring the necessary fill material either cost-effectively or in sufficient quantities. Khalil Abusaba asked whether CH2M HILL investigated a source of sediment to bring a wetland up to grade – 2 to 3 million cubic yards, citing competition for available dredged fill sources close to the South Bay.

Risk Discussion (Slides 17 through 20)

Lloyd Slezak presented comments on the risks of pursuing an innovative alternative based on the SIP LOS criteria and, in particular, an alternative for which the implementation timeframe may be uncertain, such as a wetland. He believes the Peer Review capital cost comparison does not reflect the true cost of the wetlands conversion and, therefore, the SIP Plant Rehabilitation Alternative and Peer Review Option 5 are not comparable.

The Peer Review report didn't include an operation and maintenance costs analysis. Brown and Caldwell's analysis of the SIP Plant Rehabilitation Alternative and Peer Review Option 5 shows only a small operational cost benefit for Option 5. They estimate no energy recovery advantage, a greater quantity of sludge production and hauling as a result of CEPT, and a net present value (NPV) difference between the alternatives that is "just beyond the threshold of significant" at $5 million over the study period. Lloyd indicated that programmatic environmental permitting costs associated with the wetlands are also not included.

Environmental Review Issues (Slides 21 and 22)

Khalil Abusaba reiterated the environmental issues that he believes should be evaluated before deciding to further consider a wetlands-based option. He states that the existing ponds are already an accepted wildlife habitat in the south bay and that conversion to treatment wetlands would be a major change in the environment and would generate significant input from the U.S. Army Corps of Engineers and environmental agencies.

Ability to Proceed Expeditiously (Slide 23)

Lloyd Slezak stated that the SIP alternatives would not delay the City in obtaining permit approvals and proceeding with the project; answering questions on implementation of a treatment wetland could delay the project.

Discussion

Glen Daigger initiated the discussion with the following comments:

1. The Peer Review team took the approach of optimizing use of the existing plant facilities to achieve the City's objectives and then looked at the need for further facilities. There is misperception of the wetlands role in the Option 5 treatment scheme. The existing 3 FGRs + 1 additional are expected to achieve the effluent NH_3 discharge limit.

2. The role of the treatment wetlands is to further ammonia removal to provide some factor of safety as well as controlling TSS (using deep water cells). The 400 acres was intended to accommodate the initial design capacity. Any additional capacity would need to be considered in the context of expanding the other parts of plant as well.

3. He agrees that the next step is to consider how conversion of the ponds to wetlands could be achieved; the Peer Review team did not consider need for imported fill in the limited scope of its work.
4. He observes that there is significant experience with CEPT in southern California that supports its performance: Los Angeles County SAN, Orange County SAN, City of Los Angeles, and City of San Diego.
5. Regarding innovation, Glen Daigger observes that the wastewater industry has a tendency to keep doing the same things that have previously been done, and one of the principal reasons is that we do not properly consider the risks and opportunities of alternative approaches, resulting in a bias in our evaluations against new technologies and approaches. When evaluating risk, the base evaluation assumes the worst case scenario and then the advantages are understated, which causes an unbalanced comparison.
6. Denny Parker stated that we need to consider the broader benefit/risk equation. Commercial entities are typically more willing to invest in risk when significant financial gains are possible. Public entities are less willing to do so – individuals' jobs are put at risk if innovation is not successful or fails.
7. Regarding abandonment of the ponds for the Plant Replacement alternative, the Peer Review team understood that costs or potential liabilities associated with abandonment of the ponds as a part of the wastewater treatment process were not to be considered in the SIP. Brown and Caldwell has clarified that costs associated with repurposing the abandoned ponds for other beneficial uses are included in the SIP. This will be correctly reflected in the Peer Review Report.
8. Observation is that the O&M cost comparison (Slide 19) is not "apples to apples" (e.g., polymer, nitrifying trickling filters [NTF] power costs). The point here is not to debate specific numbers but to help the City understand the risks and mitigating factors for the alternatives put before them and how they align with their objectives.

Risk and Innovation

Glen Daigger emphasized that the decision on the acceptable level of risk is the City's. If the Plant Rehabilitation option best achieves their objectives for the plant at an acceptable level of risk, then they should continue on this path. If the City truly wants to look at a different alternative, then he recommends they look carefully at the specific merits of the alternative considered, and then look at risk separately –don't bury the alternative simply by the comparison. Procedures such as risk and opportunity analysis and Monte-Carlo based procedures for estimating the potential range of project costs (capital and NPV) are available to more accurately compare options. These techniques could be used by staff to more clearly understand the range of potential outcomes for a particular alternative.

Denny Parker questioned whether the Peer Review options yield the benefits usually looked for in adopting an innovative alternative because they have not been implemented before as a collective process. The typical drivers for a community to adopt an innovative process are stated as benefits, such as cost, performance, or conformance with sustainability goals of the community. The community must also establish a scientific methodology to identify risk

tolerance and to adopt risk. Brown and Caldwell understood that the City's risk tolerance was low. If the City's risk tolerance has changed he asks how they consider risk for a new option.

Glen Daigger suggested that the unknown factors should be analyzed; if the list of "don't knows" is large, you don't proceed. If there are manageable unknowns, then identify the true risk and how to manage it.

Denny Parker stated that his work on FGRs is the most comprehensive on this type of application, and that anyone designing them was relying on his work. He is not confident that the FGR process will work. He recommends a pilot study to manage that risk. Glen Daigger agrees entirely with the need for further study; it is important to consider uncertainties of a less conventional alternative.

Don Eisenberg questioned whether there is a compelling reason to look at another alternative (other than Plant Rehabilitation). He reiterated that when the City began the SIP, they intended to continue with the existing treatment process. As the SIP progressed, they didn't want to get half way down the road (of implementation) and discover that there was something better out there. He is not sure he's heard yet that there is something better – there is no compelling reason unless you do innovation for innovation's sake.

Glen Daigger reiterated that the Peer Review options reflect the City's goals that were stated at the beginning of the Peer Review project. The Peer Review team also understands that these goals may be different than those given to the SIP team. He agrees there is the need to work through pilot testing and performance issues of the options; however, the Peer Review team assessment was that all the recommended options will be reliable. The Peer Review team's perception was that the conversion of ponds to wetlands would be viewed as a positive; sense was that the City was concerned about the ponds for long-term beneficial use and as liability. To move beyond a matter of opinion, the City would need to further evaluate the environmental issues and perhaps implement demonstration wetlands.

Wetlands Conversion

The Peer Review team assumed that there would be some cut/fill balancing and perhaps some imported material to convert the ponds to wetlands. The next level of engineering is required to better understand this; it was beyond the scope of the Peer Review project.

Denny Parker reiterated that the pond levees aren't designed as dams and the ponds aren't lined. Lloyd Slezak pointed out that there aren't any wetland examples in which the water surface elevation is below the surrounding water surface elevation. Glen suggested that a possible approach is to do the engineering to confirm the assumptions

Jeff Sorrick asked if processing biosolids in the ponds is required for any alternative.
Ray Goebel stated that the City's plan is to remove a foot of biosolids from the ponds as part of the Plant Rehabilitation alternative.

Activated Sludge Alternatives Discussion

It was suggested that the Plant Replacement alternative (AS) and Option 7 – HRAS could be combined into one alternative. The group discussed the degree of carbon capture with CEPT, how or whether to incorporate the FGRs in Option 7, and the need for piloting.

Regarding incorporation of the FGRs in an activated sludge process, the need for denitrification was discussed as well as the cost of maintaining the FGRs. In the SIP, the hybrid AS option did take advantage of the FGRs. Denny Parker explained that there were two motivations for this: 1) the fact that they're existing infrastructure and 2) for energy capture of organic matter and to reduce aeration requirements. Ray Goebel asked if there is really significant carbon capture in HRAS. Glen Daigger responded that European experience with the AB process has taught us that if you drive SRT down low enough you can accomplish the equivalent of CEPT in aeration basins. Glen Daigger noted that if investment in FGRs is required beyond the rehab cost presented in the SIP (this cost was assumed for Option 7), then that could tip the alternative and disadvantage any FGR options.

Denny Parker believes the SIP cost for FGR rehabilitation is appropriate for use in Option 7. However, he believes the proposed alternative won't be stable at high SVI because of insufficient energy to control bulking; also, the mixed liquor won't settle or compact well, and won't filter. He added that wastewater characterization work wasn't done so modifications that would ultimately be required are unknown. On the basis of Brown and Caldwell's experience at Dublin San Ramon Services District (DRSRD) (in the Bay Area) and the King County South Wastewater Treatment Plant (in Renton, Washington), a plant with an anaerobic selector with a 2- to 2.5-day SRT would produce an acceptable effluent quality and a stable SVI of its mixed liquor that would compact well. Option 7 doesn't have enough clarifiers and would require more aeration to get to that 2- to 2.5-day SRT. The SIP Plant Replacement alternative is far less constrained. He considered HRAS but didn't see an advantage over the conventional activated sludge alternative.

On the basis of the information exchange in the discussion, Glen agreed that there probably is not a cost benefit or energy benefit to Option 7 and concurs that the SIP and Peer Review activated sludge alternatives should be combined. Denny Parker recommends that if there isn't a particular motivation to retain the FGRs, then conventional AS should be used. Glen added that even if the FGRs are used initially in HRAS, the plant layout should assume that they'll be phased out eventually because they're old and a more stringent N limit is likely to be required at some point.

FGR Media Replacement

Denny Parker led a discussion of the need to replace the existing FGR media. He didn't observe any condition that indicated the need for replacement (for at least the plant replacement alternative). In addition, after many years of algae loading there wasn't a lot of biomass sloughing observed in the mode change demonstration (when Mode 1 testing was initiated). He isn't worried about impacts to the media from Option 7, but is worried about the heavier load that heterotrophic organisms can add to the media with Option 5. He recommends isolating an FGR for full-scale testing before initiating CEPT.

Dan Hammons stated the FGR tower is out of plumb and needs modification. Lloyd Slezak said that a fix could be accomplished without media replacement. He expects that it can be addressed at the top of the unit; replacing the top 4 feet of media and the distributor arm was budgeted in the SIP FGR rehabilitation.

Refining Alternatives to Present at May 10 Council Study Session

Glen Daigger led a discussion of how the City could resolve the uncertainties among the alternatives. He suggested that the City allocate funding for studies to investigate the unknowns, which could include a Monte Carlo analysis. Lloyd Slezak said that a Monte Carlo analysis was considered for the SIP but the City chose to not pursue; Lorrie stated that one concern was conveying risk management information to the Council in a comprehensible, actionable form, but suggested that it could help to inform staff relative to their decision process. The question remains – how do you get a true "apples-to-apples" comparison?

Denny Parker again questioned the function of the wetlands in Peer Review Option 5 and believed wetland performance couldn't be known without piloting. Glen stated that the expectation is that four FGRs would result in a discharge NH_3 concentration at the permit limit (2 mg/L). He agrees that models for wetlands aren't as accurate as for other processes but that there is a good amount of empirical data available on which to form a judgment. He agrees that demonstration testing is warranted. But he expects addition of the fourth FGR plus wetlands will buffer the City for future N and TSS requirements. Denny Parker reiterated that performance will vary summer to winter because wastewater characteristics vary seasonally and that models can't predict this. An objective with this alternative would be to retain the current permit limits for BOD and TSS – a good argument to support this is that it is still a natural treatment system. Ray Goebel cautioned that if we change the process, more stringent discharge limits may be imposed.

It was agreed that the SIP Plant Replacement (AS) and Peer Review Option 7 (HRAS) can be combined into one alternative. Lloyd Slezak emphasized that what's in the SIP is "tunable" in the future and that the analysis presented was intended to be conservative. Glen Daigger suggested that during predesign, retaining the FGRs as long as possible should be explored and then, should more stringent permit limits be imposed, to phase out the FGRs to leave carbon available for achieving N removal. The need for future methanol addition was discussed.

Outstanding Issues

Common to All Alternatives

1. Flow/loads confirmation. Can be done concurrently with wastewater characterization.
2. "Apples to apples" cost comparison.
3. Energy consumption of each alternative.
4. Hydraulic grade line considerations.
5. Sea Level Rise (see discussion below).

Ponds/Rehabilitation

1. Already doing Mode 1 testing for ammonia removal.

Activated Sludge Alternatives

1. Perform traditional wastewater characterization required by process models; confirm by bench scale testing that nitrification is not inhibited due to any influent issues.

Wetlands

1. Engineering study to identify the most cost-effective manner to convert ponds to wetlands to add certainty to the alternative.
2. From an environmental perspective, compare ponds vs. wetlands vs. decommissioning with conversion to an amenity. Consider the cost and environmental issues of each today and in future.
3. Demo CEPT full scale.
4. Replumb a single FGR for CEPT to understand failure potential of media and performance capabilities, minimum 1 year. Post precipitation phenomenon resulting from ferric addition – not sure it's a high-risk issue. Also have the ability to fine tune between ferric and polymer. Alternatively, assume in the Option 5 alternative that the media must be replaced (and include in capital cost) and conduct this at pilot scale.
5. Pilot study of FGR + wetlands using media of same type, and also producing Title 22 water. Minimum 1 year operation.

Nutrient Removal

1. Lorrie believes nutrient removal needs to remain a required capability of the alternatives. Nutrient removal strategies to be considered include the following:
   - For the SIP Plant Rehabilitation, seasonal nitrogen removal occurs in the ponds, and this needs to be taken into consideration. The first step in negotiating with the Regional Board on this issue is to point this out, with the objective of deferring the implementation of nitrogen removal at Sunnyvale. Should (and when) further nitrogen removal be required, this would best be accomplished by a fixed growth denitrification system using methanol or some other external carbon source. The SIP considered denitrifying filters with methanol addition, which is an acceptable option and "placeholder" for this potential requirement.
   - For the activated sludge alternative, nitrogen removal can be incorporated into the process for an intermediate degree of treatment, then treated further to lower levels with a tertiary fixed growth denitrification system.
   - With respect to achieving low nitrogen levels out of wetlands, all of the nitrification should occur upstream in cold weather, but denitrification will always be enhanced by carbon addition.
   - P removal should be considered in the long term. The activated sludge alternative could lay out basins to achieve N and P removal. Carbon will be limiting, so an analysis will be required regarding how to balance N and P removal against one form of chemical addition or another.

- For the SIP Plant Rehabilitation alternative, chemical P removal could be accomplished in the primaries.
- Wetlands option is dependant on CEPT so substantial P removal would be achieved upstream of the wetlands. Getting below 1 mg/L will require further enhancements.

Sea Level Rise

Chuck Neumayer stated that the City will soon begin storm and sanitary sewer master planning and a common datum will be established. What sea level rise (SLR) was assumed for SIP? Lloyd Slezak stated that a specific SLR was not selected but that will not impact the Headworks/Primaries design because there will be significant pumping downstream regardless of the alternative. It was asked how the plant will be protected from SLR – levees? Lloyd Slezak stated that significant variation exists on SLR estimates and that we can't decide with any degree of certainty on a design SLR. Plant staff observed that high tide already inundates the plant effluent channel when not pumping effluent. SLR design criteria will need to be identified.

Concluding Comments

Glen Daigger reiterated that the Peer Review Team recognizes that the SIP and Peer Review were developed under very different framework. His assessment is that the SIP presents a solid body of work that is based on the constraints that were laid out at the beginning of that project. This work was of good quality and provided the basis for the analysis provided by the Peer Review. He also observed that as the SIP evolved, the City's objectives evolved. The City intentionally conducted the Peer Review project independent of the tremendous background provided by the SIP team. The Peer Review provides the final piece of work – "are there other alternatives?" He clarified that the Peer Review team was not advocating for an alternative, but answering the critical question of "are there other alternatives?" Option 5 surfaced as a new option that the Peer Review team believed aligned with the City's current objectives.

He concludes that from a strategic perspective, all three alternatives are good options, as follows:

- The Plant Rehabilitation alternative gives the City the best idea of what you'll get.
- The AS alternative allows the City to consider the question of how to incorporate FGRs for a period of time and is the most predictable to adapting to future standards. It's also the most conventional process and requires more money up front. But moving forward, it also provides the least opportunity for resource recovery in the future.
- The wetlands alternative is the least predictable, but uncertainties are addressable. This alternative provides the greatest opportunity for resource recovery. If the City is in a hurry, then the time required to manage the uncertainties will be a hindrance. If not in a hurry, then it presents an advantage because it can be parceled out over time. Its potential needs to be managed.

Denny Parker reiterated that he doesn't see a difference in resource recovery among the alternatives (e.g., a selector can be added to AS for P recovery). With respect to opportunities, the SIP team was constrained by the original charge they were given. But he

still comes back to the fact that the City wanted to know if it was a good idea to keep rehabilitating the existing process. Deferring the decision and undertaking the studies required by Option 5 sends a message to the council that the process that is already in place is fine, which validates the SIP recommendation, but does not convey any sense of urgency to proceed with the program. Lloyd Slezak commented that proceeding with Plant Rehabilitation option allows greatest flexibility and requires less construction to implement.

All concur with proceeding with the new headworks and primaries replacement.

Wetlands conversion is the significant uncertainty: how to construct within the framework of an operating plant, and whether wetlands would open a whole new door for public concern. Lloyd Slezak thinks it's a major undertaking if wetlands are included in environmental review.

Overall Next Step

The City needs to make the decision to proceed with the following: Engineering Study of Final Evaluation of Alternatives, begin environmental review, hire program manager, develop sequence for overall project completion, and initiate studies to address plant power distribution and other ancillary facilities.

To better define project costs for financial planning, it was suggested that a predesign level of engineering would be the appropriate time for the City to revisit the project overall budget (and in fact additional engineering would be the only way more refined cost estimates could be developed).

Attachments

WORKSHOP AGENDA

SIP/PEER REVIEW FOLLOW-UP

May 4, 2011

9:00 a.m. – 1:00 p.m.

1. Introductions – All
2. Discussion – Do we have four viable alternatives that should move forward in the process?
    a. Questions on alternatives
    b. Critical issues – technical, regulatory, political, economic, uncertainties, etc.
    c. Pros and cons for each alternative
    d. Issues yet to be resolved
3. Firms' ranking of the alternatives and reasons why
4. To Each Firm:
    - What direction would you provide to the City on next steps toward making a final decision on SIP alternatives, given what has been presented in the SIP and Peer Review Reports?

SUNNYVALE WPCP SIP and PEER REVIEW

MEETING SIGN-IN

May 4, 2011

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Original SIP Goals

- Compare Rehabilitate Existing Plant alternative to Plant Replacement alternative (new state of the art plant).
- Rehabilitate Existing Plant alternative was fundamentally defined as maintaining the oxidation ponds in their current role as the principal secondary treatment process.
- Specific unit optimization studies were requested for Rehabilitate Existing Plant alternative:
  - New biosolids dewatering process
  - Alternatives to AFTs for separating algae from pond effluent
  - Improving nitrification performance for pond effluent
  - Anaerobic digestion of pond algae
  - Recycled water treatment process alternatives

Original SIP Goals (cont.)

- Plant Replacement Alternative Technology Screening
  - Replacement technology proven reliable for full nitrification treatment.
  - Other screening criteria: Present worth cost, energy consumption, footprint requirement, process maturity, resource consumption.
  - Oxidation Ponds would not be used as part of treatment scheme (except small portion retained for flow equalization)
    - Abandoned ponds would be ultimately converted to habitat compatible with mosaic of habitats established in the Baylands Ecosystem Habitat Goals Report (open water habitat seemed reasonable assumed outcome).
    - Decision on ultimate fate of ponds would not interfere with plant replacement.

Option 5 – Questions regarding Proven Reliability

- CEPT -> Carbon Oxidizing / Nitrifying FGR -> Treatment Wetlands
- Each individual process is well proven in other treatment combinations and for varying treatment roles.
- Prior example of this combination of processes is unknown, therefore there are reliability questions.

Chemically Enhanced Primary Treatment (CEPT)

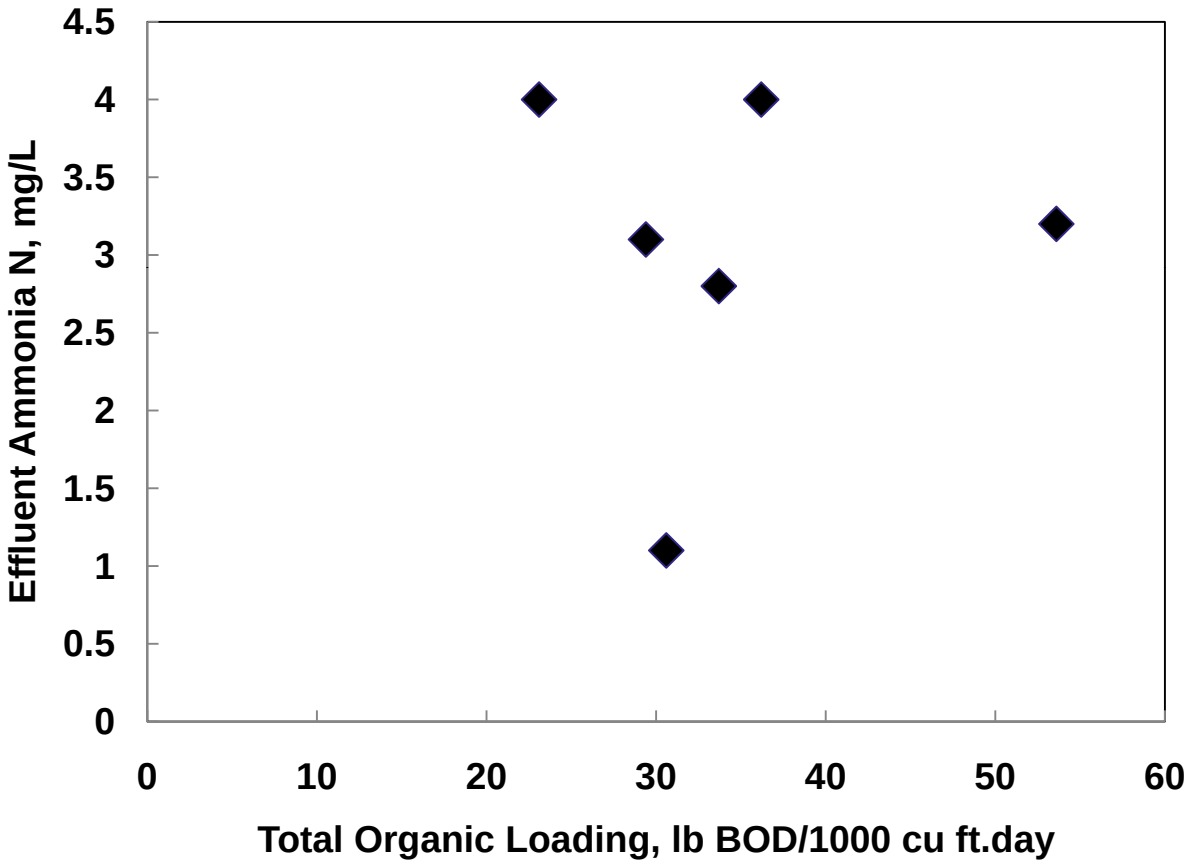
- Used since the 70's in Great Lakes for phosphorus removal.
- BC has applied CEPT for recent projects in Seattle, Portland, Cleveland, and Columbus (mostly for excess wet weather flows).
- Coagulant / Flocculant chemical mix optimized for individual plants through testing.

Nitrifying FGR after CEPT

- BC involved in two applications with carbon oxidation FGRs following CEPT.
- Only one known pilot test of carbon oxidation / nitrifying FGR following CEPT at Windsor, Ontario.
- Carbon Oxidizing / Nitrifying FGRs have issues with competition between carbon oxidizing heterotrophs and slower growing nitrifiers (which can be displaced).
- All prior applications utilized secondary clarifiers for final TSS removal.

FGR Effluent Ammonia from Windsor Pilot Study for Wastewater Temperatures Above 16 C (data from Parker et al,. 1998)

- Only known example of CEPT -> Nitrifying FGR
- Higher Density Cross Flow Media (42 sf / cf)
- No consistent relationship of Effluent Ammonia to TOL
- Models not sufficient for design
- Pilot or demonstration testing necessary for risk mitigation.



Treatment Wetlands

- Unique application for FGR TSS removal / nitrification polishing.
- Peer Review Report indicated that for 2035 max month flow (22.4 mgd):

3 FGRs	> 1200 acres required
4 FGRs	~ 400 acres required

- For Ultimate Capacity Allocation max month (39.6 mgd), is there footprint available for treatment scheme?
- Ultimate Capacity Allocation reserved for near term possibility of annexing flows from neighboring communities

Option 5 - Recycled Water Production

- Option assumes Title 22 water production is met by direct filtration of treatment wetlands effluent.

- Pilot study likely necessary to confirm that coagulation / flocculation / sedimentation are not required prior to filtration to achieve 2 NTU turbidity requirement.

High Rate Activated Sludge Alternative

- BC would have eliminated this option in preliminary screening for new treatment plant. (Insufficient reliability to meet effluent criteria.)
- High loading to activated sludge results in sludge bulking.
- More clarifiers necessary for reliable effluent TSS at higher flows.
- Recycled water production would require coagulation / flocculation / sedimentation prior to filtration as consequence of dispersed TSS quality from high rate activated sludge process.

Treatment Wetlands Discussion

- Few examples of similar wetlands
- Stockton uses wetlands between secondary clarifiers and NTFs
- No examples of nitrification wetlands to the 2 mg/L level
- TSS and metals removals are acceptable
- Cold temperatures result in inadequate removal of ammonia

Risk Discussion Subjects

- There is a risk of mosquito propagation in large wetlands (e.g. Stockton) without close controls using mosquitofish and parasitic controls such as BTI.
- Nitrification rates decline at low temperatures in wetlands. Sunnyvale ponds experience periods with temperatures below 10 degrees C.
- Would conversion to wetlands be compatible with goals of the Bayland Ecosystem Habitat Goals Report? Outcome of CEQA analysis and required mitigation unknown.
- Risk from mercury being converted to methylmercury in the wetlands. Monitoring for mercury would be a new programmatic cost.

Mercury monitoring….

- Status quo: little interaction with foraging wildlife and bottom of pond
- Treatment wetland: Creates food web accessible to foraging wildlife, including endangered species
- CEQA Precedent Set by South Bay Salt Ponds
  - Mitigation Measure is “adaptive management”
  - Requires long term monitoring program
  - Components include water, sediment, biota
  - If monitoring shows signs of a problem, additional obligation to respond
  - Response actions available to Sunnyvale for treatment wetland could be constrained by service needs

… a lifetime commitment.

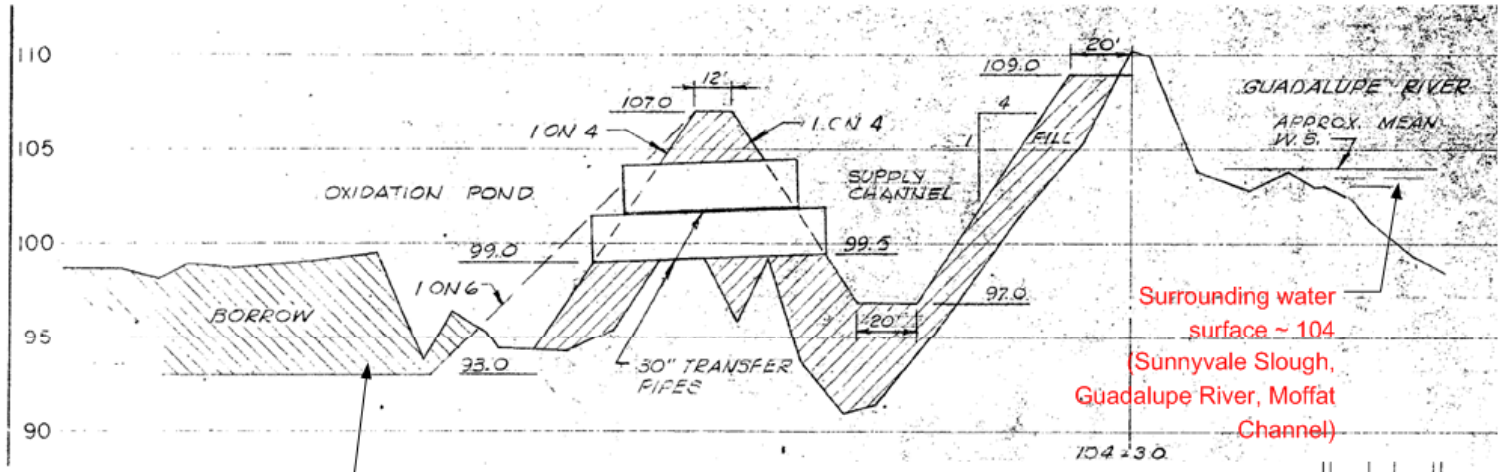
- Precedent set by South Bayland Mercury Project
  - Baseline monitoring for Pond A8 Restoration
  - 200 Acres of tidal wetlands
- Result after two years and $740,000:
  - "This study provides the baseline measures of condition that could serve as a foundation for the monitoring program that is needed"

Phase	Task	Cost	Completion Date
Phase 1	1: Finalize problem definition	5,250	Month 1
	2: Finalize sentinel species selection	10,500	Month 3
	3A: Assess risk of slough scour	75,250	Month 12
	3B: Develop sentinel species indicators	14,650	Month 9
	3Ci: Pond A8, Alviso Slough and reference site sentinel species survey	137,300	Month 12
	3Cii: Pond A8 and Alviso Slough Water Sampling	310,000	Month 12
	3Ciii: Pond A8 sediment sampling	20,000	Month 12
	4: Manage data	30,000	Ongoing
	5: Project management	15,000	Ongoing
Phase 1 subtotal			**617,950**
Phase 2	6: Survey Hg problem for SPRP	47,900	Month 24
	7: Explain HG accumulation patterns	71,725	Month 24
Phase 2 subtotal			**119,625**
Grand Total			**737,575**

Engineering Subjects

- Pond levees are built on and out of bay mud, which will require gradual sideslopes of 4:1 or more. Mosquito management favors sharp edges between the levees and water, which the current levees do not have.
- Dropping the water level by 6 ft in the ponds to accommodate the emergent wetland plants may cause seepage from the neighboring ponds and watercourses to intrude into the wetlands. Should assume that matching local hydraulic grade line may be necessary,

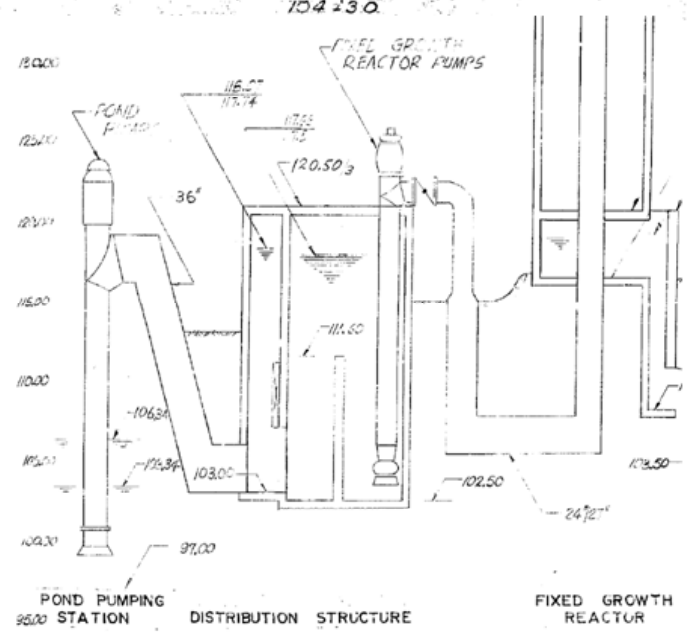
Ponds Hydraulic Grade Line



Surrounding water surface ~ 104 (Sunnyvale Slough, Guadalupe River, Moffat Channel)

Pond bottom varies 93 – 97 ft.

Pond operated at levels close to surrounding water.



Where would the fill come from?

- Estimate 2 million – 3 million cy sediment needed
- All dredging projects in Bay total 3 million – 6 milllion cy per year
- At least six other projects competing for suitable fill
  - Other projects are in more accessible locations
  - Noted in January, 2011 LTMS Management Committee Meeting:
    - Most dredging projects not close to South Bay
    - Significantly increases costs of transportation

What are the drivers to take on risks of an innovative alternative?

- Capital Cost
- Operational Costs
- Energy Recovery
- Resource Consumption / Hazardous Chemical Usage
- Compatibility with Neighboring Environment
- Expedient Completion for Renewal of Aged Infrastructure

Capital Costs

- Table 3 from Peer Review Report suggests there is no difference in capital cost between SIP Plant Rehabilitation and Option 5 CEPT -> Treatment Wetlands.
- $18.9 million allocated to 400 acres of wetlands conversion (~$47,000 per acre).
- Significant fill project. At least 4 – 6 feet of fill for significant portion of 400 acres.
- 2 – 3 million yards of imported fill could be required. Cost infers assumption that fill can be provided at very low cost.
- Will low cost fill be available in a timely manner?
- Little probability that capital cost will be lower, reasonable concern that cost could be substantially higher.

Operational Cost Comparison SIP Plant Rehabilitation vs Peer Review Option 5 (for costs unique to alternatives)

Item	**SIP Plant Rehabilitation**	**Peer Review Option 5**
Recovered Methane Credit	$ - 456,000 / year	$ - 415,000 / year
Ferric Chloride Cost	$ 0 / year	$ 550,000 / year
Supplemental Ferric Sludge	0 wet tons / year	5000 wet tons / year
Total Sludge Production	8,800 wet tons / year	13,100 wet tons / year
Sludge Processing Polymer Costs (Usage for Extended Stabilized Biosolids Lower)	$ 14,000 / year (3.5 lb / dry ton, $1.75/ lb)	$ 115,000 / year (20 lb / dry ton, $1.75 / lb)
Sludge Processing Power Costs	$ 50,000 / year	$ 74,500 / year
Sludge Hauling Costs	$ 393,000 / year	$ 585,000 / year
DAF Polymer Costs	$ 1,200,000 / year	$ 0 / year
DAF Power Costs	$ 200,000 / year	$ 0 / year
NTF Power Costs (Extra Recirculation, Extra Lift, Extra Ventilation)	$ 343,000 / year	$ 524,000 / year
Net Operational Cost (for costs unique to alternatives)	$ 1,744,000 / year	$ 1,433,500 / year

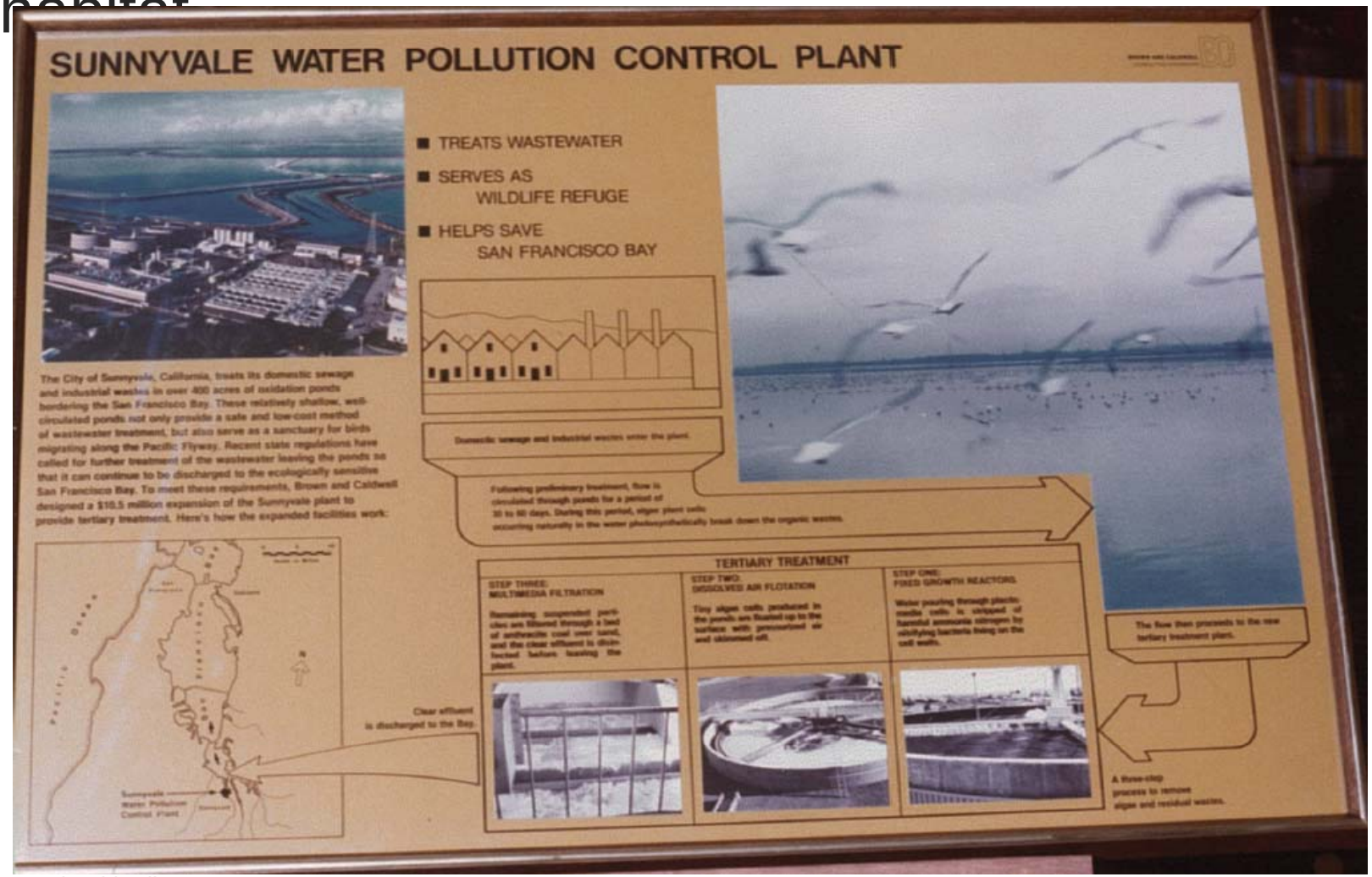
Brown and Caldwell Table Source: USGS

Small operational cost benefit for Option 5

- No energy recovery advantage
- No energy consumption advantage
- Introduction of more hazardous chemical ($FeCl_3$)
- More sludge trucks to and from site.
- Net operational benefit is just greater than 5% of total estimated operational costs.
- NPV of net operational benefits is about $5 million over SIP study period
- Programmatic costs for wetland habitat conversion not considered here.

Environmental Review Issues

- Existing oxidation ponds are already a wildlife habitat



Conversion to Treatment Wetlands

- Major change in habitat from status quo.
- Environmental Review will attract all players from Baylands Ecosystem Habitat Restoration Community.
- Open question regarding incorporation of existing disposed sludge into wetland fill.
- Finding imported fill from SF Bay dredging operations will require program development. Competition for quality dredgings in a short time period.
- City could be responsible for ensuring environmental quality of imported fills.

SIP Alternatives Have Better Chance to Proceed Expeditiously

- Rehabilitate Existing Plant alternative involves no significant change to existing accepted wildlife habitat provided by the ponds. Almost 50 years of history for current use with little concern from neighboring environment.

- Plant Replacement alternative disconnects ponds from treatment function. New facilities construction not dependent on determining ultimate use of ponds.

Treatment wetlands questions could hold up proceeding with project.

- Unproven treatment process combination.
- Engineering challenges.
- Potentially challenging review process for habitat change.
- New stakeholders in environmental review
- Adaptive management issues for new habitat.
- Challenges for acquiring economical fill.
- Questions on role of existing sludge in pond fill.
- Environmental monitoring for imported fill
- Environmental monitoring for changed habitat.