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Energy Savings Opportunities

The following table is a list of all Energy Efficiency Measures (EEMs) and Process Optimization Measures (POMs) identified during the 2015 pre-audit site walk at RP1, RP4, RP5, CCWRF, Recycle Water pump stations and the Head Quarters building. RP2 measures are not included as the annual energy usage for this plant is relatively less. The phases in the tables below indicate the anticipated implementation phasing at the time of initial presentation.

Table 1: Preliminary List of energy savings measures for RP1

Measure	Name	Brief Description	Phase 1	Phase 2	Phase 3	Status
1	Replace or repair Aeration Basin Blowers	Repair or overhaul aeration basin blowers to be more efficient	X			SCE Approved, but not installed
2	Install ORP, ASPCON, or Ammonia/Nitrate sensor control the blowers	Install sensors in the aeration basins to control blower energy usage to meet aeration requirements in aeration process to adjust blower usage to meet aeration requirements.	X			In Progress
3	Install Indirect Evaporative Coolers in blower rooms	Conditioning the blower inlet air increases the oxygen concentration and reduces aeration requirements in the aeration process.	X			SCE Approved, but not installed
4a	Add a Mix Liquor Recycle in the Aeration Process	Recover the process oxygen and biologics with the adding of a mixed liquor return in the AS1 process.	X			In Progress
4b	Install sensor to enable 1 tank denitrification	Instead of adding a MLR process and add the pumping load, use sensors and basin configuration to enable a 1 tank denitrification process.	X			N/A (MLR added)

5	Install Ultrafine Bubble Diffusers	Install high SOTE diffuser to decrease aeration requirement. *Existing Parkson panels are great operationally, but have high maintenance costs. IEUA willing to implement a replacement, if better SOTE and lower maintenance costs. (SOC preferred)*	X			SCE Approved, but not installed
6	Replace anoxic zone 15hp mixers with more efficient mixers.	Replace the existing 15hp mixers in the anoxic zones of the aeration basins to more efficient mixers.		X		
7a	Replace anaerobic digester mixing pumps and gas blowers with linear motion mixers.	Reduce digester mixing energy required			X	
7b	Replace or repair anaerobic digester mixing pumps	Repair or overhaul digester pumps to be more efficient			X	
7c	Replace or repair digester gas blowers	Repair or overhaul digester gas blowers to be more efficient			X	
8	Optimize RAS % of influent return	RAS returns organisms needed for the aeration process along with nitrates for denitrification and BOD destruction in the anoxic zones. Increasing nitrates decreases aeration requirements on the blower, but increases energy used for RAS pumping. Optimize the % influent flow rate return of RAS.	X			In Progress
9	Replace or repair aeration grit chamber blowers	Repair or overhaul aeration grit chamber blowers to be more efficient		X		In Progress

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10	Upgrade interior & exterior lighting at facility	Upgrade existing interior & exterior lighting to be more efficient.	X			Completed
11	Install Occupancy Sensors	Install occupancy sensors to control lighting.	X			Completed
12	Replace or repair odor scrubber blowers	Repair or overhaul odor scrubber blowers to be more efficient	X			
13	Replace or repair odor control/biofilter system blowers	Repair or overhaul odor control/biofilter system blowers to be more efficient	X			
14	VFD Optimization for Intermediate Pump Station A, B, and/or C	As system conditions change, the original VFD setpoints may require adjustment. Optimize the VFD set-points or retro-commission the VFD to meet system conditions.	X			Awaiting confirmation of interest from IEUA
15	Optimize IPS wet well level	There is a sweet spot on a pump's curve that maximizes the flow and allows the pump to operate most efficiently. If that spot is higher than the existing wet well level setpoint, the pumps do not need to work as hard. *Ensure optimized level is less than lagoon level for gravity flow from lagoon to IPS wet well.*	X			Awaiting confirmation of interest from IEUA
16	Replace or repair older pumps	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X	X		Completed + In Progress
17	Investigate consolidating air compressors and right size the system	Investigate if it makes sense to consolidate the small air compressors and decrease the design pressure from 150 psi to 90 psi.			X	

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18	Upgrade SCADA to include energy metrics	Integrate energy monitoring with performance metrics to manage baseline energy usage with performance objectives.			X	kW meters added to the plant, but not used to sequence or optimize operation

Table 2: Preliminary List of energy savings measures for RP4

Measure	Name	Brief Description	Phase 1	Phase 2	Phase 3	Status
1	Blower Efficiency Improvement	Evaluate existing aeration basin blowers for reasons of inefficiency. Conduct an overhaul of the blowers to bring them back to OEM specifications or implement a design change to meet current system conditions.		X		PA Review
2	Install Ultrafine Bubble Diffusers	Install high SOTE diffuser to decrease aeration requirement.		X		
3	Install ASPCON, or Ammonia/Nitrate sensor to control the blowers	Install sensors in the aeration basins to control blower energy usage to meet aeration requirements in aeration process to adjust blower usage to meet aeration requirements.		X		PA Review
4	Optimize RAS % of influent return	RAS returns organisms needed for the aeration process along with nitrates for denitrification and BOD destruction in the anoxic zones. Increasing nitrates decreases aeration requirements on the blower, but increases energy used for RAS pumping. Optimize the % influent flow rate return of RAS.		X		

5	Optimize Mixed Liquor (ML) % of influent return	ML returns nitrates for denitrification and BOD destruction in the anoxic zones. Increasing nitrates decreases aeration requirements on the blower, but increases energy used for MLR pumping. Optimize the % influent flow rate return of ML.		X		
6	Replace anoxic zone 4hp & 6.2hp mixers with more efficient mixers.	Replace the existing 4hp mixers in the anoxic zones of the aeration basins to more efficient Gridbee mixers.	X			On Hold – Pending IEUA vetting of Gridbee mixing technology
7	Optimize Wet Well level of Influent Pump Station	There is a sweet spot on a pump's curve that maximizes the flow and allows the pump to operate most efficiently. If that spot is higher than the existing wet well level setpoint, the pumps do not need to work as hard.	X			
8	Optimize Trident filter air scour and backwash cycle by turbidity level.	The existing air scour & backwash cycle is based on recurring time intervals with a pressure differential as the backup logic. The frequency of air scour & backwashes may be more than is required to maintain turbidity requirements. Install turbidity meters by filter to trigger air scour and backwash.			X	
9	Optimize AquaDisk filter backwash & sludge waste cycle based on turbidity level.	The existing backwash & sludge waste cycle is based on recurring time intervals. The frequency of backwashes and sludge waste cycles may be more than is required to maintain turbidity requirements. Install turbidity meters by rotating filter to trigger backwash & the sludge waste cycle.			X	

10	Optimize 1158 pump station wet well level	There is a sweet spot on a pump's curve that maximizes the flow and allows the pump to operate most efficiently. If that spot is higher than the existing wet well level setpoint, the pumps do not need to work as hard.	X			Completed
11	Optimize reservoir level control of 1299 pump station.	There is a sweet spot on a pump's curve that maximizes the flow and allows the pump to operate most efficiently. If that spot is lower than the existing reservoir level setpoint, the pumps do not need to work as hard.	X			IEUA decided not to pursue
12	Install more efficient domestic water heater	Install a more efficient water heater in the control building and maintenance building.	X			
13	Replace or repair older pumps	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X			Completed
14	Upgrade interior & exterior lighting at facility	Upgrade existing interior & exterior lighting to be more efficient	X			Completed
15	Install Occupancy Sensors	Install occupancy sensors to control lighting	X			Completed
16	Upgrade SCADA to include energy metrics	Integrate energy monitoring with performance metrics to manage baseline energy usage with performance objectives.		X	X	
17	High efficiency Ice maker machine	Evaluate ice machine	X			
18	Upgrade interior & exterior lighting at RP-4 and IERCF	HPS to LED lighting upgrades and other lighting upgrades	X			Completed

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19	Install MOV Controls					PA Review

Table 3: Preliminary List of energy savings measures for Recycle Water Pump Stations

Measure	Name	Brief Description	Phase 1	Phase 2	Phase 3	Status
1	Optimize fluid flow system of Montclair Pump Station	Automate the gates at the Montclair Diversion Structure to increase flow by gravity and decrease pumping at Montclair Pump Station using recycle water demand logic. *IEUA to check on status of this project.*	X	X		
2	Replace or repair older pumps	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X	X		
3	Optimize reservoir level control of recycle water pump stations	There is a sweet spot on a pump's curve that maximizes the flow and allows the pump to operate most efficiently. If that spot is lower than the existing reservoir level setpoint, the pumps do not need to work as hard. *This is part of UCR EPIC grant and recycle water system study.*			X	
4	Install new force main on Philadelphia Pump Station	Increase the pipe diameter of the force main to increase flow and decrease frictional losses so the pumps do not work as hard.			X	

Table 4: Preliminary List of energy savings measures for The Head Quarters Buildings

Measure	Name	Brief Description	Phase 1	Phase 2	Phase 3	Status
1	Upgrade interior & exterior lighting at facility	Upgrade existing interior & exterior lighting to be more efficient.	X			Completed
2	Reset supply air temperature	Resetting supply-air temperature based on outside air temperature. The two-way valves on the cooling coils will be modulated based on the outside air temperature.		X		Awaiting IEUA Review
3	Install VFD on Water Pumps for cooling tower	Install a VFD to modulate the speed of motors based on flow requirements.		X		
4	Install Vending Miser Controls on Beverage Vending Machines	Install a vending control device to power down the vending machine when the surrounding area is vacant.		X		
5	High efficiency Ice maker machine	Evaluate ice machine	X			
6	Install Occupancy Sensors	Install occupancy sensors to control lighting.	X			
7	Cooling Tower Water System	Pipeline for cooling water & a building may not provide optimal conditions for cooling tower air.		X		
8	Chilled water system	Supply pumps on chiller are 4-5 years old, thus may need an overhaul or replacement. Cooling water may require better insulation. Chiller requires an additional battery pack to enable usage for an additional 2 hours.		X		

Table 5: Preliminary List of energy savings measures for RP5 – *On-hold due to RP-5 expansion project*

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Measure	Name	Brief Description	Phase 1	Phase 2	Phase 3	Status
1	Blower Efficiency Improvement	Evaluate existing aeration basin blower equipment for reasons of inefficiency. Conduct an overhaul of the blowers to bring them back to OEM specifications or implement a design change to meet current system conditions.		X		IEUA decided not to accelerate blower upgrade before 2020-21
2	Install ORP, ASPCON, or Ammonia/Nitrate sensor to control the blowers	Install sensors in the aeration basins to control blower energy usage to meet aeration requirements in aeration process to adjust blower usage to meet aeration requirements.		X		
3	Install Indirect Evaporative Coolers in blower rooms	Conditioning the blower inlet air increases the oxygen concentration and reduces aeration requirements in the aeration process.		X		
4	Install sludge blanket sensors	Install sludge blanket sensor to automate sludge pumps based on sludge blanket level in the secondary clarifiers.		X		
5	VFD Optimization on Influent Pumps	As system conditions change, the original VFD setpoints may require adjustment. Optimize the VFD set-points or retro-commission the VFD to meet system conditions.			X	
6	Install VFD on Mix Liquor Recycle Pumps	Install a VFD to modulate the speed of motors based on flow requirements.		X		
7	Optimize Mixed Liquor (ML) % of influent return	ML returns nitrates for denitrification and BOD destruction in the anoxic zones. Increasing nitrates decreases aeration requirements on the blower, but increases energy used for MLR pumping. Optimize the % influent flow rate return of ML.		X		

8	Optimize RAS % of influent return	RAS returns organisms needed for the aeration process along with nitrates for denitrification and BOD destruction in the anoxic zones. Increasing nitrates decreases aeration requirements on the blower, but increases energy used for RAS pumping. Optimize the % influent flow rate return of RAS.		X		
9	Optimize flow to the aeration process	A flow equalization basin is available at the site. Install a flow meter to optimize the flow entering the secondary treatment process, optimize aeration process, and enable participation in DR.		X		
10	Replace anoxic zone 7.5hp mixers with more efficient mixers.	Replace the existing 7.5hp mixers in the anoxic zones of the aeration basins to more efficient Gridbee mixers.	X			IEUA decided not to pursue
11	Turbidity Based backwashing of filters	Installation of turbidity sensors at output of tertiary filters and schedule backwashing based on the turbidity of water at the output. *IEUA is willing to investigate alternate filter strategy, as existing filters are costly to maintain.*			X	
12	Upgrade interior & exterior lighting at facility	Upgrade existing interior & exterior lighting to be more efficient.	X			Completed
13	Install Occupancy Sensors	Install occupancy sensors to control lighting	X			Completed
14	Replace or repair older pumps	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X	X		Completed

15	Upgrade SCADA to include energy metrics	Integrate energy monitoring with performance metrics to manage baseline energy usage with performance objectives.		X	X	

Table 6: Preliminary List of energy savings measures for CCWRF – *On-hold due to facility study*

Measure	Name	Brief Description	Phase 1	Phase 2	Phase 3	Status
1	Retrofit Aeration Basin Blowers to pony blowers	Retrofit the existing one (1) 400hp Blowers with a single stage pony blower with VFD.			X	
2	Blower Efficiency Improvement	Evaluate existing aeration basin blowers for reasons of inefficiency. Conduct an overhaul of the blowers to bring them back to OEM specifications or implement a design change to meet current system conditions.		X		
3	Install Ultrafine Bubble Diffusers	Install high SOTE diffuser to decrease aeration requirement.			X	
4	Install ORP, ASPCON, or Ammonia/Nitrate sensor to control the blowers	Install sensors in the aeration basins to control blower energy usage to meet aeration requirements in aeration process to adjust blower usage to meet aeration requirements.			X	
5	Install VFD on Mix Liquor Recycle Pumps	Install a VFD to modulate the speed of motors based on flow requirements.			X	

6	Replace anoxic zone 12hp mixers with more efficient mixers.	Replace the existing 12hp mixers in the anoxic zones of the aeration basins to more efficient Gridbee mixers.		X		
7	Optimize RAS % of influent return	RAS returns organisms needed for the aeration process along with nitrates for denitrification and BOD destruction in the anoxic zones. Increasing nitrates decreases aeration requirements on the blower, but increases energy used for RAS pumping. Optimize the % influent flow rate return of RAS.			X	
8	Optimize Mixed Liquor (ML) % of influent return	ML returns nitrates for denitrification and BOD destruction in the anoxic zones. Increasing nitrates decreases aeration requirements on the blower, but increases energy used for MLR pumping. Optimize the % influent flow rate return of ML.			X	
9	Upgrade interior & exterior lighting at facility	Upgrade existing interior & exterior lighting to be more efficient	X			Completed
10	Install Occupancy Sensors	Install occupancy sensors to control lighting	X			Completed
11	Control Utility Water use in Aeration Basins based on influent flow	At the time of the site walk the utility water was constant on to mitigate the foam build up in the aeration basins. Add controls to the utility water pumps to adjust flows per influent flow requirements.		X		
12	Overhaul WAS PUMP #1	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X			SCE Approved, but not installed (approval has expired)

13	Overhaul WAS PUMP #2	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X			SCE Approved, but not installed (approval has expired)
14	Overhaul CCWRF RW PS #1	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps. IEUA already installed new pumps. Pumps may require new pump tests. *IEUA already installed new pumps. Pumps may require new pump tests.*			X	Cancelled
15	Overhaul CCWRF RW PS #2	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps. IEUA already installed new pumps. Pumps may require new pump tests. *IEUA already installed new pumps. Pumps may require new pump tests.*			X	Cancelled
16	Overhaul CCWRF RW PS #3	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps. IEUA already installed new pumps. Pumps may require new pump tests. *IEUA already installed new pumps. Pumps may require new pump tests.*	X			Determined not to be an opportunity
17	Overhaul CCWF EFF P-1	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X			Not SCE Approved (pump tests were outdated)
18	Overhaul CCWRF PSL-1	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X			SCE Approved, but not installed
19	Overhaul CCWRF PSL-2	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X			SCE Approved, but not installed

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20	Overhaul MIXED LIQUOR 2	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X			Completed
21	Overhaul MIXED LIQUOR 4	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X			SCE Approved, but not installed (approval has expired)
22	Overhaul MIXED LIQUOR 3	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X			SCE Approved, but not installed (approval has expired)
23	Overhaul MIXED LIQUOR 1	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X			Completed
24	Replace or repair older pumps	Investigate existing pumps for reason of inefficiency and replace or repair them to improve the OPE of the pumps.	X	X		Completed + SCE Approved
25	Upgrade SCADA to include energy metrics	Integrate energy monitoring with performance metrics to manage baseline energy usage with performance objectives.			X	
26	High efficiency ice maker machine	Evaluate ice machine	X			
27	Replace or repair odor scrubber blowers	Repair or overhaul odor scrubber blowers to be more efficient *Depending on the year of replacement, the phase might move to Phase 3.*		X		

Energy Efficiency
Engineering

Inland Empire Utility Agency:

Preliminary WWTP Benchmarking Report

Water Infrastructure and System

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DISCLAIMER AND CONFIDENTIALITY

This report is not intended to serve as an engineering design document, but is intended to provide estimated energy-efficiency savings, possible utility/federal incentives, and Return-On-Investment (in years) associated with the proposed energy-efficiency measures (EEM) for the specific locations at the Inland Empire Utility Agency Water Systems. The information and recommendations represented in this report are very high level and not for design or construction. Prior to any installation, it is highly recommended that a detailed energy audit is conducted.

It is to be noted that the savings estimates presented herein have been based on the available data, and information obtained from Southern California Edison (SCE). Lincus, Inc. and/or SCE are not liable if the projected estimated savings or economics are not actually achieved because of varying operating conditions at the site. All the savings and cost estimates are for informational purposes, and are not to be construed as a design document or as guarantees. The customer should independently evaluate the information presented in this report, and in no event will Lincus, Inc. or SCE be held liable if the customer fails to achieve a specified amount of energy savings, operation of their facilities, or any incidental or consequential damages of any kind in connection with this report or the installation of the recommended measures.

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Executive Summary

Lincus was requested by Southern California Edison (SCE) to assist the Inland Empire Utility Agency (IEUA) in identifying energy-efficiency opportunities at their wastewater treatment plants. As a part of this effort, Lincus conducted a very high level analysis using available and empirical data to estimate the potential savings opportunity based on the available plant data and historical pump test results for IEUA. The pumps tests that were used in this analysis were noted to be conducted between years 2010 and 2012. The benchmarking analysis presented here assumes that all the pumps for which the pump test results were provided to Lincus, are operational at the site currently and that no retrofit has been done on those, which will be verified during the detailed audit procedure.

Table 1 below provides a high-level summary of the recommended Energy Efficiency Measures (EEMs). Lincus has developed the following “Low Range and “High Range” savings estimates based on multiple approaches in calculating system efficiency. The proposed energy efficiency measures provide a total energy savings of 5,509,745 to 10,323,684 kWh/year[1] and 674 to 1,238 Peak kW[2], which equates to an annual utility cost savings[3] of $377,342 to $747,645. The total cost to implement these measures is estimated to be $1,627,800 to $7,125,000 which along with the estimated SCE incentives of $541,834 to $1,011,657 puts the simple payback period between 2.9 to 8.2 years. As a part of the detailed audit, Lincus engineers will work closely with the IEUA and SCE to identify eligible program measures and maximize the total utility incentives possible from the measures identified.

[1] Savings for EEM6 only includes CCWTP pumps. Upon additional pump tests being performed, savings may increase.

[2] System Optimization Peak kW savings calculated by the annual kWh saving divided by 8760 hours of use and multiplying by a 0.65 CDF. Pump Efficiency Improvement Peak kW savings calculated using a 0.65 CDF.

[3] Based on average utility rate of by plant using billing analysis, Incentive rate of $0.08/kWh & $150/kW, maximum SCE incentive = 50% of project cost.

Table 1: Estimated Savings

			EEM 1		EEM 2		EEM 3		EEM 4		EEM 5		EEM 6	
	Project Total		Sys. Opt. of RP1		Sys. Opt. of RP2		Sys. Opt. of RP4		Sys. Opt. of RP5		Sys. Opt. of CCWTP		Pump Efficiency Improvement	
	Low Range	High Range	Low Range	High Range	Low Range	High Range	Low Range	High Range	Low Range	High Range	Low Range	High Range	Low Range	High Range
kWh/yr. Savings	5,509,745	10,323,684	3,650,000	6,205,000	40,150	131,400	463,139	1,512,514	316,206	739,606	547,958	1,232,333	492,292	502,831
Peak kW Savings	673.69	1,238.42	416.67	708.33	4.58	15.00	52.87	172.66	36.10	84.43	62.55	140.68	100.93	117.31
Measure Cost	$1,627,800	$7,125,000	$752,500	$3,500,000	$25,800	$150,000	$273,050	$1,270,000	$258,000	$1,200,000	$178,450	$830,000	$140,000	$175,000
Utility Savings	$377,342	$747,645	$218,598	$371,617	$9,227	$30,199	$44,288	$144,635	$38,257	$89,484	$35,277	$79,337	$31,694	$32,372
SCE Incentive	$541,834	$1,011,657	$354,500	$602,650	$3,900	$12,762	$44,982	$146,900	$30,711	$71,833	$53,219	$119,688	$54,522	$57,824
Net Cost	$1,085,966	$6,113,343	$398,000	$2,897,350	$21,901	$137,238	$228,068	$1,123,100	$227,289	$1,128,167	$125,231	$710,312	$85,478	$117,176
Simple Payback	2.9	8.2	1.8	7.8	2.4	4.5	5.1	7.8	5.9	12.6	3.5	9.0	2.7	3.6

Facility Overview:

Wastewater Treatment Facilities:

Inland Empire Utilities Agency is a regional wastewater treatment agency and wholesale distributor of imported water. Today, IEUA is responsible for serving approximately 830,000 people over 242 square miles in western San Bernardino County. IEUA is focused on providing three key services: (1) treating wastewater, developing recycled water, local water resources, and conservation programs to reduce the region's dependence on imported water supplies and drought-proof the service area; (2) converting biosolids and waste products into a high-quality compost made from recycled materials; and (3) generating electrical energy from renewable sources. IEUA consists of a wastewater collections system, 5 wastewater treatment plants, and a recycled water system. Table below highlights the wastewater treatment facilities.

This facility utilizes primary, secondary, and tertiary treatment systems to produce water adequately filtered for their recycled water system demands. The secondary treatment system is equipped with nitrogen removal technology to provide compliance with the total inorganic limits. The advanced tertiary treatment facilities utilize multimedia filtration technology and chlorine disinfection.

Benchmarking Methodology

This preliminary benchmarking analysis is based on the available pump test results and water use data for the IEUA pumps as collected by SCE Hydraulic Services and the SCE 2012-2014 monthly billing historical energy consumption. This type of benchmarking process provides a very high level overview of savings potential present in the system. This process also yields a first iteration of savings that could be potentially achieved at the wastewater site to see if it deserves a more detailed analysis of the complete system.

Lincus' purpose in this two-step process is to first identify projects at a high level to ensure that the client is still interested in moving forward with energy efficiency projects. Once this step is determined based on the magnitude of savings, Lincus will address system optimization measures as well as detailed savings and estimated costs within the second step. In addition to providing a list of possible measures that could be potentially targeted using a detailed analysis, this two-step approach also provides an indication of time investment needed by water and wastewater agencies in supporting the program, i.e. data requests, on site audits, whetting different approaches to system optimization etc.

Wastewater Treatment Plant Benchmarking

As per a study conducted by the California Energy Commission (CEC), a typical urban wastewater treatment plant uses about 2,500 kWh/MG processed. The range of energy intensities for the wastewater systems could vary anywhere from 1,000 kWh/MG to 3,500 kWh/MG depending on the type of treatment process employed. Based on historical energy consumption at the sites and the plant capacities, the sites have current energy usage metrics of 2,675-3,107 kWh/MG processed. Table 2 below presents the typical ranges of energy use intensities for Wastewater treatment plants of different types.

Table 2: Typical Wastewater Treatment Plant Energy Intensities

Treatment Plant Type	kWh/MG	
	Low Range	High Range
Primary Treatment	1,000	1,200
Secondary Treatment	1,400	1,800
Tertiary Treatment	2,000	3,500

As noted from the Table 2 above, a typical tertiary treatment plant is estimated to consume anywhere between 2,000 kWh/MG to 3,500 kWh/MG for its processing. Figures 1 & 2 below shows a schematic of the major energy consuming equipment at each step of the wastewater treatment and the typical energy contributions of the different processes in wastewater treatment plants.

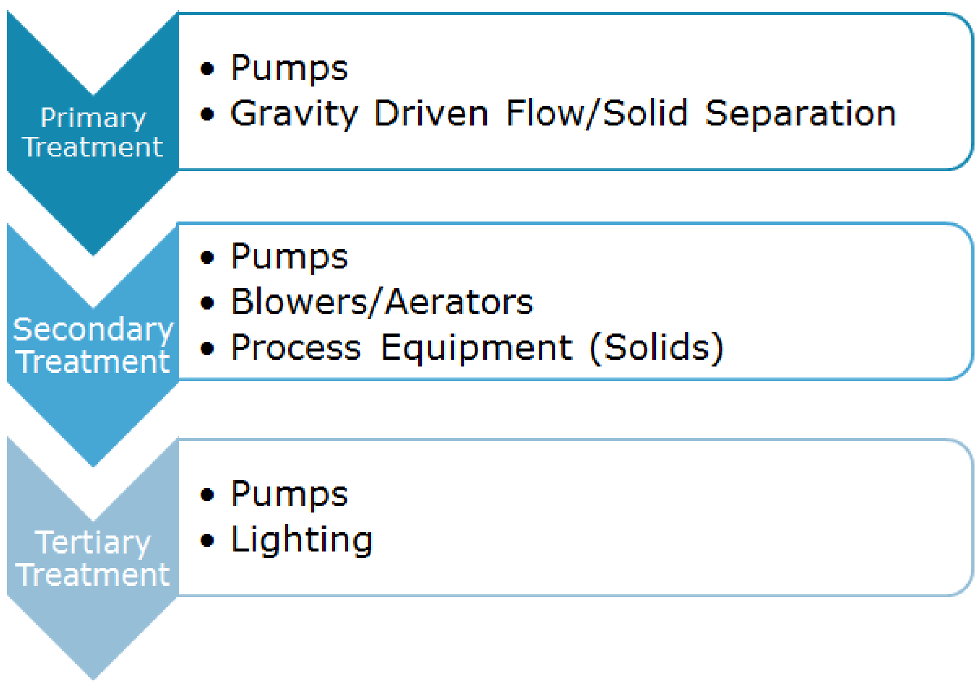

Figure 1: Major Energy Consuming Equipment in Treatment Plants

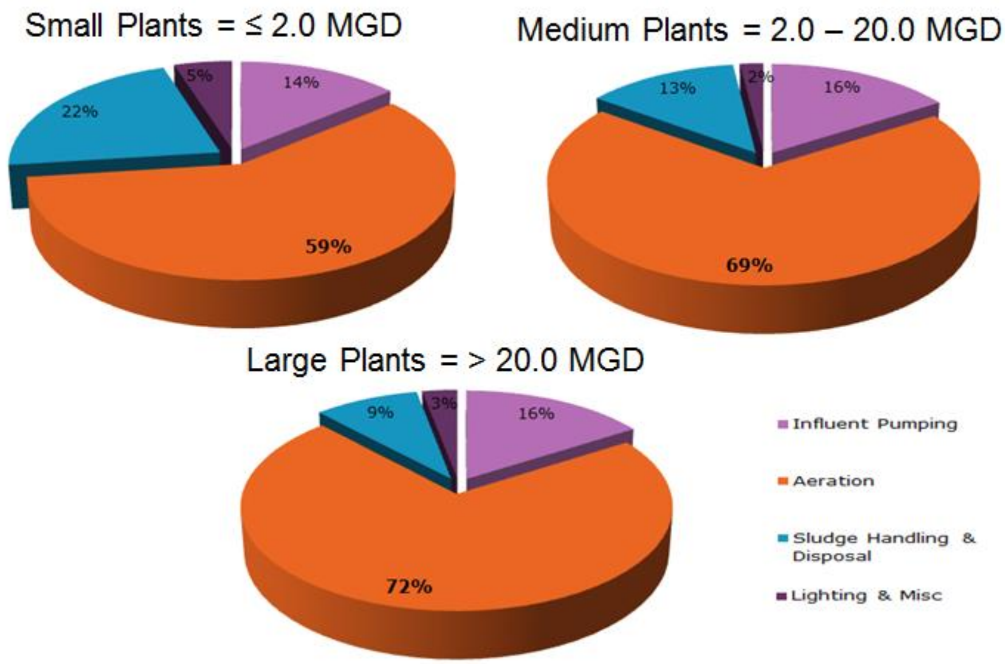

Figure 2: Energy Contributions of different processes in WW Plants

From Figures 1 and 2, it follows that for a plant similar to the IEUA sites, the pumps and the blower equipment components' energy use could well account for nearly 70% - 80% of the total plant's consumption. Given the current efficiency improvement opportunities in these pumps and blower systems as identified, the low and high energy intensity range of 2,500 – 2,750 kWh/MG has been used to estimate the respective savings ranges for this treatment plant as a part of this benchmarking analysis.

The following Energy Efficiency Measures ("EEMs") are preliminarily identified as measures that may be applicable to significantly and economically optimize energy use. Please note that there may be many other measures identified resulting from an energy audit of the IEUA facilities.

1) EEM 1: System Optimization of Wastewater Systems;
2) EEM 2: Pumps Efficiency Improvement.

Wastewater system optimization includes multiple measure opportunities, including, but not limited to VFD application on Treatment blowers, Optimize DO control and Aerobic Digestion Process, High Efficiency Transfer Diffusers, Optimize Mixing in Anaerobic digesters, VFD application on Pumps, Optimize Pump Sequencing,. Specific opportunities will be evaluated upon an on-site audit and detailed analysis of existing systems.

The implementation of the pump efficiency improvement measure may include, but may not be limited to pump bowl assembly and impeller repairs or replacements, impeller trimming, pump operation improvement, and right sizing of equipment.

Energy Efficiency Measures

EEM 1: System Optimization of Wastewater Systems

VFD Application on Treatment Blowers, Optimize DO Control and Aerobic Digestion Process

A variable-frequency drive (VFD) controls the rotational speed of an electric motor by varying its input voltage and frequency, thus changing the flow rates. This allows the delivery of air to track the demand from the system. For example, when the demand for air in treatment is relatively low, the blower motor of a wastewater treatment system modulates to a lower speed, delivering just the right amount of air required to maintain the correct amount of dissolved oxygen in the basins. The baseline would be flow control through an inlet valve. This would then result in a lower flow rate from the blower. This is an inefficient way of flow control due to the high amount of energy wasted. The drives are most commonly controlled automatically via a SCADA (Supervisory Control and Data Acquisition) system but also can be controlled manually, typically via a keypad.

High Efficiency Transfer Diffusers

Air diffusers are aeration devices typically in the shape of a disc, tube or panel, which are used to transfer air or oxygen into sewage or industrial wastewater. Oxygen is required by microorganisms/bacteria residents in the water to break down the pollutants. Diffusers produce coarse, fine or ultra-fine bubbles when connected to a piping system which is supplied with pressurized air by a blower.

The demand for air in treatment is influenced by the efficiency of the air diffusers. With lower transfer efficiency diffusers there is greater demand for air to maintain the correct amount of dissolved oxygen in the basins. The baseline would be a low transfer efficiency diffuser on a blower with a VFD. The blower needs to work harder to maintain dissolved oxygen requirements with a low transfer efficiency diffuser, thus wastes energy.

Optimize Mixing in Anaerobic Digesters

Digester mixing systems are designed for the following purposes:

- Provide contact between active biomass and feed sludge
- Provide physical, chemical and biological uniformity within a digester
- Distribute organics and dilute inhibitory substances within a digester
- Utilize the digester volume effectively
- Prevent stratification and temperature gradients

- Minimize the formation of a scum layer and the deposition of solids

This measure involves installation of high efficiency mixers which aim to increase both mixing efficiency and operational efficiency. Increasing the operational efficiency would result in a reduction in energy consumption.

VFD Application on Pumps

A variable-frequency drive (VFD) controls the rotational speed of an electric motor by varying its input voltage and frequency, thus changing water flow rates. This allows the delivery of the water to track the load of that system.

For example, when the wastewater pumping requirements are relatively low (say, during the wee hours of the day), the pump in a treatment plant system modulates to a lower speed, delivering the minimum amount of water required to maintain the operation of the various systems. The baseline would be flow control through a throttling valve, on-off control, or another flow control valve strategy. These baseline flow control strategies described above are inefficient ways of flow control due to the high amount of energy wasted.

Optimize Pump Sequencing

Process equipment like pumps lose efficiency over time due to normal equipment wear and tear. Overall plant efficiency (OPE) is also affected by system conditions and how far off they are from equipment design conditions. Pumps with greater OPEs consume less energy for similar volumes of water pumped.

For processes with multiple pumps in parallel, there may be a pump with a greater OPE relative to the other pumps within the booster station. This measure sequences the pump operations such that the pump with the greatest OPE is the primary pump. Once the demand exceeds the capacity of the primary pump, the pump with the next greatest OPE is turned on to meet the demand, and so on. This pump sequencing optimizes the energy consumed to meet system demands.

EEM 2: Pump Efficiency Improvement

Process equipment like pumps lose efficiency over time due to normal equipment wear and tear. Overall equipment efficiency is also affected by system conditions and how far off they are from equipment design conditions. The measure is a pump that is overhauled for improved efficiency to better match the design of the pump to the actual system operating conditions. Doing so will improve the overall plant efficiency (OPE) of the pump. Table 3 below shows the typical Overall Plant Efficiency percentages as a function of motor HP for the well and booster pumps as recommended by the industry experts[4].

[4] Overall Plant Efficiency Chart, California Public Utilities Commission Efficiency Ranges

Table 3 Typical Pump Overall Plant Efficiencies

Motor HP	Low%	Fair %	Good %	Excellent		
				Well Pump	Booster	Submersible
3 - 5	≤ 41.9	42.0 - 49.9	50.0 - 54.9	≥ 55.0	≥ 55.0	≥ 52.0
7.5 - 10	≤ 44.9	45.0 - 52.9	53.0 - 57.9	≥ 58.0	≥ 60.0	≥ 55.0
15 - 30	≤ 47.9	48.0 - 55.9	56.0 - 60.9	≥ 61.0	≥ 65.0	≥ 58.0
40 - 60	≤ 52.9	53.0 - 59.9	60.0 - 64.9	≥ 65.0	≥ 70.0	≥ 62.0
75 - up	≤ 55.9	56.0 - 62.9	63.0 - 68.9	≥ 69.0	≥ 72.0	≥ 66.0

Implementation of this measure includes, but not limited to

- Replacing and/or repairing bowl assembly, impellers and other integral equipment components of the pump.
- Improving pump operations.
- Installing right sized equipment that will improve the overall plant efficiency of the pump operation.

Figure 3 shows the pump equipment contributing to the OPE and a visual representation of systems to evaluate when implementing this measure.

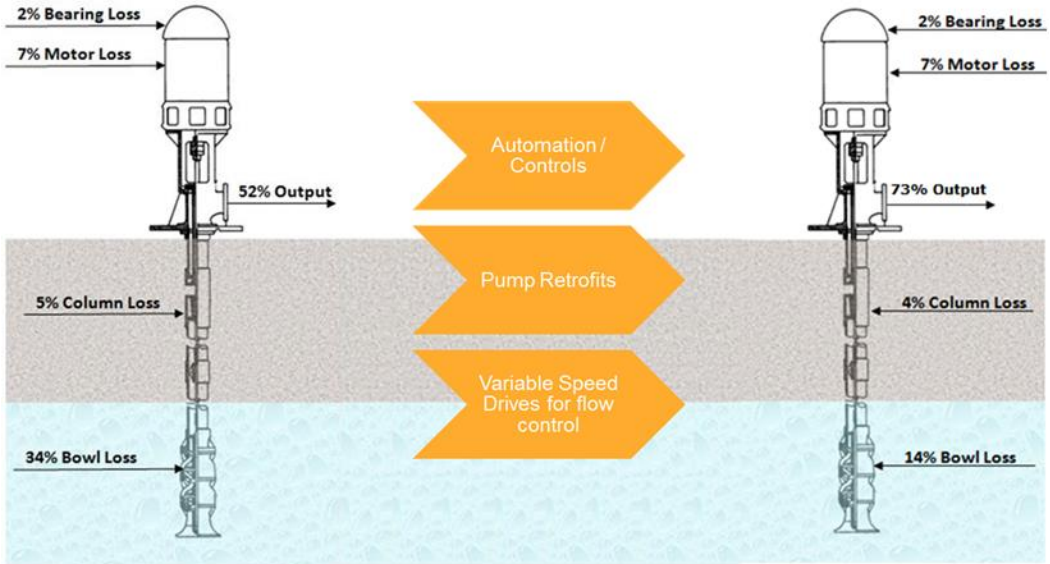

Figure 3: Pump Efficiency Improvement Example

MODEL BASED CONTINUOUS OPTIMIZATION OF PUMP SYSTEMS (iPT)

The measure includes the installation of the Lincus Integrated Pump Tool (iPT) via the installation pump system controls and software with the capability of calculating pump OPE on a real-time basis. This tool provides opportunity for implementation for optimized pump sequencing. It also informs operators when there is opportunity for pump efficiency improvement based on OPE thresholds. The controls also enable the pump system's eligibility to participate in Auto Demand Response Programs.

The measure may also include the development of a hydraulic model via WaterCAD and/or WaterGEMS to verify the overall system efficiency. The model may be re-run annually to ensure persistence of implemented measures and identification of degradation of overall system efficiency.

Appendix: Savings Output

The following tables include specific energy efficiency and consumption calculation information on each pump Lincus has reviewed.

Table 4: Pump Efficiency Improvement of Wastewater Treatment Plant Booster Pumps

							Pump Efficiency Improvement					
							Low Range			High Range		
SCE Service Account #	Pump Name	Test Date	Pump Location	Motor HP	Test Eff. %	Impr. Eff. %	Estimated Savings (kWh/yr)	Estimated Peak kW Savings	Measure Cost ($)	Estimated Savings (kWh/yr)	Estimated Peak kW Savings	Measure Cost ($)
10610784	WAS PUMP #1	10/7/2010	14950 TELEPHONE AVE	7.5	13.6	57.0	20,447	1.68	1,312.50	20,447	1.68	1,312.50
10610784	WAS PUMP #2	10/7/2010	14950 TELEPHONE AVE	7.5	14.8	57.0	18,859	1.55	1,312.50	18,859	1.55	1,312.50
10610784	CCWRF RW PS #1	10/6/2011	14950 TELEPHONE AVE	200	64.2	72.0	56,385	17.27	35,000.00	56,385	17.27	35,000.00
10610784	CCWRF RW PS #2	10/6/2011	14950 TELEPHONE AVE	200	63.2	72.0	47,188	19.13	35,000.00	47,188	19.13	35,000.00
10610784	CCWRF RW PS #3	10/6/2011	14950 TELEPHONE AVE	200	64.7	72.0	-	-	-	10,539	16.39	35,000.00
10610784	CCWF EFF P-1	6/2/2010	14950 TELEPHONE AVE.	125	53.1	70.0	102,464	8.45	21,875.00	102,464	8.45	21,875.00
10610784	CCWRF PSL-1	9/14/2010	14950 TELEPHONE AVE	30	10.1	61.0	15,313	2.51	5,250.00	15,313	2.51	5,250.00
10610784	CCWRF PSL-2	9/14/2010	14950 TELEPHONE AVE	30	10.0	61.0	20,832	2.51	5,250.00	20,832	2.51	5,250.00
10610784	MIXED LIQUOR 2	10/7/2010	14950 TELEPHONE AVE	50	37.5	65.0	56,175	12.82	8,750.00	56,175	12.82	8,750.00
10610784	MIXED LIQUOR 4	10/7/2010	14950 TELEPHONE AVE	50	38.4	65.0	52,181	11.91	8,750.00	52,181	11.91	8,750.00
10610784	MIXED LIQUOR 3	11/10/2010	14950 TELEPHONE AVE	50	44.0	65.0	49,444	10.99	8,750.00	49,444	10.99	8,750.00
10610784	MIXED LIQUOR 1	10/7/2010	14950 TELEPHONE AVE	50	40.6	65.0	53,004	12.10	8,750.00	53,004	12.10	8,750.00

Table 5: IEUA WWTP Energy Use Metrics

Plant	Annual SCE Energy Cost ($)	SCE kWh/yr	Total kWh/yr	MG/day	MG/year	Capacity MGD	kWh/MG
RP1	$1,011,035.37	16,881,548	31,755,000	28	10220	44	3107.14
RP2	$110,810.26	482,151	1,335,900	2	730	N/A	1830.00
RP4	$2,014,187.10	21,063,284	12,006,264	11.5	4197.5	14	2860.34
RP5	$1,295,979.82	10,711,616	11,324,606	11.6	4234	16.3	2674.68
CCWTP	$485,216.18	7,536,762	7,884,000	7.5	2737.5	11.4	2880.00