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Technical Memorandum #1

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Subject: Task 1.1 – Laguna Wastewater Treatment Plant (LTP) Process Energy Audit
Santa Rosa Energy Optimization Plan (EOP) - Phase 1
K/J Project: 1368024*01

Kennedy/Jenks Consultants (KJ) conducted a process energy audit of the City of Santa Rosa (Santa Rosa) Laguna Wastewater Treatment Plant (LTP) on April 10 and 11, 2014. The purpose of the process energy audit was to identify and recommend cost-effective Energy Efficiency Measures (EEMs) and Process Improvements (PI) that can be achieved primarily through changes in plant operations and process. EEMs are recommended changes that would result in energy savings, while PIs are recommended changes that may be beneficial to plant personnel or performance but do not necessarily result in direct energy savings.

1.1 Recommendations

Overall, the audit found that LTP is well operated and maintained and is in the top-tier nationally in its performance and practices. There was no “low-hanging fruit” in terms of energy savings. LTP exceeds normal industry standards.

- The average electrical rate for LTP plant is $0.1095 per kilowatt hour (kWh).
- The off-peak energy rate (6 pm to noon) is approximately $0.07 per kWh, and the on-peak energy rate (noon to 6 pm) jumps to $0.13 kWh (which was referred to by LTP staff as the “high cost period”). The highest electric demand charge is during summer peak between May 1 and October 31.

A total of 10 EEMs were identified during the audit and are shown in Table 1-1. Most of the recommendations only require operational or SCADA changes, making these EEMs very cost-effective.

Table 1-1: List of Recommended Energy Efficiency Measures

EEM#	Title
1	Raise Tertiary Filter Wet Well Level
2	Replace Ultraviolet (UV) Disinfection
3	Raise Raw Wet Well Level
4	Modify (3W) Water Scum Spray and Install VFDs
5	Reduce Air to Mixed Liquor and Primary Channel
6[1]	Run Idle Cummins Engines on Natural Gas to Generate Electricity
7	Optimize Return Activated Sludge
8	Stagger Digester Mixing Pumps During Peak Energy Period
9	Install VFDs on Aerated Grit System
10	Implement Building and Lighting EEMs

[1] EEM-6 is not included in the overall total savings.

Before and after electrical readings on select equipment and/or operational trials would allow a more refined projection of estimated annual savings. It should be noted that demand charges were also not included in the potential savings, though time of day charges were where applicable. Data loggers and/or electrical readings over a period of time would be needed to accurately determine the potential demand savings. Since the process audit recommendations are mostly based on changes to process set-points and standard operating procedures, demand savings cannot be estimated until the recommended changes have been made or tested. Calculated values are based on rough order of magnitude estimates and what is believed to be the best available data. The cost estimates are based on the Association for the Advancement of Cost Engineering International (AACEI) standards for cost estimating accuracy of +50% and -30%.

Should Santa Rosa implement all of the recommendations in this Tech Memo, it could achieve in an estimated average annual net savings of nearly $250,000 per year with a Net Present Value (NPV) of the cumulative average annual savings of $2.99 million. This does not include EEM-6 “Run Idle Cummins Engines on Natural Gas to Generate Electricity,” which was not included in the savings totals because this recommendation came from a 2013 Brown and Caldwell study and was not solely a KJ recommendation. In addition, excluding EEM-2 Replacement of the UV Disinfection System, the electricity savings are still over 734,000 kWh per year, with an average annual net savings of about $124,000 and NPV of cumulative net savings of over $1.76 million. PG&E incentives are based on the capital cost and energy savings of an EEM. For projects without capital cost, such as nearly all of the recommended EEMs, PG&E would not offer an incentive. The UV project may be eligible for a substantial incentive, but to be conservative we did not include an incentive in this analysis.

The savings shown in Table 1-2 below illustrates only the potential savings that can be estimated with available information.

Table 1-2: Summary of Recommended Energy Efficiency Measure Savings

Electricity Savings (kWh/Yr)	Demand Savings (kW)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings[1] ($)
6,890,700	$785,000	1,416	$12,377,900	$1,000	$12,376,900	$248,500	$2,993,500
TOTAL without EEM-2: Replacement of the UV Disinfection System							
734,469	$83,641	151	$3,000	$1,000	$2,000	$124,385	$1,762,210

[1] Based on a 4.0% loan/bond rate, 1.0% loan/bond issuance cost, 2.5% inflation rate, 3.1% real discount rate and 5.7% nominal discount rate. Time period ranges from 10 to 20 years, depending upon the EEM.

The priority order for implementation by Santa Rosa is based on the Return on Investment (ROI) for each recommended EEM. ROI is calculated using the Excel IRR function but cannot be calculated if the capital cost is zero ("NC" represents "not calculable" in Table 1-3 below). Essentially, the ROI is infinite without capital costs; therefore, EEMs with zero capital cost are ranked based on the amount of NPV of cumulative net savings it brings to Santa Rosa. The recommended implementation order is in Table 1-3.

Table 1-3: Priority Implementation Order for Energy Efficiency Measures

Rank	EEM #	Title	ROI %	NPV of Life of Savings ($1,000)
1	EEM 6	Run Idle Cummins Engines on Natural Gas to Generate Electricity	IDTD[1]	$1,743
2	EEM 5	Reduce Air to Mixed Liquor and Primary Feed Channel	NC[2]	$685
3	EEM 7	Optimize Return Activated Sludge	NC[2]	$447
4	EEM 8	Stagger Digester Mixing Pumps During Peak Period	NC[2]	$262
5	EEM 1	Raise Tertiary Filter Wet Well Level	NC[2]	$230
6	EEM 3	Raise Raw Wet Well Level	NC[2]	$96
7	EEM 4	Modify 3W Water Scum Spray and Install VFD	NC[2]	IDTD[1]
8	EEM 10	Implement Building and Lighting EEMs	NC[2]	IDTD[1]
9	EEM 9	Install VFDs on Aerated Grit System	110%	$43
10	EEM 2	Replace Ultraviolet (UV) Disinfection	9%	$1,231

[1] IDTD - Insufficient Data To Determine at this time
[2] NC = Not calculable because the ROI for projects with zero capital cost do not calculate using the Excel IRR function. With zero capital cost the ROI is essentially infinite.

In addition to the ten EEMs six PIs were also identified. Since PI recommendations do not directly result in energy savings, no cost savings were identified in the tech memo for these suggestions. They are listed in Table 1-4 below.

Table 1-4: List of Recommended Process Improvements

PI#	Title
1	Reroute Filter Backwash Water
2	Enhance SCADA Screens
3	Increase Belt Press Solids Concentration
4	Monitor Primary Sludge pH
5	Upgrade Digester Mixing
6	Reduce Sludge Yield

1.2 Background

1.2.1 Plant Description

LTP is a tertiary wastewater treatment facility with an average flow of 22.0 million gallons per day (MGD). The plant processes investigated for this audit task include:

- Headworks Screening and Grit Removal
- Primary Treatment
- Activated Sludge with Anoxic Selector
- Tertiary Filtration
- UV Disinfection
- Solids Handling
- Anaerobic Digestion

1.2.2 Energy Use and Cost

As part of the data collection prior to the onsite audit, Santa Rosa provided baseline energy usage for its Regional Water Reuse System, including LTP. The baseline provides a snapshot of how much energy is currently used at LTP to allow for comparison to what impacts the various audit recommendations will have. The baseline energy profile for LTP includes electricity use and natural gas use.

KJ worked with Santa Rosa staff to collect the necessary data to create the baseline in a spreadsheet model entitled “Santa Rosa Energy Baseline.” Baseline data were developed using daily operating data from the Santa Rosa SCADA system and monthly billing data from PG&E for the period of January 2012 through December 2013.

For LTP, the electricity baseline was broken down by process as shown in the SCADA data, as shown in Table 1-5.

Table 1-5: Baseline Electricity Usage for LTP

Process Category	Baseline Annual Electricity Use (kWh/Yr)[1]	Baseline Annual Electricity Cost ($/Yr)
Influent Pumping	1,355,000	$86,000
Primary Treatment[2]	409,000	$29,000
Aeration	5,616,000	$365,000
UV Disinfection	9,678,000	$619,000
W3 Pumping	860,000	$55,000
Activated Sludge[3]	1,278,000	$81,000
Miscellaneous On-Site[4,5]	7,614,000	$486,000
Total Electricity Used at LTP	**26,617,000**	**--**
Electricity Generated On-Site	11,020,000	--
Total Electricity Purchased from PG&E[5]	**15,597,000**	**$1,707,000**

[1] Unless otherwise noted, data are from Santa Rosa SCADA system from Jan 2012 to Dec 2013.
[2] Includes 2013 data only. This category was not tracked separately until Dec 2012.
[3] Includes mixed liquor recycled pumps and anoxic mixers.
[4] Includes solids handling, lighting, HVAC, and an extremely small amount of usage for Alpha Pond, Waste Management, and Sewer Meter Station.
[5] Data are from PG&E from Jan 2012 to Dec 2013.

Monthly electricity usage for LTP by process category is shown in Figure 1-1. As illustrated in the figure, the UV system uses the greatest amount of electricity. Other large uses are the combined solids handling, lighting and HVAC category, and aeration.

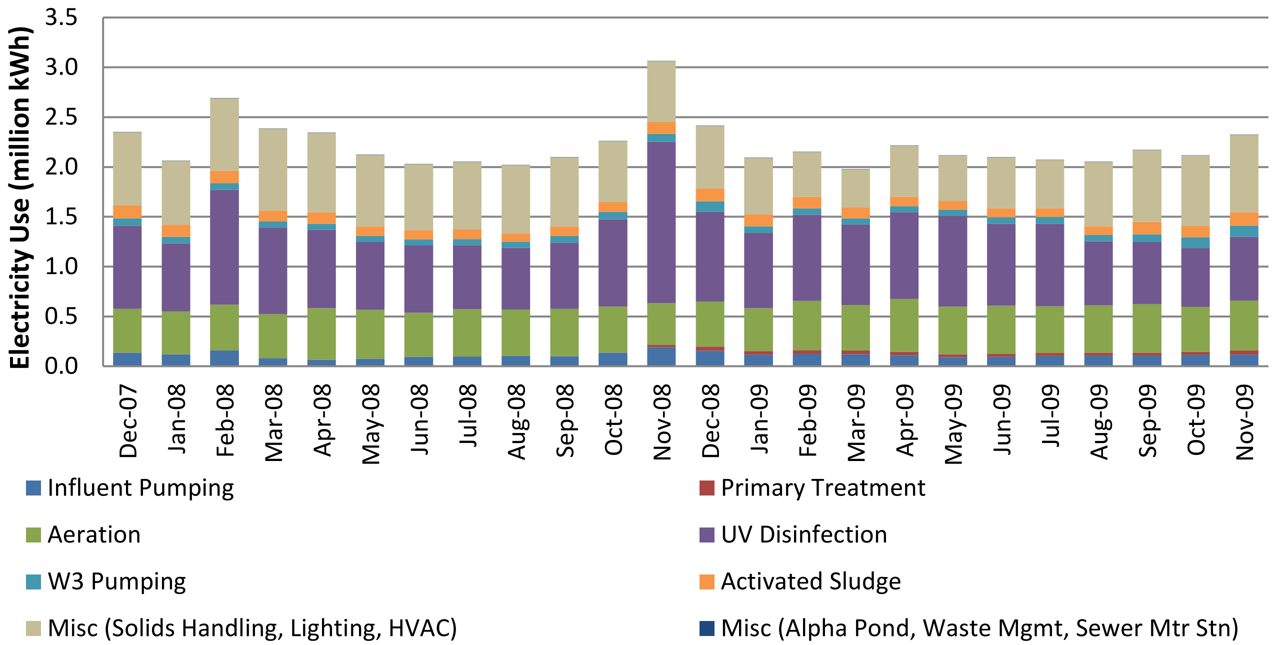

Figure 1-1: Monthly Electricity Usage for LTP by Process Category

As shown in Figure 1-2, LTP uses 75% of the total electricity of the Regional Water Reuse System.

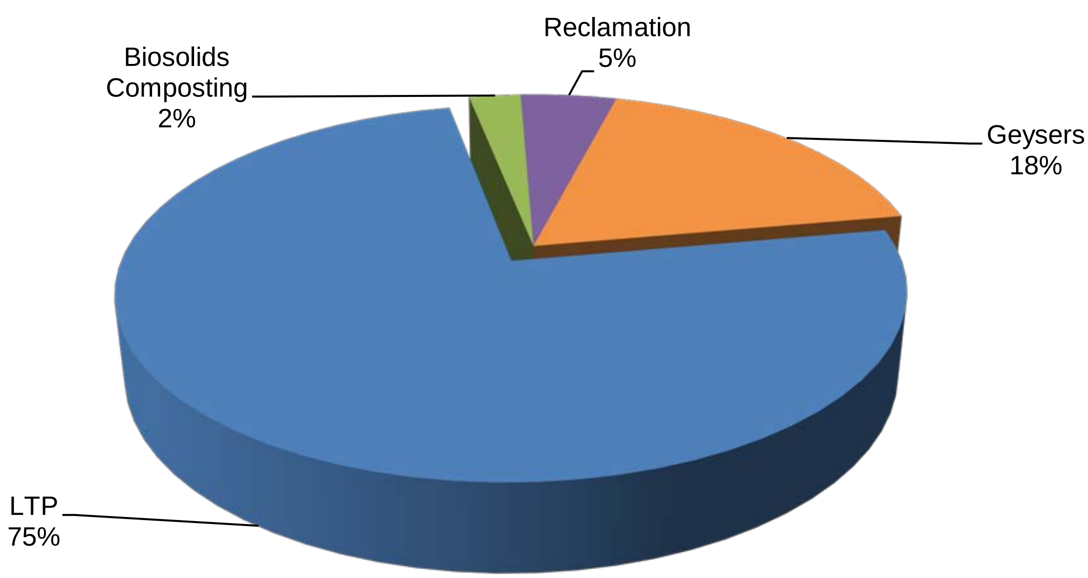

Figure 1-2: Annual Electricity Usage for Regional Water Reuse System by Category

The natural gas data are broken into Core and Non-Core categories by PG&E. The annual Non-Core data are shown separately for 2012 and 2013, since the CHP project came online in early 2013 and reduced the natural gas usage significantly. The post-CHP numbers are expected to be representative of future natural gas purchases. The baseline natural gas usage for LTP is shown in Table 1-6.

Table 1-6: Baseline Natural Gas Usage for LTP

Process	**Baseline Annual Natural Gas Use (therms/Yr)**	**Baseline Annual Natural Gas Cost ($/Yr)**
Core	55,000	$45,000
Non-Core (2012, pre-CHP)	*639,000*	*$26,000*
Non-Core (2013, post-CHP)	150,000	$10,000
Total Natural Gas Purchased from PG&E (post-CHP)	**205,000**	**$55,000**

1.3 Overview of Audit Methodology

The process energy audit consisted of both an off-site review of data and an on-site tour of LTP. The objective of the on-site tour was to understand the plant history and processes, participate in a guided walk-through of the plant to identify all of the processes and equipment that use energy, provide a detailed assessment of energy using equipment, quantify their energy use, and identify preliminary EEMs.

After the tour, a process energy audit workshop was held at LTP. The goal of the workshop was to examine ideas developed during the offsite data review and utilize LTP staff's significant plant-specific knowledge to develop additional money saving and process related recommendations. Wastewater Solutions, Inc. (WSI) and KJ met with Joe Schwall (LTP Operations Superintendent) and Terry Schimmel (LTP Maintenance Superintendent).

Table 1-7 below shows the summary of the analysis of the 10 identified EEMs. A more detailed description of each recommendation is provided in the following sections. Cost savings spreadsheets were developed for the EEMs where we could quantify the savings and costs and are provided electronically.

Table 1-7: Summary of Identified Energy Efficiency Measures

EEM #	Title	Energy Savings (kWh/Yr)	Avg Annual Net Savings ($/Yr)	NPV of Life of Savings ($)	Description
EEM 1	Raise Tertiary Filter Wet Well Level	95,776	$16,239	$230,081	Increase the wet well level to lower the pumping TDH. This will result in reduced pump electrical usage. (LTP will install data loggers to determine savings potential.)
EEM 2	Replace Ultraviolet (UV) Disinfection	6,156,296	$124,093	$1,231,297	Switching to hypochlorite could result in significant savings from reduced electrical usage (equivalent to 920 HP/day).
EEM 3	Raise Raw Wet Well Level	39,907	$6,766	$95,867	Increase the wet well level to lower the pumping TDH. This will result in reduced pump electrical usage.
EEM 4	Modify 3W Water Scum Spray and Install VFD	IDTD	IDTD	IDTD	Install VFDs on 3W pumps. Also consider water reduction measures.
EEM 5	Reduce Air to Mixed Liquor and Primary Channel	285,000	$48,324	$684,650	Shut off or reduce the air to the Mixed Liquor Suspended Solids (MLSS) channel and the primary feed channel.
EEM 6	Run Idle Cummins Engines on Natural Gas to Generate Electricity	3,135,000	$209,691	$1,743,110	Utilize natural gas to run other generators and reduce purchase of electricity off the grid.
EEM 7	Optimize Return Activated Sludge	186,246	$31,579	$447,416	Reduce RAS rate. Use state point to ensure minimum RAS rate. Saves energy through reduced RAS and WAS pumping, reduced numbers of GBTs, and also improves secondary performance.
EEM 8	Stagger Digester Mixing Pumps During Peak Period	108,916	$18,467	$261,647	Consider shutting down the digester mixing pumps for 2.5 hours during the electric rate peak period.

EEM #	Title	Energy Savings (kWh/Yr)	Avg Annual Net Savings ($/Yr)	NPV of Life of Savings ($)	Description
EEM 9	Install VFDs on Aerated Grit System	18,625	$3,009	$42,551	Add VFDs to aerated grit blowers. Allow turn-down or pacing at low flows.
EEM 10	Implement Building and Lighting EEMS	IDTD	IDTD	IDTD	BASE energy equipment audit indicated energy savings opportunities in the building envelope and the facility lighting.
	Totals (Not including EEM-6)	**6,890,765**	**$248,478**	**$2,993,507**	

IDTD - Insufficient Data To Determine

2012 BASE Equipment Audit

At the site workshop, Santa Rosa's prior energy audit with Pacific Gas and Electric (PG&E) was briefly discussed. In June 2012 Santa Rosa participated in a Large Integrated Energy Audit Program (LIA) with PG&E's Customer Energy Efficiency (CEE) Department in conjunction with Base Energy, Inc. (BASE). The Audit resulted in the issuance of Report No. BASE_PGE_11-05.

Five "Other Measures Considered" (OMCs) were evaluated in the report and are listed in Table 1-8 below. These measures were not included in the Energy Efficiency Opportunities (EEOs) section due to simple payback periods greater than 10 years.

Table 1-8: Energy and Cost Savings Summary for Other Measures Considered

OMC No. Description	Energy Savings (kWh/Yr)	Peak Demand Savings (kW)	Energy Cost Savings ($/Yr)	Implementation Cost ($)	Potential Incentive ($)	Simple Payback w/ Incentive (Yrs)
Install a Low-Pressure High-Intensity Ultraviolet (UV) Radiation Disinfection System	5,893,987	482.7	$505,968	$14,000,000	$578,729	26.5
Install Mechanical Pumping Sludge Mixing Systems in the Anaerobic Digesters	175,310	20.0	$15,140	N/A	$17,778	N/A
Install High Efficiency Pumps	133,122	15.2	$11,496	$306,953	$13,501	25.5
Install More Efficient Water-Cooled Chillers	66,913	20.3	$7,027	$130,706	$12,066	17
Install High Efficiency Fans	73,757	8.4	$6,370	$188,020	$7,480	28
Total	**6,343,089**	**546.6**	**$546,001**	**$14,625,679**	**$629,554**	**25.6**

Five EEOs, which are considered economical, have been analyzed in this report and are listed in the Energy Efficiency Opportunities (EEOs) Table 1-9.

Implementation of these EEOs could result in the following savings:

- Electrical energy savings of 353,350 kWh per year representing 1.0% of the facility's electrical energy consumption (1.7% of electrical energy procured from PG&E).
- Peak demand savings of 36.9 kW.
- No natural gas energy savings expected for any of the measures.
- Potential cost savings of $31,434 per year representing 1.4% of the facility's total annual energy costs.
- Total potential incentives and rebates of $26,699.
- Total installed cost with incentives and rebates of $134,546.
- Overall simple payback period with incentives and rebates of 4.3 years.

Table 1-9: Summary of BASE Energy Efficiency Opportunity Costs and Savings

EEO	Measure Description	Energy, Cost and GHG Savings					Project Costs, Incentives, and Payback			
		Peak Savings (kW) **	Electricity (kWh/Yr)	Natural Gas (Therms /Yr)	Annual Cost Savings ($/Yr)	CO2 Saved (Tons /Yr)	Estimated Installed Cost ($)	Potential PG&E Incentive ($)	Net Measure Cost ($)	Pay-back Period (Yrs)
EEO-1[1]	Optimize Control of Filter Influent Pumps to Increase Pumping System Efficiency	0.0	48,810	0	$4,218	14.0	$3,600	$4,393	-$793	0.0
EEO-2	Widen Deadband Between Cooling and Heating Setpoint Temperatures and Setback Zone Temperatures During Unoccupied Hours for Compost Facility Offices	0.0	12,558	0	$943	3.6	$0	$0	$0	0.0
EEO-3[1]	Install Automatic Lighting Controls	0.0	59,112	0	$5,149	17.0	$10,903	$2,931	$7,972	1.5
EEO-4	Install a More Efficient VFD Air Compressor	5.2	45,534	0	$3,933	13.1	$22,031	$4,618	$17,413	4.4
EEO-5	Install High Efficiency Fluorescent Lighting in Various Areas	31.7	187,336	0	$17,191	53.9	$124,711	$14,757	$109,954	6.4
Recommended EEM Totals		**36.9**	**353,350**	**0**	**$31,434**	**101.6**	**$161,245**	**$26,699**	**$134,546**	**4.3**

[1] Already implemented (Joe Schwall comments 12-11-14)

1.4 Detailed Descriptions of Recommended Energy Efficiency Measures

EEM-1: Raise Tertiary Filter Wet Well Level

Treated wastewater is pumped from the tertiary wet well through the tertiary filters. Raising the wet well level by 2 feet (and up to 3 feet) would lower Total Dynamic Head (TDH) by approximately 10% and reduce pumping energy. An estimate of energy savings for this EEM is based on the Raw Wet Well test done by LTP staff that raised the well 10 inches. This estimate for raising the well two feet is proportional to that estimated savings and is presented in the table below. To more accurately determine the potential savings, data loggers would need to be installed on the system, which Joe Schwall (LTP Operations Manager) indicated that he would do in the future.

Raising the well level would likely be a seasonal optimization measure. With increased wet weather flows, there would be a greater risk of bypass of the tertiary filters due to overflow. During the dry months an off-line clarifier is available for overflow protection. The wet well set point is controllable through SCADA and can be set to automatically adjust to the desired wet well level based on influent flow conditions.

Figure 1-3: Tertiary Filter Wet Well Pumps

Table 1-10: EEM-1 Raise Tertiary Filter Wet Well Level Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
95,776	$10,907	20	$0	$0	$0	$16,239	$230,081

EEM-2: Replace Ultraviolet (UV) Disinfection

The objective of this EEM is to reduce energy consumption by exploring options to replace the use of UV disinfection with a less energy intensive disinfection option.

Santa Rosa has taken several steps to meet stringent discharge compliance requirements set by the Regional Water Quality Control Board (RWQCB), including minimizing discharge when possible and modifying the disinfection process at LTP to eliminate disinfection byproducts (DBPs) within the reclamation system. Prior to 2000, Santa Rosa used gaseous chlorine for disinfection. As the quantity of chlorine needed to meet water quality requirements increased and DBPs became a regulatory concern, Santa Rosa changed their treatment process from chlorination to UV in 2000. The switch to UV increased the energy use at LTP and resulted in the occurrence of increased biological growth in the recycled water conveyance system due to the lack chlorine residual.

The UV system realized capacity is approximately half of the stated design. Each bank of UV channels uses approximately 1 MW of electricity or 27,000 kWh per day. Currently LTP spends on average $80,000 per month ($960,000 per year) for UV electricity.

Figure 1-4: UV Disinfection Equipment

Santa Rosa is currently exploring alternatives for disinfection, including chlorination and pasteurization, to address deficiencies in the current UV system. For the purpose of this analysis, it is assumed that chlorination would be used in place of UV, although Santa Rosa may select another form of disinfection in the future. Based on a preliminary discussion with Santa Rosa, an alternative chlorination system could include one of the following:

1) Use existing (mothballed) chlorine contract chamber (CCC) located next to UV.
2) Construct a facility to inject chlorine or hypochlorite at an alternative location.
3) Construct a new CCC in the northern area of LTP.

EEM-2 considers four options for reducing the use of UV disinfection at LTP, as described in the following sections. Complete replacement of UV with chlorination is not considered at this time due to the sensitivity of DBPs present in the discharge from Delta Pond to the Laguna de Santa Rosa.

Figure 1-5: LTP and Meadow Lane Pond

Option 1: Separate Geysers from UV

Deliveries to the Geysers Steamfield account for approximately two thirds of the recycled water produced at LTP. Switching the Geysers flow from UV to chlorination would reduce approximately two thirds of the electricity usage. Physically, this could be achieved by installing a pipeline to convey the disinfected water from an alternative disinfection facility at LTP to the Geysers Llano Pump Station across the street. A new pump station may also be required to convey disinfected effluent to Llano Pump Station, depending on the location of the new disinfection facilities. The main reclamation water transmission line to agricultural and urban customers would still convey UV disinfected water year-round.

One challenge to this approach is maintaining a steady rate of flow to Llano pump station during periods when LTP is receiving low flows. The Geysers steam fields cannot accommodate changes in flow greater than 2 MGD because exceeding this value is linked to an increase in seismic activity in that region.

Option 2: Seasonal Chlorination

The switch to seasonal chlorination could reduce energy costs while maintaining UV disinfection during the discharge season (October 1 to May 15) when the formation and release of DBPs to the Laguna de Santa Rosa are a concern. It should be noted that Santa Rosa actively manages the Reclamation System to avoid discharge and no significant discharge has occurred from 2012 to 2014. Chlorination of recycled water would occur during the summer, and the UV system would be turned off during this period. The entire flow leaving LTP would be treated with chlorine using the existing CCC. During the winter season, when treated effluent is being stored, the UV system would be turned on.

Option 3: Separate Geysers from UV and Seasonal Chlorination

This option combines options 1 and 2, decreasing the overall UV usage year-round. The Geysers System would receive chlorinated water year-round and agricultural and urban users would receive chlorinated water in the summer. UV disinfection would be reserved for periods when treated effluent is being stored.

Option 4: UV Prior to Discharge Only

This option minimizes the use of UV to the greatest extent by predicting when discharge would be needed and only turning on the UV system in advance of required discharge. The challenges for this scenario are: predicting when discharge will be needed and predicting the time period necessary to ensure that DBPs would not be present in Delta Pond when discharge is needed.

Randy Piazza indicated that Santa Rosa has some general guidelines for predicting when discharge is required:

- Santa Rosa aims to maintain between 1.0 and 1.1 billion gallons (of the 1.4 billion gallon storage) prior to discharge.
- 17 MGD is delivered to the Geysers Steamfield in the winter, thus Santa Rosa needs to maintain 1 billion gallons in storage to meet Calpine contract delivery requirements if there is no storm flow and only waste water.

Regarding the formation and attenuation of DBPs, additional evaluation would be needed to understand:

- The degree of formation of DBPs based on the selected chlorination practice.
- The extent of attenuation or volatilization of DBPs expected in a reservoir like Delta Pond (i.e., through surface aeration)
- The RWQCB permitting requirements that would need to be met to support the use of chlorination during the winter discharge season.
- An approach to demonstrate that control of DBPs in the disinfection system will be adequate and the UV system could be turned on in time to eliminate or minimize risk of discharging DBPs.
- Potential need for a bench-scale or pilot-scale testing program to demonstrate a recommended approach.

Summary of Options for UV Reduction

Table 1-11 summarizes the pros and cons of the above four options for UV reduction.

Table 1-11: Summary of EEM #2- UV Reduction Options

Option #	Description	Pro	Con
1	Separate Geysers from UV	• Proximity and ease to separate Geysers from UV by adding a short pipeline from LTP to Llano Pump Station (PS) • Energy savings on disinfection for 2/3 of LTP flow Year-round • Potential reuse of decommissioned CCC	• Requires maintaining two independent of disinfection systems • Need for infrastructure to connect tertiary RW from new disinfection to Geysers PS • Confirm Calpine contract will accept switch from UV to chlorination for RW supply
2	Seasonal Chlorination	• Energy savings during summer high usage periods on disinfection for 100% of LTP flow • Potential reuse of decommissioned CCC	• Only provides energy savings in the summer period • Potential residual DBPs in Delta Pond at start of winter discharge season
3	Separate Geysers from UV and Seasonal Chlorination	• Energy savings on disinfection for 2/3 of LTP flow in the winter plus100% of LTP flow in the summer • Potential reuse of decommissioned CCC • No need for additional infrastructure to separate Geysers from UV system	• Requires maintaining two independent of disinfection systems, with only limited UV use • Confirm Calpine contract will accept switch from UV to chlorination for RW supply • Potential residual DBPs in Delta Pond at start of winter discharge season
4	UV Prior to Discharge Only	• Energy savings on disinfection for 100% of LTP flow year-round, with the exception of discharge years. • Potential reuse of decommissioned CCC	• Requires maintaining two independent of disinfection systems, with only limited UV use • Confirm Calpine contract will accept switch from UV to chlorination for RW supply • Potential residual DBPs in Delta Pond at start of winter discharge season • Challenge to obtain RWQCB buy-in for addressing DBPs in winter discharge season

As described in Table 1-11 above, there are numerous issues that would need to be resolved prior to implementing an alternative disinfection strategy. Additional analysis would be also needed to evaluate the type, capacity, location and associated internal pumping and piping required to implement an alternative disinfection facility.

However, if the plant were to implement Option #1; electricity use and cost for UV disinfection would be reduced by roughly two-thirds. Construction would include a new hypochlorite tank, a building, dosing equipment, and other appurtenances. A rough estimate of the capital needed is approximately $10 million, but this amount would need to be refined once a preliminary design has been done. In addition, by switching to hypochlorite disinfection it is estimated that between 550 and 1,000 pounds per day of chemical would be required. At $1.05 per pound, the estimated additional chemical cost would be between $580 and $1,000 per day. In addition, a chlorine system upgrade would require a major capital project. Assuming a reduction of two-thirds of the electricity use, $10 million capital cost and $1,000 per day in chemical cost; it is estimated that a hypochlorite disinfection system in Option #1 would save Santa Rosa an average of $124,000 per year compared to the current UV system, with a NPV of cumulative net savings of nearly $1.23 million. The UV project may be eligible for a substantial incentive (approximately $492,000 if all the capital costs were eligible and the savings estimate were verified), but to be conservative we did not include an incentive in this analysis.

Table 1-12: EEM-2 Replace UV Disinfection Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
6,156,296	$701,079	1,265	$12,375,893	$0	$12,375,893	$124,093	$1,231,297

EEM-3: Raise Raw Wet Well Level

Similar to EEM-1, increasing the raw wet well level would reduce the pumping TDH. Joe Schwall tested the system by raising the wet well level by 10 inches and calculated a flow-normalized daily electrical savings based on an annual average flow of 22 MGD to be 164 kWh/day. The plant may not be able to run at this higher wet well level during the higher flow winter months without flowing onto the deck and partially bypassing over an isolation gate into the manual screen channel. Assuming the raw wet well level could be raised for eight months of the year with electricity savings of 39,900 kWh per year, the average annual net savings is estimated to be over $6,700 per year, and the NPV of cumulative net savings is nearly $96,000.

The wet well set point is controllable through SCADA and can be set to automatically adjust to the desired wet well level based on influent flow conditions.

Table 1-13: EEM-3 Raise Raw Wet Well Level Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
39,907	$4,545	8	$0	$0	$0	$6,766	$95,867

EEM-4: Modify 3W Water Scum Spray and Install VFDs

LTP currently uses about 1.0 MGD of tertiary treated recycled water (3W water), mostly for the primary clarifier scum spray system. The water spray system is designed to push the scum to a removal spot, which is not the most efficient method and wastes a lot of water. Staff has considered the option of re-designing and replacing the spray nozzles to change the flow and spray patterns.

Figure 1-6: Recycled Water (3W) Booster Pumps

It is recommended that LTP consider the installation of a tipping skimming trough across each of the primary clarifiers to allow the water flow to push the scum to the trough instead of the water spray. This would require significant engineering and construction expense, which are not estimated here.

The 3W water pumps may also be a good candidate for VFDs. Currently the four 75 horsepower (HP) 3W pumps cycle on/off in response to changes in system pressure. Generally there are two pumps running at any given time. VFDs on two units would allow a base pump without a VFD to run 100% along with a pump with a VFD. The energy savings associated with this EEM cannot be calculated with the information available at the time of the audit.

EEM-5: Reduce Air to Mixed Liquor and Primary Feed Channels

The mixed liquor channel leading to the secondary clarifiers and the channel feeding the primary clarifiers both have coarse bubble diffusers to keep the contents in suspension while flowing. This air comes from the variable speed aeration blowers. Reducing or eliminating the air would result in less blower energy to meet the overall demands.

Figure 1-7: Mixed Liquor Channel with Aeration

A visual inspection showed that the velocity in many parts of the channels is probably sufficient to keep material in suspension without the use of the air. LTP staff would need to manually shut off drop legs to the diffuser grids and watch for settling. At the same time, they can determine the difference in blower energy with some or most of the channel diffusers shut off. Note that the velocity in the channels would be the lowest during the lowest diurnal flow period. The velocity needs to be 1 foot per second (fps) or greater to ensure settling does not occur. A 5% reduction in aeration blower output would create a savings of 285,000 kWh per year, with an average annual net savings of over $47,400 per year, and NPV of cumulative net savings of over $672,000. This estimate is based on a 2013 summary data provided by LTP. Velocity in the channels was calculated to be 0.2 fps based on 20 MGD and a cross sectional area of 160 square feet. There may be a slope to the channels (which was not clear from the hydraulic profile) that could increase the velocity. Note that the channel bends and splits and the velocity was not consistent throughout the channel during the visual inspection. Though the mathematical velocity looks too low to support this recommendation, some experimentation with closing some or partially closing other channel air headers may enable an air reduction without allowing setting.

If the air to the channels could be choked down or shut off (and not cause settling in the channel), it is our professional judgment that approximately 5% to 10% of the aeration blower output could be saved. The cost savings is based on 5% reduction in current blower energy output.

Table 1-14: EEM-5 Reduce Air to Mixed Liquor and Primary Feed Channels Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
285,000	$32,456	59	$0	$0	$0	$48,324	$684,650

EEM-6: Run Idle Cummins Engines on Natural Gas to Generate Electricity

LTP typically operates one of four available Cummins generators, using mostly digester gas, to produce 1.1 MW of electricity and heat for the Digester Heat Return Supply (HRS) loop.

Figure 1-8: Overview of the CHP Facility

Currently the cost of producing electricity with the CHP using purchased natural gas is lower than purchasing electricity from PG&E. It is recommended that Santa Rosa move forward with the recommendation in the “Natural Gas Evaluation Technical Memorandum” (Brown and Caldwell, December 2013) to run one (and possibly two) of the idle generators on natural gas. That study estimates annual electrical savings of $300,000 for one generator running off natural gas, and over $700,000 per year for two generators running off natural gas. KJ did a review of the savings that would be achieved by running one engine on natural gas. The analysis showed an estimated average annual net savings of $209,000 per year, with a NPV of cumulative net savings over ten years of over $1.74 million. Since this recommendation had already been presented in a 2013 Brown and Caldwell study, these savings were **not** included in our overall savings estimate from this energy process audit.

It should be noted that a substantial upgrade to the CHP emissions scrubber system would be required for this recommendation to be viable. The costs of the capital improvement project were not included in the calculations shown below.

Table 1-15: EEM-6 Run Idle Cummins Engines on Natural Gas Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
3,135,000	$987,613	1,782	$775,000	$0	$775,000	$209,691	$1,743,110

EEM-7: Optimize Return Activated Sludge (RAS)

Each of the five secondary clarifiers has its own RAS pumping station. The Mixed Liquor Suspended Solids (MLSS) to RAS ratio and the Statepoint model both indicate the RAS rate can be reduced. RAS optimization benefits include lower RAS pumping energy, improved selector performance, reduced sludge volume, increased single pass aeration detention time, and improved clarifier settling conditions. However, RAS optimization is limited by poor turndown on the existing RAS pumps, which have plugging issues in the clarifier RAS tubes when the RAS is turned down too low. This RAS restriction currently precludes the facility's ability to optimize the RAS flow as recommended.

Figure 1-9: RAS Pumps Adjacent to the Clarifier

It was roughly and conservatively estimated that 30 HP could be realized through RAS optimization. This would result in an average annual net savings of 186,000 kWh per year, approximately $31,000 per year, with a NPV of cumulative net savings of over $447,000. LTP staff is working to measure actual savings.

Table 1-16: EEM-7 Optimize Return Activated Sludge Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
186,246	$21,210	38	$0	$0	$0	$31,579	$447,416

EEM-8: Stagger Digester Mixing Pumps During Peak Period

LTP has four 40 HP digester mixing pumps. It is recommended that Santa Rosa turn off the digester mixers for at least 2.5 hours during the peak period, staggering the shut-off during the period so that not all the pumps are turned off at the same time. This change is estimated to save over $18,000 per year, nearly 109,000 kWh, with a NPV of cumulative net savings of over $261,000. It is recommended that LTP staff check gas quality and production and watch digester stability and control numbers. If there is no degradation of digester performance, the duration of pump shut off could be increased.

Figure 1-10: Digester Gas Mixing Pumps

Table 1-17: EEM-8 Stagger Digester Mixing Pumps During Peak Period Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
108,916	$12,403	22	$0	$0	$0	$18,467	$261,647

EEM-9: Install VFDs on Aerated Grit System

LTP currently runs two aerated grit systems seven months and one for five months out of the year. Each grit system is aerated by a 10 HP blower. At night when the flow drops, the plant gets much less grit due to lower sewer velocity and less inorganic loading. However, the blowers run at a constant speed. The addition of a VFD could allow turndown during the low flow periods.

Figure 1-11: Grit Tank with Aeration

As currently operated, it costs approximately $10,000 per year to run the grit blowers. This EEM would save approximately $3,000 per year, or 18,600 kWh, with a NPV of cumulative net savings of over $42,400. VFDs could result in the equivalent of shedding three HP for the year. The capital costs and energy savings are based on upgrading only two of the aerated grit blowers with VFDs.

Table 1-18: EEM-9 Install VFDs on Aerated Grit System Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
19,500	$2,879	4	$3,000	$1,000	$2,000	$1,779	$40,654

EEM-10: Implement Building and Lighting EEMs

In June 2012 BASE Energy, Inc. prepared an Integrated Energy Audit Report No. BASE-PGE-11-05 for LTP building and lighting systems. KJ did not do a review or verify these recommendations but advises Santa Rosa to consider cost-effective EEMs that have not already been implemented.

1.5 Detailed Descriptions of Recommended Process Improvements

PIs differ from the EEMs in that PIs are not recommendations that would necessarily result in electrical savings. They are added to the technical memo to allow documentation of recommendations that may be beneficial to plant personnel or performance.

PI-1: Reroute Filter Backwash Water

KJ recommended rerouting the filter backwash water to the head of the plant so that the anthracite lost in the filter backwash is removed by the grit system and does not settle in the primary influent channel.

LTP management liked this idea of this PI and took it under serious consideration. However, it was reluctantly rejected. The backwash waste basin is shared with the belt press filtrate. Separating the two streams would require rerouting the filtrate either to the headworks or the flow equalization basin and would result in slug loading on the aeration system. Introducing soluble BOD to the primary system is also not desirable because it does not get removed in the primary system and therefore reduces capacity.

PI-2: Enhance SCADA Screens

It is recommended that a “power screen” be added to SCADA system. The power screen would summarize current power use, percent change from previous day, percent of CHP, etc. Including a read-out showing the highest electrical peak for the month (to date) would be a useful tool for making equipment operation decisions. This would provide operations with real-time feedback.

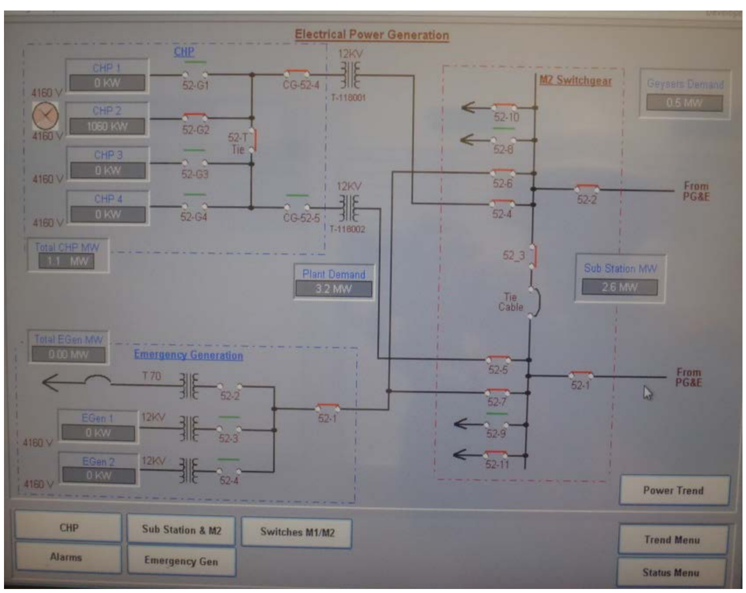

Figure 1-12: SCADA Electrical Power Generation Screen

Other SCADA pages could include cost of energy and chemicals where beneficial to allow LTP operators to see the effect and cost of process changes they initiate through SCADA.

PI-3: Increase Belt Press Solids Concentration

The sludge concentration leaving the belt presses averages 14.8%. LTP contracts with a trucking company to relocate the sludge from the Belt Press Building to the biosolids composting site located across the street on Llano Road. Three to four trucks per day, six days per week is the average hauling frequency. Increasing the sludge concentration to 18% would reduce the number of trucks by almost 90 trucks per year (9% reduction). The associated energy savings is described in TM #2 – Biosolids Compost Audit. An increase in belt press solids also increases the capacity of the in vessel composting and provides labor, truck wear, and fuel savings.

Various potential methods of increasing the solids concentration were discussed with LTP staff during the workshop. Most had been tried without success, but one possible idea is to change the way the polymer is selected. LTP currently requires the polymer be capable of producing 15% sludge. Changing the requirement to 18% might result in a different polymer and better sludge. However, the cost per dry ton of the new and old polymer would need to be analyzed.

There also may be a potential to replace the weave on one of the belt systems to allow for a higher dewatering rate and/or improved dewatering capabilities.

Figure 1-13: Belt Press Equipment

PI-4: Monitor Primary Sludge pH

It is recommended that primary sludge pH monitoring be instituted as a means of checking for sludge septicity. Septicity in the primary sludge increases energy use and cost of the aeration and blower systems. In addition, it may create organic acids that can lead to filament growth. It is recommended that the current sampling method and frequency be evaluated to ensure the daily numbers are representative.

PI-5: Upgrade Digester Mixing

It is recommended that LTP revisit and implement the upgrades to the digester mixing system documented in the Technical Memorandum: Laguna Regional Water Reuse Water Reclamation Facility, Digester Mixing System (Kennedy/Jenks, 14 March 2003). While an upgrade to the mixing system may or may not be a direct energy savings measure, it would have operational and cost savings benefits such as improved mixing, the potential from increased gas production, and the ability to put fats, oils and grease (FOG) and food waste into the digesters.

Optimizing the digester mixing system to a more efficient and higher rate system has benefits that stand on their own merit as mentioned above. As discussed previously in EEM-8, the toggling of the digester mixing pumps off for 2.5 hours each during the peak electrical period has merit of its own due to the energy savings potential. It is recommended the toggling be trialed with the current mixing system and again with a new mixing system, should the current mixing system be upgraded.

PI-6: Reduce Sludge Yield

In 2013 LTP secondary system operated with an annual average sludge yield ratio of 0.9. Sludge yield is the mass of waste sludge produced per pound of Biological Oxygen Demand (BOD) to the aeration basin:

Sludge Yield (ratio) = Pounds of Waste Sludge Generated /Pound of BOD Load to Aeration

A lower sludge yield would indicate that microbes had converted more of the secondary solids (created when they consume the dissolved BOD) into carbon dioxide and digester gas, resulting in less secondary sludge. Text book numbers for sludge yield for a plant process similar to LTP are between 0.6 and 0.7. Reducing the sludge yield from the current 0.9 to 0.7 would result in a 20% reduction in the secondary sludge.

A lower sludge yield results in lower waste pumping, lower RAS pumping, reduced number of gravity belt thickeners, possibly lower polymer use, and increased digester capacity.

Sludge yield could potentially be reduced by increasing aeration of the MLSS and/or by increasing treatment detention time. It is recommended that staff experiment with increasing the MLSS to see the effect on sludge yield and how it affects treatment performance. Cost savings cannot be estimated without a change of operation and a determination of actual changes in sludge yield and the associated pumping.

Trend charting historical MLSS/Solids Retention time versus Sludge Yield may illustrate whether small changes to the MLSS would result in a reduced sludge yield. This could be done prior to any field testing.