17 February 2015

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 Subregional 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.

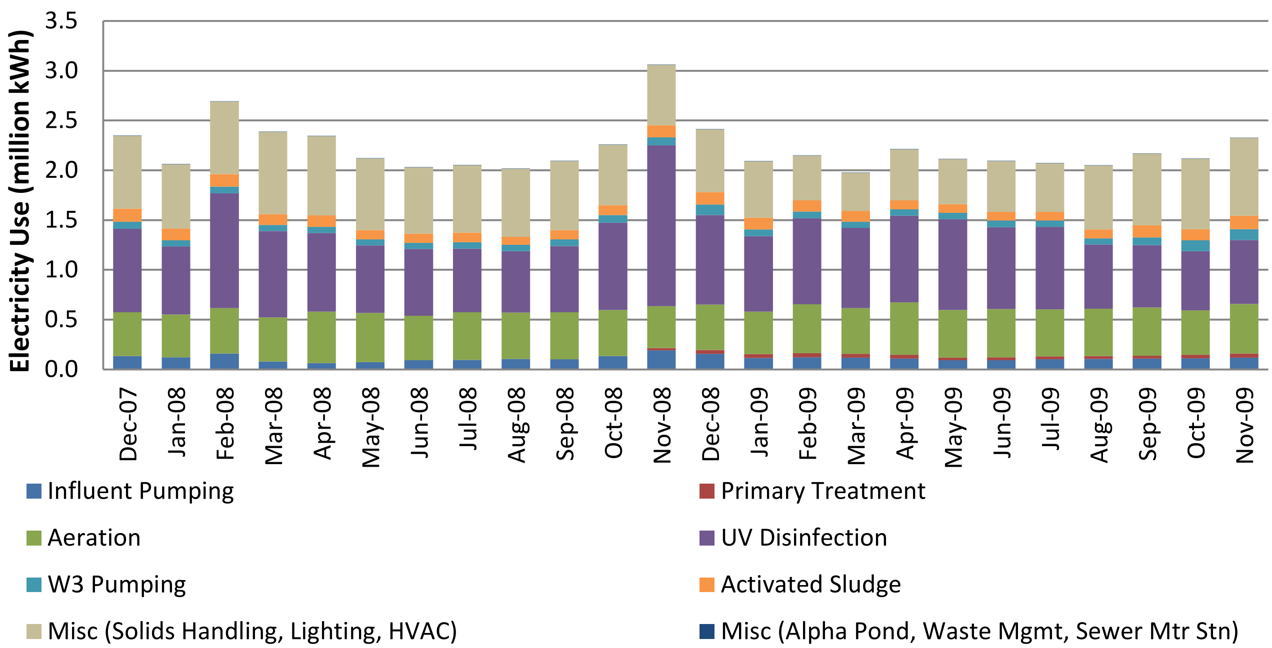

Figure 1-1: Monthly Electricity Usage for LTP by Process Category

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

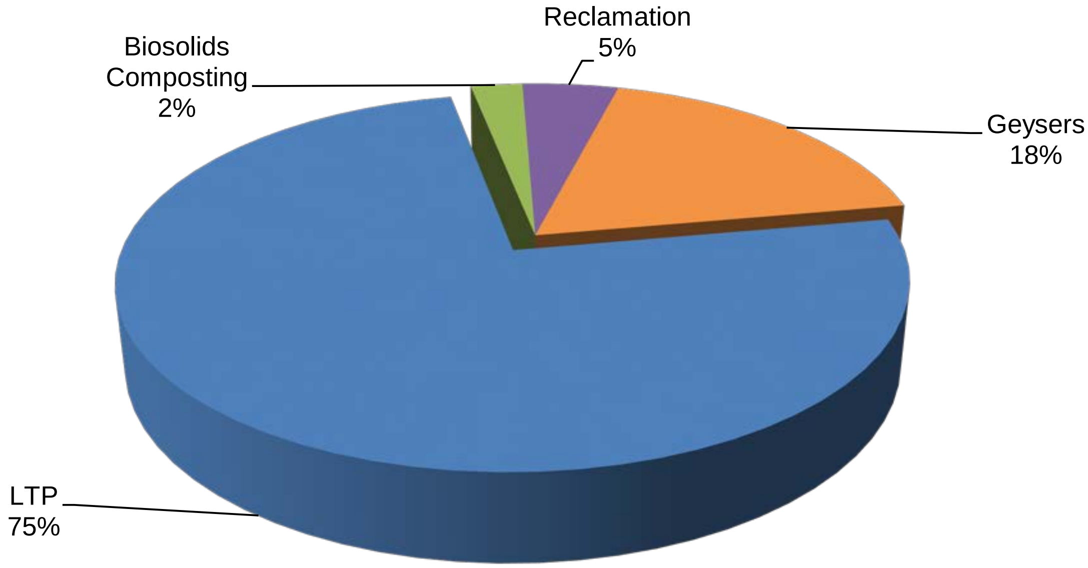

Figure 1-2: Annual Electricity Usage for Subregional System by Category

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.

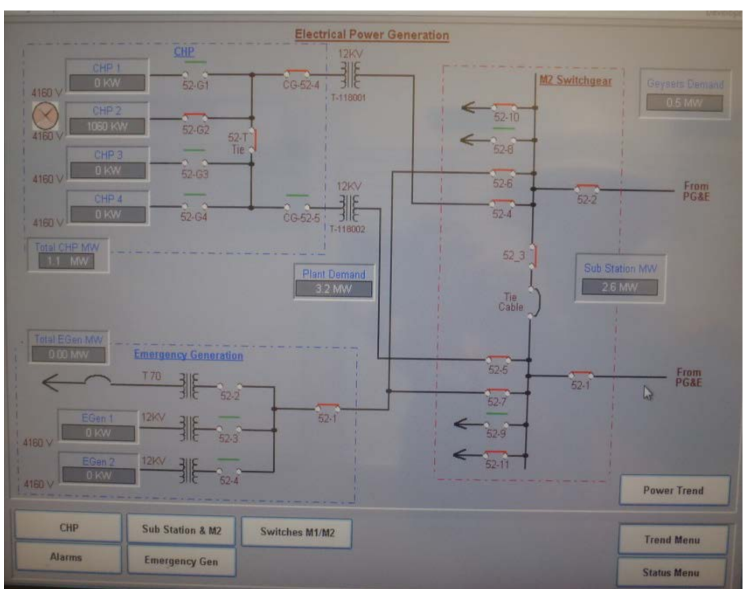

Figure 1-12: SCADA Electrical Power Generation Screen

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 Subregional 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.

17 February 2015

Technical Memorandum #2

To: Mike Prinz, Zachary Kay, and Colin Close, City of Santa Rosa

From: Charles Wright, P.E. – Compost Audit Deputy Lead
Mark Cullington, P.E. - Compost Audit Lead
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Subject: Task 1.2 – Compost Facility Energy Audit
Santa Rosa Energy Optimization Plan (EOP) – Phase 1
K/J Project: 1368024*01

An energy audit was conducted by Kennedy/Jenks (KJ) at the Laguna Subregional Compost Facility (Compost Facility) on April 10, 2014. The purpose of the audit was to identify and recommend cost-effective Energy Efficiency Measures (EEMs) for implementation by the Compost Facility staff to save energy and reduce operating costs.

2.1 Recommendations

Four EEMs were identified during the audit. After the analysis was conducted, two EEMs were determined to be cost-effective and are recommended for implementation and are listed in Table 2-1 below. Cost-effectiveness is defined as an EEM that had a positive Net Present Value (NPV) from savings over the life of the EEM.

Table 2-1: List of Recommended Energy Efficiency Measures

EEM #	Title	Average Annual Net Savings ($/Yr)
1	Modify Exhaust Fan Operation	$13,000
3	Install Solar PV (PPA)	$41,400

As shown in Table 2-2, implementing the two recommended EEMs would result in about $54,400 in average annual net savings, a NPV of $797,600 in savings over the 20 to 30 year lives of the EEMs, and a reduction in GHG emissions of over 421 metric tons of CO_2 per year. The estimated electricity savings and generation of 1,911,700 kWh per year, which is greater than the Compost Facility energy use in 2013 (890,000 kWh).

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

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
1,911,700	$219,500	421	$50,000	$0	$50,000	$54,400	$797,600

In addition, it is recommended that Santa Rosa consider implementing the Compost Facility-specific lighting recommendations provided in the Integrated Energy Audit (BASE Energy Inc, 2012), which is described in TM #1 – LTP Process Energy Audit.

Typically, the recommended priority order for implementation 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 (a "NC" represents "not calculable"). Essentially, the ROI is infinite without capital costs; so EEMs with zero capital cost are therefore ranked based on the amount of NPV of cumulative net savings it brings to the City. Therefore the priority order is based on average annual net savings, as listed in Table 2-3.

Table 2-3: Priority Implementation Order

Rank Order	EEM#	Title	ROI (%)[1]	NPV of Life of Savings ($)
1	1	Modify Exhaust Fan Operation	NC	$183,500
2	3	Install Solar PV (PPA)	17%	$614,400

[1] 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.

Although the City's current composting system provides for an effective means of producing a quality Class A biosolids compost product and has done so for over 15 years, there are alternative technologies available to the City that would potentially save energy, reduce emissions, and significantly reduce overall operations and maintenance costs. Alternative composting technologies could include covered aerated static piles, aerated static piles, and in-vessel systems. KJ suggests the City investigate alternatives in the near future. Evaluating these alternatives was beyond the scope of work for this energy audit which focused on the existing system.

2.2 Background

Facility Description

The Compost Facility converts anaerobically digested biosolids (approximately 8,000 wet tons in 2013) to a high quality Class A biosolids compost product, the majority of which is sold to local landscaping companies. Lesser amounts are sold to individuals or donated to local community gardens and schools. The facility is an aerated, agitated in-vessel composting system that uses four compost turners (agitators) that turn the material in the bins each day. Following construction of the facility in 1995, Compost Facility staff has made adjustments to increase process throughput and minimize operational costs. Most recently these efforts have included adjusting the compost recipe in terms of the amount of biosolids used and closely monitoring the moisture content of the material as it moves through the composting process.

Figure 2-1: Panorama View of the Laguna Subregional Compost Facility

Energy Use and Cost

As part of the data collection prior to the onsite audit, Santa Rosa provided baseline energy usage for its Subregional system, including the biosolids Compost Facility. The baseline provides a snapshot of how much energy is currently used at the existing Compost Facility to allow for comparison to what impacts the various audit recommendations will have. The baseline energy profile for the Compost Facility includes electricity use, since natural gas usage is negligible.

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 the Compost Facility, the electricity baseline was broken down into Compost and Miscellaneous Storage Facility categories, which respectively include data from SCADA and PG&E. The baseline is summarized in Table 2-4.

Table 2-4: Baseline Electricity Usage for Compost Facility

Category	Baseline Annual Electricity Use (kWh/Yr)	Baseline Annual Electricity Cost ($/Yr)
Compost[1]	890,000	$61,000
Miscellaneous Storage Facility[2]	5,600	$1,200
Total Electricity Used for Biosolids Composting	**896,000**	**$62,000**

[1] Data are from Santa Rosa SCADA system from January 2013 to December 2013. Data from 2012 were not representative of typical operations.
[2] Average annual PG&E data from January 2012 to December 2013.

As shown in Figure 2-2, the biosolids Compost Facility uses a relatively small percentage of the total electricity of the Subregional system.

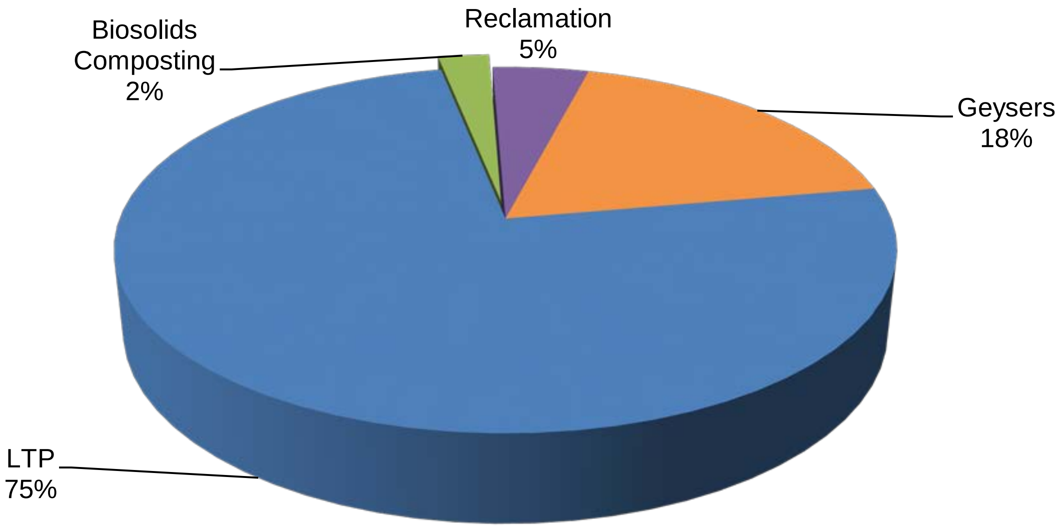

Figure 2-2: Annual Electricity Usage for Subregional System by Category

2.3 Overview of Audit Methodology

The energy audit for the Compost Facility included initial data collection and review, an on-site field audit and an evaluation of potential EEMs.

Initial background data collection and review included the following documents:

1. Biosolids Management Strategic Plan, January 2014.
2. Laguna Subregional Water Reclamation Facility, Draft Final Biosolids Program, Phase II, June 2003.
3. Annual Biosolids Reports (2010-2013).
4. Biosolids Compost Audit (A document prepared by Compost Facility staff in response to initial background questions posed by KJ).

After completing the initial data collection and review, a field audit was conducted on April 10, 2014. Participants included all 8 staff members from the Compost Facility (Zachary Kay, Al Myers, Christina Holton, Ed Garcia, Tim Turner, Mike Endercott, Jim Swanson, and Paul Sheridan). KJ participants included Mark Cullington and Charles Wright. A project team discussion was held with all Compost Facility staff to provide a thorough overview of composting operations and Santa Rosa's biosolids beneficial reuse program. An initial list of facility challenges and opportunities for energy and/or process optimizations was developed during the meeting.

A tour of the Compost Facility followed the team meeting. The objective of the tour was to gain a better understanding of the facility and to identify all of the existing processes and equipment that use energy and identify potential areas for improvement.

The field audit concluded with a final team meeting. Information gathered during the initial team meeting and subsequent facility tour was reviewed for accuracy. The initial list of facility challenges and opportunities for improvements was refined, and a number of potential EEMs were vetted by Compost Facility staff for their initial reaction.

Using information gathered during the initial data review and subsequent field audit, EEMs were identified and evaluated for cost-effectiveness. This analysis provides a summary of these EEMs and the potential cost savings that could be realized. Cost calculation tables were developed for all EEMs and are provided as electronic attachments.

2.4 Detailed Descriptions of Recommended Energy Efficiency Measures

The following section describes two EEMs that were identified during the audit as being cost-effective and are thus recommended for implementation. All 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%.

EEM-1: Modify Exhaust Fan Operation

Five, 100 horsepower (HP) variable speed fans are used to draw air from inside the active composting area and exhaust it through a 50,000 square foot biofilter. The system was provided to eliminate fugitive odors and to maintain acceptable working conditions inside the Compost Facility building in terms of air quality. Four of the five fans are original having been installed in 1995. One fan broke down and was replaced in 2001. While the existing fans could be replaced by newer more efficient units, it is very unlikely that doing so would be cost effective. As a result, the objective of EEM-1 is to reduce energy consumption by modifying operation of the Compost Facility building exhaust fans instead of replacing them.

Figure 2-3: Compost Building Exhaust Fans

The existing fans have variable frequency drives (VFDs) that allow fan speed to be adjusted to provide appropriate ventilation rates. Compost Facility staff has developed a table of speed settings that correspond to fan speed (as shown in Figure 2-4). This does not directly correlate with motor speed because belt drives connect the nominal 1,800 revolutions per minute (rpm) motors to the fans themselves. Facility staff currently operates the fans at speed setting-6 (955 rpm) during working hours. Fan speed is reduced to setting-4 (640 rpm) during non-working hours (evenings and weekends). The range of speed settings (4 to 6) is the maximum possible according to Compost Facility staff and was developed based on recommendations of the manufacturers of the fan and the motor.

Figure 2-4: Exhaust Fan Speed Setting Chart

Although the exhaust fans operate at reduced speeds during non-working hours, this EEM would further reduce energy use by turning fans off during non-working hours. To determine the number of fans that might be turned off and still maintain appropriate ventilation rates, the following should be considered:

- National Fire Protection Association (NFPA) 820 Standards for Fire Protection of Wastewater Treatment and Collection Facilities. These standards state that for enclosed compost facility to be considered “unclassified” they must be ventilated at no less than six air changes per hour.
- Fugitive odors. Ventilation must be adequate to keep odors from escaping the Compost Facility building.

The existing system was designed to provide twelve air changes per hour during working hours. The fans are rated at 32,000 standard cubic feet per minute (scfm) each, which Compost Facility staff believe can be achieved by running the fans at speed setting-6 (955 rpm). If correct, and assuming a total ventilated building volume of 755,000 cubic feet, the current practice of running all fans at speed setting-6 should slightly exceed the design air change value.

Based on standard performance curves for centrifugal fans, reducing fan speed from setting-6 (955 rpm) to setting-4 (640 rpm) should be expected to result in an air flow of about 20,000 scfm per fan. In order to provide six air changes per hour (minimum rate needed for the building to be considered an “unclassified” space), four fans running at this reduced speed would be needed. Thus, only one fan could be potentially turned off during non-working hours and energy savings were calculated on this basis. A summary of the results of the financial analysis for EEM-1 is provided in Table 2-5.

Table 2-5: EEM-1 Modify Exhaust Fan Operation Summary

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 Avg Annual Net Savings ($)
81,100	--	17	$0	$0	$0	$13,000	$183,500

Assumptions:

- Calculations based on turning one fan off during non-working hours.
- Fan power draw: speed setting-6 = 80 HP/fan, speed setting-4 = 25 HP/fan.
- Fan flow rates: speed setting-6 = 32,000 scfm/fan, speed setting 4 = 21,000 scfm/fan
- Composting season is eight months/year. Other months exhaust fans are turned off.
- Net present value calculation is based on a 20 year time period.

Prior to implementing this EEM, KJ recommends that Compost Facility staff measure and confirm ventilation flow rates to ensure that the target air changes are being achieved. Two factors lead to this recommendation. The first is the relatively high level of ammonia in the air inside the compost building noticed during the site audit. While KJ understands that Santa Rosa staff has recently initiated air quality monitoring for ammonia, high ammonia level would be indicative of airflows less than 12 changes per hour. The second factor is lower than anticipated energy consumption by the Compost Facility. As is explained in later sections of this analysis (EEM-4), one explanation for this could be that the fans are not achieving their design flow rates resulting in less energy use than would occur if they were meeting design requirements.

Ports in the existing air piping used to convey air to the biofilters can be used to measure total air flow with pitot tubes. This should be done with the fans running both at full and reduced speeds to determine how many fans could potentially be turned off and appropriate minimum operating speeds. In addition, power use should also be measured under the various operating scenarios. Doing so may show that running fewer fans at full speed may actually be more efficient than running the fans at lower speeds.

Additional items that should be considered prior to the permanent implementation of this EEM is the extent of existing fan corrosion, and the impact operational changes may have on increasing rates of corrosion on interior building surfaces. Reducing the amount of ventilation during non-working hours may increase moisture, temperature, and ammonia levels inside the building. Because this may cause corrosion problems, staff should initially monitor conditions inside the building after first implementing changes in fan operation.

EEM-3: Install Photovoltaic Panels

The Compost Facility has approximately 3.6 acres north of the biofilters that could be made available for installation of solar photovoltaic (PV) panels. However, this area would not be available if endangered species (e.g., California Tiger Salamander) are present and a thorough investigation should be completed prior to moving ahead with this alternative. While the Compost Facility building has a significant amount of roof space, a prior investigation by Santa Rosa determined that it cannot support the weight and wind loads that would be created by the installation of PV panels. However, the roof structure is in the process of being evaluated for possible replacement the design of which could take into account the installation of PV panels on the roof.

Another option not evaluated in this report that may warrant additional investigation, would be construction of a floating photovoltaic power system. Storage ponds adjacent to the Compost Facility could potentially be used for this purpose.

On average, solar panels can be installed to achieve approximately one kilowatt (kW) of electricity per 100 square feet of useable space when placed flat. When tilted, the kW installed per 100 square foot is somewhat less as the panels need to be placed apart so not to cast shadows on one another; however, the energy produced is greater when tilted. The estimated project size for the 3.6 acre area is listed in Table 2-6.

Table 2-6: Dimensions of Potential Solar PV Location at Composting Facility

Location	Approximate Area (square feet)	Assumed Technology	Estimated Size (kW)
Area north of biofilters	157,000	Fixed tilt at latitude	1,490

In order to determine kWh production, the electricity production for a 100 kW PV installation at various locations was calculated using the PVWatts tool developed by the researchers at the National Renewable Energy Laboratory (NREL): http://www.nrel.gov/rredc/pvwatts/grid.html. The PVWatts calculator works by creating performance simulations that provide estimated monthly and annual energy production in kilowatts and energy value. It uses meteorological year weather data for the selected location and determines the solar radiation. Solar radiation is then converted and annual AC energy production is calculated (in kilowatt-hours per year per installed kilowatt). Based on PVWatts calculations, the annual energy production from a 100 kW PV installation is shown in Table 2-7.

Table 2-7: PVWatts Estimated Production per 100 kW System

Tilt	First-Year Energy Production (kWh produced per 100 kW installed)[1]
Open (Ground) Mount	
Fixed at 0 degrees (Flat)	118,000
Fixed Tilt at Latitude	132,000

[1] Includes energy production during the first year after installation. A solar PV system would lose efficiency every year at an approximate rate of 0.50% per year.

As shown in Table 2-8, a 1,490 kW fixed tilt PV project (ground mount) could produce an average of 1,830,600 kWh per year. Although this is greater than the baseline energy use of the Compost

Facility, Santa Rosa could take advantage of California's Virtual Net Metering (VNM) incentive, which allows local governments and special districts to install renewable generation of up to five MW at one location within its geographic boundary, and to generate credits that can be used to offset the generation charges at one or more other locations within the same geographic boundary.

Table 2-8: Projected Average Annual Energy and GHG Reduction

Location	Total Size (kW)	Average Annual kWh Produced (kWh/Yr)[1]	% of Compost Facility Baseline[2]	Average Annual Metric Tons of CO_2 Reduced
Area north of biofilters	1,490	1,830,600	204%	400

[1] Average annual production over 30 years. Assumes an annual PV degradation impact and loss of efficiency of approximately 0.50% per year.

[2] Average energy use at the Compost Facility of 896,000 kWh per year in 2013.

Santa Rosa could pursue a solar PV project through two different purchase structures options:

- Own and Operate: Santa Rosa would purchase a solar PV system using its capital, install the system on its property, and use Santa Rosa staff to operate the system.
- Power Purchase Agreement (PPA): A third party would finance, own and operate the solar PV system, and Santa Rosa would purchase the power generated from the third party. This could be an advantage for Santa Rosa because of no upfront capital costs and the availability of tax credits to a third party (which could be rolled into the pricing for Santa Rosa).

For an Own and Operate structure, prices vary based upon site conditions and system design (ground mounds, trackers, roof penetrations, etc.) and financing structure. According to Go Solar California, as of May 2014 the average cost of solar PV projects greater than 500 kW installed at government facilities in Sonoma County was approximately $3.95 per Watt (California Energy Commission & California Public Utilities Commission, http://www.californiasolarstatistics.ca.gov/).

A previously available incentive for solar PV projects in Northern California was the California Solar Initiative (CSI), which offers rebates to customers in California's investor-owned utility territories. PG&E has sufficient solar PV projects in the queue to use up its allocation and therefore is not offering any CSI incentives at this time; however, Santa Rosa should track the program to be informed if it gets extended by the legislature and the CPUC. Additional information can be found at: http://www.cpuc.ca.gov/PUC/energy/Solar/CSI_General_Market_Program.htm

For a PPA structure, current rates may range from approximately $0.09/kWh to $0.12/kWh, depending upon the provider, annual escalator, and other negotiated terms.

Based on an installed cost of $3.95 per Watt (not including the CSI incentive) and a PPA cost of $0.10/kWh, a summary of the results of the financial analysis for a 1.49 MW solar PV system is provided in Table 2-9.

Table 2-9: EEM-4 Photovoltaic Panels Summary

Ownership Structure	Average Electricity Produced (kWh/Yr)	Demand Savings (kW)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Avg Annual Net Savings[1] ($)
a.) Own & Operate	1,830,600	--	400	$5.9M	$0	$5.9M	-$52,000[2]	-$1.478M[2]
b.) PPA				$0.05M	$0	$0.05M	$41,400	$0.614M

[1] NPV is based on a 30 year period.
[2] Negative savings in red equals a cost to Santa Rosa.

2.5 Detailed Descriptions of Energy Efficiency Measures Not Recommended

The following section describes EEMs that were identified during the audit but not found to be cost-effective and are thus not recommended for implementation.

EEM-2: Change Compost Screen Location

The objective of EEM-2 was to reduce the fuel consumption and labor associated with moving compost to the screening equipment. As shown in Figure 2-5, material from the agitated bins is conveyed from inside the Compost Facility building and dropped near the center of the covered area used to store compost overs, yard debris, and bulking material. A front loader with five cubic yard bucket moves the material from this point to the screening equipment (shown in the background of Figure 2-5). This EEM would place the screening equipment directly beneath the conveyor discharge chute, which would reduce material handling costs associated with use of the front-end loader.

Figure 2-5: Screening Equipment Location Relative to Conveyor

During the audit, Compost Facility staff stated the screening equipment had at one time been located directly beneath the conveyor. It was moved after experiencing problems with synchronizing operation of the two pieces of equipment. Additional discussion suggested that staff had been able to successfully adjust speed settings to synchronize operation but that this information may not have been conveyed during changes in staffing at the facility.

A summary of the results of the financial analysis for EEM-2 is provided in Table 2-10.

Table 2-10: EEM-2 Change Screen Location Summary

Diesel Savings (gal/Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Avg Annual Net Savings ($)
306	3	$0	$0	$0	$14,500	$208,500

Assumptions:

- Front end loader capacity = 5 yd^3
- Compost production rate = 350 yd^3/day
- Composting season = 8 months
- Time required per trip between conveyor and screen = 1 minute.
- Front end loader fuel consumption = 1.5 gallons/hour
- Fuel cost = $3.50/gallon
- Labor savings equivalent to 0.1 FTE.
- NPV is based on a 20 year time period.

After further evaluation of relocating the screener under the conveyor discharge chute it has been determined by the Compost Facility staff that EEM-2 will not be practical due to the configuration of the screener. Relocation will actually cause addition work load on the loader and the need to install push walls for the fines and overs coming off the screener. In addition, the plastics bin will be trapped between the conveyors and the overs pile making it very difficult, if not impossible, for the bin to be picked up by the hauling company. Therefore, this EEM is not recommended.

EEM-4: Reduce Moisture Content of Biosolids

Increasing the solids content of the biosolids could reduce the energy consumption and all other operating costs associated with the Compost Facility. Prior studies, including the 2014 Biosolids Management Strategic Plan (Strategic Plan), examined potential positive impacts to the facility if the moisture content of biosolids was reduced.

Biosolids received from the Laguna Wastewater Treatment Plant (LTP) range in solids concentration from 12% to 18% with a typical value of about 15%. As noted in prior studies, the solids content has a significant impact on composting and the time needed for the facility to process a given mass of biosolids. Two factors are directly related to this:

- As the percent solids decreases, to compost an equivalent amount of biosolids on a dry mass basis, the total wet mass must increase.
- Ratio of biosolids to green waste in the compost recipe must decrease as the biosolids become wetter (decreasing dryness and solids concentration). If not, the compost mixture can become too wet and heavy causing the agitators to operate more slowly. This leads to increased operating time and can prevent the material from being turned within a normal

working day. Compost Facility staff also report that wear on the agitators increases and is accompanied by a significant increase in the frequency of breakdowns and increase in maintenance costs.

Changes in the solids content of the biosolids has a compounding effect on the dry weight of biosolids that can be composted. In other words, as the moisture content in the biosolids increases, not only does the total mass increase but the amount that can be treated in each batch of compost decreases. This results in a rapid increase in the amount of composting needed to treat the same amount of biosolids on a dry mass basis.

The Strategic Plan identified several means of increasing solids content (e.g., operational changes, covered biosolids storage, and improved dewatering at the Plant). Cost savings that could be obtained by increasing the throughput of the Compost Facility (economy of scale) were then determined. An annual throughput goal of 12,000 wet tons of biosolids was identified as an optimum goal with an associated potential annual savings of about $120,000. The Strategic Plan recommended this goal be met via operational changes rather than significant capital investment (e.g., covered storage). It suggested changing to a "just-in-time" model for delivering biosolids to the Compost Facility. The intent was to avoid accumulating biosolids in the Compost Facility's uncovered biosolids pond storage area (Figure 2-6). Because it is uncovered, storing solids in the pond during years with normal precipitation has resulted in significant wetting of the material resulting in solids concentrations as low as 10% to 12%. Other changes requiring significant capital investment (e.g., constructing covered biosolids storage) were not recommended.

Figure 2-6: Composting Facility Pond Biosolids Storage Area

As noted, the Strategic Plan based its value for annual savings on composting 12,000 wet tons of biosolids each year. Actual operations since 2010 show an average of only 8,000 wet tons of biosolids composted per year. Compost Facility staff believe that achieving a 50% increase in the amount of biosolids composted each year is not likely. This conclusion is based on the following:

- Compost recipe would have to change significantly. The current recipe uses 12,000 wet pounds of biosolids per batch. The ratio of biosolids in the recipe has increased dramatically over the years with staff reporting as little as 6,000 wet pounds of biosolids per batch was used during earlier years of operation. Staff invested a significant amount of time to fine tune the compost recipe and have unsuccessfully tried using as much as 14,000 pounds per batch. In order to achieve a 50% increase in the amount of biosolids composted each year, with no increase in the composting season (eight months out of the year), a total of 18,000 wet pounds of biosolids would have to be used in each compost batch. Compost Facility staff does not believe this is possible regardless of the solids concentration of the biosolids.

- Composting is more costly than land application. Diverting more biosolids to the Compost Facility would reduce the amount of solids available for land application. Because composting costs as much as five times more than land application of Class B biosolids, diverting biosolids to composting would increase overall operating costs of the beneficial use program.

Increasing the amount of biosolids treated each year does not appear feasible; therefore, this EEM assumes the facility will continue to compost biosolids at the current average rate of 8,000 wet tons per year. Cost and energy use benefits to the Compost Facility were instead based on the amount of time by which the composting season could be shortened if dryer biosolids were treated. Savings associated with a shortened operating season were then used to evaluate the cost-effectiveness of various alternatives that could be used to increase the solids content of the biosolids.

Because increasing the amount of biosolids treated each year is not likely, we assume the Compost Facility will continue to compost biosolids at the current average rate of 8,000 wet tons per year. To determine if any energy use and cost savings could be obtained at the Compost Facility we focused on the amount of time by which the composting season could be shortened if dryer biosolids were treated. We analyzed two options: 1) changing the dewatering process (EEM-4a), and 2) covering the biosolids storage area (EEM-4b). As shown below, neither option is likely to be cost-effective and is not recommended for implementation.

EEM-4a: Cover Biosolids Storage Area

During periods of the year when the Compost Facility's other storage facility (Alpha Farm) is full and land application has not yet started (typically in the late spring), biosolids production from LTP exceeds that which can be composted. Solids are then stored in the pond storage area of the Compost Facility. As previously noted, significant wetting of the uncovered biosolids can happen during years with normal precipitation, leading to solids concentrations as low as 10% to 12%. Covering the biosolids storage pond area would be one option to increase the overall average solids concentration of the biosolids being composted each year.

The Strategic Plan examined this as one potential alternative and estimated construction costs ranging from $1 to $3.4 million depending on the type of structure provided. The lower end of the cost range would be a less permanent structure such as a tent, whereas the higher end of the cost range would replicate something similar to the Alpha Farm storage building (Figure 2-7).

Figure 2-7: Alpha Farm Biosolids Storage Building

The financial analysis for this EEM was based on continuing to compost biosolids at a rate of 8,000 wet tons per year. Of this amount, it was assumed that 25% would typically be placed into the pond storage area. The solids concentration of the stored biosolids after being subjected to normal levels of precipitation was assumed to be 13%. Based on the facility's annual biosolids reports for 2010 through 2013, the solids concentration for all biosolids combined (both stored and not) was assumed to be 15%. With these assumptions, covering the biosolids storage pond could potentially increase overall solids concentration of all biosolids composted to about 15.8%. This coupled with an assumed increase to 13,000 pounds from the current 12,000 pounds of biosolids processed per batch of compost could decrease the composting season by one month resulting in both energy and labor savings. A summary of the financial analysis for the lower cost cover ($1 million for a tent-like structure) is summarized in Table 2-11.

Table 2-11: EEM-4a Cover Biosolids Storage Area Summary

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 Avg Annual Net Savings ($)
124,000	--	25	$1.0M	$0	$1.0M	-$15,000[1]	-$251,700[1]

[1] Negative savings in red equals a cost to Santa Rosa.

Assumptions:

- Total biosolids composted = 8,000 wet tons per year.
- Biosolids typically placed into the pond storage area = 25%.
- Solids concentration of stored biosolids during a normal precipitation year if not covered = 13%.
- Current average solids concentration for all biosolids combined = 15%.
- Average solids concentration for all biosolids combined if stored solids were covered = 15.8%.
- Normal composting season = 8 months.
- Amount by which the composting season could be shorted with increase in biosolids dryness = 1 month
- Energy use during an average normal 8 month composting season estimated to be 1,000,000 kWh
- Labor savings were calculated assuming that 4 staff members are directly affected by operation of the facility. For example, the amount of labor that could be saved by closing the facility 1 month early would be equal to about 690 hours (4 staff x 1 month x year/12 months x 2080 hours/FTE).

Covering the storage pond is not a cost-effective alternative and is therefore not recommended. However, other considerations beyond the scope of this audit could move Santa Rosa toward approval of the project. For example, runoff from the storage pond and adjacent finished compost piles is most likely high in dissolved organic material with low ultraviolet light (UV) transmittance. Depending on rain fall and the relative amount of runoff compared to total plant flow, this organic material could negatively impact the performance of the Plant's UV disinfection system resulting in higher energy use than would otherwise be needed. Solids contained in the runoff from the site would also increase overall loading to LTP that could result in higher energy use. An additional benefit of covering the storage pond, not accounted for in this analysis, would be increased flexibility for land application. Currently, all solids placed in the storage pond must be composted because the high water content from rainfall makes transporting them for land application unreliable. If the storage pond were covered, the facility would have the option to land apply the stored solids.

Verify Electrical Use

The preceding analysis was based on the assumption that the Compost Facility consumes about 1,000,000 kWh of electrical energy during a normal eight month composting season. This value was based on de-rated values of name plate motor horsepower and operating times as reported by Compost Facility staff. However, a baseline analysis of 2013 energy use for the Subregional treatment facilities showed that total consumption for the year was only about 890,000 kWh. Although this value is reasonably close to the calculated value (11% difference) and the vast majority of energy is consumed during the composting season, the values are different enough to warrant closer evaluation.

One explanation for the difference in energy use values could be that the building exhaust fans are not meeting system design values for air flow. The exhaust system was originally designed based on the fans providing 12 air changes per hour for the enclosed composting area. However, based on the relatively high levels of ammonia present in the air during the site audit, the fans may not actually be achieving this value. Because energy use is directly related to air flow, electrical consumption would be less than should otherwise be expected.

Verify Ventilation Flow Rates

Compost Facility staff reported direct experience with the relationship between exhaust fan air flow and energy consumption having seen increased electrical use after rebuilding the facility's biofilter beds in 2009. Prior to this work, staff had noted that exhaust air flow was abnormally low because of plugged air laterals in the filter beds. After rebuilding the beds and replacing all the original wood chip media with lava rock air flows increased dramatically along with a noticeable increase in electrical use.

As with other EEM's evaluated, KJ recommends that Compost Facility staff measure and confirm ventilation flow rates to ensure that the target air changes are being achieved. Doing so may yield information that could also explain the relatively high levels of ammonia within the Compost Facility building. Lowering these levels could lead to improved working conditions for Compost Facility staff.

EEM-4b: Change Dewatering Process

As previously noted, biosolids received from LTP's dewatering process range in solids concentration from 12% to 18% with a typical value of about 15%. Changes in the dewatering process at the Plant could increase this value leading to energy and cost savings at the Compost Facility. An analysis of the energy and potential cost savings that could be achieved with dryer biosolids was done and the results are summarized in Table 2-12. Alternatives for improving the dewatering process were not evaluated as part of this audit. As a result the capital cost for this EEM is shown as needing to be determined (TBD). However, the values shown for savings should be useful to staff in evaluating the cost-effectiveness of alternatives assuming they wish to consider changes to LTP's dewatering process.

Table 2-12: EEM-4b Change Dewatering Process Summary

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 Avg Annual Net Savings ($)
280,000	--	60	TBD	TBD	TBD	$149,000	$2.1M

Assumptions:

- Total biosolids composted = 8,000 wet tons per year.
- Current average solids concentration = 15%.
- Solids content after dewatering improvements = 18%.
- Current compost recipe uses 12,000 pounds per batch. After dewatering improvements assumed use of 14,000 pounds per batch.
- Normal composting season = 8 months.
- Amount by which the composting season could be shorted with increase in biosolids dryness = 2.3 months
- Energy use during an average normal 8 month composting season estimated to be 1,000,000 kWh
- Labor savings were calculated assuming that 4 staff members are directly affected by operation of the facility. For example, the amount of labor that could be saved by closing the facility 2.3 months early would be equal to about 1,600 hours (4 staff x 2.3 month x year/12 months x 2,080 hours/FTE).

17 February 2015

Final Technical Memorandum #3a (Amendment)

To: Mike Sherman, Mike Prinz and Colin Close City of Santa Rosa

From: Rod Houser, P.E., BCEE – Reclamation System Audit Lead for amendment
Julia Lund, PE, LEED AP – Deputy Project Manager
Alan Zelenka – Kennedy/Jenks Project Manager

Subject: Task 1.3a - Reclamation System Energy Audit (Amendment to TM #3)
Energy Optimization Plan (EOP) – Phase 1
K/J Project: 1368024*01

This analysis determines the potential costs and benefits of improvements at two large recycled-water pump stations: Delta Pond Pump Station and the City's B-Pond Pump Station. Improvements at these two pump stations were not contemplated in the original Technical Memorandum #3 (TM) due in part to the lack of energy or demand data that could be used as the benchmark for comparing energy-efficiency measures (EEMs). Since that time, new information was obtained that allows energy savings to be estimated for the following four additional EEMs:

- EEM-8: New Hydropneumatic Tank on West College Section of the Transmission Main
- EEM-9: New Hydropneumatic Tank on Laguna Section of the Transmission Main
- EEM-10: Common Hydropneumatic Tank for Laguna and West College Transmission Mains
- EEM-11: Operate Laguna and West College Transmission Mains at Common Hydraulic-Grade Line (HGL) without a Hydropneumatic Tank

3a.1 Recommendation

None of the four additional EEMs where recommended because they do not provide enough cost savings to offset the capital cost of implementation and there may be operational limitations that would prevent implementation.

While this TM does not recommend any new capital projects or changes to operational practices, there remains some concern over the fact that the rated working pressure of the low-pressure transmission main is unknown. This places a severe limitation on how the system is currently operated, and also limits the range of alternatives that could reduce operational costs in the future.

Additionally, the absence of flowmeters on the City's largest recycled-water pump stations (B Station and Delta Pump Station) makes it difficult to accurately track pump performance and daily/monthly production values.

Therefore, we recommend the following:

- Install flowmeters on the discharge manifolds at E-Station and Delta-Pond Pump Station.
- Research the original design basis for the low-pressure transmission main to establish a safe working pressure rating for the pipeline.
- Review the maintenance history of the pipeline to identify areas where excessive repairs have been made.
- Assess potential EEMs after the working pressure rating has been established.

3a.2 Background

System Description

The supply of reclaimed water is automatically controlled by regulating pump speed to maintain a narrow range of pressures in the low-pressure transmission main. During periods of very-low demand, however, pump output can exceed demand. This is because minimum pump output cannot be reduced beyond a preset threshold, which is usually established by the pump and/or motor manufacture. When the pump is regulated this way, excess pumpage is shunted out of the transmission main to limit maximum pressures. This pressure-limiting control action burns energy that cannot be recovered, so reducing their occurrence should result in a commensurate energy savings.

The principal storage reservoirs involved with this study are located at the Meadowlane complex (Ponds A, B, C and D) next to the Laguna wastewater treatment plant (LTP), and Delta Pond to the north. A third reservoir exists at the West College facility, located approximately midway between the Meadowlane complex and Delta pond. A low-pressure transmission main connects these reservoirs. Additional storage reservoirs have connections to the transmission main, but isolation valves usually prevent transfers of water during the irrigation season.

The low-pressure transmission main is used to convey recycled water from LTP to all of the storage ponds and irrigation pump stations. This pipeline operates at a typical HGL that ranges between elevations 127 feet, near LTP, to elevation 112 feet, near Delta Pond. During the irrigation season, maximum HGL near West College reservoir is usually limited to elevation 111 feet. This is accomplished via an overflow weir that relieves excess pumpage from the Delta Pond pump station. Water stored in this manner is eventually pumped into the City's urban-reuse system or is allowed to drain back into the low-pressure transmission main. Thus, most of the energy consumed during these diversions is later recovered.

A mainline valve is typically closed during the irrigation season to isolate the West College (northern) and Laguna (southern) sections of the transmission main. The same valve is opened during the wet-weather season to allow recycled water to be conveyed from the Meadowland complex northward to Delta Pond, and other reservoirs. The overflow weir at West College reservoir is typically isolated from the transmission main during these periods.

From the Meadowlane complex, irrigation water is supplied by the B pumps at E-Pump Station and B Pond. Pumps EB1, EB2 and EB3 operate in parallel to deliver water out of the E-Station wet well into the 48-inch Laguna and 30-inch Poncia transmission mains. Pumps B1 and B2 deliver water from Pond B into the Laguna mainline.

During low-demand periods, pumping into the Laguna main is limited to a single variable-speed pump (B1). A programmable logic controller (PLC) maintains a constant pressure in the Laguna section of the transmission main by regulating the speed of pump B1. The minimum-allowable speed of pump B1 is limited, however. Thus, pump output can exceed demand during periods of very-low demand. When this occurs, a motor-operated valve (MOV - B1B) automatically limits the maximum pressure by shunting excess pumpage back to B Pond. While this pressure-limiting action consumes excess energy, City staff report that it is a relatively rare occurrence. The average volume of water shunted back to B Pond cannot be accurately tracked at this time because there is no flowmeter on the bypass line. Thus, for purposes of this analysis, 8% of the pump output at minimum speed (50 gpm) is assumed to flow through MOV – B1B for purposes of pressure regulation.

Energy Use and Cost

This study focuses on the energy wasted when excess pumpage is shunted out of the transmission main. Quantifying this energy is complicated owing to the fact that flows are not measured; therefore estimates and assumptions were made using readily-available information. This included communications with staff, review of standard operating procedures, and several simplifying assumptions.

Energy Consumed Via Overflow Weir at West College Reservoir

Average daily volume supplied from Delta pump station is 2.76 MGD, as summarized in Table 3a-1.

Table 3a-1: Delta Pump Station Historical Output[1]

Irrigation Season					
Start	**Stop**	**Days**	**Recycled Water Volume (Mgal)**	**Avg Daily Demand (MGD)**	**Avg Daily Demand (gpm)**
6/8/2011	11/7/2011	152	503	3.31	2,290
5/14/2012	11/26/2012	196	456	2.32	1,610
4/13/2013	10/12/2013	182	504	2.77	1,920
	TOTAL	**530**	**1,462**	**2.76**	**1,910**

Monthly estimates of pump station output were estimated by prorating the average-daily flow based on the reference evapotranspiration (ETo) for CIMIS Zone 5. These values are summarized in Table 3a-2.

[1] Email, Karl Righetti, City of Santa Rosa, 7/8/14.

Table 3a-2: Estimated Monthly Demands

Reference ET for CIMIS Zone 5			Average Demand	
Month	**ET**	**% of Avg**	**MGD**	**gpm**
May	5.58	105%	2.90	2,010
June	6.30	119%	3.27	2,270
July	6.51	123%	3.38	2,345
August	5.89	111%	3.06	2,122
September	4.50	85%	2.34	1,621
October	3.10	58%	1.61	1,117

Minimum output of Delta pumps D1P and D3P is estimated at 2,000 gallons per minute [gpm][2]. Thus, excess pumpage is expected to occur during the months of September and October when demand is less than the minimum pump output. Specific energy of the pump is approximately 186 kWh/Mgal at reduced speed, when delivering 2,000 gpm from Delta Pond (HGL 62 feet) to the West College transmission main (HGL 108 feet). Thus, the excess energy consumed via the overflow weir at West College reservoir is approximately 10,400 kWh per year. Approximately 90% this energy is recovered, however, when water stored in the West College reservoir either drains back into the low-pressure transmission main, by gravity, or is pumped into Santa Rosa's urban-reuse distribution system. Therefore, the net excess energy consumed (i.e., that energy that cannot be recovered) is approximately 1,000 kWh per year.

Energy Consumed Via MOV – B1B

Minimum pump output of pump B1 is estimated to be 600 gpm. This is based on a vertical-turbine pump with a rated condition of 1,900 gpm at 45 feet of head[3]. Detailed performance data was not readily available, so performance was estimated assuming a two-stage Floway model 14FKH. Specific energy of this pump is 186 kWh/Mgal when delivering 600 gpm from B Pond (HGL 86 feet) to the Laguna transmission main (HGL 127 feet).

Due to the absence of a flowmeter, two key assumptions were made to estimate flows shunted out of the transmission main via MOV-B1B:

- Excess flows occur over 60 days (September and October), similar to Delta pump station.
- 8% of pump output (50 gpm) is shunted back to Pond B during this period.

Using these assumptions, excess energy of approximately 800 kWh per year is consumed by shunting excess pumpage from the Laguna transmission main back to Pond B.

[2] Based on Peabody-Floway model MKN with a rated condition of 8,000 gpm at 100 feet of head.
[3] Standard Operating Procedure for E-Pump Station, City of Santa Rosa, 3/26/2014.

3a.3 Detailed Descriptions of EEMs that are Not Recommended

This section describes the details of the four EEMs that were analyzed but rejected. 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%. Offsetting credits associated with PG&E energy-savings incentives were not considered in this analysis.

EEM-8: New Hydropneumatic Tank on West College Section of the Transmission Main

The objective of this EEM is to eliminate excess discharges to the West College reservoir during periods of low demand. This would be accomplished with three modifications:

- Connect a new 30,000 gallon hydropneumatic tank to the West College transmission main. This could be constructed at any convenient location along the pipeline.
- Isolate the West College overflow weir from the transmission main.
- Modify control logic at the Delta Pond pump station to automatically cycle the pump when pressure exceeds an allowable operating band.

Table 3a-3: EEM-8 New Hydropneumatic Tank on West College Section of the Transmission Main

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
1,000	$100	<1	$160,000	$0	-$13,000	-$244,000

EEM-9: New Hydropneumatic Tank on Laguna Section of the Transmission Main

The objective of this EEM is to eliminate excess discharges via MOV-B1B during periods of low demand. This would be accomplished with three modifications:

- Connect a new 7,000 gallon hydropneumatic tank to the West College transmission main. This could be constructed at any convenient location along the pipeline.
- Modify control logic for pump B1 to automatically cycle the pump when pressure exceeds an allowable operating band.

Table 3a-4: EEM-9 New Hydropneumatic Tank on Laguna Section of the Transmission Main Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
800	$80	<1	$80,000	$0	-$6,900	-$129,000

EEM-10: Common Hydropneumatic Tank for Laguna and West College Transmission Mains

The objective of this EEM is to eliminate excess discharges via MOV-B1B or the overflow weir at West College reservoir, during periods of low demand. This would be accomplished with four modifications:

- Connect a new 7,000 gallon hydropneumatic tank to the transmission main. This could be constructed at any convenient location along the pipeline.
- Operate the transmission main at a common HGL by opening all mainline valves along the pipeline.
- Modify control logic for pump B1 to automatically cycle the pump when pressure exceeds an allowable operating band.
- Isolate the West College overflow weir from the transmission main.

This EEM would be expected to increase maximum pressures in the West College section of the transmission main by no more than seven psig. This value corresponds to the difference in HGLs previously described for the Laguna and West College transmission mains: elevations 127 feet and 111 feet, respectively.

Table 3a-5: EEM-10 Common Hydropneumatic Tank for Laguna and West College Transmission Mains Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
1,800	$180	<1	$80,000	$0	-$6,700	-$126,000

EEM-11: Operate Laguna and West College Transmission Mains at Common HGL without a Hydropneumatic Tank

The objective of this EEM is to eliminate excess discharges via MOV-B1B or the overflow weir at West College reservoir, during periods of low demand. This would be accomplished with three modifications:

- Operate the transmission main at a common HGL by opening all mainline valves along the pipeline.
- Isolate the West College overflow weir from the transmission main.

This EEM would be expected to increase maximum pressures in the West College section of the transmission main by no more than seven psig. This value corresponds to the difference in HGLs previously described for the Laguna and West College transmission mains: elevations 127 feet and 111 feet, respectively. The viability of this EEM is dependent on the maximum-allowable pressure for the transmission main, which could not be verified for this study.

This EEM assumes that the minimum speed for pump B1 could be set such that minimum output corresponds with the minimum combined demand for the common section of transmission main. This approach eliminates the energy wasted via the motorized valve (MOV B1-B) because pump output exactly matches demand at all times.

Table 3a-6: EEM-11 Operate Laguna and West College Transmission Mains at Common HGL without a Hydropneumatic Tank Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
1,800	$180	< 1	$0	$0	$380	$6,500

17 February 2015

Technical Memorandum #3

To: Mike Prinz, Allen Balser and Colin Close, City of Santa Rosa

From: Dawn Taffler, PE, LEED AP – Recycled Water System Audit Lead
Julia Lund, PE, LEED AP – Deputy Project Manager
Alan Zelenka – Kennedy/Jenks Project Manager

Subject: Task 1.3 - Recycled Water System Energy Audit
Energy Optimization Plan (EOP) – Phase 1
K/J Project: 1368024*01

An energy audit of the City of Santa Rosa (Santa Rosa) Recycled Water System was conducted by Kennedy/Jenks (KJ) on March 26, 2014. The audit included a workshop with Santa Rosa operations staff, followed by a short site tour. The purpose of the audit was to identify and recommend for implementation cost-effective energy efficiency measures (EEMs) by analyzing the treatment, storage and conveyance system of recycled water.

3.1 Recommendation

Six EEMs associated with treatment process, pump station and customer focused improvements were identified for the Recycled Water System during the audit. After the analysis was conducted, four EEMs were determined to be cost-effective, and are therefore recommended for implementation. Cost-effectiveness is defined as an EEM that had a positive Net Present Value (NPV) from cumulative savings over the life of the EEM. All four of the recommended EEMs could be implemented immediately or in the near term. The four EEMs that were recommended are listed in Table 3-1 and summary of each follows.

Table 3-1: List of Recommended Energy Efficiency Measures

EEM#	Title	Average Annual Net Savings ($/Yr)
2	Replace Ultraviolet (UV) Disinfection	Included in TM #1 – Laguna Treatment Plant Process Energy Audit
3	Eliminate Pressure-Relief Bypass	$1,200
5	Reduce Delivery Pressures	$2,000
6	Optimize Time of Use Rates	$10,200

EEM 2: Replace UV Disinfection – Reducing the UV system costs is part of a larger strategy to address disinfection at the Laguna Treatment Plant (LTP). Potential energy savings for replacing the system are evaluated in TM #1 – LTP Process Energy Audit, which estimates a capital cost of over $12 million, an average annual **net** savings of approximately $124,000, and a NPV of cumulative savings of over $1.23 million.

EEM 3: Eliminate Pressure-Relief Bypass – Connecting a hydropneumatic tank at Todd Road Pump Station is estimated to have a $36,000 capital cost, an average annual net savings of approximately $1,200, and a NPV of cumulative savings of $25,000.

EEM 5: Reduce Delivery Pressures – Targeting pump stations with high specific energy for pump replacement is estimated to have a $18,000 capital cost, an average annual net savings of approximately $2,000, and a NPV of cumulative savings of $22,200.

EEM 6: Optimize Operations for Time of Use Rates – By optimizing the operations of five pumps with the highest electricity use for the time of use rates has an estimated capital cost of $10,000, an average annual net savings of $10,200, and a NPV of cumulative savings of $146,900.

If the recommended EEMs (3, 5, and 6, but not 2 which is included in TM#1 – LTP Process Energy Audit) were implemented, Santa Rosa's capital cost would be approximately $64,000. It could reduce its operating costs of the Recycled Water System by an average of $13,000 per year with a NPV of cumulative savings of approximately $194,500. It should also be noted that if these pump stations were to be taken off Santa Rosa's energy bill, then some of the strategies from EEM 3 and 6 would need to be reassessed.

Table 3-2: Summary of Recommended Energy Efficiency Measure Savings

Electricity Savings (kWh/Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
28,030	6	$64,000	$0	$64,000	$12,950	$194,479

The priority order for implementation by Santa Rosa is based on the Return-On-Investment (ROI) for each recommended EEM. The recommended implementation order is shown in Table 3-3.

Table 3-3: Priority Implementation Order

Order	EEM#	Title	ROI (%)
1	6	Optimize Operations for Time of Use Rates	82%
2	5	Reduce Delivery Pressures	16%
3	3	Eliminate Pressure-Relief Bypass	1.3%
4	2	Replace UV Disinfection	n/a

3.2 Background

System Description

The Recycled Water System is defined by the infrastructure used to convey recycled water from LTP to irrigation customers in Santa Rosa and Rohnert Park and the Geysers Steamfield. Two thirds of the recycled water produced at LTP is conveyed directly to the Geysers Steamfield year-round. The remaining recycled water is conveyed through a complex system of ponds and pump stations for irrigation, urban usage (primarily in the summer) and discharge when needed. An overview of the Recycled Water System conveyance facilities is provided in Figure 3-1.

Santa Rosa's recycled water storage ponds provide a combined capacity of approximately 6 billion gallons. Attachment A includes a map illustrating the storage pond locations. Santa Rosa manages the recycled water system to meet recycled water demands and minimize discharge of recycled water to the environment. Tertiary disinfected recycled water produced at LTP meets California Code of Regulations for Title 22 disinfected tertiary recycled water (Attachment B).

Currently, the Delta Pond is the primary discharge location for the Recycled Water System, though there has been no substantial discharge within the last three years. Discharge is also permitted at Meadow Lane Pond and can directly discharge at LTP. The last discharge from Meadow Lane Pond was during the 2006 flood.

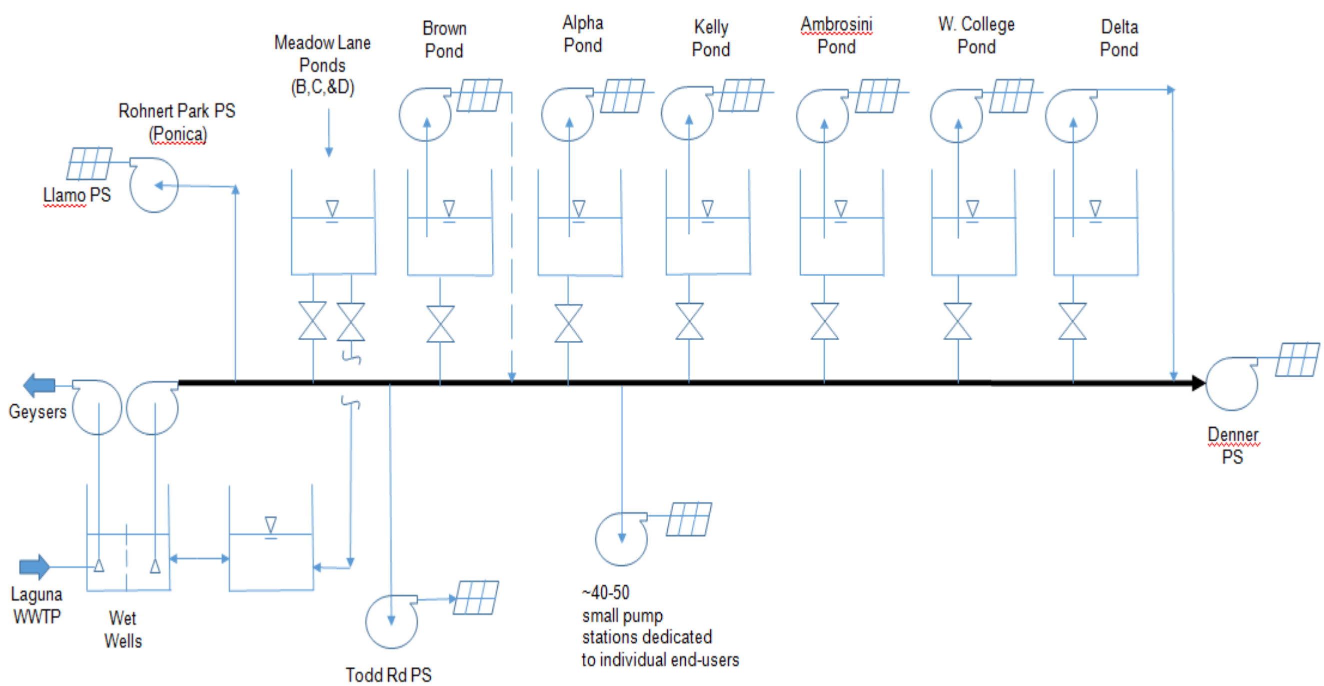

Figure 3-1: Overview of Santa Rosa Recycled Water System Major Conveyance Facilities

As shown in Figure 3-1, major recycled water pump stations (PS) including: Llano (Geysers system), Rohnert Park, Meadow Lane Ponds, Brown Pond, Alpha Pond, Kelly Pond, Ambrosini Pond, West College Pond, Delta Pond, Denver, and Todd Road; pump recycled water from storage ponds or directly from the conveyance trunk line for reuse. In addition, 40 to 50 other small pump stations are used to distribute recycled water to individual end users.

Santa Rosa has implemented several energy saving improvements for existing pump stations, including installation of variable frequency drives (VFDs), electronic valves (EVs), supervisory control data acquisition (SCADAs) and other features to improve the Recycled Water System's efficiency in the last few years. Attachment C lists pump stations improvements implemented as of

April 2014. Santa Rosa also works directly with customers to operate the system at a higher efficiency by educating and encouraging farmers to irrigate at night, which saves water and energy. Santa Rosa is willing to further investigate operational energy efficiency improvements to decrease costs. This type of proactive approach will pay dividends to rate-payers for years to come.

Energy Use and Cost

As part of the data collection effort prior to the onsite energy audits, Santa Rosa provided baseline energy usage for its Subregional System, including the Recycled Water System. The baseline energy usage provides a snapshot of how much energy is currently used at the existing Recycled Water System to allow for comparison to what impacts the various audit recommendations will have. The baseline energy profile for the Recycled Water System only includes electricity use, since natural gas usage is negligible.

KJ worked with Santa Rosa staff to collect the necessary data to create the baseline energy profile 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 the Recycled Water System, the electricity baseline energy usage was broken down into Pumping and Pond categories, which respectively include data from PG&E and the SCADA system. The baseline is summarized in Table 3-4.

Table 3-4: Baseline Electricity Usage for the Recycled Water System

Category	Baseline Annual Electricity Use (kWh/Yr)	Baseline Annual Electricity Cost ($/Yr)
Recycled Water Pumping[1]	1,594,000	$350,000
Recycled Water Pond[2]	78,000	$6,000
Total Electricity Used for Recycled Water System	**1,672,000**	**$356,000**

[1] Data are from PG&E from January 2012 to December 2013.

[2] Data are from Santa Rosa SCADA system from January 2012 to December 2013, excluding March and October 2012.

As shown in Figure 3-2, the Recycled Water System uses a relatively small percentage (approximately 5%) of the total electricity of the Subregional System.

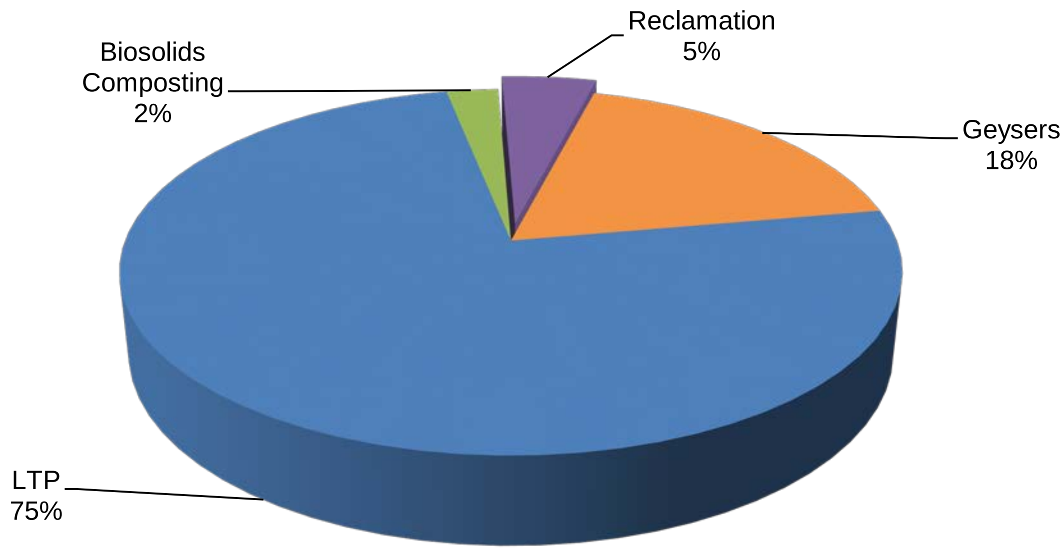

Figure 3-2: Annual Electricity Usage for Subregional System by Category

3.3 Overview of Audit Methodology

The Recycled Water System energy audit involved looking at all pump stations and pipelines that convey recycled water; and assessing the cost-effectiveness and energy savings of changing the operation of the equipment, retrofitting the existing equipment, or replacing the existing equipment with a more energy efficient option. In addition, the audit evaluated treatment processes at LTP that relate to recycled water production to identify changes that could lower costs and save energy (further described in TM #1 – LTP Process Energy Audit).

Audit Participants

Audit participants included staff from Santa Rosa and KJ. Dawn Taffler and Rod Houser (the audit team) met with Randy Piazza, Karl Righetti, and Rip Forrey to discuss the audit process for Santa Rosa. The audit focused on the evaluation of recycled water pump stations and the level of treatment and disinfection needed to meet regulatory requirements and customer demands for recycled water.

Audit Methodology

The energy audit consisted of both an off-site review of data, a workshop with Santa Rosa staff, and an on-site tour of some recycled water conveyance system infrastructure. The objective of the audit was to understand the operation of conveyance infrastructure to identify all of the equipment and operational practices that consume energy, provide a detailed assessment of energy using equipment, quantify their energy use, and identify preliminary EEMs.

The audit included a workshop conducted by Dawn Taffler and Rod Houser of KJ, who led participants through a discussion of operations, energy use, and performance. Staff was willing to explore incorporating many of the ideas into the operations of the Recycled Water System. The audit relied heavily on the operation-specific knowledge and experience of Santa Rosa staff, and the workshop allowed an exchange of information that increased the number and applicability of the recommendations.

The seven EEMs were identified during the workshop and tour and are listed in Table 3-5.

Table 3-5: List of Identified Energy Efficiency Measures (EEMs)

EEM #	Category	Title
1	Treatment Process Improvements	Produce Two Recycled Water Qualities
2		Replace UV Disinfection[1]
3	Pump Station Improvements	Eliminate Pressure Relief Bypass
4		Incorporate VFDs
5		Reduce Deliver Pressures to Select Customers
6	Customer-Focused Improvements	Optimize Operations for Time of Use Rates

[1] The replacement of UV disinfection is described and evaluated in TM #1 – LTP Process Energy Audit.

Data Review

Prior to the onsite audit, KJ reviewed data provided by PG&E and Santa Rosa, including: maps of customers and infrastructure (Attachment B); energy usage and cost per customer; recycled water flow data by pump station and/or customer accounts; a pump improvements list identifying pumps that have magnetic meters, e-valves, VFDs, SCADAs, pressure tanks, PLC, filter systems, or Cl injection (Attachment C); and a Santa Rosa assessment of pump efficiency.

Santa Rosa provided a list of pump stations they perceived to operate efficiently and inefficiently. The pump station efficiency evaluation metrics for these pump stations are summarized in Table 3-6.

Table 3-6: Pump Station Efficiency Evaluation by Santa Rosa

Pump	Motor Horsepower (HP)	Recycled Water Deliveries (MG)	PG&E Average Annual Energy (kWh)	PG&E Average Annual Cost ($)	Specific Energy Requirements[1] (kWh/MG)	Unit Cost Per Flow ($/MG)
Pump Stations Identified by Santa Rosa as "EFFICIENT"						
Beretta North	40 HP	42	31,435	$6,908	754	$166
McClelland Dairy	75 HP	97	106,956	$14,908	1,099	$153
Pump Stations Identified by Santa Rosa as "INEFFICIENT"						
Mello- East	50 HP	49	53,368	$10,548	1,094	$216
Lafranconi-West	50 HP	76	73,227	$12,576	970	$167
Dei South[2]	60 HP	52	44,678	$12,162	853	$232
Terri Linda[2]	60 HP	69	56,431	$11,251	822	$164
Dei Home	30 HP	45	31,488	$7,665	705	$172
Lafranconi-Pipeline[3]	25 HP	33	N/A	N/A	N/A	N/A

[1] Calculated by dividing recycled water deliveries by energy data from PG&E on a monthly basis and taking the average of the values over the year.
[2] These pump stations are currently be updated.
[3] No data available from PG&E.
(Source: Randy Piazza, City of Santa Rosa 4/1/14)

Further evaluation of pump efficiency was conducted by KJ using PG&E data and recycled water flow data from Santa Rosa. The review of data included reconciling the different meter numbers and pump station identifiers between the PG&E and Santa Rosa data sets and identifying pump stations with more than one pump. A summary of pump station account numbers, addresses and meter identifications are included in Attachment D.

The energy evaluation was based on input from Santa Rosa and the following assumptions:

- Recovery pumps, pumps no longer in service and pumps that did not have a motor greater than 10 horsepower (HP), were assumed to not have a large impact on Santa Rosa's efficiency and were excluded from the analysis. A list of pumps that were excluded from the analysis is provided in Attachment E.
- Pump names are based on pump locations on the map provided by Santa Rosa.
- Pump stations were identified using the map provided by Santa Rosa while the "pumps at pumps stations" column in Attachment D was named from the "pump list" in the spreadsheet provided by Santa Rosa. Santa Rosa verified that the pumps at pump stations were matched up correctly.
- Service (SVC) numbers in the pump station list from Santa Rosa were used to match up with the SAID numbers in the spreadsheet PG&E spreadsheet. Santa Rosa assisted in matching pump station names for flow from recycled water with the pump stations listed in the PG&E spreadsheet.
- Monthly flow data for recycled water was provided by Santa Rosa from 2011 to 2013.
- Monthly energy and cost data was provided from PG&E from 2011 to 2013.
- Specific energy requirement of kilowatt-hour per million gallon (kWh/MG) was calculated by dividing energy usage data from PG&E by flow data from recycled water.
- Unit cost ($/MG) was calculated by dividing the cost data from PG&E by the recycled flow data. Similar to specific energy requirement, unit cost values divided the three-year sum of each value; not by taking the average of the three years.

A summary of the pump station efficiency evaluation is provided in Table 3-7. Pump stations are sorted from highest to lowest specific energy requirement (kWh/MG) to determine which pumps should be further analyzed to incorporate EEMs.

This audit mainly focuses on specific energy requirement (kWh/MG) because it provides insight into pump efficiency. Currently, Vananzza pump station has the highest specific energy requirement of approximately 2,500 kWh/MG and should be explored to incorporate EEMs to improve efficiency. Other pumps that should be further analyzed for implementing EEM measures are Morrison/N West 30 HP, Hansen F West, Robbins, and Todd Road Pump Station. Further evaluation of how these five pumps can reduce their specific energy requirement is described in Section 3.4.

Only 26 out of the 44 pumps had flow and energy data. KJ could not perform an analysis on the pumps for which data were not available (N/A), but recommends that in the near future Santa Rosa gathers the appropriate information to analyze the efficiency of these 18 pumps.

Table 3-7: Pump Station Efficiency Evaluation

Pump Station [1]	Motor (HP)	Energy and Flow Data (2011-2013)					
		Flow (MG/Yr)[2]	Metered Energy (kWh/Yr)[3]	Cost ($/Yr)[4]	Specific Energy Requirement (kWh/MG)[5]	Cost Per Flow ($/MG)[6]	Cost per Energy ($/kWh)[7]
VANAZZA	75	4.5	10,200	$3,800	2,503	$926	$0.34
MORRISON/N WEST 30HP	30	27.0	57,500	$11,400	2,155	$426	$0.17
HANSEN F WEST	40	11.5	19,800	$5,100	2,138	$542	$0.24
ROBBINS	20	8.4	14,100	$3,400	1,688	$401	$0.23
KELLY FARM	300	57.8	81,400	$17,900	1,500	$351	$0.20
TODD RD PS	20,30, 30,30	28.0	38,600	$9,600	1,464	$362	$0.25
MORRISON /S.WEST	15	7.4	9,600	$2,500	1,413	$405	$0.24
HANSEN F EAST	30,10	45.9	53,000	$8,900	1,158	$195	$0.16
TOMROSE	30	13.4	14,900	$4,200	1,119	$311	$0.27
OAKRIDGE	25	8.8	9,700	$3,300	1,114	$384	$0.35
DENNER AG PUMPS 525HP	525	160.4	176,000	$39,400	1,104	$247	$0.21
PETERS DAIRY	75	80.6	87,600	$13,900	1,091	$179	$0.19
DEI SOUTH	60	42.1	43,400	$11,000	1,072	$271	$0.25
MELLO A JR E	50	52.6	52,100	$10,100	1,000	$195	$0.20
MUELRATH HM	20,30	29.1	29,300	$7,500	983	$254	$0.28
CHRISTENSEN S	20	12.5	11,600	$1,700	925	$252	N/A
TERRI LINDA	60	45.5	40,100	$9,400	894	$221	$0.25
LAFRANCONI WEST	50	79.0	69,600	$11,200	887	$143	$0.15
BERETTA SOUTH	60	42.6	35,200	$7,500	836	$178	$0.21
HENRY 15HP	15	11.6	9,400	$2,700	816	$230	$0.28
BERETTA RNCH	40	39.3	29,000	$6,300	733	$160	$0.24
MUELRATH S	15	9.6	7,000	$2,100	722	$216	$0.29
#1384 DEI HOME	30	46.3	31,800	$7,200	693	$157	$0.22
MATOS 30HP	30	52.3	27,700	$6,500	599	$142	$0.24
#3066 - ALPHA FARM	200	75.7	34,800	$11,900	441	$163	$0.17
AMBROSINI HOME 20HP	20	17.5	N/A	N/A	N/A	N/A	N/A
MACK	20	0.3	N/A	N/A	N/A	N/A	N/A
MELLO A JR W	20	24.6	N/A	N/A	N/A	N/A	N/A
AGGIO	100	54.5	N/A	N/A	N/A	N/A	N/A
AMATO	60	15.3	N/A	N/A	N/A	N/A	N/A
CARINALLI	125	53.4	N/A	N/A	N/A	N/A	N/A
DOTTI BROS	75	76.1	N/A	N/A	N/A	N/A	N/A
GLEASON PUMP	60	48.3	N/A	N/A	N/A	N/A	N/A
HANSEL PMP	40	3.1	N/A	N/A	N/A	N/A	N/A

Pump Station [1]	Motor (HP)	Energy and Flow Data (2011-2013)					
		Flow (MG/Yr)[2]	Metered Energy (kWh/Yr)[3]	Cost ($/Yr)[4]	Specific Energy Requirement (kWh/MG)[5]	Cost Per Flow ($/MG)[6]	Cost per Energy ($/kWh)[7]
AG LAFRANCONI PIPELINE	25	33.0	N/A	N/A	N/A	N/A	N/A
NOMMSE C	N/A	22.0	N/A	N/A	N/A	N/A	N/A
A PLACE TO PLAY	30	17.7	N/A	N/A	N/A	N/A	N/A
LA FRANCHI	140	56.1	N/A	N/A	N/A	N/A	N/A
WTR TRTM PONCIA PMP ST	350	269.1	N/A	N/A	N/A	N/A	N/A
STONE	100	42.0	N/A	N/A	N/A	N/A	N/A
#3066 - BROWN	250	217.4	N/A	N/A	N/A	N/A	N/A
DELTA POND PMP STA 600	300, 300, 75,20	N/A	352,500	$50,400	N/A	N/A	$0.14
LAFRANCONI EAST	40	N/A	N/A	N/A	N/A	N/A	N/A
AMBROSINI/WCII 20HP	20	10.5	N/A	N/A	N/A	N/A	N/A

[1] Pump Station name provided by City of Santa Rosa. See Attachment D for account information and meter numbers.
[2] 3-year average annual recycled water deliveries reported by Santa Rosa (monthly meter readings from 2011-2013).
[3] 3-year average annual energy use reported by PG&E (monthly meter readings from 2011-2013).
[4] 3-year average annual energy cost reported by PG&E (monthly meter readings from 2011-2013).
[5] Calculated by dividing the annual flow by the annual energy use. Presented as the three-year average from 2011-2013.
[6] Calculated by dividing the annual cost by the annual flow. Presented as the three-year average from 2011-2013.
[7] Calculated by dividing the annual cost by the annual energy use. Presented as the three-year average from 2011-2013.
N/A = data not available at time of this Tech Memo.

3.4 Detailed Descriptions of Recommended EEMs

This section describes the details of the four recommended EEMs and provides financial summaries. 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 Class 5 planning level cost estimating with an estimated accuracy range between +50% and -30% suitable for comparison purposes between alternatives or options. Incentives amounts are based on best estimates and need to be verified by applying to the appropriate PG&E program.

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. The detailed analysis of this EEM is provided in TM#1 – LTP Process Energy Audit (EEM #2).

EEM 3 – Eliminate Pressure-Relief Bypass

Incorporating hydropneumatic tanks at pump stations, in lieu of pressure relief bypasses, has the potential to increase pump station energy efficiency. Currently, pressure relief bypass systems are used at Todd and Rohnert Park (Poncia) pump stations to limit maximum discharge pressures when demand is less than pump output. The bypass routes excess pumpage back to the pump suction, which results in the recirculation of water and unnecessary energy consumption. Hydropneumatic tanks can be used to store excess pumpage, in place of constant recirculation. A pressure switch on the pump discharge is then used to cycle power to the pump to maintain the discharge pressure within an allowable operating band that corresponds to the best efficiency point of the pump(s).

Santa Rosa currently has four hydropneumatic tanks that are in use at Denner, Rohnert Park, Countyside, and Finley pump stations. A fifth hydropneumatic tank is located near the Todd Rodd Pump Station, which is currently not integrated in the system but planned for installation in 2014. There are no other plans for installing hydropneumatic tanks at other reclamation pump stations.

Todd Road Pump Station

Todd Road pump station consists of four pumps (one 20 HP and three 30 HP). A 1,000 gallon hydropneumatic tank, from another decommissioned pump station, has been placed at the Todd Road pump station site (see Figure 3-3). Santa Rosa recently installed new VFDs at the Todd Road pump station, as well as a bypass. Connecting to the hydropneumatic tank would address Santa Rosa's current recirculation problem due to the existing the bypass relief valves. The hydropneumatic tank would provide a small amount of usable storage that allows the pumps to cycle on and off when demands are less than pump output. Ideally, the relief bypass valves would only be used in emergency situation if there was a failure of the pressure regulation controls.

The Energy Efficiency Audit and Retrofit Options for the Todd Reclamation Booster Pump Station (Lescure, 2013) also recommended incorporation of the hydropneumatic tank. Connecting the hydro tank creates an estimated annual energy reduction of approximately 2,930 kWh, an estimated $36,000 capital cost, and an annual average net energy savings of approximately $1,240 per year (calculated based on the difference between the VFD plus Hydro Tank Option and the VFD Only Option provided in the Lescure report). It is recommended that Santa Rosa install the hydropneumatic tank Todd Road pump station to realize the full potential energy savings.

An incentive may be available from PG&E through its Customized Retrofit Incentive program for this EEM (http://www.pge.com/en/mybusiness/save/rebates/ief/index.page).

Figure 3-3: Disconnected Hydropneumatic Tank at Todd Road Pump Station

EEM 5 – Reduce Delivery Pressures

Targeting pump stations with high specific energy requirements for pump replacement may be a viable way to reduce energy consumption. There are two possible causes for pump stations with high specific energy requirement: (1) the existing pump(s) are inefficient given the operating duty condition they are operating on, and (2) the delivery pressure(s) to end users are higher than typical. It is also possible for both of these conditions to occur simultaneously.

Small pump stations, dedicated to individual users, that have a calculated specific energy requirement of greater than 1,200 kWh/MG (the average of all pumps in Table 3-7), were evaluated to estimate the potential savings due to replacement with more efficient pumps. The calculated energy savings, estimated capital costs, and estimated average annual savings for each pump replacement is shown in Table 3-8.

Delivering water at lower pressures may not be acceptable at every location, depending on the topography of the site and type of use. For example, properties at higher elevation require high pressure to serve and vineyards that rely on drip irrigation may require less energy than pastures irrigated by larger rotary sprinklers.

Santa Rosa provided a list of water delivery pressures for all the pump stations listed in Table 3-7 and a description of the typical use and/or conditions where known.

Table 3-8: Pump Replacement to Reduce Specific Energy Requirement

Pump Station	Estimated Energy Savings (kWh/Yr)[1]	Estimated Capital Costs ($)[2]	Estimated Cost Savings ($/Yr)[3]
VANAZZA	4,800	$45,000	-$2,700
MORRISON/N WEST 30 HP	25,100	$18,000	$2,600
HANSEN F WEST	6,000	$24,000	-$900
ROBBINS	4,100	$12,000	-$300
MORRISON /S.WEST	700	$9,000	-$600

1 Calculated based on a design specific energy requirement of 1,200 kWh/MG multiplied by the metered flow minus the metered energy (metered data from 2011-2013 listed in Table 3-7).
2 Estimated based on $600/HP replacement cost.
3 Calculated based on the estimated energy savings multiplied by the unit cost per energy from Table 3-7.

Due to the modest energy savings versus the capital costs for most of the pumps, only replacement of the Morrison/N West 30 HP pump results in an estimated savings for Santa Rosa, and is shown in Table 3-9.

Table 3-9: EEM-5 Reduce Delivery Pressures Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
25,100	$2,690	5	$18,000	$0	$2,000	$22,200

Santa Rosa currently charges three rates for recycled water: one for sites requiring high-pressure deliveries, one for sites with low-pressure deliveries, and a third for sites where Santa Rosa provides additional equipment for operations. Santa Rosa may want to further investigate the existing tiered rate structure to consider a more equitable distribution or allocation of costs for pumps that are consistently operating at high specific energy. While this is more of a management and policy issue, Santa Rosa could recognize significant energy cost savings without a capital cost investment.

EEM 6 – Optimize Operations for Time of Use Rates

PG&E electricity rates vary significantly depending on the time of day. Limiting pumping during peak electricity rate periods can significantly decrease electricity costs for the Recycled Water System. PG&E has a cost multiplier that is applied depending on the time of day and season electricity is consumed. The most expensive period is during peak hours from 1 pm to 8 pm and the least expensive period is during night non-peak hours from 11 pm to 6 am. Summer months are generally more expensive during the day, though winter months can have higher night time rates. Current PG&E time of day factors can be found on their website.

Ideally, all Recycled Water System pumps would be operated at night, when energy demands and costs are lowest. Santa Rosa controlled pump stations are mostly operated in the evening, though some pumping occurs during the day time to fill ponds from LTP. Santa Rosa has also made continuous efforts to encourage agricultural users to irrigate at night, to improve water efficiency, and reduce pumping during peak electricity periods.

Limitations to night-time irrigation include:

- Farms that rely on manual labor to move hand lines and wheel lines to provide full coverage irrigation of their fields require mostly daytime irrigation.
- Monitoring runoff is more difficult in the evening.
- Response to leaks and/or line breaks would be slower during off-work hours.

The electricity energy cost evaluation looked at pumps with higher unit electricity costs, representative of pump stations that may not currently be operating at the optimal time based on the higher electricity rates applied for day time operations. The pumps in Table 3-7 show a range in metered unit electricity cost from $0.14/kWh to $0.35/kWh and an average unit electricity cost of $0.23/kWh. Table 3-10 lists the calculated electricity cost savings if pumps that had a greater than average unit electricity cost were to operate at a unit electricity costs equal to $0.23/kWh. In other words, this EEM assumes that pumps with higher unit electricity costs would change operations to irrigate in a more similar manner to the average pump station in Santa Rosa's Recycled Water System. Electricity demand (kW) savings are not included.

The modest electricity savings associated with this EEM are because it only assumes a shift in electricity use to some off-peak hours and an average annual cost per electricity of $0.23/kWh. Enforcement of this EEM will be challenging because many agricultural users rely on day-time staff to provide manual irrigation. Potential risks associated with line breaks and regulatory repercussions from runoff are further deterrents to implementation. Additional studies may be warranted to identify and track customers who are not encumbered by irrigation time-of-day operations and methods that could be employed to limit potential risks associated with leak response time.

Table 3-10: Electricity Cost Savings from Optimizing Time of Use Operations

Pump	Average Annual Cost per Electricity ($/kWh)[1]	Average Annual Electricity Cost ($/Yr)[1]	Optimized Electricity Cost ($/Yr)[2]	First Year Estimated Electricity Cost Savings ($/Yr)[3]
OAKRIDGE	$0.35	$3,300	$2,200	$1,100
VANAZZA	$0.34	$3,800	$2,300	$1,500
MUELRATH S	$0.29	$2,100	$1,600	$500
MUELRATH HM	$0.28	$7,500	$6,700	$800
HENRY 15 HP	$0.28	$2,700	$2,200	$500
TOMROSE	$0.27	$4,200	$3,400	$800
TODD RD PS	$0.25	$9,600	$8,900	$700
DEI SOUTH	$0.25	$11,000	$10,000	$1,000
TERRI LINDA	$0.25	$9,400	$9,200	$200
HANSEN F WEST	$0.24	$5,100	$4,600	$500
MORRISON/ S.WEST	$0.24	$2,500	$2,200	$300
MATOS 30 HP	$0.24	$6,500	$6,400	$100

[1] Metered billing data from 2011-2013 listed in Table 3-7.
[2] Calculated as optimal $0.23/kWh multiplied by the metered electricity.
[3] Calculated as metered cost minus optimized electricity cost.

Table 3-11: EEM-6 Optimize Operations for Time of Use Rates Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Avg Annual Net Savings ($/Yr)	NPV of Cumulative Net Savings ($)
0	$8,000	0	$10,000	$0	$10,200	$146,900

3.5 Detailed Descriptions of EEMs Not Recommended

EEM 1 – Produce Two Recycled Water Qualities

A summary of recycled water uses allowed in California are listed in Attachment B. Santa Rosa currently produces Title 22 disinfected recycled water recycled water, suitable for unrestricted non-potable reuse. Some of Santa Rosa's existing customers could be served with secondary treated recycled water. For example, pasture for milk animals for human consumption are allowed to have disinfected secondary-2.2 and/or disinfected secondary-23 recycled water. Reducing the level of treatment could reduce the energy demands associated with the additional treatment.

The minimum level of treatment for recycled water is limited based on the following contractual and regulatory requirements for end users:

1. Geyser Steamfield (Calpine Contract) requires disinfected tertiary recycled water.
2. Urban users (Rohnert Park and Santa Rosa URP) require Title 22 disinfected tertiary recycled water due to the level of human contact.

Though disinfected secondary recycled water may be suitable for some existing agricultural uses, serving multiple recycled water qualities would have the following challenges:

- Need for additional infrastructure at LTP to produce two water qualities.
- Additional operational complexities to produce two water qualities.
- Need to separate or add an additional disinfection treatment train (one for each water quality produced).
- The existing conveyance backbone pipeline and pond system is structured to serve urban and agricultural customers.
- The costs of developing a parallel reclamation conveyance system would be cost prohibitive.
- The quantity of water delivered to urban and agricultural customers is less than one third of the total recycled water produced.

The requirement to design and build a parallel reclamation treatment and conveyance system for a relatively small amount of recycled water would have a high dollar per unit flow cost and add significant operational complexities; therefore EEM-1 is not recommended.

EEM 4 – Incorporate VFDs

The objective of this EEM is to provide electricity consumption reductions for a pump station by installing a VFD to vary the frequency and the speed of the inner channel pump to maintain desired operating conditions. The Recycled Water System includes 10 large pumps and approximately 40 to 50 small pumps. Many of the existing pumps already have VFDs installed (see Attachment C), demonstrating Santa Rosa's commitment to improving pump efficiency and capturing energy savings. The analysis for this EEM shows that in some cases VFDs may not reduce energy consumption sufficiently to offset the cost of equipment and installation. Energy savings due to the installation of VFDs is a function of the capacity of the pump. Thus, smaller pumps may not see the same energy efficiency benefits as larger pumps; therefore EEM-4 is not recommended.

References

Lescure Engineers, Inc. 2013. Energy Efficiency Audit and Retrofit Options for the Todd Reclamation Booster Pump Station. Prepared for the City of Santa Rosa. January 2013.

PG&E. 2013. Frequently Asked Questions PG&E's Power Purchase Agreement for Small Renewable Generation "Feed-in Tariffs". Pacific Gas and Electric Company. Retrieved on 5 March 2014. http://www.pge.com/includes/docs/pdfs/b2b/wholesaleelectricsuppliersolicitation/Feedin_Tariffs_FAQs.pdf

Attachment A: Recycled Water Storage Pond Layout

See PDF

Attachment B: Recycled Water Uses Allowed in California

See PDF

Attachment C: Recycled Water Pump Station Improvements as of April 2014

LOCATION	MAG METER	E-VALVE	VFD	SCADA	PRESSURE TANK	PLC	FILTER SYSTEM	CL INJECTION	NOTES
AGGIO	X	X		X					manure pump
ALPHA IRR			X	X			X		
ALPHA RECOVERY									
AMBROSINI HOME		X		Z?		Z?			
AMBROSINI POND									
APTP	X		X	X			X	X	3 pumps; 2 irrigation - 1 prs. pump; on demand
BALLETTO OCCIDENTAL									Pond; has 2 diesel & 1 electric motors
BALLETO GUERNVILLE									Off mainline has diesel motor
BERETTA NORTH	X	X	X	X					manure pump
BERETTA SOUTH	X	X	X	X					
BEVILL									Off mainline has diesel motor
BRADY									
BROWN IRR			X	X			X		
BROWN RECOVERY									
CARINELLI	X	X		X					Valve control of flow
CHRIST S									
COUNTYSIDE			X	Z?	X		X		On demand station
DEI NORTH/HOME									
DEI SOUTH	Z	Z		Z					summer/fall 2014
DENNER	X	X	X	X	X		X		4 pumps; 2 vfd's;2 soft start
DOTTI	X	X		X					Valve control of flow
FOXTAIL	X	X		X					Pond fill off mainline; 3 valves
FREITAS IRR							X		
FREITAS WELL									
GLEASON/NEIMENS	x	x		x					

LOCATION	MAG METER	E-VALVE	VFD	SCADA	PRESSURE TANK	PLC	FILTER SYSTEM	CL INJECTION	NOTES
HANSEL / CHRIST. N									
HANSEN EAST	X	X	X	X			X		2 pumps; 1 VFD; 2 valves
HANSEN WEST	X	X		X			X		
IDYLEWILD/BRENTWOOD		X				X			Valve control of flow
KAHN/HENRY		Z				Z			
KELLY IRR	X		X	X			X		
KELLY RECOVERY									
LAFRANCONI EAST									
LAFRANCONI MIDDLE	Z	X		Z					
LAFRANCONI WEST	Z	X		Z					
LEE									
MACK									
MATOS		X				Z			
MELLO EAST	Z	Z		Z					
MONONI									
MORRISION NORTH	Y	X		Y					manure pump
MORRISION SOUTH		X				Y			
MUELRATH HOME		X				Z			
NOMMSEN									Pump station plus off Todd Rd. PS
NONELLA									
OAKRIDGE/SR RIDING CTR.	Z?	X		Z?		Z?			
O'NEEL/VANAZZA									Vineyard
PACHECO									Has pond that is filled from Brown thru Dotti
PETERS	X	X		X					
PONCIA HOME	X	X	X	X					Off RPPS
PONCIA TERRI-LINDA	Z	Z		Z					
RANCHO LAGUNA	X	X	X	X					2 pumps; 1 VFD; 1 soft start

LOCATION	MAG METER	E-VALVE	VFD	SCADA	PRESSURE TANK	PLC	FILTER SYSTEM	CL INJECTION	NOTES
ROBBINS	X								Off Ambrosini pond thru Korbel sump
RPPS	X		X	X	X		X	X	
SANCHETTI HOME									Pond; cng powered motors
SANCHETTI PARK ROYAL									Pond; cng powered motors
SANCHETTI/RASMUS SEN									Pond; cng powered motors; off Ambrosini pond
STONE	X	X		X					
SUNRISE		X				Z			
TODD RD PS	X	X	Y	X	Z				2 valves; wells/trunk line
TOMROSE		X	X			Z			
WC IRR/FINLEY	X		X	X	X		X	X	
WELLS/STRUNK VALVE		X				Z			Runs off Todd Rd. PS
WINKLER/MUELRATH SOUTH		X		.		Z			

Source: Email from Rip Forrey on 5 May 2014
X=existing
Y=installed/non-operational
Z=proposed
It should be noted that all pump stations have a flow meter, though some meters have been recently updated.

Attachment D: Background Recycled Water Pump Station Information

Pump Stations	Pumps at Stations	Address	Account Number	City Meter ID	PG&E Meter ID
Dei	#1384 DEI HOME	831 HIGH SCHOOL RD	6314244758	880R64	880R64
	DEI SOUTH	831 HIGH SCHOOL RD	2549728005	X04891	1003202603
Terri Linda	TERRI LINDA	597 WILFRED AVE	6314244766	5190R8	1009921404
LaFraconi	AG LAFRANCONI PIPELINE	2500 LLANO RD	6314244562	26277R	N/A
	LAFRANCONI WEST	1811 LUDWIG AVE	6314244652	34M162	34M162
	LAFRANCONI EAST	1811 LUDWIG AVE	6314244648	33M862	1008840167
Mello	MELLO A JR	2700 LLANO RD	8439244212	35P476	35P476
	MELLO A JR (WEST)	2700 LLANO RD	6314244564	26304R	N/A
Beretta	BERETTA SOUTH	3215 LLANO RD	6314244516	4963R5	5000034202
	BERETTA RNCH	3233 LLANO RD	4855905020	47447R	5000034176
Todd RD PS	TODD RD PS	LLANO RD & COLGAN CREEK	6314244528	5090R2	1009513114
Nommsen	NOMMSE C	3915 LLANO RD	6314244532	1778R3	N/A
Matos	MATOS 30 HP	3669 LLANO RD	6314244536	880R32	1009927338
Hansen	HANSEN F WEST	3420 GUERNEVILLE RD	6314244544	1M1052	5000033586
	HANSEN F EAST	3420 GUERNEVILLE RD	6314244546	0497R6	1006491524
Dotti	DOTTI BROS	2145 LLANO RD	8439244552	#N/A	N/A
Carinalli	CARINALLI	2600 LLANO RD	6314244572	1M0557	N/A
Kelly Farm	KELLY FARM	5344 OCCIDENTAL RD	8439244968	2P2639	1004778120
Hansel	HANSEL PMP	5700 HALL RD	6314244592	34M236	N/A
GLEASON PUMP	GLEASON PUMP	5915 HALL RD	6314244596	47499R	N/A
Amato	AMATO	435 SANFORD RD (SR HORSE CO)	6314244598	603R38	N/A
Stone	STONE	5743 OCCIDENTAL RD STONE	6314244662	X02504	N/A
Christensen S	CHRISTENSEN S	600 SANFORD RD	6314244666	X18883	5000034010
Ambrasini	AMBROSINI HOME 20 HP	4265 HALL RD	6314244682	1P8925	N/A

Pump Stations	Pumps at Stations	Address	Account Number	City Meter ID	PG&E Meter ID
	AMBROSINI/WCII 20 HP	4265 HALL RD	6314244686	44612R	1008842153
Mack	MACK	4735 HALL RD	6314244684	6504R3	5000033561
Henry	HENRY 15 HP	497 LAGUNA VISTA RD	6314244688	P98824	5000034025
VANAZZA	VANAZZA	5151 HALL RD	6314244692	OM9898	5000034199
Morrison	MORRISON /S.WEST	5157 STONY POINT RD	6314244776	47433R	5000033549
	MORRISON/N WEST 30 HP	5157 STONY POINT RD	6314244784	X45746	1005515491
Mulerath	MUELRATH HM	3800 WALKER AVE - MUELRATH	4855905010	X05382	5000033595
	MUELRATH S	3800 WALKER AVE	8124437855	#N/A	5000102181
Tomrose	TOMROSE	5307 STONY POINT RD	3028550857	X34208	5000033565
Oakridge	OAKRIDGE	3184 GUERNEVILLE RD	4855905025	M15532	1006491491
Alpha Pond	#3066 - ALPHA FARM	3600 LLANO RD	4855905068	20P699	20P699
Place to Play	A PLACE TO PLAY	2375 W 3RD ST	6314244498	0458R0	N/A
Robbins	ROBBINS	3086 GUERNEVILLE RD	4855905458	97939R	1009945946
Aggio	AGGIO	5915 HALL RD	4855905040	89R116	N/A
Rancho Laguna	LA FRANCHI	4000 PINER RD - RANCHO LAGUNA	4855905045	2840R8	N/A
Denner	DENNER AG PUMPS 525 HP	4390 WOOLSEY RD	4855905512	P29180	1004779272
Peters Dairy	PETERS DAIRY	3600 WOODWORTH RD	4855905070	47489R	1009869348
Rohnert Park	WTR TRTM PONCIA PMP ST	5200 STONY POINT RD	4855905075	P30564	N/A
Delta Pond	DELTA POND PMP STA 600	WILLOWSIDE RD	4855905272	2P2634	1009398262
Brown Pond	#3066 - BROWN	2200 LLANO RD	8439244901	2P2638	N/A

* This table identifies which pump stations have one or more pumps

Attachment E: Recycled Water Pumps Excluded from Analysis

ACCOUNTS EXCLUDED	REASONING
FREITAS TREE FARM	10 HP or Under
LEE #86-2980 CTY AG PS	10 HP or Under
IRRIG BRADY 7.5 HP	10 HP or Under
CNTYSIDE IRRIG LNDSCPE	10 HP or Under
PARK AVE TURF 10 HP	10 HP or Under
MONONI	10 HP or Under
WSTE WTR 30 HP CITY	Pump Removed
SEBASTOPOL	Pump Removed
PARK AVE. TURF	Recovery Pump
#3066 - BROWN REC	Recovery Pump
ALPAH REC	Recovery Pump

17 February 2015

Technical Memorandum #4

To: Mike Prinz, Mike Sherman, and Colin Close – City of Santa Rosa

From: Rod Houser, PE, BCEE – Geysers Energy Audit Lead
Julia Lund – Deputy Project Manager
Alan Zelenka – Project Manager

Subject: Task 1.4 - Geysers Energy Audit
Santa Rosa Energy Optimization Plan (EOP) – Phase 1
K/J Project: 1368024*01

An energy audit and workshop was conducted by Kennedy/Jenks (KJ) at the Geysers Operations Center on April 16, 2014. The purpose of the audit was to identify and recommend cost-effective Energy Efficiency Measures (EEMs) for implementation by the City of Santa Rosa (Santa Rosa) to save energy and lower operating costs.

4. 1. Recommendation

Four EEMs were identified during the audit. After the analysis was conducted three EEMs were determined to be cost-effective and are recommended for implementation and are listed in Table 4-1 below. Cost-effectiveness is defined as an EEM that had a positive Net Present Value (NPV) from savings over the life of the EEM.

Table 4-1: List of Recommended Energy Efficiency Measures

EEM #	Category	Title
1	Process	Restore Pipeline Capacity
4	HVAC	Limit Operation of the Air-Handling Unit

A summary of the total costs, energy savings, and reductions in greenhouse gas emissions of these recommended EEMs is provided in Table 4-2.

Table 4-2: Summary of Recommended Energy Efficiency Measure Savings

Electricity Savings (kWh/Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Avg Annual Net Savings ($)
37,600	**28**	**$70,800**	**$0**	**$77,800**	**$13,300**	**$152,000**

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 (a “NC” represents “not calculable”). Essentially, the ROI is infinite without capital costs; so EEMs with zero capital cost are therefore ranked based on the amount of NPV of cumulative net savings it brings to Santa Rosa. The recommended implementation order is in Table 4-3.

Table 4-3: Priority Implementation Order

Order	EEM#	Title	ROI (%)
1	4	Limit Operation of the Air-Handling Unit	NC
2	1	Restore Pipeline Capacity	18%

4. 2. Background

System Description

Santa Rosa owns and operates the Geysers System that consists of four medium-voltage pump stations and forty miles of pipeline. The System was designed to pump up to 40 million gallons per day (MGD) of tertiary effluent from the Laguna Treatment Plant (LTP) approximately 30 miles to Alexander Valley.

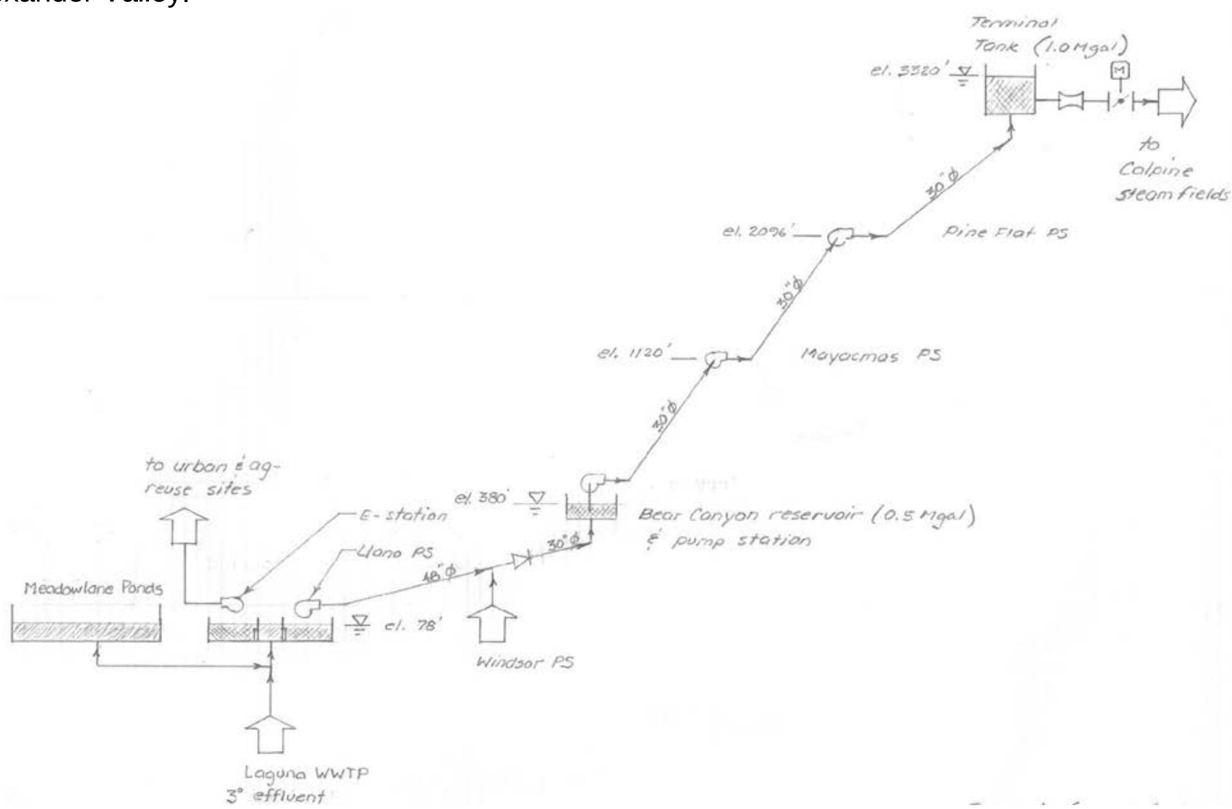

Figure 4-1: Geysers System Schematic

A turnout exists near Red Winery Road where up to 24 MGD of recycled water service could, in the future, be extended to vineyards in that region. The remaining 16 MGD can be conveyed to the 0.5 million gallon (Mgal) reservoir located at the Bear Canyon Pump Station. From there, three pump stations convey the recycled water through 3,000 feet of vertical lift to the 1.0 Mgal Terminal Tank. Calpine Corporation controls a flow-control station at the Terminal Tank where they regulate water deliveries to the injection wells located above the steam fields.

Midway between the first pump station (Llano) and Bear Canyon, the Town of Windsor injects between 0.2 – 0.7 MGD of tertiary effluent into the pipeline, where it blends with water from the LTP. Santa Rosa operates all of the pump stations; however, Calpine pays for the electricity to run the three North pump stations (Bear Canyon, Mayacmas and Pine Flat). The Town of Windsor pays for the electricity to run its pump station. For this reason, the scope of this study focused on pumping operations at Llano Pump Station and the pipeline that connects it to Bear Canyon Reservoir.

Energy Use and Cost

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

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 the Geysers System, the electricity baseline was broken down into Pumping and Miscellaneous categories, which respectively include data from SCADA and PG&E.

Table 4-4: Baseline Electricity Usage for Geysers System

Category	Baseline Annual Electricity Use (kWh/Yr)	Baseline Annual Electricity Cost ($/Yr)
Geysers Pumping[1]	6,407,000	$404,000
Miscellaneous (Building, Catholic Protection) [2]	74,000	$8,200
Total Electricity Used for Geysers System	**6,481,000**	**$412,000**

1 Data are from Santa Rosa SCADA system from January 2012 to December 2013.
2 Data are from Santa Rosa SCADA system and PG&E from January 2012 to December 2013.

As shown in Figure 4-2, the Geysers System uses close to 20% of the total electricity of the Subregional System.

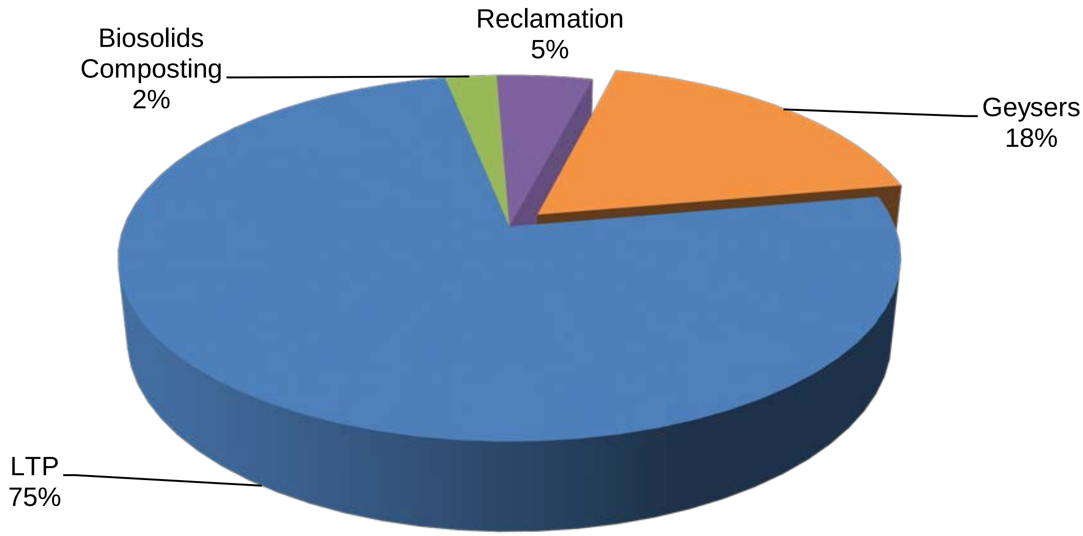

Figure 4-2: Annual Electricity Usage for Subregional System by Category

4. 3. Overview of Audit Methodology

KJ performed two different types of audits for the Geysers System: an equipment audit and a process audit. The equipment audit involved reviewing the major pieces of equipment at Llano Pump Station and assessing the cost-effectiveness and energy savings of changing the operation of the equipment, retrofitting the existing equipment, or replacing the existing equipment with a more energy efficient option. The audit systematically attempts to identify EEMs in several categories – building envelope, lighting, HVAC, and plug load. In addition to the main pump and pipeline performance characteristics, the following pump-station appurtenances were reviewed:

- Two 20 horsepower (HP) air compressors
- One 5 HP air-handling unit
- Building lighting

The process audit involved the review and evaluation of operational processes and procedures to identify changes that could lower costs and save energy.

Rod Houser of KJ conducted the energy audit and led a workshop with the Geysers Operations staff, which included the following participants: Mike Sherman, Tami Duval, Mike Pinoris, Daryl Clark, Andrew Klein, and Art Blass.

During the workshop four EEMs were identified for further analysis. For each EEM the auditor identified energy efficient replacement equipment or process change, assessed its cost-effectiveness, energy savings, GHG emission reductions, and identified operational impacts, and benefits as applicable. Actual electricity consumption data was used where available. If data were not available, working assumptions were made and used in this analysis. To determine the cost-effectiveness of the EEMs, capital cost, energy savings, PG&E incentives, net cost, average net annual cost/savings, and the net present value (NPV) of the average annual net savings were calculated.

Energy Efficiency Measures Analyzed

Building Envelope

Building envelope EEMs are associated with improving the energy efficiency of the windows (if any), weather-stripping around doors, and the insulation in the walls, ceiling and floor (if any). There is one concrete-masonry building at the Llano Pump Station that is approximately ten years old. The building has a metal standing-seam roof with no observable defects. There are no windows, and the building is usually unmanned (i.e., occupied less than 100 hours per year). No building envelope failures were identified, therefore no building envelope EEMs were identified for the Llano Pump Station building.

Lighting

Lighting EEMs save energy by installing controls or more efficient replacement lights. For the unmanned building at Llano Pump Station, no light-fixtures were identified for replacement due to the intermittent use of the building. The lights are normally left off unless some type of planned maintenance requires entry into the building space.

HVAC

HVAC EEMs save energy by replacing existing heating, ventilation and air conditioning equipment with more efficient equipment. For Llano Pump Station, HVAC consists of two roof-mounted exhaust fans and a five HP air-handling unit that forces fresh air into the building. There were no equipment replacement alternatives related to the HVAC system. However, one HVAC process improvement was identified; EEM-4: reduce operation of the air-handling unit.

Plug Load

Plug Loads address non-permanent office equipment like computers, copiers, and appliances. For Llano Pump Station, we recommend creating a policy of buying only Energy Star rated equipment.

Process

Process EEMs are changes to the operations at Llano Pump Station that result in energy savings. The following process EEMs were identified at Llano Pump Station:

- EEM-1: Restore Pipeline Capacity.
- EEM-2: Replace 800 HP Pump with 650 HP Pump.
- EEM-3: Change Pump-Control Logic.

A summary of the energy analysis is provided in Table 4-5, below. The EEMs highlighted in green are those that we found to be cost-effective, and are recommended for immediate implementation. A more detailed description of each EEM is provided in Section 4.

Table 4-5: Summary of Identified Energy Efficiency Measures

EEM No.	Category	Title	Energy Savings (kWh/Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg-Annual Net Savings ($/Yr)	NPV of Avg Annual Net Savings ($)
1	Process	Restore pipeline capacity	109,000	22	$70,800	$0	$70,800	$9,200	$104,600
2	Process	Replace 800-HP pump with more-efficient unit	7,765	2	$910,800	$620	$910,800	-$66,400	-$976,000
3	Process	Modify pump-control logic	5,290	1	$7,000	$0	$7,000	$122	$1,245
4	HVAC	Reduce operation of the air-handling unit	28,600	6	$0	$0	$0	$4,100	$47,400
		Total of Recommended EEMs	**37,600**	**28**	**$70,800**	**$0**	**$77,800**	**$13,300**	**$152,000**

4. 4. Detailed Descriptions of Recommended Energy Efficiency Measures

The following section describes the details of the recommended EEMs and provides financial summaries. All calculated numbers are based on rough order of magnitude estimates and parametric cost curves.

EEM-1: Restore Pipeline Capacity

Excessive head losses are occurring in the Geysers Pipeline, according to a report prepared in 2011[1]. The report narrowed the location of excessive head loss to the 30-inch segment of HDPE pipe within two miles of Bear Canyon Reservoir. The approximate location is shown in Figure 4-3 below. Based on conversations with Geysers Operations staff, additional investigations are needed to more precisely locate the location of unusual head loss.

Camera access to the dewatered pipeline interior can be made through any one of several manways provided along the alignment. Access for maintenance activities of this nature would require careful planning and attention to confined-space safety precautions.

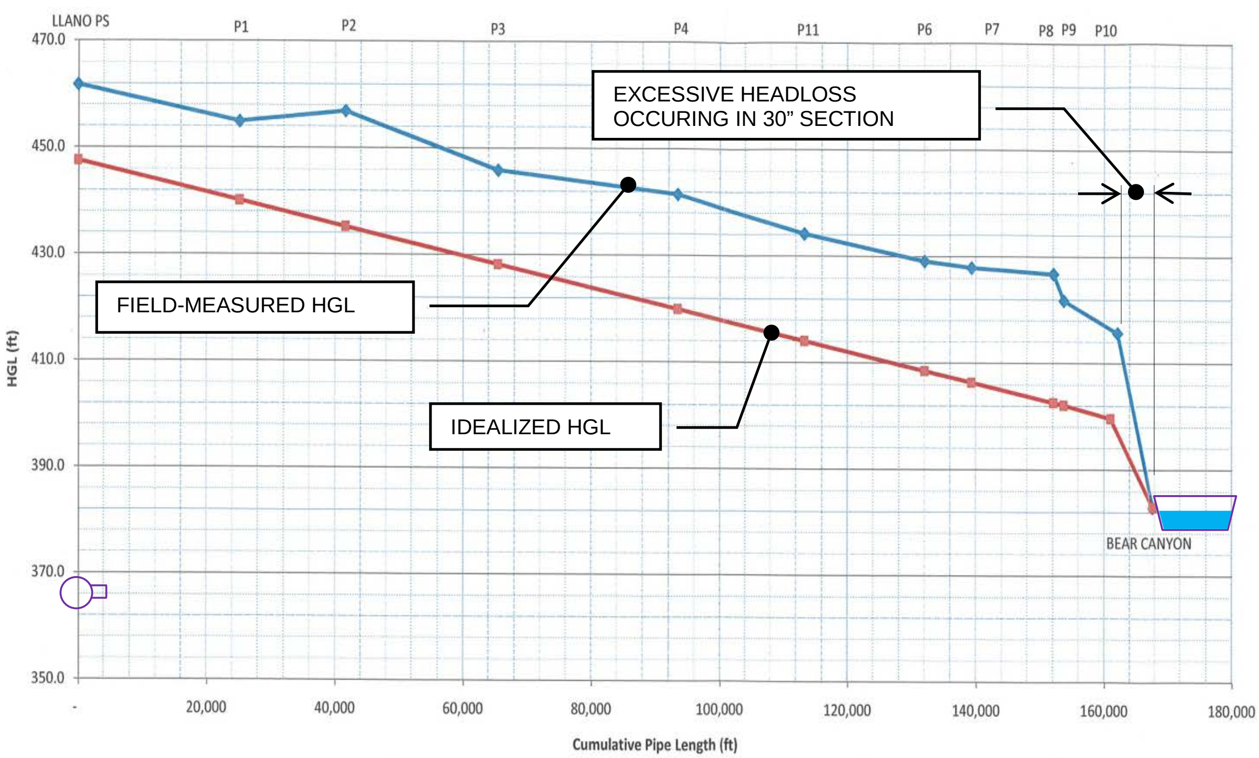

Figure 4-3: Hydraulic Profile

[1] Rocky Vogler, P.E., "Geysers Pipeline Hydraulic Testing", Winzler & Kelly Technical Memorandum, June 10, 2011.

Energy savings estimated for this EEM were taken from the Winzler & Kelly 2011 study.

Table 4-6: EEM-1 Restore Pipeline Capacity Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Avg Annual Net Savings ($)
109,000	$11,700[1]	22	$70,800	$0	$70,800	$9,200	$104,600

EEM-4: Reduce Operation of the Air-Handling Unit (AHU) to Summer Months

The existing five HP AHU is designed to automatically turn on whenever one of the 1,250 HP pumps is operating. However, operations staff observed that the building maintains adequately low temperature to prevent overheating of the equipment unless ambient temperatures are very warm. This is most likely due to fans installed on the VFD cabinets, in addition to two roof-mounted exhaust fans that run continuously. One reason they turn it off in the winter is because the fan can suck rain into the building interior.

This EEM would require the AHU to be operated in HAND mode only during the warmest three months during the summer. The AHU would be turned off for the rest of the year when the other fans are adequate to ventilate the space.

A summary of capital cost and energy savings is provided in Table 4-8 below.

Table 4-8: EEM-4 Reduce Operation of the Air-Handling Unit Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Avg Annual Net Savings ($)
28,600	$3,060	6	$0	$0	$0	$4,100	$47,400

4. 5. Detailed Description of Energy Efficiency Measures Not Recommended

EEM-2: Replace Existing 800 HP Pump with More Efficient Unit

The four existing constant-speed 800 HP pumps are used to augment supply when demand at the Geysers exceeds maximum output of the 1,250 HP pump (about 13 MGD). When demand reaches 17 MGD (11,800 gallons per minute), the 1,250 HP unit delivers 6,400 gallons per minute at approximately 85% hydraulic efficiency. The 800 HP unit makes up the difference of 5,400 gpm and operates far to the right of the best-efficiency point (BEP), as shown in Figure 4-4. This is because the pumps were originally designed to deliver up to 40 MGD (24 MGD to Alexander Valley plus 16 MGD to Geysers). In contrast, the current maximum contract delivery rate is 17.0 MGD, so the pumping head at this flow is significantly lower compared to what it would be at 40 MGD.

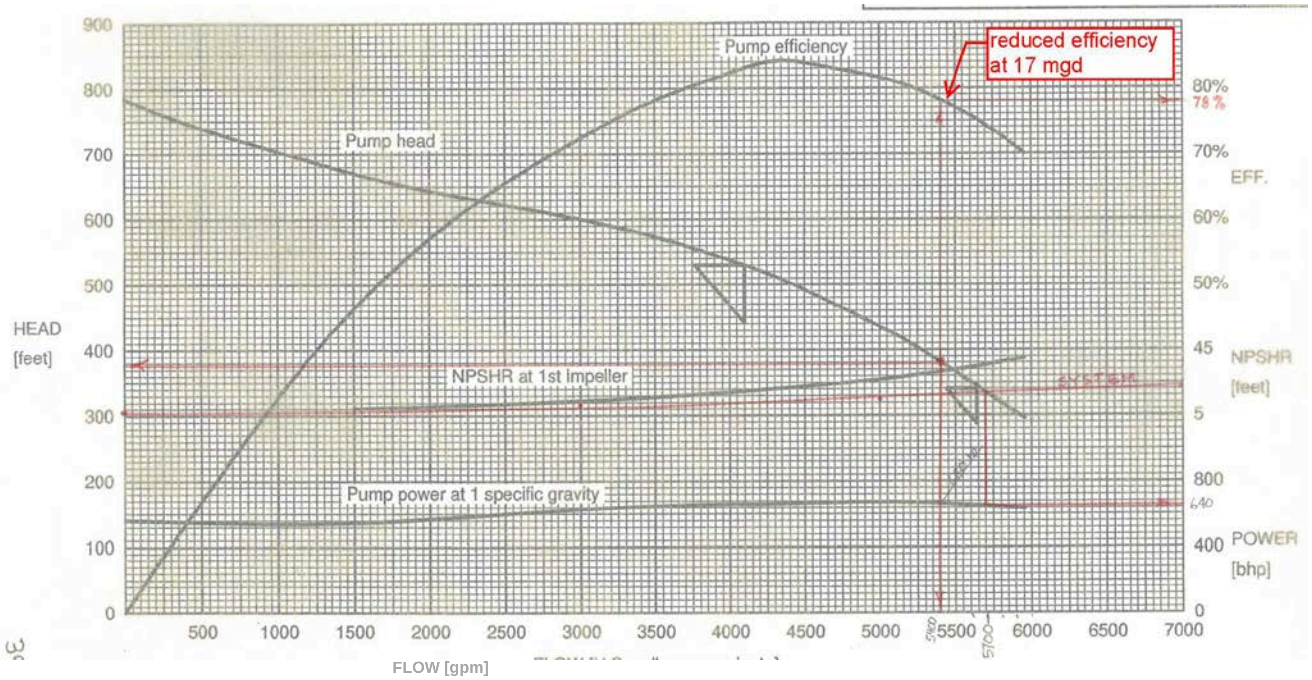

Figure 4-4: Performance Curve for Existing 800 HP Pump

This EEM would add a smaller pump (650 HP) that is hydraulically optimized to deliver 17 MGD when pumping in parallel with the existing 1,250 HP unit. If sized optimally, the pump could be expected to operate close to 85% efficiency while pumping in parallel with the larger unit (at a combined flow of 17 MGD), thereby reducing energy consumption.

A summary of energy savings and costs are provided in Table 4-9 below. An incentive of $0.08/kWh for the first year of actual energy savings likely would be available through the basic non-lighting PG&E Customized Retrofit Incentive program: http://www.pge.com/en/mybusiness/save/rebates/ief/index.page. Capital costs for this EEM far outweigh the meager electricity savings realized by improving the hydraulic efficiency; therefore, this EEM is not cost-effective and not recommended.

Table 4-9: EEM-2 Replace Existing 800 HP Pump Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Avg Annual Net Savings ($)
7,765	$833	2	$910,800	$620	$910,180	-$66,400	-$979,600

EEM-3: Optimize Pump-Control Logic

Currently, the first constant-speed pump (800 HP) is turned on when the 1,250 HP unit cannot keep up with demand. When the constant-speed pump starts, the 1,250 HP unit ramps down until pump station output matches demand. Hydraulic efficiency of the 800 HP unit is only 78% when operating together with the 1,250 HP unit, compared to 86% at its BEP.

This EEM would start the second 1,250 HP unit (instead of the 800 HP unit) when demand exceeds supply from a single 1,250 HP unit. Both 1,250 HP pumps would ramp up and down in unison to match demand. When operating in this mode, efficiency improves slightly.

A summary of energy savings and costs are provided in Table 4-7 below. The actual energy savings could be field measured using the customer-side metering provided at the pump station. This verification step should be completed to confirm the actual savings, before making any changes to the pump control logic. One advantage of this EEM is that it costs very little to implement since no new equipment is needed. However, the estimated cost savings is negligible and it would render the constant-speed pumps useless for normal deliveries.

Table 4-7: EEM-3 Optimize Pump-Control Logic Summary

Electricity Savings (kWh/Yr)	Electricity Savings ($/1st Yr)	GHG Emission Reduction (MT/Yr)	Capital Cost ($)	Incentive Amount ($)	Net Cost ($)	Avg Annual Net Savings ($/Yr)	NPV of Avg Annual Net Savings ($)
5,290	$568	1	$7,000	$0	$7,000	$122	$1,245

17 February 2015

Technical Memorandum #5

To: Mike Prinz and Colin Close - City of Santa Rosa

From: Julia Lund - Kennedy/Jenks Deputy Project Manager
Alan Zelenka - Kennedy/Jenks Project Manager

Subject: Description of Brainstorming Workshop #1 Process and Outcomes – Draft TM #5
Santa Rosa Energy Optimization Plan
K/J 1368024*01

5.1 Background

Kennedy/Jenks (KJ) has been assisting the City of Santa Rosa Utilities Department (Santa Rosa) to develop the first phase of an Energy Optimization Plan (EOP) to serve as a master plan and road map to strategically and systematically optimize energy use, promote resource recovery, and provide leadership in environmental initiatives.

The work completed to date includes energy audits of four systems within Santa Rosa's Subregional System, including: 1.) Laguna Wastewater Treatment Plant (LTP), 2) Biosolids Compost Facility. 3) Recycled Water System, and 4) Geysers Recharge System.

The four energy audits identified 29 potential Energy Efficiency Measures (EEMs), and of these 20 EEMs were deemed to be cost-effective and were recommended. In addition, six Process Improvements (PIs) identified for LTP. Inclusion of the replacement of the LTP Ultraviolet (UV) Disinfection System could also add substantially more benefit. Cumulatively, the benefits from the energy audits to Santa Rosa and are shown in Table 5-1 below.

Table 5-1: Cumulative Benefit of the Four Energy Audits

Benefit Metric	Cumulative Benefit from Identified EEMs	Including UV Disinfection Replacement
Electricity Savings (kWh/Yr)	3.4 Million	9.5 Million
Greenhouse Gas Emission Reductions ($MMCO_2$/Yr)	609	1,874
Net Capital Cost ($)	$349,000	$12.8 Million
Average Annual Net Savings ($/Yr)	$427,000	$551,000
Net Present Value of Cumulative Lifecycle of Savings ($)	$7.3 Million	$8.5 Million

5.2 Workshop Objective

The EEMs and PIs identified during the energy audits represent a relatively comprehensive group of projects for each system, but the projects were narrowly focused on each individual system involving a small group of individuals with specific technical expertise. The objective of the Project Brainstorming Workshop (Workshop #1) was to involve a broader range of people and consider a larger, more holistic list of potential energy saving and GHG reducing projects for the Subregional System that were not already evaluated as part of the energy audits. Once the list was developed it would be narrowed to a short-list list of projects that would be assessed in detail as part of the next phase of the EOP.

5.3 Participants

The Workshop #1 participants included:

- Allen Balser (Santa Rosa, Acting Reclamation Superintendent)
- Colin Close (Santa Rosa, Research & Program Coordinator)
- Rip Forrey (Santa Rosa, Irrigation Program Coordinator)
- David Guhin (Santa Rosa, Director)
- Mike Prinz (Santa Rosa, Deputy Director of Subregional Operations)
- Terry Schimmel (Santa Rosa, Mechanical Superintendent)
- Joe Schwall (Santa Rosa, Wastewater Treatment Superintendent)
- Mike Sherman (Santa Rosa, Geysers Operations)
- Tasha Wright (Santa Rosa, Administrative Analyst)
- Rocky Vogler (Santa Rosa, Water Resources Planning)
- Julia Lund (Kennedy/Jenks, Deputy Project Manager)
- Alan Zelenka (Kennedy/Jenks, Project Manager)

Other Santa Rosa staff who were asked to provide input were: Edward Garcia (Utilities Technician), Zach Kay (Biosolids Coordinator), and Karl Righetti (Senior Wastewater Plant Operator).

5.4 Workshop Process Overview

Before Workshop #1, Santa Rosa staff was asked to develop a list of potential energy saving/generating and GHG reducing projects or programs in their area of responsibility for the Subregional System, drawing from other colleagues' input or other previous documents or studies. KJ staff also compiled potentially applicable projects using their expertise from previous projects. A total of 49 projects were identified.

On July 22, 2014, twelve Santa Rosa and KJ staff gathered for Workshop #1. After reviewing a summary of the four energy audits, the group reviewed the list of potential projects developed by Santa Rosa and KJ, asking clarifying questions as needed to ensure the concept of each project was understood. Some projects were removed from consideration since they were already evaluated or implemented by Santa Rosa, while others were consolidated with other similar concepts.

Each participant then voted for the five projects they felt should be evaluated further, based on their own technical knowledge and personal perspective. The projects were scored and sorted on a spreadsheet from highest number of votes to lowest. The five projects with the most support became the short-list of projects, which will be evaluated further in the next phase of the EOP. Projects with insufficient support will not be evaluated further but could be evaluated in the future if circumstances change.

5.5 Project Scoring and Outcomes

Of the initial 49 projects proposed, 25 were either consolidated with other projects or removed from consideration since they have already been evaluated or implemented. The group voted on the remaining 24 projects. The scoring and sorting of the projects from highest number of votes to lowest is shown in Table 5-2.

The group came to a consensus that the top five projects were appropriate to evaluate in the next phase of the EOP. The group debated whether or not to include the projects on the cusp (specifically Projects #6, #7 and #8) but ultimately decided that none of them should be further evaluated at this time.

Table 5-2: Workshop #1 Scoring Results

#	**Project Title**	**Total Votes**	**Votes w/o K/J**	**Notes**
1	Waste Heat Investigation (including Organic Rankin Cycle)	8	7	
2	Pump Efficiency Software/Energy Management Software	8	6	
3	KJ and Power Hydrodynamics Collaboration/Pressure Dynamics of Irrigation System	7	6	
4	Comprehensive Solar Assessment (including Floatovoltaics)	6	5	
5	Install a Mechanical Digester Mixing System in Place of Existing Gas Injection Systems	6	6	
6	Wind	4	4	
7	Purchase a till-n-pak roller assist with planting see after sludge application/ no till drill	3	2	
8	Microturbines	3	3	
9	Biodiesel	2	2	
10	Landfill methane capture & generation	2	0	

#	Project Title	Total Votes	Votes w/o K/J	Notes
11	Microhydro projects	2	1	
12	Refrigerant leak detection	2	2	
13	Mello/Lafranconi (SCADA, PLC)	1	1	
14	Fleet fuel reductions	1	0	
15	Gridz storage	0	0	
16	C pond pump	0	0	
17	Install a 40 HP VFD air compressor in the digester gallery.	0	0	
18	Replace the compost facility's exhaust fans with high efficiency fans	0	0	
19	Replace several high HP pumps with more efficient options	0	0	
20	Replace existing desiccant air dryer for air compressor with new refrigerated air dryer	0	0	
21	Replace the two 50 ton air-cooled chillers and one 60 ton chiller that serve the HVAC equipment at the Administration building with single high efficiency water cooled chiller	0	0	
22	Absorption chillers	0	0	
23	Renewable energy credits (RECs) and other GHG reduction projects	0	0	
24	Sequestration from forestry, peat bogs, and wetlands projects	0	0	
25	LTP solar array	--	--	Consolidated with #4
26	Optimization of delta pump station	--	--	Removed (included in TM #3)
27	Solar panels at pump stations	--	--	Consolidated with #4
28	Run two Cummins engines on natural gas to generate electricity	--	--	Removed (included in TM #1)
29	Poncia/Terri-Linda (SCADA, PLC)	--	--	Removed (already evaluated)
30	Dei south (SCADA, PLC)	--	--	Removed (already evaluated)
31	Tomrose (SCADA, PLC)	--	--	Removed (already evaluated)
32	Delta #2 motor	--	--	Removed (included in TM #3)
33	North pump station reprogramming	--	--	Removed (already evaluated)
34	Install flow meter at Delta Pond pump station	--	--	Removed (included in TM #3)

#	Project Title	Total Votes	Votes w/o K/J	Notes
35	No till drill	--	--	Consolidated with #7
36	Program the SCADA system to divide the flow equally between the pumps whenever the flow requires more than one pump	--	--	Removed (included in TM #1)
37	Widen dead band between cooling and heating set points for compost facility offices	--	--	Removed (already implemented)
38	Install a solar PV system at LTP	--	--	Consolidated with #4
39	Purchase cleaner electricity from PG&E and/or another entity	--	--	Removed (already evaluated)
40	Clean energy purchases (including participation in Community Choice Aggregation program like Sonoma Clean Power Agency)	--	--	Removed (already evaluated)
41	Energy management software	--	--	Consolidated with #2
42	Fleet vehicle fuel-switching, no-idle policy, replacements and upgrades (e.g., hybrids, CNG, and biodiesel)	--	--	Consolidated with #14
43	FOG & Food-Waste-To-Energy	--	--	Removed (already evaluated)
44	Fuel cells	--	--	Removed (already evaluated)
45	GHG offsets	--	--	Consolidated with #23
46	Headquarters Building energy efficiency (e.g., HVAC, lighting, etc.)	--	--	Removed (already evaluated)
47	Joining a JPA or CCA	--	--	Removed (already evaluated)
48	Invest in renewable purchases	--	--	Consolidated with #23
49	Utility-scale wind	--	--	Consolidated with #6

5.6 Scope of Work for Short-Listed Projects

With consensus on the five short-listed projects, KJ asked Santa Rosa staff to further refine what specifically would be investigated for each project in Phase 2 of the EOP. The following are the refined scope of work items for each short-listed project.

5.6.1 Waste Heat Investigation

A. Conduct a heat and use balance study for current conditions.
B. Investigate options to take advantage of excess combined heat and power (CHP) heat generation, and identify alternative uses for the waste heat.
C. Determine if an Organic Rankine cycle system is feasible and cost-effective.

D. Determine the amount of waste heat generated by running idle Cummins engines on purchased natural gas to generate additional electricity (per TM #1 – LTP Energy Audit EEM-6).

5.6.2 Energy Management Software Investigation

A. Determine the ability of the existing Subregional SCADA system to improve energy efficiency, operate the system to minimize energy use, and take advantage of Time-Of-Use rates.
B. Indentify strategies to increase energy efficiency gains (e.g., optimizing for Time-Of-Use rates, identify pumps/motors for First-On-First-Off strategy, and pump optimization).
C. Identify SCADA programming needs to take advantage of identified strategies.
D. Identify cost-effective and necessary additional instrumentation of equipment needed to implement the identified strategies and integrate with the SCADA system, and estimate their capital cost.
E. For the above subtasks, specifically discuss impacts on the operational constraints and on the plant process stability. The decision to pursue any strategy will be the sole purview of Santa Rosa.

5.6.3 Irrigation System Optimization Investigation

A. Analyze existing pressure needs and compare them to current operational practices.
B. Identify what measures, either equipment and/or operational practice changes, would be cost-effective and beneficial for Santa Rosa.
C. For City cost-effective measures, estimate if they are cost-effective for the agriculture sector customers.
D. Work with Santa Rosa staff to identify which irrigation fields and pumps should be tested by Power Hydrodynamics through a separate contract managed by Santa Rosa. For this subtask we are assuming that the Delta Pond pump station and Meadow Lane pump stations will be tested by Power Hydrodynamics (up to 12 pumps). Once the test results are received from Power Hydrodynamics, use KJ's Cost/Savings Template to calculate the cost-effectiveness and estimate the energy savings of each pump tested.

5.6.4 Comprehensive Solar PV Investigation

A. Perform an assessment of flotovoltaics as a new solar PV technology and assess the work already done by the County.
B. Conduct a comprehensive site evaluation study of Santa Rosa-owned sites, prioritize potential sites, and identify three top sites.
C. For the top three sites, determine the cost-effectiveness of solar PV projects using three financing options: Power Purchase Agreement, lease-buyout, and own and operate.
D. Assess the existing solar PV systems (e.g., Alpha Farm 21 kW, Brown Farm 60 kW, LTP 21 kW, LTP roof 50 kW), and investigate potential cost-effectiveness enhancements to

performance, specifically address moving the inverter at the Alpha control building that is currently creating surplus heat.

E. Analyze the interaction and impacts of new Santa Rosa solar PV projects with potential participation by Santa Rosa in Sonoma Clean Power (SCP), specifically looking at net metering, disposition of excess generation, rates, and costs/benefits.

5.6.5 Mechanical Digester Mixing

A. Summarize the existing KJ analysis and design from 2006 for mechanical digester mixing and assess if there are any changes that could further optimize the design.
B. Identify and assess other options, and make a recommendation on the preferred approach for Santa Rosa.
C. Conduct a high level cost estimate for the preferred approach.
D. Estimate the amount of new digester gas production from the mechanical mixing, estimate the change in energy produced and cost from additional mechanical digester mixing compared to only the existing gas mixing system, estimate the value of additional electricity generated using the existing CHP system, and conduct a cost/benefit analysis. For this analysis, use both SCP and PG&E rates with (SCP rates being 3% to 5% lower).
E. Using the analysis for the newly designed high strength waste (HSW) and fats, oils and grease (FOG) system; analyze and estimate the incremental digester gas production attributable to the recommended digester mixing approach.