2020 Energy Management Plan Update

ORANGE WATER AND SEWER AUTHORITY

OWASA is Carrboro-Chapel Hill's not-for-profit public service agency delivering high quality water, reclaimed water, and wastewater services.

Executive Summary

OWASA's Energy Management Program is a comprehensive and inclusive approach to reducing electricity and natural gas use across the organization. Over the past decade, we have made tremendous progress, not just in reducing our energy use and greenhouse gas emissions, but in imbedding energy in our decision-making on capital improvements, operations, and maintenance activities.

The table below outlines our progress against energy management objectives set by the OWASA Board of Directors in 2015.

	Objective	***Progress***	***Annual Avoided Costs (FY20)***	***GHG Reduction***
1:	Reduce use of purchased electricity by 35% by the end of Calendar Year 2022 compared to the Calendar Year 2010 baseline	*Purchased electricity use reduced by 29.4%*	*About $525,000*	*GHG from purchased electricity reduced by 49%*
2:	Reduce use of purchased natural gas by 5% by the end of Calendar Year 2020 compared to the Calendar Year 2010 baseline.	*ACHIEVED: Purchased natural gas reduced by 28%*	*About $40,000*	*GHG from purchased natural gas reduced by 39% since 2010*
3:	Beneficially use all WWTP biogas ~~by 2022~~[1], provided the preferred strategy is projected to have a positive payback within the expected useful life of the required equipment.	*ON HOLD*	*NA*	*NA*
4:	Formally engage local governments and partners in discussion about potential development of a biogas-to-energy project at the Mason Farm WWTP.	*COMPLETED*	*NA*	*NA*
5:	Seek proposals for third-party development of renewable energy projects on OWASA property.	*3 of 5 planned solar lease projects will off-set over 425,000 kWh of purchased electricity, reducing FY20 purchased electricity by 2.7%*	*Year 1 (and all subsequent years): the lease payment will be less than the energy savings*	*Will reduce OWASA's current annual emissions by 3% (142 metric tons/year)*

Our progress is the result of OWASA's three-tiered energy management strategy:
1) Conservation and optimization efforts
2) Investment in cost-effective energy efficiency projects
3) Energy-minded decision-making

[1] In 2018, the OWASA Board of Directors determined that there was no apparent and cost-effective strategy to achieve this goal by 2022. As a result, the OWASA Board abandoned the 2022 deadline, but maintained the commitment long-term.

This year, with the installation of three photovoltaic (PV) solar arrays, OWASA will add a fourth tier to our strategy: renewable energy.

With our natural gas use reduction goal achieved/surpassed and electricity goal within reach, the following Plan celebrates our progress and outlines a series of strategies that have potential to further reduce our use of purchased electricity and achieve our goal by the end of 2022. It also introduces considerations for OWASA's energy management potential beyond 2022.

Background

OWASA uses a significant amount of energy to operate our water, wastewater and reclaimed water facilities, protect the environment, and provide service to about 83,300 residents through about 21,800 customer accounts in the Carrboro-Chapel Hill community. From July 2019 through June 2020[2], our facilities used about 60 billion BTUs of energy – enough to power about 910 average American homes for a year. That energy came at a cost of about $1.1 million, comprising about 5% of our annual operating expenses in Fiscal Year 2020.

By reducing our use of energy and increasing our use of renewable energy sources, we reduce the environmental impact of our operations, lower operating costs, and improve reliability and resiliency of the services we provide.

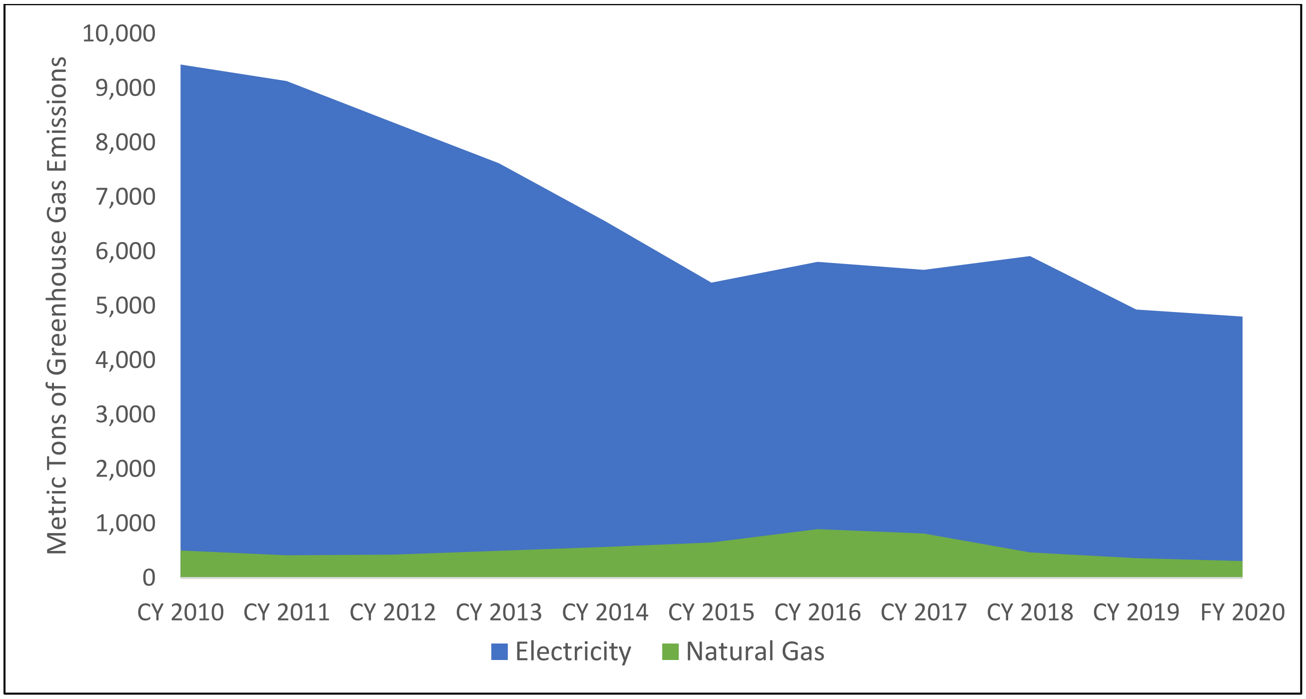
In 2014, the OWASA Board of Directors identified the "Implementation of an Energy Management Program" to be a top strategic priority for the organization. Since that time, with the assistance of OWASA staff, the OWASA Board of Directors has reviewed an assessment of OWASA's energy use, established Calendar Year (CY) 2010 as the baseline year, identified concrete goals and objectives against that baseline, worked with staff to define an energy management program, regularly tracked energy data against the baseline, and developed and approved annual plans in pursuit of the following goals:

Objective 1: Reduce use of purchased electricity by 35% by the end of Calendar Year 2022 compared to the Calendar Year 2010 baseline.
Objective 2: Reduce use of purchased natural gas by 5% by the end of Calendar Year 2020 compared to the Calendar Year 2010 baseline.
Objective 3: Beneficially use all WWTP biogas ~~by 2022~~[3], provided the preferred strategy is projected to have a positive payback within the expected useful life of the required equipment.
Objective 4: Formally engage local governments and partners in discussion about potential development of a biogas-to-energy project at the Mason Farm WWTP.
Objective 5: Seek proposals for third-party development of renewable energy projects on OWASA property.

[2] Please note that, due to the timing of this report's delivery to the OWASA Board of Directors this year, we will be comparing the Fiscal Year of 2020 (from July 2019 through June 2020) to previous calendar years. We are making this change in order to provide an update on a more recent "annual" energy use. However, for purposes of continuity, we will continue to report against calendar year energy use.
[3] In 2018, the OWASA Board of Directors determined that there was no apparent and cost-effective strategy to achieve this goal by 2022. As a result, the OWASA Board abandoned the 2022 deadline, but maintained the commitment long-term.

In the pursuit of these objectives, OWASA is committed to reducing our direct emissions of greenhouse gases. **Since 2010, we have reduced our greenhouse gas emissions associated with our use of purchased natural gas and electricity by 52%,** from 10,663 to 5,113 metric tons per year. A portion of this reduction is due to a decline in the carbon intensity of Duke Energy's generation portfolio. The remaining reduction is due to OWASA's improved energy efficiency and conservation. Figure 1 shows the annual greenhouse gas emissions attributed to OWASA's electricity and natural gas over the past ten years.

Figure 1: Greenhouse Gas Emissions from OWASA's Electricity and Natural Gas Use



OWASA's Energy Management Program is designed to systematically identify and evaluate energy management opportunities and to pursue those deemed to be cost-effective for the organization. (Cost-effective has been defined as having a positive net present value within the rated life of the asset). It is also structured to more directly integrate energy management and clean energy strategies into our everyday decision-making.

The OWASA Board of Directors requested that Staff incorporate the social cost of carbon (SCC) in the business case evaluations of clean energy projects and to base the economic value of carbon emission reductions on the Federal Interagency Social Cost of Carbon Working Group's central value for the SCC. This provides a method for quantifying the societal costs of climate change, including (but not limited to) changes in net agricultural productivity, human health, and property damages from increased flood risk. Using the methodology, we have avoided over $1.3 million of costs to society as a result of OWASA's energy management efforts and Duke Energy Carolina's transition away from carbon intensive energy sources when compared to the baseline year of 2010.

OWASA's Energy Management Program involves staff from across the organization, including a committed group of individuals serving on the organization's Energy Team, as well as numerous partners and stakeholders. Our program employs a comprehensive, systematic methodology for identifying, evaluating, and prioritizing clean energy strategies that will increase the sustainability of our organization and community for years to come. (Appendix A summarizes the criteria that the OWASA Energy Team uses to prioritize clean energy strategies.) Our Energy Management Plan is a result of the collective contributions of all those involved in our Program.

This document serves as an update to OWASA's 2019 Energy Management Plan (EMP), as well as an update provided to the OWASA Board regarding our solar lease project in September 2019. It documents our progress towards our energy management goals and objectives and presents an updated suite recommendations and proposed strategies for further improving our use of energy and reducing our carbon footprint.

The remainder of this document summarizes our progress against our energy goals to-date. It celebrates our successes and identifies a path forward to meet, and eventually surpass, the goals set by the Board of Directors five years ago.

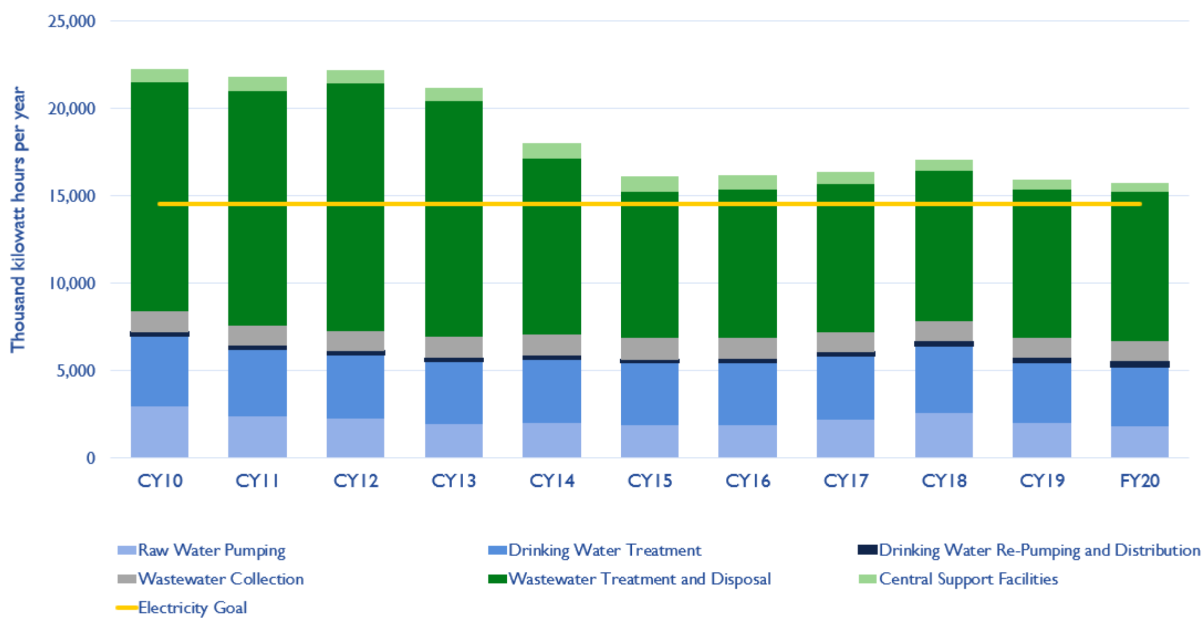
Update and Progress Towards Electricity Use Goals

Reduce use of purchased electricity by 35% by the end of Calendar Year 2022 compared to the Calendar Year 2010 baseline (Objective 1). In support of Objective 1, seek proposals for third-party development of renewable energy projects on OWASA property (Objective 5).

Trends in Electrical Energy Use and Costs

Figure 2 shows eleven years of historical electrical energy use (serviced by Duke Energy Carolinas and Piedmont Electric Membership Corporation) across all OWASA facilities by major functional area. The trend demonstrates a significant and sustained reduction in energy use throughout this time, realized from investments in more energy efficient equipment and processes, as well as water conservation. **In Fiscal Year 2020 (FY20), OWASA collectively used 29.4% less electrical energy than in Calendar Year 2010.**

Figure 2: Electrical Energy Use by Major Functional Area



Our commitment to reducing and managing one of the largest line items in our operating budget has resulted in significant financial savings for OWASA rate payers. In 2010, OWASA was billed $1.26 million for electricity at an average of $0.0575 per kWh. In FY 2020, we were billed $1.04 million at an average of $0.0658 per kWh. In absolute dollars, we spent about $225,000 less on electricity in FY 2020 than in 2010. However, if we had used the same amount of electrical energy in 2020, as we did in 2010, charged at 2020 levels, we would have paid about $436,000 more. This is a more accurate way of calculating our energy cost savings.

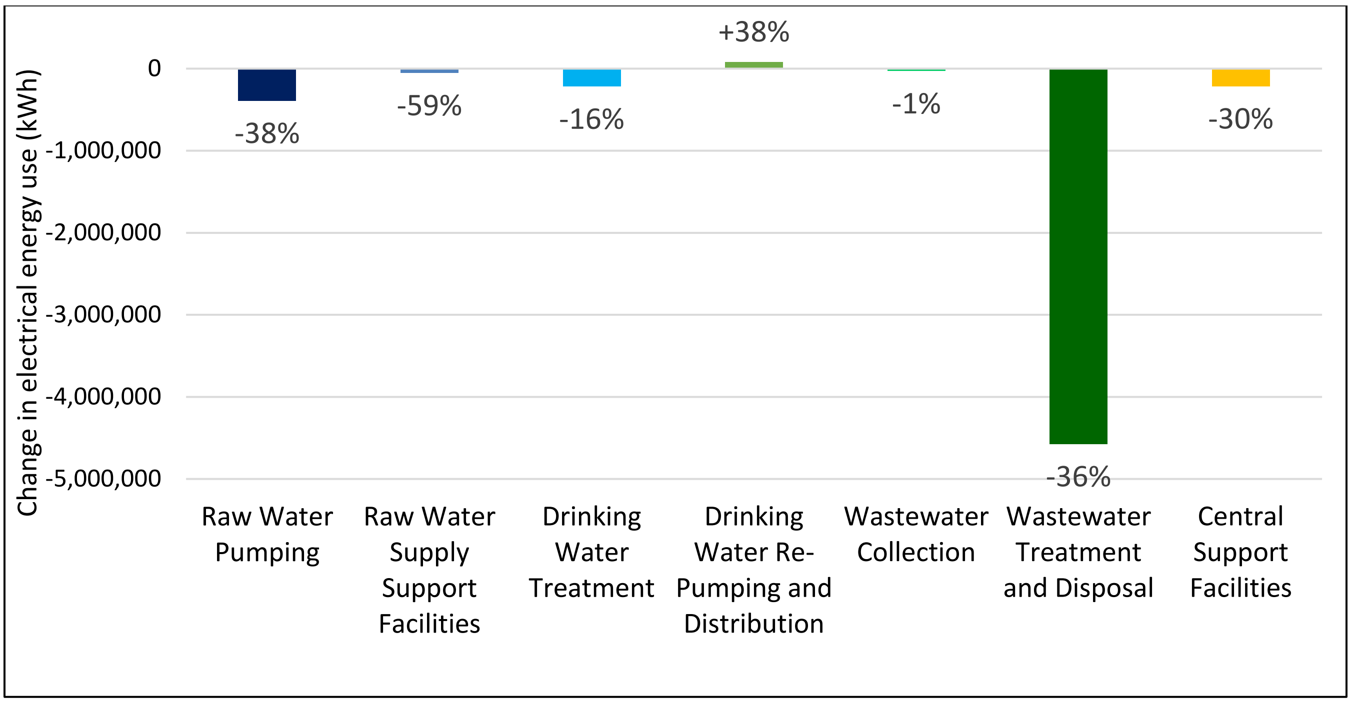
Additionally, as a large commercial/industrial customer, our energy management program includes a detailed and regular analysis of our energy rate contracts. Our avoided costs are lower than what they would have been without these efforts. In other words, we have made changes to our rate structure in partnership with Duke Energy over the last ten years that have brought down our costs per kWh. For example, we adjusted the minimum contract demand for three facilities, which we estimate avoided an additional $13,000 each year in energy costs. Additionally, after a cost-benefit analysis, we opted out of participation (i.e. contribution) in Duke Energy's energy efficiency rider at the Wastewater Treatment Plant, the Cane Creek Reservoir complex, and the Jones Ferry Road campus. These changes effectively reduce our per kWh rate. We estimate this saved OWASA approximately $75,000 last year. Moreover, we intentionally shift demand to off-peak periods when we can to reduce our demand charges.

In sum, through our strategic energy management efforts (energy use reduction; rate modifications; opting out of energy efficiency rider), we avoided about $525,000 in annual energy expenses in FY20.

Summary of Implemented Electricity Management Strategies

Figure 3 shows the change in electrical energy use since 2010, by functional area. The size of the bar represents the change in electrical energy use in kilowatt hours (kWh), while the text within the figure shows the percent change for that functional area.

Figure 3: Change in Electrical Energy Use Since Calendar Year 2010, by functional area



The reductions in our electricity use are attributable to the following projects and practices:

Increase in Aeration Efficiency at Wastewater Treatment Plant (WWTP): The most significant reduction in electrical energy use over the past ten years has been in wastewater treatment and disposal, primarily due to a $8.4 million investment in energy efficient blowers, mixers, and fine bubble diffused aeration system (funded with a 20-year, no interest loan from the NC State Revolving Fund). This capital project has resulted in a reduction of about 4 million kWh/year and represents about an 18% reduction against our 2010 baseline.

Raw Water Pumping Efficiency Upgrade: We've also seen a significant decrease in the amount of energy used for raw water pumping. This is due in part to the installation of a new, low-flow pump and variable frequency drive (VFD) at the University Lake Pump Station which has enabled us to better optimize system-wide raw water pumping across a wide range of demand conditions. The University Lake Pump Station Improvement project cost about $300,000, most of which was funded with an American Reinvestment and Recovery Act grant. We estimate that this project is responsible for a reduction of about 500,000 kWh per year, representing a 2% reduction against our 2010 baseline.

In addition, in recent years, we restored use of the larger water main between University Lake and the Jones Ferry Water Treatment Plant and upgraded the raw water pumps at University Lake. Within the last fiscal year, we have begun to see the impact of this project, further reducing the energy use intensity of our raw water pumping.

Water Conservation and Use of Reclaimed Water: Our customers' water use stewardship has helped to reduce our use of energy across the board, from pumping raw water, treating and delivering drinking water, collecting and pumping wastewater, and treating and disposing of wastewater. In Fiscal Year 2020, we treated about 13% less drinking water than in 2010, despite a 9% increase of customer accounts.

About half of this demand reduction can be attributed to a concurrent increase in reclaimed water demands. Since 2010, we increased our annual production and delivery of reclaimed water from about 195 million to 247 million gallons, which we estimate uses about three-quarters of the energy required to pump and treat raw water from our reservoirs.

Additionally, in 2018-2019, OWASA upgraded all our meters used for billing customers with Advance Metering Infrastructure. This technology allows for early notification of potential leaks. Over the last year, our Agua Vista Web Portal has detected over 17,000 potential leaks.

Moreover, the work of our Distribution and Collections and Engineering Teams to repair and replace leaking and broken water lines help to maintain a minimal amount of water loss in the system. In addition to ensuring reliable water service, this is an important energy management effort.

Given current energy use intensity estimates for finished drinking water, wastewater treatment, and reclaimed water treatment and delivery, we estimate that the reduction in drinking water demand corresponds to an estimated annual energy savings of about 357,000 million kWh per year (about 1.6% of the 2010 baseline).

LED Lighting: We have replaced approximately 80% of our lighting with LED efficient lighting technology. We estimate that this has saved another 350,000 kWh of electricity use (1.5% of 2010 baseline).

Heating, Ventilation, and Air Conditioning (HVAC) Unit Upgrades: As our HVAC equipment reaches the end of its 15-year rated life, we are replacing our HVAC equipment with high-efficiency units. We estimate that through these upgrades, most notably the replacement of the HVAC unit in the OWASA Administration Building, we have reduced our use of purchased electricity by about 200,000 kWh/year (1.0% of 2010 baseline).

Energy-Minded Decision Making: We estimate that the remaining electricity reduction is the result of a suite of energy efficiency projects, such as cool roof installations on buildings, replacement of pumps, motors, and motor controls with more efficient equipment and VFDs, and an on-going commitment to optimization of our operations with energy management in mind.

Organizational Energy IQ: There are also a series of strategies implemented in recent years to improve the energy "IQ" of the organization and integrate energy data into day-to-day decision making. It is difficult to quantify the impact of these initiatives but over time their impact can be significant.

Through the energy management program, we have received outside funding to host two in-depth energy workshops in our facilities. In 2018, the NC State University Industrial Assessment Center funded an expert in pump efficiency from the Department of Energy (DOE) to teach a two-day course at OWASA, using our pump stations as class examples.

Additionally, we have deployed a series of online tools to help inform the maintenance and replacement of our infrastructure with energy in mind. Access to energy data can be a powerful tool for energy savings as well as asset management. For example, using energy use data, we noticed that energy use at the Calvander Finished Water Pump Station had almost doubled (from 7,500 kWh/month to 14,500 kWh/month). Triggered by this dramatic increase in energy use, our maintenance team investigated and found that a check valve was malfunctioning, causing the pumps to work much harder than necessary. Fixing the problem in a timely manner prevented energy waste and protected the health of the pumps.

We are using a dynamic pump optimization tool called Specific Energy that provides real-time information (based on actual pump curves) on the most energy efficient pumping scheme to achieve desired flows. We have deployed this technology with our finished water pump station, and we are proposing its use at more pump stations in this 2020 Energy Management Plan. This resource helps to inform real time energy efficient decision-making by our Operations Team.

Upcoming Electrical Energy Management Strategies

(described in detail in Appendices A and B)

To meet our goal of 35% reduction in purchased energy by 2022, we need to reduce our annual electrical energy use by an additional 1.3 million kWh, another 5.6% percentage points of the 2010 baseline. Each year, our EMP identifies a series of energy management strategies to pursue and evaluate. These plans have provided us with a blueprint and budget for reducing our use of purchased electricity.

Over the last year, we have continued to identify and evaluate new and upcoming energy management strategies.

The following section provides a summary of strategies that have been recently completed, are underway, and are proposed to pursue or evaluate. Table 1 below lists each of these strategies, their estimated electrical energy reduction potential (if enough information is available to develop an estimate), a three-year timeline, cost estimates, and assignment of the responsible party for moving forward with each strategy. Appendix B provides a more detailed description of each one.

Projects recently completed (savings pending): We have recently completed a suite of energy management strategies for which it is too early to fully measure their impact on energy use. **We estimate that these projects will ultimately reduce our use of purchased electricity by at least 105,000 to 160,000 kWh per year (0.5 – 0.7% of the 2010 baseline).**

Projects underway (savings pending): For these energy management strategies currently underway for which we can estimate savings, **we estimate that these projects will ultimately reduce our purchased electricity by at least 441,500 to 626,000 kWh per year (2.0- 2.8% of the 2010 baseline).**

Projects currently in CIP: Of the projects in our CIP, seven have the potential to improve the energy efficiency of our operations. For these projects, the reduction in energy savings is a secondary rather than primary objective. From preliminary information that we have on some of these projects, **we estimate that this suite of strategies has the potential to reduce purchased electricity by at least 188,000 to 302,000 kWh per year (0.9-1.4% of the 2010 baseline)**. These reductions will likely occur post-2022. Other projects are too early in the engineering and design phase to estimate energy savings. (Please note that these projects could be delayed from the projected timeline in the FY22-FY26 CIP.)

Strategies to implement and evaluate/implement: Based on a favorable evaluation against the criteria of OWASA's Energy Management Program, the Energy Team recommends the implementation of three additional strategies in the coming years.

In addition, there are five additional strategies that are recommended for further evaluation. These projects have potential but given current uncertainty about their specific costs and benefits, it is currently unclear if these are viable strategies for OWASA. If the evaluation proves favorable, staff may request funding to pursue these strategies in the FY22 budget.

The most significant strategy proposed to implement is the solar photovoltaic system at Cane Creek Reservoir. Due to budget constraints in FY21, we renegotiated our solar lease agreements for the PV systems planned for the Administration Building, the Operations Center, and our Biosolids Site in order to achieve $0 down payment (beyond what would be covered by a rebate from Duke Energy) and annual lease payments that were equal or less than projected energy savings. Unfortunately, we were unable to achieve this with the Cane Creek Reservoir Solar lease agreement. In the fall of 2020, we will submit an application for a $100,000 grant from the Orange County Climate Action Fund to use for a down payment on this project. With this funding, we can achieve a $0 down payment (when combined with Duke Energy's solar rebate) and lease payments that are less than projected energy savings. (In other words, the cost will be less than what we will save on our energy bill in Year 1).

Without the installation of the Cane Creek Reservoir Solar PV system, we estimate that these projects will reduce our use of purchased electricity by at least an additional 17,500 to 486,000 kWh per year (about 0 – 2.4% of the 2010 baseline).

With the pending installation of the Cane Creek Reservoir Solar PV system, we estimate that these projects will reduce our use of purchased electricity by at least an additional 492,500 to 1.06 million kWh per year (about 2.2 – 4.8% of the 2010 baseline). Installing the Cane Creek Reservoir solar PV system with the help of the Orange County Climate Action Grant will assure that we meet and surpass our goal for reduced use of purchased electricity by the end of 2022.

Table 1: Project Plan for Electricity Management Strategies and Estimated Energy Savings and Costs

Energy Management Strategy	Estimated Potential Energy Savings (kWh)	Timeline and Cost (in $1,000s) Light shading: Study Dark shading: Implement			Project Management
		FY 21	FY 22	FY 23	
Recently Completed (Savings Pending)					
University Lake Pump Station Improvements	80,000 – 110,000				Engineering
WWTP Switchgear Building HVAC Replacement	25,000 – 50,000				Engineering
Partnership for Clean Water Self-Assessment and Optimization	NQ				Team Effort
Underway (Savings Pending)					
Optimize WWTP Filter Backwash	20,000 – 100,000				WWTP Ops
Increase Level of Morgan Creek Wet Well	50,000 – 58,000				WWTP Ops
Reduce WWTP Aeration Foam	21,500 - 43,000				Eng./WWTP Ops
Pump Optimization Tool (Finished Water Pump Station)	TBD	6	6	6	Sustainability/WTP Ops
Pump Station Operational Assessments (277-40)	TBD	80			Engineering
Solar Lease Projects on Admin, Ops, and Biosolids Site	350.000 – 425,000	26	26	26	Sustainability
Analysis of Operational Changes with Odor Control System (WWTP)	TBD	TBD	TBD	TBD	Engineering
Online ORP/Nitrate Monitoring	TBD				WWTP Ops
Currently in CIP (Savings Realized Post-2022)					
Reduction of I&I in Wastewater System (276-17 & 18)	TBD				Eng./Ops/ Sustainability
Building Envelope Rehabilitation (278-68)	TBD				Engineering

Energy Management Strategy	Estimated Potential Energy Savings (kWh)	Timeline and Cost (in $1,000s) Light shading: Study Dark shading: Implement			Project Management
		FY 21	FY 22	FY 23	
HVAC: Equipment Replacement (As needed and >15 years old) (272-51)	50,000 – 52,000				Engineering
SCADA Master Plan (272-49)	TBD				Engineering/Ops
Cane Creek Raw Water Transmission Main (271-05)	TBD				Engineering
Cane Creek Pump Station Improvements (270-16)	138,000–250,000				Engineering
Finished Water Pump Replacement (272-42; 272-54)	TBD				Engineering
WWTP Facilities Planning (Master Plan) (278-75)	TBD (See below)				Engineering
Off-Site Biosolids Mixing Project (TBD)	TBD				Engineering
Implement and Evaluate/Implement					
Solar PV Lease at Cane Creek Reservoir	475,000 – 525,000	27	27	27	Sustainability
Reduce operating speeds at NPW pump station, using pump optimization tool	17,500 – 35,000	17	3.5	3.5	Sustainability/ WWTP Ops
Install pump station energy monitoring at University Lake Pump Station	TBD	30	7	7	Sustainability/ WTP Ops./Asset Mgmt
Install pulsed large bubble mixing at Rogerson Drive PS	75,000 – 107,000	20			Sustainability / WWTP Ops
Install pulsed large bubble mixing in on-site biosolids storage tank	160,000 – 250,000	75			Engineering
Reduce operating speeds at NSL PS, using pump optimization tool	35,000 – 70,000	20	4	4	Sustainability /WWTP Ops
WWTP UV System Energy Assessment	TBD				WWTP Ops and Maintenance
WWTP Non-Potable and Potable Water Conservation	15,000-24,000				Sustainability/ Maintenance

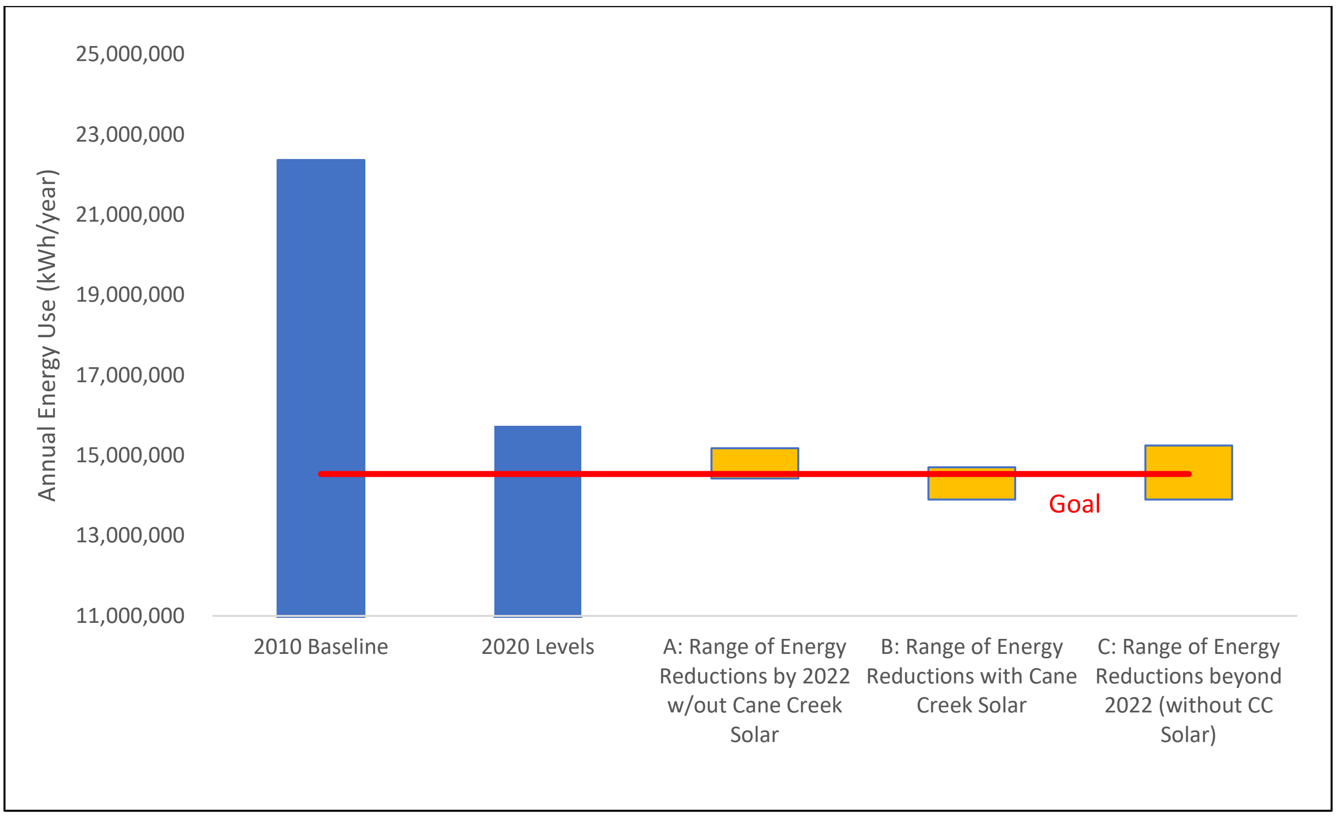
Figure 4 shows the impact of various scenarios for energy management, as described below.

Scenario A assumes that we implement the energy projects currently underway and those proposed to be evaluated and implemented before the end of 2022. The range reflects the range of potential savings. Scenario A assumes that the Cane Creek Reservoir Solar PV project is not installed. Under this scenario, it is highly unlikely that we will achieve our goal to reduce purchased electricity by 35% by 2022.

Scenario B assumes that we implement the energy projects currently underway and those proposed to be evaluated and implemented before the end of 2022 AND that the Cane Creek Solar PV System is installed. In installing the Cane Creek Solar PV project, we are much more likely to achieve our electricity goal by 2022.

Scenario C looks beyond 2022 and incorporates potential energy savings associated with projects currently in the CIP, assuming that the Cane Creek Reservoir Solar PV project is not developed. While promising more energy savings, without the Cane Creek Solar PV system, there is a still a possibility that we will not achieve our 35% reduction goal.

Figure 4: Summary of Progress and Potential Towards Achieving Objectives 1 and 5



Fiscal Year 2022 Proposed Budget: In addition to what is budgeted for projects currently in the CIP, the following is requested in the FY22 budget to pursue evaluation and implementation of the strategies listed above:

- **Operations and Maintenance Budget: $146,700**
    - Online Energy Dashboard: $3,200
    - Pump Station Optimization Start-Up Costs
        - University Lake: $23,000
        - Non-Potable Water: $10,000
        - Nutrified Sludge: $12,000
    - Pump Station Optimization Annual Fees
        - Finished Water Pump Station: $6,000
        - Non-Potable Water: $3,500
        - University Lake: $7,000
        - Nutrified Sludge: $4,000
    - Solar Lease Payments for Administration, Operations Center, and Biosolids Systems: $26,000
    - Solar Lease Payments for Cane Creek Reservoir PV System: $27,000
    - Analysis of pulsed large bubble mixing at Rogerson Drive: $20,000

- **Capital Improvement Plan: $75,000**
    - Preliminary Engineering Report for On-Site Biosolids Storage Tank: $75,000

Although shown as expenses, many of the projects have corresponding energy savings associated with them. If successful, this suite of projects is projected to save OWASA an additional $45,000 to $145,000 in electricity costs per year.

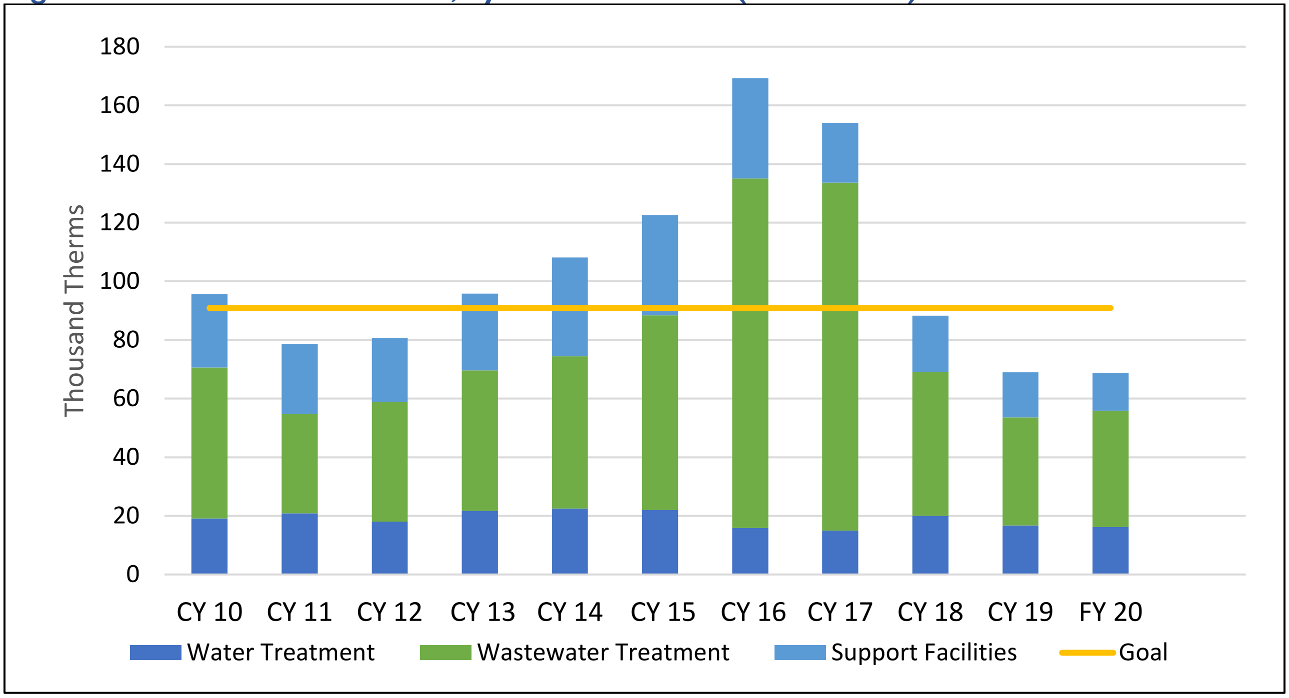
Update on Achievement of Natural Gas Goals

Objective 2: Reduce use of purchased natural gas by 5% by the end of Calendar Year 2020 compared to the Calendar Year 2010 baseline.

Trends in Natural Gas Use and Costs

Figure 5 shows historical natural gas use across the major functional areas, based on monthly billing data for our nine different natural gas accounts over the past nine years and how this use compares to our goal of reducing purchased natural gas by 5% from 2010 levels.

Figure 5: Purchased Natural Gas, by Functional Area (2010 – 2020)



In 2020, we surpassed our 5% goal, using 28% less natural gas than in 2010.

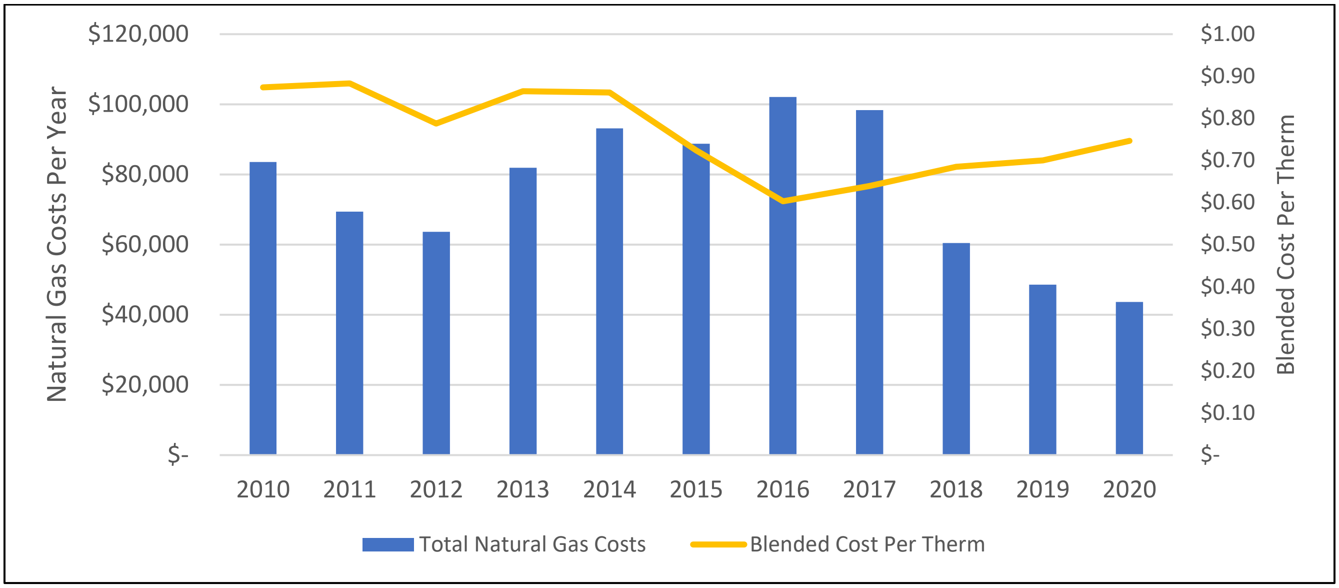
The primary driver for meeting this goal was bringing the biogas-to-boiler system back online at the Mason Farm WWTP, which has historically accounted for the largest amount of natural gas we use. Natural gas is used mostly as a supplemental fuel for running the two boilers that heat anaerobic digestors for solids treatment. Methane – or biogas – is produced as a by-product of the digestion process and under normal operations is used as the primary fuel in our boilers at the plant. However, from 2015 through March 2018, we had to rely almost exclusively on purchased natural gas to heat the boilers while two digesters and our gas storage unit were undergoing major rehabilitation. In restoring the biogas-to-boiler system in March 2018, we reduced our natural gas use at the WWTP by about 70,000 therms per year.

We also use natural gas for space and water heating at our 400 Jones Ferry Road campus. The new HVAC system in the Administration Building significantly reduced our use of natural gas for space heating. This system has resulted in a savings of 7,000 -11,000 therms per year.

In other spaces, adjustments to thermostats, improvements to building insulation, and investment in high efficiency HVAC equipment has further helped to reduce our use of natural gas.

Figure 7 summarizes trends in natural gas costs over the past ten years**. Our natural gas conservation resulted in about $40,000 less in expenditures in FY20 than in CY10.** This conservation will be even more valuable to the organization if and when natural gas prices increase to the levels that they were earlier in the decade.

Figure 7: OWASA's Natural Gas Costs (2010 – 2018)



We are committed to sustaining our reduction in natural gas use and continuing to identify cost-effective opportunities to further decrease our use of natural gas, alongside a reduction in electricity use.

Update on Biogas to Energy Objectives

Objective 3: Beneficially use all WWTP biogas ~~by 2022~~, provided the preferred strategy is projected to have a positive payback within the expected useful life of the required equipment.

Objective 4: Formally engage local governments and partners in discussion about potential development of biogas-to-energy project at the Mason Farm WWTP.

Given financial uncertainties regarding analyzed options to beneficially use all WWTP biogas and the lingering potential for regional collaboration on a more economically feasible project, in 2018, the OWASA Board of Directors agreed to repair the biogas-to-boiler system, support complementary analysis of potential regional partners, and abandon a previously set goal to have a biogas-to-energy project completed by 2022.

OWASA is currently pursuing an update to a Wastewater Treatment Plant Master Plan. Biogas-to-energy, as well as FOG (Fats, Oils and Grease) receiving and co-digestion strategies, will be an important consideration in any update to the Master Plan.

Although, there are no obvious paths forward at this time, we will continue our commitment to identify a cost-effective strategy to utilize 100% of the biogas generated at the WWTP. In the meantime, we will remain diligent in our efforts to utilize half of the biogas produced on-site in the boilers that heat the digesters.

The Future of OWASA's Energy Management Program

With our natural gas use reduction goal achieved/surpassed and electricity goal within reach, OWASA is beginning to think about the next chapter of our Energy Management Program. Over the past decade, we have made tremendous progress, not just in reducing our energy use, but in imbedding energy in our decision-making on capital improvements, operations, and maintenance activities. Ensuring that our progress is sustained will continue to be an important component of our Energy Management Program.

We will also continue to identify, evaluate, and pursue strategies that offer marginal reductions in our energy use through energy conservation and cost-effective investment in energy efficiency projects. Although we have "picked much of the low-hanging fruit," it will be important to maintain a strategic and systematic approach to advancing clean energy at OWASA. We hope that our budget allows for OWASA to continue to think long-term in terms of energy investments and continue to pursue energy projects that will result in positive net present value over the life of an asset.

This will include the eventual evaluation of installing solar PVs on the top of the clearwell at the Jones Ferry Road Water Treatment Plant. This project was originally proposed alongside the other solar projects included in this Plan. However, in a recent inspection of the clearwell, we identified repairs in the roof that are needed before solar PV could be installed. Once these repairs are made, we will reconsider the installation of solar PV on the clearwell. The original design estimated that approximately 220,000 kWh of clean energy could be generated per year from this system.

Additionally, this year, we will begin the process of updating our long-term Master Plan for the Mason Farm Wastewater Treatment Plant (WWTP). The purpose of this project is to update a long-range plan for meeting capacity and nutrient reduction needs in the future. It will also be an important time to consider the energy impact of various strategies and treatment approaches. Last year, we engaged a firm to conduct a high-level assessment of potential energy saving strategies for the WWTP. The consultant proposed a suite of energy management projects that would have a significant impact on the integrated processes at the WWTP. As such, it is recommended that these projects be considered within the larger context of the Master Plan. It is too early to say what will or will not be viable strategies to pursue at the Mason Farm Wastewater Treatment Plant; however, they are noted in Appendix B of this Plan.

Beyond our electricity and natural gas use to power our facilities, OWASA directly uses fuel to operate our fleet and indirectly uses energy in the materials that we use and way that we conduct our business. Staff anticipates that next year's Energy Management Plan will provide recommendations to the Board on continuing and potentially expanding OWASA's Energy Management Program.

Conclusion

OWASA's Energy Management Program is a comprehensive and inclusive approach to reducing electricity and natural gas use across the organization. Through implementation of the program, we have realized and sustained energy use and greenhouse gas emission reductions.

When developing the budget for FY22 for the Board's consideration, staff plans to present options for investing in the evaluation and pursuit of energy management strategies from this Plan.

It is important to note that funding for the strategies included in this plan will be proposed alongside other organizational priorities in future budget considerations. This Energy Management Plan Update is intended to provide a progress update and a plan for what is needed to meet strategic goals established by the Board.

Staff requests approval of the Plan to include projects in the upcoming budgets for the Board's consideration.

In approving the Plan, the Board is asked to approve the overall approach and the potential ahead, if funded. Although, the Energy Management Plan is designed to be cost neutral (at minimum) in the long-term, short term needs may need to be prioritized above long-term strategies.

Appendix A: Strategy Evaluation and Prioritization

Strategies included in the Appendix B summaries were developed from staff expertise, as well as information learned through two recent assessments. OWASA engaged the firm AESC, Inc (Energy Engineering for Utilities and Industry) to conduct a high-level assessment of energy saving potential at the Mason Farm Wastewater Treatment Plant. Projects introduced by this assessment are noted as sourced by "AESC" in Appendix B. In addition, OWASA engaged Kimley-Horn to conduct pump station evaluations. Projects identified through these assessments are sourced as "Kimley-Horn."

As reviewed, discussed, and accepted by the OWASA Board of Directors, the OWASA staff evaluated each strategy qualitatively against the following six criteria (and guiding considerations).

1. Financially Responsible (High level)
   a. Likely a good use of public funds
   b. Financial viability of similar projects in similar organizations and circumstances
   c. Opportunities for outside funding/financing
2. Realistic/Implementable
   d. Degree to which the strategy has been proven at a scale relevant to our operation
   e. Organizational capacity to undertake and manage the project
   f. Reasonable amount of staff time to implement
3. Operational Impacts
   g. Consistent with how OWASA wants to operate
   h. Degree to which strategy helps to resolve an existing or expected problem
   i. Impact on safety, comfort, and productivity
4. Energy/Carbon Reduction Potential
   j. Potential to reduce OWASA's energy use and/or carbon emissions
5. Coordination with Other Projects
   k. Interdependence with other project(s)
   l. Potential to take advantage of economies of scale to save money and/or staff time
6. Community Impacts
   m. Stakeholder enthusiasm
   n. Coordination with community initiatives

After reviewing energy management summaries (See Appendix B), the OWASA Energy Team met on Oct. 13, 2020 to review, discuss, and prioritize each of the energy strategies.

Projects were then categorized as:

Energy Management Projects Recently Completed (1-3)

Energy Management Projects Underway (4-11)

Energy Management Projects Currently in the CIP with Potential to Reduce Energy Use (12-23)

Energy Management Projects to Pursue and Evaluate (24-33)

Energy Management Projects to Consider in Wastewater Treatment Plant Master Plan (34-45)

Energy Management Projects to Delay Until Upgrade (46-53)

Appendix B: Energy Management Summaries – 2020 Update

Energy Management Projects Recently Completed

1. University Lake pump station improvements

In an early phase of this project, we re-activated the use of a parallel 42" water line for delivering University Lake raw water to the Water Treatment Plant. In recent years, we had only used a 24" water line. Due to the decrease in friction in the larger water line, we decreased our energy use intensity (kWh used to pump a million gallons of water)) by about 7%. We estimate that this will save approximately $7-$10 per million gallons pumped when pumping from University Lake (or 85 – 120 kWh per million gallons pumped).

The second phase of the project involved replacing Pumps #1 (200 hp), #2 (200 hp), and #3 (400 hp) at the University Lake Pump Station with two 450 hp pumps with variable frequency drives (VFDs), as well as completely rehabilitating Pump #4. Following this change, we have seen an additional 13% decrease in energy use intensity. We estimate that this will save an additional $6-$8 per million gallons pumped (or 75 – 100 kWh per million gallons pumped).

Historically, the energy use intensity has been lower for the Cane Creek Pump Station than for the University Lake Pump Station, despite being almost 10 miles further from the Jones Ferry Road Water Treatment Plant. Through the improvements made in this project, this should change, which will significantly reduce the overall energy required for raw water pumping.

Estimated Energy Savings: Assuming that we pump approximately 500 million gallons from University Lake ever year, these improvements have the potential to decrease annual energy use by 80,000 – 110,000 kWh and reduce electricity costs by $6,500 - $9,000 in year 1.

2. Switchgear HVAC

In early 2020, we replaced the 6 SEER HVAC system in the Switchgear building with a high-efficiency Liebert Unit. The older unit had reached the end of its useful life.

Estimated Energy Savings: This unit is estimated to save 25,000 – 50,000 kWh per year.

3. Administration Building HVAC

An innovative water-to-water heat exchange (using water from the distribution system for thermal loading and off-loading) in the OWASA Administration Building was completed in early 2019. With over a year of use, we can now document the savings of this project. A comparison of September 2019 through August 2020* energy use data estimated that the new HVAC system is responsible for:

- A 29% decrease in electricity use (a savings of about 145,000 kWh and $12,000 per year), accounting for the increase in energy use and cost for retreating the water returned to the Water Treatment Plant
- A 97% decrease in natural gas use (a savings of 13,600 therms and $15,500 per year)

Energy Management Projects Underway

4. Extend WWTP backwash filter cycles and reduce air scouring frequency

Source: AESC and EMP

Up until recently, the tertiary filters were back-washed and air scoured on a rotating three-day basis so that two filters were washed daily. We are working to reduce frequency of high-energy backwashing and constraining backwash aeration to what is essential to meaningfully filter turbidity and head-loss performance metrics rather than fixed schedule. Energy savings are achieved as the tertiary filter backwash pumps and blowers operate less frequently.

Estimated Energy Savings: Depending on the optimal frequency, savings projected range from 20,000-100,000 kWh/year ($1,600 - $8,000)

Operational Considerations: Staff will take an incremental approach to adjusting cycles. On July 22, 2020, we moved to a 2-1-2 cycle. If that goes well, we will move to a 1-2-1 cycle in the Winter of 2021.

Recommended Next Step: Underway, move to 1-2-1 cycle in Winter of 2021

5. Increase Morgan Creek pump station wet well level

Source: AESC, Kimley-Horn, EMP

The four pumps at the Morgan Creek pump station are each rated at 7,500 gallons per minute (gpm) and 30 feet total dynamic head (TDH), which makes this one of OWASA's most energy-intensive pump stations This strategy involves increasing the wet well level to reduce the lift required for the pump to overcome. The pump station has excess capacity to quickly reduce the wet well level prior to and during a storm.

This change can be made programmatically via the Supervisory Control and Data Acquisition (SCADA) system, and can most likely be done in-house without outside assistance from an integrator.

Estimated Energy Savings: 50,000 -58,000 kWh/year ($3,500/year)

Operational Considerations: On August 19, 2020, Operators increased the wet well level by one foot to 3.5 feet. This adjustment took the water level right below the influent pipe to the station. Shortly after the wet well was increased, we experienced difficulties with the Morgan Creek Pump Station unrelated to this change. Levels were lowered again to troubleshoot the issue. We will be closely evaluating the situation in the Morgan Creek Wet Well.

Recommendation: Attempt raising the wet well levels again once conditions in the wet well are fully evaluated and improved

6. Reduce plant water foam control spray demand

Source: AESC

The existing 5 HP foam pump operates at full speed, 24 hours a day, 365 days per year. The 25 HP plant water pump also operates 24 hours each day, 365 days per year with a VFD. Installing a control to spray only when needed will allow the foam pump to operate at reduced hours and the plant water pump to operate on average at reduced operating speeds thus saving pump energy.

This project is currently underway and will be completed in the Winter of 2020.

Estimated Energy Savings: An assessment by AESC estimated that this has the potential to save 43,000 kWh/year ($2,500/year)

Operational Considerations: Minimizing foam has many benefits for the aeration process. Moreover, there is a safety benefit to installing a fixed spray system, rather than running hoses across the deck of the aeration basins.

Recommended Next Step: Finish project and evaluate impact in 2021

7. Wastewater pump station operational and needs assessments (277-40)

Source: EMP

In 2019, a detailed evaluation of six of OWASA's pump stations was conducted to determine the energy usage of the pumps and the condition of the critical site components. Pump energy usage analysis was based on measured pump performance tests as well as pump speed and operating level data from historical SCADA data. The project objectives were to determine if energy usage could be reduced by making modifications to each of the pump stations and to develop a list of tasks to be completed at each station, based on either improving energy efficiency or the condition of the components. Recommendations from Phase 1 of the evaluations are considered in this plan.

In 2020-2021, we will conduct a similar analysis on six more pump stations (Phase 2).

Pump Station Name	Phase of Evaluation	Annual Energy Use (kWh)	Number of Associated Pumps	Total Associated Horsepower
Morgan Creek	Complete	580,000	4	400
Reclaimed Water	Complete	550,000	4	650
NSL	Complete	440,000	4	300
Lake Ellen	Complete	41,000	2	60
Countryside	Complete	67,000	2	68
Non-Potable Water	Complete	92,000	3	75
Intermediate Pump Stations #1 and #2	Phase 2	400,000	6	330
Rogerson Drive	Phase 2	750,000	4	800
Eastowne	Phase 2	28,000	2	100
Meadowmont #1	Phase 2	22,000	2	30
Heritage Hills	Phase 2	34,000	2	100
Eubanks	Phase 2	41,000	2	100

Estimated Energy Savings: No direct energy savings associated with this project

Operational Considerations: These pump station evaluations have the added benefit of investigating the health of the pump station. Recommendations on operational improvements will be considered by the wastewater team accordingly.

Recommended Next Step: Pursue Phase 2 of Pump Station Evaluations and consider recommendations in FY22 budget and beyond.

8. Solar Lease Projects at Administration, Ops. Center and Biosolids site

Source: EMP

Last year, in order to make progress on the energy goals set by the Board of Directors, we entered into a solar lease partnership with Eagle Solar and Light. Under a solar lease partnership, ESL owns and maintains solar panels on OWASA land and facilities. The energy generated by the solar panels offsets energy used by our facilities. OWASA receives the purchased electricity (kWh) and cost reduction on our Duke Energy bills. This agreement also allows us to take advantage of up to $75,000 in rebates from Duke Energy for each facility with solar panels.

The original locations proposed for solar installations were: (a) rooftop of the Admin Building; (b) rooftop of the Operations Center; (c) top of the clearwell; (d) small portion of a field on our biosolids property; and (e) portion of a field at Cane Creek Reservoir. We subsequently delayed any solar development on the top of the clearwell until needed repairs identified in a recent inspection are made and at Cane Creek due to financial constraints.

The original lease agreements required a down-payment from OWASA and had five-year terms. At the end of the five years, OWASA would have had the option to purchase the system. Given the budget situation for FY21, we worked with ESL to re-negotiate the leases. We re-signed leases that required no additional down payment (beyond the Duke Energy rebate) AND in year 1 (and all subsequent years), the lease payment will be less than the energy savings. In other words, from year 1, these projects will provide a cost benefit (or at least break even) to OWASA ratepayers. These lease agreements have 25-year terms. We have renegotiated leases for the solar PV systems for the Admin Building Rooftop, the Operations Center Rooftop , and Biosolids Field . Unfortunately, we have yet to identify a way that we can pursue the Cane Creek Reservoir installation and meet the goal of no down payment and annual lease payments less than energy savings.

We are now in the final stages of project planning and permitting for the three following solar PV installations. Below is the proposed plan for construction:

1. Biosolids Ground-Mount System: Construction in late-October through late-November (2020)
2. Operations Center Rooftop: Construction in mid-December through mid-January (2021)
3. Administration Building Rooftop: Construction in mid-January through mid-February (2021)

Estimated Energy Savings: Approximately 427,757kWh/year

Operational Considerations: Administration Building Rooftop panels will be installed after the roof replacement is completed. Under the lease agreement, Eagle Solar and Light will maintain the solar PV systems.

Recommended Next Step: Install and evaluate solar PV

9. Recommission odor control system

Source: EMP

The Mason Farm Wastewater Treatment Plan (WWTP) has multiple odor control systems located throughout the plant. Air from various processes in the plant are pumped to chemical and dry media scrubbers. The odor control system is estimated to use approximately 900,000 kWh per year. In 2018, Hazen and Sawyer conducted a high-level balancing assessment of the odor control system that included a review of duct sizing, air intakes, and the ability to appropriately balance the system. As a follow-on, it was recommended that OWASA conduct a recommissioning of its odor control system to ensure that there is balance in the system. This process would help ensure that the odor control system is working as efficiently and effectively as possible. It could also inform settings for changes in operations, to help maintain balance in the system. The potential energy savings that could be realized from commissioning the odor control system are uncertain, but as one of the largest energy-using systems at the WWTP, fine-tuning odor control operations has great potential.

This project is currently underway and the findings from the analysis are pending.

Estimated Energy Savings: TBD

Operational Considerations: The odor control system at the WWTP is an integrated and complex system. It will be important that recommissioning, if recommended, is pursued with a comprehensive systems-thinking approach.

Recommended Next Step: Evaluate the findings of the odor control study and pursue (with caution) recommended adjustments

10. Impact and cost evaluation of operational changes with aeration basin odor scrubbers (WWTP)

Source: EMP

This strategy assesses the costs and benefits of how the dry media scrubber system for the aeration basins is operated. This system alone is estimated to use about 500,000 kWh/year. It is an opportune time to assess the costs/benefits, as it is nearing the time to replace the carbon in the filters (about $50,000 project).

The odor control system was designed to treat the air from all aerated cells, as well as the nitrified sludge (NSL) basins. However, about two years ago, plant staff adjusted how the aeration basins are operated and began aerating two uncovered cells – without a significant change in observed odors by staff or odor complaints from neighbors.

Currently, an engineering consultant is evaluating the effects of decreasing the air flow rates and potentially decommissioning part of the odor control system at the Wastewater Treatment Plant. The intent of the project is to reduce energy usage and redirect existing capacity to parts of the plant where increased odor control is needed.

Estimated Energy Savings: TBD

Operational Considerations: The odor control system at the WWTP is an integrated and complex system. It will be important to approach any recommissioning, if recommended, with a comprehensive systems-thinking approach.

Recommended Next Step: Evaluate the findings of the odor control study and pursue (with caution) recommended adjustments

11. Online ORP/Nitrate monitoring

Source: EMP

Although we have achieved greater energy efficiency in our aeration system at the Mason Farm WWTP, this process still uses approximately 5% of the electricity used at the Plant (approximately 1.6 million kWh per year). Energy is used to power blowers in aerated basins that help to reduce nutrients and organic matter in the water and in mixers, which run in all basins to maintain an environment that supports the necessary biology. The aeration system maintains dissolved oxygen concentrations at optimum levels for the biological treatment process. By optimizing the biological treatment process and aeration system, OWASA could reduce energy and chemical use while improving treatment performance.

In 2020, we installed two ORP (oxidation reduction potential) probes in the back channels of the aeration basins that will help us optimize the biological treatment process and aeration system. These probes have the potential to allow us to turn down the air during the time these back channels are aerated. The data will be integrated into the SCADA system and will allow for real-time "dialing" of blowers and mixers.

Estimated Energy Savings: TBD

Operational Considerations: Control of the aeration system and turndown of the blowers needs to be considered for the mixing it provides.

Recommended Next Step: Monitor and assess the potential to turn down blowers in 5A and 5B channels.

Energy Management Projects Currently in the CIP with Potential to Reduce Energy Use

12. Reduction of inflow and infiltration in wastewater system (276-18, 276-48)

Source: Multiple plans

OWASA regularly conducts preventative and corrective maintenance on our sewer collection system to identify and stop inflow and infiltration (I&I). I&I generates additional flow that needs to be pumped to and treated at the Wastewater Treatment Plant. In reducing I&I, we reduce the energy required to pump and treat this water.

In 2020, we completed a Gravity Sewer Master Plan that included temporary flow and capacity modeling. We have strategically implemented Cured-in-Place-Pipe Lining (CIPP) sewer pipe lining and manhole lining. We have begun a program to monitor pump run times on pump stations in the collection systems and have initiated a program to replace defective lateral caps. We are beginning a comprehensive investigation of I&I in the Rangewood neighborhood.

Data collected from the system will be stored in a newly commissioned dashboard tool to track and trend I&I. Through this series of initiatives, our goal is to target and reduce I&I in the collection system.

Estimated Energy Savings: Difficult to quantify, but it is important to manage energy peaking at wastewater pump stations and the wastewater treatment plant

Operational Considerations: There are a myriad of operational benefits to reducing I&I

Recommended Next Step: Support Asset Manager and Distribution and Collections Team in efforts to reduce I&I

13. Building envelope rehabilitation (278-68)

Source: CIP

This project includes the rehabilitation of building envelope systems (roofs, walls, windows, etc.) at a prioritized set of OWASA's buildings and structures as recommended by a FY 2017 condition assessment. This project has the potential to reduce heating and cooling load on the impacted buildings; however, it is difficult to estimate the energy savings expected from this strategy at this point. Impacts on energy use will be incorporated into decision-making for these projects.

Estimated Energy Savings: Difficult to quantify, but it is important to managing energy used for HVAC to ensure efficient operations

Operational Considerations: Envelope maintenance is required as general maintenance on our buildings

Recommended Next Step: Continue to evaluate and prioritize envelope rehabilitation and consider the energy impacts of such work

14. HVAC: Equipment Replacement (272-51)

Source: CIP FY22-FY23

An assessment conducted through the Energy Management Program recommended the replacement of aging, inefficient HVAC units with more efficient units once they have reached the end of their rated life. The project provides scheduled funding for the replacement of identified HVAC units that are over their rated service life (typically 15 years) with units rated at or above 15 SEER (seasonal energy efficiency ratio). Existing units identified for replacement are listed below:

Unit Location	Potential Energy Savings
Warehouse Office	1,000 kWh/year
WWTP Lab	27,000 kWh/year

WWTP Filter Building 24,000 kWh/year

This project also currently include an update to the control system at the Operations Center and the Water Treatment Plant's administration building.

Estimated Energy Savings: 50,000 – 52,000 kWh/year

Operational Considerations: Proactively replacing HVAC equipment at the end of its useful life, rather than at failure significantly reduces the risk of unexpected failure, which could lead to disruption of operations and higher costs for replacement.

Recommended Next Step: Include energy use reduction as a secondary objective of the project

15. SCADA Master Plan (272-49)

Source: CIP FY 21

This project will evaluate the entire SCADA system at the Water Treatment Plant (WTP) and other water facilities to identify deficiencies, potential improvements, and the development of a phased master plan to ensure optimal performance. Improving our use of SCADA at both treatment plants has the potential to allow for increased and better integration of energy use data into day-to-day decision making.

Estimated Energy Savings: TBD

Operational Considerations: The primary reason for this project is to reduce operational risk.

Recommended Next Step: Include energy use management as an objective of the project.

16. Cane Creek raw water transmission main (271-05)

Status: CIP FY 21

In advance of the planned upgrade of the Cane Creek Pump Station, the Capital Improvement Program (CIP) includes a project in FY21 to evaluate the friction coefficient of the existing 24-inch diameter raw water main from the Cane Creek Reservoir to the Quarry Reservoir. This test will help determine if the main needs to be cleaned to restore its designed carrying capacity. This study and any related follow-up work are planned to be completed prior to initiation of design on the pump station improvements.

Estimated Energy Savings: TBD from improvements in transmission that increases pump efficiency

Operational Considerations: The primary reason for this project is to improve the operations of raw water pumping from Cane Creek Reservoir.

Recommended Next Step: Include energy use reduction as a secondary objective of the project

17. Cane Creek pump station improvements (270-16)

Source: CIP FY23-FY25

Funds are included in the CIP for FY 2023 - FY 2025 for adding automatic generator transfer switchgear, building a permanent enclosure for the generator, and installing variable frequency drives (VFD). An analysis conducted by the NC State University Industrial Assessment Center estimated that the installation of VFDs at the Cane Creek Pump Station could result in a savings of 138,000 – 227,000 kWh per year. Some of these savings may not be available if the Cane creek Transmission main inline generator occurs.

Additionally, the 2017 Energy Management Plan evaluated in-pipeline turbines for hydropower generation and recommended that pursuit of this specific strategy be "delayed until upgrade." This Main Capacity Study is an opportunity to consider current technology and infrastructure upgrades that could be viable for generating in-line hydropower in the raw water transmission line. It has been estimated by previous studies that there is enough flow and fall from Cane Creek Raw Water Main to the head of the Jones Ferry Road Water Treatment Plant to generate about 250,000 kWh/year. The use of inline hydro may be able to offset the cost or need of VFD's at the Cane Creek Pump Station. The project is especially viable if the in-line sleeve valve needs to be replaced as well.

Estimated Energy Savings: 138,000 – 227,000 kWh per year (estimated by NCSU Industrial Assessment Center); 250,000 kWh/year (if inline hydropower is developed)

Operational Considerations: The primary reason for this project is to improve the operations of raw water pumping from Cane Creek Reservoir.

Recommended Next Step: Include energy use reduction as a secondary objective of the project; consider in-line hydro in the alternative analysis for the project

18. Finished water pump rehabilitation and replacement (272-54)

Source: CIP FY23

The WTP uses four pumps (Finished Water Pumps Nos. 4 through 7) to send drinking water from the plant into the distribution system. Finished water pumping is the largest consumer of electrical energy at the WTP. Pumps Nos. 4, 6 and 7 utilize variable frequency drives (VFD) and have pumping capacity ranges from 6 to 10 MGD, from 7 to 12 MGD, and from 3 to 7 MGD, respectively. A VFD is being installed on Pump No. 5 as part of an on-going project (272-42).

The existing VFD for Finished Water Pump No. 6 was installed in 2000. Repair parts for the unit are becoming increasingly difficult to obtain, and recent maintenance problems indicate the need for near-term replacement. Funds are included in FY 2023 for this replacement.

Estimated Energy Savings: TBD, unlikely to be large but an important energy project nonetheless

Operational Considerations: Replaces aging assets

Recommended Next Step: Include energy use reduction as a secondary objective of the project

19. Wastewater Treatment Plant Facilities Planning (278-75)

Source: CIP FY21-FY23

The most recent hydraulic and treatment capacity evaluation of the WWTP was completed in 2010 and determined that the next WWTP capacity upgrade to 18.5 million gallons per day (MGD) would cost $59 million (2010 dollars) but would not be required until at least 2030.

Funds are provided in FY 2021 through FY 2023 to perform an updated capacity evaluation and facility master plan for the WWTP. This project creates an opportunity to consider game-changing ideas and process optimization methods that can improve treatment efficiency and reduce energy use. Moreover, it will allow us to consider if and how co-digestion of high strength organic waste could be incorporated into our operations and allow for a viable biogas-to-energy strategy.

Estimated Energy Savings: TBD

Operational Considerations: Countless possible impacts to operations

Recommended Next Step: Incorporate energy savings as an objective of the Master Plan, expand the consideration of future strategies to include innovative energy-saving projects, and incorporate energy use into the decision criterion

20. Off-site biosolids mixing project (278-88)

Source: CIP FY21

Use of our off-site biosolids storage tanks has increased significantly over the past few years as we work to meet our goal of applying 75% of our biosolids directly to agricultural land as a liquid. The off-site storage tanks serve as a buffer and help us to manage biosolids volumes when conditions (such as weather) do not allow us to apply biosolids directly to farmland. Over the past 12 months, we used over 400,000 kWh to load, unload, and mix biosolids at the off-site storage facility. That was nine times more energy than we used at this facility in 2010.

The FY21 Capital Improvement Program includes funding for an analysis of mixing alternatives for the off-site storage tanks. This request is primarily driven by the need to improve the effectiveness of mixing in the storage tanks; however, it has the added potential benefit of improving the energy efficiency of mixing.

Estimated Energy Savings: TBD

Operational Considerations: The primary reason for this project is to improve the operations of and mixing capabilities in the storage tanks.

Recommended Next Step: Include energy use reduction as a secondary objective of the project

21. WWTP Return Activated Sludge (RAS) pumping improvements (278-88)

Source: CIP FY24-FY25

A FY 2018 evaluation of the WWTP RAS pumping system made several recommendations to improve the reliability of the system:

- Replace aging and obsolete RAS pumps for secondary clarifiers No.1, 2 and 3 with larger design flows
- Installation of piping to allow for rapid connection of a backup diesel pump (to be purchased through future Capital Equipment budget)
- Install new RAS piping between Clarifier Nos. 2 and 3 and the nitrified sludge (NSL) tanks

Funds are included in FY24 and FY25 for completion of recommended improvements.

Estimated Energy Savings: TBD, likely to be minor but still an important energy-related project

Operational Considerations: The primary reason for this project is to improve the reliability of the system.

Recommended Next Step: Include energy use reduction as a secondary objective of the project

22. Intermediate pump station pump/motor replacements (278-93)

Source: CIP FY25

We are currently budgeting to evaluate and replace the pumps and motors in the intermediate pump station at the WWTP in FY25. The pump station evaluation will help to identify energy saving opportunities in this project.

Estimated Energy Savings: TBD

Operational Considerations: The primary purpose of this project is to replace aging assets.

Recommended Next Step: Include energy use reduction as a secondary objective of the project

Energy Management Projects to Pursue and Evaluate

23. Solar lease project at Cane Creek

Two of the five solar projects originally planned have been delayed: the Cane Creek Reservoir 360 kW system and the Clearwell 180 kW system. The Clearwell system has been delayed until repair of the clearwell top can be made. For the Cane Creek system, we were, unfortunately, unable to achieve the simultaneous financial goals of no effective down payment and annual lease payments less than energy savings. In order to achieve the goals, we will require an additional $100,000 to supplement the $75,000 rebate from Duke Energy to put down on the system with a 25-year lease term. We are applying for the Orange County Climate Action Grant Program to make up the difference.

Estimated Energy Savings: 524,406 kWh/year

Operational Considerations: Eagle Solar and Light will be responsible for operating and maintaining the system. It will require more attention to mowing and weed maintenance around the solar array.

Recommended Next Step: Pursue Orange County Climate Action Funding

24. Reduce operating speeds on Non-potable water (NPW) System, using pump optimization tool

Source: Kimley-Horn

This site operates to maintain a pressure in the NPW system without any pressure or volume storage. Reducing the speed at which this site operates will result in energy savings. K-H recommend that we investigate running the pumps at a slower speed, as well as install a hydropneumatics tank to allow for some pressure and volume storage to reduce the amount of time the pumps are required to run at or near full speed.

Estimated Energy Savings: 35,000 kWh/year ($2,200/year) by adjusting the control regime to operate the majority of the time at 85% speed.

Operational Considerations: To accomplish this, programmatical changes will be necessary.

Recommended Next Step: Install Specific Energy to help with this ($13,000 upfront cost + $3,425 annual cost)

25. Pump Station Energy Monitoring and Pumping Optimization Technology at University Lake

In 2020, we upgraded the University Lake Pump Station with two new pumps with VFDs. Additionally, we rehabilitated an older, smaller third pump. There are multiple benefits to installing a pump monitoring system on the University Lake Pump Station.

1) As an essentially new pump station, a pump monitoring technology could help ensure that the pump station is operating as designed.
2) We can develop a baseline on pump health on which we can compare performance for years to come to help in the management of this asset.
3) Raw water pumping is a third largest functional use of energy at OWASA (after wastewater treatment and drinking water treatment and pumping). Installing a pump optimization technology on one of our largest pump stations sets us up to optimize energy use in our raw water pumping for years to come.
4) There are challenges to pumping water when University Lake is at low levels. A tool that monitored pump performance in relation to lake levels could help to better understand the impact of lake levels on pump performance and operations.

Estimated Energy Savings: TBD

Operational Considerations: Multiple benefits (see above)

Recommended Next Steps: Pursue Specific Energy technology for University Lake Pump Station (estimated cost: $23,000 set-up fee + $7,000 annual fee)

26. Retrofit aeration blowers with high efficiency inlet filters

Source: AESC

The secondary treatment basin receives air from the (4) 250 HP Turblex blowers rated at 5000 scfm to deliver low pressure dissolved oxygen to the activated sludge process. The blowers are staged based on dissolved oxygen (DO) content in the aeration basins. Each blower utilizes a standard filter on the air inlet, which may be replaced with a higher efficiency model. Pressure drop at this filter is significant and adds to the blower load. Blower savings are estimated at 2% from the reduced filtration pressure drop.

Currently, we use MERV (minimum efficiency removal value) 11 filters in the blowers.

Estimated Energy Savings: 46,000 kWh/year ($2,700/year)

Operational Considerations: Estimated implementation costs are $16,000

Recommended Next Step: Evaluate the feasibility and cost of using high efficiency inlet filters.

Update: Given the layout of our blower building, we are not able to retrofit the blowers to use high efficiency inlet filters. This project will not work for OWASA and is not recommended to pursue. The potential energy savings and costs have been removed from the report.

27. Install Pulsed Large Bubble Mixing in Rogerson Drive Pump Station

Source: AESC

The purpose of this measure aims to reduce the energy demand associated with the pass-through of dissolve sulfide, sBOD and Ammonia-N generated in the collection system that is added to in-plant processes.

The sequential large bubble mixing system provides bursts of air radially through narrowly spaced twin plates fixed to the floor of the wet well. This burst radiates a broad plate of air outward, which induces formation of a large bubble (3-4 feet in diameter) into the liquid at the bottom of the Rogerson Drive PS wet well. Mixing is created via the buoyant force of the massive bubble rising through the liquid. The upward velocity of the bubble both pushes and pulls water through the column by creating pressure at the top of the rising bubble, and vacuum below the bubble as it rises.

Additionally, at the moment of the "burst," the air provides a shallow, intense hydraulic shock wave outward across the floor of the tank. This hydraulic shock wave essentially helps to jar any organic sediments off of the floor and into the flow of water coming in towards the bubble. This dual moment of energy prevents the accumulation of lighter sediments, keeping all but the densest solids (such as rocks and heavy grit) in suspension. These otherwise settled organics currently ferment creating both odors and sulfides, reduced generation will improve the corrosive environment that currently exists.

Aside from the mixing function, sequential large bubble mixing provides additional benefits in a wide variety of applications. While major benefits are seen in the tanks using the SLB Mixers, several benefits are realized in downstream processes and effluent quality. The basic categories of benefit are:

- Energy-efficient mixing
- Low maintenance effort
- Prevents sediment accumulation
- Increases active tank volume
- Eliminates septicity associated with sedimentation

- Increases biological activity and efficiency in activated sludge
- Reduces solids loading rate to secondary clarifiers
- Reduces RAS pumping requirement
- Reduces filter loading and backwash
- Reduces chorine demand or UV energy demand

The floor-mounted bubble ejection plates are typically secured to the existing concrete bottom of the wet well without any significant retrofitting. The large bubbles do not strip any significant H2S because of their surface area ratio. The robust mixing action eliminates accumulation of sediments and floating grease, which would otherwise contribute to septicity and H2S generation, thus it actually reduces nuisance conditions and maintenance requirements.

Estimated Energy Savings: 107,000 kWh/year ($6,000/year)

Operational Considerations: Currently, grit mixing system does not work well at RDPS. This strategy could help with this. According to Wil, SGWASA utilized a similar technology, and it worked well.

Recommendation: Study – work with vendor (Pulsed Hydraulics) to evaluate further (Budget for working with AESC to help evaluate impact: $20,000)

28. Install pulsed large bubble mixing in on-site biosolids storage tank

Source: AESC

Currently, we use a 128-horsepower diffused air mixing system in the onsite biosolids storage tank. This system includes a fixed coarse bubble diffuser grid located near the floor of each of the biosolids holding tanks (fed by the blowers used for aeration). The system is operated intermittently prior to scheduled removal of the material. Due to settling between operation, transfer pumps are used to recirculate material to supplement the current system. Nonetheless, material still accumulates, and the tanks are taken off-line for cleaning about twice per year.

AESC recommended a pulsed large bubble mixing system. The sequential large bubble mixing system provides bursts of air radially through narrowly spaced twin plates fixed to the floor of a tank or vessel. This burst radiates a broad plate of air outward, which induces formation of a large bubble (3-4 feet in diameter) into the liquid at bottom of tanks and vessels. Non-aerated mixing is created via the buoyant force of the massive bubble rising through the liquid. The upward velocity of the bubble both pushes and pulls water through the column by creating pressure at the top of the rising bubble, and vacuum below the bubble as it rises. As the large bubble rises through the tank, it creates micro-currents along the sides of the bubble which creates latent eddies to enhance the mixing effect.

Aside from the mixing function, sequential large bubble mixing provides additional benefits. While some of the benefits are seen in the tanks using the SLB Mixers, several benefits are realized in downstream processes and effluent quality. The basic categories of benefit for the Biosolids Storage Tank are:

- Energy-efficient mixing
- Low maintenance effort
- Prevents sediment accumulation
- Increases active tank volume

The floor-mounted bubble ejection plates are typically secured to the existing concrete bottom of the wet well without any significant retrofitting. Further analysis of the existing operation should be evaluated to determine feasibility.

In 2018, CDM Smith conducted a business case analysis of replacing the current system with a more effective hyperboloid mixer. (They also analyzed the operational costs and benefits of running the current diffused air mixing system continuously.) In their analysis, they estimated that the current system uses about 300,000 kWh/year assuming our current intermittent operating strategy. (If it ran continuously, it would use approximately 839,000 kWh/year.) Assuming the same intermittent operating strategy, CDM Smith estimated that two new 30-hp gear-driven hyperboloid mixers would use about 140,000 kWh/year. The up-front cost for the new mixers is estimated to be approximately $410,000.

On energy costs alone, a hyperboloid mixer was not recommended. The Energy Team recommends that a hyperboloid mixer be considered when operational needs require the upgrading of the biosolids storage tank mixing system. That time seems to be now.

Estimated Energy Savings: 160,000 – 250,000 kWh/year ($9,600 - $15,000/year)

Operational Considerations: A new system would likely be more reliable, relieve the demands on the main aeration system, and reduce the impact of mixing equipment on the odor control system.

Recommended Next Step: Budget for a Preliminary Engineering Review of alternative mixing strategies for the on-site biosolids tanks ($75,000)

29. Reduce operating speeds at Nutrified Sludge site, using pump optimization tool

Source: Kimley-Horn

This site currently operates the majority of the time in the 65% to 80% speed range. Adjusting the speed of this station to operate more slowly will result in energy savings. The slowest practical speed available is 60%. K-H recommend OWASA investigate the implications of adjusting the program regime to bias the pumps towards the lower end of the practical speed range. Care should be taken to make sure program changes do not negatively affect treatment processes.

Estimated Energy Savings: 35,000 -70,000 kWh/year ($4,400/year)

Operational Considerations: Unsure about what the impact of this change would be on the process; we need to conduct more analysis

Recommendation: Study; if potentially viable, consider Specific Energy to help with this ($15,000 upfront cost + $4,100 annual cost)

30. Wastewater Pump Station Energy Monitoring and Pumping Optimization Technology (Specific Energy)

Source: Multiple sources

The 2019 Energy Management Plan recommended the installation of a pump station optimization technology, Lift Station Guardian (LSG) on at least one wastewater pump station. This product is similar to the pump optimization tool because it conducts a pump performance analysis (monthly rather than daily) and provides recommendations on when the cost of pump repair or replacement is less than energy savings. LSG conducts high resolution monitoring of lift station behavior to track pump health and support preventative maintenance decisions. Our current practice is to run a pump to failure provided we have pumping system redundancy. This can be a challenge under current situations where it may take up to 16 weeks to replace a pump. Knowing ahead of time when a pump might fail could help us get ahead of this.

Upon further study, it was determined that the Lift Station Guardian was not a viable technology for our facilities. Instead, we requested a series of quotes for Specific Energy Optimization technology. When aligned with recommended control strategies from Kimley-Horn's evaluation, there are two pump stations for which we should consider installation of Specific Energy Technology from an energy perspective: the Non-Potable Water (NPW) Pump Station and the Nutrified Sludge (NSL) Pump Station.

Pump Station	Annual Energy Use (kWh/year)	Pump Station Evaluation	Cost of Specific Energy Installation and Annual Fee	Recommended Control Strategy Relevant to Pump Speed	Estimated Savings
Knolls	25,000	No	$8,100 + CITI + $1,500 (annual service fee)	NA	
Meadowmont #1	21,000	Phase 2	$8,100 + CITI + $1,500 (annual service fee)	TBD	
Morgan Creek	265,000	Phase 1	$11,700 + CITI + $4,208 (annual service fee)	Optimization and 2 pumps running	13,500/yr ($810/yr)
NPW	296,000	Phase 1	$9,900 + CITI + $3,425 (annual service fee)	Optimization	35,000 kWh/yr ($2,100/yr)
NSL	420,000	Phase 1	$11,700 + CITI + $4,100 (annual service fee)	Slowest practical speed	70,000 kWh/yr ($4,400/yr)
RCW	520,000	Phase 1	$11,700 + CITI + $5,150 (annual service fee)	None without hydropneumatics tank	
RDPS	795,000	Phase 2	$11,700 + CITI + $5,600 (annual service fee)	TBD	
Countryside	70,000	Phase 1	TBD	None	
Lake Ellen	50,000	Phase 1	TBD	None	

Estimated Energy Savings: See recommendations above regarding NPW and Nutrified Sludge (NSL) pump station monitors

Operational Considerations: Assuming the process can handle changing the speed, it should have minimal negative impact on operations and measurable improvements on pump health

Recommended Next Step: Pursue Specific Energy technology for the NPW pump station, and perhaps the NSL pump station (see cost estimates above)

31. UV system optimization

Source: CIP

The UV Disinfection System at the Wastewater Treatment Plant is estimated to use about 5% of the annual electrical energy use at the WWTP (about 400,000 kWh per year). Currently, our UV banks are flow-paced (banks and lamps turn on and off, depending on the flow), and we use high-efficiency light bulbs. Although we are measuring the transmissivity of the water, it is not directly being used to control the system. If we can incorporate a real-time transmittance information and control system, we could potentially turn down the UV system light intensity automatically when it is not demanded by the water quality. Additional investigation is needed to determine if this is possible and cost-effective given our existing UV system.

The City of Grand Rapids, Michigan moved from an exclusively flow-paced UV disinfection system to one that incorporated real-time monitoring of percent ultraviolet transmittance (%UTV) and light intensity. They reduced energy use of the system by 65%. A 65% reduction in the amount of energy that we use for UV disinfection would reduce energy use at our WWTP by an estimated 210,000 kWh per year, but we don't yet know if we could achieve this level of savings.

Estimated Energy Savings: TBD; relevant case studies site a 65% reduction in energy used for UV disinfection

Operational Considerations: Minimal, but could increase the complexity and automation of UV System; Very important to consider and evaluate the impact on reclaimed water quality

Recommended Next Step: Evaluate further

32. Wastewater Treatment Plant water conservation: potable and non-potable

Source: EMP

Non-potable water (i.e. NPW; wastewater treatment plant effluent) is re-used throughout the Mason Farm WWTP for various processes that require water and can be met with non-drinking quality water. The current NPW system provides process water throughout the plant and runs underground. While we have metered total NPW use for a little over a year (we use about 360,000 gallons of NPW each day), we do not meter it on a process level.

Additionally, there is opportunity to assess and reduce the use of potable water at the Mason Farm Wastewater Treatment Plant. OWASA expends 2,356 kWh for every million gallons of water treated. With an annual demand of 16.4 million gallons of annual water demand, this water use accounts for over 38,000 kWh of energy.

Estimated Energy Savings: We anticipate a 30% reduction in NPW energy use from the new pumps and the NPW water use reduction from the new rotary drum presses for solids, taking energy use from the system from about 11,500 kWh per month to 8,000 kWh per month for an annual savings of about 40,000 kWh. Assuming water conservation could reduce pump run time by 25%, the energy use of the NPW system could be reduced another 24,000 kWh per year.

Operational Considerations: Metering NPW water would increase knowledge of operations at the WWTP and would help to identify potential sources of NPW system leaks and efficiencies

Recommended Next Steps:

- Once new rotary drum thickeners are installed, meter NPW use throughout the plant to help quantify the amount of water lost to leaks
- Audit NPW water uses for water conservation opportunities (cost to audit the water system and repair)

Energy Management Projects to Consider in Wastewater Treatment Plant Master Plan

33. Pure Oxygen Infusion at Rogerson Drive Pump Station

Source: AESC

This measure offers an innovative alternative to current aeration technology utilizing high velocity engineered nozzles to create clouds of micro nano-bubbles to be utilized upstream of the treatment facility. Delivering supersaturated oxygen and other gas-water solutions through high velocity nozzles creates "clouds" of micro-nanobubbles which optimize remediation or wastewater treatment, biological activity and wastewater odor management. The recommended measure neutralizes dissolved sulfide and would create an aerobic environment to prevent downstream generation of sulfide, ammonia-N and volatile acids which contribute to significant corrosion, add to the oxygen-energy demand at the treatment plant and increases the toxicity to the activated sludge process. This measure proposes to reduce organic loading to the treatment facility through integration at Rogerson Drive pump station.

The micro-nanobubble solution enables oxygen to remain in the solution up to weeks without measurable loss to off-gassing. This process combines enhanced dissolution capabilities and patented high velocity nozzles for superior oxygen transfer efficiency delivering up to 40x more dissolved oxygen than conventional aeration. The micro nano-bubbles oxygen-water emulsions range from a few nanometers to microns in diameter, resulting in a reduced rate of rise, and minimizing losses to off gassing. This increases the time that dissolved oxygen is available for stabilizing aerobic conditions, biological processes, chemical treatment and environmental remediation.

Estimated Energy Savings: Estimated at 143,000 kWh/year

Operational Considerations: Rapid dissolved oxygen delivery is effective in preventing conditions that produce odors and health hazards; Inline injection could potentially assist in reducing sewer pipe corrosion; Low operating costs, minimal operator requirements; Increased positive biological activity, enhanced organic sludge reduction, oxidation of various contaminants; Micro-nanobubbles' low buoyancy reduces off gassing; The micro nano-bubble process results in enhanced solubility and gas transfer efficiency, making higher concentrations available, providing more interface surface area and extended time in solution. It combines for better biological activity, chemical reactions or emulsification of various contaminants; Potential elimination the operation of "Peacemaker" odor control system

Recommendation: Consider in WWTP Master Plan

34. Develop side stream treatment for digester filtrate

Source: AESC

Digester filtrate is a major energy load to the Biological Nutrient Removal (BNR) system. The digester filtrate is blended at the BNR entrance with primary influent flow. Digester filtrate is highly concentrated with Ammonia-N, creating a large biological load that the BNR aeration system must remove. The digester filtrate also creates alkalinity demand and pH fluctuation which affects stability of the activated sludge process causing them to carry excess bio-solids. This all adds to energy demand for basic treatment, oxidation of excess solids and mixing of excess tank volume. It is recommended to install a side treatment system which can specifically target the biology of the digester filtrate. The side treatment would include NanO2 Oxygen infusion and bio-augmentation in a spare tank, specific location to be determined. The recommendation not only reduces the activated sludge aeration load but also reduces chemical cost (pH control and acetic acid) and provides better process balance for downstream systems.

Estimated Energy Savings: Estimated 330,000 kWh/year

Operational Considerations: Multiple operational considerations

Recommendation: Consider in WWTP Master Plan

35. Chemically enhanced primary treatment in headworks

Source: AESC

A semi-standard practice is to add 8-20 mg/L ferric chloride and 0.1-0.5 mg/L cationic polymer to raw sewage entering the plant. This increases solids removal across primary clarifiers. Additionally, the recommendation allows higher hydraulic loading rate and reduction in number of tanks in service which translates to reduced pumping energy and potentially creates redundancy in the system. The increased removal of solids in the primary means reduced pass-through of particulate and colloidal BOD, which reduces blower energy in BNR system. Iron salts also promote biological fermentation, which could enhance the performance of the fermenter, when returned to service. As a potential future side benefit an increase in digester gas should be expected from this measure, this would be impactful if OWASA pursued generation technologies utilizing digester gas as the fuel or considered in other co-generation studies currently under consideration.

Estimated Energy Savings: 129,000 kWh/year

Operational Considerations: Multiple operational considerations; Could help to minimize solids, if we go down to two clarifiers.

Recommendation: Consider in WWTP Master Plan

36. Bioaugmentation of Primary Fermenter

Source: AESC

It is recommended to add selected bacterial cultures to produce specific, desired volatile fatty acids (VFAs) in the secondary treatment basin. The goal is to reduce or even eliminate casual production of toxic VFAs that negatively impact nitrifying bacteria yet increase biological oxygen demand and thus the load on the blowers. Through generation of the correctly balanced VFAs there would also be a significant reduction in the chemical costs needed to maintain process specifications (i.e. caustic to balance pH when over producing nitrification). If an aeration train can be removed from service, there would be additional energy savings from no longer needing to operate the associated mechanical mixers.

Estimated Energy Savings: 49,000 kWh/year

Operational Considerations: Multiple operational considerations

Recommendation: Consider in WWTP Master Plan

37. Secondary Treatment Ammonia Based Aeration Control, Pulsed Bubble Mixing and Oxygen Infusion

Source: AESC

The plant currently utilizes dissolved oxygen (DO) measurement and fixed setpoint control for aeration sequencing. DO control is a proxy to ensure that biological processes are occurring but often results in over aeration and/or chemical utilization. Activated sludge mixing is mostly achieved using submerged Invent hyperboloid mixers in each zone. The plant has three activated sludge aeration trains, each with four zones which can be used as either aerobic or anoxic zones, as needed. Utilizing an active monitoring system such as ammonia-based aeration control will reduce energy associated with excessive aeration blower and mixer demands. Ammonia-based aeration control (ABAC) is a feed-forward and feed-back cascade control concept for controlling total ammonia nitrogen (NHx-N) in the secondary treatment process. Its main goals are to tailor the aeration intensity to the NHx-N loading and to maintain consistent nitrification/denitrification, to meet effluent limits but minimize excessive energy consumption. The time interval for nitrification and denitrification phases is based on real time measurements of NH4-N and NO3-N in the SBR tank. Understanding both NH4-N and NO3-N levels in the treatment basin ensures the correct level of DO for the nitrification stage and prevents nitrate exhaustion causing orthophosphate release during the denitrification state or untreated nitrate harming the total nitrogen compliance and reducing settling efficiency. This improves floc formation and settling. This increases treatment capacity and will likely support removal of one BNR train from active service during dry-weather months, eliminating energy wasted in mixing of excess volume. Should the wastewater eventually have a specific ammonium and total nitrogen limit, functionality can be built into the control strategy to allow priority to be given to a particular parameter, giving the plant maximum compliance protection and improved treatment flexibility.

The function of the pulsed large bubble technology is to improve overall mixing and gain full function of tank volumes for secondary treatment. Large bubble mixing will eliminate "dead zones" on the floor and in the corners of the tanks (~10% of tank volume). It will also eliminate toxicity and oxygen demand associated with septic sludge accumulating on the floor of the tanks and gain full treatment activity.

The sequential large bubble mixing system provides bursts of air radially through narrowly spaced twin plates fixed to the floor of a tank or vessel. This burst radiates a broad plate of air outward, which induces formation of a large bubble (3-4 feet in diameter) into the liquid at bottom of tanks and vessels. Non-aerated mixing is created via the buoyant force of the massive bubble rising through the liquid. The upward velocity of the bubble both pushes and pulls water through the column by creating pressure at the top of the rising bubble, and vacuum below the bubble as it rises. As the large bubble rises through the water, it creates micro-currents along the sides of the bubble which creates latent eddies in the column of water. These eddies spin the mixed liquor in anoxic and aerobic zones. It also entraps diffused air bubbles in the aerobic zones, causing the small aeration bubbles to linger in the water, and continue oxygen transfer to the activated sludge. Additionally, at the moment of the "burst," the air provides a shallow, intense hydraulic shock wave outward across the floor of the tank. This hydraulic shock wave essentially helps to jar any organic sediments off the floor and into the flow of water coming in towards the bubble. At the water surface, the velocity gradient moves any foam away from the middle of the tank and towards the outer perimeter, where it is usually pulled back into the water, or where may be removed. This helps to keep the surface of the tank clear of foam and debris that can harbor undesired organisms, such as Nocardia. Oxygen infusion offers an innovative addition to current aeration technology utilizing high velocity engineered nozzles to create clouds of micro nano-bubbles to be used in combination with the current aeration blowers. Delivering supersaturated oxygen and other gas-water solutions through high velocity nozzles to create "clouds" of micro-nanobubbles which optimize remediation or wastewater treatment, biological activity and wastewater odor management.

Below is an overview of the key characteristics and benefits of this measure:

• The micro-nanobubble solution enables oxygen to remain in the solution for prolonged periods without measurable loss to off-gassing. The SOTE of infused oxygen is not constrained by tank depth as there is virtually no rate of rise. This process combines enhanced dissolution capabilities and patented high velocity nozzles for superior oxygen transfer efficiency delivering up to 40x more dissolved oxygen than conventional aeration. The micro nano-bubbles oxygen-water emulsions range from a few nanometers to microns in diameter, resulting in near-zero rate of rise, and minimizing losses to off gassing. This increases the time that dissolved oxygen is available for biological processes, chemical treatment and environmental remediation.

• Rapid dissolved oxygen delivery effective in preventing conditions that produce odors; SOTE approaching 95% with a rated alpha factor of 1.0.

• Low operating costs, minimal operator requirements

• Increased biological activity, enhanced organic sludge reduction, oxidation of various contaminants

• Micro-nanobubbles' low buoyancy virtually eliminates off gassing

• The micro nano-bubble process results in enhanced solubility and gas transfer efficiency, making higher concentrations available, providing more interface surface area and extended time in solution. It combines for better biological activity, chemical reactions or emulsification of various contaminants.

Estimated Energy Savings: 610,000 kWh/year ($36,700/year)

Operational Considerations: This strategy will be a key consideration in efforts to reduce nitrogen levels in effluent.

Recommended Next Step: Consider in WWTP Master Plan

38. Convert Aeration Basin(s) to Simultaneous Nitrification / Denitrification

Source: AESC

In combination with installing Ammonia-based aeration control (see strategy above), it is recommended to utilize a simultaneous Nitrification Denitrification (SNdN) control strategy. Biological nitrogen removal from wastewater typically happens through aerobic nitrification (from ammonia to nitrate) and anoxic denitrification (nitrate to nitrogen gas). If conversion is directly from ammonia to nitrogen gas, there is less oxygen required, reduced air demand and therefore less energy consumed. SNdN technologies can produce reuse quality effluent and meet the most stringent nutrient limits given the right flowsheet and appropriately sized diffused aeration systems. Additionally, with nitrification and denitrification taking place in the same tank, resulting process can provide an "oxygen credit". Depending on the extent of denitrification, it is possible to recover more than 50% of oxygen consumed for ammonia oxidation.

As the most common challenge to getting the full benefit from SNdN is turndown of equipment and process monitoring. Systems must be equipped with enough aeration turndown and similar process turndown. The Mason Farm WWTP appears to have adequate turndown in its aeration equipment. Automation should properly control oxygen delivery to efficiently hit operator adjustable set-points. Consistent nitrogen removal can be achieved and tight limits with ammonia-N below 1 mg/l and TN below 3mg/l in conventional activated sludge systems.

Estimated Energy Savings: 430,000 kWh/year

Operational Considerations: This strategy (in combination with ABAC – see above) will be a key consideration in efforts to reduce nitrogen levels in effluent.

Recommended Next Step: Consider in WWTP Master Plan

39. Convert Dewatering and Sludge Handling to Thermal Vacuum Desiccation System

Source: AESC

The thermal vacuum desiccation (TVD) system pasteurizes, lyces and dries sludge to an increased control point, typically in the range of 85-98% TS. The system uses thermal (steam) vacuum and dehydration to produce dried solids with low emissions, high-energy efficiencies and where applicable pathogen kill. In a single operation involving two stages, the liquid waste is first dewatered under pressure and then dried under vacuum. While the DryVac unit appears physically similar to standard plate filter presses, the actual plates are replaced by DryVac Elastic Envelope Modules (DEEMs). These modules expand and contract according to pressure/vacuum being applied either externally or internally. The system can make use of waste heat and is an excellent heat sink for potential waste heat from power generation technologies (for example internal combustion engine). This could allow the DryVac unit to operate with or in the absence of the digestion system. The estimated energy savings are assumed to be in the absence of digestion, energy savings are also achieved by no longer running the existing dewatering equipment.

• Stage One: the dewatering takes place in a very similar way as with the rotary press. That is, conditioned sludge is pumped into the sludge chambers, which are lined with filter cloths; solids are retained in the press while liquids are forced out.

• Stage Two: is where the DryVac process differs from standard filtration presses. In the drying stage, low-pressure steam is used to inflate the DEEMs and, at the same time, a vacuum is applied to the filtrate ports. During this process the cells lyse to release biophysically held water and the cake is squeezed as the DEEMs inflate. The application of heat to the filter cake and the pulling of a vacuum on the filter chamber result in the remaining water being vaporized at low temperature. The walls of the expanding DEEMs remain in contact with the sludge ensuring effective heat transfer. By regulating the duration of the drying stage, the dry solids of the end product can be accurately controlled. Because the cake is much drier (~90-95% TS) than with a conventional press, at the end of the drying cycle the solids drop out easier, leaving the DEEMs relatively clean. The net benefit here is a significantly reduced solids handling cost while still being able to land apply the dried solids cake and therefore no penalty in disposal related costs.

Estimated Energy Savings: 570,000 kWh/year

Operational Considerations: AESC reports that Thermal Vacuum Desiccation meets the UW EPA 503 regulations for Class A biosolids. Staff have expressed concerns/have questions about the viability of this strategy given current infrastructure. Staff also doubts the capital costs projected for this project ($1.7 million).

Recommended Next Step: Consider in WWTP Master Plan

40. Implement Solids Retention Time (SRT) Control removing Secondary Clarifier

Source: AESC

The plant currently utilizes a dissolved oxygen control for aeration sequencing. With only infrequent monitoring of treatment constituents, energy is wasted with extended mixing and aeration cycles, over-processing and delay in cycle-time control. Utilizing recommended ammonia-based aeration control (38) and simultaneous nitrification denitrification (39) along with solids retention time (SRT) control improves overall BNR performance and minimizing energy demand. SRT is a process measure used to control the mass of biology in the BNR. It is often controlled longer than is necessary, sometimes greater than 20 days, causing excessive energy demands as bio-solids oxidize in the BNR rather than downstream in the digester(s). Automating this process, typically in the 8-10 days range, will reduce the number of oxidizing bio-solids which create added BOD thus demand on the aeration blowers and creates added solids production in the secondary clarifiers. It is preliminarily estimated that adequate SRT control would result in needing to operate only one secondary clarifier. This would reduce the energy required for the system. Furthermore, it would give the plant extra redundancy and reduce wear and tear on the equipment, improving its life expectancy and associated maintenance and replacement costs.

Estimated Energy Savings: 112,000 kWh/year

Operational Considerations: Current plant infrastructure and control limitations are significant to achieve tighter controls

Recommended Next Step: Consider in WWTP Master Plan

41. Install 1 MGD Reflective UV Treatment Chamber Train

Source: AESC

Reflective chambers enhance UV efficacy so that it is possible to achieve greater dosage with lower wattage. Reflective chamber light systems capitalize on UV light "bouncing back" through the water multiple times until absorbed by the intended targets rather than concrete walls. This required significantly lower source light, source power, and overall energy consumption. The existing UV system operates well at high and medium plant loading. However, the existing UV system has minimal turndown capability for low load operation and has operational deficiencies when attempting to trim beyond the system capability. Overall, the UV system demonstrates excellent UV transmittance (UVT) specifically calibrated to 254 nm and with many years of quality remaining life expected. Therefore, it is recommended to install a trim UV treatment chamber train. The recommended system will provide matched capacity during low load operation and has a better UVT performance. It is estimated that energy savings will be achieved for approximately 40% of the annual operating hours.

Estimated Energy Savings: 114,000 kWh/year

Operational Considerations: Staff have questions on the cost viability of this strategy, considering that it is likely to require extensive construction.

Recommended Next Step: Consider in WWTP Master Plan

42. Convert Trickling Filtration Beds to EQ Basins

Source: AESC

This measure proposes to utilize the existing trickling filters system as the primary means for equalization. The trickling filters are estimated at a total capacity of 1,000,000 gallons. This measure would serve to reduce treatment plant power by improving the organic loading through controlled hydraulic loading when conditions allow for utilization of the recommended equalization (EQ). The existing infrastructure to facilitate this measure does exist but will need to be extensively overhauled to ready them as equalization basins. The cost could be significant to modify the trickling filters to EQ basins, the specifics of this cost has not been evaluated in detail. Although the facility could greatly improve from EQ capacity this may not make economic sense, especially with other recommended measures supporting the balancing of organic and hydraulic loading.

Estimated Energy Savings: 80,000 kWh/year ($4,800/year)

Operational Considerations: An EQ basin would provide significant benefit to operations on a day-to-day basis. However, the cost would be great.

Recommended Next Step: Consider in WWTP Master Plan

43. Install High Efficiency Digester Mixing System

Source: AESC

This project suggests replacing one 45HP digester gas mixing pump and connected distribution nozzles with a submersible mixing device internal to the digester. The new mixers will be equipped with real-time intelligent controls to adjust speed to save energy and avoid cavitation. Additionally, the fully adjustable mixers increase redundancy and mixing energy across the tank while maximizing tank turnovers to increase biogas production. The new mixers allow the operators to adjust the height and angle from outside the tank and allows for easy access for mixer inspection and maintenance without the need to remove the digester from service. It is proposed to replace the existing mixing pumps with a more efficient internal, submersible mixing system. The new mixing system would be approximately 10HP, while maintaining or exceeding the number of daily turnovers required by the site.

Estimated Energy Savings: Estimated 220,000 kWh/year

Operational Considerations: Multiple operational considerations

Recommended Next Step: Consider in WWTP Master Plan

44. Install Organic Rankine Cycle (ORC) Power Generation Unit Utilizing Digester Gas

Source: AESC

The WWTP utilizes anaerobic digestion to treat biosolids. The digestion process produces digester gas as a co-product of the system. Digester gas is used as the sole fuel source for the hot water boilers that provide heating to the digester solids. Approximately 50% of the produced digester gas is used in the boilers. Excess digester gas is flared, providing minimal benefit to the facility nor larger societal benefit. OWASA has previously evaluated many alternatives to utilize the digester gas in the hope of identifying a useful and cost-effective option. To date a viable option has not been identified. It is recommended for further investigation into an Organic Rankine Cycle power generator. Preliminary analysis is presented in this report for a 240kW output system with an estimated simple payback of approximately 11 years.

Estimated Energy Savings: Estimated 1,610,000 kWh/year

Operational Considerations: Multiple operational considerations

Recommended Next Step: Consider in WWTP Master Plan

Energy Management Projects to Delay Until Upgrade

45. Install Hydropneumatic Tank on WWTP NPW System

Source: Kimley-Horn

Installation of a hydropneumatic tank may reduce the amount of time that the pumps are in operation because they are trying to maintain pressure. Additional investigations are required to determine sizing and whether a significant savings can be realized.

Estimated Energy Savings: TBD

Operational Considerations: A hydropneumatic tank would better regulate pressure in the system and improve operations.

Recommendation: Delay until upgrade/technology advancement

46. Install VFDs on Treatment Plant Odor Scrubbers

Source: AESC

The WWTP is equipped with a 40 HP Main Odor Scrubber Fan and a 25 HP Biofilter Foul Air Fan. The odor exhaust fans are used to remove potentially harmful build-up of H2S gas. The exhaust fans operate full speed 24 hours per day with fixed damper positions throughout the exhaust collection system. It is recommended to install a VFD on each of the exhaust fans as well as H2S meters with a feedback loop controlling the VFD speed. The fans could operate at reduced speeds depending on the measured H2S PPM in the space.

It is recommended to have multiple H2S meters for each fan and the meter with the higher PPM reading would dictate the speed of the fan. The dampers throughout the exhaust collection system could be set to the fully open position to remove unnecessary pressure drops in the system. Sizable energy savings can be achieved as the power draw of the fan is proportional to the cube of the speed, according to fan affinity laws. The auditor used an exponent of 2 rather than 3 to be conservative, with the understanding that the third power is theoretical.

Estimated Energy Savings: 198,000 kWh/year ($11,900/year) – if partnered with projects that reduce foul air flow

Operational Considerations: This strategy has potential energy savings if foul air flow is reduced through other measures. Currently, increased air flow is needed. Staff is skeptical about the efficacy of the technology.

Recommendation: Delay until upgrade/technology advancement

47. Install Pony Blower for Secondary Treatment

Source: AESC

The secondary treatment basin receives air from the (4) 250HP Turblex blowers rated at 5000 scfm to deliver low pressure dissolved oxygen to the activated sludge process. The blowers are staged based on dissolved oxygen (DO) content in the aeration basins. Each blower is capable of turn down to 45% capacity. It is most common for the aeration demand to require either one or two blowers to run at a time. During the site visit one blower was operating at minimum turndown (45% capacity) and a second blower was operating at approximately 80-85% capacity.

It is not recommended to install a pony blower at this time as there appears to be adequate turndown capacity with implementing the recommended measures in this report that impact aeration load. It is conservatively forecasted that with implementation of other measures to turn down aeration needs, a single blower would operate at near minimum turndown. It is recommended to monitor the aeration blower performance to appropriately determine the future relevance of a pony blower.

Estimated Energy Savings: Unknown

Operational Considerations: Staff is unsure about the viability of this strategy given current infrastructure and controls on aeration system.

Recommended Next Step: Delay until upgrade

48. Install Sludge Density Meter in Digester

Source: AESC

Monitoring of the inlet sludge density will improve control of sludge concentration and heat demand in the digesters. The sludge concentration will, through a feedback loop, dictate the pumping rate and temperature control thereby reducing the amount of cold water entering the digester and reducing pumping rates. Heating demand on the boiler would be reduced thereby maintaining a greater available volume of digester gas, this would be beneficial if a viable utilization of digester gas is implemented in the future.

Estimated Energy Savings: 66,000 kWh/year

Operational Considerations: In 2020, we will be installing new rotary drum thickeners, and we will not be able to judge sludge thickness. Staff is skeptical about the efficacy of current technology.

Recommended Next Step: Delay, continue to monitor technology

49. Upsizing the impellers at Morgan Creek Pump Station

Source: Kimley-Horn

Upsizing the impellers has the potential to offer savings up to approximately $5k per year. Combining this with other alternatives could increase the savings even more. If OWASA needs more capacity or needs to replace an impeller, K-H recommend considering upgrading the impellers and then reevaluating the station to determine the optimum speed ranges to operate in based on test results with the new impellers.

Includes installing full diameter impellers in each pump. This option would also be coupled with other options to maximize efficiency but without test data from a new impeller, combined scenario calculations are not possible.

Estimated Energy Savings: 60,000 kWh/year ($5,000/year)

Operational Considerations: Unknown

Recommendation: Delay until upgrade

50. Install additional hydropneumatics tanks on Reclaimed Water (RCW) system and on-site at UNC

Source: Kimley-Horn

The reclaimed water station operates to maintain a pressure range with limited volume/pressure storage. Adjusting the controls regime does not result in a very significant energy savings under any scenario. The greatest energy savings is to adjust the controls such that the largest pumps run more often than the smaller pumps, but this is estimated to only save approximately $2,500 per year. Installing additional storage in the RCW system would allow for a reduction in the amount of time that each pump is in operation and would allow for more flexibility to adjust the pumps so they operate in a more efficient range. The intent of the additional hydropneumatic tank would be to "buffer" the RCW station from fluctuations in demands, resulting in less frequent starts/stops. Furthermore, the hydropneumatic tank and/or elevated storage to meet system demands and pressures, reducing pump run times and energy consumption.

Estimated Energy Savings: Unknown

Operational Considerations: This strategy would help to manage pressure fluctuations in the reclaimed water distribution system.

Recommendation: Delay until upgrade

51. Water tank-mounted micro-wind turbine

Source: EMP

The 2017 Energy Management Plan considered the installation of large-scale wind turbines and found such an approach for OWASA unviable given the generally low average wind speeds in our region. However, micro-wind turbines have recently emerged as potentially promising for installation on elevated water tanks. The installations would be relatively simple and for water tanks with associated or nearby energy use, could help offset small but continuous energy needs. These turbines (such as this https://www.halo.energy/technology) are relatively small, 20-kW installations with the potential to generate 8,000 – 15,000 kWh per year. They are designed to take advantage of the wind tunnel created by the round shape of the tank itself. It is estimated that a unit would cost about $20,000 to purchase plus installation costs. Although the generation potential is relatively small, the Energy Team recognizes the unique nature of this renewable energy generation potential and recommends additional analysis of a potential pilot application at the Nunn Mountain Elevated Tank.

Estimated Energy Savings: TBD, relatively small

Operational Considerations: Minimal, relatively new technology

Recommended Next Step: Monitor technology and evaluate upon upgrade

52. Use batteries to improve system resilience, reduce energy costs, and utilize renewable energy

Source: EMP

According to Bloomberg New Energy finance, the price of a lithium-ion battery dropped 73% since 2010, due in part to technology improvements and economies of scale. We are approaching a time where batteries could be used to provide back-up power for small pump stations, which would potentially be a more resilient approach than mobile generators for managing power outages. Moreover, when partnered with renewable energy generation, batteries can provide options for significantly reducing our use of purchased electricity and evening out our demand on the grid.

As OWASA considers power resiliency for the future, the Energy Team recommends that analysis of what situations and at what price points do batteries become a viable option for system resiliency, energy cost reduction, and renewable energy integration in OWASA's operations. In particular, the Energy Team recommends that the upcoming study of diesel fuel capacity needs at our pump stations include a consideration of the incorporation of batteries for back-up generation needs (particularly at smaller pump stations).

Evaluations for Cane Creek solar system were completed this year, but there was no cost competitive way to add batteries as of yet.

Estimated Energy Savings: TBD

Operational Considerations: Potential to avoid deploying mobile generators when power is out

Recommended Next Step: Monitor technology and evaluate upon upgrade