MEMORANDUM
Honouliuli Wastewater Treatment Plant
State Land Use District Boundary Amendment Petition
Department of Environmental Services, City and County of Honolulu

Date:	June 28, 2019
To:	Mr. Curtis T. Tabata Matsubara, Kotake & Tabata 888 Mililani Street, Suite 308 Honolulu, Hawai'i 96813
From:	Mr. Jim Niermann R. M. Towill Corporation (RMTC) 2024 North King Street, Suite 200 Honolulu, Hawai'i 96819 (808) 842-1133
Purpose:	Climate Change Analysis and Sustainability Principles for the Honouliuli Wastewater Treatment Plant (WWTP) State Land Use District Boundary Amendment (SLUDBA) Petition TMK: (1) 9-1-069: 003 and 004; (1) 9-1-013: 007
Prepared By	Mr. Jim Niermann, RMTC Ms. Michelle Marchant, RMTC Ms. Roxanne Lee, RMTC
Enclosure	*City and County of Honolulu Carbon Footprint Study for the Honouliuli Wastewater Treatment Plant Secondary Expansion*, Prepared for R. M. Towill Corporation, Prepared by McGovern McDonald Engineers, June 4, 2019

The following is a statement and analysis for climate change and sustainability principles for the Honouliuli WWTP based on the Land Use Commission's draft amended rules, §15-15-50(24) and (25). This information is provided in support of a Petition for a State Land Use District Boundary Amendment and a Motion to Amend Decision and Order A88-627 for the Honouliuli WWTP.

> *(24) A statement and analysis pursuant to section 226-109, HRS, addressing climate change related threats to the proposed development and proposed mitigation measures. The statement and analysis shall address, but not be limited to, the following issues:*
>
> (A) *The impacts of sea level rise on the proposed development;*

EXHIBIT "7"

The Honouliuli WWTP site elevation ranges from 25 to 40 feet above the mean sea level (MSL). This property is above the potential 0.3 to 1.5 feet sea level rise impact and should not be affected through 2050. Even though the site will not be affected immediately, the City and County of Honolulu (CCH) recognize the threat of climate change as well as sea level rise and will address these impacts during the design phase in accordance with appropriate standards and regulations.

(B) Infrastructure adaptations to address the impacts of climate change including sewer, water and roadway improvements;

The proposed improvements will be designed to meet all applicable International Building Code (IBC) and Federal, State, and CCH requirements. Improvements will include the use of vegetated bioretention facilities or swales to attenuate peak storm water flow leaving the property, recharge local groundwater, mitigate stormwater pollution and maintain ecological function of the site. Other infrastructure adaptations will include a back-up power supply that would be available at the facilities to help prevent Sanitary Sewer Overflows during emergencies and power outages. Permeable pavements will be considered to encourage rainfall infiltration and reduce storm water runoff.

(C) The overall carbon footprint of the proposed development and any mitigation measures or carbon footprint reductions proposed; and

The proposed project would have a short-term air quality impact from emissions caused by construction activities. Mitigation measures during construction will incorporate best management practices (BMP) to minimize visible fugitive dust emissions. After construction, operation of the Honouliuli WWTP will have an increase energy demands on fuel and electricity. To mitigate increased energy consumption, the proposed project would include an upgrade to the standby power capacity and an increase in mobile source operation due to the plant expansion and an increase in wastewater treatment capacity. The Department of Environmental Services (ENV) is contemplating implementation of an energy-saving combined heat and power (CHP) system, which recovers energy by using digester biogas. Digester biogas is a byproduct of the WWTP operations and is an available on-site resource. A CHP system that uses digester biogas would be consistent with CCH's sustainability and climate protection strategy which recommends beneficial use of digester biogas as an alternative energy source. A CHP facility would require permits according to State and Federal air regulations. The system selected for the expansion project is expected to offset approximately 35% of the total power used by the plan, which will prevent about 9,300 metric tons/year of anthropogenic CO_2

equivalent emissions. The system can capture up to 3,600,000 BTU/hour of high grade heat equivalent to 1,054 kW.

Other alternative energy technologies that were considered feasible to mitigate energy demands at the Honouliuli WWTP include:

- Solar Photovoltaic (PV) – Converts energy from the sun to electricity. Photovoltaic panels are proposed to be installed on the roofs of all the new Support Facilities as part of the expansion. The power generated is expected to offset approximately 28% of the power consumption required by these facilities, ultimately preventing over 2,800 metric tons per year of anthropogenic CO_2 equivalent emissions.
- Solar Thermal – Converts thermal energy from the sun to heat potable water for domestic uses.
- Methane Recovery Projects – This is covered by the CHP system, which recovers all biogas (methane) generated by the plant.
- Fuel Efficient and Alternative Fuel Vehicles - The plant, following the lead of others in Hawaiian counties has the goal to have all electric vehicles by 2035. Electric vehicle recharging will be provided for the City vehicles as well as the public.
- Compact Building Design – Minimize energy use of Support facilities by providing energy and water efficient fixtures and educate staff and public on sustainable practices.
- Transportation Alternatives – Install bicycle racks, showers, and other amenities to promote bicycle use by employees and visitors

Alternative energy technologies that were considered not to be feasible include:

- Wind Power – Not recommended due to lack of wind at the Honouliuli WWTP.
- Solar Thermal (Process hot water) – Not necessary if the CHP unit is installs, which would supply primary process heat needs at the Honouliuli WWTP.
- Solar Thermal (Sludge drying; land area and sludge quantity dependent) – Utilizes energy from the sun to dry biosolids without the use of supplemental fossil fuels. Includes a drying bed inside a greenhouse that maximizes solar energy while protecting biosolids from precipitation. Requires a large area
- Biosolids (Fluid bed incinerator) – Produces insert ash from a combustion reaction that occurs in the presence of excess oxygen. The digestion/CHP option is preferred due to high capital, O&M costs.
- Biosolids (Gasification) – Converts coal and other biomass to a fuel gas (syngas). The digestion/CHP option is preferred due to high capital, O&M costs and a potential need for supplemental fossil fuel consumption.

A Carbon Footprint Study for the Honouliuli Wastewater Treatment Plant Secondary Expansion (June 2019) was prepared by McGovern McDonald Engineers and is enclosed with this memorandum. The study concluded that without considering the emissions avoided by including PV Generation and Co-Generation (CHP System), the Secondary Treatment Expansion Project would have increased anthropogenic emissions of the plant by 18,788 CO2e metric tons/yr., or 230%. However, because these sustainable alternatives were considered during the design, the net increase in emissions is only 83%. Considering that the level of treatment, population, flow, and loads to the plant are also increasing during the project time period, this value is expected. The Environmental Impact Statement for the Secondary Treatment Expansion came to the similar conclusion that there was an expected increase in the GHG emissions associated with the WWTP expansion project. However, given its global effects, such a typical infrastructure development project would unlikely cause any meaningful global warming effects.

(D) The location of the proposed development and the threats imposed to the proposed development by sea level rise, based on the maps and information contained in the Hawai'i Sea Level Rise Vulnerability Adaptation report and the proposed mitigation measures taken to address those impacts.

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), the Honouliuli WWTP site is located in flood zone D and X. The property also ranges from 25 to 40 feet above MSL. This area is at low-risk for inundation and sea level rise hazards. However, the proposed project will plan for future sea level rise and climate change adaption during the design phase. Planning efforts will be made to align with the State and City policies and regulations. This will also support several recommendations provided by the Hawai'i Sea Level Rise Vulnerability Adaptation report such as supporting sustainable and resilient land use and community development.

(25) A statement and analysis addressing the proposed development's adherence to sustainability principles and priority guidelines and climate change issues as contained in section 226-108, HRS, the Hawai'i State Plan (sustainability), and smart growth principles, including, but not limited to:

(A) Walkability;

The proposed project is to expand and upgrade the Honouliuli WWTP in order to provide higher level of wastewater treatment for an improved quality of effluent that is discharged. A plan for future bike path/ pedestrian walkway is proposed along the east boundary of the WWTP facility outside of the fence line. The pathway will be a public multi-use path that is proposed to be developed by others within the OR&L right-of-way.

(B) Accessibility to alternate forms of transportation;

Other than the proposed new access points and driveway, the proposed project will also include a new 14-foot wide bike lane (10-foot wide lane with 2-foot wide shoulder on each side) adjacent to the new driveway near Geiger Road. This will provide bicycle access from Geiger Road and connect to the Leeward Bikeway system, which runs north of the project site along the OR&L right-of-way. The new bike lane will be constructed in a future phase of development. There is also a proposed multi-use pedestrian and bicycle perimeter path that will include safe crossings at all project driveways. The WWTP facilities will include the installation of bicycle racks to encourage employees to bicycle to work.

(C) Transit oriented development opportunities;

The closest proposed Rail Transit station to the project is East Kapolei Station, located more than a mile northwest of the Honouliuli WWTP. The Honouliuli Rail Transit Project will traverse through the Honouliuli sewer basin and possibly encourage higher density, transit oriented development in the vicinity of the proposed stations.

(D) Green infrastructure, including water recharge and reuse and water recycling;

The proposed project will incorporate green infrastructure and green building practices. This includes the Honouliuli Water Recycling Facility (HWRF) which produces reclaimed water from secondary treated wastewater effluent. The HWRF facility can produce R1 water for irrigation and reverse osmosis water for industrial purposes. The proposed upgrades and expansion to the WWTP and HWRF support development of a dual water source and distribution system for non-potable water by expanding the treatment of WWTP effluent for water reclamation and reuse. Other feasible green infrastructure may include the energy-saving CHP system and the other alternative energy technologies that were mentioned in the statement/ analysis for (24) (C).

Byproducts of the plant such as pellets from secondary solids can be reused as fertilizer or contribute to H-Power. The proposed WWTP improvements will also implement permanent BMPs strategies such as storm water infiltration basins and vegetated conveyance swales to retain storm water onsite and minimize non-point source pollution from storm water runoff.

(E) Mitigation of heat island effects; and,

The proposed WWTP upgrade and expansion will use energy-efficient facilities and equipment (see response for [25] [D]). The proposed project will incorporate green infrastructure and practices such as using a light color for the buildings surfaces in order to reduce the heat island effect.

(F) Urban agricultural opportunities.

Currently, there are no agricultural uses on the project site due to various soil limitations. However, the proposed new facilities would be landscaped after construction. Native Hawaiian plants species will be used for landscaping whenever possible. Honouliuli WWTP will also produce R-1 recycled water that can be used for irrigation.

City and County of Honolulu
Carbon Footprint Study for the Honouliuli Wastewater Treatment Plant Secondary Expansion

Prepared for: R. M. Towill Corporation

By: McGovern McDonald Engineers

DRAFT REPORT

June 4, 2019

Contents

1.0 Summary

1.1 Background

The City and County of Honolulu (CCH) owns and operates the Honouliuli Wastewater Treatment Plant (HIWWTP). R.M. Towill Corporation (RMTC) is currently leading a consultant team in designing the expansion of the secondary treatment system and ancillary support facilities. The secondary expansion facilities are located on both the existing HIWWTP site, and also on an undeveloped parcel adjacent to the existing site. A portion of this undeveloped parcel is currently designated for agricultural use. As such, a State Land Use District Boundary Amendment (SLUDBA) petition must be obtained to change the land use zoning for the site.

One of the requirements of the SLUDBA petition is to address environmental impacts, climate change, and adherence to sustainability principles, including an assessment of Greenhouse Gas (GHG) emissions. This includes addressing priority guidelines and climate change issues as contained in Section 226-108, HRS, the Hawaii State Plan (Sustainability), and smart growth principles.

This report provides an assessment of the environmental impact, specifically the emissions of greenhouse gases, of the treatment plant expansion. Additionally, the emissions of the existing plant and the emissions of the fully completed plant were assessed to provide a basis of discussion of mitigation measures should it be determined that the impact of the development will have meaningful global warming effects.

1.2 Regulatory Framework

The Honouliuli Wastewater Treatment Plant Secondary Treatment and Support Facilities project will expand the plant to the North and East of the existing plant. Some of the expansion includes Land Use area that is designation for Agricultural Use. In order to expand the plant into this area, Honouliuli WWTP is pursuing a SLUDBA Petition for the Secondary Treatment and Support Facilities. The new facilities that are part of the expansion area mainly consist of Support Facility Buildings, retention basins, and half of the secondary clarifiers. An additional area of the existing plant that consists of the Influent Pump Station, Screenings, and Headworks Odor Control System, is also being included in the Petition, as it was previously designated as an Agricultural Land Use District. These areas are shown as red shading within the bold black area in Figure 1.

Figure 1 - State Land Use Area District Map.

1.2.1 Compliance with State Law

The sections of the Hawai'i State Plan that are most relevant to the proposed project are Section 226-108 [13]:

> **CHAPTER §226-108, HAWAI'I REVISED STATUTES – SUSTAINABILITY**
>
> *[§226-108] Sustainability. Priority guidelines and principles to promote sustainability shall include.*
>
> *(1) Encouraging balanced economic, social, community, and environmental priorities;*
> *(2) Encouraging planning that respects and promotes living within the natural resources and limits of the State;*
> *(3) Promoting a diversified and dynamic economy;*
> *(4) Encouraging respect for the host culture;*
> *(5) Promoting decisions based on meeting the needs of the present without compromising the needs of future generations.*
> *(6) Considering the principles of the ahupuaa system; and*
> *(7) Emphasizing that everyone, including individuals, families, communities, businesses, and government has the responsibility for achieving a sustainable Hawaii*

Identifying and quantifying the sources of the greenhouse gas emissions of the plant under existing and future conditions contributes to the planning process and provides a basis of discussion for stakeholders to make decisions about present needs while considering the needs of future generations.

Mandatory reporting of greenhouse gases (GHGs) is required by Title 40 Code of Federal Regulations Part 98 only for facilities where emissions from stationary combustion are greater than 25,000 CO_2e per year. The results of this report show that the HIWWTP is below this threshold. Reporting of GHGs is purely optional, however, the latest Honolulu Mayor's Directive highlights the importance of quantifying and reporting climate change metrics. HIWWTP can benefit from the results of a GHG emissions estimate by using it to create a baseline for future reporting requirements and to calculate future emissions reductions.

In 2007, Hawaii became the first state in the nation to enact ACT 234, the "Global Warming Solutions Act", which commits all countries – developed and developing – to mitigate GHG emissions and adapt to already occurring impacts of climate change. Hawaii will track efforts to achieve the goal of reducing emissions to below 1990 levels by 2020, in accordance with the near-term milestone to achieve net-zero greenhouse gas emissions by 2045. Initiated by the ACT 234, the 2008 Hawaii Clean Energy Initiative, a partnership between the U.S. Department of Energy and the State of Hawaii also calls for 100% clean energy by 2045.

Kirk Caldwell, the Mayor of the City and County of Honolulu, signed a proclamation in June 2017 to commit the City of Honolulu to join the Climate Mayors Network and the We are Still In initiative, which is part of the U.S Climate Change Alliance. In joining this initiative, the City and County of Honolulu commits to pursue actions to achieve emissions reductions by developing a community GHG inventory, setting near- and long-term targets to reduce emissions, and by developing a Climate Action Plan aligned with the city's target. In joining the US Climate Change Alliance, the City and

County of Honolulu has pledged to remain actively engaged with the international community as part of the global effort to decrease GHG emissions, and therefore, warming. [2]

1.3 Primary Greenhouse Gases of Concern

The Kyoto Protocol, an international environmental agreement, identifies six primary types of greenhouse gases that should be considered in emissions assessments: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). In the context of wastewater treatment, HFCs, PFCs, and SF_6 are typically negligible, therefore the scope of this report only includes CO_2, CH_4, and N_2O. The total emissions for each of these gases will be calculated separately but reported in "carbon dioxide-equivalents" (CO_2e). This allows the emission of non-CO_2 gases to be reported on a common basis. These CO_2 equivalents are calculated using Global Warming Potential (GWP) factors provided by the Fifth Assessment Report from the Intergovernmental Panel on Climate Change (IPCC), as presented in Table 1. They are given on a 100-year time horizon [3].

Table 1 - Global Warming Potential (GWP) values relative to CO_2 (3).

Greenhouse Gas	GWP Value (kg CO_2e/kg gas)
Carbon Dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous Oxide (N_2O)	265

These values are based on the gases effectiveness in treating heat in the atmosphere, and is a ratio of heat trapped by one unit of the gas compared to CO_2 over a 100-year time period. For example, the GWP value for methane shows that it is 28 times more effective at trapping heat than CO_2.

1.3.1 Carbon dioxide (CO_2)

CO_2 is produced during the treatment process. The biological processes occurring in the sludge digesters produce biogas, which is typically combusted on-site for a beneficial use or disposed of by flaring. The combustion of biogas converts it to mainly CO_2. It can also be produced during the activated sludge process. Indirect emissions calculations, such as those for purchased electricity, will also include CO_2.

1.3.2 Methane (CH_4)

Methane is produced in anaerobic conditions during wastewater treatment, specifically during anaerobic degradation and during digester gas combustion [4]. Biogas that is not combusted (fugitive biogas) has a methane content of 60%. [5]

1.3.3 Nitrous Oxide (N_2O)

Nitrous oxide is produced during digester gas combustion but also during nitrification/denitrification. Release of N_2O occurs at the plant as well as in the discharge effluent after it flows into the receiving water body. Nitrous oxide emissions are highly dependent on operating conditions and therefore difficult to accurately estimate [5].

2.0 Scenarios Evaluated

This report includes the results of greenhouse gas estimates for three flow scenarios:

1. **Existing WWTP, 2016**
2. **Secondary Treatment Expansion Completed, 2035**
3. **Secondary Treatment Expansion Complete, SLUDBA Permit Areas Only, 2035**

A summary of the Flows considered for each scenario shown in Table 2 below.

Table 2 - Summary of Maximum Month Design Values for Each Treatment Scenario.

Scenario	Flow (mgd)	Land Use Area*	Population Equivalents	BOD_5 (lbs/day)	TSS (lbs/day)	TKN (lbs N/day)	Design Year	Source
1	31	1	356,000	56,200	59,600	9,600	2016	11
2	43	2	453,000	71,400	75,800	12,200	2035	6, 11
3	43	3	453,000	71,400	75,800	12,200	2035	6, 11

*Shown in Figure 2.

These design flows and loadings are consistent with R.M. Towill's Engineering Report Basis of Design [11]. This analysis of greenhouse gas emissions is based on the maximum month flow and loading conditions. The difference in GHG emissions are due predominately, in this case, to the energy used to treat pollutant loadings, which are essentially the same during average day annual flow conditions as during average day maximum month flow conditions. The loadings are not driven by influent flow – but by the connected population equivalents.

The Land Areas considered for each scenario are shown in Figure 2 below in yellow:

Figure 2 - Land Areas for each Scenario Evaluated. [6]

The results of the green house analysis of the secondary treatment expansion (Scenario 3) relative to the existing conditions (Scenario 1) are used to compare the potential environmental impact of the Secondary Treatment Expansion project, and to use these results for a discussion of potential mitigation measures. The greenhouse gas emissions for Scenario 3 will be submitted as part of the State Land Use Boundary Amendment (SLUDBA) petition.

2.1 Scenario 1 - Existing WWTP

The Hawaii Gas Purification Facility sends all biogas to their distribution system, therefore most of the emissions related to biogas are not considered as part of the estimate. It is assumed that 3% of the biogas produced is fugitive emissions released on-site, and the tail gas stream resulting from the purification process is also released to the atmosphere at the treatment plant.

2.2 Scenario 2 - Secondary Treatment Expansion Completed

The Secondary Treatment Expansion will provide an improved level of treatment to future flows and loads that is higher than the existing level. This results in an increase in biogas production and power usage. The biogas values used for this estimate were provided as part of the Pro2D Treatment Model results. [10] A component of the expansion that has a large impact on the emission estimate is that biogas combustion will be moved from off-site (Hawaii Gas pipeline) to on-site as part of the Combined Heat and Power (CHP), or Cogeneration system. Additionally, there will be photovoltaic (PV) panels to supplement the additional electrical load required by the new Support Facilities.

2.3 Scenario 3 - Secondary Treatment Expansion Complete, SLUDBA Areas Only

Facilities included in Land Use Areas defined as "A-Agricultural" include the Support Facilities, part of the Secondary Clarifiers and Aeration Basins, Influent Pump Station, Screenings, and the Headworks Odor Control System, per the *Phasing Plan for the Secondary Treatment Expansion* provided by R.M. Towill. Only emissions resulting as part of these processes/facilities will be included in the estimate.[6]

3.0 Methodology

3.1 Protocols

There are several protocols that are widely accepted as the standard protocol used when quantifying greenhouse gas emissions. The following presents the most commonly used protocols:

<u>Kyoto Protocol</u>: One of the more well know regulations, signed by many of the world's developed nations. An international agreement which sets emissions reduction targets and identifies greenhouse gases of concern. Includes methods for monitoring and reporting emissions.

<u>Intergovernmental Panel on Climate Change (IPCC) National Greenhouse Gas Inventories Guidelines</u> [7]: An internationally recognized "top-down" approach to determining carbon footprints. This protocol is designed for large-scale evaluations and is not plant specific.

<u>GHG Protocol</u> [8]: Developed by World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). Used worldwide to quantify GHG emissions from businesses.

<u>Local Government Operations Protocol (LGOP)</u> [4]: Based on the GHG Protocol and developed with California agencies. The LGOP is the U.S. national standard guidebook and provides methods for calculating GHG emissions specifically for water and wastewater treatment facilities. **The methods for this study were based on this protocol.**

3.2 Defining Boundary Conditions

The calculation of GHG emissions can be narrow or widely inclusive. For example, carbon emitted from the treatment plant process will be included, but the carbon emitted at the factory where chemicals used at the plant are manufactured may not be included in the overall emissions estimate.

The LGOP requires reporting on GHG emissions categorized into three "Scopes" [4]:

Scope 1: All **direct** GHG emissions.

Scope 2: **Indirect** emissions association with the consumption or purchase of electricity, steam, heating, or cooling.

Scope 3: All other indirect emissions not covered in Scope 2.

Scopes 1 and 2 are typically included in a GHG emission estimate, while Scope 3 is optional. This report focuses on Scope 1 and 2, which includes plant operations within the fence line and indirect emissions from purchased electricity. This does not include biosolids trucking or operation of plant vehicles. Biogenic emissions – those that are part of the natural carbon cycle – are excluded from these GHG emissions total; however, they are still calculated and reported separately. CO_2 emissions produced as a result of combusting digester gas are considered biogenic because they originated from biologic sources. CH_4 and N_2O emitted from biogas combustion are not considered biogenic because they would not be produced had the biomass naturally decomposed. While CH_4 and N_2O from nitrification, denitrification, and effluent discharge are by definition "biogenic", these gases have a much higher GWP and are therefore included in GHG reporting for most accounting methods [9]. Biogenic emissions are not used in compliance obligations or regulatory requirements.

The calculations included in this report are based on numbers from the following publications:

<u>Pro2D design details</u> [10] [11]: The Pro2D design model, created by CH2M, was run on January 26, 2019 for the completed Secondary Treatment Expansion project and is based on a plant influent flow rate of 43 MGD, the maximum month design flow for 2035. The values of biogas production and power usage for the secondary treatment expansion scenarios are based on this buildout flow model. See reference list for more information on the specific model used.

<u>R.M. Towill Phasing Plan</u> [6]: The phasing plan defines which plant processes will be constructed on the District Land Use Area designated as "A", or Agricultural.

<u>Electrical Master Plan and Support Facilities Scope [15]</u> This document contained actual electricity bills that were used as the basis for current electricity usage. The Support Facilities Scope provided as estimate of electrical power usage by the new Support Facilities, and an estimate of power generation by the photovoltaic panels that will be part of those buildings.

<u>Noncovered Source Permit (NSP)for Biogas Project:</u> The existing biogas usage was provided as part of the details in the NSP permit. Currently Hawaii Gas is using all

biogas provided as part of their biogas purification project. The process produces tail gas, which is released on-site to the atmosphere.

IPPC Guidelines [3]: The IPCC provides methodologies for estimating emissions of GHGs. This report uses the Fifth Assessment Report, Table 8.7, for the GWP Values used in the calculations.

EPA emissions factors [1]: The Emissions & Generation Resource Integrated Database (eGRID) is a data source for environmental characteristics for almost all electric power in the United States. For this report, this source was used for emission factors Hawaii State specific electricity emission rates. Emission factors were also sourced from the 40 Code for Federal Regulations (CFR), Part 98. See reference list for more information.

3.3 Method

3.3.1 Approach

Per LGOP, the emissions sources at the wastewater treatment plant were categorized into the Scopes defined in Boundary Conditions. The sources of these emissions can be classified as the following types:

Stationary Combustion Emissions: Stationary combustion emissions include the combustion of natural gas and biogas in the cogeneration engine, biogas in the boilers and flares, and diesel in the emergency generator. By flaring excess digester gas, the GHG emissions are reduced by 28 (or the GWP of methane). The resulting CO_2 emissions are considered biogenic and reported separately, because they originated from biological sources.

Non-Stationary Emissions: This includes the remainder of the plants GHG emissions:

Fugitive and Process Emissions: The basic fugitive and process GHG emissions associated with wastewater treatment at this plant specifically are: CH_4 emissions from the incomplete combustion of digester gas, N_2O emissions from treatment works with and without nitrification/denitrification (depends on secondary treatment processes), and N_2O emissions from effluent discharge into receiving bodies of water.

Indirect Emissions (Purchased Electricity): Electricity is purchased from the grid for other processes, including the six pumps at the influent pump station, headworks processes, primary clarification, sludge thickening, and UV disinfection. Hawaii State emission rates from the EPA eGRID database are used to calculate the emissions produced by generation of this electricity. (Source: eGRID 2016).

Mobile Combustion Emissions: This includes the emissions released from fleet vehicles and biosolids hauling trucks. These emissions would fall under Scope 3 per the LGOP and are not included in the scope of this report

3.3.2 Calculations

GHG emission were calculated per LGO Protocol based on the following general equation [4]:

$$\textbf{\textit{Emissions}} \left[\frac{tons\ CO_2e}{yr}\right] = gas\ use \left[\frac{m^3}{yr}\right] * gas\ energy\ content \left[\frac{BTU}{m^3}\right] * emission\ factor \left[\frac{ton}{BTU}\right] * GWP$$

The emissions factor is sourced from the EPA CFR40. Once the emission is calculated it is converted to a CO_2e value using the GWP factors provided by the IPCC.

Table 3 shows the types of emissions that are included in the calculation, and how they are divided by LGOP scope. Scope 1 includes stationary combustion and fugitive & process emissions. Scope 2 includes indirect emissions, which in this case consists of purchased electricity. As outlined by the LGOP, both anthropogenic and biogenic values are calculated, although biogenic values typically are not included in regulatory reporting because they are considered to be part of the natural carbon cycle. For example, Table 3 shows that CO_2 emissions from digesters are considered biogenic. Note that while N_2O from nitrification/denitrification and effluent discharge would seem to be biogenic, or occurring naturally, protocol requires them to be reported as anthropogenic due to the extremely high GWP of N_2O. Values of ∅ indicates that the gas is not a part of that emission source or is negligible and is assumed to be zero.

Table 3 - Steps for Calculating GHG Emissions by LGOP Scope [4].

Scope	Emissions Source	Type	CO_2	CH_4	N_2O
1 (Direct)	Natural Gas	*Stationary combustion*	A	A	A
	Fuel Oil	*Stationary combustion*	A	A	A
	Digester Gas Used	*Stationary combustion*	B	A	A
	Digester Gas Flared	*Stationary combustion*	B	A	∅
	Fugitive Gas from Digester	*Fugitive & process emission*	∅	A	∅
	Tail Gas from Biogas Purification *(Existing Plant Only)*	*Fugitive & process emission*	B	A	∅
	Nitrification/Denitrification	*Fugitive & process emission*	∅	∅	A
	Effluent Discharge	*Fugitive & process emission*	∅	∅	A
2 (Indirect)	Purchased Electricity	*Indirect emission*	A	A	A
			A=Anthropogenic, B=Biogenic		

Indirect emissions were calculated per the LGO Protocol and using Hawaii State annual output emissions rates from the EPA [12].

Once the values for each emission source are calculated in units of the relative gases, they are then converted to CO_2e values and summed. This process is completed for each evaluated treatment option. Anthropogenic and biogenic emissions are reported separately.

3.3.3 Assumptions

There are several assumptions that were made as part of the method and calculations. They are:

1. It is assumed that there is 3% fugitive gas for the existing biogas purification process.

2. With an anticipated 55 peak hour vehicles entering the project site under the future operational condition, the on-road traffic induced air quality impacts are anticipated to be minimal. Emissions due to vehicle traffic on-site are not considered as part of this estimate. [14]
3. The City has a pledge to use all electric vehicles by 2035. Vehicle charging loads are not included in this estimate. [22].
4. Emissions produced as a result of construction or decommissioning are not included in this estimate. The embodied carbon associated with manufacturing equipment used on site is similarly excluded.
5. For calculation of emissions from effluent discharge, the TN influent loading is assumed equal to TKN influent loading for purposes for the estimate.
6. Imported sludge is considered to be independent of the liquid treatment stream and will not affect the N concentration of the effluent.
7. All emissions as a result of the emergency generator operation are assumed to be CO2. Concentrations of other gas values are negligible.
8. For estimating emissions due to power usage in Scenario 3, it is assumed that all emissions from the Support Facilities are emitted in the SLUDBA Petition Area.
9. Part of the Secondary Clarifiers and Aeration Basins are outside of the Area considered in Scenario 3. However, for estimating emissions due to nitrification/denitrification in Scenario 3, it is assumed that all emissions occur in the SLUDBA Petition Area.
10. The HECO Substation is not included in this estimate.
11. There is no natural gas used at the existing facility.
12. The Pro2D model did not include the power usage from the support facilities. This was added to the Power Usage estimate from the model.
13. New Dryers will be powered by the heat exhaust from the CHP system. [16]
14. Regarding power usage, the future scenario Pro2D model uses power for maximum month flow and loads, which is approximately 20% higher than average. The existing scenario is based on power use in average conditions.

4. 0 Results

GHG emissions were estimated for the LGO Protocol scopes and sources identified in Table 3. A summary of the total emissions for each scenario defined in Section is shown below in Table 4.

Table 4 - Summary of Anthropogenic CO2e Emissions for Treatment Scenarios.

SCENARIO	Flow Rate (MGD)	Anthropogenic CO_2e (metric tons/yr)	CO_2e kg/MG WW treated
1. EXISTING - Existing Treatment at Design Flows, 2016	**31**	18,015	1,591
2. SECONDARY TREATMENT EXPANSION – Expanded Secondary Treatment at Design Capacity Year, 2035	**43**	25,615	1,631
3. SECONDARY TREATMENT EXPANSION, SLUDBA Land Use Only at Design Capacity Year, 2035	**43**	10,453	666

The Secondary Treatment Expansion project will increase anthropogenic greenhouse gas emissions by 7,600 CO_2e metric tons/year, for a total of 25,615 CO_2e metric tons/year. The portion of the emissions resulting from processes and facilities in the SLUDBA area is 10,453 CO_2e metric tons/year.

The following Tables 5 through Table 7 summarize the results of these emissions calculations, broken out by the source of the emissions. Biogenic and anthropogenic emissions are reported separately.

For the future Scenarios 2 and 3, note that the Purchased Electricity values are offset by the future photovoltaic (PV) system and Combined Heat and Power (CHP) System. The emissions shown are calculated based on the net electricity used after considering the energy recovered.

Table 5- SCENARIO 1 - CO2 Equivalent Emissions for Existing Treatment Conditions at Design Flows, 2016.

			Emissions (metric tons/yr)			CO_2e (metric tons/yr)	
Scope	**Emissions Source**	**Type**	CO_2	CH_4	N_2O	**Biogenic**	**Anthropogenic**
1	Natural Gas	*Stationary combustion*	0	0	0	0	0
	Fuel Oil	*Stationary combustion*	1,344	0	0	0	1,344
	Digester Gas Used	*Stationary combustion*	1,143	0	0	1,143	6
	Digester Gas Flared	*Stationary combustion*	0	0	0	0	0
	Fugitive Gas from Digester	*Fugitive & process emission*	0	69	0	0	1,944
	Tail Gas from Biogas Purification[1]	*Fugitive & process emission*	4,135	79	0	4135	2,212
	Nitrification/Denitrification	*Fugitive & process emission*	0	0	1	0	276
	Effluent Discharge	*Fugitive & process emission*	0	0	16	0	4,222
2	Purchased Electricity	*Indirect emission*	7,955	1	0	0	8,011
					Total	5,278	**18,015**

[1] Digester Gas used in Hawaii Gas purification project is sent to outside pipeline, therefore is not included in this estimate. Gas Used value only includes Boiler heating.

Table 6 – SCENARIO 2 - CO2 Equivalent Emissions for Secondary Treatment Expansion at Design Capacity Year, 2035.

Scope	Emissions Source	Type	Emissions (metric tons/yr) CO_2	CH_4	N_2O	CO_2e (metric tons/yr) Biogenic	Anthropogenic
1	Natural Gas	*Stationary combustion*	5	0.00	0.00	0	5
	Fuel Oil	*Stationary combustion*	4,441	0	0	0	4,441
	Digester Gas Used[2]	*Stationary combustion*	8,637	0.53	0.10	8,637	43
	Digester Gas Flared	*Stationary combustion*	182	0	0	182	0
	Fugitive Gas from Digester	*Fugitive & process emission*	0	98	0	0	2,741
	Nitrification/Denitrification	*Fugitive & process emission*	0	0	1.4	0	384
	Effluent Discharge	*Fugitive & process emission*	0	0	13	0	3,322
2	Purchased Electricity[2]	*Indirect emission*	14,576	1.5	0.2	0	14,679
					Total	8,819	**25,615**

[2] Digester Gas is used for CHP process. Therefore the calculation for Purchased Electricity uses the Net Value after considered energy recovered.

Table 7 – SCENARIO 3 - CO2 Equivalent Emissions for SLUDBA Land Use Only at Design Capacity Year, 2035.

Scope	Emissions Source	Type	Emissions (metric tons/yr) CO_2	CH_4	N_2O	CO_2e (metric tons/yr) Biogenic	Anthropogenic
1	Natural Gas[3]	*Stationary combustion*	0	0	0	0	0
	Fuel Oil[3]	*Stationary combustion*	0	0	0	0	0
	Digester Gas Used[3]	*Stationary combustion*	0	0	0	0	0
	Digester Gas Flared[3]	*Stationary combustion*	0	0	0	0	0
	Fugitive Gas from Digester[3]	*Fugitive & process emission*	0	0	0	0	0
	Nitrification/Denitrification	*Fugitive & process emission*	0	0	1.4	0	384
	Effluent Discharge	*Fugitive & process emission*	0	0	0	0	0
2	Purchased Electricity	*Indirect emission*	9,998	1.03	0.16	0	10,069
					Total	0	**10,453**

[3] No processes creating or combusting Digester Gas, Natural Gas, or Fuel Oil are present in Land Use "A" areas.

5.0 Discussion

Figure 3 graphically shows the emissions from each plant processes for each scenario considered. The emissions due to Purchased Electricity are the greatest portion of total emissions for all the scenarios. Again, note that emissions are calculated from net power consumption, after considering energy generated by the new PV and CHP systems. For the SLUDBA Land Only, the only other source of emissions is resulting from Nitrification/Denitrification. All other emissions are a result of processes that occur in the existing plant area.

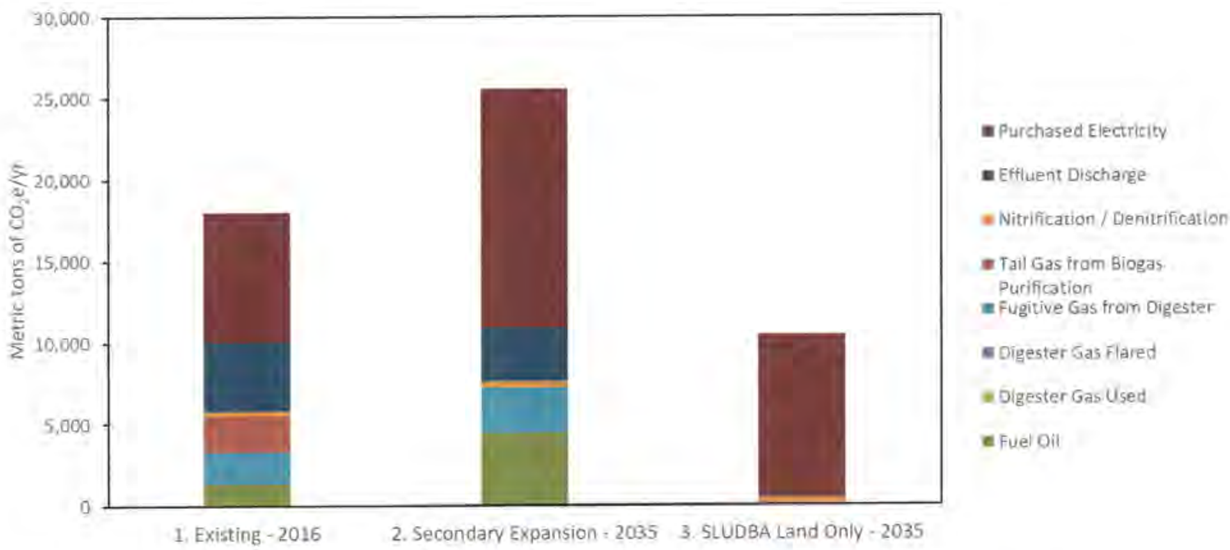

Figure 3 - Annual Anthropogenic CO2e Emissions by Emission Source.

Emissions resulting from effluent discharge decrease after the Secondary Treatment Expansion, despite an increased plant flow, because the Total Nitrogen leaving the plant is reduced as a result of a higher level of liquid stream treatment.

Emissions resulting from tail gas released from the biogas purification process are only present in the existing treatment scenario. The purified biogas is sent to the distributed system and combusted offsite, therefore the resulting emissions were not considered for the existing scenario. Biogas currently diverted to the purification project will be combusted on-site after the expansion in the CHP system. While this leads to greater emissions released on-site, they are mostly biogenic (those that are a part of the natural carbon cycle). Moving to a CHP system will decrease the anthropogenic emissions because the system offsets electrical power consumption from the plant. Purchased electricity is typically a large source of anthropogenic emissions, depending on the source of the electricity generation. Emissions are calculated using a state-specific Emission Factor (in lb./MWH) provided by the EPA. [12]

6.0 Conclusions

6.1 Summary

Without considering the emissions avoided by including PV Generation and Co-Generation (CHP System), the Secondary Treatment Expansion Project would have increased anthropogenic emissions of the plant by 18,788 CO_2e metric tons/yr., or 230%. However, because these sustainable alternatives were considered during the design, the net increase in emissions is only 83%. See Figure 4 which illustrates this concept.

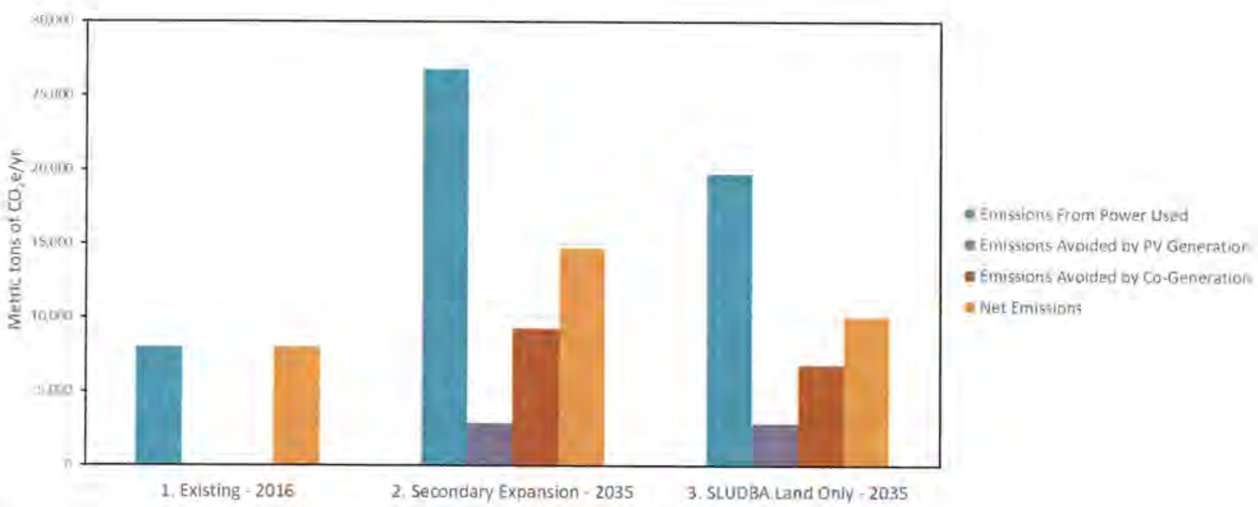

Figure 4 - Annual Indirect CO2e Emissions and Emissions Avoided.

Considering that the level of treatment, population, flow, and loads to the plant are also increasing during this time period, this value is expected. The Environmental Impact Statement for the Secondary Treatment Expansion came to the similar conclusion that there was an expected increase in the GHG emissions associated with the WWTP expansion project. However, given its global effects, such a typical infrastructure development project would unlikely cause any meaningful global warming effects. [14]

6.2 Mitigation Measures

The City has already considered and included in their design mitigation measures of to offset the increased GHG emissions resulting from the Secondary Treatment Expansion. The design for the future facility will include investment in a PV system and a new CHP system which will provide electricity and heat for local facilities, offsetting electricity and fossil fuels use.

- **Photovoltaic (PV) Panels**: The photovoltaic panels are proposed to be installed on the roofs of all the new Support Facilities as part of the expansion. The power generated is expected to offset about 28% of the power consumption required by these facilities, ultimately preventing over 2,800 metric tons/year of anthropogenic CO_2 equivalent emissions.

- **Combined Heat and Power (CHP) Cogeneration:** This system consists of an Internal Combustion Engine with electrical generators and heat recovery equipment. The system uses biogas recovered from the digesters to generate electricity, which will be used to power plant processes. The system also produces usable heat, which is recovered from the exhaust of the Internal Combustion Engine, and will be reused in the new sludge drying process, eliminating the need for supplemental natural gas or additional power. [16] The system selected for the expansion project is expected to offset about 35% of the total power used by the plant, which will prevent about 9,300 metric tons/year of anthropogenic CO_2 equivalent emissions. The system can capture up to 3,600,000 BTU/hour of high grade heat, equivalent to 1,054 kW.

Additional options to consider may include investing further in the Sustainability "Smart Growth Practices" approach to land use planning which balances environmental protections, economic development and social objectives without compromising future generations. Options to consider include:

- **Solar projects** – The plant design already incorporates PV arrays on the roof of the new Support Facilities.
- **Methane Recovery Projects** – This is covered by the CHP system, which recovers all biogas (methane) generated by the plant.
- **Fuel Efficient and Alternative Fuel Vehicles** - The plant, following the lead of others in Hawaiian counties has the goal to have all electric vehicles by 2035. Electric vehicle recharging will be provided for the City vehicles as well as the public.
- **Compact Building Design** – Minimize energy use of Support facilities by providing energy and water efficient fixtures and educate staff and public on sustainable practices.
- **Transportation Alternatives** – Install bicycle racks, showers, and other amenities to promote bicycle use by employees and visitors

Emissions due to electricity used are the largest contributor to emissions at the plant. Because of this, the greatest impact will be in pursuing options that will reduce energy use. Additional opportunities to improve efficiency and energy savings include implementing a demand management plan, developing operational efficiency improvements throughout the plant, optimizing plant processes, and implementing newer technologies to improve pump and motor efficiency.

Definitions

Anthropogenic carbon: CO_2e emissions due to human activity, typically associated with fossil fuels. These are considered to be outside of the normal carbon cycle.

Biogenic carbon: CO_2e emissions from combustion or decomposition of biological-based materials other than fossil fuels. Biogenic CO_2 emissions are considered to be part of the natural carbon cycle; therefore, many protocols do not require them to be included in reporting.

Carbon footprint: The total emissions produced directly and indirectly to support human activities.

Direct Emissions: Actual emissions of GHGs from a facility or equipment through on-site combustion and/or as a by-product of a treatment process.

Global Warming Potential (GWP): The capacity of 1 kg of a specific type of gas to trap energy in the atmosphere compared to that of CO_2 over a 100-yr period.

Greenhouse gas (GHG): A gas that traps energy radiating from the earth causing the atmosphere to warm analogous the glass panes in a greenhouse retains heat.

Indirect Emissions: Emissions caused by activity of the facility but not directly emitted from the facility (e.g. purchased electricity).

List of Figures and Tables

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