

Technical Appendix – Documentation of GHG Reduction Assumptions

Measure 1: Electric Boiler Installation at the Mendenhall Wastewater Treatment Plant

The existing fuel boilers at the Mendenhall Wastewater Treatment Plant (MWWTP) currently burn approximately 80,000 of fuel per year¹, and it is assumed that conversion to an electric boiler using 100% renewable hydropower will offset all of the emissions currently produced by the fuel oil boiler. Assuming the project follows the estimated implementation timeline, the boiler will be fully operational by the fall of 2026.

A: Annual CO₂e Emission Reduction Calculations

Several EPA GHG emission calculation resources were used to quantify the annual projected emission reductions for this measure.

- 1.) EPA’s calculation for gallons of diesel consumed² (heating fuel is closest in composition to diesel)

$$\text{10,180 grams of CO}_2\text{/gallon of diesel} = 10.180 \times 10^{-3} \text{ metric tons CO}_2\text{/gallon of diesel} \times 80,000 \text{ gallons} = 814.4 \text{ MT CO}_2 \text{ saved.}$$

- 2.) The following calculations were derived from EPA’s *Emission Factors for Greenhouse Gas Inventories*³ for Distillate Fuel Oil No. 1:

$$\text{Annual Methane (CH}_4\text{) Reduction} = 80,000 \text{ gallons} \times 0.00042 \text{ kg CH}_4\text{/gallon} = 33.60 \text{ kg CH}_4$$

$$\text{Annual N}_2\text{O Reduction} = 80,000 \text{ gallons} \times 0.00008 \text{ kg N}_2\text{O/gallon} = 6.4 \text{ kg N}_2\text{O}$$

Fuel Oil Savings (gallons)	Fuel oil Savings MMBtu	Carbon Dioxide CO ₂ kg / MMBtu	Carbon Dioxide CO ₂ kg	Methane CH ₄ kg / MMBtu	Methane CH ₄ kg	Nitrous Oxide N ₂ O kg / MMBtu	Nitrous Oxide N ₂ O kg
80,000	11,120	73.25	814,400	0.003	33.36	0.0006	6.4

- 3.) The 100 year GWP as identified in the IPCC’s Fifth Assessment Report were used to identified CO₂-equivalent for CH₄ and N₂O.

$$\text{Methane CO}_2\text{e} = 33.36 \text{ kg} \times 28 = 934.08 \text{ kg} \times 0.001 = 0.934 \text{ MT CO}_2\text{e}$$

¹ https://juneau.org/wp-content/uploads/2023/08/2021-GHG-reports_08012023_FINAL.pdf (p.15)

² <https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references>

³ <https://www.epa.gov/system/files/documents/2024-02/ghg-emission-factors-hub-2024.pdf> (Updated February 13, 2024)

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Nitrous Oxide CO₂e = 6.4 kg x 265 = 1696 kg x 0.001 = 1.696 MT CO₂e

Annual CO₂e = 814.4 MT CO₂ + 0.934 MT CO₂e (CH₄) + 1.696 MT CO₂e (N₂O) = 817.03 MT CO₂e

4.) The EPA's Greenhouse Gas Equivalencies Calculator⁴ was used to verify the numbers above. See screenshot below.

Step 1 - Enter and convert data

Select data to convert: ☐ Energy data ☒ Emissions data

Enter data for one or more gases:

Carbon Dioxide or CO ₂ Equivalent*	814.4	Metric Tons
Carbon		Metric Tons
CH ₄ - Methane	33.36	Kilograms
H ₂ O - Nitrous Oxide	6.4	Kilograms
Hydrofluorocarbon gases		Metric Tons
HCFC-22		
Perfluorocarbon gases		Metric Tons
CF ₄		
Anesthetic gases		Metric Tons
HCFE-235da2 (isoflurane)		
SF ₆ - Sulfur Hexafluoride		Metric Tons

*If your estimated emissions of methane, nitrous oxide, or other non-CO₂ gases are already expressed in CO₂ equivalent or carbon equivalent, please enter your figures in the row for CO₂ or carbon equivalent.

Step 2 - View results

817 Metric Tons of Carbon Dioxide (CO₂) equivalent

This is equivalent to greenhouse gas emissions from:

B: GHG Reductions for 2025 – 2030 and 2025 - 2050

Assuming the project follows the estimated implementation timeline, the boiler will be fully operational by the fall of 2026. This means that no fuel emissions will be offset by the measure, only one quarter of fuel emissions will be offset in 2026, and the full annual 817 MT CO₂e will be offset for the subsequent years.

Per Year CO₂e Emissions Reduced (MT)

2025	2026	2027	2028	2029	2030
0	204.25 MT	817 MT	817 MT	817 MT	817 MT

Total GHG Reductions from 2025 through 2030 = 817 MT x 4.25 years = **3472.25 MT CO₂e**

Total GHG Reductions from 2025 through 2050 = 817 MT x 44.25 years = **19,812 MT CO₂e**

⁴ <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>

C: Calculations Uncertainties

CBJ conducted the preliminary research regarding project equipment lead times to develop an informed implementation timeline, however, future supply chain disruptions have the potential to cause unforeseen delays. Juneau's northern location requires that the boiler replacement can only take place in the summer months when it is possible to turn off the heat. For this reason, equipment delays could require the project to be delayed by up to a year.

If this were the case, the total GHG reduction from the measure would decrease in alignment with the length of the project delay, with an 817 MT reduction for each year of delay.

Measure 2: Energy Audit of the Mendenhall Wastewater Treatment Plant (MWWTP)

While the comprehensive energy audit of the MWWTP is likely to result in significant energy use reductions at the facility, as well as key learnings for applications in other facilities, it is not possible at this time to quantify GHG emission reductions as a direct result of the measure.

As such, the GHG reduction calculations for measure 1 are also the cumulative for both measures combined.