

September 13, 2017

To: Lisa Wolff

From: Ted Siegler and Natalie Starr

**Re: Net Green House Gas emissions from Ecomaine WTE facility when compared to landfilling of the same tons of municipal solid waste**

You have asked DSM Environmental Services, Inc. (DSM) to provide you with a comparison of estimated net Greenhouse Gas (GHG) Emissions associated with waste-to-energy (WTE) combustion of 179,939 tons of mixed municipal solid waste (MSW) processed at the ecomaine facility in 2016 with net GHG emissions if that same quantity of mixed solid waste had been landfilled at a Maine landfill this past year.

DSM has used the US EPA Waste Reduction (WARM) Model to conduct the analysis. The US EPA created the WARM model. According to the EPA website, *"EPA created the WARM model to help solid waste planners and organizations track and voluntarily report GHG emission reductions from several different waste management practices."* The first version of WARM was released by EPA in 1998. DSM used the most recent version (2016) of the WARM model (version 14) to compare landfilling of waste from ecomaine communities with combustion of the same amount of waste in ecomaine's WTE facility.

WARM calculates emissions for baseline and alternative waste management practices, including source reduction, recycling, combustion, composting, and landfilling. Emissions can be calculated in metric tons of carbon dioxide equivalent (MTCO<sub>2</sub>E) and metric tons of carbon equivalent (MTCE) for material types commonly found in municipal solid waste (MSW).

WARM applies material-specific emission factors for each management practice to calculate the GHG emissions and energy savings and allows certain inputs - such as landfill gas recovery practices and transportation distances to MSW facilities - to be modified to match actual conditions.

Emission factors were developed following a life-cycle assessment methodology using estimation techniques developed for national inventories of GHG emissions. Version 14 reflects revised data on the average recycled content values for materials available in the marketplace, and the EPA's latest MSW characterization report *Advancing Sustainable Materials Management: Facts and Figures*.

It is important to note that one cannot compare total emissions of carbon dioxide from ecomaine's WTE facility with the results from the WARM model because EPA is interested in net emissions, not total emissions. EPA discounts carbon dioxide emissions from biogenic materials (e.g., wood, paper, food waste) because it is assumed that these materials are replaced with new growth which utilizes carbon dioxide. Therefore, the primary emissions of concern to EPA are emissions from the combustion of anthropogenic (manmade) sources, such as plastic, which when combusted release carbon dioxide that was stored (as either natural gas or petroleum) into the atmosphere.

In addition, the WARM model assumes that the electricity produced by ecomaine replaces electricity produced from the mix of power plants in use in Maine. This further offsets total carbon dioxide emissions because some of Maine’s power supply comes from combustion of natural gas, oil and coal which are all anthropogenic sources.

And finally, because ecomaine recycles the steel from the ash, the WARM model calculates a negative emission factor because the recycled steel offsets emissions associated with production of new steel.

It should be noted here that the WARM model also discounts some portion of potential emissions from landfilling of biogenic materials to the extent that they do not decompose over the model lifetime, and therefore are assumed to be sequestered in the landfill. However, biogenic materials landfilled that decompose and contribute to methane generation are counted; and, because methane is roughly 25 – 28 times as potent a GHG as carbon dioxide, methane that is released from landfills has a significant impact on GHG emissions.

### Comparison of GHG Emissions from Ecomaine With Landfill Disposal of the Same Quantity of MSW

Last year, 179,939 tons of municipal solid waste (MSW) were disposed at ecomaine’s facility. Using the EPA Warm Model (v. 14, 2016), roughly 8,422 Metric Tons of net CO2 (MTCO2E) equivalent emissions were generated from combustion. This can be compared against landfilling of the same quantity and composition of MSW at a Maine landfill at 77,650 MTCO2E (SEE TABLE).

Material	Tons Combusted	Total MTCO2E	Tons Landfilled	Total MTCO2E
Mixed MSW	179,939	8,422	179,939	77,650

Assuming the landfill(s) used were, on average of 50 miles away (and transport to the ecomaine facility averages 20 miles<sup>1</sup>), the same tonnage landfilled would generate 77,650 metric tons of CO2 equivalent emissions. The savings of using a combustion facility over landfilling in Maine would be equivalent to taking 14,574 passenger vehicles off the road for a year, saving 7,789,787 gallons of gasoline.

This calculation is made assuming that avoided electricity-related emissions from combustion are from the regional "marginal" electricity grid mix emission factor for Maine. It also assumes that the landfill(s) used would have gas recovery but that they flare the gas (as opposed to producing electricity from the gas<sup>2</sup>) and that the moisture conditions and associated bulk MSW decay rate (also referred to as “k values”, which impact the rate of decomposition of organic waste in the landfill), is greater than 40 inches of rainfall a year.

These results are consistent with prior similar modeling exercises compiled by the Energy Recovery Council (<http://energyrecoverycouncil.org/>) in their evaluation of the positive benefits MSW WTE plants have on mitigating solid-waste related GHG emissions.

<sup>1</sup> Transport distances are a relatively small component of overall GHG emissions.

<sup>2</sup> Which is the case for Maine landfills based on data from the State of Maine.