CLEAN AIR
TASK FORCE

Evaluation of Greenhouse Gas Emissions from the San Mateo Final Landfill and Organic Waste Treatment Through Anaerobic Digestion

Summary for Decision Makers

Introduction

Methane is a harmful climate pollutant that is more than 80 times more potent than carbon dioxide in its first 20 years in the atmosphere and is responsible for about half a degree Celsius of the global warming experienced to date.[1] The waste sector – both solid waste and wastewater systems – is responsible for approximately 20% of global methane emissions and is critical for achieving reduction targets. Solid waste emissions from landfills and dumpsites represent the majority of methane from this sector. Methane from solid waste is generated from the decay of organic waste – food and yard waste, as well as paper, cardboard, and wood – in the oxygen-free environments found in land disposal sites. A key first step to mitigating methane from landfills is assessing the current emissions at the disposal site and analyzing options for mitigation.

Clean Air Task Force (CATF) and Soluciones Integrales para la Problemática (SIPRA) assessed emissions at the San Mateo disposal site, located in the municipality of Naucalpan de Juárez in the State of Mexico, as part of the Waste Methane Assessment Platform (WasteMAP) initiative. The study, summarized below, also included an evaluation of options to divert organic waste from the disposal site and an estimation of resulting greenhouse gas (GHG) emissions reductions.

WasteMAP, a joint initiative by RMI and CATF, is an open online platform that brings together waste methane emissions data with decision support tools for stakeholders in the waste sector. The platform is supported by country engagement that involves collaboration with national and subnational governments, waste management officials, and other key decision makers to provide capacity building and technical assistance – providing a pathway to reduce solid waste methane emissions. Please visit our website https://wastemap.earth/ to learn more.

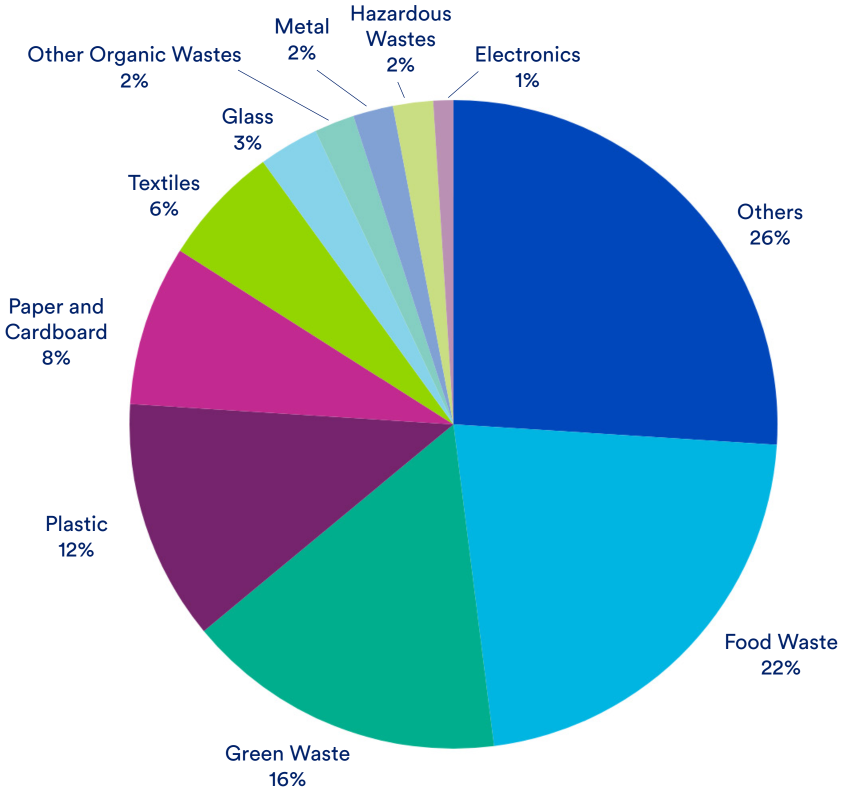
1 IPCC. (2021). Climate Change 2021: The Physical Science Basis, Working Group I, SPM, Fig 2. https://www.ipcc.ch/report/ar6/wg1/downloads/figures/IPCC_AR6_WGI_SPM_Figure_2.png

Background and Methodology

The San Mateo disposal site started as a dumpsite in 1976. The landfill began operating in 2006, in accordance with national regulations (NOM-083-SEMARNAT-2003) and technical systems with an estimated useful life of 20 years. A gas collection and flaring system was implemented in 2018 as stipulated by the official Mexican standard NOM-083-SEMARNAT-2003.[2] The active landfill cell is expected to close in 2026 with a new cell opening adjacent to it in 2027.

In May 2023, a waste quantification and characterization study was conducted by SIPRA, and estimated that approximately 617 tons of municipal solid waste – 47% of which is organic – are deposited each day in the San Mateo landfill. Figure 1 illustrates the results of the waste characterization conducted at the landfill.

Figure 1: Characterization of Waste entering the San Mateo Landfill, May 2023



To estimate GHG emissions and biogas production for this study, two tools were used:

1. The Solid Waste Emissions Estimation Tool (SWEET) was developed by the U.S. Environmental Protection Agency (USEPA) to calculate GHG emissions from waste management systems. SWEET Version 4.0.2 was used to estimate emissions for the status quo management of solid waste in the landfill as well as emissions for different management alternatives, including organic waste diversion for anaerobic digestion (AD).
2. The Anaerobic Digestion Screening Tool (ADST) also developed by USEPA estimates biogas production and methane emission reductions from AD projects based on the amount and type of feedstocks available. ADST Version 2.2 was used to estimate the volume of biogas generated by AD of the organic waste diverted at the San Mateo disposal site.

2 SEGOB, 2004

To estimate emissions from the San Mateo site using SWEET, four phases of the disposal site's operation were examined:

1. The original dumpsite where waste was dumped from 1976 to 2006.
2. The current cell, modeled as a controlled landfill, with waste disposal from 2006 to 2026; a gas collection and flaring system installed in 2018; and proposed diversion of a portion of the organic waste to AD facilities beginning in 2024.
3. The current cell with emissions modelled after closure in 2027.
4. The future cell, modeled as a sanitary landfill, with waste disposal beginning in 2027; active capture and use of biogas from the landfill; and a portion of the organic waste diverted to AD.

The study examined the implications of diverting organic waste from the disposal site to an AD facility; it also estimated emissions with gas capture and use systems (GCCS) in the new cell starting in different years. The two diversion scenarios examined include 50%, or 52,915 tons/year, and 80%, or 84,665 tons/year, of organic waste being diverted from the San Mateo landfill. The five modeled scenarios include:

1. A business as usual (BAU) case with no diversion of organic waste from the disposal site; and with flaring but no gas capture and use systems in place.
2. 50% diversion of organic waste for AD; flaring at the current site; and GCCS at the new site from 2055.
3. 80% diversion of organic waste for AD; flaring at the current site; and GCCS at the new site from 2055.
4. 50% diversion of organic waste for AD; flaring at the current site; and GCCS at the new site from 2027.
5. 80% diversion of organic waste for AD; flaring at the current site; and GCCS at the new site from 2027.

The estimates in this report are developed based on various assumptions and are subject to uncertainty, it is recommended to use them as a first order estimate, with additional analysis and more detailed studies needed for project development.

Results

Emissions from the San Mateo Landfill

The BAU and four diversion and gas capture scenarios were modeled in SWEET to compare emissions reductions. While the study examined total GHG and methane emissions scenarios, the report highlights landfill methane mitigation. Figure 2 illustrates the methane emissions associated with the BAU and alternative scenarios. Scenario four, with an 80% diversion of organic waste from the disposal site starting in 2024 and GCCS in the new cell in 2027, results in the greatest emissions reductions.

3 A Global Warming Potential of 28 is used to convert emissions of methane to carbon dioxide equivalents (CO_2e).

Figure 2: Comparison of methane emissions for modeled scenarios at the San Mateo Landfill

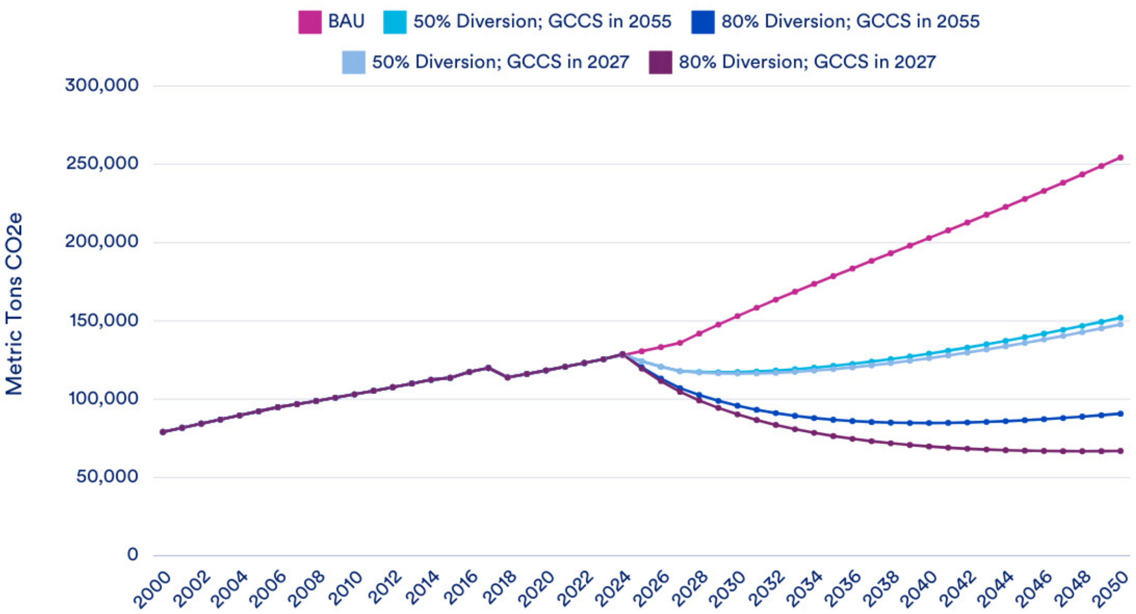


Table 1 shows the total emissions reductions compared to the baseline under the four scenarios over six years, 19 years, 26, and 46 years. Over a 46-year period (2024-2070), between 4 million and 7 million metric tons of CO_2e can be mitigated by diverting organic waste and improving gas capture and use at the landfill.

Table 1: Total emissions reductions compared to BAU (Metric Ton CO_2e)

Years	Period	50% diversion; GCCS in 2055	80% diversion; GCCS in 2055	80% diversion; GCCS in 2027	50% diversion; GCCS in 2027
2024-2030	6 years	84,602	135,332	153,982	86,526
2031-2050	19 years	1,320,452	2,111,739	2,420,359	1,378,132
2024-2050	26 years	1,405,054	2,247,071	2,574,341	1,464,658
2024-2070	46 years	3,928,966	6,172,075	7,128,035	4,007,052

AD Potential of Diverted Organic Waste

The study also examined the implication of treating the diverted organic waste via AD at the San Mateo site. ADST was used to estimate the amount of gas and digestate that could be generated under 50%, 80% and 100% diversion scenarios. Table 2 illustrates the potential biogas, methane,[4] and digestate production with varying levels of diversion.

4 Assuming the biogas is comprised of 50% methane and 50% carbon dioxide and other gases.

Table 2: AD products at different diversion rates

Product	100% diversion	80% diversion	50% diversion	Unit
Biogas	249,788	199,830	124,894	m^3/year
Methane	124,644	99,715	62,322	m^3/year
Digestate	105,687,225	84,549,780	52,843,612	kg/year

Table 3 presents potential uses of the biogas produced under a 100% diversion scenario. Digestate can be treated further and used as a soil amendment, generating economic benefits when sold or used by the Naucalpan de Juárez City Council for the maintenance of green areas.

Table 3: Energy recovery options from 100% organic waste diversion

Unit	Value
Electricity production (purified biogas to natural gas quality) (MWh)	1,198
Electricity production (biogas only) (MWh)	810
Production of renewable natural gas (m^3/year)	124,644
Cooking gas potential (houses/year)	2,281
Domestic heating potential (houses/year)	1,711
Gas lamps (lamps/year)	456

Conclusion

In Mexico, huge quantities of waste are disposed of daily in landfills; a lack of infrastructure for proper management of solid waste at these disposal sites can contribute to a number of environmental and human health risks, including emissions of methane and other GHGs. Managed properly, with improved treatment and gas capture technologies, these facilities could contribute to the climate and energy goals of Mexico.

The municipality of Naucalpan de Juárez has the opportunity to reduce emissions generated by the final disposal of waste in the San Mateo Landfill. By diverting organic waste from the landfill and treating this waste stream via AD, Naucalpan can mitigate between 4 million and 7 million metric tons of CO_2e over a 46-year period.

Additionally, the diversion of organic waste from the landfill can have a number of other positive benefits including:

- Reduced leachate generation & costs associated with leachate management;
- Minimized fire risk at the landfill;
- Mitigation of other air pollutants (nitrogen oxides, sulfur dioxide, and particulate matter); and,
- Reduction of odors on site.