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PROGRAM FOR LOCAL AND URBAN SUSTAINABILITY

TASK 2: GREENHOUSE GAS MITIGATION OPPORTUNITIES FOR USAID SOLID WASTE SECTOR ACTIVITIES

Guidance to Reduce and Measure GHG Emissions Along the SWM Value Chain

October 2023

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ACRONYMS

Acronym	Definition
3R	Reduce, Reuse, and Recycle
AD	Anaerobic Digestion
CAPEX	Capital Expenditure
CCBO	Clean Cities, Blue Ocean
EPA	U.S. Environmental Protection Agency
EPR	Extended Producer Responsibility
GESI	Gender, Equity, and Social Inclusion
GHG	Greenhouse Gas
LFG	Landfill Gas
MRF	Material Recovery Facility
MWRP	Municipal Waste Recycling Program
O&M	Operations and Maintenance
PAYT	Pay-As-You-Throw
PLUS	Program for Local and Urban Sustainability
RNG	Renewable Natural Gas
SLCP	Short-Lived Climate Pollutant
SOSI	Save Our Seas Initiative
SWM	Solid Waste Management
TPY	Tons Per Year
USAID	U.S. Agency for International Development
WtE	Waste-to-Energy

I. INTRODUCTION

A. BACKGROUND

The United States Agency for International Development (USAID), through its Program for Local and Urban Sustainability (PLUS), implemented by Deloitte Consulting LLP, is carrying out the *Guidance to Reduce and Measure Greenhouse Gas (GHG) Emissions Along the Solid Waste Management (SWM) Value Chain Activity*. This Activity aims to strengthen SWM systems and build the expertise of USAID staff to advance the development, implementation, and assessment of SWM programs that reduce ocean plastics while achieving measurable GHG reductions consistent with the *Climate Strategy 2022-2030*.

The absence of robust SWM approaches in cities and countries around the world is responsible for significant environmental, social, and economic challenges. Globally, at least 33 percent of waste produced is openly dumped or burned, contributing to GHG emissions and accelerating climate change.[1] As a result, communities in proximity to waste disposal sites are exposed to unpleasant odors and contaminated water, tourism is threatened by environmental pollution, and marine wildlife is adversely impacted by ocean plastic.

Successfully responding to these challenges requires a coordinated response that engages local and national governments, businesses, civil society, and other partners. Since 2016, USAID has been working around the globe to advance SWM efforts that contribute to cleaner cities and healthier oceans. For example:

- From 2016 to 2021, USAID's Municipal Waste Recycling Program (MWRP) partnered with local and national governments, businesses, and civil society to implement sustainable and locally led SWM and recycling solutions in 32 locations across Indonesia, the Philippines, Sri Lanka, and Vietnam.[2]
- In 2019, USAID established the flagship Clean Cities, Blue Oceans (CCBO) program to implement the Save Our Seas 2.0 Act. CCBO is implemented under a five-year contract in collaboration with global, regional, and local stakeholders to promote Reduce, Reuse, and Recycling (3R) practices and improve SWM systems in over 25 cities in Asia, Pacific Islands, Latin America, and the Caribbean. The program prevents an estimated 11 million metric tons of plastic from flowing into the ocean each year.[3]
- In 2019, USAID partnered with Circulate Capital to incentivize private capital investment in the recycling value chain in South and Southeast Asia. The partnership is leveraging more than $100 million in private sector investments through a $35 million, 50 percent loan-portfolio guarantee through the Development Credit Authority.[4]
- In 2022, USAID launched the Save Our Seas Initiative (SOSI) to combat ocean plastics pollution globally, and PLUS to help cities achieve multiple development objectives, including reducing pollution and waste.[5]

Also in 2022, USAID launched its *Climate Strategy 2022-2030*, which aims to confront the climate crisis by prioritizing equitable and ambitious climate actions that achieve net-zero GHG emissions. USAID's SWM and ocean plastic programs are positioned to play an important role in advancing the Climate Strategy's mitigation target. With PLUS, USAID is working to integrate meaningful climate actions into its SWM programming, and to provide Mission staff and local partners with the tools,

[1] Kaza, S. et al., (2018). "What A Waste 2.0: A Global Snapshot of Solid Waste Management to 2050."
[2] USAID. (2020). "Partnering with Cities to Reduce Ocean Plastics – the Municipal Waste Recycling Program."
[3] USAID. (n.d.). "About Clean Cities, Blue Ocean."
[4] USAID. (n.d.). "Circulate Capital Partnership."
[5] USAID. (2022). "Program for Local and Urban Sustainability (PLUS): A Field Support Mechanism to Advance Integrated Urban Programming."

data, expertise, and other resources they need to drive additional GHG emissions reductions in the solid waste sector in accordance with the Climate Strategy targets and local SWM objectives.[6]

B. PURPOSE AND OBJECTIVES

This report aims to provide actionable information for USAID staff[7], Missions, and local partners working to advance climate mitigation as a top priority for the Agency's waste sector activities and initiatives. It highlights recent and ongoing SWM and ocean plastics activities, breaks down and describes key steps in the SWM value chain, identifies sources of GHGs across the value chain, and outlines specific opportunities for reducing GHG emissions. USAID and local partners can use this information to plan for, enhance, and supplement their portfolio of SWM activities and initiatives in a manner that drives additional GHG emissions reductions while simultaneously achieving local waste sector objectives.

C. METHODOLOGY

The following steps were taken to identify USAID activities in the solid waste sector, assess opportunities for GHG mitigation, and make associated recommendations.

- **Conducted one-hour consultations with the CCBO team and four USAID Missions** (Kenya/East Africa, Dominican Republic, Indonesia, and Peru) to gather information about current and planned SWM and ocean plastics activities, and to identify tools, resources, or training gaps that can help Missions achieve additional GHG emissions reductions while simultaneously enhancing SWM.
- **Reviewed key documents** shared by USAID Washington, Missions, CCBO, and the USAID Green Cities Division—and those published for CCBO and MWRP on UrbanLinks website—to gain a broader understanding of current and planned USAID SWM and ocean plastics activities.
- **Inventoried current and planned SWM and ocean plastics activities** identified during the one-on-one consultations and via the literature search. "Activities" refer to specific projects and tasks executed jointly by USAID and local partners. An activity typically includes local or national technical and capacity building support provided by international experts, local staff and consultants, program grantees, and private sector partners to improve SWM and reduce ocean plastics pollution.[8] For example, USAID's work to assess waste collection routes in Peru is counted as an activity, while CCBO's general engagement efforts in Peru in the absence of an on-the-ground project is not considered an activity.
- **Categorized the inventoried activities** by step in the SWM value chain (as depicted in **Figure 1** and **Appendix 1**).
- **Identified the GHG mitigation opportunities and recommendations** for each step in the value chain using information gathered via the consultations and a technical literature review.
- **Identified and examined key geographic and development considerations, as well as gender, equity, and social inclusion (GESI)** impacts for each GHG mitigation recommendation.

[6] USAID. (2022). "Program for Local and Urban Sustainability (PLUS): A Field Support Mechanism to Advance Integrated Urban Programming."
[7] This document is intended primarily for USAID Missions and their local partners responsible for on-the-ground planning and implementation of climate focused SWM activities. The terms "USAID staff" and "USAID" is used to refer broadly to all the Agency entities—including Missions, as well as Washington-based Bureaus and Operating Units—charged with advancing SWM and related GHG objectives.
[8] USAID. (2019). "CBCO Monitoring, Evaluation, and Learning Plan."

D. HOW TO USE THIS REPORT

The following bullets describe each section of this report and how USAID staff, Missions, and local partners can best use the information provided.

- **USAID Activities Across the SWM Value Chain.** This section describes the SWM value chain and categorizes recent and ongoing USAID activities that correspond to each step. USAID staff and local partners can use this section to gain familiarity with the universe of recent and ongoing SWM activities, and to consider how waste sector initiatives can be enhanced or supplemented in the future to drive additional GHG emissions reductions.
- **Overview of Solid Waste Sector Emissions and Mitigation Opportunities.** This section provides USAID staff and local partners with an overview of the sources of GHG emissions in the solid waste sector and identifies opportunities for mitigating carbon dioxide, methane, and black carbon along steps in the SWM value chain.
- **GHG Mitigation Opportunities and Recommendations.** This section provides summary tables that identify GHG mitigation opportunities and recommendations for each step in the SWM value chain. USAID staff and local partners can consider these opportunities and recommendations as they plan for, enhance, and supplement their portfolio of SWM activities.
- **Appendix 1.** This appendix provides a full list of current and planned USAID SWM activities and programs from 2016 – 2023, as identified via consultations with Missions and desktop research.
- **Appendix 2.** This appendix summarizes the key considerations for developing countries for key waste processing and treatment options. USAID staff and local partners can use this section to help assess the feasibility and applicability of these options to the local context.
- **Appendices 3-8.** These appendices provide key resources and additional considerations that are intended to supplement the summary tables provided in the GHG Mitigation Opportunities and Recommendations section.

The information provided in this report complements a separate document, the *GHG Monitoring and Reporting Guide*. This Guide identifies and describes a set of tools and methodologies that USAID and local partners can use to measure GHG emissions from their SWM programs and activities.

II. USAID SWM AND OCEAN PLASTICS ACTIVITIES WITH GHG MITIGATION OPPORTUNITIES

A. USAID ACTIVITIES ACROSS THE SWM VALUE CHAIN

The SWM value chain, depicted in Error! Reference source not found., refers to the chain of activities, p rocesses, and stakeholder interactions necessary for managing solid waste in an economically viable and environmentally sustainable manner. Successful implementation of SWM activities at each step in the value chain also involves cross-cutting policy, regulatory, and governance support to build the legal, regulatory, and oversight capacity of local and national governments. This value chain below is adapted from CCBO's "Wasteshed," which defines designated CCBO support areas where waste is produced, managed, and recovered or discarded.[9]

Figure 1: SWM Value Chain

Source: Adapted from USAID. (2019). "CBCO Monitoring, Evaluation, and Learning Plan."

USAID is currently implementing and planning a wide range of activities intended to improve SWM and reduce ocean plastics across the value chain. While some of these activities have the co-benefit of reducing GHG emissions, their primary objective is to help partners manage and reduce solid waste and ocean plastics. This report identifies 104 such activities undertaken from 2016 to 2023.

Table 1 includes several representative examples of USAID activities at each step in the SWM value chain. Information about these activities was gathered during one-on-one consultations with the CCBO team and four USAID Missions. A complete list of USAID activities undertaken from 2016 to 2023—identified via a literature search of the CCBO and MWRP websites—is provided in **Appendix 1**.

[9] USAID. (2019). "CBCO Monitoring, Evaluation, and Learning Plan."

Table 1: Examples of USAID Activities Along the SWM Value Chain

Step in SWM Value Chain	Example USAID Activities
Waste Prevention and Minimization Preventing and minimizing waste at the consumer level by advancing social and behavior changes in waste generators (e.g., households, businesses). Building capacity and providing technical guidance to businesses and their partners to reduce packaging waste	• Advancing social and behavior change for more sustainable waste reduction and post-consumer waste management among households, communities, and businesses in the Dominican Republic. • Increasing social awareness, especially among youth, on how plastic consumption and disposal practices impact plastic leakage into oceans in Mombasa, Kenya. • Partnering with businesses in Kepulauan Seribu (Thousand Islands), Indonesia, to promote the sale of goods in bulk to reduce the use of plastic packaging.[10]
Source Separation Sorting and separating waste into different waste streams (e.g., organics, plastics) at the point of waste generation	• Working with local grantees in Indonesia to establish and improve Waste Banks ("Bank Sampah"), which separate waste into different waste streams.[11] • Conducting behavioral change work to improve source separation of waste at the household level in Peru.
Collection and Transportation Collecting and transporting waste from the source to treatment plants or final disposal sites	• Building the capacity of local communities in Kota Semarang, Indonesia to manage solid waste aggregation facilities, engage informal collectors and recyclers, and enhance end-markets for collected recyclables.[12] • Assessing collection routes and transportation options to optimize waste collection routes in Peru and Indonesia.
Processing and Treatment (Pre-land Disposal) Pre-land disposal processes such as recycling, composting, and anaerobic digestion (AD), as well as thermal treatment from incineration and waste-to-energy (WtE) technologies	• Providing technical assistance to municipalities to get funding from the central government for piloting a composting project in Peru. • Working with local grantees to transform local organics and single-use plastics into usable products, such as ocean and climate-friendly compost and eco-bricks, through a community "Eco Hub."
Final Disposal (Land Disposal) Disposing waste at landfills or dumpsites, capturing landfill gas (LFG), and remediating dumpsites	• Providing technical guidance to remediate and close two open dumps, and design, develop, and open a new regional sanitary landfill in Las Terrenas and Santa Barbara, Dominican Republic. • Providing technical assistance to remediate two open dumps in Mancora, Peru as preparation for transforming it into a sanitary landfill with vents and methane collection systems.
Policy, Regulatory, Governance (cross-cutting) Strengthening the capacity of national and subnational governments to develop and implement policies and programs that improve and mitigate GHGs at every stage of the SWM value chain	• Supporting the development and implementation of Extended Producer Responsibility (EPR) regulation in Kenya. • Providing technical assistance to develop a SWM Master Plan that will help Kota Ambon, Indonesia establish a more cohesive and strategic approach to SWM. • Developing and implementing tools to increase the local governments capacity for waste management (e.g., Solid Waste Capacity Index for Local Governments, Solid Waste Cost-of-Service Analysis).

[10] USAID. (2023). "Small Island Solutions to a Global Challenge."
[11] World Bank. (2013). "Waste Not, Want Not: "Waste Banks" in Indonesia"
[12] USAID. (2023). "Indonesia Factsheet."

Applying a wider lens, **Figure 2** breaks out USAID's 104 SWM activities by step in the value chain. During this timeframe, **Collection and Transportation** constituted the largest share of USAID SWM and ocean plastics activities. Most **Collection and Transportation** activities focus on building the capacity of collectors, specifically in the informal sector, to gather and recycle waste. These activities are typically high-impact opportunities to improve and minimize the environmental impacts of SWM, and to enhance the livelihoods and health and safety of waste workers and communities surrounding waste sites. **Final Disposal** activities, including remediating or closing existing dumpsites and transitioning to sanitary landfills with environmental controls, made up the smallest share of USAID SWM and ocean plastics activities. These activities typically involve extensive long-term planning, complex permitting and approval processes, and new private sector partnerships, making them relatively more difficult and costly to implement.

Figure 2: Between 2016-2023, collection and transportation made up the largest share of USAID SWM/Ocean Plastics activities.

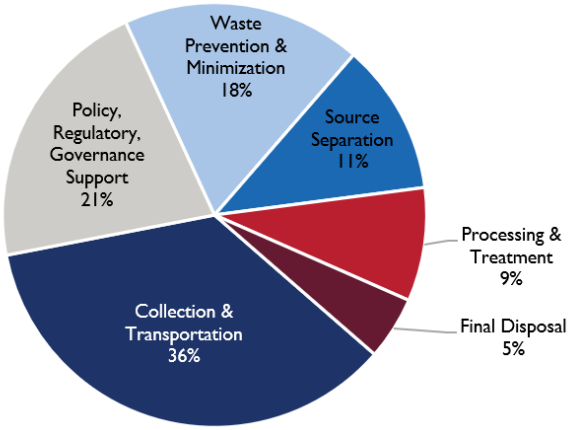
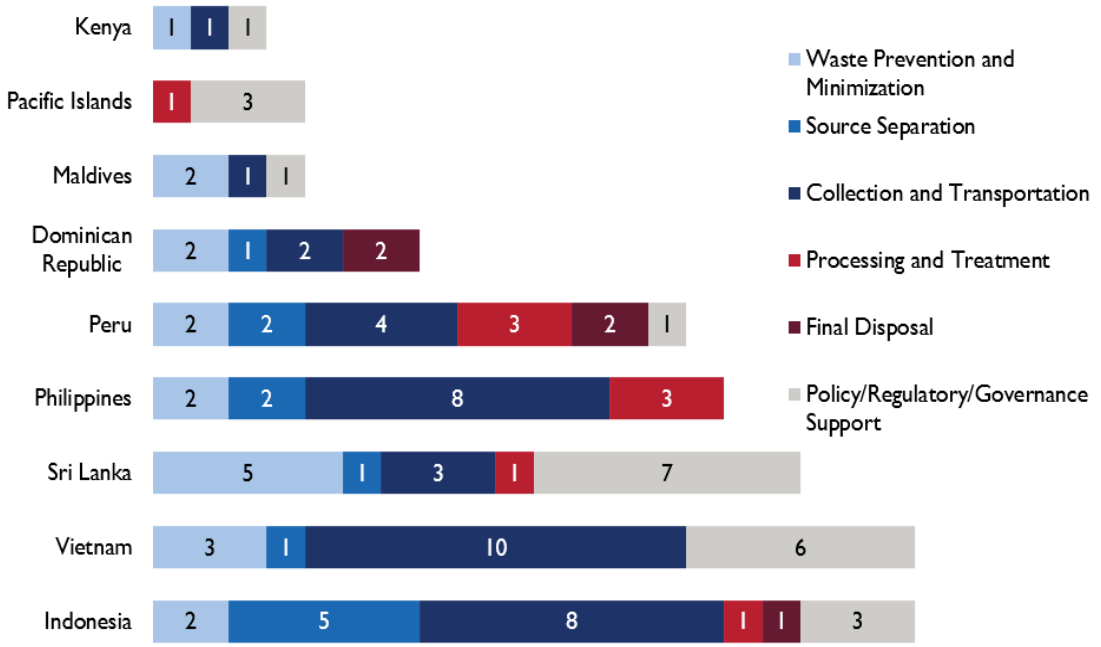


Figure 3 below categorizes USAID's 104 SWM activities by country and step in the value chain. USAID is currently active through CCBO and MWRP in nine countries, with notable involvement in Indonesia, Vietnam, and Sri Lanka (currently ramping up engagement in Kenya/East Africa).

Figure 3: USAID Activities by Country and Step in the SWM Value Chain



B. OVERVIEW OF SOLID WASTE SECTOR EMISSIONS AND MITIGATION OPPORTUNITIES

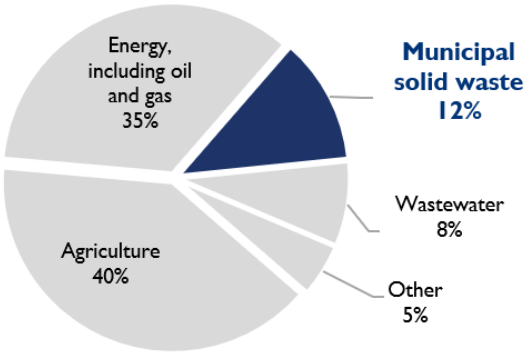
To advance Climate Strategy goals, USAID staff and local partners must be able to identify GHG emissions sources and associated mitigation opportunities at each step in the SWM value chain. With this information, the Agency can consider trade-offs between SWM activities and prioritize those that offer significant climate mitigation while simultaneously addressing local priorities for waste management, environmental protection, and human health.

GHG Emissions from the Solid Waste Sector

Globally, municipal solid waste makes up roughly five percent of total anthropogenic GHG emissions.[13] From a product lifecycle perspective—that accounts for GHG emissions from the extraction of raw materials and manufacturing of products before they become waste—this percentage is significantly higher. The UN International Resource Panel's 2019 Global Resources Outlook estimates that natural resource extraction and processing contribute to about half of all global GHG emissions.[14] Three GHGs are responsible for the significant majority of total waste sector emissions: carbon dioxide, methane, and black carbon.[15]

- **Carbon dioxide** is emitted throughout a product's lifecycle. At the **pre-consumer stage**—before products become waste, carbon dioxide is emitted from the consumption of fossil fuels during raw material extraction and product manufacturing. At the **post-consumer stage**—during waste management, carbon dioxide is emitted from the use of fossil fuels to power waste collection vehicles, processing and treatment facilities, and landfill tractors and compactors. It is also emitted as a byproduct from the decomposition of organic waste under anaerobic (low- or zero-oxygen) conditions at landfills and dumpsites, and from the burning of waste.
- **Methane** is emitted as a byproduct from the anaerobic decomposition of organic waste at landfills and open dumpsites. While treating organic waste at composting or AD facilities can significantly reduce methane emissions, small quantities of methane may still be emitted or leaked depending on a facility's approach to management and maintenance. Overall, the solid waste sector is the third largest source of methane, contributing to roughly 12 percent of all anthropogenic emissions (see **Figure 4**).[16] Compared to carbon dioxide, methane is 80 times more powerful at trapping heat in the atmosphere over 20 years, making it the most significant contributor to climate change in the solid waste sector. Methane is a "short-lived climate pollutant" (SLCP) that disappears from the atmosphere 12 years after it is emitted, which means cutting even a small amount of methane can have a significant near-term impact on climate change. Many waste sector methane reduction strategies—which may be as simple as separating organic waste—can be readily implemented with minimal up-front costs.

Figure 4: Municipal solid waste contributes 12 percent of global methane emissions, a short-lived climate pollutant (SLCP) with near-term warming



Source: UNEP & CCAC Global Methane Assessment

[13] UNEP. (2010). "Waste and Climate Change."
[14] UNEP. (2019). "Global Resources Outlook 2019: Natural Resources for the Future We Want – Summary for Policymakers."
[15] EPA. (2023). "Solid Waste Management and Climate Change."
[16] UNEP & CCAC. (2021). "Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions."

- **Black carbon,** a component of particulate matter[17], is emitted by the incomplete combustion of fossil fuels and burning of waste. Black carbon is not classified as a GHG because it is a solid particle or aerosol, not a gas. However, it is considered an SLCP (it stays in the atmosphere for several days) and has a warming impact of 500 to 1,500 times that of carbon dioxide per unit mass.[18]

Figure 5 below summarizes the sources of carbon dioxide, methane, and black carbon from the solid waste sector across the product lifecycle.

Figure 5: GHG Emissions Sources from the Solid Waste Sector

PRE-CONSUMER (UPSTREAM)	POST-CONSUMER (DOWNSTREAM)		
Raw Material Extraction and Product Manufacturing	**Solid Waste Collection and Transportation**	**Solid Waste Processing and Treatment**	**Solid Waste Final Disposal**
Carbon dioxide from energy consumed during raw material extraction and product manufacturing	**Carbon dioxide** and **black carbon** from fossil-fueled collection vehicles **Carbon dioxide** and **methane** from uncollected, decomposed, organic waste under anerobic conditions	**Carbon dioxide** and **methane** leakages from poor operations and maintenance of organic waste treatment facilities **Carbon dioxide** and **black carbon** from energy consumed during operation of processing and treatment facilities.	**Carbon dioxide** and **methane** from decomposed organic waste at unmanaged, unsanitary landfills without landfill gas capture systems or other control measures **Carbon dioxide** and **black carbon** from fossil-fueled landfill compactors and tractors **Carbon dioxide** and **black carbon** from landfill fires

Other GHGs emitted by the solid waste sector include **nitrous oxide** and **hydrofluorocarbons**. Like methane and carbon dioxide, nitrous oxide is emitted as a byproduct from the anaerobic decomposition of organic waste at landfills, open dumpsites, and—in small quantities—at composting and AD facilities. Hydrofluorocarbons are emitted from the improper disposal of products containing refrigerants (e.g., air conditioners, refrigerators). The amount of nitrous oxide and hydrofluorocarbon emitted by the solid waste sector is negligible compared to carbon dioxide, methane, and black carbon;[19] therefore, they are not a focus of this report.

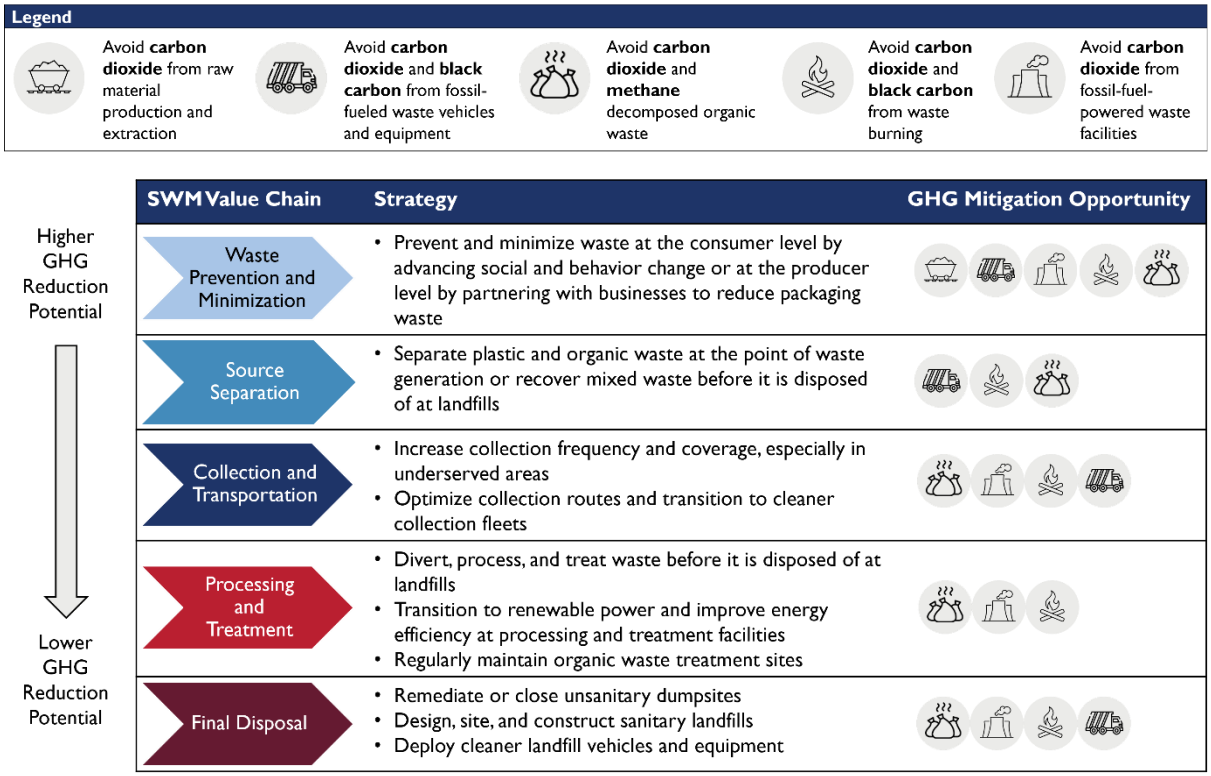
GHG Mitigation Opportunities Across the SWM Value Chain

Figure 6 summarizes key GHG mitigation opportunities at each step in the SWM value chain. Of the five steps, **Waste Prevention and Minimization** presents the most cost-effective and significant opportunity for GHG mitigation.[20] This is because reducing waste—by not consuming a product in the first place—avoids GHGs from the pre-consumer extraction of materials and manufacturing of products, as well as the post-consumer processing, treatment, and disposal of solid waste.

The second step in the SWM value chain, **Source Separation**, which involves separating waste into organic and inorganic streams at the point of waste generation, can help avoid GHGs by improving waste collection and transportation, as well as processing and treatment. Source separation can improve recycling and increase the value of recyclables by preventing contamination. It can also contribute to cleaner feedstock for more efficient waste treatment at composting, AD, or WtE facilities. Source Separation must be followed by proper waste collection, processing, and treatment in order to avoid GHGs from landfills because separated waste may still end up at landfills. While waste can be separated after it is collected, doing so incurs labor and infrastructure expenses and is therefore typically less cost-effective than source separation prior to collection.

[17] EPA. (n.d.). "Global Greenhouse Gas Emissions Data."
[18] CCAC. (n.d.). "Black Carbon."
[19] UNEP. (2010). "Waste and Climate Change."
[20] EPA. (2020). "Solid Waste Management Toolkit for Developing Countries."

Figure 6: GHG Mitigation Opportunities across the SWM Value Chain[21]



The third step in the SWM value chain is **Collection and Transportation**. Increasing the frequency of waste collection and expanding collection areas are essential for reducing carbon dioxide and methane emissions from improper waste disposal methods, such as open burning and dumping. Collection areas should include informal settlements, as well as living quarters for low-income, underserved, and marginalized populations. While increasing waste collection and transportation is important, these actions can be taken in tandem with optimizing collection routes and transitioning to low-emissions collection vehicles. Similarly, there may be opportunities to reduce transportation related GHG emissions by siting recycling and landfill infrastructure as close as possible to the waste source. Quantifying associated transportation related GHGs can provide useful information that local partners can consider as they make planning and infrastructure decisions regarding the location of processing and disposal sites.

Processing and Treatment is the fourth step in the SWM value chain. Taking action to process and treat waste before it reaches landfills is another opportunity to prevent GHGs resulting from incineration (without energy recovery), burning, or open dumping. Transitioning to renewable power at these facilities can further reduce carbon dioxide from power generation. **Table 2** summarizes the advantages and disadvantages of each waste processing and treatment option. Establishing material recovery facilities (MRF) and composting facilities are comparatively simple to implement and have lower upfront capital costs and operations and maintenance (O&M) costs. AD and WtE facilities are more technically complex, have higher upfront capital and O&M costs, and may have adverse environmental outcomes if not properly managed. **Appendix 2** includes additional factors that developing countries can consider when selecting waste processing and treatment options.

The fifth and last step in the SWM value chain is **Final Disposal** at landfills. Under circumstances in which proper waste management has occurred earlier in the value chain, this step has the lowest GHG reduction potential. This is because final disposal is a "last resort" waste management strategy

[21] Waste Prevention and Minimization *indirectly* avoids GHGs from "pre-consumer" material extraction and product manufacturing, as well as "post-consumer" waste management. Source separation also *indirectly* avoids GHGs by facilitating reductions in subsequent steps of the SWM value chain.

for materials that have not already been reused, recycled, or recovered for energy use. The reality in many developing countries, however, is that open dumping of waste at dumpsites or landfills is a common waste disposal method and a major source of GHGs. As such, remediating or closing existing open dumpsites is a key opportunity to reduce carbon dioxide and methane from legacy organic waste decay, as well as carbon dioxide and black carbon from landfill fires. Converting open dumpsites to sanitary landfills with leachate[22] collection, soil cover, and LFG collection systems can help mitigate the impacts of land disposal on human health and the environment. Deploying cleaner landfill vehicles and equipment (e.g., landfill compactors and tractors) can further reduce carbon dioxide and black carbon from fossil-fueled vehicles.

Table 2: Advantages and Disadvantages of Different Waste Processing and Treatment Options[23]

Treatment Facility	Advantages	Disadvantages
MRF: Sorts and prepares recyclable materials—using both people and machines—to sell to end-users and manufacturers.	• High waste diversion rates of up to 70 percent • Relatively low up-front capital cost (US$70 – US$75/tons per year (TPY)) and Operation and Maintenance cost (O&M) (US$35 – US$38/ton)	• Exposure to dust and other contaminants by MRF workers while manually sorting waste • A market for recyclables may not exist
Composting facility: Converts organic waste into compost, a nutrient-rich soil-like material that can be used as soil amendment or fertilizer through the decomposition of organic waste with microorganisms (e.g., worms) in aerobic (oxygenated) conditions.	• Relatively simple to implement • Relatively low up-front capital cost (US$75 – US$80/TPY) and O&M (US$40 – US$45/ton) • Compost can be used as soil amendment or fertilizer	• Can produce GHG emissions if aerobic conditions are not maintained, and organic waste decomposes anaerobically in open air • Requires organic feedstock with low contamination rates, consistent with high-quality compost • A market for compost may not exist
AD facility: Converts organic waste into biogas through a controlled anaerobic decomposition process in an enclosed, low- to zero-oxygen tank.	• Biogas produced from AD can be used as a clean energy source • Digestate—the material left after AD happens—can be used as organic fertilizer, animal bedding, crop irrigation, and other products	• Medium-high complexity • Relatively high up-front capital cost (US$140 – US$250/TPY, depending on project scale) and O&M (US$20 – US$60/ton[24]) • Biogas leakages may occur at AD facilities if they are not properly operated and routinely maintained • Requires organic feedstock with low contamination rates to maximize biogas production[25] • A market for biogas/digestate may not exist

[22] Leachate is a contaminated liquid generated from water percolating through solid waste piles.
[23] Correal, M. and Rihm, K. "Towards the Valorization of Solid Waste in Latin America and the Caribbean."
[24] Kaza et al., (2018). "What a Waste 2.0."
[25] EPA. (2020). Solid Waste Management Toolkit for Developing Countries."

Treatment Facility	Advantages	Disadvantages
WtE facility: Converts mixed waste into energy by burning it and capturing the resulting heat.	• Energy recovered can be used to displace fossil fuels • Completely removes organic waste	• Medium-high complexity • Relatively high up-front capital cost (US$500 – US$700/TPY) and O&M (US$65 – US$90/ton) • Requires energy-rich feedstocks with low moisture content (e.g., plastics, paper, yard waste), which may be difficult to obtain without proper source separation[26] • Requires highly qualified operating staffs (e.g., electrical, mechanical, or chemical engineers) • Emits carbon dioxide and may emit local air toxics • Potential for public resistance due to environmental impacts

[26] EPA. (2020). Solid Waste Management Toolkit for Developing Countries."

III. GHG MITIGATION OPPORTUNITIES AND RECOMMENDATIONS

This section discusses GHG mitigation opportunities and recommendations that USAID staff, Missions, and local partners can consider as they plan and prioritize new waste sector activities, and enhance existing initiatives in a manner that drives additional GHG emissions reductions while simultaneously achieving local waste sector objectives.

The first subsection below describes an illustrative framework that can support climate focused SWM planning and implementation. Each additional subsection provides a summary table of GHG mitigation opportunities and recommendations for plastic and organic waste—the two largest waste categories that make up over half of global waste composition[27]—that corresponds to steps in the SWM value chain. The legend for each summary table is below (**Table 3**).

The GHG mitigation opportunities and recommendations described below are proven, replicable, and well understood. They have been successfully implemented in cities and communities around the world and have the potential to reduce GHGs at a low or moderate implementation cost in most situations and geographic locations. While several of the recommendations provided under **Waste Prevention and Minimization** and **Source Separation** do not reduce GHGs directly, they support reductions in subsequent steps of the SWM value chain. Additional details on each opportunity and recommendation—including key resources and related development, geographic, GESI, and co-benefits considerations—are provided in **Appendices 3-8**.

Table 3: Legend for GHG Mitigation Opportunities and Recommendations Summary Tables

Legend	
Applicable Waste Material	**GHG Mitigation Opportunity**
Organic waste	Avoid **carbon dioxide** and **black carbon** from fossil-fueled waste vehicles and equipment
Plastic waste	Avoid **carbon dioxide** and **methane** from organic waste decomposition
	Indirectly avoid GHGs
	Avoid **carbon dioxide** from raw material production and extraction
	Avoid **carbon dioxide** and **black carbon** from burning waste
	Avoid **carbon dioxide** from fossil-fuel-powered waste facilities

A. CLIMATE FOCUSED SWM PLANNING AND IMPLEMENTATION

With the tiered approach to prioritizing waste sector GHG mitigation in **Figure 6**, USAID Missions can collaborate with local partners to design and execute a climate focused SWM planning and implementation process that can be applied at the level of a city, region, and country. [28] Such a process can consider key local factors, such as political preferences, location-specific mitigation opportunities, and resource availability. USAID Missions and local partners can also consider factors such as existing SWM infrastructure, applicable local regulations and programs, waste type and quantity being generated, potential sources of GHG emissions, and key stakeholders.

An important overlay to any successful SWM planning and implementation process is consideration of key waste sector variables, such as local geography and climate, the degree of urbanization, and prevailing economic circumstances. It is similarly important to account for the role that women

[27] Kaza, et al. (2018). "What a Waste 2.0."

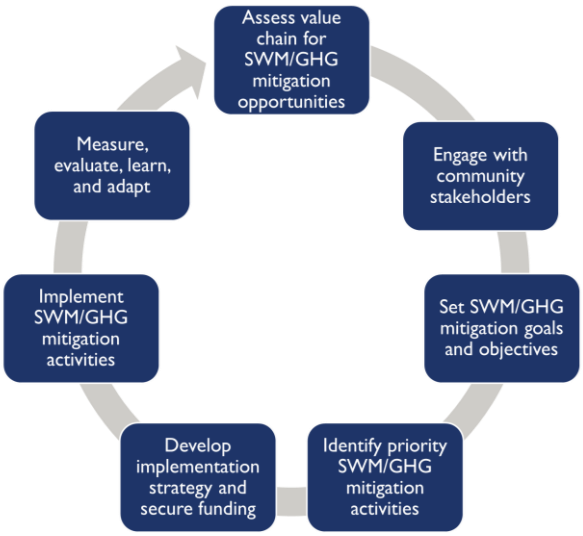
[28] While this section is intended primarily for USAID Missions and local partners engaged in "in-country" SWM planning, this information may also be useful for internal USAID purposes.

and under-represented populations, mainly informal waste collectors, currently play in the SWM value chain, as well as the geographic and spatial distribution of SWM facilities—and associated local air pollution impacts—in densely populated areas (**Appendices 3-8** identify key considerations for each of the SWM recommendations in **Section III**). By addressing these topics early in the planning process, USAID Missions and their partners can better position themselves to identify, prioritize, and implement a set of locally appropriate SWM strategies that not only reduce GHG emissions, but are sustainable and durable over longer time frames.

Figure 7 at right offers an illustrative framework that can be used as applicable to support climate focused SWM planning and implementation. It identifies a series of key steps—such as assessing the SWM value chain for additional waste management and GHG mitigation opportunities, collaborating with community stakeholders, setting goals, and implementing SWM activities—and is sufficiently flexible to accommodate the above factors and considerations. The Framework also reinforces the importance of measuring GHG emissions reductions, evaluating program effectiveness, and adapting SWM plans and activities to support the achievement of SWM and GHG reduction goals over time.

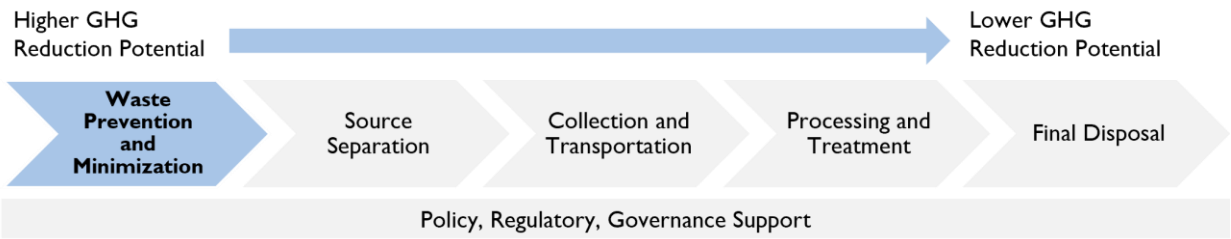
Once a planning and implementation process is underway, USAID and local partners can consult a separate document, the *GHG Monitoring and Reporting Guide*, to support the development of robust approaches for measuring and reporting GHG emissions reductions (as shown in the last step of the Framework).

Figure 7: Illustrative Framework for Climate Focused SWM Planning and Implementation



Source: Adapted from USAID. (2018). "Sector Environmental Guideline for Solid Waste."

B. WASTE PREVENTION AND MINIMIZATION



Waste generation is expected to rapidly increase due to increased consumption and production patterns, economic development, and population growth. Preventing and minimizing waste presents the highest GHG mitigation opportunity. It can avoid carbon dioxide from pre-consumer raw material extraction and product manufacturing, as well as carbon dioxide, black carbon, and methane from post-consumer waste management processes.

The two waste materials with the highest GHG mitigation potential include:

- **Plastic (a type of inorganic waste).** Prioritizing plastics for waste prevention is critical because 90 percent of GHG emissions associated with the plastic lifecycle come from production, transportation, refining, and conversion of fossil fuels into plastic products.[29]

[29] USAID. (2022). "Links between Plastic Pollution and Climate Change. Technical Guidance for USAID Mission Ocean Plastic Champions."

- **Food waste (a type of organic waste).** Minimizing food waste avoids emissions from the pre-consumer production and transportation of food, as well as post-consumer emissions from the disposal and decomposition of organic waste. Food waste accounts for approximately 8 to 10 percent of global GHG emissions.[30] It also decomposes in landfills faster than any other type of organic waste (e.g., yard waste), increasing the potential for methane emissions.[31] For these reasons, USAID's Climate Strategy includes reductions in food loss and waste as a key opportunity for GHG mitigation.[32]

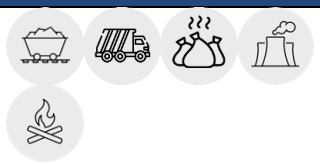
A key step when planning waste prevention and minimization activities is conducting a waste characterization study to identify the types and amount of waste being generated by sector (e.g., households, businesses). While this step does not result in GHG reductions directly, it can help decision-makers understand where to target waste prevention efforts.

Table 4 provides a brief summary of select recommendations for reducing GHGs through **Waste Prevention and Minimization.** The recommendations are not listed in any specific order. Refer to **Table 3** on page 16 for the legend. Refer to **Appendix 3** for more information on related development, geographic, co-benefits, and GESI considerations, as well as key resources for each recommendation.

Table 4: Summary of GHG Mitigation Opportunities and Recommendations for Waste Prevention and Minimization

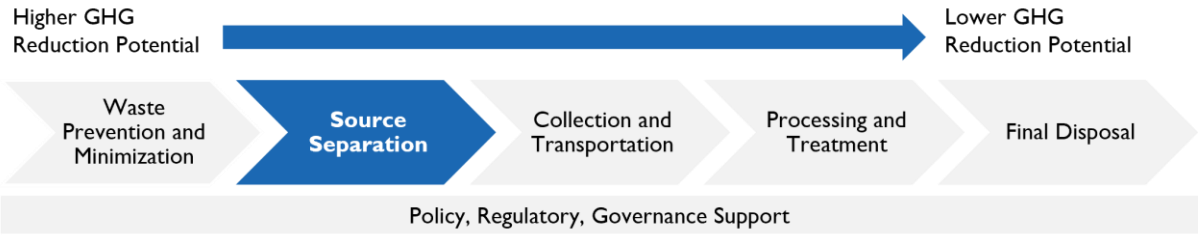
GHG Mitigation Recommendations	Applicable Waste Material	GHG Mitigation Opportunity
Utilize social and behavioral change research, which helps local governments and policymakers identify impactful and sustainable behavioral changes to reduce waste. Employing Trials of Improved Practices, a research approach that involves asking a small sample of people in the population to test certain behavioral changes, can help determine whether they are feasible and sustainable.[33]		
Organize household food waste campaigns that raise awareness about the benefits of reducing food waste and the practical ways people can do so at home.		
Support the integration of food waste reduction into school curriculum. USAID, through the MWRP program, funded the Centre for Social and Development to design curricula on plastic waste recycling for schools in Hue, Vietnam. This was replicated and implemented in 35 schools across the city.[34]		
Provide technical guidance and capacity building support to crop farmers and food wholesalers and retailers to reduce food loss and waste.[35]		

[30] UNEP. (2021). "UNEP Food Waste Index Report 2021."
[31] Kaza, S. et al. (2018). "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050."
[32] USAID. (2022). "USAID Climate Strategy 2022-2030."
[33] USAID. (2023). "Trials of Improved Practices Manual."
[34] USAID. (2023). "Schools Stem the Tide of Plastic Pollution, Spark Waste Reduction."
[35] World Bank. (2020). "Addressing Food Loss and Waste: A Global Problem with Local Solutions."

GHG Mitigation Recommendations	Applicable Waste Material	GHG Mitigation Opportunity
Promote food donation, especially at hotels, grocery stores, supermarkets and restaurants with surplus prepared food, produce, meat, bakery, and dairy items that remain safe to consume.[36]		
Partner with international and local businesses to reduce packaging waste, including strategies like bulk vending and refillable containers for certain products (e.g., nuts, grains, milk). In 2021, for example, USAID MWRP partnered with businesses in Kapulauan Seribu (Thousand Islands), Indonesia, to promote the sale of goods in bulk to reduce the use of plastic packaging.[37]		
Leverage extended producer responsibility (EPR) policies, including taxes on plastic manufacturers and recycled content standards to set requirements for the quantity of recycled plastic used in new products.[38]		
Implement recycling laws and incentives, including subsidies for manufacturers that meet specific criteria to reduce plastic pollution. This includes pay-as-you throw (PAYT) policies that require people to pay a fee to dispose of waste, landfill bans to ban certain materials from entering a landfill, and deposit-refund schemes to incentivize recycling of certain plastic products such as bottles or bags.[39]		
Organize behavior change and educational campaigns to raise awareness about the negative ecological, social, and economic impacts of single-use plastics, as well as the benefits of reducing plastic waste by switching to alternatives such as reusable metal straws instead of plastic straws, reusable grocery bags, etc.		
Invest in locally appropriate and innovative technology and infrastructure, which may include plastic alternatives (e.g., biobased plastics made from biomass such as corn, sugarcane, wheat, or residues of other products), detect/manage marine plastic pollution, install stormwater and wastewater filters, and increase access to infrastructure to maintain a successful recycling system and reduce plastic "leakage" into the ocean.		

[36] EPA. (2015). "Reducing Wasted Food and Packaging: A Guide for Food Services and Restaurants."
[37] USAID. (2023). "Small Island Solutions to a Global Challenge."
[38] EPA. (2023). "Best Practices for Solid Waste Management: Addressing Plastic Waste"
[39] Ibid.

C. SOURCE SEPARATION



Separating plastic and organic waste at the source is a key opportunity to avoid methane and carbon dioxide emissions that would otherwise occur at each subsequent step in the SWM value chain. Organic waste typically accounts for over half of the total solid waste stream in low-income countries.[40] Separating organics before they are collected and disposed of at landfills can reduce carbon dioxide emissions from transportation because this fraction of the waste stream is dense, heavy, and requires larger collection vehicles that consume more fuel. It can also increase the diversion of organics from landfills, preventing methane emissions that result from decomposition. Alternatively, separating plastics can improve recycling by preventing contamination from food and other organic wastes. Improved recycling can increase the value and marketability of recyclables, reducing waste generation and disposal at landfills and avoiding GHGs at both pre-consumer and post-consumer stages.

Table 5 provides a brief summary of select recommendations for reducing GHGs through **Source Separation** activities and associated GHG mitigation opportunities. The recommendations are not listed in any specific order. Refer to **Table 3** on page 16 for the legend. Refer to **Appendix 4** for more information on related development, geographic, co-benefits, and GESI considerations, as well as key resources for each recommendation.

Table 5: Summary of GHG Mitigation Opportunities and Recommendations for Source Separation

Recommendations	Applicable Waste Material	GHG Mitigation Opportunity
Support the development and implementation of **regulations** that incentivize or require plastic (inorganic) and organic waste source separation.		
Organize educational campaigns and awareness programs aimed at helping households and other waste generators learn about the different types of waste and effective disposal methods. Providing clear instructions on what can be recycled in which bins is critical for preventing the contamination of recyclable materials such as plastics. This approach can additionally reduce the labor and energy costs associated with cleaning and decontaminating recyclable materials.		
Engage the informal sector on organic waste separation. Informal waste workers rely on recycling for income and therefore play an important role in improving recycling rates. These workers are typically less focused on recovering organic waste due to its lower economic value.		

[40] Kaza, S. et al., (2018). "What A Waste 2.0: A Global Snapshot of Solid Waste Management to 2050."

Recommendations	Applicable Waste Material	GHG Mitigation Opportunity
Increase access to source separation infrastructure to encourage greater participation in source separation efforts. For example, many cities have color coded communal bins (e.g., blue for paper waste, green for recyclable packaging, gray for organics) in multifamily housing complexes or neighborhoods. Some cities have waste collection push carts, bicycles, or vehicles, with separate bags or bins for different waste materials so that waste collectors can separate organic and plastic waste as they collect them.		

D. COLLECTION AND TRANSPORTATION

Frequent waste collection, especially in underserved communities, is a key opportunity to reduce carbon dioxide, methane, and black carbon from illegal dumping and burning. Many low- and middle-income countries rely on fossil-fueled collection vehicles. From a lifecycle GHG emissions perspective, increasing waste collection coverage and frequency using fossil-fueled collection trucks contributes to carbon dioxide. However, when compared to methane and carbon dioxide from illegal dumping at unsanitary, unmanaged, landfills, this contribution is comparatively minor.

A recent study by the Regional Resource Center for Asia and the Pacific found that GHG emissions from unsanitary landfills[41] are three times higher than GHG emissions from transporting waste from the source to processing and treatment facilities and landfills.[42] Therefore, expanding and increasing the frequency of waste collection in similar circumstances is typically a priority. This can be paired with the deployment of low-emissions collection vehicles to further decrease the carbon footprint of SWM collection and transportation.

Table 6 provides a brief summary of select recommendations for reducing GHGs through **Collection and Transportation** activities and associated GHG mitigation opportunities. The recommendations are not listed in any specific order. Refer to **Table 3** on page 16 for the legend. Refer to **Appendix 5** for more information on related development, geographic, co-benefits, and GESI considerations, as well as key resources for each recommendation.

Table 6: Summary of GHG Mitigation Opportunities and Recommendations for Collection and Transportation

Recommendations	Applicable Waste Material	GHG Mitigation Opportunity
Support the expansion of collection service coverage and frequency to underserved communities to prevent illegal dumping and open burning and reduce associated carbon dioxide and methane emissions. Waste collection services in developing countries are often only available in more affluent or central areas.		

[41] Landfills or open dumpsites that are not engineered or monitored to prevent air pollution, and water and soil contamination from solid waste.
[42] Verma, R. and Borongan, G. (2022). "Emissions of Greenhouse Gases from Municipal Solid Waste Management System in Ho Chi Minh City of Vietnam." Regional Resource Centre for Asia and the Pacific.

Recommendations	Applicable Waste Material	GHG Mitigation Opportunity
Support the transition to low- or zero-emission collection vehicles to reduce the carbon footprint of waste collection. In Rio De Janeiro, the municipal waste management corporation purchased electric waste collection vehicles to collect hospital waste across the city.[43]		
Optimize collection routes to maximize collection coverage and so that collection vehicles follow the most efficient paths, have full loads, and reduce fuel consumption.		
Support formalization of informal waste collection. Informal workers rely on collecting waste and recovering recyclables as a source of income. However, they often lack the required equipment to collect waste, making their collection process unsafe and inefficient. For example, some informal workers collect recyclable materials from open dumpsites, streets, or community bins without any protective gear, and transport large and heavy loads by bike or carts. Formalizing informal waste collection can help increase collection rates, while improving the livelihoods of informal workers and minimizing the environmental and climate impacts of mismanaged waste.		

E. PROCESSING AND TREATMENT (PRE-LAND DISPOSAL)

Diverting organic waste from landfills and processing it using processing and treatment technologies (e.g., MRV, composting, AD, and WtE) is a key opportunity for preventing carbon dioxide and methane emissions that result from improper downstream incineration, burning, and open dumping of plastic and organic waste. Transitioning to renewable power and improving energy efficiency at processing and treatment facilities can further eliminate carbon dioxide emissions from fossil fuel powered equipment and machinery.

Table 7 provides a brief summary of select recommendations for reducing GHGs through **Processing and Treatment (Pre-Land Disposal)** activities and associated GHG mitigation opportunities. The recommendations are not listed in any specific order. Refer to **Table 3** on page 16 for the legend. Refer to **Appendix 6** for more information on related development, geographic, co-benefits, and GESI considerations, as well as key resources for each recommendation.

[43] CCAC. (2018). "Webinar: Best Practices for Waste Characterisation."

Table 7: Summary of GHG Mitigation Opportunities and Recommendations for Processing and Treatment (Pre-Land Disposal)

Recommendations	Applicable Waste Material	GHG Mitigation Opportunity
Provide technical support for selecting and deploying technologies to treat organic and plastic waste. **Table 2** and Appendix 2 lists advantages and disadvantages, as well as the feedstock, cost, operations and maintenance, and other factors to consider for MRF, composting, AD, and WtE. Potential areas for technical support may include identifying the types, quantities, and sources of waste to be processed and treated, appropriately sizing treatment facilities, identifying end-markets to sell end products such as recyclables, biogas, compost, or electricity, and identifying sources of funding to finance the project.		
Build the capacity of workers to operate and maintain organic waste treatment facilities[44] by establishing education programs that cover basic digestor operational fundamentals, process control, laboratory and leak testing, and maintenance. This can avoid methane leakages that occur when organic waste treatment facilities are not routinely maintained.		
Provide technical support for the establishment and upgrade of MRFs to increase the quantity and quality of recycled materials, including plastics. MRFs include a combination of technologies and manual labor to sort and clean recyclables. Typically, more mechanized MRFs have higher capacity to sort and clean recyclables, and, therefore, higher GHG reduction potential. Manual MRFs that rely on hand sorting can process up to 1,500 tons of recyclables per year. Semi-mechanized MRFs with some machines (e.g., conveyor belts, weighing and compaction equipment, separation and packaging equipment) and some manual labor can process between 1,500 and 40,000 tons of recyclables per year. Totally mechanized MRFs with many machines and little to no manual labor can process over 40,000 tons of recyclables per year.[45]		
Improve energy efficiency and transition to clean energy sources at processing and treatment facilities. This is critical because turning recyclable materials into new products is an energy intensive process. Improving energy efficiency and transitioning to clean energy sources at MRF, AD, composting, WtE, and other processing and treatment facilities can reduce or eliminate carbon dioxide from fossil fuel powered equipment and machinery.		

[44] Organic waste treatment facilities divert and convert organic waste (e.g., food waste, yard waste) into useful products. Composting and AD are common types of organic waste treatment facilities.
[45] Correal, M. and Rihm, K. "Towards the Valorization of Solid Waste in Latin America and the Caribbean."

Recommendations	Applicable Waste Material	GHG Mitigation Opportunity
Promote the treatment of organic waste at home, including yard waste and food waste from food preparation and leftovers, before they are sent for processing or to landfills. Household composting may include vermicomposting (worm composting) in a small bin in the kitchen, as well as composting in large piles in the yard. Small-scale AD systems may also be used to process organic waste. The gas generated may be used for cooking and the digestate as soil amendment in the garden. While home composting or AD systems may not have a large impact on GHG reductions compared to large-scale facilities, they could be a good way to build awareness about organic waste management.		
Provide technical, capacity building, and financial support for the establishment of "Waste Banks", decentralized and small-scale recycling facilities. Waste Bank staff, typically local residents, receive, separate, and bundle recyclable materials, and sell them to recyclers. Some waste banks may have the equipment to turn recyclable materials into new products. The Waste Bank model was first established in Indonesia and successfully replicated in other countries, such as Thailand[46] and the Philippines.[47] CCBO is currently working with local grantees to improve waste bank facilities in Kota Makassar, Indonesia. MWRP worked to improve waste bank facilities in Raja Ampat Islands and South Sulawesi, Indonesia in 2021.		
Provide technical assistance and capacity building support for establishing measurement, reporting, and verification (MRV) systems for tracking the GHG emissions and emissions reductions at waste treatment facilities. Measuring these emissions at the facility-level can provide local, subnational and national governments with the data needed to set ambitious reduction targets, deploy targeted reduction solutions, and track emissions reductions progress. When implementing an MRV system, considerations include developing a measurement plan and methodology, understanding the interested parties that may require submission of a report, and identifying a third-party to verify data.		

F. FINAL DISPOSAL (LAND DISPOSAL)

Remediating or closing existing dumpsites and designing, siting, and constructing sanitary landfills engineered to prevent air pollution, and water and soil contamination, are key opportunities to

[46] Fang, E. (2020). "One Man's Trash is Another Man's Treasure: The Success of Thailand's Waste Bank Initiative."
[47] World Vision. (2022). "Generating Incomes form Wastes."

capture the carbon dioxide and methane emissions from decomposed organic waste, and to reduce carbon dioxide and black carbon from landfill fires at unmanaged landfills. Deploying cleaner landfill vehicles and equipment at dumpsites is an additional approach that avoids carbon dioxide.

Table 7 provides a brief summary of select recommendations for reducing GHGs through **Final Disposal (Land Disposal)** activities and associated GHG mitigation opportunities. The recommendations are not listed in any specific order. Refer to **Table 3** on page 16 for the legend. Refer to **Appendix 7** for more information on related development, geographic, co-benefits, and GESI considerations, as well as key resources for each recommendation.

Table 8: Summary of GHG Mitigation Opportunities and Recommendations for Final Disposal (Land Disposal)

Recommendations	Applicable Waste Material	GHG Mitigation Opportunity
Provide technical assistance to national governments to remediate or close existing dumpsites. In the Dominican Republic, CCBO provided technical guidance to the national government to safely remediate and close open dumps in Las Terrenas and Santa Barbara de Samana. Stormwater and leachate management systems were constructed in remediated dumpsites to prevent leakage into local groundwater.[48]		
Provide technical assistance in the design, siting, and construction of a sanitary landfill. Sanitary landfills are engineered to prevent air pollution, and water and soil contamination when managing waste. In addition to the remediation of the two open dumps in Samana, Dominican Republic, CCBO is providing technical assistance to the design and siting of the regional and provincial sanitary landfill.		
Provide technical assistance to recover LFG from landfills. LFG can be used as a clean energy source that avoids emissions from fossil energy consumption, while simultaneously reducing local methane emissions. CCBO is remediating two open dumps in Mancora, Peru as preparation for transforming it into a sanitary landfill with vents and methane collection systems.		
Advocate for landfill fees and bans to incentivize waste diversion for recovery through processing and treatment. Most low-income countries have no or low tipping fees—a charge paid by anyone who disposes of waste in landfills. Charging a fee can disincentivize landfill disposal and encourage recycling and reuse. Banning certain materials or items from being disposed of at landfills (e.g., organics) can prevent potential methane emissions from organic waste decomposition.		

[48] USAID. (2023). "A model for waste site remediation to reduce climate impacts and ocean plastic pollution."

Recommendations	Applicable Waste Material	GHG Mitigation Opportunity
Deploy cleaner landfill vehicles and equipment. Local partners can support countries with the procurement of electric or renewable-powered vehicles and equipment to support landfill operations. One option includes procuring vehicles and equipment powered by renewable natural gas (RNG) derived from LFG.[49]		
Engage with and build the capacity of private sector actors, such as landfill managers and operators. Many cities have found success in hiring trained landfill managers to properly operate and manage sanitary landfill sites.[50] Typically, before waste is disposed of at landfills, the manager develops a plan to manage the waste at the site. The plan specifies the site location for waste disposal, how often and where soil cover will be used, what environmental controls are in place to minimize environmental impacts, how often waste gets compacted, how LFG will be monitored and managed, etc.		

G. POLICY, REGULATORY, GOVERNANCE SUPPORT

Strengthening the capacity of national and subnational governments to develop and implement policies and programs that improve SWM is a key opportunity to mitigate GHGs at every stage of the SWM value chain.

[49] RNG-powered vehicles and equipment are fueled by LFG captured from landfills instead of natural gas or diesel. Landfill operators can send the LFG captured and collected at the landfill to RNG facilities for processing and conversion into RNG. This RNG can then be used to power RNG vehicles and equipment operating at landfills, creating a circular economy.

[50] EPA. (2020). "Solid Waste Management Toolkit for Developing Countries."

Table 9 provides a brief summary of select recommendations for reducing GHGs through **Policy, Regulatory, and Governance Support** activities and associated GHG mitigation opportunities. The recommendations are not listed in any specific order. Refer to **Table 3** on page 16 for the legend. Refer to **Appendix 8** for more information on related development, geographic, co-benefits, and GESI considerations, as well as key resources for each recommendation.

Table 9: Summary of GHG Mitigation Opportunities and Recommendations for Policy, Regulatory, Governance Support

Recommendations	Applicable Waste Material	GHG Mitigation Opportunity
Provide technical assistance on the design and implementation of EPR policies that transfer the responsibility of managing the end-of-life of products to producers (e.g., raw material manufacturers, packers or fillers, brand companies, retailers). EPRs can target different points in a product's lifecycle. Local partners can consider providing technical assistance to countries/stakeholders on EPR design, stakeholder consultation, data collection, and implementation.		
Build capacity for local and regional governments to include GHG mitigation considerations and opportunities when developing SWM plans, which are often required by law.		
Support the development and implementation of PAYT programs that impose waste collection fees on waste generators, which can disincentivize waste generation and offer a source of finance for waste collection.		
Provide technical assistance on the design of recycled content standards, certification schemes, or product standards that require producers to specify that a certain percentage of their products or packaging is made from recycled materials. These standards can increase the demand for recycled materials. For example, governments may require that recycled plastics make up at least 50 percent of the plastic products from manufacturers, packagers, or consumer product companies. Governments can also align their public procurement policies with the recycled content standards.[51] Recycled content standards reduce the need for virgin raw materials, thereby avoiding carbon dioxide from raw material extraction. Similarly avoids carbon dioxide and black carbon from improper disposal of recyclable materials (e.g., incineration and burning)**.**		
Provide technical assistance on the design and implementation of national strategies to reduce food loss and waste. Strategies may involve requiring companies to measure and report food loss and waste, standardizing food date labeling, supporting informal food retailers to better manage food, or including food waste reduction in school curricula.		

IV. CONCLUSION: SUMMARY OF GHG MITIGATION OPPORTUNITIES AND RECOMMENDATIONS

Implementing the *Climate Strategy 2022-2030* requires USAID to view its suite of international development and humanitarian initiatives through a climate lens, and to evaluate these initiatives for GHG reduction opportunities. USAID staff and Missions can use the information contained in this report to lead discussions with local partners on opportunities to plan for, enhance, and supplement

[51] OECD. (2022). "Global Plastics Outlooks: Economic Drivers, Environmental Impacts and Policy Options."

their SWM activities to reduce GHG emissions while simultaneously achieving local objectives for managing solid waste.

While there is no "one-size-fits-all" approach to lowering waste sector GHG emissions, ongoing discussions with local partners can encourage the implementation of SWM activities that have greater GHG reduction potential. In particular, USAID can steer resources and attention to preventing and minimizing waste. Activities that avoid waste in the first place are widely recognized as the most cost-effective SWM activity with the highest GHG reduction potential.[52] As described above, these actions avoid GHG emissions from "pre-consumer" product manufacturing as well as from "post-consumer" waste handling and disposal. Another opportunity for USAID to drive significant GHG reductions is to encourage local partners to focus on diverting waste to recycling and treatment facilities. This can be accomplished through proper source separation, collection, and transportation. In cases where disposal at dumpsites or landfills is unavoidable, USAID can encourage GHG-reducing activities related to remediation and improved landfill design and operation, such as capturing methane gas for "beneficial uses".

With this tiered framework for waste sector GHG reductions in hand, USAID Missions can collaborate with local partners to design and execute a climate focused SWM planning and implementation process. **Figure 7** presents one approach to standing up such a process, with consideration of key local factors such as political priorities, location-specific mitigation opportunities, and resource availability. USAID and its partners can similarly consider factors such as existing SWM infrastructure, applicable local regulations and programs, waste type and quantity being generated, potential sources of GHG emissions, and key stakeholders.

An important overlay to any successful SWM planning process is consideration of related factors, such as local geography and climate, the level of urbanization, and prevailing economic circumstances (refer to **Appendices 3-8** for key considerations for each recommendation discussed in **Section III**). It is similarly important to account for the role that women and under-represented populations, especially informal waste collectors, currently play in the SWM value chain, as well as the geographic and spatial distribution of SWM facilities (and associated pollution impacts) in densely populated areas. By understanding this context, USAID and its partners can more effectively collaborate to set mitigation goals and identify, prioritize, and implement the set of locally appropriate SWM strategies with the highest GHG reduction potential.

Once a climate focused planning and implementation process is underway, an important next step is identifying and adopting approaches for measuring the GHG impacts. The PLUS team's consultations found that there is opportunity to take additional steps in this area, given that USAID does not currently require the use of a uniform set of GHG measurement protocols, methodologies, or indicators to evaluate its SWM and ocean plastics activities. As a result, USAID is likely undercounting the full GHG impact of its recent and ongoing SWM activities towards achieving Climate Strategy goals. The lack of widespread use of a GHG measurement approach may also be hindering USAID's visibility into the types of SWM activities that maximize on-the-ground reductions, and therefore its ability to align future planning and program decisions with the Climate Strategy.

Information about best-practice approaches for measuring GHG emissions across the value chain is available in a separate document, the *GHG Monitoring and Reporting Guide*.

[52] EPA. (2020). "Solid Waste Management Toolkit for Developing Countries."

APPENDICES

APPENDIX 1: USAID SWM AND OCEAN PLASTIC ACTIVITIES SUMMARY TABLE

The table below identifies and categorizes USAID SWM and ocean plastic activities under each step of the SWM value chain. This information was collected in consultation with CCBO and Missions, as well as via a literature search of the CCBO and MWRP webpages. "Activities" here refer to specific projects and tasks executed jointly by USAID and local partners. An activity typically includes local or national technical and capacity building support provided by international experts, local staff and consultants, program grantees, and private sector partners to improve SWM and reduce ocean plastics pollution (i.e., general discussions or engagement, in the absence of an on-the-ground project is not considered an activity). For example, USAID's work to assess waste collection routes in Peru is counted as an activity, while CCBO's more general engagement efforts in Peru are not.

Table 9: Summary Table of USAID SWM and Ocean Plastics Activities Under Each Step of the SWM Value Chain

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Developing new programs to aggregate and return recyclable materials to the local circular economy, in partnership with local hotels, businesses, and emerging recycling businesses	Collection and Transportation	Samana	Dominican Republic	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_DR_-FS_Feb_2023_508-1.pdf
Building local capacity for communities to manage solid waste aggregation facilities and enhance end markets	Collection and Transportation	Kota Semarang	Indonesia	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Indonesia_FS_Jan23_508.pdf
Strengthening local government coordination and capacity for handling solid waste collection and transport	Collection and Transportation	Thousand Islands	Indonesia	2016-2021	MWRP	https://urban-links.org/wp-content/uploads/DCA-Fact-Sheet_Sep23.pdf

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Developing tech for ocean plastic prevention and expanded recycling	Collection and Transportation	Denpasar	Indonesia	2016-2021	MWRP	https://urban-links.org/wp-content/uploads/Gringgo-Fact-Sheet_USAID.pdf
Using public-private partnership to improve Semarang city waste management and recycling	Collection and Transportation	Semarang	Indonesia	2016-2021	MWRP	https://urban-links.org/wp-content/uploads/BINTARI-Fact-Sheet_USAID.pdf
Assessing collection routes and transportation options to optimize routes	Collection and Transportation		Indonesia	2023	CCBO	PLUS Consultations
Piloting new programs to aggregate and return recyclables, enhance end markets, and engage informal sector	Collection and Transportation		Indonesia	2023	CCBO	PLUS Consultations
Working with local partners to strengthen the island's waste management system by creating a system for regular plastic collection, engaging with Women's Development Committees to increase opportunities for additional income through new and improve waste collection services, increasing recycling rates through compacting stations and promoting reuse and reduction of waste	Collection and Transportation	Baa Atoll	Maldives	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Maldives_FS_Jan23_508.pdf
Strengthening Routing and Collection for Improved Waste Management Fact Sheet	Collection and Transportation	Pisco	Peru	2023	CCBO	https://urban-links.org/wp-content/uploads/Final_FactSheet_RoutingAndCollection_508.pdf

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Building local government capacity to advance SWM, including through improved and expanded waste collection services	Collection and Transportation	Pisco	Peru	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Peru_FS_Feb_2023_508.pdf
Assessing collection routes and transportation options to optimize routes	Collection and Transportation		Peru	2023	CCBO	PLUS Consultations
Piloting new programs to aggregate and return recyclables, enhance end markets, and engage informal sector	Collection and Transportation		Peru	2023	CCBO	PLUS Consultations
Establishing "Eco-Ikot" (Eco-Circular) Centers to collect and provide a source of low-value plastics and other waste that can be made into new recycled plastic goods, create jobs for local women, and serve as a community education center	Collection and Transportation	Paranaque	Philippines	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Philippines_FS_Jan23_508.pdf
Building local government capacity and helping local waste collectors to establish profitable, sustainable waste businesses	Collection and Transportation	Manila	Philippines	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Philippines_FS_Jan23_508.pdf
Collecting Better Data to Manage Plastic Waste in Manila Bay	Collection and Transportation	Manila	Philippines	2016-2021	MWRP	https://urban-links.org/wp-content/uploads/20210629-UGA-Fact-Sheet-1-1.pdf

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Supporting grants to Catholic Relief Services to train and mentor 89 interested local residents as door-to-door waste collectors to improve SWM services in the target barangays	Collection and Transportation	Manila	Philippines	2016-2021	MWRP	https://urban-links.org/insight/from-informal-waste-collectors-to-recycling-business-owners/
Bringing technology to waste collectors	Collection and Transportation	Manila	Philippines	2016-2021	MWRP	https://urban-links.org/wp-content/uploads/USAID-MWRP-Phil-World-Vision-6-13-19.pdf
Workingd with SWM officials to improve collection efficiency	Collection and Transportation	Negombo and Katunayake	Sri Lanka	2016-2021	MWRP	https://urban-links.org/wp-content/uploads/Janathakshan-Fact-Sheet_Sept23.pdf
Establishing private waste collection enterprises and provided outreach and education on collecting recyclable items	Collection and Transportation		Sri Lanka	2016-2021	MWRP	https://urban-links.org/wp-content/uploads/SL-Sevanatha_6-13-19.pdf
Working to establish and build the capacity of informal waste collector cooperatives to formalize their role in waste management, increase their collection volumes and earnings, and improve worker safety and protections	Collection and Transportation	Bien Hoa	Vietnam	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Vietnam_FS_Jan23_508.pdf

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Supporting the effort by developing public-private partnerships and engaging with informal waste collectors to build their capacity, support their integration into municipal waste operations, and align their services with increasing waste demands	Collection and Transportation	Da Nang	Vietnam	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Vietnam_FS_Jan23_508.pdf
Promoting plastic waste reduction strategies	Collection and Transportation	Phu Quoc	Vietnam	2016-2021	MWRP	https://urban-links.org/wp-content/uploads/WWF_Moving-toward-plastic-free-island-living-003.pdf
Building a green city through women-led plastic recycling	Collection and Transportation	Da Nang	Vietnam	2016-2021	MWRP	https://urban-links.org/wp-content/uploads/20200510-MWRP-Vietnam-CECR-Factsheet.pdf
Testing and scaling innovative waste collection tools	Collection and Transportation	Nam Dinh	Vietnam	2016-2021	MWRP	https://urban-links.org/wp-content/uploads/USAID-MWRP-Vietnam-MCD-Nam-Dinh-Final-.pdf
Reducing mismanaged plastic waste by organizing independent waste collectors	Collection and Transportation	Ho Chi Minh City	Vietnam	2016-2021	MWRP	https://urban-links.org/resource/mwrp-vietnam-reducing-mismanaged-plastic-waste-through-healthier-waste-entrepreneurs/
Developing technical guidance to remediate and take steps toward closure of two open dumps in Las Terrenas and Santa Bárbara de Samaná and design, develop, and open a new regional sanitary landfill	Final Disposal	Samana	Dominican Republic	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_DR_-FS_Feb_2023_508-1.pdf

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Providing technical guidance to landfill operators on safety protocols and equipment to improve the livelihood and safety of those working in the waste sector	Final Disposal	Samana	Dominican Republic	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_DR_-FS_Feb_2023_508-1.pdf
Conducting dumpsite remediation of two open dumps in Mancora Peru in preparation for turning it into a sanitary landfill; Installing vents and methane collection systems at dumpsites	Final Disposal	Mancora	Peru	2023	CCBO	PLUS Consultations
Providing technical support for improving informal dumpsites and sanitary landfills	Final Disposal		Peru	2023	CCBO	PLUS Consultations
Providing technical support for improving informal dumpsites and sanitary landfills	Final Disposal		Indonesia	2023	CCBO	PLUS Consultations
Providing technical assistance to develop a SWM Master Plan that will help the city better understand its existing solid waste system and improve management	Policy/Regulatory/ Governance Support	Kota Ambon	Indonesia	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Indonesia_FS_Jan23_508.pdf
Working with partners to develop and pilot a community-based waste management model, focusing on households and hotels and to integrate waste management into the island's annual socio-economic development plans	Policy/Regulatory/ Governance Support	Phu Quoc	Vietnam	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Vietnam_FS_Jan23_508.pdf

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Working to strengthen the local authority over the management of plastic waste and advance Extended Producer Responsibility schemes	Policy/Regulatory/ Governance Support	Colombo	Sri Lanka	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Sri-Lanka_FS_Jan23_508.pdf
Partnering with local grantees to improve coordination and participatory decision-making related to SWM planning to move the city towards a circular economy—including, developing an Integrated SWM Action Plan that formalizes the role of the informal waste collector and the services they provide.	Policy/Regulatory/ Governance Support	Galle	Sri Lanka	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Sri-Lanka_FS_Jan23_508.pdf
Building the capacity of local government waste management systems and, through local grantees, is working to reduce inorganic waste from the cities' artisanal fishing sector in their landing sites	Policy/Regulatory/ Governance Support	Paita and Mancora	Peru	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Peru_FS_Feb_2023_508.pdf
(Future) Facilitating a Solid Waste Capacity Index for Local Government in select cities so that local governments can improve their capacity to develop and implement robust SWM systems	Policy/Regulatory/ Governance Support		Pacific Islands	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Pacific-Islands_-FS_Jan23.pdf

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
(Future) Collaborating with the Secretariat of the Pacific Regional Environmental Programme to support the development of the Pacific Stakeholders Landscape Analysis Report and update its Pacific Regional Action Plan on Marine Litter 2018-2025	Policy/Regulatory/ Governance Support		Pacific Islands	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Pacific-Islands_-FS_Jan23.pdf
Combining extended Producer Responsibility with Stakeholder Responsibility	Policy/Regulatory/ Governance Support	Semarang	Indonesia	2021	MWRP	https://urban-links.org/wp-content/uploads/Bintari-Fact-Sheet_Sept23.pdf
Harnessing the Power of City Governments to Reduce Ocean Plastic Pollution	Policy/Regulatory/ Governance Support		Indonesia	2021	MWRP	https://urban-links.org/wp-content/uploads/GIDKP_Harnessing-the-power-of-Cities-Governments.pdf
Establishing a stronger legal framework for tackling ocean plastic pollution	Policy/Regulatory/ Governance Support		Sri Lanka	2021	MWRP	https://urban-links.org/wp-content/uploads/PILF_A-stronger-legal-framework-for-tackling-ocean-plastic-pollution.pdf
Building consensus on Sri Lanka's extended producer responsibility approach	Policy/Regulatory/ Governance Support		Sri Lanka	2021	MWRP	https://urban-links.org/wp-content/uploads/CCC_Building-consensus-on-Sri-Lanka%E2%80%99s-extended-producer-responsibility-approach.pdf
Helping city government develop a ten-year SWM and recycling plan	Policy/Regulatory/ Governance Support	Hoi An	Vietnam	2021	MWRP	https://urban-links.org/wp-content/uploads/GreenViet-Fact-Sheet_Sept23.pdf

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Conducting a workshop on plastic waste	Policy/Regulatory/ Governance Support	Ha Long	Vietnam	2021	MWRP	https://urban-links.org/wp-content/uploads/GreenHub_Raising-public-engagement-in-coastal-heritage-area-1.pdf
Strengthening existing waste management by providing technical assistance to local government authorities	Policy/Regulatory/ Governance Support	Nam Dinh	Vietnam	2020	MWRP	https://urban-links.org/wp-content/uploads/USAID-MWRP-Vietnam-MCD-Nam-Dinh-Final-.pdf
Supporting policy, regulations, and incentives to promote improved waste management	Policy/Regulatory/ Governance Support	Ha Long	Vietnam	2019	MWRP	https://urban-links.org/wp-content/uploads/USAID-MWRP-Vietnamn-MCD-Ha-Long-Bay-Final-.pdf
Supporting the development and implementation of Extended Producer Responsibility (EPR) regulation	Policy/Regulatory/ Governance Support		Kenya	2023	CCBO	PLUS Consultations
Working with local grantees to increase waste management capacity, improve community recycling systems and waste bank facilities, and enhance local government participation	Source Separation	Kota Makassar	Indonesia	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Indonesia_FS_Jan23_508.pdf
Transforming local organics and single-use plastics into usable products, such as ocean and climate change-friendly compost and eco-bricks, through a community "Eco Hub"	Processing and Treatment	Pasig	Philippines	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Philippines_FS_Jan23_508.pdf

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Partnering with Bank Sampah to support a community waste recycling program	Processing and Treatment	Raja Ampat Islands	Indonesia	2021	MWRP	https://urban-links.org/wp-content/uploads/Misool-Foundation-Fact-Sheet_Sept23.pdf
Transforming a SWM system through the use of waste banks	Source Separation	South Sulawesi	Indonesia	2021	MWRP	https://urban-links.org/wp-content/uploads/MWRP-Transformasi-fact-sheet.pdf
Using public-private partnership to improve Semarang City waste management and recycling	Processing and Treatment	Semarang	Indonesia	2018-2020	MWRP	https://urban-links.org/wp-content/uploads/BINTARI-Fact-Sheet_USAID.pdf
Establishing a private sector partnership to build a sustainable recycling system	Processing and Treatment	Manila	Philippines	2021	MWRP	https://urban-links.org/wp-content/uploads/USAID-MWRP-Phil-World-Vision-6-13-19.pdf
Building local capacities to treat solid waste	Processing and Treatment	Manila	Philippines	2021	MWRP	https://urban-links.org/wp-content/uploads/USAID-Mother-Earth-Fact-Sheet.pdf
Providing technical assistance to municipalities to solicit funding from central government for pilot composting project	Processing and Treatment		Peru	2023	CCBO	PLUS Consultations
Working with local grantees to improve community recycling systems and waste bank facilities	Source Separation	Kota Makassar	Indonesia	2023	CCBO	PLUS Consultations

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
(Future) Providing technical assistance through the provision of experts in SWM, marine litter, dumpsite remediation, recycling, materials recovery facility, and other areas	Processing and Treatment		Pacific Islands	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Pacific-Islands_-FS_Jan23.pdf
Working with the local government, businesses, and households to promote and increase waste segregation for improved recycling rates	Source Separation	Pisco	Peru	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Peru_FS_Feb_2023_508.pdf
Expanding recycling by households and small businesses, especially in the tourism sector where recycling can generate employment	Source Separation	Thousand Islands	Indonesia	2021	MWRP	https://urban-links.org/wp-content/uploads/DCA-Fact-Sheet_Sep23.pdf
Converting low-value plastic waste into marketable products	Source Separation	Manila	Philippines	2021	MWRP	https://urban-links.org/wp-content/uploads/PBE_Converting-low-value-plastic-waste-into-marketable-products.pdf
Improving household waste segregation at source	Source Separation	Manila	Philippines	2021	MWRP	https://urban-links.org/wp-content/uploads/USAID-Mother-Earth-Fact-Sheet.pdf
Teaching at-source separation to 8,123 individuals in 21 towns	Source Separation		Sri Lanka	2021	MWRP	https://urban-links.org/wp-content/uploads/USAID-SL-SLCDF-Fact-Sheet-Update_Jan2020.pdf
Training 15,6000 students, teachers and schools on plastic waste recycling	Source Separation	Hue	Vietnam	2021	MWRP	https://urban-links.org/wp-content/uploads/CSRD-Fact-Sheet_Sept23.pdf

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Conducting behavioral change work to improve source separation of waste	Source Separation		Peru	2023	CCBO	PLUS Consultations
Conducting ethnographic research on SWM in Samana Province, Dominican Republic	Waste Prevention and Minimization	Saman	Dominican Republic	2023	CCBO	https://urban-links.org/wp-content/uploads/2023.06.29_USAID-CCBO_DR_Ethnographic-Research-on-SWM_508.pdf
Reducing single-use plastics through social and behavior change research	Waste Prevention and Minimization	N/A	Maldives	2023	CCBO	https://urban-links.org/wp-content/uploads/2023_USAID-CCBO_Reducing-SUPs-Through-SBC_508.pdf
Working with local partners to promote more sustainable household waste practices that reduce the use of single-use plastics and aim for plastic-free lifestyles	Waste Prevention and Minimization	Male	Maldives	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Maldives_FS_Jan23_508.pdf
Advancing social and behavior change for more sustainable waste practices among households, communities, and businesses	Waste Prevention and Minimization	Samana	Dominican Republic	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_DR_-FS_Feb_2023_508-1.pdf
Partnering with leading companies to reduce their plastic footprint; engaging local and national government authorities to design and launch three plastic recovery centers in the Kaduwela Municipal Council	Waste Prevention and Minimization	Colombo	Sri Lanka	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Sri-Lanka_FS_Jan23_508.pdf

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Developing a social and behavior strategy to support the adoption of responsible waste management behaviors.	Waste Prevention and Minimization	Paita and Mancora	Peru	2023	CCBO	https://urban-links.org/wp-content/uploads/USAID_CCBO_Peru_FS_Feb_2023_508.pdf
Testing a cost-effective model for "zero-waste" in Indonesian communities	Waste Prevention and Minimization	Bandung	Indonesia	2021	MWRP	https://urban-links.org/wp-content/uploads/MWRP-GAIA-YPBB-Factsheet.pdf
Piloting of bulk stores that avoid plastic packaging, which is especially important on small islands where the first step is to reduce the volume of plastics waste that must be managed	Waste Prevention and Minimization	Thousand Islands	Indonesia	2021	MWRP	https://urban-links.org/wp-content/uploads/DCA-Fact-Sheet_Sep23.pdf
Educating millions about ocean plastic pollution via Metro Manila's shopping malls	Waste Prevention and Minimization	Manila	Philippines	2021	MWRP	https://urban-links.org/wp-content/uploads/PRRCFI-SM-Fact-Sheet_Sept23.jpg
Encouraging plastic waste reduction in marine protected areas	Waste Prevention and Minimization	Puerto Princesa	Philippines	2021	MWRP	https://urban-links.org/wp-content/uploads/C3MC-Fact-Sheet_Sept23.pdf
Empowering local communities to reduce plastic waste in marine environments	Waste Prevention and Minimization		Sri Lanka	2021	MWRP	https://urban-links.org/wp-content/uploads/SLCDF-Jaffna_-Empowering-local-communities.pdf
Training 25 schools in plastic waste reduction and recycling approaches	Waste Prevention and Minimization		Sri Lanka	2021	MWRP	https://urban-links.org/wp-content/uploads/USAID-SL-SLCDF-Fact-Sheet-Update_Jan2020.pdf

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Collaborating with local supermarket chains to reduce plastic shopping bag use	Waste Prevention and Minimization	Negombo and Katunayake	Sri Lanka	2021	MWRP	https://urban-links.org/wp-content/uploads/Janathakshan-Fact-Sheet_Sept23.pdf
Testing innovative fishing technology to mitigate Styrofoam waste leakage from fish farms into Ha Long Bay and Bai Tu Long Bay	Waste Prevention and Minimization	Ha Long	Vietnam	2021	MWRP	https://urban-links.org/wp-content/uploads/GreenHub_Raising-public-engagement-in-coastal-heritage-area-1.pdf
Reducing single-use plastic by mandating eat-in lunches and introducing reusable utensils	Waste Prevention and Minimization	Hue	Vietnam	2021	MWRP	https://urban-links.org/wp-content/uploads/CSRD-Fact-Sheet_Sept23.pdf
Building the capacity of the private sector–especially collectors, recyclers, and manufacturers–to create a robust circular economy, while also creating jobs	Collection and Transportation	Mombasa	Kenya	2023	CCBO	PLUS Consultations
Increasing social awareness, especially among youth, on how people's plastic consumption and disposal practices impact plastic leakage into oceans in order to change behavior	Waste Prevention and Minimization	Mombasa	Kenya	2023	CCBO	PLUS Consultations
Centralizing collection improvements, resulting in 240 informal dumps that will be converted into eight landfills with transfer stations	Collection and Transportation	N/A	Dominican Republic	2023	CCBO	PLUS Consultations
Addressing behavior change by setting up a pilot for source segregation and improved collection	Source Separation	N/A	Dominican Republic	2023	CCBO	PLUS Consultations

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Providing technical assistance to municipalities to solicit central government funding; Working with the central government to pilot composting, collecting organic waste	Processing and Treatment	N/A	Peru	2023	CCBO	PLUS Consultations
Reducing waste through promotion of alternative materials	Waste Prevention and Minimization	N/A	Vietnam	2023	CCBO	https://urban-links.org/ccbo-in-vietnam/
Establishing recycling collection centers	Collection and Transportation	N/A	Philippines	2023	CCBO	https://urban-links.org/insight/from-the-field-empowering-women-entrepreneurs-to-combat-plastic-pollution-in-the-philippines
Providing training for women IWC to establish or expand their collection businesses	Collection and Transportation	N/A	Philippines	2023	CCBO	https://www.youtube.com/watch?v=UMudS8XuUJ0&t=2s
Providing training for women IWC to establish or expand their collection businesses	Collection and Transportation	N/A	Indonesia	2023	CCBO	https://www.youtube.com/watch?v=UMudS8XuUJ0&t=2s
Creating better working conditions and a safe environment for IWC	Collection and Transportation	N/A	Philippines	2023	CCBO	https://urban-links.org/insight/eco-warriors-from-waste-collectors-to-community-leaders
Testing new models of waste collection in Phu Quoc for communities that are not covered by the public waste collection services	Collection and Transportation	N/A	Vietnam	2023	CCBO	https://urban-links.org/ccbo-in-vietnam/

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Partnering with the Asian Society for Social Improvement and Sustainable Transformation (ASSIST) to create an innovative public-private partnership scheme that integrates informal waste collectors into municipal waste operations at selected community material recovery facilities, transfer stations, and at landfill	Collection and Transportation	N/A	Vietnam	2023	CCBO	https://urban-links.org/ccbo-in-vietnam/
Partnering with Environment and Development in Action (Enda Vietnam) to establish and build the capacity of informal waste collector cooperatives to formalize their role in waste management, increase their collection volumes and earnings, and improve safety conditions through the provision of appropriate protective gear	Collection and Transportation	N/A	Vietnam	2023	CCBO	https://urban-links.org/ccbo-in-vietnam/
Partnering with Ham Long Research and Support Center for Social Work (HLC) to strengthen networking within government, high-profile experts, the private sector, informal and formal waste collectors, and members of women and youth unions	Collection and Transportation	N/A	Vietnam	2023	CCBO	https://urban-links.org/ccbo-in-vietnam/
Piloting an improved and localized SWM system with Ham Long Research and Support Center for Social Work (HLC) to address the mounting issue of poor waste management in two wards in Hue city to better sustain community behavior change by strengthening internal resources, environmental practices, and local capacity	Policy/Regulatory/ Governance Support	N/A	Vietnam	2023	CCBO	https://urban-links.org/ccbo-in-vietnam/

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Collaborating with Prevented Ocean Plastic Indonesia, a subsidiary of Prevented Ocean Plastic Southeast Asia, to explore advanced collection and recycling infrastructure in the rapidly urbanizing cities of Semarang and Makassar to strengthen a supply chain model for recycled plastic	Collection and Transportation	N/A	Indonesia	2023	CCBO	https://urban-links.org/ccbo-in-indonesia/
Developing inorganic waste management models for fishing operations with World Wildlife Fund (WWF-Peru) in Mancora and Paita's landing sites. Models will focus on circular economy principles—recycling inorganic fishing waste, plastics, and addressing the issue of abandoned, lost, or otherwise discarded fishing gear	Processing and Treatment	N/A	Peru	2023	CCBO	https://urban-links.org/ccbo-in-peru/
Developing an education and communication strategy and related resources with Inforegion Agencia de Prensa Ambiental to promote the adoption of responsible waste management behaviors, based on formative behavior change research to identify public's perception regarding waste and the drivers or change	Waste Prevention and Minimization	N/A	Peru	2023	CCBO	https://urban-links.org/ccbo-in-peru/
Partnering with Ceylon Chamber of Commerce (CCC), who, in 2021 and 2022, built off their grant from USAID's Municipal Waste Recycling Program to increase the amount of PET and HIPS packaging that was collected and upcycled by creating private sector consortium to facilitate implementation	Collection and Transportation	N/A	Sri Lanka	2023	CCBO	https://urban-links.org/ccbo-in-sri-lanka/

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Collaborating with Human and Environment Links Progressive Organization (HELP-O) to improve coordination and participatory decision-making for solid waste management planning in Galle that can move the city towards a circular economy model	Policy/Regulatory/ Governance Support	N/A	Sri Lanka	2023	CCBO	https://urban-links.org/ccbo-in-sri-lanka/
Partnering with the Island Climate Initiative (ICI) to support local and national companies reduce their single-use plastic footprint through a series of challenges where innovators can propose solutions to specific challenges that companies are facing in reducing or eliminating plastic from their operations	Waste Prevention and Minimization	N/A	Sri Lanka	2023	CCBO	https://urban-links.org/ccbo-in-sri-lanka/
Partnering with Janathakshan to work closely with local and national government authorities to design and launch three plastic recovery centers in the Kaduwela Municipal Council, Colombo	Processing and Treatment	N/A	Sri Lanka	2023	CCBO	https://urban-links.org/ccbo-in-sri-lanka/
Engaging with Public Interest Law Foundation (PILF), who carried out a comprehensive review and assessment of the existing legal and regulatory frameworks on plastic use and waste management in Sri Lanka under the USAID Municipal Waste Recycling Program	Policy/Regulatory/ Governance Support	N/A	Sri Lanka	2023	CCBO	https://urban-links.org/ccbo-in-sri-lanka/
Collaborating with SEVANATHA Urban Resource Center to strengthen the waste value chain by identifying and filling gaps in source separation, collection, policies, and markets for plastic materials in Moratuwa. By involving and incorporating feedback from multiple stakeholders, Sevanatha will design and test a 3R	Policy/Regulatory/ Governance Support	N/A	Sri Lanka	2023	CCBO	https://urban-links.org/ccbo-in-sri-lanka/

USAID Activity	Step in the SWM Value Chain	City/Province	Country	Year	Initiative	Source
Action Plan that advances the Moratuwa Municipal Council toward its zero waste goals						
Engaging with Soneva Namoona, who is building on its Soneva Namoona program that works with island communities on waste management. Soneva is working with the local Atoll Council to audit current waste management systems and address system gaps—ultimately creating and piloting an island model for waste management that can be replicated across Baa Atoll and other island communities	Policy/Regulatory/ Governance Support	N/A	Maldives	2023	CCBO	https://urban-links.org/ccbo-in-maldives/
Partnering with Pacific Island Recycling Foundation, in collaboration with Waste Recyclers Fiji Ltd and as part of Fiji's national solid waste strategy, to design and build I-Recycle Hub Bins in Suva City making recycling more user-friendly	Policy/Regulatory/ Governance Support	N/A	Pacific Islands	2023	CCBO	https://urban-links.org/pacific-islands-federated-states-of-micronesia-fiji-and-papua-new-guinea/

APPENDIX 2: KEY CONSIDERATIONS FOR WASTE PROCESSING AND TREATMENT OPTIONS SUMMARY TABLE

The table below summarizes the key considerations for developing countries for different waste processing and treatment options. The information in this table was taken from a technical note by the Inter-American Development Bank.[53]

Table 10: Summary Table of Key Considerations for Waste Processing and Treatment Options

Considerations	Material Recovery Facility (MRF)	Composting	Anaerobic Digestion (AD)	Waste-to-Energy (WtE)
Inputs	• **Feedstock:** Mixed waste	• **Feedstock:** Organic waste with low contamination	• **Feedstock:** Organic waste with low contamination	• **Feedstock:** Energy-rich feedstocks with low moisture content (e.g., plastics, paper, yard waste)
Outputs	• Recyclable materials. Amount of recyclables produced depends on the number and types of machines used. MRFs that are highly mechanized (i.e., uses conveyor belts, weighing and compaction equipment, and separation and packaging equipment) can process more tons of recyclables per year	• Compost • Leachate (if composting piles are not properly drained)	• Biogas • Digestate to use as soil amendment or fertilizer • Wastewater	• Electricity and heat • Ash
Costs	• **Capital expenditure (CAPEX):** US$70 – US$75/tons per year (TPY) • **Operations and maintenance (O&M):** US$35 – US$38/ton	• **CAPEX:** US$75 – US$80/TPY • **O&M:** US$40 – US$45/ton	• **CAPEX:** US$140 – US$250/TPY, depending on project scale • **O&M:** US$20 – US$60/ton[54]	• **CAPEX:** US$500 – US$700/TPY • **O&M:** US$65 – US$90/ton
Technical Complexity	• Medium	• Low-medium	• Medium-high	• High
Potential impacts	• Odors, noise, or visual pollution	• GHG emissions can occur if aerobic conditions are not	• Biogas leakages can occur at AD facilities if they are	• Carbon dioxide and toxic air pollutants (e.g., particulate

[53] Correal, M. and Rihm, K. "Towards the Valorization of Solid Waste in Latin America and the Caribbean."
[54] Kaza et al., (2018). "What a Waste 2.0."

Considerations	Material Recovery Facility (MRF)	Composting	Anaerobic Digestion (AD)	Waste-to-Energy (WtE)
	• MRF workers can be exposed to dust and other contaminants while manually sorting waste; Requires proper ventilation and the provision of protection equipment (e.g., dust masks, gloves) to minimize health and safety risks	maintained, resulting in organic waste that decomposes anaerobically in open air; Requires compost piles to be regularly aerated (by turning the pile or installing perforated pipes) to maintain oxygenated conditions; Also requires compost piles to be well-drained to prevent leachate formation	not properly operated and routinely maintained • Odor impacts can occur in waste reception or feeding areas (the process itself does not generate odors)	matter, nitrogen oxide) can occur, potentially impacting public health in surrounding communities
Conditions for successful introduction of technology	• Qualified and trained personnel to operate machinery and manually classify and separate waste • Enabling legislation or regulation that requires or incentivizes MRFs to separate waste, and that creates a market for recyclable products	• Organic waste feedstock with low contamination rates—both for inorganic materials and for pathogens, trace metals, and per- and polyfluoroalkyl substances (PFAS)—that lead to high-quality compost • Enabling legislation and regulations that require or incentivize composting, and that create a market for the sale of compost	• Organic waste feedstock with low contamination rates to enhance digester efficiency, high levels of gas production, and clean digestate • Qualified and trained personnel to operate machinery and monitor for biogas leakages • Enabling legislation or regulation that creates a market for biogas as an alternative, clean source of energy	• Energy-rich feedstocks with low moisture content (e.g., plastics, paper, yard waste), which may be challenging for cities and regions without source separation. Some countries may have regulations that prohibit the burning of waste with low energy content • Qualified and trained personnel to operate WtE plants, including expertise in electrical, mechanical, or chemical engineering • Strong regulatory and environmental standards and protocols in place to reduce the associated climate, health, and environmental risks[55]

[55] For example, in Copenhagen, the Copenhill WtE plant was built in compliance with strict national and European emission standards, which guaranteed low GHG emissions and minimal impacts to surrounding communities. IEA Bioenergy. (2021). "Waste-to-Energy and Social Acceptance: Copenhill WtE Plant in Copenhagen."

APPENDIX 3: WASTE PREVENTION AND MINIMIZATION

Table 12 below provides more detailed information on the recommendations in **Table 4**, as well as related development, geographic, GESI, and co-benefits considerations, and key resources.

The legend below applies to the tables in **Appendices 3-8.**

Table 11: Legend for Mitigation Opportunities, Recommendations, and Related Considerations Tables

Legend	
Applicable Waste Material	**GHG Mitigation Opportunity**
 Organic waste	 Avoid **carbon dioxide** and **black carbon** from fossil-fueled waste vehicles and equipment
 Plastic waste	 Avoid **carbon dioxide** and **methane** from organic waste decomposition
	 Indirectly avoid GHGs
	 Avoid **carbon dioxide** from raw material production and extraction
	 Avoid **carbon dioxide** and **black carbon** from burning waste
	 Avoid **carbon dioxide** from fossil-fuel-powered waste facilities

Table 12: Waste Prevention and Minimization Mitigation Opportunities, Recommendations, and Related Considerations

Recommendation: Utilize social and behavioral change research that helps local governments and policymakers identify impactful and sustainable behavioral changes to reduce waste. Employing Trials of Improved Practices, a research approach that involves asking a small sample of people in the population to test certain behavioral changes, can help determine whether they are feasible and sustainable.[56]	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **GESI & development consideration:** Public perception and attitudes towards waste may vary by income level. In low-income countries, people may be motivated to reuse and prevent waste because of the 1) high cost of virgin materials; 2) level of absolute poverty; 3) large market for used goods and products made from recycled materials. Waste that is non-recyclable or uneconomical to recycle in affluent societies may have value in low-income countries (i.e., coconut shells and dung are used as fuel).[57]
Key Resources	• USAID's Trials of Improved Practices Manual – An Introduction to Reality Testing for Sustainable Waste Behaviors
Recommendation: Organize household food waste campaigns that raise awareness about the benefits of reducing food waste and the practical ways people can do so at home. For example, the Love Food, Hate Waste campaign, based in the United Kingdom, resulted in 14 percent reduction in food waste in the first six months since its launch. Other campaign examples include Curb Your Food Waste in Los Angeles, Food Waste Reduction Campaign in Tokyo, and Mad uden Spild (Food without Waste) in Copenhagen. Food waste campaigns should be tailored to suit the local context. For example, in many developing countries, it is common for households to shop for food daily because of the ease of access to street vendors and local farmer's markets. This is a key consideration when preparing meal planning and shopping tips for food waste campaigns. The U.S. Environmental Protection Agency's (EPA) Food: Too Good to Waste Implementation Guide and Toolkit provides guidance for organizing small-scale food waste reduction campaigns. The Toolkit provides high-level principles to consider when designing food waste campaigns, including: • Selecting target population. • Choosing targeted behaviors and tools. • Determining the timing and length of campaigns. • Adapting messages and tools to the needs of the community. • Leveraging existing networks and organizations.	

[56] USAID. (2023). "Trials of Improved Practices Manual."
[57] UNEP. (2005). "Solid Waste Management."

Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **Development:** Food waste campaigns should target more affluent communities that are able to buy more than enough food for their family. • **GESI:** Women are a key demographic for behavioral changes regarding household waste management. They are often responsible for food planning, preparation, preservation, and storage.
Key Resources	• EPA's Food: Too Good to Waste Implementation Guide and Toolkit
Recommendation: Support the integration of food waste reduction into school curriculum. USAID, through the MWRP program, funded the Centre for Social and Development to design curricula on plastic waste recycling for schools in Hue, Vietnam. This was replicated and implemented in 35 schools across the city.[58]	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **Development:** In low-income countries, schools are often underfunded, which can be a significant barrier to expanding and improving school curricula. Lesson plans on food waste reduction are easy to adopt and replicate at low cost. • **GESI:** Food waste curricula at all levels should be accessible to all students without discrimination or exclusions. Lesson plans and activities can be designed and adapted to increase the likelihood that children with disabilities or speakers of minority languages are not excluded. • **Co-benefits:** Improved nutrition. A Harvard Public Health Study found that 60 percent of fresh vegetables and 40 percent of fresh fruits are being thrown away at school cafeterias. Educating children about the importance of reducing food waste can potentially improve nutritional intake, especially in undernourished students where school food service is their primary nutrition source.[59]
Key Resources	• MWRP Vietnam Case Study

[58] USAID. (2023). "Schools Stem the Tide of Plastic Pollution, Spark Waste Reduction."
[59] Harvard. (2014). "New School Meal Standards Significantly Increase Fruit, Vegetable Consumption."

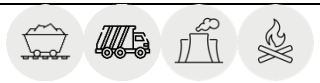
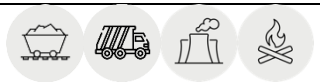
Recommendation: Provide technical guidance and capacity building support to crop farmers and food wholesalers and retailers to reduce food loss and waste.[60] Activities may include: ● Training farmers to harvest at the right maturity and use appropriate harvesting equipment. ● Training food wholesaler/retailer in temperature management of product handling, packaging, and inventory management. ● Reviewing cosmetic specifications of food and advocating for the acceptance of a wider diversity of produce. ● Building the capacity of wholesalers/retailers to handle and expand cold storage systems.	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	● **Development:** In low-income regions, food wastage tends to occur higher upstream during agricultural production, post-harvest handling, and storage. In middle and high-income regions, food wastage is caused by strict food cosmetic specifications and poor packaging and inventory management by food wholesalers and retailers.[61] ● **Geographic and development:** In low- and middle-income countries, informal food retailers—including those that sell food in open-air wet markets and on streets—can be considered. Raw food and materials can spoil very quickly, especially in warmer or more humid climates, increasing the risk of food waste. ● **Co-benefits:** ○ Cost-savings to businesses. For every $1 invested in things like training staff to reduce food loss during production, $14 or more were saved.[62] ○ Improve food safety from proper temperature management, packaging, and inventory management.
Key Resources	● World Bank's Addressing Food Loss and Waste: A Global Problem with Local Solutions ● FAO's Toolkit for Reducing the Food Wastage Footprint

[60] World Bank. (2020). "Addressing Food Loss and Waste: A Global Problem with Local Solutions."
[61] FAO. (2013). "Toolkit for Reducing the Food Wastage Footprint."
[62] World Resources Institute. (2017). "By the Numbers: The Business Case for Reducing Food Loss and Waste."

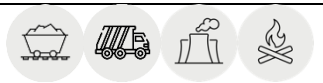
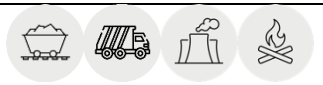
<table>
<tr><td colspan="2">Recommendation: Promote food donation or establish food donation programs by partnering with retailers such as hotels, grocery stores, supermarkets and restaurants with surplus prepared food, produce, meat, bakery, and dairy items that remain safe to consume.[63]

In Hong Kong, PARKnSHOP, a leading supermarket chain, launched the Food Rescue for the Needy program (in partnership with Food Angel, a non-profit organization) that delivers surplus food from the supermarket to individuals or families in need. From 2012-2018, PARKnSHOP donated over 3,1000 tonnes of food that would otherwise be landfilled.[64]</td></tr>
<tr><td>Applicable Waste Material</td><td>  </td></tr>
<tr><td>GHG Mitigation Opportunity</td><td>  </td></tr>
<tr><td>Related Considerations</td><td>• Development: In developing countries, retailers may not donate surplus food because of the added cost and effort. It may be easier and cheaper for retailers to dispose of surplus foods at landfills, especially if there are no or low landfill fees. Several charities and non-profits have established replicable food donation programs that cover the logistics and cost of collecting surplus food from retailers and redistributing it among the needy. For example, in Jaipur, India, the Annakshetra Foundation, established a network of over 1,500 hotels, marriage halls, and other retailers. The Foundation's volunteers and staff redistribute surplus foods from these retailers to slums, orphanages, and other low-income areas of the city. Since their inception in 2010, they have saved over 45,000 meals (in tons).[65]
• Co-benefits: Alleviate hunger and food poverty. The United Nation Food and Agriculture Organization estimated that cutting global food loss and waste along the food chain can provide food to feed an additional 2 billion people.[66]</td></tr>
<tr><td>Key Resources</td><td>• Hong Kong PARKnSHOP Case Study</td></tr>
<tr><td colspan="2">Recommendation: Partner with international and local businesses to reduce packaging waste, including strategies like bulk vending and refillable containers for certain products (e.g., nuts, grains, milk). In 2021, for example, USAID MWRP partnered with businesses in Kapulauan Seribu (Thousand Islands), Indonesia, to promote the sale of goods in bulk to reduce the use of plastic packaging.[67]</td></tr>
<tr><td>Applicable Waste Material</td><td>  </td></tr>
<tr><td>GHG Mitigation Opportunity</td><td>  </td></tr>
</table>

[63] EPA. (2015). "Reducing Wasted Food and Packaging: A Guide for Food Services and Restaurants."
[64] The Consumer Goods Forum. (2017). "Case Study Booklet – Food Waste Commitments & Achievements."
[65] Annaksetra. (n.d.). "Welcome to Annakshetra."
[66] FAO. (2013). "Monitoring food loss and waste essential to hunger fight."
[67] USAID. (2023). "Small Island Solutions to a Global Challenge."

Related Considerations	• **Development:** In low- and middle-income countries, a major concern for local businesses is the high initial cost of reusable or bulk packaging. Costs may include storage systems, return transportation logistics for empty reusable packaging components etc. Many businesses choose to use cheaper single-use containers instead to reduce costs and remain competitive in the market.[68] • **Co-benefits:** Cost-savings to businesses in the long-run. Reusable packaging made of more durable and longer lasting materials can reduce overall packaging consumption and associated costs.
Key Resources	• MWRP Indonesia Case Study
Recommendation: **Leverage extended producer responsibility (EPR) policies**, including taxes on plastic manufacturers and recycled content standards to set requirements for the quantity of recycled plastic used in new products.[69]	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **Development:** In low- and middle-income countries, two key barriers to extended producer responsibility policies are the lack of SWM infrastructure and lack of enforcement [70] • **Co-benefits:** Cost-savings due to reduced contamination and the collection, sorting, and processing of waste.[71]
Key Resources	• EPA Best Practices for Solid Waste Management: Addressing Plastic Waste
Recommendation: Implement recycling laws and incentives, including subsidies for manufacturers that meet specific criteria to reduce plastic pollution. This includes pay-as-you throw (PAYT) policies that require people to pay a fee to dispose of waste, landfill bans to ban certain materials from entering a landfill, and deposit-refund schemes to incentivize recycling of certain plastic products such as bottles or bags.[72]	
Applicable Waste Material	
GHG Mitigation Opportunity	

[68] FAO. (2014). "Appropriate Food Packaging Solutions for Developing Countries."
[69] EPA. (2023). "Best Practices for Solid Waste Management: Addressing Plastic Waste"
[70] Ibid.
[71] Ibid.
[72] Ibid.

Related Considerations	• **Development:** In low- and middle-income countries, a barrier for recycling laws and incentives is lack of SWM management infrastructure. Disposal bans or fees may unintentionally encourage illegal dumping. • **Co-benefits:** Cost-savings due to reduced contamination, and collection, sorting, and processing of waste.[73]
Key Resources	• EPA Best Practices for Solid Waste Management: Addressing Plastic Waste
Recommendation: Organize behavior change and educational campaigns to raise awareness about the negative ecological, social, and economics impacts of single-use plastics, as well as the benefits of reducing plastic waste by switching to alternatives such as reusable metal straws instead of plastic straws, reusable grocery bags, etc. Activities may include reinforcing social or cultural norms; increasing education in schools; developing targeted media initiatives; enhancing tourism branding; and increasing data collection.[74]	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **GESI:** Plastics-related curricula should be accessible to all students without discrimination or exclusions. Lesson plans and activities can be designed and adapted to increase the likelihood that children with disabilities or speakers of minority languages are not excluded. • **Co-benefits:** Cost-savings due to reduced contamination, and collection, sorting, and processing of waste.[75]
Key Resources	• EPA Best Practices for Solid Waste Management: Addressing Plastic Waste
Recommendation: Invest in locally appropriate and innovative technology and infrastructure, which may include plastic alternatives (e.g., biobased plastics made from biomass such as corn, sugarcane, wheat, or residues of other products), detect/manage marine plastic pollution, install stormwater and wastewater filters, and increase access to infrastructure to maintain a successful recycling system and reduce plastic "leakage" into the ocean.	
Applicable Waste Material	
GHG Mitigation Opportunity	

[73] Ibid.
[74] Ibid.
[75] Ibid.

Related Considerations	• **Development:** In low- and middle-income countries, funding is a major barrier to adopting technology and expanding infrastructure. It is important to understand the entire lifecycle of plastic alternatives to reduce the risk that the alternatives come with their own waste-management, emissions, or other challenges. Consumers may be hesitant to use alternative plastics without proper education or if plastic alternative products are not affordable. • **Co-benefits:** Cost-savings due to reduced contamination, and collection, sorting, and processing of waste.[76]
Key Resources	• EPA Best Practices for Solid Waste Management: Addressing Plastic Waste

[76] EPA. (2023). "Best Practices for Solid Waste Management: Addressing Plastic Waste"

APPENDIX 4: SOURCE SEPARATION MITIGATION

The table below provides more detailed information on the recommendations in **Table 5**, as well as related development, geographic, GESI, and co-benefits considerations, and key resources. Please refer to **Table 11** on page 47 for the legend.

Table 13: Source Separation Mitigation Opportunities, Recommendations, and Related Considerations

<table>
<tr><td colspan="2">Recommendation: Develop and implement regulations that incentivize or require inorganic (plastic) and organic waste source separation, including:
Establish legal requirements for waste generators to separate their waste.
Provide waste generators with color-coded bins for different types of waste.
Deposit-refund schemes to incentivize proper separation of plastic products such as bottles or bags.
For example, in India the 2016 Solid Waste Management Rules require waste generators to separate their waste into color-coded bins. Waste that is not separated is not collected.[77] The categories of separated waste in a city typically depend on the processing and treatment options available. Cities can therefore tailor source separation plans based upon the presence of existing local and regional markets for recyclables.</td></tr>
<tr><td>Applicable Waste Material</td><td>  </td></tr>
<tr><td>GHG Mitigation Opportunity</td><td>  </td></tr>
<tr><td>Related Considerations</td><td>Development: In low-income countries, separated waste may nevertheless end up in landfills and contribute to GHGs (due to the cost and burden of managing separated waste streams). Cities with the necessary waste collection, transportation, and processing and treatment systems and infrastructure are better positioned to realize GHG reductions from source separation.</td></tr>
<tr><td>Key Resources</td><td>CCAC's Organic Waste Separation Best Practices
EPA Best Practices for Solid Waste Management: Addressing Plastic Waste</td></tr>
<tr><td colspan="2">Recommendation: Organize educational campaigns and awareness programs aimed at helping households and other waste generators learn about the different types of waste and effective disposal methods. Providing clear instructions on what can be recycled in which bins is critical for preventing the contamination of recyclable materials such as plastics. This approach can additionally reduce the labor and energy costs associated with cleaning and decontaminating recyclable materials.
In some cases, waste generators have concerns about the odor, uncleanliness, and rodent/pest infestations associated with organic waste. To build community support for organic waste separation, it is crucial for campaigns to not only focus on how to separate organic waste, but also why it is important.</td></tr>
</table>

[77] CCAC. (2018). "Organic Waste Separation: Program and Policy Options."

Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **GESI:** Household waste management is not a gendered responsibility as it has been typically assumed. In a qualitative research study conducted in the Dominican Republic, both men and women are involved in household waste management. Women often dispose of household waste because they are often at home when waste collectors or trucks come by. However, when women were out and men were at home, men engage in household waste management just as frequently.[78]
Key Resources	• USAID Samaná Province, Dominican Republic Case Study
Recommendation: Engage the informal sector in organic waste separation. Informal waste workers rely on recycling for income and therefore play an important role in improving recycling rates. These workers are typically less focused on recovering organic waste due to its lower economic value. In Pune, India, a social enterprise of informal waste workers called Solid Waste and Collection Handling (SWaCH) began operating composting facilities at apartment buildings and institutional campuses around Pune. The resulting compost is owned and used by the communities, and communities receive a real estate tax rebate, incentivizing them to employ SWaCH members. This initiative has made communities and informal waste workers more aware of the value of separating organic waste.[79]	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **GESI:** Integrating the informal sector into source separation of organics can improve livelihoods by providing an additional source of income.
Key Resources	• Waste Pickers Lead the Way to Zero Waste
Recommendation: Increase access to source separation infrastructure to encourage greater participation in source separation efforts. For example, many cities have color coded communal bins (e.g., blue for paper waste, green for recyclable packaging, gray for organics) in multifamily housing complexes or neighborhoods. Some cities have waste collection push carts, bicycles, or vehicles, with separate bags or bins for different waste materials so that waste collectors can separate organic and plastic waste as they collect them.	

[78] USAID. (2022). "Creating Sustainable Waste Management Model in Samana Province, Dominican Republic."
[79] Global Alliance for Incinerator Alternatives (GAIA). (2012). Waste Pickers Lead the Way to Zero Waste.

Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **Development**: In low-income countries, separated waste may nevertheless end up in landfills and contribute to GHGs (due to the cost and burden of managing separated waste streams). Cities with the necessary waste collection, transportation, and processing and treatment systems and infrastructure are better positioned to realize GHG reductions from source separation.
Key Resources	• EPA Best Practices for Solid Waste Management: Addressing Plastic Waste

APPENDIX 5: COLLECTION AND TRANSPORTATION

The table below provides more detailed information on the recommendations in **Table 6**, as well as related development, geographic, GESI, and co-benefits considerations, and key resources. Please refer to **Table 11** on page 47 for the legend.

Table 14: Collection and Transportation Mitigation Opportunities, Recommendations, and Related Considerations

<table>
<tr><td colspan="2">Recommendation: Support the expansion of collection service coverage and frequency to underserved communities to prevent illegal dumping and open burning, and reduce associated carbon dioxide and methane emissions by:
Conducting waste generation studies to determine waste generation rates and optimize collection coverage. An underestimation of the amount of waste generated can result in inadequate provision of service, while an overestimation can lead to the inefficient allocation of resources.
Conducting waste characterization studies to understand waste composition and prioritize and increase collection frequency in areas with high organic waste volumes.</td></tr>
<tr><td>Applicable Waste Material</td><td>  </td></tr>
<tr><td>GHG Mitigation Opportunity</td><td>  </td></tr>
<tr><td>Related Considerations</td><td>GESI: In low-income countries, underserved communities may include residents of informal settlements (often referred to as “slums”). Waste from informal settlements is often unaccounted for because these areas fall outside of government control or regulation. Local officials may consider conducting surveys of informal settlements not currently covered by collection services to estimate waste generation rates and plan for future collection.
Geographic: In hot and humid areas with high organic waste volumes, frequent collection is critical because organic waste decomposes quickly under high temperatures, resulting in methane.
Development: Rapid urbanization, population growth, and changes in consumption patterns contribute to changes in the amount and type of waste to be collected.
Co-benefits: Reduced local air pollution from the burning of uncollected waste.</td></tr>
<tr><td>Key Resources</td><td>EPA’s Naucalpan, Mexico Case Study
Characterization of municipal waste in Kampala, Uganda</td></tr>
<tr><td colspan="2">Recommendation: Support the transition to low- or zero-emission collection vehicles to reduce the carbon footprint of waste collection. In Rio De Janeiro, the municipal waste management corporation purchased electric waste collection vehicles to collect hospital waste across the city.[80]</td></tr>
</table>

[80] CCAC. (2018). “Webinar: Best Practices for Waste Characterisation.”

Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **GESI and geographic:** Certain large collection vehicles may not be suitable for marginalized populations living in areas with narrow, unpaved roads. Electric vehicles may similarly be inappropriate for populations without access to charging stations. In these instances, small collection vehicles, such as handcarts, tricycles, animal carts, rickshaws or tractors may be more appropriate. • **Co-benefits:** Reduced local air pollution from tailpipe emissions of fossil-fueled vehicles.
Key Resources	• New Zealand Case Study • Seattle, Washington, USA Case Study
Recommendation: Optimize collection routes to maximize collection coverage while ensuring that collection vehicles follow the most efficient paths, have full loads, and reduce fuel consumption. The route optimization process may include: • Reviewing existing waste management plans and policies to identify and engage stakeholders involved in collecting waste, financing equipment, and providing legal protection to waste collectors. • Conducting a macro-routing analysis by determining collection areas through waste generation and waste characterization studies, dividing collection areas into subsections or districts, and surveying existing processing and disposal sites and determining the optimum quantity of waste that can be processed and disposed of each day. • Performing route balancing, which involves assessing the volume of waste to be collected and the routes serviced by each collection grew. • Conducting a micro-routing analysis to determine the specific path or route each collection vehicle should follow, taking into account geographic, demographic, climatic, and other factors that may impact waste collection.	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **Geographic:** ○ Large disposal sites and processing facilities are often located far from densely populated areas, increasing collection distances. Establishing transfer facilities, where waste can be aggregated, sorted (if necessary), and compacted, can reduce the number of trips to final disposal or processing facilities.

	○ Geographical barriers to waste collection, which may include rivers, railroad embankments, hills, unpaved and windy roads, and heavy traffic. ● **Co-benefits:** Reduced labor, fuel, and vehicle maintenance costs.
Key Resources	● CCAC's Best Management Practices for Optimizing Waste Collection Routes ● UN-Habitat's Collection of Municipal Solid Waste in Developing Countries
Recommendation: Support formalization of informal waste collection. Informal workers rely on collecting waste and recovering recyclables as a source of income. However, they often lack the required equipment to collect waste, making their collection process unsafe and inefficient. For example, some informal workers collect recyclable materials from open dumpsites, streets, or community bins without any protective gear, and transport large and heavy loads by bike or carts. Formalizing informal waste collection can help increase collection rates, while improving the livelihoods of informal workers and minimizing the environmental and climate impacts of mismanaged waste. Formalizing informal recycling may involve: ● Collecting information on the number, waste collection capacity, and contribution of informal waste collectors. ● Promoting the legal recognition of informal workers to give them the same credibility and legitimacy as formal workers. This may involve issuing identification cards, birth certificates, or other legal documents; recognizing informal work as a profession by registering informal workers into city databases; organizing awareness campaigns on the contributions of informal workers to SWM to destigmatize and facilitate recognition and acceptance of informal work. ● Engaging with informal workers to identify solutions to integrate them into the formal work force.	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	● **GESI:** Women face structural barriers in both the formal and informal sector to full participate in the waste value chain. They commonly lack the financial skills and training to move beyond lower-tier and dangerous waste picking and separating jobs at landfills. Men dominate the higher-income roles, whether that be as truck drivers, scrap dealers, or repair shop workers.[81]
Key Resources	● EPA's Solid Waste Management Guide for Developing Countries. ● EPA's Equity in Solid Waste Management Chapter.

[81] Ocean Conservancy. (2019). "The Role of Gender in Waste Management."

APPENDIX 6: PROCESSING AND TREATMENT (PRE-LAND DISPOSAL)

The table below provides more detailed information on the recommendations in **Table 6**, as well as related development, geographic, GESI, and co-benefits considerations, and key resources. Please refer to **Table 11** on page 47 for the legend.

Table 15: Processing and Treatment (Pre-land Disposal) Mitigation Opportunities, Recommendations, and Related Considerations

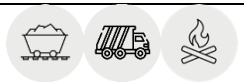
Recommendation: Provide technical support for selecting and deploying technologies to treat separated organic waste. Table 2 and **Appendix 2** lists the feedstock, cost, operations and maintenance, and other factors to consider for composting, AD, and WtE. Potential areas for technical support may include: • Identifying the types, quantities, and sources of organic waste to be treated. • Appropriately sizing treatment facilities. • Identifying end-markets to sell end products such as biogas, compost, or electricity. • Identifying sources of funding to finance the project.	
Applicable Waste Material	
GHG Mitigation Opportunity	

Related Considerations	• **Development:** Many large-scale projects may have high up-front capital costs, which can be a significant barrier to adoption, especially in lower-income countries (refer to Appendix 2 for cost considerations). Common types of financing for projects in the waste sector include:
	  • Grants, which are low risk because they can help offset the costs of large projects and do not require repayment. Common sources of grants include national governments, financial institutions, and foundations.
	  • Results-Based Financing, where payments are made after a pre-defined goal or target is achieved.
	  • Public-Private Partnerships, which are long-term agreements between the government and private partners, whereby the private partner delivers and funds public services and shares the associated risks.
	  • Bonds, where an investor lends money to a company or government for a set period of time in exchange for regular interest payments.
	  • Loans, which are typically issued by financial institutions or banks and have fixed repayment rates over a set period.
	• **GESI:** In developing countries, population surges and rapid urbanization limit the amount of cheap land available, pushing waste treatment facilities to rural areas. Low-income communities in rural areas are most vulnerable to the adverse impacts of waste management. To increase the likelihood that waste treatment facilities do not disproportionately impact

	nearby residents, USAID Missions may consider the spatial distribution of facilities, air pollution and groundwater contamination risks, population density and the need for resettlement, cultural, ethnic, and historic impacts.
	• **Co-benefits:**
	  ○ Revenue stream from selling compost or power produced from AD or WtE.
	  ○ Clean energy source from AD.
	  ○ Digestate from AD and compost can add critical nutrients to soil.

Key Resources	• EPA's Anaerobic Digester Project Development Handbook (Refer to Section 6, Economic and Financial Factors) • UNEP's Waste to Energy: Consideration for Informed Decision-making • GIZ's Waste-to-Energy Options in Municipal Solid Waste Management • Sustainable Financing and Policy Models for Municipal Composting
Recommendation: Build the capacity of workers to operate and maintain organic waste treatment facilities by establishing education programs that cover basic digestor operational fundamentals, process control, laboratory and leak testing, and maintenance. This can avoid methane leakages that occur when organic waste treatment facilities are not routinely maintained.	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **Geographic:** Many digesters do not have a cooling system, which can lead to overheated equipment in regions prone to extreme heat. This can cause digesters to malfunction and leak methane. Biodegradation activities may generate additional heat, aggravating the problem.[82]
Key Resources	• EPA's Anaerobic Digester/Biogas System Operator Guidebook
Recommendation: Provide technical support for the establishment and upgrade of MRFs to increase the quantity and quality of recycled materials, including plastics. MRF includes a combination of technologies to sort and clean recyclables. Common technologies used at MRFs include rotating-cylindrical screens that separate materials by size, conveyor belts to move materials to recycling workers for manual sorting, and overhead magnets to collect materials containing metals (e.g., iron and steel). Once recyclable materials are sorted and processed, they are often sold to manufacturing facilities to be made into new products.	
Applicable Waste Material	

[82] Biomass Magazine. (2023). "Commonly Overlooked Reasons for Anaerobic Digester Failures."

GHG Mitigation Opportunity	
Related Considerations	• **Development:** High-tech MRFs are not as common in low-income countries because of their high upfront cost. Many cities in low-income countries instead use smaller-scale, lower-tech solutions such as hand sorting. Some MRFs source recyclables from intermediaries that buy, sort, and clean recyclables from informal sector workers. • **GESI:** Workers at MRFs are often exposed to dust and other contaminants. It is important for MRFs to have proper ventilation and for workers at MRFs to have protection equipment (e.g., dust masks, gloves).
Key Resources	• Asian Development Bank's Materials Recovery Facility Toolkit
Recommendation: Improve energy efficiency and transition to clean energy sources at processing and treatment facilities. This is critical because turning recyclable materials into new products is an energy intensive process. Improving energy efficiency and transitioning to clean energy sources at MRF, AD, composting, WtE, and other processing and treatment facilities can reduce or eliminate carbon dioxide from fossil fuel powered equipment and machinery. EPA's Waste Reduction Model (WARM) tool can be used to calculate the full lifecycle GHG emissions of a product's lifecycle, including those associated with energy use during the transportation of waste to processing and treatment facilities, and the operation of facilities.	
Applicable Waste Material	
GHG Mitigation Opportunity	

Related Considerations	• **Development:** In low-income countries, the availability of clean and affordable energy sources may be limited; therefore, focusing on improving energy efficiency by switching to energy-efficient equipment or electrifying can reduce the need to procure clean energy.
	• **Co-benefits:**
	  ○ Reduced energy costs.
	  ○ Improved local air quality.

Key Resources	• EPA's Waste Reduction Model (WARM)
Recommendation: Promote the treatment of organic waste at home, including yard waste and food waste from food preparation and leftovers, before they are sent for processing or to landfills. Household composting may include vermicomposting (worm composting) in a small bin in the kitchen, as well as composting in large piles in the yard. Small-scale AD systems may also be used to process organic waste. The gas generated may be used for cooking and the digestate as soil amendment in the garden. While home composting or AD systems may not have a large impact on GHG reductions compared to large-scale facilities, they could be a good way to build awareness about organic waste management.	

Applicable Waste Material	
GHG Mitigation Opportunity	

Related Considerations	• **GESI:** Small-scale AD systems can be a reliable source of energy, especially for communities without access to affordable and reliable energy.
	• **Co-benefits:**
	  ○ Clean and reliable energy source from AD.
	  ○ Digestate from AD and compost can add critical nutrients to soil.

Key Resources	○ EPA's Best Practices for Composting at Home ○ GMI's Successful Applications of Anaerobic Digestion from Across the World
Recommendation: Provide technical, capacity building, and financial support for the establishment of "Waste Banks", decentralized and small-scale recycling facilities. Waste Bank staff, typically local residents, receive, separate, and bundle recyclable materials, and sell them to recyclers. Some waste banks may have the equipment to turn recyclable materials into new products. The Waste Bank model was first established in Indonesia and successfully replicated in other countries, such as Thailand[83] and the Philippines.[84] CCBO is currently working with local grantees to improve waste bank facilities in Kota Makassar, Indonesia. MWRP worked to improved waste bank facilities in Raja Ampat Islands and South Sulawesi, Indonesia in 2021.	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **Geographic:** Typically, local members of waste banks belong to the lower- to middle-income class. A study on waste banks in Semerang city, Indonesia, found that middle- to upper income residents did not see the need to sell recyclables to waste banks for economic reasons.[85] The siting of waste banks near lower- to middle- income communities can help increase membership. • **Development:** Waste bank facilities require basic infrastructure (e.g., permanent buildings or office space). Some waste bank facilities have failed in Indonesia because of the difficulties in securing permanent spaces for aggregating waste.[86]

[83] Fang, E. (2020). "One Man's Trash is Another Man's Treasure: The Success of Thailand's Waste Bank Initiative."
[84] World Vision. (2022). "Generating Incomes form Wastes."
[85] Pratama, R. et al. "The Challenges in Sustaining Waste Banks in Serang City: How Far the Circular Economy Can go?"
[86] Pratama, R. et al. "The Challenges in Sustaining Waste Banks in Serang City: How Far the Circular Economy Can go?"

Key Resources	• CCBO Indonesia Factsheet • CCET's Waste Bank Module
Recommendation: Provide technical assistance and capacity building support for establishing measurement, reporting, and verification (MRV) systems for tracking the GHG emissions and emissions reductions at waste treatment facilities. Measuring these emissions at the facility-level can provide local, subnational and national governments with the data needed to set ambitious reduction targets, deploy targeted reduction solutions, and track emissions reductions progress. When implementing an MRV system, considerations include developing a measurement plan and methodology, understanding the interested parties that may require submission of a report, and identifying a third-party to verify data.	
Applicable Waste Material	
GHG Mitigation Opportunity	

Related Considerations	• **Development:** In low-income countries, weak governance at the national level results in weak policies, which in turn lead to inadequate implementation, compliance, and enforcement at the local level. MRV activities require detailed data, including activity data and emission factors, as well as collaboration among multiple organizations and experts including various reporting organizations and an independent third-party to verify data. Below are some considerations to overcome these challenges:
	  ○ Establish or refine legal requirements for SWM projects or facilities to report specific GHG reduction data annually
	  ○ Establish a mechanism for collecting, aggregating, and sharing data by establishing a centralized data portal or offering incentives or recognition to entities that voluntarily share their data

Key Resources	• The Global Methane Initiative's Policy Maker's Handbook for Measurement, Reporting, and Verification in the Biogas Sector.

APPENDIX 7: FINAL DISPOSAL (LAND DISPOSAL)

The table below provides more detailed information on the recommendations in **Table 7**, as well as related development, geographic, GESI, and co-benefits considerations, and key resources. Please refer to **Table 11** on page 47 for the legend.

Table 16: Final Disposal (Land Disposal) Mitigation Opportunities, Recommendations, and Related Considerations

Recommendation: Provide technical assistance to national governments to remediate or close existing dumpsites. In the Dominican Republic, CCBO provided technical guidance to the national government to safely remediate and close open dumps in Las Terrenas and Santa Barbara de Samana. Stormwater and leachate management systems were constructed in remediated dumpsites to prevent leakage into local groundwater.[87]	
Applicable Waste Material	
GHG Mitigation Opportunity	

Related Considerations	• **Development:**
	  ◦ Low- and middle-income countries may have limited technical and financial resources to upgrade dumpsites and develop methane mitigation projects at landfills. Contracting with the private sector—through public-private partnerships (PPP)—can be an effective option for overcoming these technical and financial barriers. In a PPP, the private party takes on the project risks and project management responsibilities, which can be advantageous for developing countries, where technical expertise may be limited. While many large multi-lateral banks (e.g., World Bank, Asian Development Bank), do not lend to municipalities, engaging with them can be helpful for identifying the most appropriate financial instruments.[88]
	  ◦ Most developing countries lack the regulatory framework for SWM and enforcement mechanisms. Without this oversight, dumpsite remediation or closure will be purely voluntary and will likely not occur.
	• **GESI:** While closing dumpsites and landfills has environmental benefits, it can come as a cost to informal recycling workers, cutting them off from their main source of income. In the Dominican Republic, CCBO provided technical guidance on safety protocols and equipment to improve the safety of informal workers collecting waste at remediated dumpsites. Previously, informal waste workers gathered recyclables by traversing through waste mounds, sometimes during landfill fires. Now, they can access recyclables in designated sorting areas.
	• **Co-benefits:**
	  ◦ Improved local air quality and avoided health impacts to informal recyclers and communities surrounding unmanaged and unsanitary landfills.

[87] USAID. (2023). "A model for waste site remediation to reduce climate impacts and ocean plastic pollution."
[88] EPA. (2020). "Solid Waste Management Toolkit for Developing Countries."

	• Avoided leachate migration into waterbodies and soil.
Key Resources	• CCBO Dominican Republic Case Study
Recommendation: Provide technical assistance to recover LFG from landfills. LFG can be used as a clean energy source that avoids emissions from fossil energy consumption, while simultaneously reducing local methane emissions. CCBO is remediating two open dumps in Mancora, Peru as preparation for transforming it into a sanitary landfill with vents and methane collection systems.	
Applicable Waste Material	
GHG Mitigation Opportunity	

Related Considerations	• **Geographic:** Extreme heat could increase the temperature of landfill sites, which could ignite combustible waste materials at landfills, causing landfill fires. Coupled with humidity, extreme heat could speed up the decomposition of organic waste and increase LFG production.
	• **Co-benefits:**
	  ○ Improve local air quality and avoid health impacts to informal recyclers and communities surrounding unmanaged and unsanitary landfills.
	  ○ Increase energy security with LFG.
	  ○ Increase revenue generation from the sale of LFG that can be used to produce electricity and RNG (that can be used to power vehicles and equipment at landfills).

Key Resources	• EPA's Landfill Gas Energy Project Development Handbook • EPA Benefits of Landfill Gas Energy Projects
Recommendation: Advocate for landfill fees and bans to incentivize waste diversion for recovery through processing and treatment. Most low-income countries have no or low tipping fees—a charge paid by anyone who disposes of waste in landfills. Charging a fee can disincentivize landfill disposal and encourage recycling and reuse. Banning certain materials or items from being disposed of at landfills can (e.g., organics) prevent potential methane emissions from organic waste decomposition.	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **Geographic:** The geographic distribution of waste recycling and treatment may impact the effectiveness of landfill fees and bans. For example, some communities may be forced to openly burn or dump waste because they are not located in close

	proximity to waste recycling or treatment sites or have no access to waste collection services. Before implementing such bans or fees, it is important to assess and evaluate the suitability of this approach. • **GESI:** Banning certain materials (e.g., plastics) from being disposed of at landfills can impact the livelihoods of informal waste collectors who depend on collecting recyclables from landfills as an income source. When imposing landfill fees or bans, consider using the collected fees to operate MRF facilities at disposal sites. MRF facilities can provide informal waste workers the opportunity to sort and collect recyclable materials, reducing the waste to be disposed of at landfills.
Recommendation: Deploy cleaner landfill vehicles and equipment. Local partners can support countries with the procurement of electric or renewable-powered vehicles and equipment to support landfill operations. One option includes procuring vehicles and equipment powered by renewable natural gas (RNG) derived from LFG.[89]	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **Development:** Raw LFG must be processed at RNG facilities before it can be used in vehicles; therefore, the use of RNG-powered vehicles and equipment depends upon the availability and proximity of RNG facilities. The construction of such facilities requires high up-front capital costs.
Key Resources	• EPA's Introduction to Renewable Natural Gas
Recommendation: Engage with and build the capacity of private sector actors, such as landfill managers and operators. Many cities have found success in hiring trained landfill managers to properly operate and manage sanitary landfill sites.[90] Typically, before waste is disposed of at landfills, the manager develops a plan to manage the waste at the site. The plan specifies the site location for waste disposal, how often and where soil cover will be used, what environmental controls are in place to minimize environmental impacts, how often waste gets compacted, how LFG will be monitored and managed, etc.	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **Geographic:** The prevailing climatic conditions in a region can influence landfill operations. For example, in areas with high precipitation landfill managers can apply landfill cover daily and leachate management systems to reduce stormwater

[89] RNG-powered vehicles and equipment are fueled by LFG captured from landfills instead of natural gas or diesel. Landfill operators can send the LFG captured and collected at the landfill to RNG facilities for processing and conversion into RNG. This RNG can then be used to power RNG vehicles and equipment operating at landfills, creating a circular economy.

[90] EPA. (2020). "Solid Waste Management Toolkit for Developing Countries."

	infiltration and limit leachate run-off to groundwater and soil. Daily cover can also help prevent landfill fires, which can potentially be ignited by LFG under extreme heat.
Key Resources	• EPA's Landfill Gas Energy Project Development Handbook • GMI's Solid Waste Disposal Site Design and Operational Considerations
Recommendation: Provide technical assistance in the design, siting, construction, and operation of a sanitary landfill. Sanitary landfills are engineered to prevent air pollution, and water and soil contamination when managing waste. Areas for technical support may include: • Identifying ways to maximize LFG collection efficiency • Measuring and monitoring LFG collection • Identifying ways to convert the captured LFG for beneficial end-products	
Applicable Waste Material	
GHG Mitigation Opportunity	

Related Considerations	• **Development:**
	  • Low- and middle-income countries may have limited technical and financial resources to upgrade design, site, and construct a sanitary landfill. Similar to the recommendation on remediating or closing dumpsites, contracting with the private sector can be an effective option for overcoming these technical and financial barriers. In a PPP, the private party takes on the project risks and project management responsibilities, which can be advantageous for developing countries, where technical expertise may be limited. While many large multi-lateral banks (e.g., World Bank, Asian Development Bank), do not lend to municipalities, engaging with them can be helpful for identifying the most appropriate financial instruments.[91]
	  • Proposals for new sanitary landfills may trigger complex and lengthy permitting processes, which may be a disincentive to project developers. However, these permitting processes are often necessary to protect local communities and address environmental or safety risks. To speed up permitting processes, engaging with key stakeholders early in the project development process may help secure buy-in and address any environmental, health, and community concerns in a timely manner.
	  • Some developing countries may not have the regulatory capacity to design and operate sanitary landfills. The successful design and management of sanitary landfills depends on providing technical support to building and maintaining adequate regulatory capacity.

Key Resources	• CCBO Dominican Republic Case Study

[91] EPA. (2020). "Solid Waste Management Toolkit for Developing Countries."

APPENDIX 8: POLICY, REGULATORY, GOVERNANCE SUPPORT

The table below provides more detailed information on the recommendations in **Table 8** as well as related development, geographic, GESI, and co-benefits considerations, and key resources. Please refer to **Table 11** on page 47 for the legend.

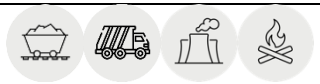
Table 17: Policy, Regulatory, Governance Support Mitigation Opportunities, Recommendations, and Related Considerations

Recommendation: Provide technical assistance on the design and implementation of EPR policies that transfer the responsibility of managing the end-of-life of products to producers (e.g., raw material manufacturers, packers or fillers, brand companies, retailers). EPRs can target different points in a product's lifecycle. Local partners can consider providing technical assistance to countries/stakeholders on EPR design, stakeholder consultation, data collection, and implementation. Example EPRs include: • **Material taxes**, which incentivize producers to reuse virgin materials and low-carbon, environmentally friendly alternatives. • **Product-take-back** requirements, where producers are required to take back the waste from their sold products. • **Deposit-refund schemes,** where consumers pay a deposit when purchasing a product, and get to take the deposit back when they return the product for recycling. EPR policies incentivize waste prevention and minimization, which helps avoid carbon dioxide from the upstream extraction and production of materials and products, as well as methane from downstream mismanagement of organic waste. EPRs can additionally establish a funding source for other waste management activities (collection, transportation, recycling), which can avoid carbon dioxide and methane from improper waste disposal.	
Applicable Waste Material	
GHG Mitigation Opportunity	

Related Considerations	• **Development:**
	  • Low-income countries may have insufficient infrastructure for collecting and treating waste stream components covered under the EPR system. This may overwhelm the waste system and increase mismanagement of waste. To implement successful EPR systems, it is crucial to first assess existing infrastructure and address any gaps.
	  • Weak governance may result in the inadequate implementation, compliance, and enforcement of EPR policies. Establishing comprehensive and stable EPR laws and enforcing them is critical for success. EPRs should also be regularly monitored by public authorities and obligated producers, and information about the scheme (e.g.,

	collection, recycling, and reuse rates achieved, fees charged, costs incurred, revenues from resale, etc.) should be publicly available.[92] • **GESI:** Informal waste collectors and recyclers face challenges under EPR approaches.[93] For example, EPRs can create barriers to participation through high registration cost or infrastructure requirements. Furthermore, EPR systems may restrict access to recyclable materials for designated service providers. Local partners can work to establish EPR approaches that integrate informal workers and verify that livelihoods are not threatened.
Key Resources	• USAID's Extended Producer Responsibility as a Policy Tool to Reduce Plastic Pollution in Lower- and Middle-Income Countries • WWF's How to Implement Extended Producer Responsibility (EPR)
Recommendation: Build capacity for local and regional governments to include GHG mitigation considerations and opportunities when developing SWM plans, which are often required by law.	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **GESI:** Marginalized groups may be reluctant to engage with decision-makers on EPRs due to mistrust. For example, informal waste workers who have previously trespassed to collect recyclables, and illegal immigrants may avoid participating for fear of retaliation. • **GESI:** Marginalized groups may face barriers to engagement, including language barriers, traveling costs, and time commitments.
Key Resources	• EPA's Solid Waste Management Toolkit for Developing Countries
Recommendation: Support the development and implementation of "Pay-As-You-Throw" (PAYT) programs that impose waste collection fees on waste generators, which can disincentivize waste generation and offer a source of finance for waste collection. PAYT programs incentivize waste prevention and minimization, which helps avoid carbon dioxide from the upstream extraction and production of materials and products, as well as methane from downstream mismanagement of organic waste. PAYT approaches can also establish a funding source for other waste management activities (collection, transportation, recycling), which can avoid carbon dioxide and methane from improper waste disposal.	
Applicable Waste Material	

[92] WWF. (2020). "How to Implement Extended Producer Responsibility (EPR).
[93] WIEGO. (2022). "Extended Producer Responsibility (EPR) and Waste Pickers."

GHG Mitigation Opportunity	
Related Considerations	• **Development:** PAYT approaches can be implemented in coordination with companies to reduce packaging waste, with the goal of lowering consumer costs. Pay-as-you-throw programs alone may not be sufficient to significantly prevent waste, especially for higher-income residents and waste generators that can afford to pay waste collection fees. Policies and programs targeted at manufacturers, packagers, and consumer product companies, including recycled content standards discussed below, can have a bigger impact on waste prevention and minimization. • **GESI:** When imposing waste collection fees, it is important to consider the impacts on low-income households. If collection fees are too high, waste generators may resort to improper waste disposal methods (e.g., burning or open dumping).
Key Resources	• EPA's Pay-As-You-Throw Resources Page
Recommendation: Provide technical assistance on the design of recycled content standards, certification schemes, or product standards that require producers to verify that a certain percentage of their products or packaging is made from recycled materials. These standards can increase the demand for recycled materials. For example, governments may require that recycled plastics make up at least 50 percent of the plastic products from manufacturers, packagers, or consumer product companies. Governments can also align their public procurement policies with the recycled content standards.[94] Recycled content standards reduce the need for virgin raw materials, thereby avoiding carbon dioxide from raw material extraction. Similarly avoids carbon dioxide and black carbon from improper disposal of recyclable materials (e.g., incineration and burning).	
Applicable Waste Material	
GHG Mitigation Opportunity	
Related Considerations	• **Development:** Low-income countries may not have the necessary enforcement mechanisms to guarantee compliance to recycled content standards. Lack of enforcement may encourage illegal dumping or mismanagement of waste.
Key Resources	• EPA's Recycling Markets Best Practices • EPA Best Practices for Solid Waste Management: Addressing Plastic Waste
Recommendation: Provide technical assistance in the design and implementation of national strategies to reduce food loss and waste. Strategies may include: • Requiring companies to measure and report food loss and waste.	

[94] OECD. (2022). "Global Plastics Outlooks: Economic Drivers, Environmental Impacts and Policy Options."

• Standardizing food date labeling practices to improve consumer understanding of product safety and quality and prevent unnecessary disposal of food. • Supporting informal food retailers by granting them access to clean water, storage areas, equipment, and training to reduce food contamination and waste. • Including food waste reduction in school curricula and food waste reduction training in public procurement programs.	
Applicable Waste Material	
GHG Mitigation Opportunity	

Related Considerations	• **Development:**
	  • In low-income regions, food wastage tends to occur higher upstream during agricultural production, post-harvest handling, and storage. In middle and high-income regions, food wastage is caused by strict food cosmetic specifications and poor packaging and inventory management by food wholesalers and retailers.[95]
	  • Limited data and information on where food loss and waste occur may hamper policy design and investment decisions in low- and middle-income countries. Local partners may consider conducting studies on the magnitude, nature, and causes of food loss and waste to help countries make informed policy decisions.
	  • Food waste is expected to increase further with income growth and shifting dietary preferences toward perishables such as fruits, vegetables, as well as animal sourced foods such as milk, eggs, and cheese. Focusing on social and behavior changes, particularly in young populations, is important to prepare for the income transition and shifting dietary preferences.[96]

Key Resources	• Addressing Food Loss and Waste: A Global Problem with Local Solutions

[95] FAO. (2013). "Toolkit for Reducing the Food Wastage Footprint."
[96] Malhotra, S. and Vos, R. "Challenges for Policy and Research to Reduce Food Loss and Waste."

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