PLASTIC POLLUTION REDUCTION AND PREVENTION IN GREATER MONROVIA, LIBERIA

SYNTHESIS REPORT

PROBLUE
HEALTHY OCEAN • HEALTHY ECONOMIES • HEALTHY COMMUNITIES

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

1818 H Street NW, Washington, DC 20433
Telephone: 202-473-1000; Internet: www.worldbank.org

Cover images: freepik.com
Designer: Ha Doan
Editor: Jennifer Stastny

ACKNOWLEDGMENTS

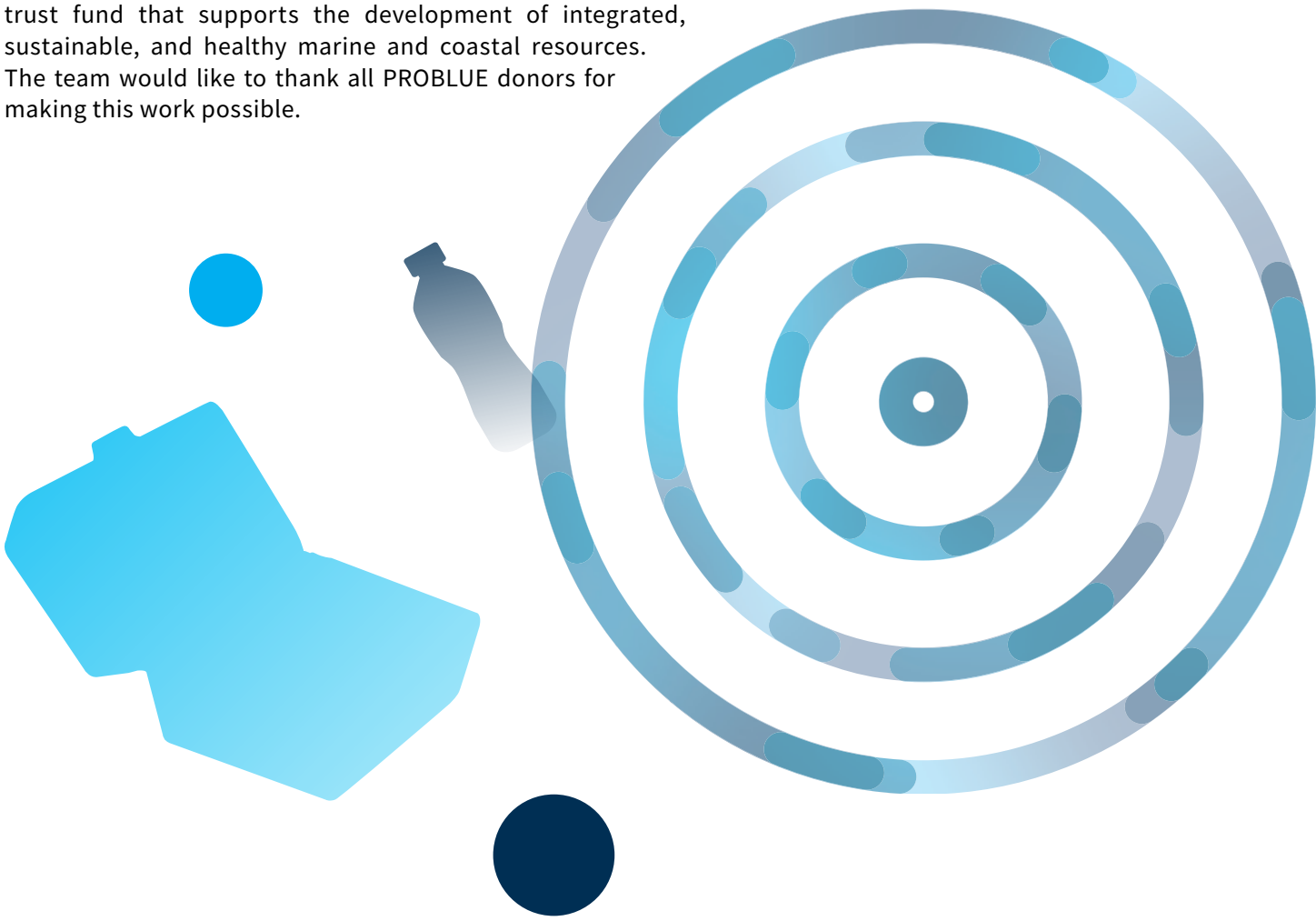
This report was prepared by a team led by Özgül Calicioglu (Enviornmental Engineer, Task Team Leader) and Peter Engel (Consultant) with the technical support of Franck Olivier, Michelle Cummins, and Marta Matias Mendes (all ECOGEOS), with inputs from Paul Maycher (WNL Development Solutions) and Solomon Wright (GreenCons).

We would like to thank the Liberia Institute of Statistics and Geo-information services, the Liberia Revenue Authority, and the Liberian Meteorological Service for their support with obtaining relevant data and information to inform the analysis in this report.

We also owe thanks to the Ministry of Public Works and the National Fisheries and Aquaculture Authority for their guidance and support in producing this report.

Finally, we wish to acknowledge the Liberian companies and communities who so freely shared their time, knowledge, and experience with us to provide a clear picture of solid waste management in the Greater Monrovia area.

This technical assistance was funded by PROBLUE, an umbrella trust fund that supports the development of integrated, sustainable, and healthy marine and coastal resources. The team would like to thank all PROBLUE donors for making this work possible.



ABOUT THIS SERIES

The “Plastic Pollution Reduction and Prevention in Greater Monrovia, Liberia” series of reports aims to equip decision-makers at all levels of government, the private sector, and civil society with insight into the current state of solid waste management in Liberia, with a focus on plastic pollution.

By analyzing waste management policies and practices, mapping waste flows, and identifying players in the circular economy with a focus on Greater Monrovia, these reports aim to describe how and what kinds of plastic pollution are generated, what structures and behaviors are in place to prevent this from happening, and how these structures can be strengthened to be more effective.

The following thematic reports are available in this series:

- ***Synthesis Report (this report)***
- *Inception Report (internal report)*
- *System Assessment and Field Work (internal report, with relevant information in annexes)*
- *Plastics Value Chain (internal report, with relevant information in annexes)*
- *Draft Plastic Pollution Reduction and Prevention Strategy for Greater Monrovia (internal report, with relevant information in annexes).*

ABOUT THIS REPORT

This Synthesis Report presents the key findings by a World Bank's PROBLUE project to improve fisheries sector and coastal plastic litter abatement in Liberia, with a focus on Greater Monrovia. The project ran from July 2023 to May 2024. During this time, the following analyses were conducted:

- *An assessment of the solid waste management system.*
- *Field investigations to determine what kinds of plastic waste contribute the most to plastic pollution at land- and marine-based pollution hotspots.*
- *An analysis of the plastics value chain, including recycling options.*

The report also includes a set of prioritized recommendations and pilot projects that could be trialed to stem the tide of land- and marine-based plastic pollution in an economically viable way. At every step, the project sought the insights of stakeholders whose buy-in would be needed for the action or pilot to succeed.

© World Bank / ECOGEOS

KEY MESSAGES

POLICY: While some waste-management legislation is in place, regulations regarding Liberia's solid waste management is relatively limited. The National Solid Waste Management Policy, published in October 2024, provides goals, objectives and strategies, but is yet to be fully implemented.

DATA: There is little qualitative or quantitative data on the generation of solid waste and plastics in Greater Monrovia. Municipal waste collection is erratic and the number of active municipal waste collection points has declined. While private sector waste collectors do exist, they primarily provide a door-to-door service to households and businesses that are willing and able to pay for the service.

INFRASTRUCTURE: The existing waste management infrastructure in Greater Monrovia needs to be expanded and upgraded to ensure efficient operations. The World Bank is supporting plans to expand and establish infrastructure for transfer and disposal as well as recycling. It is also supporting work to define a sustainable financing and funding system.

STAKEHOLDERS: The number of stakeholders in the waste management sector is relatively limited and there is a tendency for stakeholders to have multiple roles (for example, collection and recycling). Coordination and cooperation within the sector needs to be strengthened.

RECYCLING: The recycling of plastics is limited, with only three companies in operation and very little waste-picking activity compared to similar developing countries in the region. Plastic recycling activities include recycling into simple products (bricks or cups for rubber collection) and pyrolysis. However, only a small portion of the plastic waste generated is recycled.

PLASTICS: A large proportion (71 percent) of plastics in municipal solid waste is considered "mismanaged". Liberia is a net importer of plastics, which presents opportunities both to control the type and composition of imported plastics and to develop policies and interventions to drive internal collection and recycling. That said, the plastics value chain needs investment to drive system improvements. The current value chains for key plastic waste streams are often incomplete and rely on external markets to supply virgin resin and demand for recycled plastics.

© World Bank / ECOGEOS

EXECUTIVE SUMMARY

The challenge of plastic pollution—and associated environmental, economic, and human health impacts—is recognized around the world. In 2016, the United Nations Environment Assembly passed Resolution 2/11 on marine plastic litter and microplastics, which called on member states to "establish and implement necessary policies, regulatory frameworks, and measures" to combat marine pollution. In 2022, Resolution 5/14 was adopted to "develop an international legally binding instrument on plastic pollution, including in the marine environment".

Liberia has not been spared the scourge of plastic pollution. Indeed, the country's capital and most densely populated region, Greater Monrovia, generates about 30,000 tons of plastic waste each year. Of this volume, 71 percent (21,000 tons) is mismanaged, resulting in about 10,360 tons (35 percent) scattered in the environment and 6,400 tons (22 percent) transported to the ocean by inland rivers and waterways.

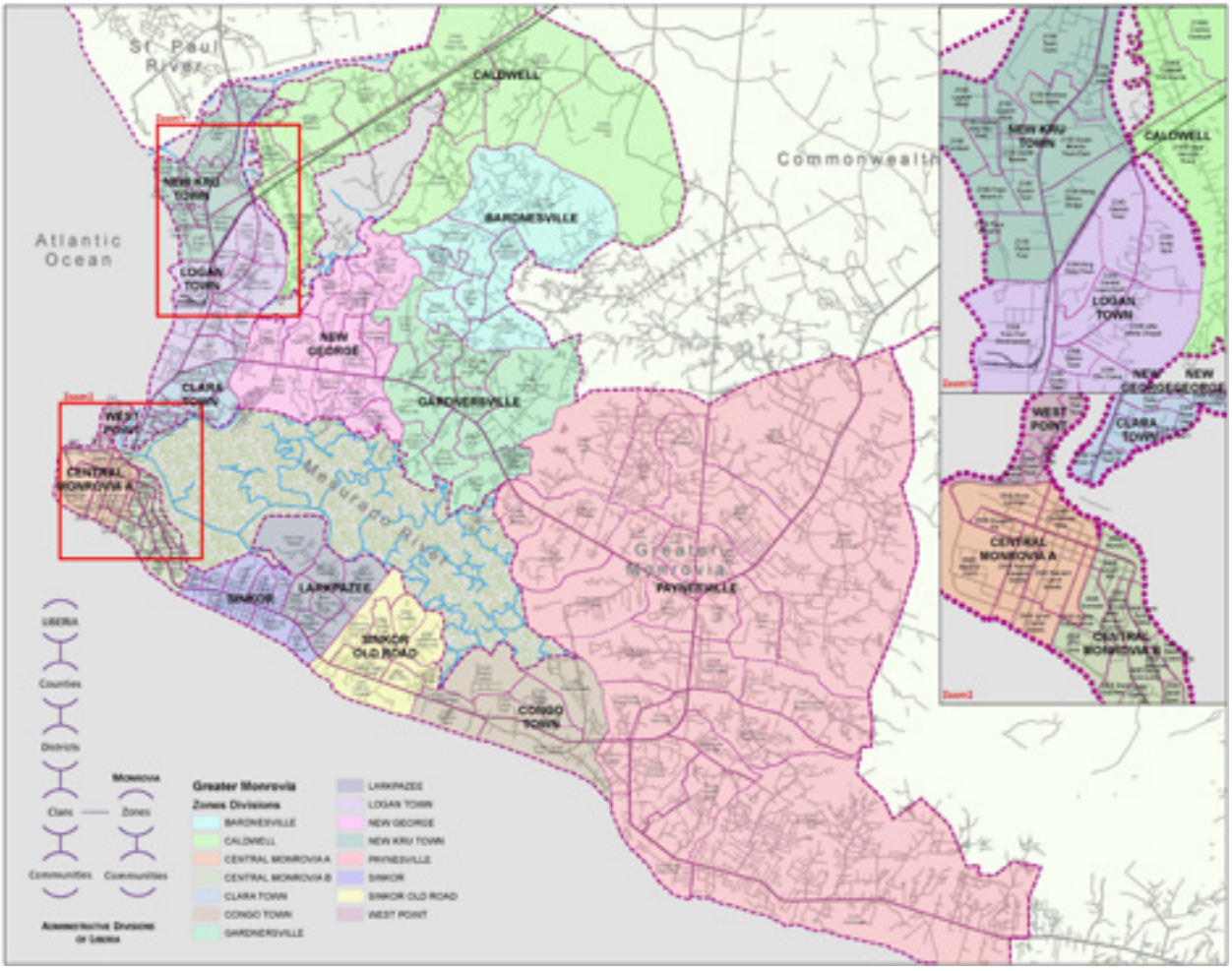
Providing adequate waste management services and infrastructure remains a significant challenge in Greater Monrovia, where only about 44 percent of municipal solid waste is collected and 19 percent of households take their waste to designated disposal locations. The number of waste collection points in the area under the Monrovia City Corporation (MCC), one of the two local municipalities that constitute Greater Monrovia, has declined from 150 (in 2009–2017) to fewer than 40, leaving many areas without a municipal collection service. Consequently, most households and businesses resort to illegally leaving their waste on the side of the road or at informal dumping points, many of which are found near markets. Only a very small proportion (2 percent) of the overall plastic waste stream is collected for recycling or for energy recovery (pyrolysis).

To better understand the plastic waste challenge in Greater Monrovia and its adjacent ocean, the scope of the World Bank's PROBLUE program in Liberia was extended to address land-based sources of plastic pollution and promote sustainable waste management and the circular economy. The World Bank also supports other projects in Liberia that aim to improve plastic waste management services and infrastructure, including the Liberia Sustainable Management of Fisheries Project and the Liberia Urban Resilience Project (LURP).

PROJECT OUTLINE

Understanding the municipal solid waste management system is an important step towards addressing land-based plastic pollution. Focusing on Greater Monrovia (Map ES1) and working in consultation with relevant stakeholders (waste collectors, plastics manufacturers, plastic recyclers, waste generators including fishing communities, and regulators and managers responsible for waste management), the project examined the legislative, institutional, management, and monitoring systems in place to manage solid waste and plastics; the sources and types of plastic pollution that accrue on land and in waterways; and the strengths and weaknesses of the plastics value chain from source to final destination, including the presence (or lack thereof) of recycling options. Based on this, a draft strategy and policy recommendations to reduce and prevent plastic pollution in Greater Monrovia, were produced and validated by stakeholders.

Map ES1. Administrative boundaries of Greater Monrovia



Source: ReliefWeb

SOLID WASTE MANAGEMENT IN LIBERIA AND GREATER MONROVIA

At the national level, the Environmental Protection Agency (EPA) is responsible for overseeing and regulating activities that affect the environment, including the waste industry. While it does register waste collectors and recycling facilities, it does not collect data on waste collection or recycling activities, nor does it monitor environmental impacts and emissions. The EPA experiences resource challenges, limiting its ability to fulfill its responsibilities. Several other government entities have peripheral or indirect roles in waste management.

While some legislation is in place (especially to assign responsibility for waste policy and management), the regulatory context is relatively limited. The National Solid Waste Management Policy (NSWMP) was published in October 2024 but is yet to be fully implemented. As of the time of writing, there was no dedicated body to promote efficient and effective waste management. Furthermore, existing bodies do not have sufficient resources to meet their regulatory requirements, such as providing services and regulating waste management activities.

The current number of stakeholders in Liberia's waste management sector is relatively limited and they tend to have multiple roles in the system (for example, collection and recycling). Despite the paucity of stakeholders, coordination and cooperation within the sector are limited. Furthermore, interaction between regulatory bodies, waste managers, and upstream (pre-consumer) stakeholders is limited. Many stakeholder groups (regulators, collectors, and recyclers) rely on external funding agencies to support their operations.

Within Greater Monrovia, the MCC and Paynesville City Corporation (PCC) are responsible for registering or certifying waste-collection activities, resulting in some level of overlap. The MCC and PCC are also responsible for waste collection and disposal services within their respective jurisdictions. Both entities have other important responsibilities, including administration, environmental and health services, and policing, resulting in low capacity for solid waste management.

As already noted, only about 44 percent of municipal solid waste is collected. This low figure can be partly attributed to budget restrictions and the low number of collection points: the MCC now has fewer than 40 collection points while the PCC has only 15, which are infrequently collected. In addition, Monrovia has only two transfer stations (which are both at capacity) and one landfill that has exceeded its capacity.

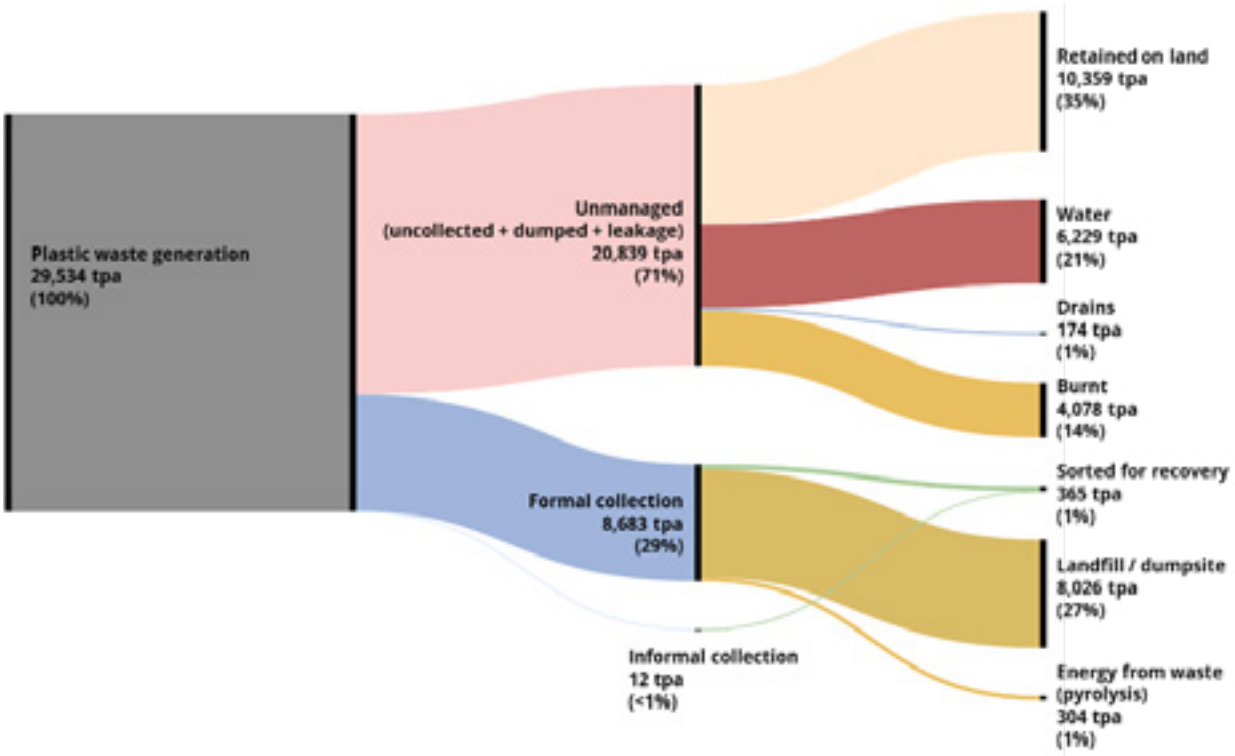
Monrovia's two major plastic waste recyclers provide some plastic waste collection services. Informal waste picking is limited compared to similar developing countries, with the 34 waste pickers working at Whein Town landfill concentrating on metals rather than plastics. These informal waste pickers are recognized as a potential future stakeholder in the plastic waste management system, particularly in relation to initiatives that add value to plastic waste to incentivize collection.

Private sector waste collectors (which are typically small- and medium-sized enterprises or certified business enterprises) contribute positively to waste collection but are accessible only to households and businesses that are willing and able to pay for the service. Together with households and businesses, private waste collectors often resort to illegally disposing of waste—often near watercourses, at former collection points, or by the roadside—largely due to a lack of alternatives or to avoid paying the disposal fee of LRD15 per ton (approximately US$0.08 per ton). Waste is also burnt to reduce volumes, both in urban areas and on the beach in fishing communities (to eliminate waste fishing nets).

PLASTIC POLLUTION IN THE ENVIRONMENT

Greater Monrovia's challenging waste collection system contributes to land-based plastic pollution, of which a significant percentage reaches marine and coastal environments. About 30,000 tons per year of plastic is generated as part of municipal solid waste. Of this, 71 percent (about 21,000 tons) is not managed or mismanaged, while only 29 percent (about 9,000 tons) is formally collected. Of the 21,000 tons that is not managed or mismanaged, about 22 percent leaks into natural water courses or drains, where it is washed out to sea (Figure ES1). Some of the volume retained on land is also likely to eventually wash into watercourses during heavy rainfall events.

Figure ES1. Sankey diagram of municipal solid waste plastics generation and management in Greater Monrovia (tons per annum [tpa])



Source: Original Sankey figure produced for this publication.

Plastics—and single use plastics in particular—represent the most significant proportion of waste in the environment across all hotspot typologies. Litter characterization was undertaken to determine the quantity and composition of litter that leaks into natural environments at 13 pollution hotspots across seven typologies (dumpsites near waterways, collection points, open channels, channel/pipe outflows, beaches, estuaries, and the ocean). The characterizations confirmed that a large portion of plastic pollution consists of recyclable plastics like transparent PET bottles. This indicates that there are unexplored opportunities for extracting value from used plastic products by collecting and preparing waste plastic for recycling. Doing so would both generate income for the people of Monrovia and reduce the proportion of plastic pollution that enters the environment and travels to the ocean.

THE PLASTICS VALUE CHAIN

Liberia imports nearly all its plastics. On average, Liberia imported about 40,000 tons of plastic and exported about 174 tons of plastics (as products, used items, and pre-consumer waste) per year between 2022 and 2023. The two sectors that contributed the most to imports were the construction and agriculture sector (44 percent, largely due to significant quantities of piping and flooring) and the food and beverages sector (22 percent). The food and beverages market is characterized by high levels of single-use plastics.

Plastic recycling value chain in greater Monrovia is very limited with only a handful of small and micro-enterprises. The two small recyclers recycle limited amounts of plastics resins, electronic waste, and organic waste, and engage in pyrolysis to produce fuel.[1] Three micro-scale recyclers (recycling less than 1 ton per month) use plastics as source material to create items such as bags, raincoats, and decorations. Prices for collected material range from LRD10 to LRD30 (US$0.05 to US$0.15) per kilogram. Low prices and limited opportunities to valorize the waste plastic are major barriers to collection and recycling.

Source separation is not widespread in Monrovia. Recyclers either source their material directly from waste generators (especially businesses) or purchase collected material from CBEs and SMEs. Waste pickers currently play a minor role in collecting waste plastics.

Artisanal fisheries report releasing very little, if any, abandoned, lost, or discarded fishing gear (AFLDG). Fishers typically go to great lengths to ensure that nets do not get lost at sea so that they can be repaired on land. One community even reported an explicit ban on deliberately dumping nets at sea. This success is believed to be due in large part to awareness building and behavior change work undertaken by NaFAA with World Bank support.

Where the nets cannot be repaired, the majority of surveyed fishing communities said they dump waste nets on the beach and either bury or burn them at a later stage. There is currently no collection or recycling of monofilament fishing nets, which points to an opportunity to reclaim value by recycling fishing nets, starting by focusing on uncontaminated end-of-life nets.

POTENTIAL TO DRIVE A CIRCULAR ECONOMY

Value chain assessments for PET bottles, HDPE/LDPE/PP packaging, and monofilament (nylon) fishing nets identified key levers for enhancing and expanding recycling and circularity in Greater Monrovia. These levers were identified by assessing: (i) connections within the value chain (that is, the relationships between various stakeholders in the value chain); (ii) the characteristics of the value chain that would support waste valorization or value addition; and (iii) what would be needed to create an enabling environment for the value chain to thrive.

Circular economy levers for monofilament fishing nets

The use of monofilament (nylon) fishing nets is banned in Liberia. The circular economy assessment found that:

- Stronger management and coordination of the fisheries sector would support the enforcement of regulations.
- Increased financial means would enable fishers to invest in higher-quality nets.
- Improved revenues for net-recycling activities would enhance collection and recovery rates.

[1] Pyrolysis is not considered and is lower than materials recovery on the waste management hierarchy. It is also generally recognized to carry a high risk of environmental pollution and health impacts, especially when practiced at small, low-tech scale.

Circular economy levers for PET bottles

The assessment found that:

- Improved financial conditions and access would enable public and private stakeholders at nearly all stages of the value chain to fulfill their roles.
- Source separation at scale would directly improve material quality and quantity, net revenues, and recovery rates.
- Access to a competitive market would help address power imbalances between Liberian and external stakeholders, and enhance net revenues.
- Increased recycled PET demand and pricing would help drive collection and recovery rates while increasing material supply.
- Enhanced awareness of the benefits and impacts of recycling and circularity would help promote stakeholder participation across the value chain, including citizens as well as recycling service providers.

Circular economy levers for HDPE, LDPE, and PP packaging

The assessment found that the levers for HDPE, LDPE, and PP packaging are very similar to that of PET bottles, with the following noteworthy differences:

- Domestic demand for recycled PE has created a more diverse value chain, which provides collectors and processors with more options and potential to improve net revenue.
- Strong demand and pricing can create incentives for greater source separation and increased recovery.
- Source separation can improve quality and thus enhance opportunities to create circularity.

PROPOSED RECYCLING PILOT PROJECTS

Based on the circular economy value chain assessments for monofilament nets; PET bottles; and HDPE, LDPE, and PP packaging, five potential pilot projects were assessed, as discussed below.

Fishing net recycling pilots

- **Option 1a: Recycling fishing nets by centralizing cleaning for recycling abroad.** This option involves purchasing partially cleaned waste fishing nets from fishing communities. Nets are then cleaned more thoroughly before being baled and stored in a storage container. The storage container is then shipped to a European recycler. This option was expected to run at a loss of US$6,000 per year due to anticipated warehousing and transportation costs and to create 1.4 full-time equivalent jobs.

- **Option 1b: Recycling fishing nets through communities cleaning nets for recycling abroad.** This option involves purchasing thoroughly cleaned waste fishing nets from fishing communities, who would be remunerated based on a price per kilogram. Cleaned nets would then be stored in shipping containers in each community before being transported to a central point for baling. A supervisor would ensure that cleaning standards and equipment are being maintained. Keeping the cleaning phase within communities would encourage participation by creating 4.4 full-time equivalent jobs. However, the upfront costs of this system are higher than Option 1a due to the need to invest in storage containers for each of the communities. Moreover, the challenge of transportation to Europe would not be solved.
- **Option 2: Local recycling of fishing nets.** This option involves collecting partially cleaned nets from fishers and transporting them to a local recycling facility. Although this option has the advantage of keeping materials within the local market, low reimbursement by the recycler means that this option would run at a loss even when processing and transport costs are excluded.
- **Option 3: Exchanging monofilament nets for cotton nets.** Instead of recycling nylon fishing nets, this option aims to gradually phase them out by exchanging waste nylon nets for new cotton nets. Cotton nets would need to be selected in consultation with the fishers to ensure that they are fit for purpose. Collected nylon nets would be disposed of at a landfill facility. Although this option creates opportunities to educate fishers on the benefits of using cotton nets, it would not be financially viable because cotton nets are significantly more expensive and there is no current source for financial subsidization. To succeed in the long term, the initiative would also need to be accompanied by strict enforcement of the ban on monofilament nets.

Plastic packaging recycling pilots

- **Option 4: Buy-back kiosks for plastic packaging.** This option aims to improve the collection rate for targeted resins by establishing buy-back kiosks at three central locations in Monrovia. PET bottles would be baled and exported to Europe for recycling—as is currently the case—while PE and PP would be locally recycled. This option is expected to run at an annual loss due to the costs involved with staffing, renting a centralized warehouse facility, and paying for the waste material. Increasing the quantity of waste accepted at the kiosks could make this option cost-neutral.
- **Option 5a: PET collection with local recycling and export.** Option 5a involves establishing three dedicated buy-back points to collect PET bottles, which are then transported to a central local recycling facility for production of washed PET flakes. These flakes are then exported at a higher price and lower transportation costs than baled bottles. Once the significant initial investment is covered, this option appears to be profitable.
- **Option 5b: Collection via buy-back kiosks and local recycling.** Option 5a involves establishing buy-back kiosks that accept a range of plastic resins. Materials are taken directly to the appropriate recycling facility, with PET going to the dedicated recycling line. This option offers the same advantages as Option 4 but the inclusion of PE and PP, which have lower margins, makes it much more difficult to cover costs and achieve profitability.

Each option was assessed based on its economic viability and potential for local job creation. The economic assessment found that, given the estimated quantities for each waste stream, **only Option 5a appears economically viable**. However, this solution addresses only one of the three priority waste streams.

While local recycling options for the other waste streams are possible (assuming the technical feasibility of the extrusion and product manufacture from fishing nets for Option 2), the prices paid by local recyclers (which, in turn, depend on the value of the products made and the local population's ability to pay) are too low to cover the collection and transport costs. Furthermore, the prices per kilogram modelled were all relatively low (to give an indication of maximum profitability per kilogram) and the amounts may not be sufficient to motivate waste generators to participate in the new collection system.

PROPOSED STRATEGY TO REDUCE AND PREVENT PLASTIC POLLUTION IN GREATER MONROVIA

Based on the findings of this study, 26 possible interventions to prevent and reduce plastic pollution in Greater Monrovia have been identified. The 26 interventions can be classified into four strategic orientations: regulatory, institutional, logistic, and financial (Figure ES2). Although these initiatives could be undertaken independently, it would be more effective if a single entity—possibly the EPA but potentially a different entity entirely—oversaw the implementation of this proposed strategy while ensuring that the benefits accrue to all stakeholders. The regulatory recommendations listed in the figure would, if effectively implemented, strengthen waste management by improving producer responsibility, integrating informal waste pickers into the waste management system, and enhancing the availability and robustness of waste management data to support evidence-led policy decisions.

Figure ES2. Possible interventions by strategic orientation

REGULATORY RECOMMENDATIONS

Initiative 1: Implementation Plan for National Solid Waste Management Policy

Initiative 2: Fulfill current regulatory obligations

Initiative 3: Phase out single-use plastics

Initiative 4: Register waste pickers

Initiative 5: Extended producer responsibility

Initiative 6: Enforce laws on illegal dumping.

INSTITUTIONAL RECOMMENDATIONS

Initiative 7: Establish a dedicated national waste management body

Initiative 8: Improve stakeholder cooperation

Initiative 9: Raise awareness

Initiative 10: Establish a recyclers' association.

LOGISTICAL RECOMMENDATIONS

Initiative 11: Characterization of waste

Initiative 12: Track use and disposal of fishing gear*

Initiative 13: Improve access to potable water

Initiative 14: Investigate alternatives to plastic packaging

Initiative 15: Source separation

Initiative 16: Provide regular waste collection

Initiative 17: Improve waste management at markets

Initiative 18 and Initiative 19: Upgrade MCC trasnfer stations and develop PCC transfer stations

Initiative 20: Support community cleanup efforts

Initiative 21: River waste barriers

Initiative 22: Marine litter capture.

FINANCIAL RECOMMENDATIONS

Initiative 23: Support alternatives to monofilament nets*

Initiative 24: Incentives for use of recycled plastic

Initiative 25: Establish waste collection fees

Initiative 26: Low-interest loans for waste management projects

Initiative 27: Regional cooperation.

** While the overall set of recommendations broadly support plastic pollution reduction (terrestrial, estuarine, marine) and plastic recycling, these two are specifically focused on fishing gear.*

PROPOSED TIMELINE FOR INTERVENTIONS

The timeline in Table ES1 was developed in consultation with waste and plastic value chain stakeholders. It aims to rank interventions by priority while also enhancing the chances that they will be successful by ensuring that supporting conditions are first sufficiently established. Short-term interventions are those that can be implemented almost immediately (1–2 years), while medium-term (3–5 years) and long-term interventions (5–10 years) require further development of the waste sector and implementation of the strategy before being implemented. The strategy is not immutable and may evolve in terms of initiative priorities.

Table ES1. Holistic view of interventions towards plastic pollution reduction and prevention for Greater Monrovia (excluding recycling pilots)

HIGH PRIORITY MEDIUM PRIORITY LOW PRIORITY	INTERVENTIONS TIME FRAME		
	Short term	**Medium term**	**Long term**
Regulatory	Implementation Plan for National Solid Waste Management Policy	Phase out single-use plastics	Extended producer responsibility
	Fulfill current regulatory obligations	Register waste pickers	
		Enforce laws on illegaly dumping	
Institutional	Improve stakeholder cooperation	Establish a dedicated national waste body	
	Raise awareness		
	Establish a recyclers' association		
Logistic	Characterization of waste	Improve access to potable water	Source separation
	Track use and disposal of fishing gear*	Investigate alternatives to plastic packaging	
	Provide regular waste collection	Improve waste management at markets	
	Support community cleanup efforts	Upgrade MCC transfer stations	
		Develop PCC transfer stations	
		River waste barriers	
		Marine litter capture	
Financial	Support alternatives to monofilament nets*	Incentives for use of recycled plastics	Establish waste collection fees
		Low-interest loans for waste management projects	
		Regional cooperation on recycling	

** While the overall set of recommendations broadly support plastic pollution reduction (terrestrial, estuarine, marine) and plastic recycling, these two are specifically focused on fishing gear.*

CONCLUSION

The initiatives proposed are designed to significantly improve the plastic challenge in Monrovia, with varying degrees of impact and implementation in the short, medium, and long term. Although these initiatives could be undertaken independently, it would be more effective if a single entity—ideally a national waste body—propagated the overall vision and strategy while ensuring that the benefits accrue to all stakeholders.

In addition to making the policy and institutional recommendations above, the report assessed the technical and financial merits of a range of potential recycling projects. Given the estimated quantities for each waste stream, it was found that only Option 5a (PET collection with local recycling) is economically viable. However, this solution addresses only one of the three priority waste streams. While it is possible to locally recycle the other waste streams, the prices paid by local recyclers (which, in turn, depend on the value of the products made and the local population's ability to pay) are too low to cover collection and transport costs.

Regardless of which pathway is chosen to reduce plastic pollution in Monrovia and Liberia, public awareness will be foundational to its success. By engaging stakeholders from various levels of government, the private sector, NGOs, and local communities at frequent intervals during stakeholder engagements for this report, the study itself helped to plant the seeds of such awareness. Further effort to raise public awareness through targeted campaigns and education drives will be needed to drive broad participation in effective waste management, recycling at the source (especially of plastics), and beach cleanup drives.

CONTENTS

LIST OF BOXES

LIST OF FIGURES

LIST OF MAPS

LIST OF PHOTOS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ALDFG	Abandoned, lost, or discarded fishing gear
CBEs	Certified business enterprises
ECOWAS	Economic Community of West African States
EPA	Environmental Protection Agency
EPR	Extended producer responsibility
GDP	Gross domestic product
HDPE	High-density polyethylene
LDPE	Low-density polyethylene
LURP	Liberia Urban Resilience Project
LRD	Liberian dollar
MARPOL	International Convention for the Prevention of Pollution from Ships
MCC	Monrovia City Corporation
NaFAA	National Fisheries and Aquaculture Authority
NSWMP	National Solid Waste Management Policy
PCC	Paynesville City Corporation
PE	Polyethylene
PET	Polyethylene terephthalate
PP	Polypropylene
PS	Polystyrene
PVC	Polyvinyl chloride
SMEs	Small and medium-sized enterprises
Tons	Metric tons (1,000 kilograms)

© World Bank / ECOGEOS

CHAPTER 1

INTRODUCTION

The challenge of plastic pollution—and the associated environmental, economic, and human health impacts—is increasingly recognized around the world. In addition to the negative impacts on the environment in terms of affecting water quality and damaging marine ecosystems, plastic pollution—and inadequate waste management in general—has detrimental impacts on human health, quality of life, and economic activities such as fishing and tourism.

In 2016, the United Nations Environment Assembly passed Resolution 2/11 on marine plastic litter and microplastics, which called on member states to "establish and implement necessary policies, regulatory frameworks, and measures" to combat marine pollution. In 2022, Resolution 5/14 was adopted to "develop an international legally binding instrument on plastic pollution, including in the marine environment".

Liberia is among the poorest countries in the world. However, over the past two decades, gross domestic product (GDP) has risen, with an average growth rate of 5 percent (World Bank 2023).[2] According to the World Bank's "What a Waste 2.0" snapshot,[3] waste generation in Liberia is close to the average for the sub-Saharan African region at 0.43 kilograms per person per day (kg/capita/day) (Kaza et al., 2018). Based on the 2022 population of Liberia of 5.2 million,[4] this equates to about 824,000 metric tons per year (tons/year), of which more than a quarter (232,000 tons/year) is generated in Greater Monrovia. A detailed waste characterization study performed in Monrovia in 2012 determined that plastics represented approximately 11 percent of municipal waste (approximately 25,500 tons/year based on 2022 estimated tonnage).[5] However, it is widely acknowledged that plastic packaging usage has increased since 2012; therefore, current plastic waste generation is expected to be greater than that.

Providing adequate waste management services and infrastructure remains a significant challenge in Monrovia, where only 19 percent of households take their waste to designated disposal locations. Most households and businesses engage in illegal dumping. The Monrovia City Corporation, one of the two local municipalities that constitute Greater Monrovia, has been forced to reduce the number of collection points from 150 (2009–2017) to fewer than 40, leaving many areas without a municipal collection service. Uncollected waste is frequently dumped illegally, blocking waterways and drainage channels and driving the pollution of sensitive areas, including wetlands. Illegal dumping presents a major source of marine litter, most of which is plastic.

Globally, about 80 percent of marine plastics originates on land, where it is transported to the ocean through rivers.[5] Land-based plastic pollution factors (quantities, composition, and points of accumulation) are primarily determined by: (i) the levels and types of plastics in municipal solid waste; (ii) the effectiveness of municipal solid waste management systems (their ability to contain, collect, recycle, and dispose of waste); (iii) human behavior; and (iv) environmental processes (such as precipitation, wind, and riverine, estuarine, and coastal zone dynamics). Understanding the municipal solid waste management system is therefore an important step towards addressing land-based plastic pollution.

---

[2] See: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=LR.

[3] Kaza S, Yao L, Bhada-Tata P, and Van Woerden F. 2018. "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050." *Urban Development*. Washington, DC: World Bank. https://hdl.handle.net/10986/30317.

[4] https://liberia.un.org/en/220493-liberia-announces-provisional-results-its-5th-national-population-and-housing-census

[5] OECD (Organization for Economic Co-operation and Development). 2020. "Reframing Financing and Investment for a Sustainable Ocean Economy. Policy Perspectives." OECD Environment Policy Paper No. 22. Paris: OECD Publishing.
https://www.oecd.org/content/dam/oecd/en/publications/reports/2020/10/reframing-financing-and-investment-for-a-sustainable-ocean-economy_eb0780e6/c59ce972-en.pdf?

In recognition of this issue, the scope of the World Bank's PROBLUE program in Liberia was extended to address land-based sources of plastic pollution and promote sustainable waste management by creating an environment to support the circular economy for problem plastics. The World Bank also supports other projects in Liberia that aim to improve plastic waste management services and infrastructure, including the Liberia Sustainable Management of Fisheries Project and the Liberia Urban Resilience Project (LURP).

PROJECT OBJECTIVES

To identify opportunities to improve solid waste and plastic management in Liberia, the project sought to:

- Understand the legislative, institutional, management, and monitoring systems in place to manage solid waste and plastic in Liberia, with a specific focus on Greater Monrovia
- Locate places where pollution is generated and/or where it accrues on land and in waterways (pollution hotspots)
- Identify common types of plastic waste in Greater Monrovia (by type and brand of origin) and how these accumulate in estuarine, coastal, and marine environments
- Assess the strengths and weaknesses of the plastics value chain from source to final destination, including the presence (or lack thereof) of recycling options.

It also developed policy recommendations and a draft strategy that includes suggestions for pilot projects to drive a circular economy for key waste streams in Greater Monrovia.

METHODOLOGY AND STAKEHOLDER MAPPING

This report synthesizes key discoveries stemming from the analysis of desktop research (including compiling data from various sources), field studies, and stakeholder consultations conducted between July 2023 and May 2024.

The stakeholders involved in the generation and management of plastic waste within Greater Monrovia can be grouped into five major categories: manufacturers; waste generators (both municipal and commercial); collectors; plastic recyclers; and regulators/managers responsible for final disposal or regulation of waste management activities.

Representatives from the following stakeholder groups were consulted at various stages of the project to verify desktop findings and strengthen data sets:

- **Manufacturers,** including the only plastics manufacturer in the country, and several large- and small-scale water and beverage companies.
- **Waste generators,** with a focus on the fishing communities of Banjor beach, Bernard beach, ELWA beach, King Gray beach, Popo beach, Tomah Town beach, and West Point beach. Municipal waste generators were represented by civil society organizations that helped to map and understand this stakeholder category.

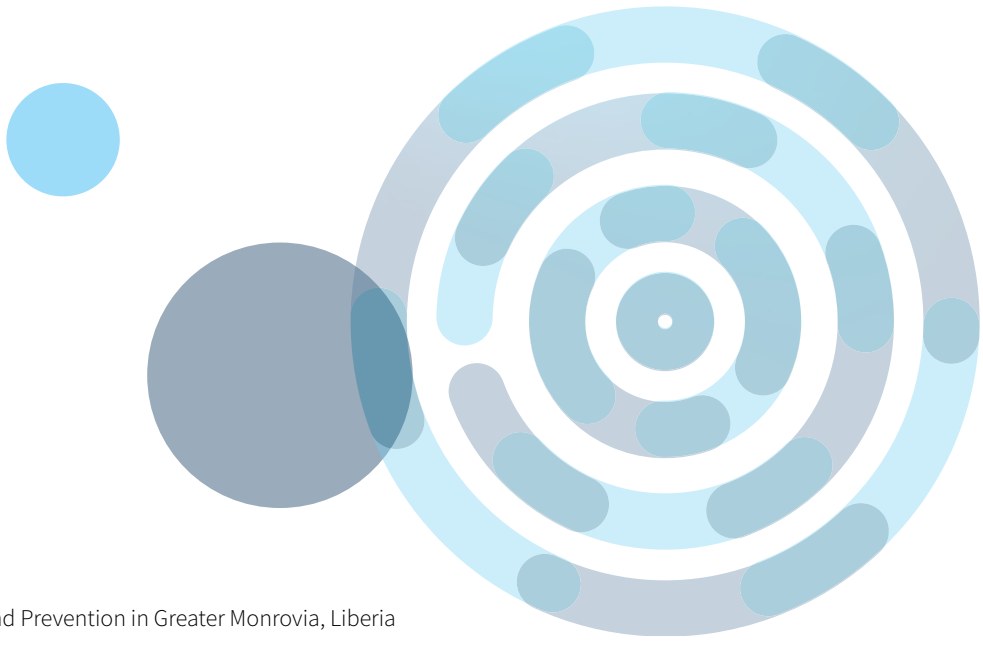
- **Waste collectors,** including small enterprises (which contract with MCC and PCC to provide primary collection from residents) and medium enterprises (which collect waste from commercial and institutional generators and markets).
- **Plastic waste recyclers,** of which there is only a small number in greater Monrovia, including a couple of small enterprises and a few micro-enterprises. Together, these handle relatively small amounts of plastic waste and face many challenges to operate sustainably.
- **Regulators and managers responsible for the final disposal or regulation of waste management activities, as well as public sector entities that hold key knowledge,** including the Ministry of Public Works, the Liberia Revenue Authority, the National Fisheries and Aquaculture Authority, the Liberian Meteorological Service, and local governments, namely the Monrovia City Corporation (MCC) and the Paynesville City Corporation (PCC).

Data-gathering and analytical methods specific to a particular line of investigation are noted in the relevant sections in this report.

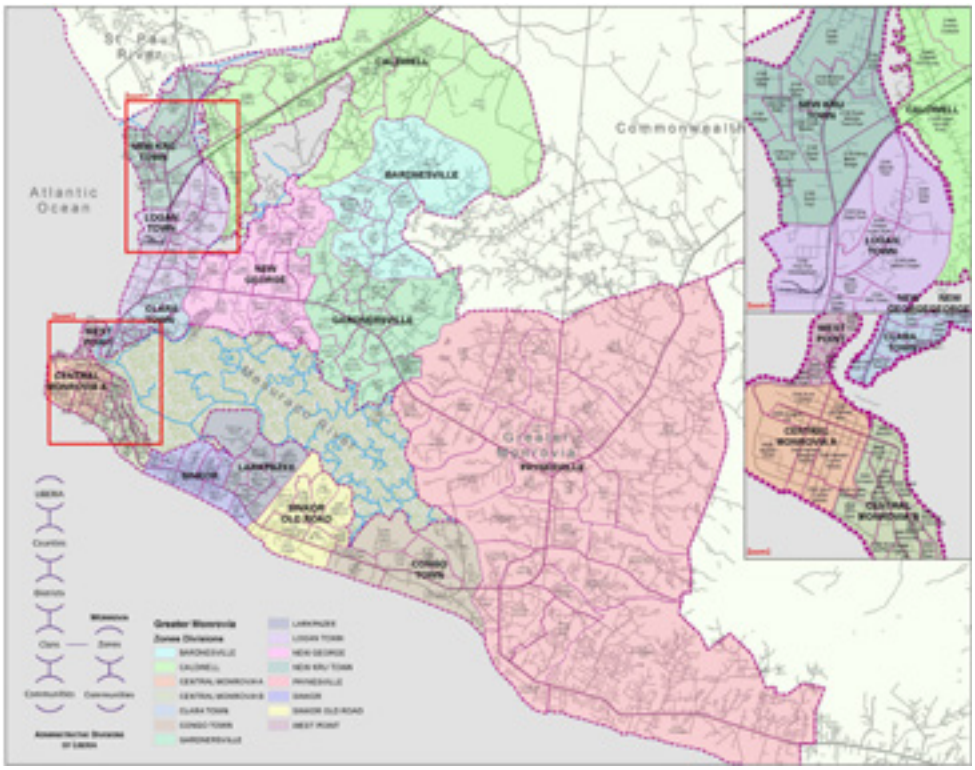
TARGET GEOGRAPHY

The project focused on Greater Monrovia, Liberia's capital and most densely populated region (Map 1). To better understand pathways of plastic waste transport through Greater Monrovia, the study area was divided into sub-catchment areas based on topographical data (Map 2). The largest sub-catchment area, the Mesurado river catchment area, represents 44 percent of the study area's land mass. This indicates that, in a large proportion of the study area, water (and the waste it carries) drains principally via the Mesurado river to the ocean. Drainage occurs directly into the ocean along the coast and in a small area of central Monrovia.

By contrast, the Saint Paul river sub-catchment, while recognized as a contributor of plastic pollution, covers a relatively small area (21 percent) of Greater Monrovia and is not as highly urbanized as the Mesurado catchment. Given this and the project's budgetary limitations on the number of land-based hotspots for plastic waste assessments, the Saint Paul river sub-catchment was excluded from the study area.



Map 1. Administrative boundaries of Greater Monrovia



Source: ReliefWeb[6]

Map 2. Sub-catchment areas of Greater Monrovia

Source: Original map produced for this publication.

[6] See: https://reliefweb.int/map/liberia/greater-monrovia-liberia-administrative-boundaries-overview-26-sep-2014.

© World Bank / ECOGEOS

CHAPTER 2

MONROVIA'S SOLID WASTE MANAGEMENT SYSTEM

This chapter provides a detailed description of the stakeholders and steps involved in solid waste management in Greater Monrovia—and the national regulatory system that oversees such management—to assess system performance and identify potential interventions to strengthen the system.

2.1 LEGISLATIVE ENVIRONMENT AND RESPONSIBLE GOVERNMENT ENTITIES

Solid waste management in Liberia (including Greater Monrovia) is guided by the following legislation and policies:

- The **Environmental Policy of Liberia (2002)** sets the framework for the sound management of resources and the environment, including solid waste management.
- The **Environmental Protection Agency Act (2003)** created the Environmental Protection Agency (EPA), an autonomous body responsible for coordinating and monitoring environmental policies and guidelines, including those on solid waste management.
- The **National Solid Waste Management Policy (NSWMP) (2024)** was signed in October 2024 and still needs an implementation plan. This policy sets goals for waste management, including that all people shall have access to a solid waste service at an affordable cost (Goal 1) and that waste generation should be decreased and waste use should be increased (Goal 6).
- Liberia's **Public Health Act (1985)** requires local municipalities to provide waste collection and waste disposal services.
- The **Environmental Protection and Management Act (2002)** and the **Liberia Waste Management and Standards Regulations (2009)** both strictly prohibit the dumping of waste outside designated containers or places, among other requirements.

The following regulatory texts apply to the prevention of pollution from marine-based sources such as abandoned, lost, or discarded fishing gear, which could contribute to marine plastic pollution:

- **Fisheries Regulations** (2010) ban the use of monofilament nets in marine waters and set conditions for the types of monofilament nets to be used in estuarine environments and multifilament nets in all fisheries waters.
- The **National Fisheries and Aquaculture Act** (2017) establishes the National Fisheries and Aquaculture Authority (NaFAA) as the body responsible for the "conservation, management, and development of Liberia's fisheries and aquaculture resources".
- The **Maritime Law Regulations** (2018) apply the provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex V Regulation to Liberian waters by banning the discharge of any garbage other than that permitted under the MARPOL Convention (thereby banning disposal of all plastics at sea).
- The **Fisheries and Aquaculture Management and Development Act** (2019) bans the use of monofilament nets, as well as receiving or selling fish caught using banned gear.

Regulatory body

The EPA is responsible for overseeing and regulating activities that impact the environment, including the waste industry. While it does register waste collectors and recycling facilities, it does not collect data on waste collection or recycling activities, nor does it monitor environmental impacts and emissions. The EPA appears to be under-resourced, limiting its ability to fulfill its responsibilities.

Implementing entities

In line with the Public Health Act, the MCC and PCC are responsible for providing waste collection and disposal services within their respective jurisdictions. The Liberia Marketing Association is responsible for helping these city corporations with waste management at markets.

In addition to waste management, both the MCC and PCC have other responsibilities, including administration, environmental and health services, and policing. As a result, capacity for solid waste management needs to be strengthened.

Section 2.2 provides insight into the government entities involved, either directly or indirectly, in plastic waste management.

2.2 KEY STAKEHOLDERS ALONG THE PLASTICS VALUE CHAIN

Stakeholder mapping illustrated the relatively limited number of stakeholders in each category as well as the tendency for stakeholders to have multiple roles in the system. Furthermore, there is currently very little interaction between regulatory bodies, waste managers, and pre-consumer stakeholders (as would be the case with an extended producer responsibility scheme, for example).

Focusing on plastics as a major contributor to solid waste in Liberia (see Section 3), it should be noted that:

- **There is only one plastics product/packaging manufacturer in Liberia.** The vast majority of plastic is imported either as preformed packaging (bottles), pre-packaged products in plastic packaging (for example, food products and some beverages), or plastic products (for example, fishing gear and household items).
- **There are many small-scale artisanal water-sachet producers who fill LDPE (low-density polyethylene) sachets.** These sachets are a major source of potable water for the local population.
- **The two major plastic waste recyclers are also involved in waste collection.**
- **Waste-picking activities are very limited** in comparison to similar developing countries. Waste pickers were not included in the schematic due to the small magnitude of their activities and their focus on other materials (metals) rather than plastics. They are, however, recognized as a potential future stakeholder in the plastic waste management system, particularly in relation to initiatives that add value to plastic waste to incentivize collection.

- **Waste management is undertaken at the local and national levels by bodies with a range of other responsibilities** outside of waste management and who, as discussed previously, face significant challenges in meeting their existing responsibilities. In addition to enabling these stakeholders to fulfill their respective responsibilities, there is a need to establish a dedicated national body for waste management. There is also an overlap between some regulatory roles, for example, both EPA and the MCC register or certify waste-collection activities. These issues, along with the lack of strategic planning on waste management, have been identified in previous studies.[7]
- **Several government entities have peripheral or indirect roles in waste management:**
  - The Ministry of Public Works is indirectly involved in collection through road maintenance.
  - The NaFAA monitors fishing activity and was involved in a net exchange program to reduce the use of monofilament (nylon) fishing nets, as required by the Fisheries and Aquaculture Management and Development Act. This law is poorly enforced and NaFAA has indicated that it needs additional resources in order to follow through with enforcement at this stage.
  - The Liberian Revenue Agency collects data on the import and export of products to and from Liberia. This is analyzed in detail in the Plastic Value Chain Assessment report.
- **External funding agencies have supported the activities of stakeholders across numerous categories.** Their presence and the funding they provide raise the question of the system's self-sufficiency should they withdraw, particularly given the previously noted budgetary issues of waste regulators and managers.

See **Section 4** for a more detailed analysis of the upstream and downstream plastics value chain.

[7] David VE, John Y, and Hussain S. 2020. "Rethinking Sustainability: a Review of Liberia's Municipal Solid Waste Management Systems, Status, and Challenges." *Journal of Material Cycles and Waste Management* 22: 1299–1317. https://doi.org/10.1007/s10163-020-01046-x.

2.3 KEY WASTE HOTSPOTS

Greater Monrovia produces an estimated 269,000 metric tons (hereafter "tons") of municipal solid waste each year, about 53 percent of which is generated in the Mesurado river catchment area.[8] Industrial activities also contribute to the overall waste generated, with at least 2,910 tons of waste from these sources arriving at the Whein Town landfill each year. A substantial amount of municipal solid waste never reaches landfill and is instead dumped on the side of the road or at informal dumping points, many of which occur around large markets close to the coast (Map 3).

Map 3. Locations of main markets and fishing communities within Greater Monrovia

A substantial portion of municipal solid waste is dumped at informal dumping points near large markets within the Mesurado river catchment area and the coastline.

Source: Original map produced for this publication.

[8] There is little data on how much solid waste Greater Monrovia generates each day, and even less on waste generated according to income level. For the purposes of analysis, this project therefore assumed that everyone in the population produced 0.5 kilograms of solid waste per day (kg/capita/day) and that the population of Greater Monrovia was 1,471,000 (based on 2019 data, which was extrapolated from 2008 census data). Population concentrations are based on 2014 population density data.

2.4 WASTE COLLECTION AND RECYCLING OR DISPOSAL

As already noted, land-based plastic waste and plastic pollution are primarily the function of failures in municipal solid waste management systems and public behavior. Understanding the municipal solid waste management system and the challenges it faces are therefore essential for assessing the factors contributing to plastic waste and identifying solutions for reducing it.

According to the World Bank report "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050", waste generation in Liberia is close to the average for the sub-Saharan African region at 0.43kg/capita/day.[9] Based on the 2022 population of Liberia of 5.2 million,[10] this equates to about 824,000 metric tons per year, of which more than a quarter (232,000 tons per year) is generated in Greater Monrovia. A detailed waste characterization study performed in Monrovia in 2012 determined that plastics represented about 11 percent of municipal waste (approximately 25,500 tons per year based, on 2022 estimated tonnage).[11] However, it is widely acknowledged that plastic packaging usage has increased since 2012; therefore, current plastic waste generation is expected to be greater than that.

The current waste collection system is characterized by challenges in collection, transfer, and disposal operations, as well as a low collection rate. A challenging collection system contributes to plastic pollution from Greater Monrovia reaching marine and coastal environments.

This section delves into waste collection, transfer, disposal, and recycling in Greater Monrovia. Section 3 then explores the fate of plastic waste, and how much of it enters the environment.

Collection

As noted, the MCC and PCC are responsible for collecting and safely disposing of municipal solid waste. However, both entities experience challenges in meeting this mandate and the average collection rate for municipal solid waste was calculated at about 44 percent, with significant variations in this figure from month to month.

This figure can be partly attributed to a decline in the number of MCC rubbish collection points, which has dropped from 150 in 2017 to fewer than 40 today. Meanwhile, the PCC has only 15 collection points, and these are infrequently collected (Photo 1).

Small- and medium-sized enterprises (SMEs) and certified business enterprises (CBEs) that collect waste from households have sprung up to fill the gap in collection services. However, these services are available only to those who are willing or able to pay. The enterprises also face competition from unlicensed collectors.[12]

---

[9] Kaza S, Yao L., Bhada-Tata P., and Van Woerden F. 2018. "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050." *Urban Development*. Washington, DC: World Bank. https://hdl.handle.net/10986/30317.

[10] See: https://liberia.un.org/en/220493-liberia-announces-provisional-results-its-5th-national-population-and-housing-census.

[11] OECD. 2020. "Reframing Financing and Investment for a Sustainable Ocean Economy. Policy Perspectives." OECD Environment Policy Paper No.22. Paris: OECD Publishing.
https://www.oecd.org/content/dam/oecd/en/publications/reports/2020/10/reframing-financing-and-investment-for-a-sustainable-ocean-economy_eb0780e6/c59ce972-en.pdf?

[12] Cities Alliance. 2021. "Greater Monrovia Solid Waste Management Baseline." https://www.citiesalliance.org/sites/default/files/2021-06/CitiesAlliance_BaselineStudyWasteManagement_2021.pdf.

These challenges are also reflected in the quantity of waste disposed of at the Whein Town landfill, which fluctuated from about 4,500 tons in February 2022 to nearly 20,000 tons in June 2022—a more-than-fourfold difference that is likely due to the amount of waste collected rather than variations in the amount of waste generated.

Photo 1. Waste accumulation at collection sites

Waste collection points in the Monrovia City Corporation's area have declined from 150 in 2017 to fewer than 40 today, while the Paynesville City Corporation has only 15 collection points, which are infrequently serviced.

© World Bank / ECOGEOS

Box 1. The challenge of illegal dumping

Households and businesses often illegally dump uncollected waste, creating a network of illegal dumpsites throughout Monrovia. Next to the Duala Market, waste is dumped to fill a swampy area, so as to enable the construction of informal homes (Photo B1). Waste and household septage are often dumped into drainage channels. The dumping of waste may also be timed to coincide with heavy rainfalls, maximizing the chance that the waste will be washed away as soon as possible. A portion of the waste is also burnt, sometimes to reduce volumes when dumpsites become too large.

Waste is also dumped by collectors (SMEs, CBEs, and unlicensed collectors) because it is more convenient to dump at a nearby informal dumping site than to transport the waste to a more distant transfer station. In the case of SMEs, dumping at informal dumping sites is also a way to avoid paying the disposal fee (of LRD15/ton or US$0.08/ton).[13]

Photo B1. Dumpsites near Duala Market (left), Waterside Market (center), and by the side of the road (right)

The illegal dumping of municipal waste by homes and businesses has given rise to a network of illegal dumpsites throughout Monrovia.

© World Bank / ECOGEOS

[13] Based on an exchange rate of LRD190/US$1, the approximate exchange rate at the time of the study.

Transfer

The MCC operates two transfer stations (Stockton Creek and Fiamah, Photo 2) and the Whein Town landfill in Paynesville, which has been in operation since 2008 and has exceeded its capacity. The transfer stations consolidate waste collected by the MCC and accept waste collected by CBEs (free of charge) and SMEs (for a fee—see Box 1). However, both transfer stations are at capacity, with Stockton Creek so full that CBEs struggle to enter the facility and the on-site digger is unable to circulate.

The PCC does not operate any transfer stations, although two potential locations for such have been identified. The PCC's collection vehicles currently transport waste directly to the Whein Town landfill, although the small size of the trucks makes this system inefficient.

Disposal

Data from 2019, 2021, and 2022 indicates that nearly 123,000 tons of waste are disposed at the Whein Town landfill each year, of which about 70 percent is from the MCC, 28 percent is from the PCC, and 2 percent is from private sources (the commercial and industrial sectors).

Photo 2. Fiamah transfer station (left) and Whein Town landfill (right)

Greater Monrovia's formal waste management infrastructure consists of two transfer stations and the Whein Town landfill, all of which experience challenges in terms of capacity, condition, and resources to ensure efficient operations.

© World Bank / ECOGEOS

Recycling

Waste-reclaiming activities at the Whein Town landfill are limited, with only 34 waste pickers, who concentrate on metals, currently working at the site. Only one recycler indicated that it received plastic waste from waste pickers.

There are very few active local plastics recyclers in Monrovia and none of them specialize in recycling a particular plastic resin. The types of plastic processing that are undertaken include grinding (for internal recycling or export), brick production, and pyrolysis (conversion to fuel for cooking or heating). See Section 4 for more on the plastic waste value chain and opportunities to drive recycling in Monrovia.

2.5 KEY FINDINGS

The key findings from the system assessment were:

- **While some legislation is in place (especially to assign responsibility for waste policy and management), the regulatory context is relatively limited.** The NSWMP was published in October 2024 but is yet to be fully implemented. As of the time of writing, there was no dedicated body to promote more efficient waste management. Furthermore, existing bodies do not have sufficient resources to meet their regulatory requirements, such as providing services and regulating waste management activities.
- **Very little qualitative or quantitative data is available on solid waste and plastics generation in Greater Monrovia.** Municipal waste collection services are unreliable, primarily due to budget restrictions, and the network of active collection points has declined substantially in recent years. Private sector waste collectors (SMEs and CBEs) contribute positively but are accessible only to households and businesses that are willing and able to pay for the service. Illegal waste disposal—often near watercourses, at former collection points, or by the roadside—is common, largely due to a lack of alternatives. Waste is also burnt to reduce volumes, both in urban areas and on the beach in fishing communities (to eliminate waste fishing nets).
- **The existing waste management infrastructure (two transfer stations in the MCC and the Whein Town landfill) is lacking** in terms of capacity, condition, and resources to ensure efficient operations.
- **The current number of stakeholders in the waste management sector is relatively limited and there is a tendency for stakeholders to have multiple roles in the system (for example, collection and recycling).** Despite having few stakeholders, coordination and cooperation within the sector are limited. Furthermore, there is very little interaction between regulatory bodies, waste managers, and upstream (pre-consumer) stakeholders. Many stakeholder groups (regulators, collectors, and recyclers) rely on external funding agencies to support their operations.

- **Plastic recycling is limited,** with only a few micro- and small enterprises in operation and very little waste-picking activity compared to similar developing countries. Plastic recycling activities include recycling into simple products (bricks or cups for rubber collection) and pyrolysis. However, only a small portion of the plastic waste generated is recycled.

In summary, the existing waste management system is deficient due to a variety of issues and challenges. Many stakeholders lack the resources required to meet their responsibilities in terms of sound waste management. As a result, uncollected waste is either burnt—causing negative health and environmental impacts from the resulting air pollution—or dumped, resulting in large quantities of (mainly plastic) waste leaking into the environment, where it creates public health and environmental issues.

Furthermore, in addition to being affected by environmental variables such as rainfall, the transport of waste pollution is heavily affected by social factors such as inconsistent access to collection points and services, as well as opportunistic dumping of waste to coincide with heavy rainfall.

© World Bank / ECOGEOS

CHAPTER 3

PLASTIC POLLUTION IN THE ENVIRONMENT

A lack of coordinated waste management in Greater Monrovia has led to uncontrolled waste management in general. This chapter presents a detailed assessment of plastic waste flows to identify what proportion of plastic waste ends up in the environment, particularly in rivers and oceans. It then goes on to characterize the nature of waste plastics and the key stakeholders in the plastics value chain that might be able to contribute to solutions.

Of the estimated 30,000 tons per year of plastic generated as part of municipal solid waste, 71 percent (about 21,000 tons) is not managed or mismanaged, while only 29 percent (about 9,000 tons) is handled by formal collection (Figure 1).

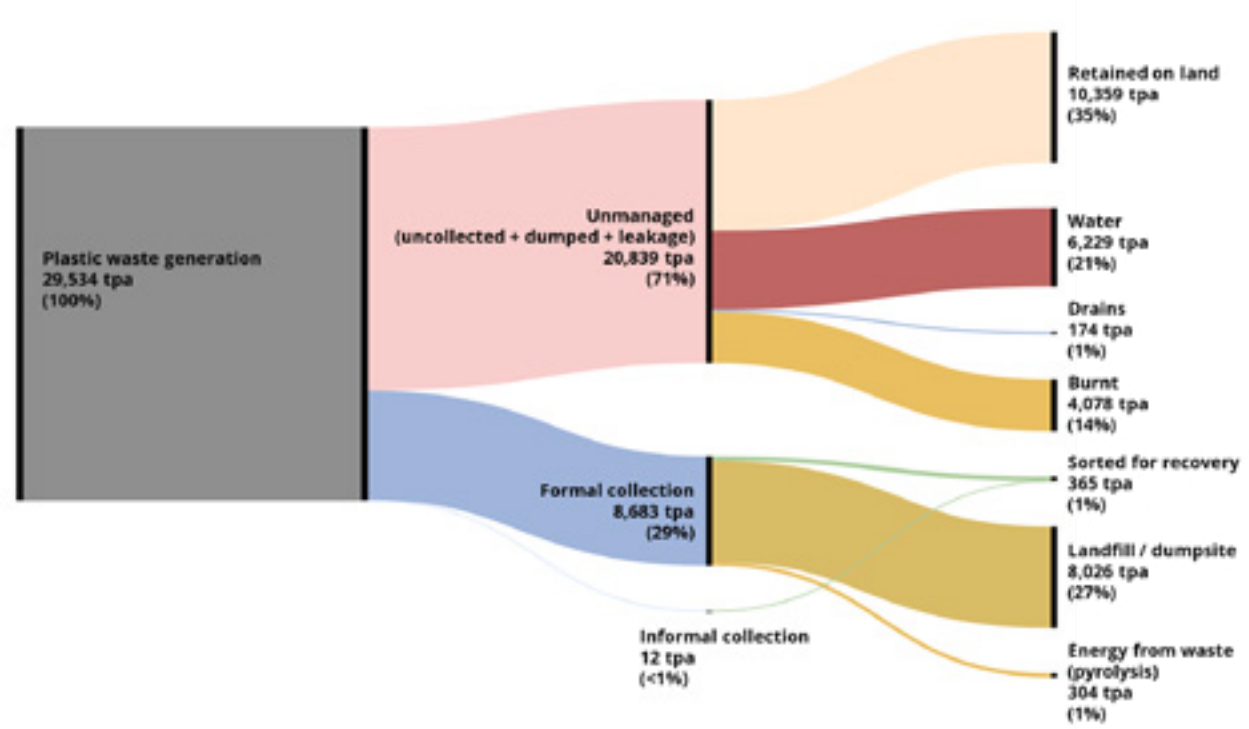
It can be assumed that a portion of the 9,000 tons per year that is regarded as managed nonetheless finds its way into the environment through losses during transport and inadequate management of disposal sites and, to a lesser extent, recycling facilities. Only a very small proportion (2 percent) of the overall plastic waste stream is collected for recycling or for energy recovery (pyrolysis).

Of the 71 percent of waste that is unmanaged or mismanaged, about 22 percent leaks into natural water courses or drains. Some of the volume retained on land is likely to eventually wash into watercourses during heavy rainfall events.

It should be noted that observational data was collected only during the dry season due to practical constraints stemming from the political situation around the country's 2023 elections. Theoretical data backed by discussions with stakeholders indicates that, for river transport, wet season transport is likely to be vastly more significant than during the dry season. The implication of this is that, during the wet season, the percentage of plastic that leaks into water and drains would be higher than 22 percent, with the percentage retained on land being proportionately lower. Furthermore, the beginning of the rainy season is generally acknowledged to be the time of greatest plastic waste flux in surface waters and drains because the plastic that has accumulated on land during the dry season is "flushed away" during the first heavy seasonal rains.

Figure 1. Sankey diagram of municipal solid waste plastics generation and management in Greater Monrovia (tons per annum [tpa]) [14]

About 30,000 tons per year of plastic is generated as part of municipal solid waste. Of this, 71 percent (about 21,000 tons) is not managed or mismanaged, while only 29 percent (about 9,000 tons) is formally collected.



Source: Original Sankey figure produced for this publication.

3.1 TYPES OF LITTER

Litter characterization was undertaken to determine the quantity and composition of litter that leaks into natural environments at 13 pollution hotspots across seven typologies (dumpsites near waterways, collection points, open channels, channel/pipe outflows, beaches, estuaries, and the ocean) (Map 4).

The locations for the hotspots were chosen based on various criteria, including representativity of the movement of waste throughout the system, access, links with other hotspots, and surrounding activities. Each hotspot has its own characteristics in terms of waste sources, the types of data to be gathered, and investigation methodology. Where possible, litter characterization was based on existing standards (such as the *Guideline for Monitoring Marine Litter on the Beaches in the OSPAR Maritime Area*).[15] However, due to the diversity of hotspot typologies and lack of published standards for sampling at (particularly inland) sites, some methodologies were developed specifically for the study.

[14] Available and extrapolated data on waste generation, composition, and management (including transport and the condition of infrastructure, as well as the likelihood of waste leaking to the environment) were used to create this Sankey diagram using the Waste Flow Diagram tool developed by GIZ, the University of Leeds, and Eawag (the AWARE project). The tool uses both quantitative and qualitative data. See: https://sankeymatic.com/build/.

[15] See: https://www.ospar.org/documents?v=7260.

Map 4. Map of waste characterization hotspots

This report is based on data collected at 12 pollution hotspots across seven typologies in Greater Monrovia.

Source: Original map produced for this publication.

This characterization exercise found that:

1. Across all hotspot typologies, plastic—and plastic packaging in particular—made up the most significant proportion of the waste stream. Plastic packaging pollution reduction (either through upstream or downstream measures) will therefore not only reduce plastic pollution but significantly reduce overall litter.
2. Plastic waste mostly consisted of shopping bags, water sachets, and soda and water bottles.
3. Major resins identified were PE (polyethylene), which is used for shopping bags and water sachets, and PET (polyethylene terephthalate) in the form of bottles.
4. Most of the PET bottles found in plastic waste were placed on the market by local soft drinks and water producers.
5. Very small quantities of abandoned, lost, or discarded fishing gear, including nylon (monofilament) fishing nets, were found in the samples.
6. Higher concentrations of beach litter were found down current from the Mesurado river, highlighting the need to improve waste management throughout Greater Monrovia to reduce the transport of plastic pollution from the Mesurado catchment to the ocean.

This information could be used as the basis for future policy and other solutions to minimize waste pollution.

While the results of this study provide some indication of the composition of waste generated in the study area, it is representative only of what has leaked into the environment at each hotspot location, not of overall waste generation by households and businesses. A waste characterization that includes both compositional data and is quantified by source (such as households by income level, businesses, and markets) would provide further valuable data to support the development of strategies to prevent and improve waste management, which is key for minimizing leakage. It would also provide baseline data from which the success of implemented initiatives could be measured.

The section that follows provides more details to support the key findings of the waste characterization exercise.

Key finding 1: Across all hotspot typologies, plastic—and plastic packaging in particular—made up the most significant proportion of litter. Reducing plastic packaging pollution (either through upstream or downstream measures) will therefore not only reduce plastic pollution but significantly reduce overall litter.

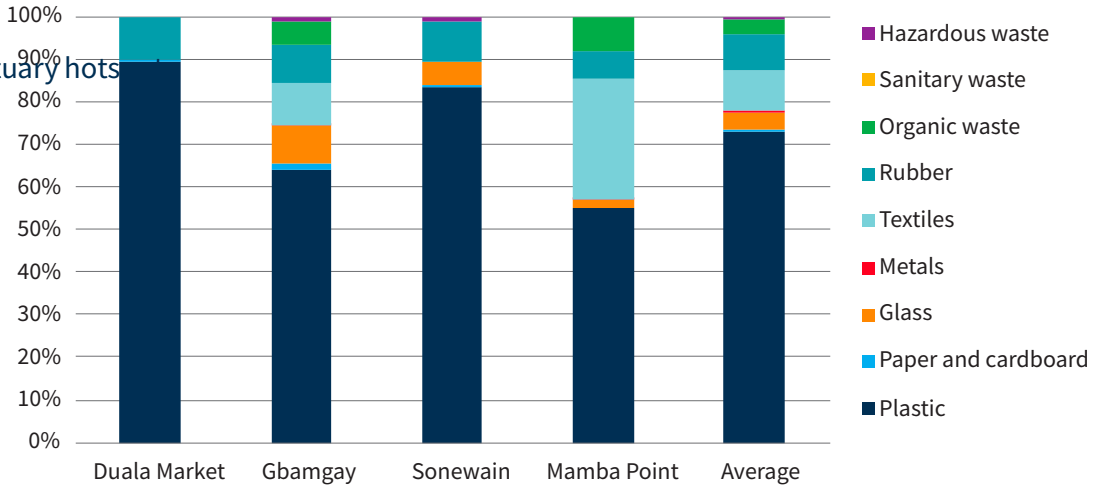
In terms of the total number of items sampled, plastic constituted 98 percent of the ocean hotspot samples and 83 percent of beach hotspot samples. Organic waste, though noticeably present in most hotspots, consisted of natural wood, leaves, and seeds, which biodegrade and therefore do not contribute to waste pollution in the long term.

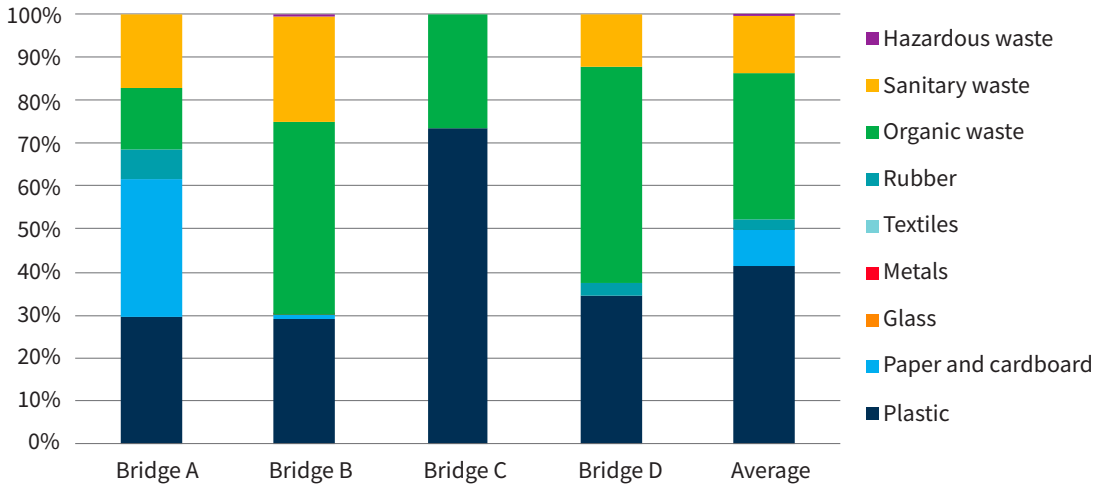
Plastic was also a dominant material across all hotspot typologies when assessed by weight. Figures 2A, B, C, and D provide a breakdown of pollution hotspot samples by material type (based on weight). On average, plastics constituted 73 percent of inland hotspot samples, 42 percent of estuary hotspot samples, 73 percent of the ocean hotspot samples, and 36 percent of beach hotspot samples.

Figure 2. Composition of samples by material type (based on weight)

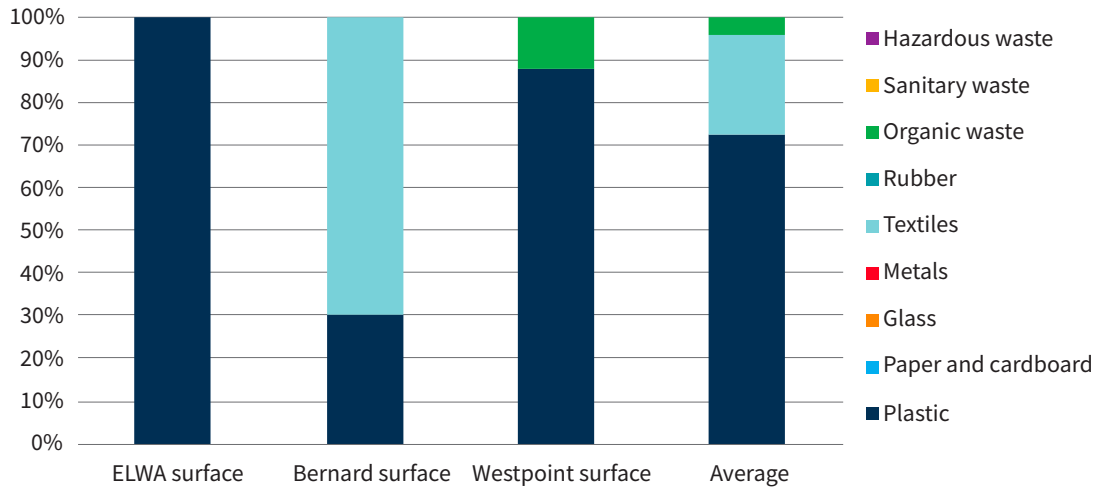
A. Inland hotspots

B. Estuary hots

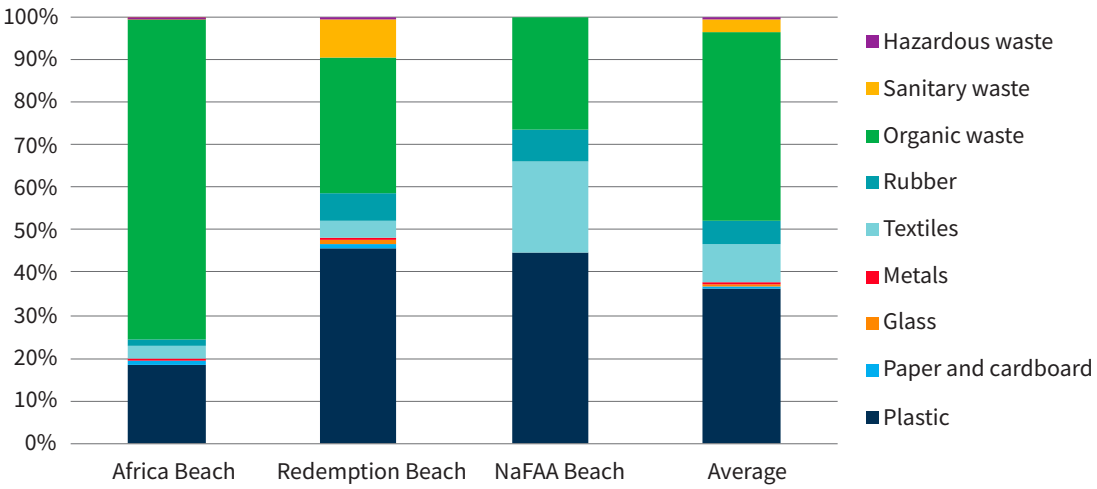




C. Ocean hotspots



D. Beach hotspots



Source: Original figures for this publication.

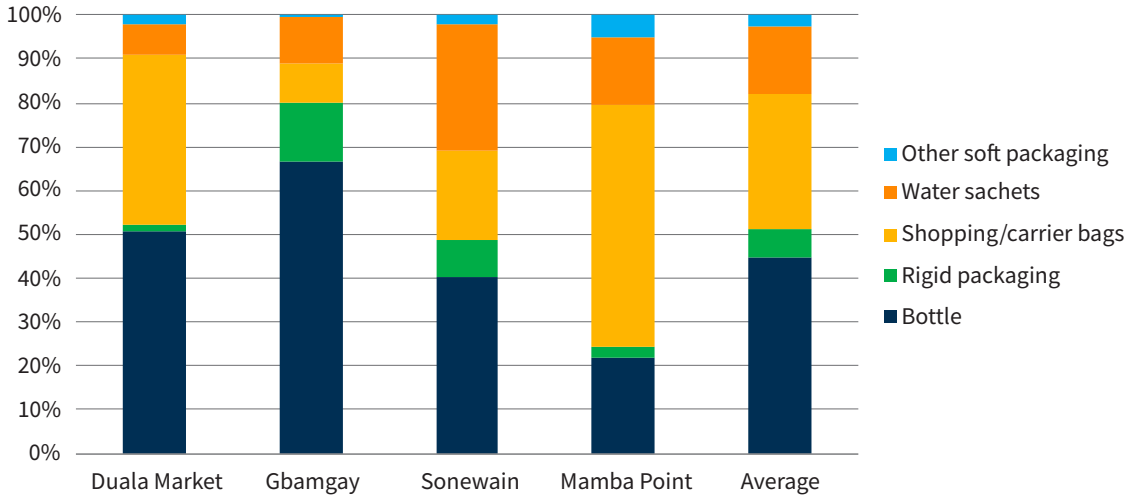
KEY FINDING 2: Plastic waste mostly consisted of shopping bags, water sachets, and soda and water bottles (Figure 3).

PET bottles are mostly used for soft drinks and water. A closer assessment of the sampled PET bottles found that most were transparent and so would have a higher value for recycling than colored bottles. See Section 4 for a more detailed discussion of PET pollution.

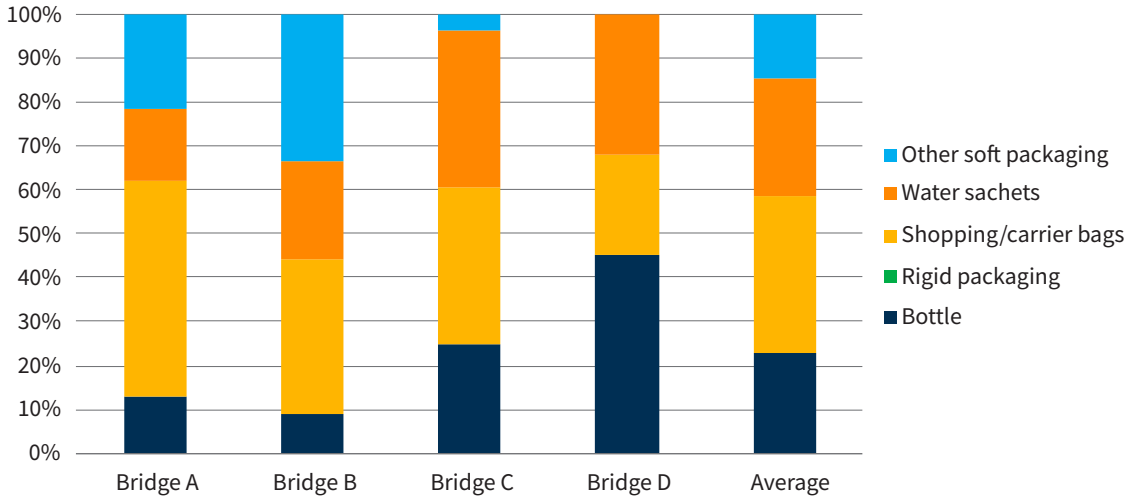
Figure 3. Composition of plastic packaging by type (based on weight)

Shopping bags, water sachets, and water and soda bottles were the most common types of plastic packaging found across all pollution hotspots.

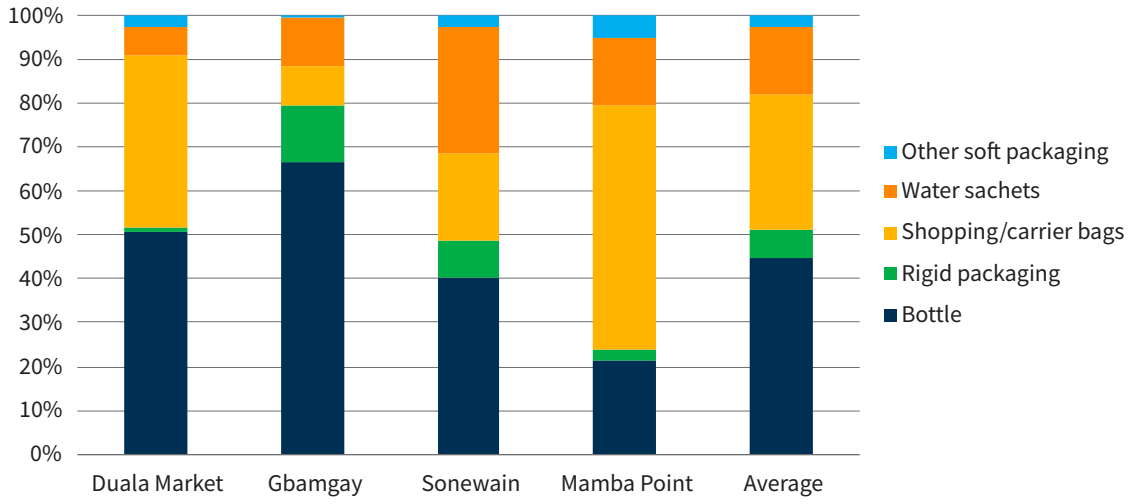
A. Inland hotspots



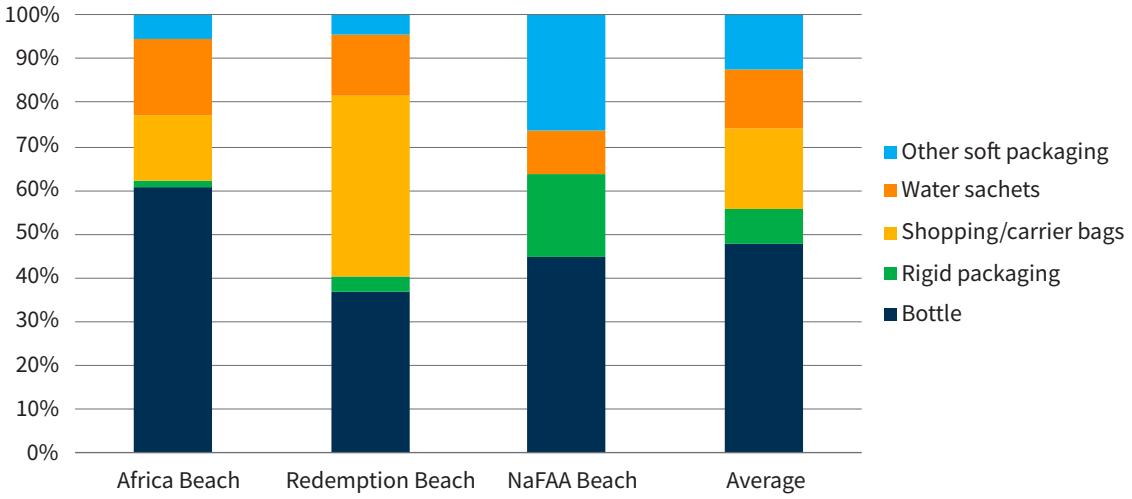
B. Estuary hotspots



C. Ocean hotspots



D. Beach hotspots



Source: Original figures for this publication.

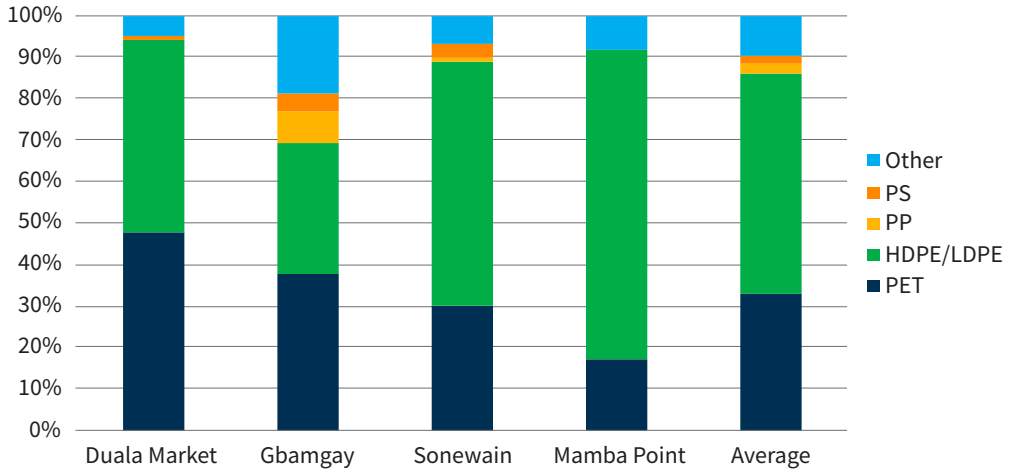
KEY FINDING 3: Major resins identified were PE (polyethylene), which is used for shopping bags and water sachets, and PET (polyethylene terephthalate) in the form of bottles (Figure 4).

PET bottles are mostly used for soft drinks and water. A closer assessment of the sampled PET bottles found that most were transparent and so would have a higher value for recycling than colored bottles. See **Section 4** for a more detailed discussion of PET pollution.

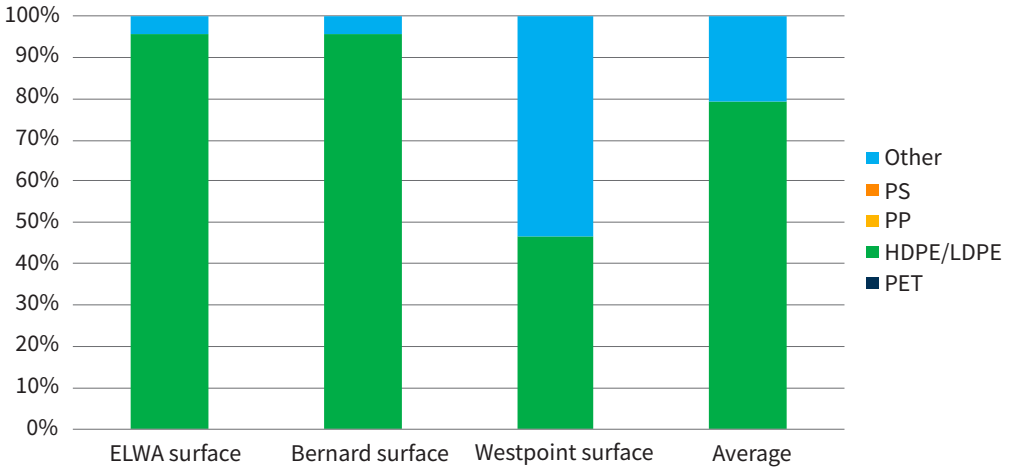
Figure 4. Composition of plastic packaging by resin (based on weight)

PET and PE were the most commonly found types of plastic across all hotspots.

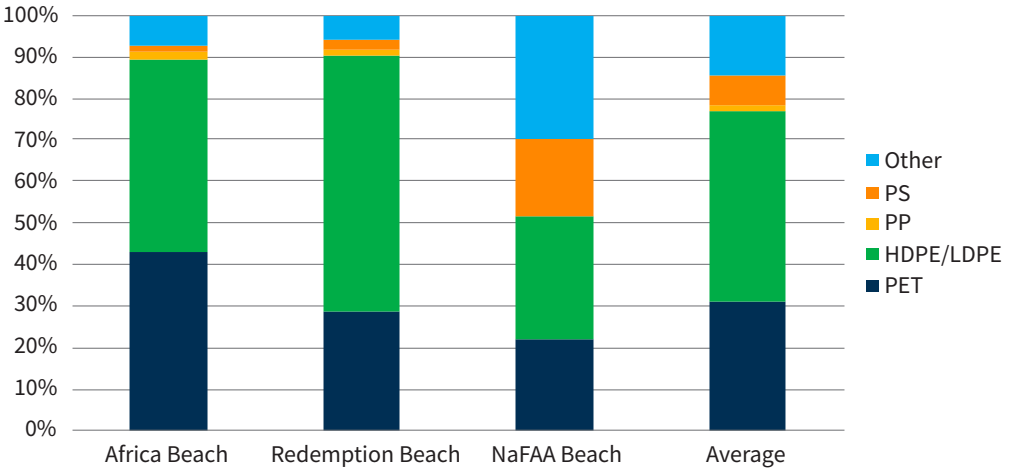
A. Inland hotspots



B. Ocean hotspots



C. Beach hotspots



Source: Original figures for this publication.

KEY FINDING 4: Most of the PET bottles sampled were placed on the market by local soft drink and water producers.

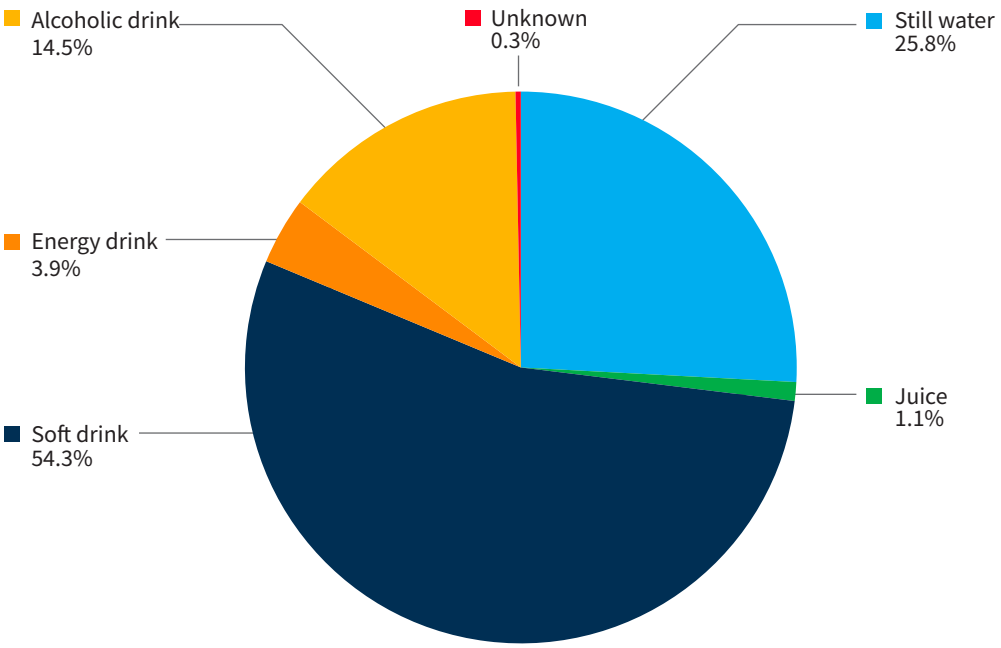
PET bottles from the inland samples were combined to provide data on the bottles disposed of at dumpsites, which leaked into waterways. Due to the large number of bottles found at Redemption beach (162 per tide over the 100-meter section), these samples were considered sufficiently large to be representative of the distribution of bottles in the marine environment.

The analysis of PET bottles by source and type found that more than half the bottles (54.3 percent of the Redemption beach sample, as shown in Figure 5) had been used for soft drinks, and the vast majority of these bottled drinks (73.6 percent of the PET bottles sampled at inland hotspots and 83.6 percent of those sampled at Redemption Beach, Figure 6) had been locally bottled.

The bottles were also sorted by color because this affects their potential recyclability, with transparent PET being more easily recyclable (and therefore in greater demand) than green, red, or brown bottles. Figure 7 shows that most of the bottles sampled at the most representative (Redemption Beach) hotspot were transparent.

Figure 5. Types of PET bottles sampled at Redemption beach

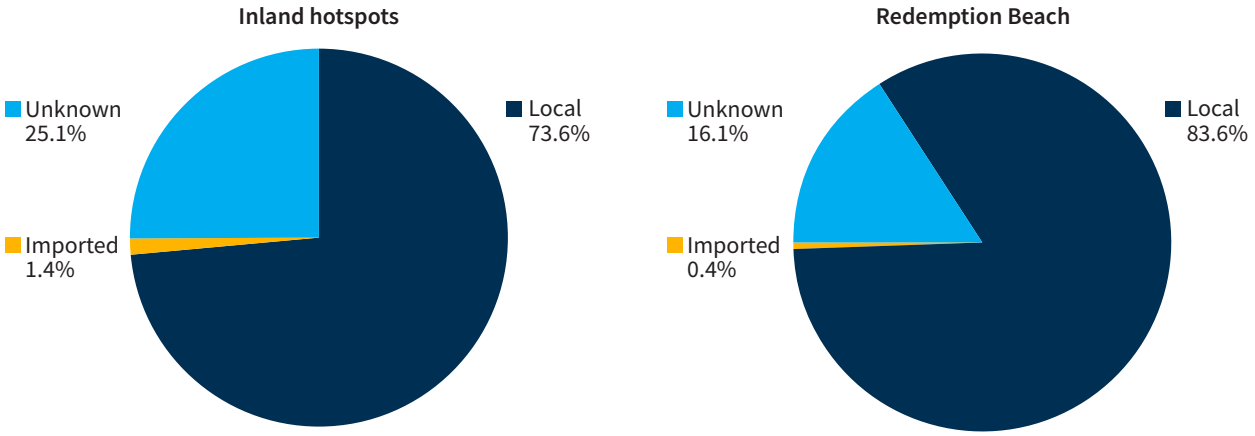
Based on a sample of more than 162 bottles collected at Redemption Beach, more than 80 percent of plastic bottles found in the marine environment once contained soft drinks and still water.



Source: Original figure produced for this publication.

Figure 6. Source of PET drink bottles for packaging found at inland hotspots (left) and Redemption Beach (right)

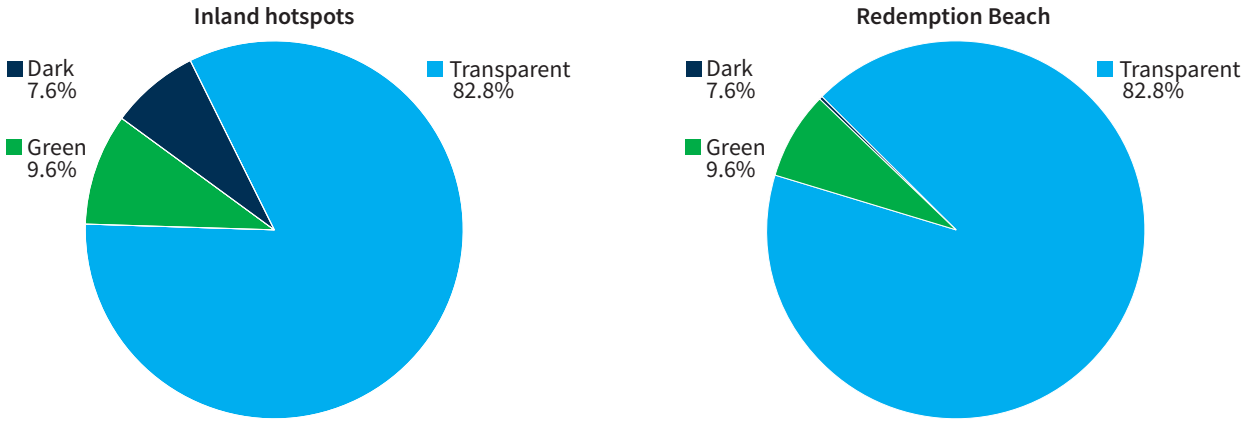
The vast majority of PET bottles found at both inland and marine hotspots had been locally bottled.



Source: Original figures produced for this publication.

Figure 7. PET drink bottles by color at inland hotspots (left) and Redemption Beach (right)

Nearly 90% of the PET bottles found at the pollution hotspots were transparent, making them suitable for recycling.



Source: Original figures produced for this publication.

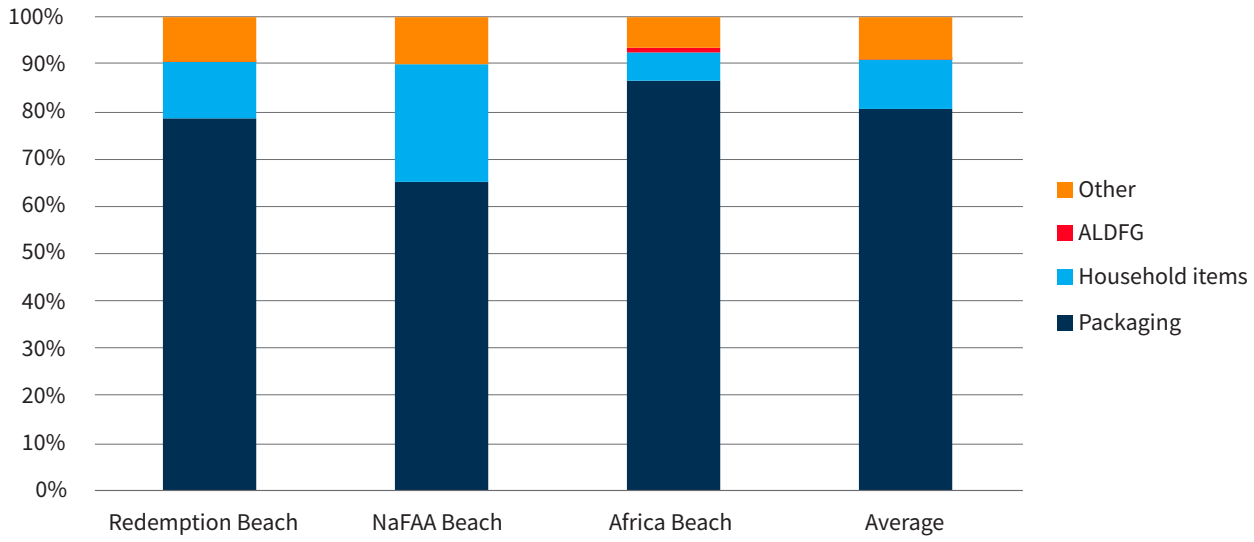
KEY FINDING 5: Very small quantities of abandoned, lost, or discarded fishing gear, including nylon (monofilament) fishing nets, were found in the samples.

Abandoned, lost, or discarded fishing gear (ALDFG) constituted an insignificant fraction of the plastic found at the beach and ocean hotspots (Figure 8). ALDFG was not found in measurable amounts in any of the ocean samples. Several factors could explain these results, including:

- The ocean hotspots, while located offshore from fishing communities, are not locations of concentrated plastic pollution.
- When lost, these materials either sink (and were therefore not included in samples taken at the surface and at shallow depths) or are carried out to sea or along the coast to areas that were not identified as pollution hotspots in this study.
- These items do not represent a significant proportion of plastic pollution in comparison to the input from land-based sources.

Figure 8. Plastics by use at beach hotspots (based on weight)

Abandoned, lost, or discarded fishing gear constituted an insignificant fraction of the waste samples taken at Redemption and Hotel Africa beach, and did not feature in samples from NaFAA beach or the ocean hotspots.



Source: Original figure for this publication.

KEY FINDING 6: Higher concentrations of solid waste were found downstream of the Mesurado river, highlighting the need to improve waste management throughout Greater Monrovia to reduce the transport of plastic pollution from the Mesurado catchment to the ocean.

Sampling was undertaken at three beaches, namely Hotel Africa beach, NaFAA beach, and Redemption beach. These beaches yielded vastly different amounts of plastic waste per tide—about 40 kilograms for Redemption beach, between 3 and 4 kilograms at Hotel Africa beach, and less than 1 kilogram at NaFAA beach. The low quantities at NaFAA beach indicate that the nearby breakwall prevents plastic pollution from reaching the beach. Hotel Africa beach is to the north of the Saint Paul and Mesurado river mouths. Because the coastal current flows from north to south, this beach did not receive additional waste from these sources. The quantities observed here can therefore be considered the background level of plastic pollution present in the ocean off Monrovia. Redemption beach received large quantities of waste from the Mesurado river, which transports waste into the ocean directly upstream of the beach.

Conclusion

In summary, plastics—and single use plastics in particular—represent the most significant proportion of waste in the environment across all hotspot typologies, particularly when considering that most of the organic fraction is natural wood (leaves, seeds, branches, and so on), which biodegrades and therefore does not contribute to waste pollution in the long term. The major resins identified were PE, particularly shopping bags and water sachets, and PET bottles. The sampled PET bottles were used mostly for soft drinks and drinking water. Most of the bottles collected were transparent, which have the greatest value for recycling. Most of the PET bottles in the waste stream are put on the market by local bottlers.

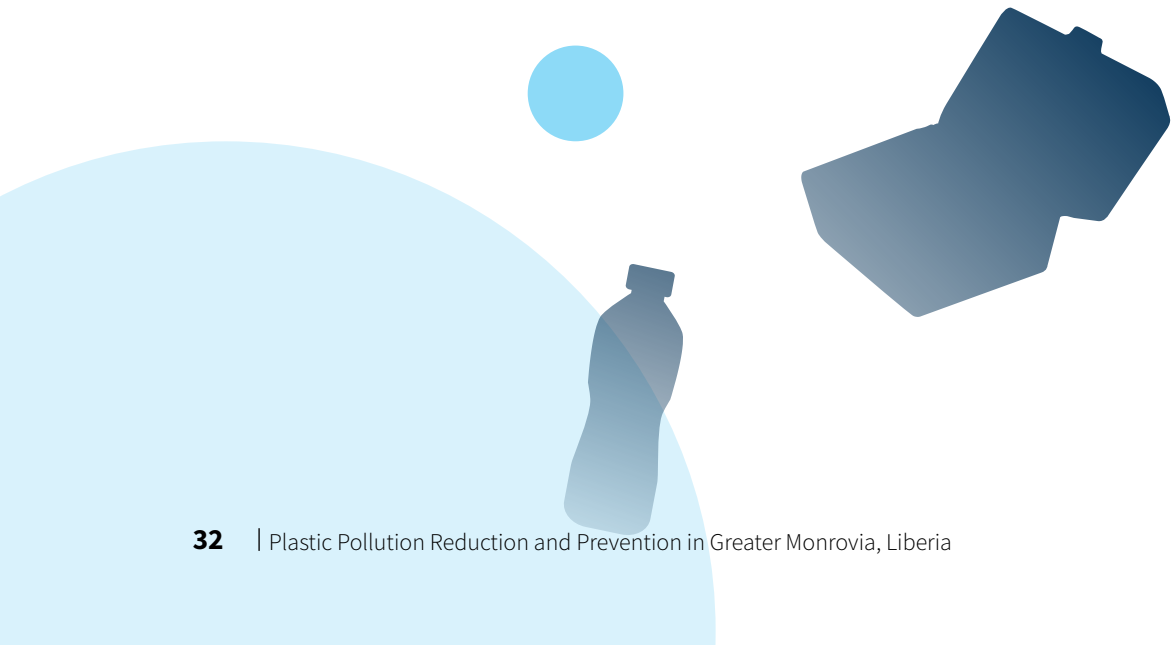
Significant differences were observed between the three beaches in terms of the quantity of plastic waste. By far the largest quantities were observed at Redemption beach, which is downstream from the Mesurado river. This is consistent with the higher concentrations of waste found in the ocean samples off West Point and Bernard beaches, which are also south (downstream) of the river mouth. This finding underlines **the significant contribution to plastic pollution in the ocean from the Mesurado sub-catchment in central Monrovia** and highlights the need to improve waste management throughout the city (both in coastal locations and inland) to reduce plastic pollution.

Box 2. Using GPS to track plastic movement

To better understand the way litter moves through waterways and into the ocean (including variables such as transport speed, accumulation locations, and the impact of tides), five plastic bottles tagged with lightweight GPS trackers were released from the King Zolu Duma Bridge. While this number is not enough to provide statistical certainty, the aim of the exercise was to find out if all trackers followed roughly the same pathway, reached the ocean in a similar time, and got caught in the same location, or whether there were significant differences between each bottle.

Map B1 shows the paths taken by the GPS trackers between their release and the end of their battery life. Tracker 4 lost signal upon launch. During the battery life of about one week, none of the remaining trackers were carried out into the ocean. Two of the trackers became stuck in the riverbank or river mouth downstream of their release point, while Tracker 5 initially moved downstream and became stuck in the riverbank before being carried upstream by tidal movements and again becoming lodged in a riverbank.

As noted earlier, the study was conducted only during the dry season. The results from the study indicate that, during the dry season, plastic transport in estuaries is driven by the tides and wind, with limited discharge to the ocean. A future study could be conducted during the rainy season to test the theory that high river flow leads to a higher percentage of plastic discharge into the ocean. In addition, trackers could be released (i) at different points in the estuary to assess flow across the system and (ii) at different times to assess transport over a longer time period.



Box 2 (continued)

Map B1. Area of study (top) and paths of GPS trackers and location of area (bottom)

The paths illustrate the complexity of how waste moves, particularly within an estuary during the dry season. These movements are consistent with published literature on river plastic transport and emissions.[16,17,18]

Source: World Bank / ECOGEOS

[16] Lebreton L, Van der Zwet J, Damsteeg JW et al. 2017. "River Plastic Emissions to the World's Oceans." Nature Communications 8 : 15611. https://doi.org/10.1038/ncomms15611.

[17] Emmerik T, De Lande S, Frings R, et al. 2022. "Hydrology as a Driver of Floating River Plastic Transport." Earth's Future 10. E2022EF002811. https://doi.org/10.1029/2022EF002811.

[18] Roebroek CTJ, Laufkötter C, González-Fernández D, and Van Emmerik T. 2022. "The Quest for the Missing Plastics: Large Uncertainties in River Plastic Export into the Sea." Environmental Pollution 312: 119948. https://doi.org/10.1016/j.envpol.2022.119948.


© World Bank / ECOGEOS

CHAPTER 4

THE PLASTICS VALUE CHAIN

To determine whether there is potential to develop a robust circular economy in Monrovia, there is a need to first understand the plastics value chain. This includes:

- **The upstream plastics value chain,** which encompasses imports, manufacturing, and consumption habits
- **The downstream plastics value chain,** with a particular focus on recycling
- **Key factors and barriers** that affect various parts of the plastics value chain.

This section provides an overview of the above elements of the plastics value chain. The data sources for these analyses vary. Data on the upstream value chain (that is, the pre-consumer stage) was largely obtained from customs records, which cover the automated ports across the whole of Liberia. On the other hand, the downstream value chain focuses on the waste generated in Greater Monrovia, which is currently not recorded in a consistent manner and therefore relies on extrapolations from the data that does exist.

4.1 THE UPSTREAM VALUE CHAIN

The number of upstream stakeholders in Liberia is limited. There is no dedicated importer or wholesaler of raw plastics in Liberia and only one major plastics product/packaging manufacturer. Local bottlers and artisanal water sachet producers, of which there are several, source their packaging either from international suppliers or the sole local manufacturer. In short, the market is very small relative to the significant local consumption of plastics.

For the purposes of this report, businesses that directly import products for resale or for use in their commercial activities (such as shops that import plastic bags) are not considered to be importers because this does not represent their main activity.

Imports

Most of Liberia's plastic packaging and products are imported. While this presents certain challenges (such as strong competition from established external markets), it may also be regarded as an opportunity to implement changes at the local level without needing to coordinate large numbers of stakeholders.

On average, Liberia imported about 40,000 tons of plastic (manufactured plastic products, semi-manufactured plastic products, and virgin resins) and exported about 174 tons of plastics (as products, used items, and pre-consumer waste) per year between 2022 and 2023 (Tables 1 and 2). Liberia is therefore a net importer of plastics, with total exports equivalent to less than 1 percent of the quantity imported each year. No plastic waste is imported into Liberia.

According to customs data, of the approximately 40,000 tons of plastics imported into Liberia each year, about 43 percent is virgin plastics and 10 percent is packaging preforms. The remaining 47 percent (17,855 tons in 2023) is manufactured products (Table 1). A slight (9 percent) decline in virgin resin imports between 2022 and 2023 can be attributed to the presidential election in October–November 2023, which resulted in periods of commercial inactivity with a related decline in product sales.

Table 1. Customs data for plastic imports (2022–2023)

Category	Import tonnage		Change 2022–2023	Remarks
	2022	2023		
Manufactured (all resins)	15,662 (39%)	17,067 (43%)	+9%	
Semi-manufactured (PET preform)	4,469 (11%)	3,926 (10%)	-12%	Could correspond to the new local production of preform
Virgin (all resins)	20,319 (50%)	18,442 (47%)	-9%	Could correspond to an increase in use of local recycled plastics or a balance with imported manufactured goods
Total	**40,450**	**39,435**	**Remained almost constant**	

Source: Liberia Revenue Authority data from automated customs ports. Manual customs ports (which are mostly in rural areas) are excluded, as is the plastic in prepackaged products such as ketchup, peanut butter, and cosmetics.

Table 2. Customs data for plastic exports (2022–2023)

Category	Export tonnage		Change 2022–2023	Remarks
	2022	2023		
Products (all resins)	0	110	–	Almost exclusively unspecified resin (seed trays)
Used items and waste (all resins)	30	7	-77%	Significant decrease
Pellets and flakes (all resins)	201	0	–	Almost exclusively ground PET
Total	**231**	**117**	**Significant decrease (~50%) but small numbers**	

Source: Liberia Revenue Authority data from automated customs ports. Manual customs ports (which are mostly in rural areas) are excluded, as is the plastic in prepackaged products such as ketchup, peanut butter, and cosmetics.

Table 3. Customs data on virgin resin imports (2022–2023)

Resin	Import tonnage		Change 2022–2023	Remarks
	2022	2023		
PET	1,155	2,225	+ 93%	Significant increase, use of new PET preform line locally
HDPE (high-density polyethylene)	6,259	5,398	- 14%	Lower HDPE consumption, potentially greater use of recycled material
PVC (polyvinyl chloride)	620	960	+ 55%	Significant increase. To be monitored as it can be pollutant if burnt (chlorinate)
LDPE	5,409	2,795	- 48%	Significant decrease. Potentially combination of higher recycling rate and change in consumption habits (more PET bottles used)
PP (polypro-pylene)	3,685	3,165	- 14%	Lower PP consumption, potentially greater use of recycled material
PS (polystyrene)	25	67	+ 168%	Significant increase but use still marginal
Other resin	3,167	3,831	+ 21%	Mainly polyether polyol and epoxy resins
Total	**20,319**	**18,442**		**-9%**

Source: Liberia Revenue Authority data from automated customs ports.

Box 3. Drive to replace water sachets with PET bottles

The beverages market—which is Liberia's largest plastics producer—is changing, with PET bottles progressively replacing LDPE water sachets. This trend is confirmed by the installation in October 2023 of a local production line for PET preforms in the country, as well as investments by bottlers into new production lines. As a result of this shift, the local waste stream is also changing.

About 4,000 tons of imported preforms are currently placed on the local market each year. This is expected to increase. Bottlers are investing to increase production of bottled water and have a greater capacity for aggressive marketing, pricing, and safety and hygiene controls during production than small water-sachet producers have.

Relative water prices will influence the extent to which PET bottles will replace LDPE sachets. As shown in **Table B1**, water sachets are cheap, costing 14 times less than bottles per liter. These sachets are used for all applications (drinking, washing hands, filling water coolers, and so on) and will therefore remain a significant part of the waste stream, particularly in lower-income communities.

Table B1. Comparison of water prices

Format	Volume	Market price (Liberian dollar [LRD])	Equivalent for 15ℓ (US$)
Water sachets (30 x 0.5ℓ)	15ℓ	100	0.53
Bottle	0.5ℓ	50	8
5ℓ jar (filling)	5ℓ	470	7.5

Figure 9 provides a breakdown of imported manufactured products by sector and product type in 2023. Due to the large number of different categories of product type, not all items could be classified. While the most common plastics were identified (based on total weight and number of items), the remaining plastic items were classified as "miscellaneous".

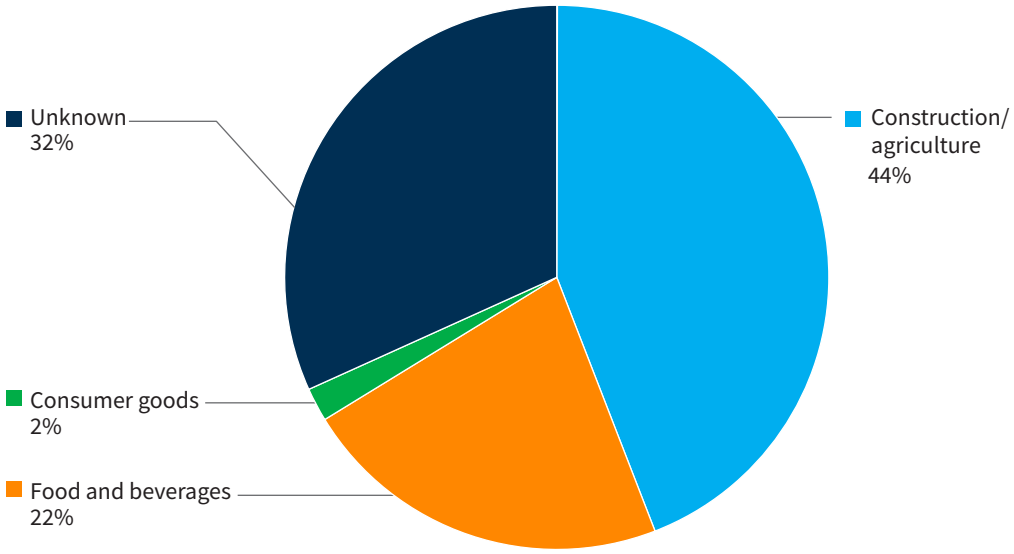
Of the identified plastic items, the two largest contributing sectors were the construction and agriculture sector (44 percent, largely due to significant quantities of piping and flooring) and the food and beverages sector (22 percent). The food and beverages sector's contribution consists largely of packaging items such as bags, caps and lids, and films, which are imported empty to be used by local businesses (as noted, the import data does not include products that are imported already in plastic packaging).

Identified plastic imports from the fisheries and healthcare sectors represented 3 tons and 4 tons (0.017 percent and 0.024 percent, respectively) in 2023 and were therefore too minor to appear in Figure 9. In the case of fishing nets, it is known that some communities buy their nets in Ghana and transport them to Liberia by road. As a result, these were not captured in automated customs data. For the healthcare sector, it is not known why the customs import quantities are so small, or which other pathways may be used to import these items.

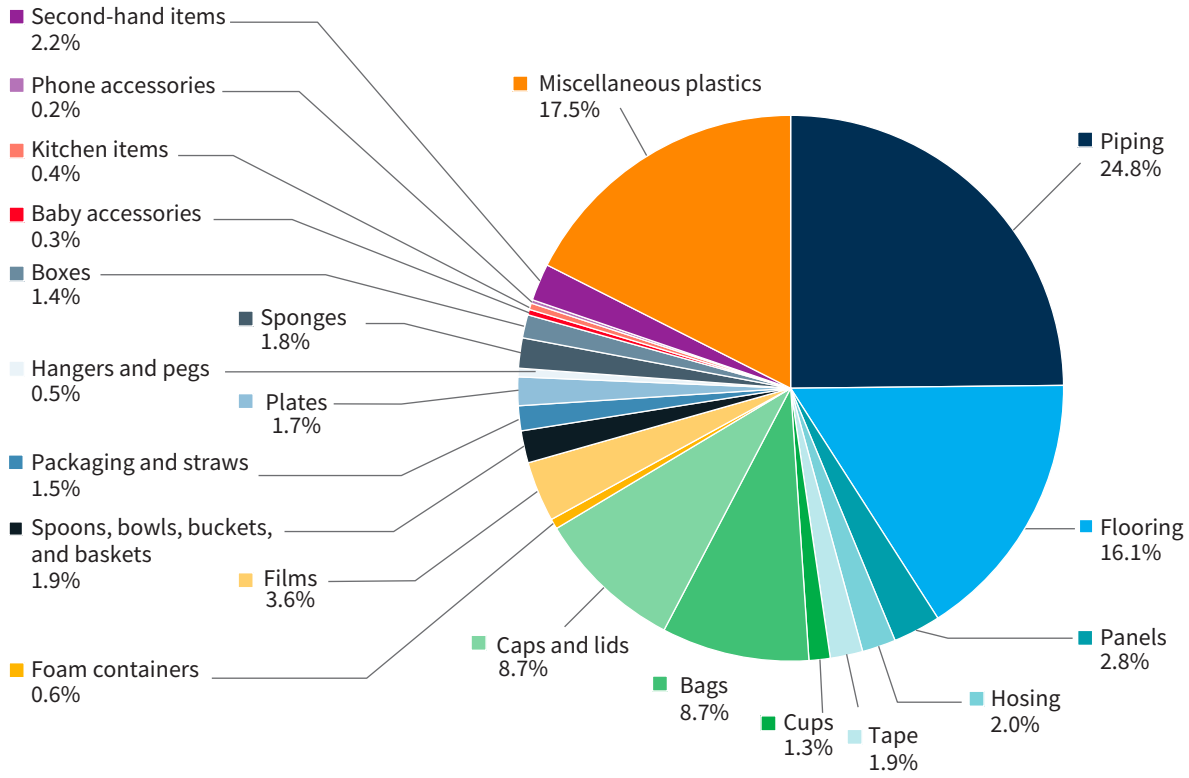
Figure 9. Breakdown of imported manufactured products in 2023 by sector (a) and product type (b)

The construction and agriculture sector's use of piping and flooring make it the largest importer of manufactured goods in Liberia. This is followed by the food and beverages sector, which imports various types of packaging.

(a) Imported manufactured products by sector



(b) Imported manufactured products by product type



Data source: Liberia Revenue Authority. Figure source: Original figures for this publication.

Plastics imported for the construction and agriculture sector are typically installed and used for a long time. Moreover, construction materials are likely to be heavier per unit. These plastics are therefore less likely to leak into the environment. Similarly, household items are generally used for significant periods of time, meaning that they leak much more slowly into the environment, even if they are eventually littered or dumped.

The food and beverages sector accounts for 22 percent of the imported manufactured products and all preforms, and a substantial proportion of virgin resins. Plastic products in this sector have a much shorter lifespan, because they are generally used once and then discarded.

Pre-consumer waste

Pre-consumer waste is generated by pre-consumer stakeholders (such as manufacturers and bottlers) before products arrive at the point of sale to consumers. Using pre-consumer waste for recycling has the advantage of producing a cleaner, higher-quality waste stream because it is not contaminated or mixed with other wastes. According to the pre-consumer stakeholders consulted during this study, nearly 10 percent of source material is wasted when making LDPE sachets, while less than 1 percent of the source material is wasted when making PET bottles from preforms.

According to larger pre-consumer companies, pre-consumer waste is either managed internally by the companies or it is ground or shredded for export to other West African countries, sometimes in partnership with a local recycler. For their part, water-sachet producers either take their waste to recyclers, or are forced to dump their pre-consumer waste due to lack of capacity at recycling facilities or low purchase prices.

Even though recycling pre-consumer waste is important for effective plastic waste management, it is not as effective at preventing plastic pollution as recycling post-consumer waste. This is due to the higher value of the material and the smaller risk of leakage.

4.2 THE DOWNSTREAM VALUE CHAIN

Post-consumer waste is a substantial contributor to plastic pollution, with plastic waste making up between 11 percent (based on 2012 waste-generation characterization data in Monrovia) and 14 percent (based on World Bank's *West Africa Coastal Areas Plastics eBook*) of overall waste generated. This is equivalent to between about 30,000 and 34,200 tons per year. The lower estimate (11 percent, 30,000 tons) is used for the purposes of analysis.

Discussions with local bottlers indicated that they are generally not concerned with the management of the products they put on the market and believe it is the government's role to use the taxes the bottlers pay to manage the waste generated by their products. One prominent bottling company spoke of a corporate-level strategy to collect the waste it puts on the market by 2030. However, no further details could be obtained as to how this strategy would be implemented.

This mixture of attitudes towards the responsibility of bottlers to manage the waste generated by their products indicates a need for further consultations on an extended producer responsibility scheme for PET bottles to maximize bottler involvement and ensure that such a scheme is compatible with other schemes in place.

4.3 RECYCLING

The recycling industry in Monrovia is characterized by a small number of stakeholders. Only six active recyclers were identified: three larger recyclers and three small-scale recyclers (recycling less than 1 ton per month). The three larger recyclers recycle various streams, including plastics (primarily PET, HDPE, LDPE, and PP), electronic waste, and organic waste, and engage in pyrolysis to produce fuel. The three small-scale recyclers use plastics as source material to create items such as bags, raincoats, and decorations.

There is no aggregator/consolidator. Waste is transferred either directly from post-consumer waste generators (businesses and households) to recyclers or it is collected via SMEs or CBEs and transported to recycling sites. Due to a lack of monitoring or reporting on recycling activities, data was gathered directly from recyclers.

Current recycling activities

Lack of available data on current recycling activities points to a dearth of monitoring in a sector that should be required to track and communicate quantitative data on their activities to the EPA.

Existing local recycling activities focus mainly on PE (HDPE and LDPE), with some recycling of PET bottles (including pre-consumer waste) and PP. There is currently no collection or recycling of monofilament fishing nets. Waste nets, while being recovered as much as possible to prevent their loss at sea, are dumped on the beach and either buried or burnt at a later stage.

Two recyclers have plans to establish buy-back kiosks to increase the quantity of plastics they collect and recycle, and the main plastics manufacturer wishes to expand its recycling capacity for PP and PET bottles.

Recyclers source their material either directly from waste generators (especially businesses) or purchase collected material from CBEs and SMEs. Prices for the collected material range from LRD10 to LRD30 (US$0.05 to US$0.15)[19] per kilogram, depending on the recycler and resin type. This range has a significant influence on the potential profitability of the activity and therefore has a significant impact on the quantities collected and recycled. A major recycler is planning to increase its recycling capacity and therefore anticipates a future increase in the quantities of plastic it will receive.

Local recycling activities are not coordinated and, generally, stakeholders are not specialized in particular processes or waste streams. Instead, they diversify their activities to achieve additional financial security, should there be collection issues or a drop in the market price for a particular plastic stream. However, it also means that stakeholders are less likely to have a deep technical understanding of the various processes employed (such as system optimization or the management of waste and emissions), particularly at smaller scales.

Waste pickers currently play a minor role in the collection of plastics. This highlights how plastic waste is currently thought of as lacking in value, a perception that is also evident in the small number of players in the recycling sector. Efforts to decrease plastic pollution therefore need to focus on increasing the value of plastic waste to create demand for its collection (by collectors, waste pickers, and the public) and ensure sufficient recycling capacity and demand for the resulting

[19] Based on an exchange rate of LRD190 per US$1, the approximate exchange rate at the time of the study.

products.

Sorting at the source

Source separation is not widespread in Monrovia. One community-based organization has engaged with local communities to separate specific waste streams at the source, offering prizes for households that clean and separate their plastic waste by resin. The organization collects about 500 kilograms of plastic waste from 15 communities at no charge. This material is then sold for recycling to cover operational costs. Another service provider collects general waste and sorted plastics once a week, for a fee. Liberia's sole plastics manufacturer has expressed a sincere interest in separation at the source due to its positive impact on the quality of input materials.

Pyrolysis

Pyrolysis is currently undertaken by three actors. This process is profitable, with production costs of about LRD150 per gallon versus a selling price of LRD650 per gallon, while fuel, in comparison, costs LRD850 per gallon. This method of processing has several advantages, including high local demand for the product, understanding of the required technology, and lack of pre-processing required on the input waste stream (that is, there is no need to sort and wash the PE and PP). For now, the facilities are relatively small in scale. However, two producers have plans to increase their production capacity.

Due to the significant environmental impacts of pyrolysis (air emissions and the use of black carbon as cooking fuel), if the process is uncontrolled, which is currently the case, enhanced control and regulation of the process is recommended if it is to be upscaled.

Box 4. Buy-back kiosks

Two of the three recyclers in Monrovia have plans to roll out a total of 12 buy-back kiosks for plastic waste (PET, HDPE, and LDPE) in 2024 to increase the quantities collected.

Given the lack of source separation and difficulties in undertaking waste collection, these buy-back kiosks are a potential source of separated post-consumer plastics that both removes the targeted materials from the general waste stream (and in so doing reduces the potential to generate plastic pollution) while offering additional income to the community and local stakeholders (collectors and recyclers).

The fact that two existing local waste management industry stakeholders have identified buy-back kiosks to improve collection rates indicates a potentially profitable gap in the market. However, it also highlights a lack of coordination in the sector. Experience in other countries indicates that external investment is needed to establish kiosks, and that buy-backs find it challenging to become financially viable. The potential to support the development of the kiosks through a pilot project is discussed further in Section **5.2.**

The recycling potential of fishing nets

Abandoned, lost, or discarded fishing gear has the potential to contribute to marine plastic pollution. To determine whether it would be viable to prevent possible plastic leaking into the environment by integrating fishing communities into the recycling value chain, the project investigated the net-disposal practices of seven out of the eight fishing communities in the Greater Monrovia area through telephonic interviews and field visits (Map 5). The community at Kpekor beach was the only community that could not be contacted.

Map 5. Location and size of fishing communities in and near Greater Monrovia

The net-disposal practices of seven out of the eight fishing communities in Greater Monrovia were examined.

Source: World Bank / ECOGEOS

Almost all the communities reported using a combination of monofilament (nylon) and cotton nets, referred to locally as “rubber” and “thread” nets, respectively. Just over half of the fishing communities surveyed prefer to use monofilament nets, mostly because cotton nets are more expensive but also because monofilament nets are less visible and, therefore, tend to produce higher yields (at least in the short term). Small quantities of multifilament nylon nets were also found, while ropes are generally PP.

Photo 3. Monofilament nylon net (left), multifilament nylon net (center), and PP ropes (right) at a central Monrovia (Front Street) vendor

Communities reported using a combination of monofilament (nylon) and cotton nets, with a small portion of fishers reporting using multifilament nylon nets. Ropes were generally found to be polypropylene.

© World Bank / ECOGEOS

Nets are assembled by specialist local workers and repaired as much as possible before being considered waste. About 70 percent of the fishing communities surveyed dump waste nets on land, while the rest burn them. Community visits revealed that nets dumped on land are often eventually burnt or buried.

Deliberate dumping at sea was not reported and even expressly forbidden in one community (Popo beach). Communities reported making an effort to recover tangled or contaminated nets (for instance, with seaweed) and to bring waste nets back to land. These efforts seem linked to a desire to reduce environmental impact and recover valuable parts of the nets such as attached ropes and weights.

Quantification of disposed nets

An estimate of the annual weight of discarded nets found that monofilament nets of typical specifications (0.28 mm, 1–5/8-inch mesh, 400 mesh depth) have a net weight of 7.1 kilograms and an average net density of 13.8 kilograms per cubic meter (kg/m^3), assuming ropes, floats, and other elements have been removed (Table 4).

The annual figure of 21 tons of waste nets is significantly higher than the quantities reported in the customs data (4 tons in 2023). However, as noted earlier, the import data does not capture a large proportion of the fishing gear unofficially imported into Liberia.

In terms of overall quantity, this waste stream is much smaller than that of imported virgin materials, preforms, and most of the common plastic items extracted from the customs data. This does not diminish the need to find solutions to prevent environmental and human health impacts by recycling waste nets rather than burning or dumping them.

Table 4. Quantification of the generation of waste nets by weight and volume

Data	Value	Data source
Number of waste nets	3,000/year	Estimated from field visit
Average net weight	7.1 kg	Calculated from average net dimensions (field visit) and online data on net weight[20]
Average net density	13.8 kg/m^3	Calculated from weight and volume of waste nets sampled during field visit
Generation of waste nets (weight)	**21 tons/year**	Calculation from figures above
	1.75 tons/month	
Generation of waste nets (volume)	**1,520 m^3/year**	
	127 m^3/month	

Process: Integration into the plastics value chain

The stakeholders responsible for, or involved in, fishing net waste management are not currently part of the plastics value chain and, currently, there are no collection or recycling options available to these waste generators. All the fishing communities contacted participated in the World Bank's Net Exchange Program and have expressed interest in participating in a potential future net-recycling pilot.

As well as being sorted by polymer type, fishing gear must be at least 85 percent clean (free of sediment and organic matter) to be considered viable for recycling.[21] Sand results in excessive wear on shredding equipment, and the presence of residual sediment can cause the recycled product to become brittle.[22] According to a Danish recycler, the purity of the recycled material can be high if the input stream is sufficiently well sorted and cleaned.[4]

Figure 10 summarizes the recycling process for fishing nets. Pilot options should ideally focus on uncontaminated, end-of-life fishing gear.

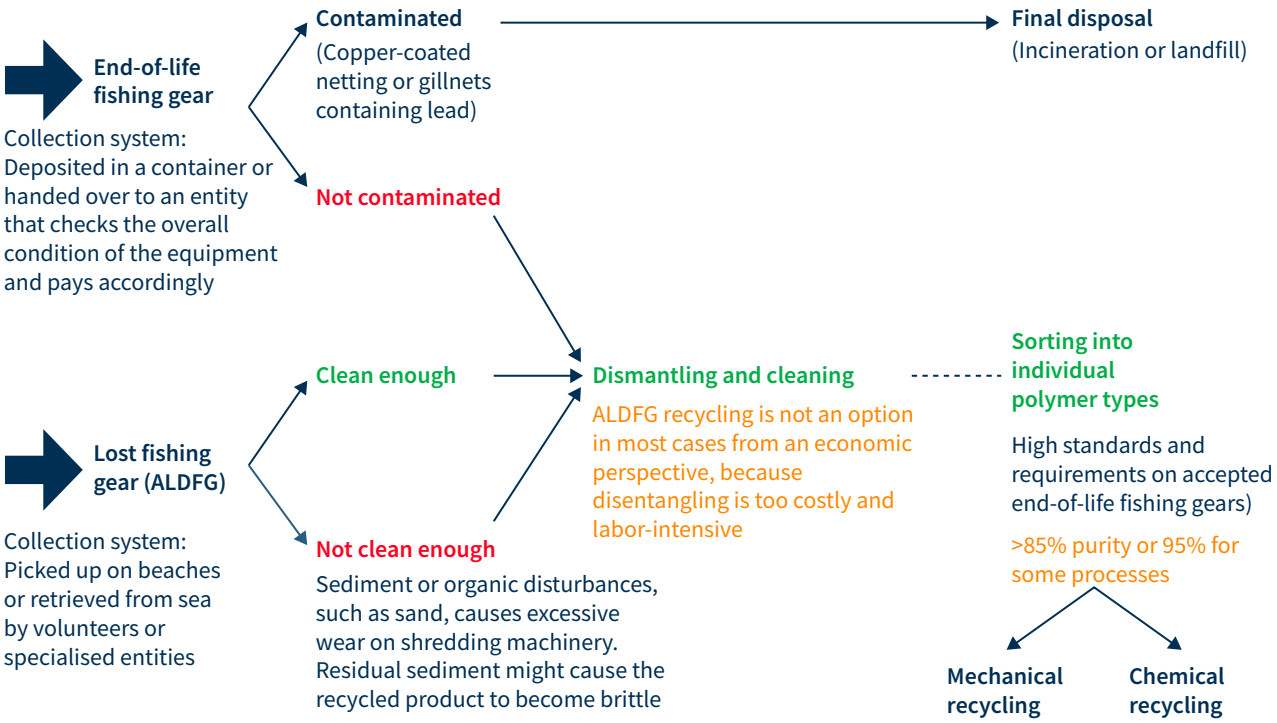
[20] See https://www.memphisnet.net/product/3-Mono-Netting. Stock number 372 was the most similar to nets used by local fishers.

[21] Global Ghost Gear Initiative. 2021. "Approaches to the collection and recycling of end-of-life fishing gear: An Overview with Contacts and Case Studies." Prepared by Christina Dixon. World Animal Protection for GGGI.

[22] OSPAR Commission. 2020. "OSPAR scoping study on best practices for the design and recycling of fishing gear as a means to reduce the quantities of fishing gear found as marine litter in the North-East Atlantic." London, UK: OSPAR Commission.

Figure 10 . Recycling potential of waste fishing nets

End-of-life fishing gear should be sorted by polymer type and at least 85 percent clean (free of sediment and organic matter) to be viable for recycling.



Source: Original figure produced for this publication.

© Adobe Stock

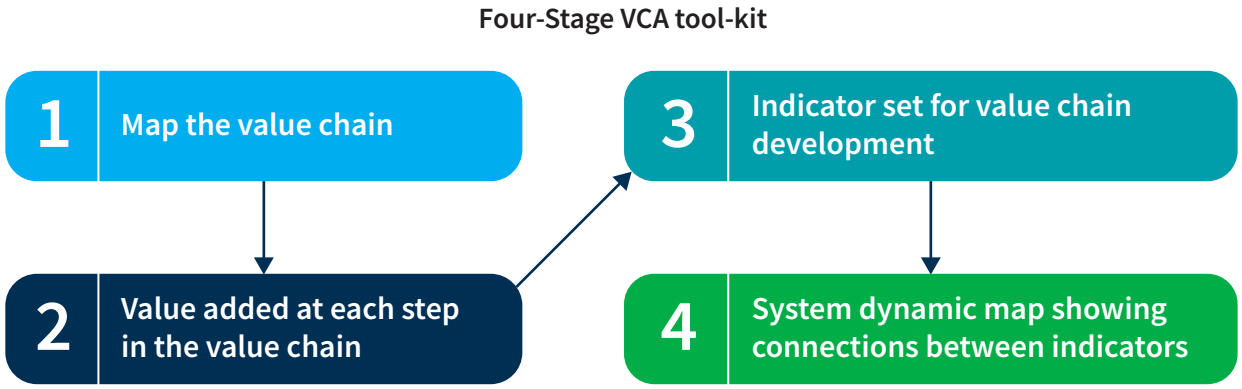
CHAPTER 5

VALUE CHAINS AND CIRCULAR ECONOMY ASSESSMENT

The composition of plastic pollution (Section 3.1) and upstream and downstream value chain inventories (Section 4.1) led to the selection of three specific value chains—those for PET bottles, HDPE/LDPE/PP packaging,[23] and monofilament (nylon) fishing nets—for further assessment through a circular economy lens. To this end, an assessment of system dynamics was performed for each value chain. Based on the findings of these assessments, potential pilot recycling projects were then identified (Section 5).

The value chain assessment consisted of the four steps outlined in Figure 11. These four steps serve to map the value chain for each of the target plastics and understand the indicators that should be the focus of proposed interventions.

Figure 11. Four stages of the value chain assessment toolkit



Source: Original figure based on Jaligot et al., 2016.

Stages 1 and 2: Mapping the value chain and identifying added value

The first two stages of the value chain assessment consist of mapping the value chain to understand the connections between various stakeholders, and identifying the value added at each step. Because data on the monetary value of the waste streams at each stage of the value chain was insufficient to allow for a quantitative assessment of the value added, a qualitative approach was taken to identify the value chain stages that add value to the material.

Monofilament (nylon) fishing nets

The current value chain for nylon fishing nets is simple, with few local stakeholders (only vendors and fishing communities) and no involvement of stakeholders from the waste management sector. Fishing communities are both the only consumers and the only downstream stakeholders, being responsible for repair (if possible) or disposal.

[23] HDPE, LDPE and PP have similar value chains in that they all involve shredding, washing, drying, and extruding at the recycling stage; their market value in Monrovia is similar (LRD20/US$0.10 to LRD30/US$16 per kilogram); and they are often processed together as a mixed stream by local recyclers.

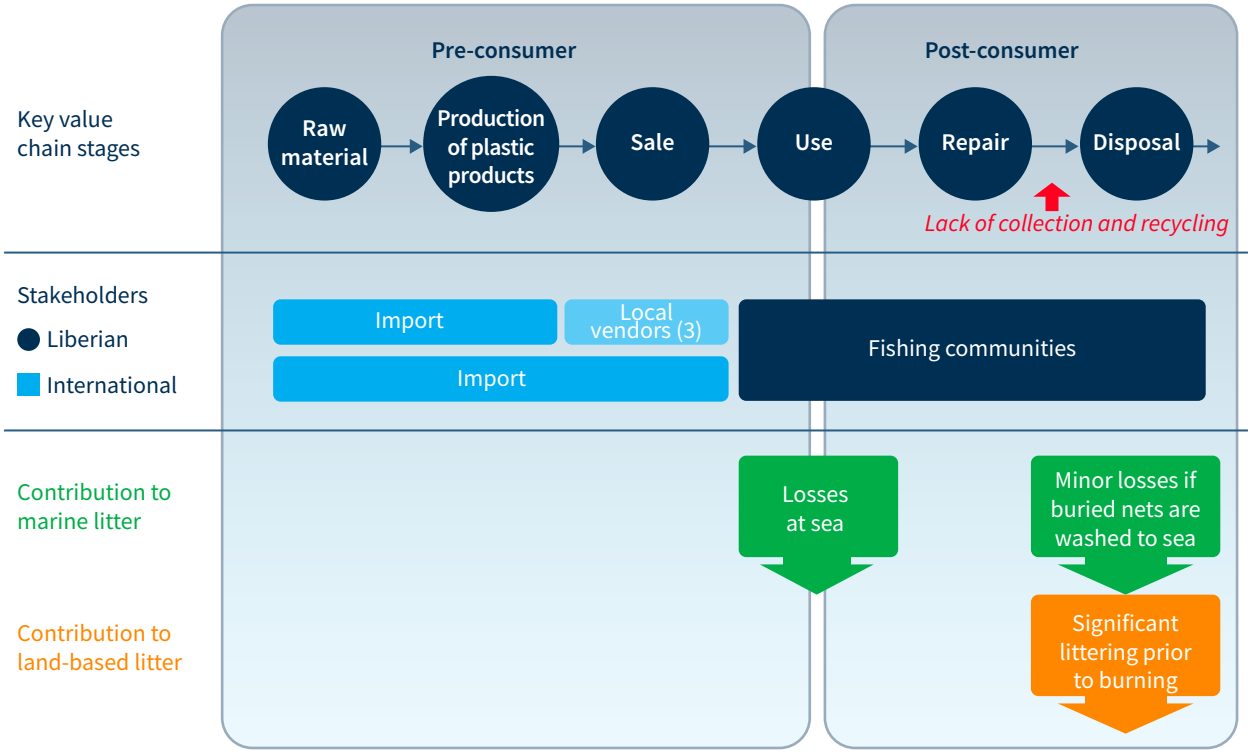
The most significant stage for generating plastic pollution is during use. Although current methods for disposing of nylon nets are not based on sound waste-management practices, the risk of them generating plastic pollution once they have been brought to land is low.

The only stage at which value is added to nylon nets is when communities repair them before they are reused. When repair becomes impossible, they are then discarded. Collection and recycling are absent from the current value chain.

Figure 12 presents the value chain map for the nylon fishing net value chain, while Figure 13 shows the steps where value is added.

Figure 12. Current value chain map (upstream and downstream) for monofilament fishing nets

The current value chain for monofilament fishing nets has few local stakeholders (only vendors and fishing communities) and excludes stakeholders from the waste management sector.

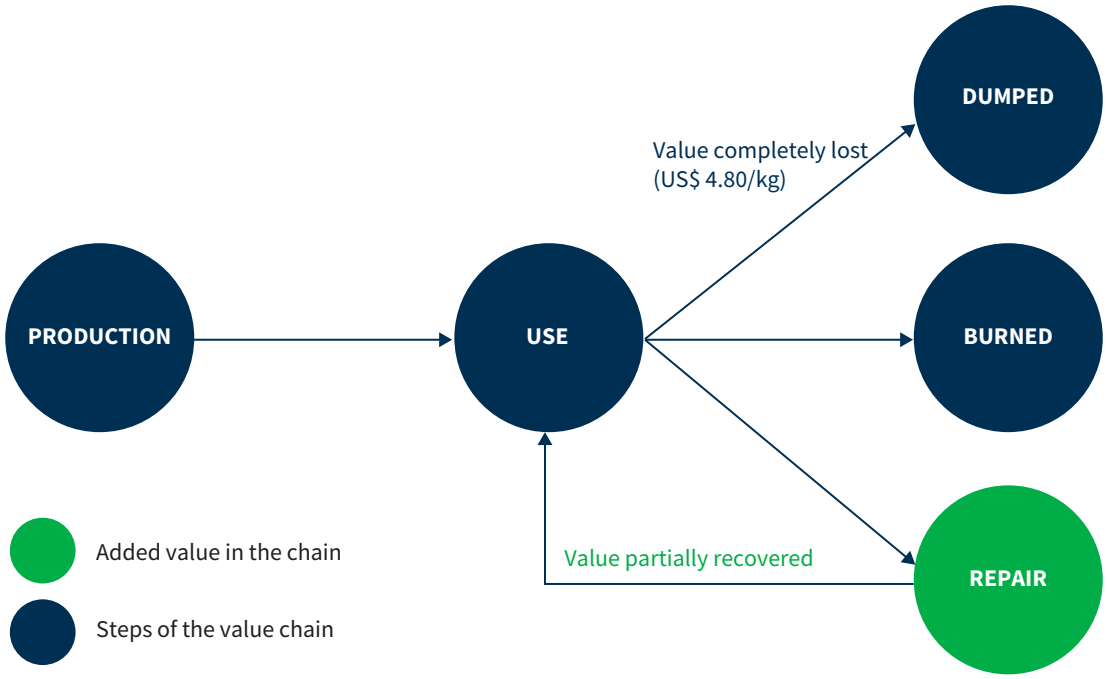


The Net Exchange Program is not presented as it is no longer active.

Source: Original figure produced for this publication.

Figure 13. Where value is added in the monofilament fishing net value chain (indicated by green outline)

At present, the only way value is added to nylon nets is when communities repair them before reuse.



Value lost is based on the average purchase price reported by fishers (US$34 per net) and average net weight (7 kilograms). Source: Original figure produced for this publication.

PET bottles & HPDE, LDPE, and PP packaging

PET bottles and PE and PP packaging are either filled in Liberia using locally manufactured or imported packaging, or imported as pre-packaged products and passed directly on to waste generators (retailers and consumers).

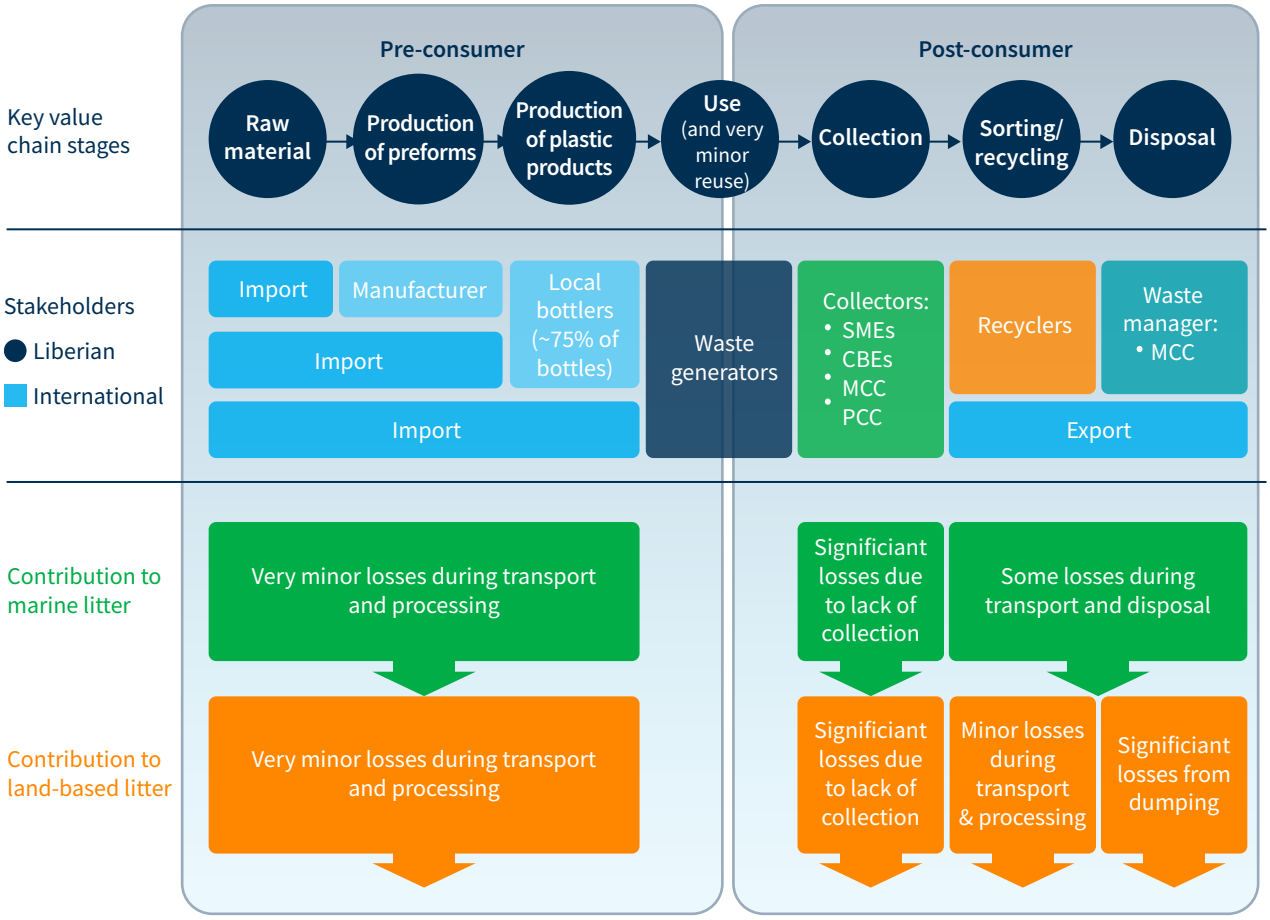
The downstream value chain for the two streams differs in terms of the small portion of PET bottles that is reused, the additional recyclers who accept PE and PP, and the exportation of some PET (but not PE and PP) for recycling.

The most significant stage for plastic pollution generation for all resins is during the collection stage, when uncollected waste is at high risk of leaking into the environment. Value is added at several stages of the downstream value chain, firstly via collection, and finally through recycling either locally (all resins) or internationally (PET only).

Figures 14 and 15 present the value chain maps for PET bottles and plastic HDPE, LDPE, and PP packaging, respectively. The value adding stages for PET bottles are represented in Figure 16 and for HDPE, LDPE, and PP packaging in Figure 17.

Figure 14. Current value chain map for PET bottles

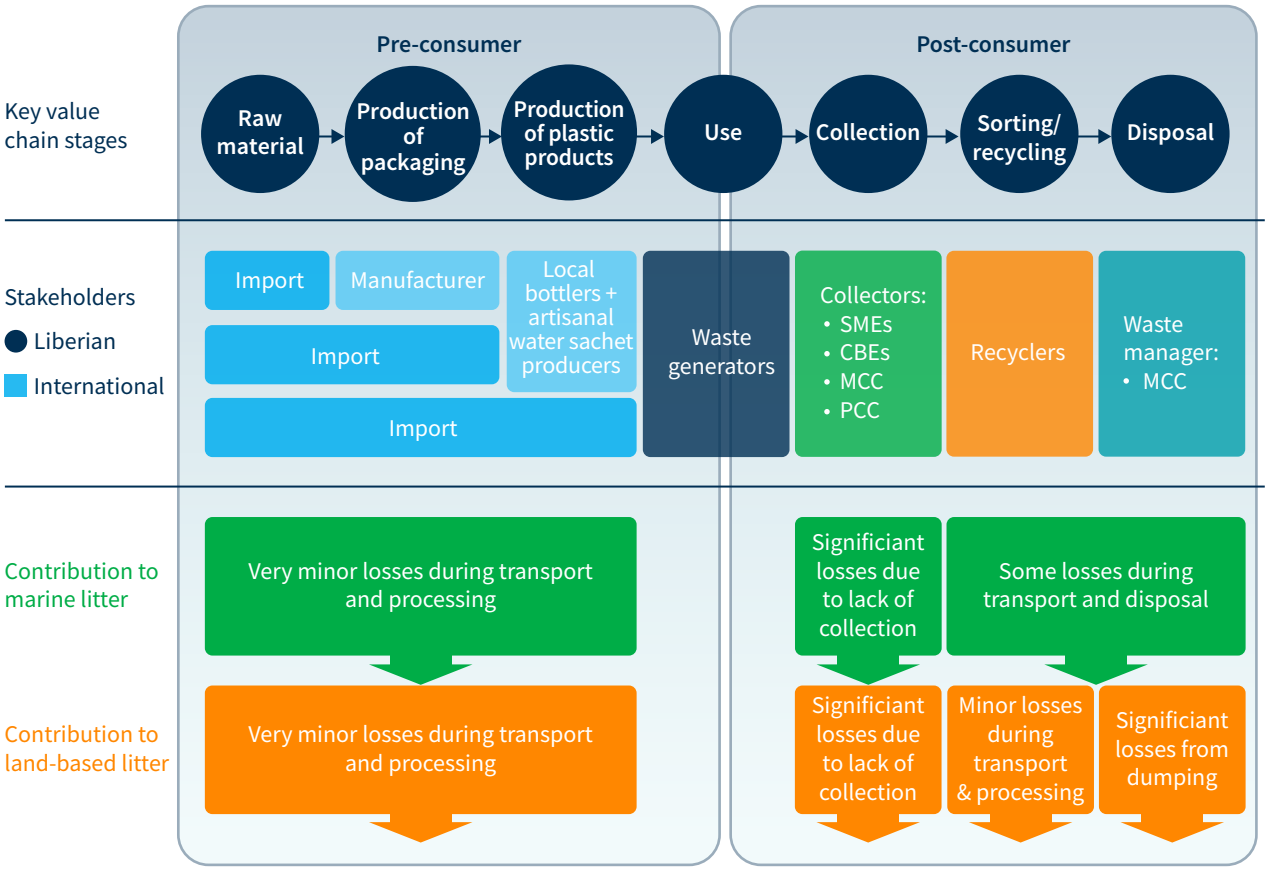
There is a high risk that uncollected waste PET leaks into the environment, limiting the opportunity to add value to the chain by recycling PET bottles either locally or internationally.



Source: Original figure produced for this publication.

Figure 15. Current value chain map for HDPE, LDPE, and PP packaging

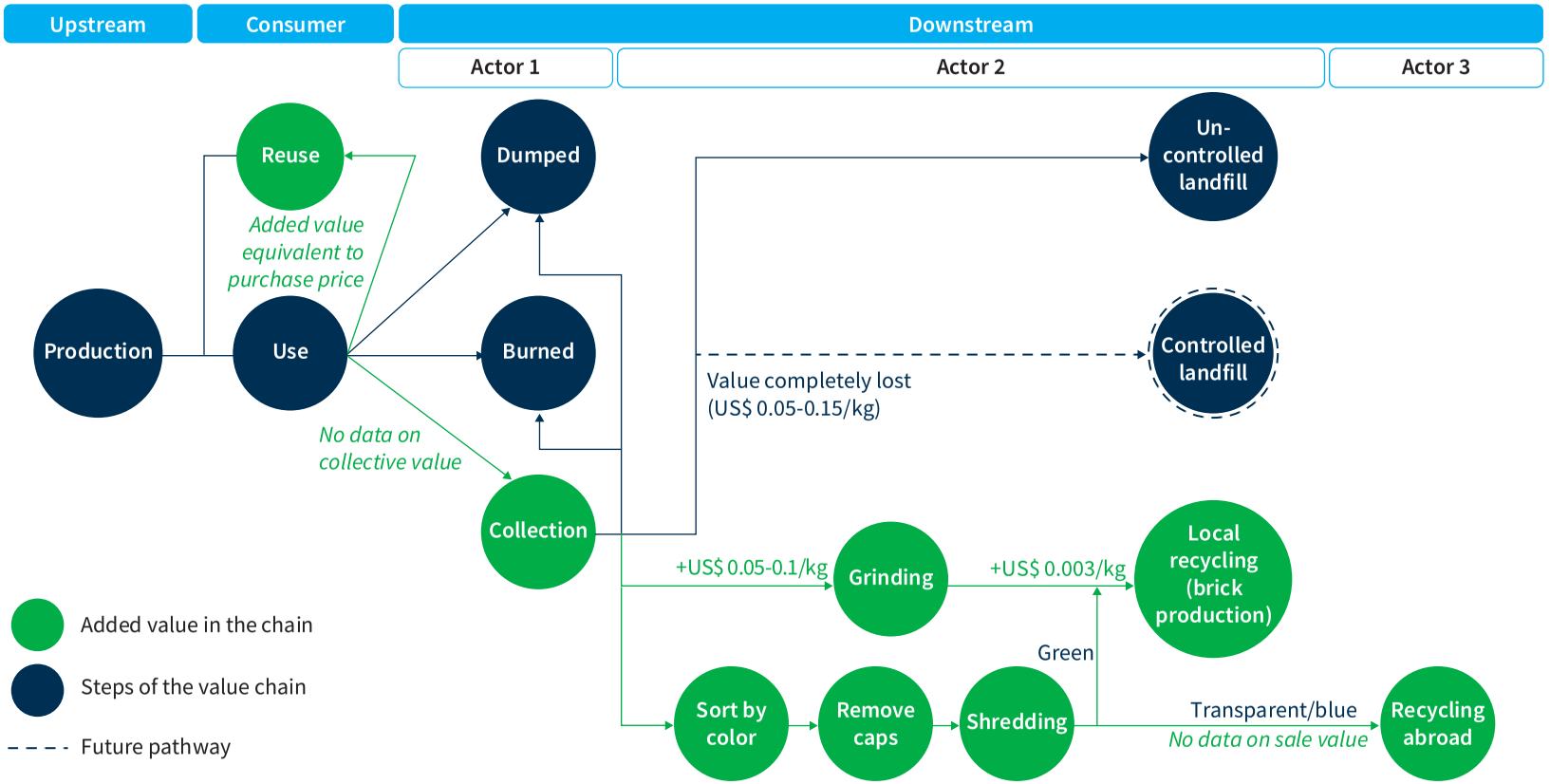
HDPE, LDPE, and PP packaging typically leak into the environment because of lack of collection and high levels of dumping. This reduces opportunities for reclaiming the value of these plastics through recycling.



Source: Original figure produced for this publication.

Figure 16. Where value is added in the PET bottle value chain

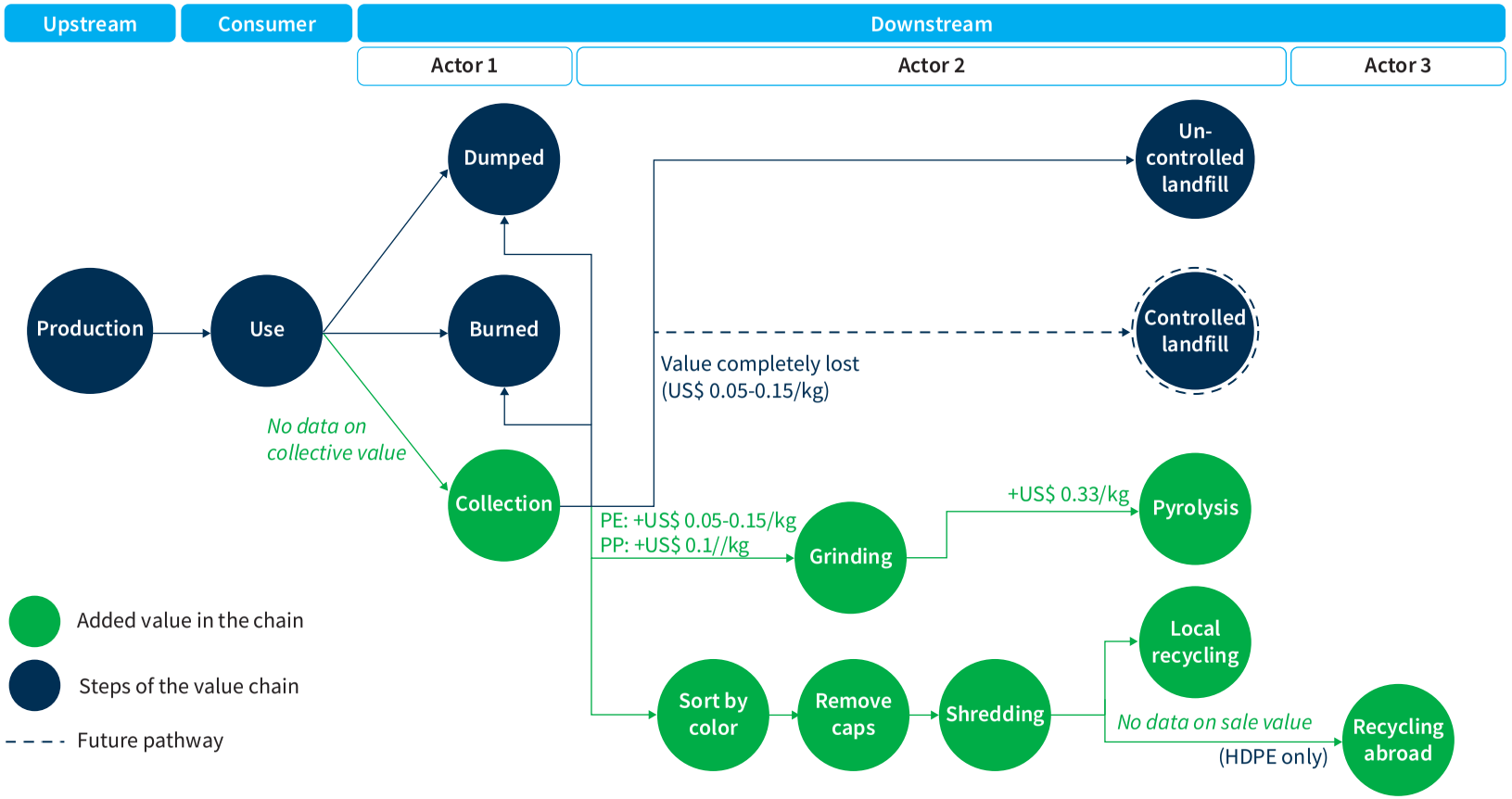
The green shapes indicate the steps in the PET value chain where value could be added.



Source: Original figure produced for this publication.

Figure 17. Where value is added in the HDPE, LDPE, and PP packaging value chains

The green shapes indicate the steps in the HDPE, LDPE, and PP value chains where value could be added.



Source: Original figure produced for this publication.

Stage 3: Indicators

The third stage of the value chain assessment toolkit involves identifying and defining indicators that capture the technical and socioeconomic challenges that need to be addressed to develop the targeted value chain. The indicators can be classified into three categories: (i) connections in the value chain, which refers to the relationships between various stakeholders in the value chain; (ii) waste valorization, which includes indicators that impact the value added at each step of the value chain; and (iii) an enabling environment, which considers the broader context of the stages in the value chain.

Table 5 identifies and defines the indicators for the targeted downstream value chains.

Table 5. Indicators for developing the PET and PP/HDPE/LDPE value chains

Connections in the value chain
Reliance on international markets Import and export are prominent in all targeted value chains. Because stakeholders rely heavily on external markets, their ability to influence market variables through policy or economic drivers is reduced. The need for the import and export of material also increases transport costs, which increases costs for consumers upstream and reduces the potential for recycling to be economically viable downstream.
Access to competitive markets This refers to the competitiveness of the markets available to stakeholders for the purchase or sale of material. Greater competition offers stakeholders greater flexibility and improves their ability to optimize their profitability by sourcing the best available prices.
Sector management and coordination The degree to which the sector is managed and coordinated influences how much stakeholders collaborate and work towards similar goals without overlapping. More effective cooperation strengthens the sector's performance on the whole but can also improve outcomes for individual stakeholders by developing beneficial partnerships and generating efficiencies.
Technical knowledge Each stakeholder requires a minimum amount of technical knowledge to fulfill their role in the value chain. Improved understanding of relevant technical aspects may help to improve each stakeholder's contribution.
Balance of power This refers to the difference in the level of power between upstream and downstream stakeholders within the value chain.
Waste valorization
Quality of material This refers to the quality of the material at each stage of the value chain (for example, the degree of separation and contamination).

Table 5 (continued)

Material supply
This refers to the quantity of the material that can be supplied to, or by, stakeholders to contribute to the flow of material through the value chain.
Net revenues
This refers to the profitability of the activities of each stakeholder: that is, whether revenues can cover upfront and operational costs, and provide a source of income.
Recycling capacity
This refers to the quantity of material that can be recycled by either local or international stakeholders. It largely reflects the accessibility of recycling equipment and infrastructure for materials within the value chain.
Value chain completeness
The value chain is closer to being complete the closer it gets to recycling material into high-value products.
Enabling environment
Financial means
Stakeholders require sufficient financial means to be able to fulfill their role in the value chain.
Source separation
Separating waste at the source generates a cleaner waste stream by minimizing contamination from other wastes (notably organics) and resins, thereby increasing the quality of the material.
Reliable waste collection
Reliable waste collection maximizes the participation of waste generators in waste collection systems and creates a regular source of waste for downstream stakeholders.
Availability of alternatives
The generation of waste is heavily influenced by the availability of alternatives. For these to be accepted at scale, they need to be affordable and comparable for users (waste generators).
Regulatory support
Regulation plays an important role in enabling or hindering stakeholders to fulfill their roles in the value chain. Even once in place, the enforcement of regulation is affected by other factors that may impact its degree of efficacy.
Awareness of benefits/impacts
This refers to the degree of awareness that each stakeholder has about the benefits or impacts that their behavior or participation has on the value chain, and the ability for other stakeholders to fulfill their roles.

Stage 4: System dynamic maps

System dynamic maps were developed for each of the value chains to show how these indicators affect both each other and the steps in the value chain.

In Figure 18, Figure 19, and Figure 20, magenta arrows are used to represent "valves", which determine the rate of flow of material from one stage to another. Green symbolizes recovery, while navy depicts disposal or loss. Dashed boxes mean the stages do not currently exist but have been added to assess dynamics across a potential value chain with more functions. The most important indicators (that is, those with the most interconnections), are shown in **bold**. To avoid overcomplicating the maps and to facilitate their interpretation, the recycling processes for plastic packaging have been simplified into local and (where relevant) overseas recycling.

Monofilament (nylon) fishing nets

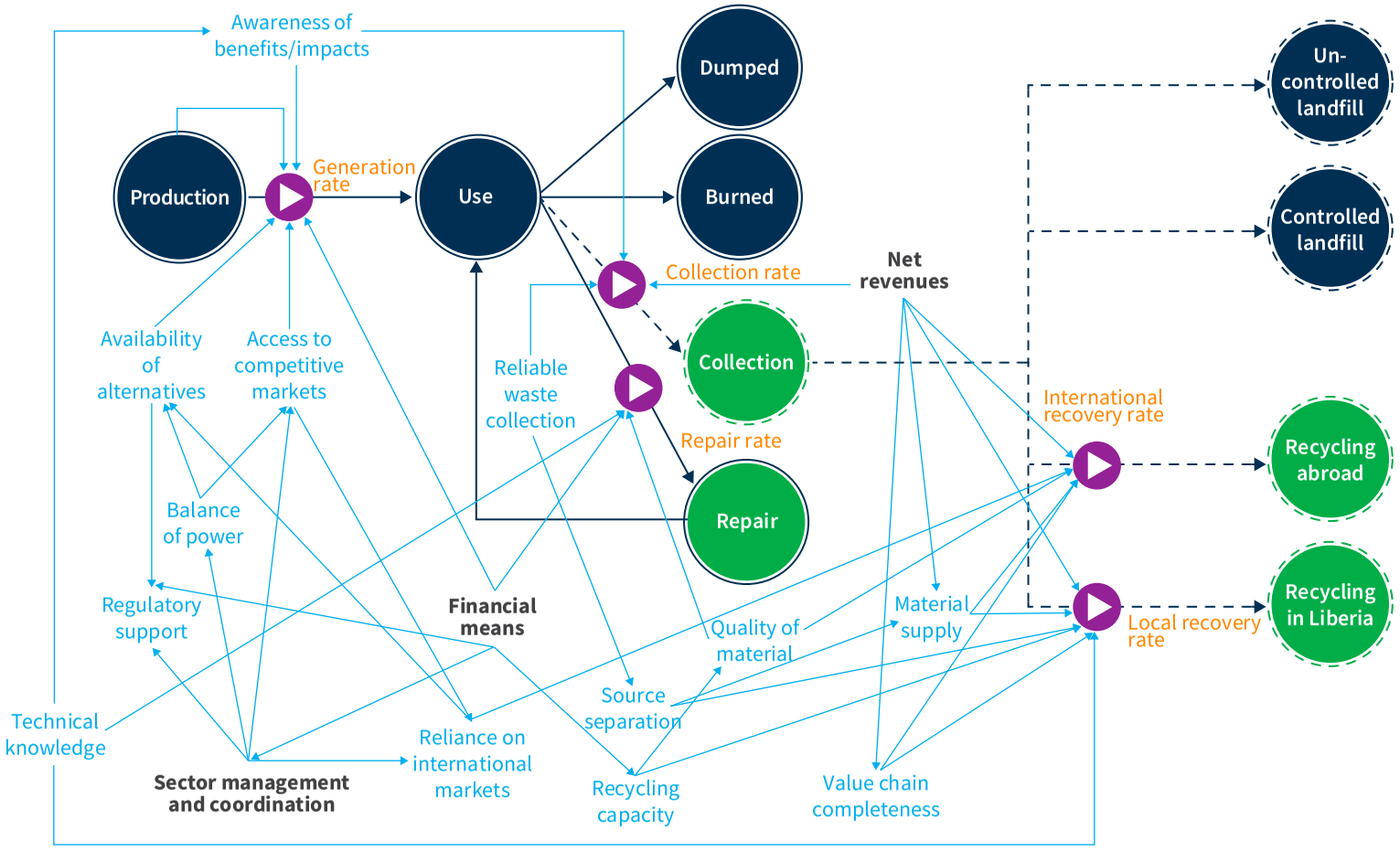
Figure 18 presents the system dynamic map for nylon fishing nets. Potential future pathways have been added for collection, recycling, and disposal that are currently not in place to allow for a better assessment of the indicators that will influence future recycling efforts (recycling pilot programs).

In Figure 18, three of the indicators (in bold) have five connections, while the next highest indicator (technical knowledge) has three. The key indicators for the development of the value chain for nylon fishing nets are therefore:

- **Sector management and coordination.** Currently, three different bodies have a relationship with the fishing communities concerning their use and disposal of fishing nets: the NaFAA, which is involved in the creating and enforcing the regulations on the use of fishing nets; the MCC, which is responsible for providing a waste collection service; and the local fisheries association, which offers support to the communities. However, despite the involvement of these bodies, the communities are largely independent in terms of the sourcing and disposal of fishing gear.
- The most significant barrier to using cotton nets was identified as the difference in upfront cost, with monofilament nets being cheaper and more available. However, there is almost a monopoly on the supply of fishing gear in Monrovia and some communities purchase gear from Ghana, highlighting a significant mark-up on local prices. Greater management and coordination of the fisheries sector could improve these imbalances by generating greater competition for cotton nets on the local market (through bulk ordering or establishing a supply shop run by the fisheries association).
- **Financial means.** Fishers' limited financial means affect their ability to be selective about the type of nets they use. As a result, they often use the cheapest available option. One positive aspect of the significant cost of the nets is the effort put into repairing them, which reduces waste. Nevertheless, increased financial means would enable fishers to invest in higher-quality nets that are in accordance with current regulations. Recyclers in Liberia and neighboring countries are also impacted by financial constraints, which limit their access to suitable recycling equipment.
- **Net revenues.** The difficulty in securing positive net revenues for the collection or recycling of nylon fishing nets is evident in the lack of stakeholders currently undertaking these activities. Improvements in this indicator would affect multiple other indicators such as material supply, value chain completeness, and, ultimately, collection and recovery rates.

Figure 18. System dynamic map for monofilament fishing nets

Magenta arrows represent "valves" that determine the rate of flow of material from one stage to another. Green outlines symbolize recovery, while blue outlines depict disposal or loss. Dashed outlines mean the value chain components do not currently exist but have been added to assess potential future dynamics. The most important indicators (those with the most interconnections) are shown in **bold**.



Source: Original figure produced for this publication.

PET bottles

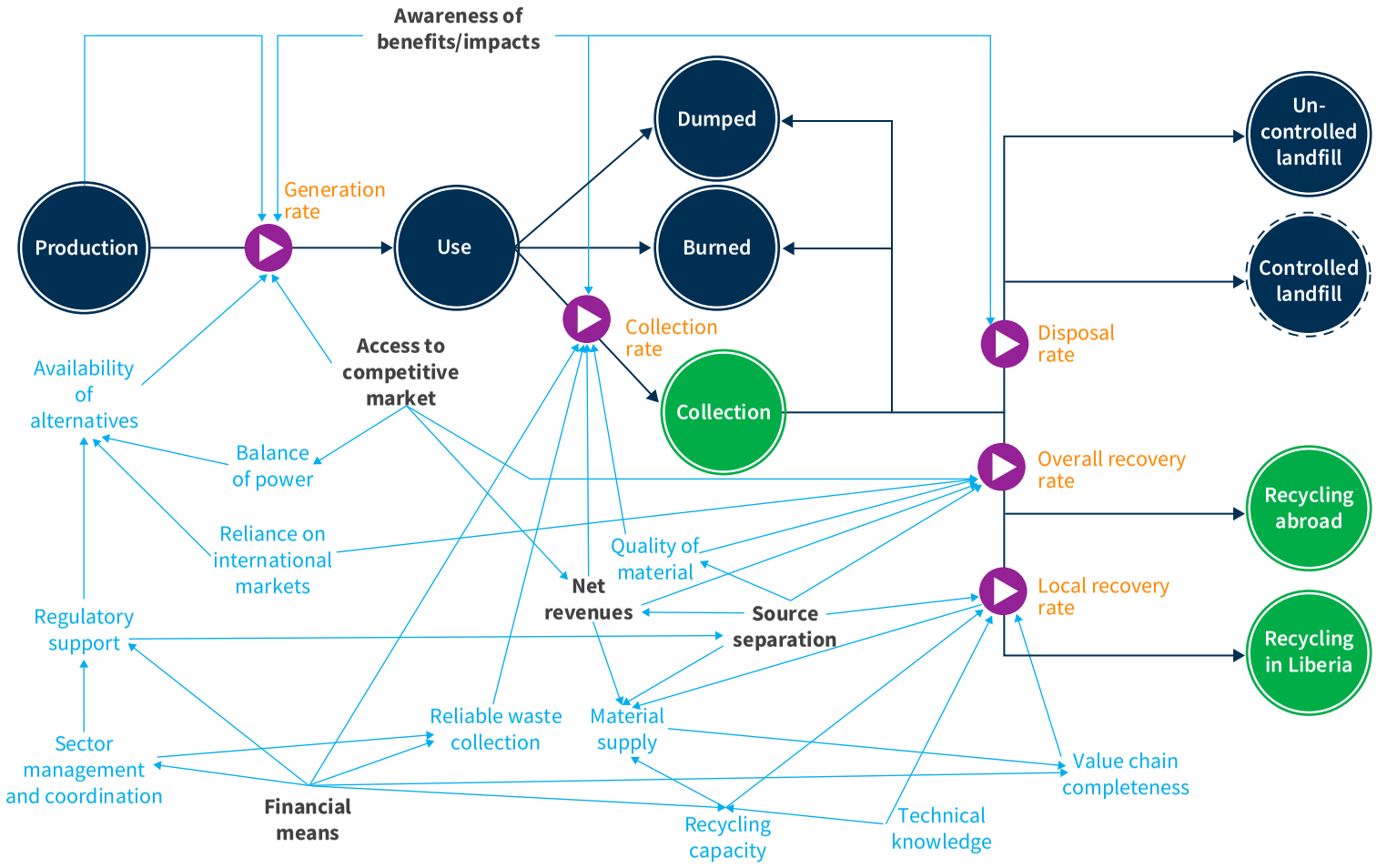
Figure 19 shows the system dynamic map for PET bottles. The most important indicators for PET bottles are those with at least three outgoing connections (bold). Of these, two indicators (financial means and source separation), had five outgoing connections. Key indicators for the PET value chain are:

- **Financial means.** Many public and private stakeholders currently lack the financial means to fulfill their role in the value chain. This lack of sufficient funds directly or indirectly affects nearly all stages of the value chain. It particularly affects the collection rate and (indirectly) the local recovery rate because recyclers lack the ability to invest in transport, recycling equipment, or storage facilities to improve local capacity and increase the completeness of the value chain.
- **Source separation.** Limited source separation currently takes place, with some collectors working directly with waste generators to separate desired waste streams. However, if implemented at a larger scale, this would directly improve several other indicators, including the quality and quantity of material, net revenues, and recovery rates.
- **Access to a competitive market.** Because there is no internal manufacture of PET preforms or bottles, all of this type of packaging is imported at the pre-consumer stage. At the post-consumer stage, the lack of a variety of internal recycling options limits net revenues and recovery rates because this resin is either recycled locally into low-value products, or must be exported (requiring expensive transport) and therefore receives the lowest price per kilogram from recyclers. Increasing competition on the market would help address the imbalance of power between Liberian and external stakeholders at both the pre- and post-consumer stages.
- **Net revenues.** The limited number of private stakeholders in the downstream value chain indicates the difficulty in achieving net revenues in the current system. Due to the limited local recycling capacity for PET bottles, stakeholders struggle to cover collection and processing costs with the value obtained from the sale of products, either locally or on export markets. Improving the potential for net revenues would help drive collection and recovery rates while increasing material supply. This indicator depends on several other key indicators, including source separation and access to a competitive market.
- **Awareness of benefits and impacts.** While recognizing that financial means and access to services also play a significant role in shaping behavior, stakeholders' awareness of the impacts of their actions is important for driving collection rates. Initiatives to improve the value chain should be accompanied by education and awareness campaigns to ensure stakeholders understand the significance of their participation. While most stakeholders do not individually generate or manage a large proportion of the overall waste stream, collective effort is required. This applies equally to waste generators (to maximize collection) and to collectors (to minimize the illegal dumping of collected waste).

It is also worth noting that the "valves" with the most connections in Figure 19 (five) are the collection and recovery rates. This is consistent with the conclusions of the system assessment, which found that a low waste collection rate and limited recycling options are key issues in the current waste management system.

Figure 19. System dynamic map for PET bottles

Magenta arrows represent "valves" that determine the rate of flow of material from one stage to another. Green outlines symbolize recovery, while blue outlines depict disposal or loss. Dashed outlines mean the value chain components do not currently exist but have been added to assess potential future dynamics. The most important indicators (those with the most interconnections) are shown in **bold.**



Source: Original figure produced for this publication.

HDPE, LDPE, and PP packaging

Figure 20 shows the system dynamic map for HDPE, LDPE, and PP packaging. Because the value chains and stakeholders are similar, the system dynamic map for HDPE, LDPE, and PP packaging is very similar to that of PET bottles, with the same key indicators. However, the following points of difference are worth noting:

- **Net revenues** has a greater number of connections because it is also connected to the balance of power. Because local recycling options for these waste streams already exist, the ability for stakeholders to make a net revenue drives a more equal balance of power between upstream and downstream stakeholders than for PET bottles. At present, the quality of materials is not connected to net revenues because there is a lack of local recycling options for high-quality waste streams.
- **Source separation** has fewer connections as there are more recycling processes available that can accommodate lower-quality and mixed streams than for PET bottles.
- **Access to a competitive market** also has fewer connections because it is no longer directly linked to the recovery rate (due to the increased competition in the recycling market for these streams in comparison to PET bottles).
- The most connected valve is the **local recovery rate.** While the collection rate remains important (five connections), net revenues can drive the local recovery rate for these waste streams.

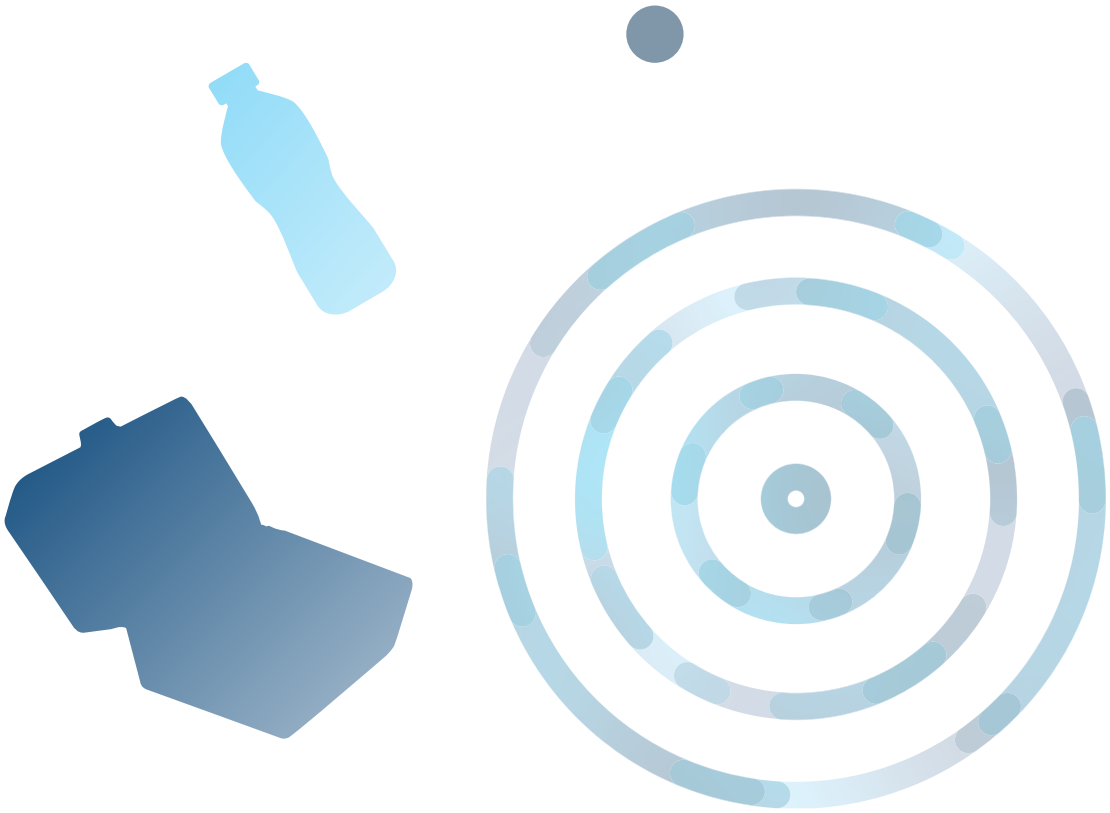
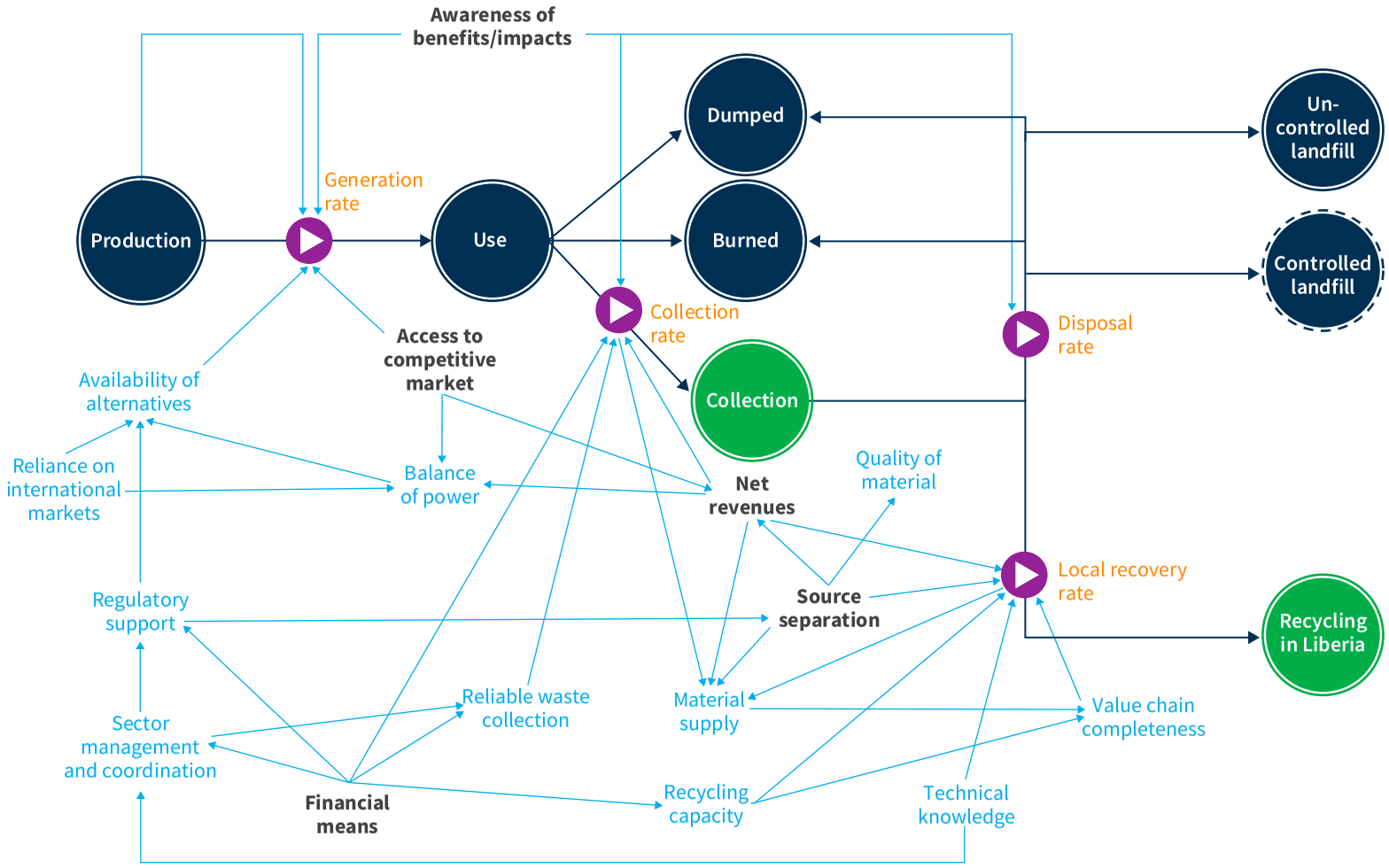


Figure 20. System dynamic map for HDPE, LDPE, and PP packaging

Magenta arrows represent "valves" that determine the rate of flow of material from one stage to another. Green outlines symbolize recovery, while blue outlines depict disposal or loss. Dashed outlines mean the value chain components do not currently exist but have been added to assess potential future dynamics. The most important indicators (those with the most interconnections) are shown in **bold**.



Source: Original figure produced for this publication.

© Adobe Stock

© Adobe Stock

CHAPTER 6

RECYCLING PILOT PROJECTS

The pilot projects proposed in this chapter are based on value chain assessment for the three targeted value chains: monofilament nets; PET bottles; and HDPE, LDPE, and PP packaging (Chapter 5). The proposed pilot projects are intended to guide potential future investments in the local recycling industry, with the ultimate aim being to improve the management of waste and prevent the generation of plastic pollution. These pilots are discussed below and summarized in Table 6.

6.1 RECYCLING FISHING NETS

A desktop review of fishing net recycling initiatives in Ghana, Senegal, Thailand, Spain, the Philippines, and Cameroon provided valuable insights into the approaches, challenges, and key considerations for developing potential pilot projects to recycle fishing nets in Liberia. A total of four pilot options were identified, of which three options (1a, 1b, and 2) focus on recycling monofilament nets without changing the types of nets used, while the final option (3) encourages phasing out the use of monofilament nets by replacing them with cotton nets.

Option 1a: Centralized cleaning for recycling abroad

Option 1a involves collecting fishing nets from the four pilot communities (Banjor beach, Popo beach, King Grey beach, and ELWA beach). Nets would be purchased at a price per kilogram and would therefore need to be cleaned by the fishers to ensure that payment is based only on the weight of the nylon targeted for recycling. Collection from each community would take half a day, once a week.

The collected nets would then be consolidated at a centralized point for a second, more thorough cleaning to further remove any contamination (for instance, from residual organics, hydrocarbons, and salt). The cleaned nets would then be baled and stored in a storage container. Once sufficient quantities have been collected for transport, the containers full of baled nets would be shipped from Monrovia to Trieste (Italy) and transported by road to Slovenia for recycling.

Option 1a would run at an expected net loss of US$6,000 per year. The key operational costs that contribute to this are the rent of a centralized warehouse for cleaning and storage, the maintenance of a vehicle to collect the waste nets, the cost to purchase nets from the fishers, and fuel. The price per kilogram paid for waste nets was based on the maximum price paid by a fishing net recycler in Ghana, who advised against setting the price too high at first because reductions would be much harder to apply than increases.

According to the average net dimensions calculated previously, at this rate one waste net would be worth about LRD280 (US$1.47). Fishing communities indicated that this price would not be sufficient to motivate them to collect and clean the nets. However, it is also possible that obtaining a source of revenue from what is currently worthless waste may be appealing. The quantity of nets that could be collected at this price would need to be determined through a pilot program. However, even at this price point, the revenue earned from the sale of material does not seem sufficient to cover the costs of the initiative.

Other factors to be considered are the relatively low number of jobs created (1.4) and other threats to the quantities of nets to be collected (namely, enforcement of the ban on monofilament nets and declining fishing activities). The option does, however, represent a significant step in

completing the value chain for this waste stream because the nets are upcycled into a high-quality product.

Option 1b: Cleaning by communities for recycling abroad

In Option 1b, cleaned nets are collected from fishers in the four pilot communities, who are paid a rate per kilogram. However, in this option, the second, more thorough cleaning process is undertaken by communities. It is hoped that creating additional job opportunities in communities and allowing participating fishers to see the next value-adding stage will drive participation and reduce the perception that external stakeholders are profiting from their inputs.

The cleaned nets will be stored in 20-foot containers installed at each community. A supervisor will visit each community for half a day every week to ensure that operations are running smoothly, that cleaning standards and equipment are being maintained, and to identify and resolve other issues. The storage containers will then be collected and taken to a central consolidation point for baling. Bales will be stored directly in a warehouse prior to shipment, as in Option 1a.

Option 1b is similar to Option 1a in most respects. The estimated annual loss is slightly lower because the additional costs required for cleaning and storing the nets in each community are offset by reduced costs for warehouse space at the centralized location (due to less space being needed). However, compared with 1a, Option 1b presents two distinct advantages:

- Job creation is higher, with a total of 4.4 jobs created and most of the employment directly in communities.
- The threat of low participation by fishers could be diminished because their participation will facilitate earnings for other members of their local communities rather than less visible, centralized employees.

On the other hand, the upfront costs are significantly higher due to the need to invest in storage containers for each of the four participating communities. This option also does not address the transport costs associated with recycling in Europe (which are significantly higher than for local recycling, as in Option 2).

Option 2: Local net recycling

In Option 2, the first stage to collect cleaned nets from fishers would be as for Option 1a. The nets would be collected from each community once a week and taken directly to the recycling facility. No secondary cleaning would be required. The recycling company surveyed indicated that it would be willing to pay LRD25 to LRD30 per kilogram (US$0.13 to US$0.16 per kilogram) for the input material.

This option, while having the advantage of keeping materials and products within the local market, has several weaknesses, the most significant being that the price the off-taking company indicated it would pay is lower than the fishers' purchase price, meaning the initiative would run at a loss even when processing and transport costs are excluded. To pursue this option, the purchase price would need to be increased while considering the price of the final product (which is potentially low if only simple household products can be manufactured) and associated processing costs. Furthermore, the solution depends on an untested process and would require that most of the upfront costs are invested in specific machinery for a single stakeholder.

While job creation directly associated with the pilot activities is low, additional employment might be created by increasing the recycling company's capabilities and capacity. Threats to this option relate to the reduction or elimination of the targeted waste stream due to regulatory or environmental factors.

Option 3: Exchange of monofilament nets for cotton nets

Instead of recycling nylon fishing nets, the third option aims to gradually phase them out by exchanging waste nets for new cotton nets. This follows the same model as the Net Exchange Program. However, based on that experience, it is recommended that the fishing communities and associations be involved in developing the net specifications to ensure that the replacement nets are acceptable to the fishers.

In this option, waste nets would be collected from, and cotton nets brought to, each community (requiring half a day of work, once a week). The collected waste nets would then be taken directly to a transfer station to allow for disposal at the active landfill facility.

The exchange process provides the opportunity for staff to educate the fishers on the benefits of using cotton nets and to encourage tracking how durable they are. Because cotton nets are more durable, the difference in upfront costs could be balanced out by the overall lifespan of the product, creating a comparable annual cost. However, this would need to be verified by gathering data on the use, repairability, and overall lifespan of the cotton nets compared to nylon nets. Any difference in performance (particularly catch sizes) would also need to be considered when assessing overall costs or benefits to the fishers.

This option does not appear financially viable because the cost of purchasing cotton nets is significant (US$157,500 per year) and there is no source of revenue. To succeed in the long term, the initiative would need to be accompanied by strict enforcement of the ban on monofilament nets. Additional availability of, and competition in, the supply of cotton nets may help to rectify some of the cost difference that currently exists between these two options. However, care should be taken to minimize long-term increases in the cost of nets that would need to be absorbed by fishing communities.

6.2 RECYCLING LAND-BASED PLASTICS

Three pilot options—Option 4, Option 5a, and Option 5b—have been developed for land-based plastics based on the quantitative data and system assessments carried out. All the options target improving waste collection by establishing collection points for the targeted waste stream(s); that is, plastic packaging (HDPE, LDPE, and PP) and PET bottles.

Option 4: Buy-back kiosks for plastic packaging

While Option 4 does not improve the current value chain for plastic packaging, it would help to improve the collection rate for targeted resins by establishing buy-back kiosks at three central locations in Monrovia. Although compositional data on waste generation in Monrovia is lacking, it is likely that the four resins to be accepted (PET, HDPE, LDPE, and PP) represent most of the plastic found in the municipal waste stream. The PET bottles would be baled and exported to Europe for recycling—as is currently the case—while PE and PP would be locally recycled.

This option creates several local jobs because one full-time employee would manage each kiosk, and two people would staff the consolidation point. Potential annual revenue was calculated based on an estimated plastic waste breakdown of 20 percent PET bottles, 40 percent ridged packaging (HDPE and PP), and 40 percent soft packaging (LDPE). These percentages are based on similar initiatives in Ghana and Senegal but would need to be verified through a pilot and the characterization of the municipal solid waste generated in Greater Monrovia. The purchase price for all resins was fixed at the low end of the recycler-proposed price (LRD20 per kilogram). The pilot phase would help determine whether this would be enough to motivate waste generators and collectors to participate.

Because this option does not include recycling PET, no value is added to this waste stream prior to export. Furthermore, the profitability of accepting PET bottles depends heavily on external factors (such as transport costs and market price). At the current estimated rates (shipping to Europe at US$0.21 per kilogram and a sale price of US$0.35 per kilogram), the margins for this resin are minimal.

The estimated operational costs for the pilot phase are based on each kiosk accepting 1,000 kilograms per month, in line with similar initiatives. This results in an annual loss of nearly US$18,000, with the major costs being staffing, renting a centralized warehouse facility, and paying for the waste material. Increasing the quantity of waste accepted at the kiosks, particularly the streams that can be recycled locally, would increase revenue and make this option more viable. According to the current cost estimate and the proportion of resins collected, each kiosk would need to collect about 8,000 kilograms per month to be cost-neutral.

Option 5a: PET collection with local recycling and export

Options 5a and 5b both aim to increase the collection rate for the targeted resin(s), but also include establishing a recycling line to generate PET flakes, thereby strengthening the plastic value chain for PET by generating higher-value recycled products (flakes instead of compacted bales). While PET flakes still need to be exported for recycling, the volume of PET currently generated in Greater Monrovia is not enough to justify significant investment (of US$12 million) in a full bottle-to-bottle recycling line.

Option 5a focuses solely on collecting and recycling PET bottles. Three dedicated buy-back points would be established and the bottles would be transported directly from there to the recycling facility. The option includes purchasing a 500-kilogram-per-hour recycling line that removes labels, grinds bottles, and produces washed PET flakes. Due to the value added, the PET flakes—while still needing to be exported to manufacture new products—can be sold at a higher price than baled bottles. Furthermore, the flakes are denser and therefore the cost of transport per kilogram becomes more efficient.

Because the investment in recycling equipment is significant, the purchase price is fixed at US$0.20 (LRD38) per kilogram—higher than for Option 4, but with the objective of providing additional incentives to increase collected quantities. For the pilot cost calculations, it was assumed that a total of 100 tons per year would be collected across the three buy-back points (2,800 kilograms per month per buy-back point).

Once the (significant) initial investment is covered, this option appears to be profitable. According to the current cost estimates, each collection point would need to collect at least 1,000 kilograms per month to achieve cost neutrality. This is partially due to the higher purchase price for the PET

flakes, but also due to lower operational costs in comparison to Option 4 because there is no need for a centralized consolidation point.

The major disadvantage of this solution is that it requires a large upfront investment while providing a solution for only one type of packaging (which likely constitutes less than 20 percent of the municipal waste stream). However, if successful, it could have a significant impact on the prevention of plastic pollution in Greater Monrovia while establishing a collection system that, if quantities increase sufficiently, could become the basis of a full local bottle-to-bottle recycling system.

Option 5b: Collection via buy-back kiosks with local recycling

The final option for the land-based waste stream combines the previous two options by establishing both multi-resin buy-back kiosks and a local recycling line for PET. As with Option 4, the cost estimates have been based on establishing three kiosks that accept PET bottles as well as HDPE, LDPE, and PP packaging. The material would be collected from each kiosk three times a week and taken directly to the appropriate recycling facility, with no need for a consolidation point or baling.

Again, given the significant upfront investment in recycling equipment, a high collection quantity has been assumed (100 tons per year in total). However, in contrast to Option 5a, the purchase price has been set at US$0.10 (LRD19) per kilogram to avoid the purchase price for non-PET streams exceeding the sale price to local recyclers.

Option 5a offers the same advantages as Option 4 in terms of providing an additional revenue source and a collection option for the general public for the most common plastic packaging streams. However, the inclusion of streams that are fully locally recycled (PE and PP), which have much lower margins between the purchase and sale prices, makes it much more difficult to cover costs and achieve profitability. Even without the costs associated with running a consolidation point, this option still appears to run at a loss of US$6,100 per year due to the significant costs associated with staffing the kiosks and transporting material. While this is affected by the assumed composition of the collected waste (20 percent PET, 40 percent HDPE and PP, and 40 percent LDPE), according to current estimates, PET would need to represent more than 60 percent of the collected waste for the option to achieve cost neutrality.

6.3 ASSESSMENT OF PILOT OPTIONS

Each option was assessed using a combination of a SWOT (strengths, weaknesses, opportunities, and threats) analysis, an estimation of economic viability (based on a comparison of upfront and ongoing costs, and potential revenue), and the potential for local job creation (Table 6). The economic assessment found that, given the estimated quantities for each waste stream, **only Option 5a appears economically viable.** However, this solution addresses only one of the three priority waste streams. While local recycling options for the other waste streams are possible (assuming the technical feasibility of the extrusion and product manufacture from fishing nets for Option 2), the prices paid by local recyclers (which, in turn, depend on the value of the products made and the local population's ability to pay) are too low to cover the collection and transport costs. Furthermore, the prices per kilogram modelled were all relatively low (to give an indication of maximum profitability per kilogram) but may not be sufficient to motivate waste generators to participate in the new collection system.

Table 6. Summary of pilot options

Pilot		Collection	Sorting and cleaning	Consolidation	Recycling	Product sale	Jobs created (full time equivalents)	Upfront costs (US$)	Ongoing costs (US$ per year)	Revenue (US$ per year)	Annual balance (US$)
Targeted waste stream: Monofilament (nylon) fishing nets											
Recycling	1a	Liberian fishermen (cleaned nets)	Secondary cleaning at centralized location	Centralized location	International company	International market	1.4	24,200	21,900	15,900	-6,000
	1b		Secondary cleaning within fishing communities				4.4	36,900	21,700	15,900	-5,800
	2		No secondary cleaning required	No consolidation, transport directly to recycler	Local recycler	Local market	0.4	35,200	7,100	2,300	-4,800
Exchange	3	No cleaning required. Import of cotton nets coordinated by fishing community association		Transfer station	None. Monofilament nets disposed of to landfill	N/A	0.4	8,000	162,000	–	-162,000
Targeted waste streams: Plastic packaging (PET bottles and HDPE/LDPE/PP packaging)											
Plastic packaging	4	General public, CBEs, and SMEs	Sorting by resin at buy-back centers, no cleaning	Baling at centralized location	International (PET) Local recycling (PE, PP)	International market (PET) Local market (PE, PP)	5	32,600	31,400	6,100	-25,300
PET bottles only	5a		Collection at dedicated buy-back points, cleaning at recycling facility	Not required. Transport directly from collection points to recycling facility	Local recycling (production of PET flakes and products from PE/PP)		4	608,700	32,300	50,000	17,700
Plastic packaging	5b		Collection at buy-back kiosks, cleaning at recycling facility				4	613,600	26,100	20,000	-6,100

CHAPTER 7

PROPOSED STRATEGY TO REDUCE AND PREVENT PLASTIC POLLUTION IN GREATER MONROVIA

Based on the findings of the study, 26 possible interventions to prevent and reduce plastic pollution in Greater Monrovia have been identified (Figure 22). While some focus on specific waste streams, most apply to multiple streams to maximize their impact.

Although the initiatives mentioned in this section could be undertaken independently, it would be more effective if a single entity propagated the overall vision and strategy, while ensuring that the benefits accrue to all stakeholders. If this entity cannot be created in the short term, the EPA or the Ministry of Sanitation and Water Resources could be appointed to oversee the first part of implementing the strategy. Without an entity to promote cohesiveness, value chain stakeholders—though empowered to implement parts of the Strategy—would find it easier to disengage. The entity that oversees implementing the strategy would also track the various projects proposed by funding agencies to identify possible collaborations and funding opportunities.

To help identify which interventions are the most relevant, it is useful to classify them according to four strategic orientations (Figure 21).

Figure 21. The four strategic orientations of the proposed interventions

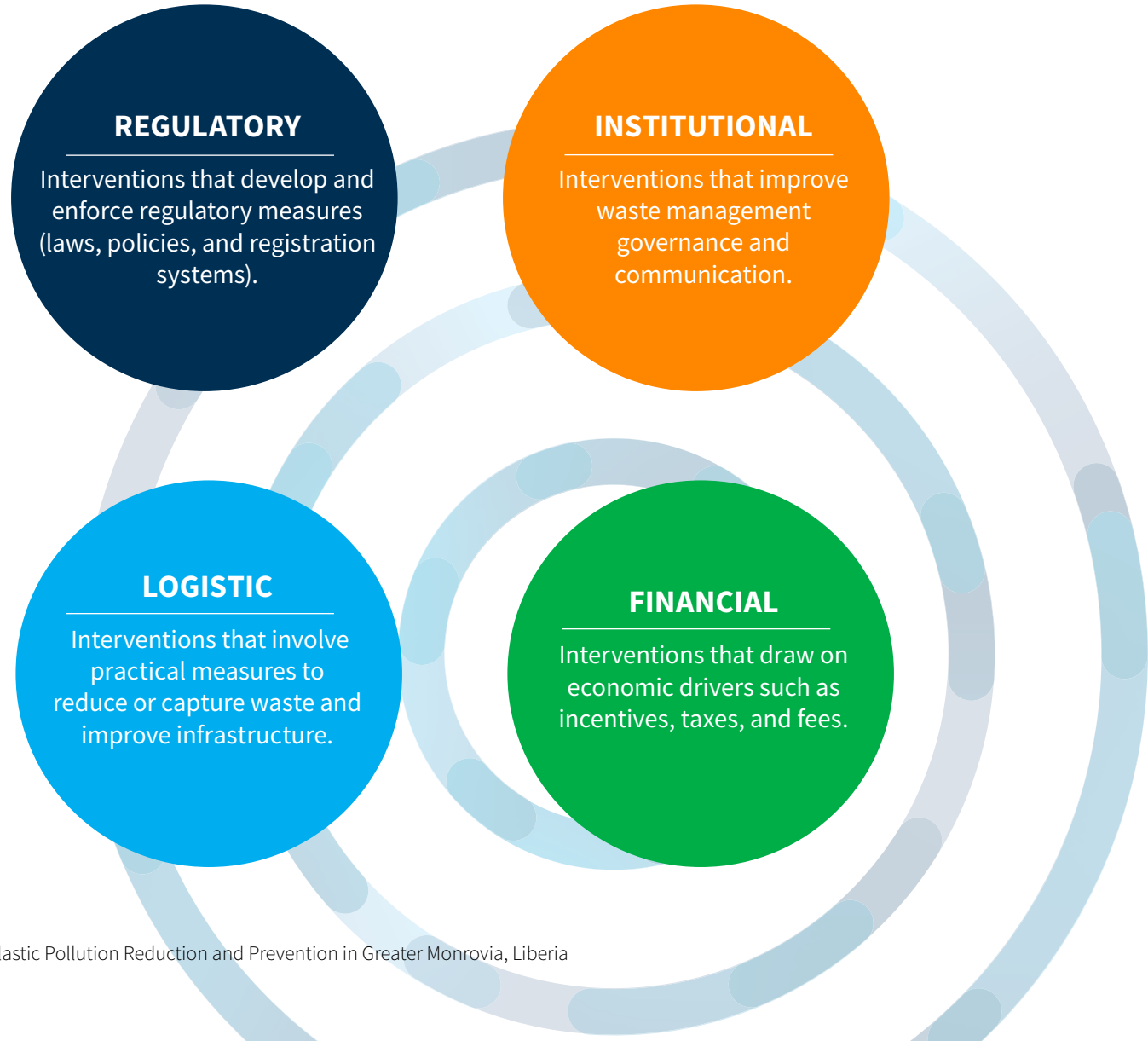


Figure 22. Possible interventions by strategic orientation

REGULATORY RECOMMENDATIONS

Initiative 1: Implementation Plan for National Solid Waste Management Policy

Initiative 2: Fulfill current regulatory obligations

Initiative 3: Phase out single-use plastics

Initiative 4: Register waste pickers

Initiative 5: Extended producer responsibility

Initiative 6: Enforce laws on illegal dumping.

INSTITUTIONAL RECOMMENDATIONS

Initiative 7: Establish a dedicated national waste management body

Initiative 8: Improve stakeholder cooperation

Initiative 9: Raise awareness

Initiative 10: Establish a recyclers' association.

LOGISTICAL RECOMMENDATIONS

Initiative 11: Characterization of waste

Initiative 12: Track use and disposal of fishing gear*

Initiative 13: Improve access to potable water

Initiative 14: Investigate alternatives to plastic packaging

Initiative 15: Source separation

Initiative 16: Provide regular waste collection

Initiative 17: Improve waste management at markets

Initiative 18 and Initiative 19: Upgrade MCC trasnfer stations and develop PCC transfer stations

Initiative 20: Support community cleanup efforts

Initiative 21: River waste barriers

Initiative 22: Marine litter capture.

FINANCIAL RECOMMENDATIONS

Initiative 23: Support alternatives to monofilament nets*

Initiative 24: Incentives for use of recycled plastic

Initiative 25: Establish waste collection fees

Initiative 26: Low-interest loans for waste management projects

Initiative 27: Regional cooperation.

** While the overall set of recommendations broadly support plastic pollution reduction (terrestrial, estuarine, marine) and plastic recycling, these two are specifically focused on fishing gear.*

At this stage, it is important to include all identified initiatives and to enable key stakeholders to take full ownership of the strategy. It should also be noted that the local context (in terms of commitments, funding, opportunities, and so on), or even the adoption of the first initiatives, could require priorities to be reviewed. Because of this, it is necessary to provide an exhaustive list of possible initiatives.

The interventions presented below exclude recycling pilots, which are discussed at length in the Value Chain report and summarized in the following sections.

Box 5. Data collection

Significant challenges were encountered in obtaining useful and up-to-date data on waste management throughout the data-gathering stages of this study. The difficulties related both to the unavailability of some data and a reluctance to share available information with the project team. Providing additional resources and capacity building to regulatory bodies would allow for improved data collection by increasing the range of data collected, ensuring that it is in a usable and transferable format, and creating greater recognition of the benefits of sharing data among stakeholders to work towards common goals.

Specifically, the following data-gathering activities and information would support future improvements to the waste management system:

- Monitoring of recycling activities (regulated by the EPA): This should focus on quantities and waste streams accepted, the treatment/disposal of waste, and the assessment of environmental impacts and emissions.
- Tracking the waste accepted at transfer stations and classifying waste by source (the MCC and PCC): This information could include the specific collection route or points serviced, the SME or CME that does the collection, and other sources of waste such as direct disposal by the private sector or the general public.
- Classifying the waste accepted at the landfill facility by source at the same level of detail as for transfer stations.
- Maintaining an inventory of illegal dumpsites, particularly in coastal zones (in accordance with the requirements of the EPM Act), riparian areas, and near markets.

7.1 REGULATORY RECOMMENDATIONS

Initiative 1: Implementation Plan for National Solid Waste Management Policy

The NSWMP, developed principally by the MCC and the Ministry of Internal Affairs, was approved in October 2024. Finalizing the NSWMP represents a step towards a comprehensive regulatory framework on solid waste management. The previous version contained only qualitative objectives and would have benefited from the addition of quantitative objectives, as well as the identification of necessary indicators and the parties responsible for collecting this data. The NSWMP calls for the development of a Policy Implementation Plan that should be reviewed and amended every five years.

Significant challenges were encountered in obtaining useful and up-to-date data on waste management for this study. The difficulties related both to the unavailability of data and a reluctance to share available information. Providing additional resources and capacity building to regulatory bodies would improve data collection by increasing the range of data collected (to meet regulatory requirements, at minimum; see Initiative 2), ensuring that data is in an exploitable and transferable format, and creating greater recognition of the benefits of sharing data among stakeholders working towards common goals. Coordinating and ensuring sufficient data collection and analysis could be one of the responsibilities assigned to the body designated to monitor waste management more closely at national level (see Initiative 7).

Initiative 2: Fulfill current regulatory obligations

Now that the NSWMP has been published, it will be necessary to define regulations that will need to be enforced at different levels and by different stakeholders. If the EPA is to have overall responsibility for solid waste regulation and regulatory monitoring and enforcement, it will need to include the national waste body (Initiative 7) to do so. It would also need the cooperation of local waste managers like the MCC and PCC. These entities will need to cooperate in gathering data to develop and monitor progress towards shared objectives. They will also be responsible for ensuring that other stakeholders abide by the law.

The existing entities do not currently have sufficient resources to meet their regulatory requirements, which include providing services and regulating waste-management activities. The country's police service may therefore need to play a role in enforcing applicable law.

Initiative 3: Phase out single-use plastics

Policies to reduce the use of single-use plastics (SUPs) are becoming increasingly widespread. Commonly targeted streams include plastic bags (which may or may not include water sachets, depending on the scope and thresholds applied), plastic cutlery, straws, stirrers, balloons, and takeaway food containers (for example, expanded polystyrene boxes). As of 2020, 34 African countries had passed regulations to reduce the use of plastic bags through bans or levies,[24] albeit with differing levels of enforcement and varying scopes. According to the characterization data gathered at the Liberian hotspots studied, targeting plastic bags and water sachets would have the

[24] Greenpeace Africa. 2020. "34 Plastic Bans in Africa: A Reality Check." https://www.greenpeace.org/africa/en/blogs/11156/34-plastic-bans-in-africa/

greatest impact on the quantity of plastic pollution generated in Greater Monrovia. Characterization of municipal solid waste generated and customs data would help with tracking the impact of any measures implemented.

Policy tools are among the most cost-effective methods for reducing plastic pollution,[25] although the benefits they bring depend on how successfully these tools are implemented.

Important factors to consider when developing regulatory measures that target SUPs include:

- Impacts on public health (how the public will access potable drinking water without SUPs)
- The availability of alternatives
- Impacts on the waste management industry, including formal and informal collectors and recyclers
- How the regulation will be enforced (whether there are sufficient resources, whether enforcement officers are suitably trained, and what penalties will be applied for trespasses)
- The risk of developing a black market.

All these factors are relevant to the Liberian context and would need to be carefully considered when developing and implementing the appropriate legislation.

Initiative 4: Register waste pickers

Waste picking is much less prevalent in Greater Monrovia than in other developing countries. Because plastic waste is not valued in Liberia, the small number of waste pickers that are active do not commonly target plastic waste. However, there is potential for this to evolve with the implementation of initiatives to increase the value of plastic waste as well as the net revenues for collecting and recycling plastic waste. Because of this potential contribution, it is important to integrate informal collectors in the development of future improvements.

One way to integrate waste pickers is to register them.[26] Registering waste pickers supports the recognition of their contributions, facilitates their integration into the greater waste management system and the tracking of their contributions, and assists in the provision of future support such as capacity building and social and health benefits.

A suitable responsible body will need to be nominated to implement the registration system. This could be the EPA, which is already tasked with registering other waste collection and treatment activities, identifying the required details, and developing a registry of waste collectors. Waste pickers should be made aware of the purposes of the registry and its anticipated benefits.

---

[25] Nikiema J and Asiedu Z. 2022. "A Review of the Cost and Effectiveness of Solutions to Address Plastic Pollution." *Environmental Science and Pollution Research* 29: 24547–24573.

[26] Department of Environment, Forestry and Fisheries (DEFF) and the Department of Science and Innovation (DSI). 2020. "Waste Picker Integration Guideline for South Africa: Building the Recycling Economy and Improving Livelihoods through Integration of the Informal Sector." Pretoria: DEFF and DSI.

Initiative 5: Extended producer responsibility

Extended producer responsibility (EPR) plans hold producers accountable for managing the waste generated by their products. The ultimate aim is to integrate the cost of waste management into the product purchase price, so generating a source of funds for managing the targeted waste stream and creating financial incentives for producers and users to minimize waste and maximize recycling.[27] EPR schemes may be voluntary or mandatory. Mandatory schemes are more effective,[28] while voluntary schemes are often limited by a lack of industry participation. In Africa, only South Africa, Kenya, and Ghana currently have mandatory EPR schemes.[29]

Stakeholder analysis revealed that the upstream (pre-consumer) private sector is not involved in waste management. An EPR scheme in Liberia would remedy this while potentially generating revenue to fund collection, recycling, and proper disposal activities.

The waste collection and governance system in Greater Monrovia already faces challenges in terms of stakeholder coordination and monitoring—both key factors for the success of EPR schemes. Therefore, although consideration of an EPR plan in Liberia is premature, it may be considered with longer-term policy options. In this case, a dedicated study is recommended to assess potential options and impacts.

Initiative 6: Enforce laws on illegal dumping

Due to the current lack of reliable waste collection, most households and businesses have no alternative but to dump their waste. It would therefore be inappropriate to consider enforcing the laws prohibiting illegal dumping until a suitable alternative is available. While this is being put in place, laws on illegal dumping could be enforced in two phases:

- Firstly, law enforcement could exclusively target dumping by SMEs and CBEs who are paid to collect waste, but who subsequently dump the collected material, either to avoid paying disposal fees or to minimize transport distances. Identifying these dumpsites and the responsible party may pose significant challenges. The enforcement process would also require financial and human resources, which are currently limited.
- The second phase of enforcement should be undertaken only once a reliable collection system is in place and should coincide with an awareness-raising campaign on the impacts of illegal dumping. At this stage, dumping by any waste generator or collector should be penalized to support the use of the collection system and further encourage behavior change.

---

[27] IRP (International Resource Panel). 2021. "Policy Options to Eliminate Additional Marine Plastic Litter by 2050 Under the G20 Osaka Blue Ocean Vision." Nairobi: UNEP (United Nations Environment Programme).

[28] OECD (Organization for Economic Co-operation and Development). 2024. "Extended Producer Responsibility: Basic Facts and Key Principles." OECD Environment Policy Paper No. 41. Paris: OECD Publishing.

[29] Totaro AI. 2023. "Africa is Working on an Ultimate Producer Responsibility." *Renewable Matter #46: Extended Producer Responsibility.* https://www.renewablematter.eu/articoli/article/africa-is-working-on-an-ultimate-producer-responsibility.

7.2 INSTITUTIONAL RECOMMENDATIONS

Initiative 7: Establish a dedicated national waste management body

Currently, none of the stakeholders responsible for waste management regulation or service provision are dedicated to waste management and all have additional portfolios and responsibilities. As a result, there is no body at any level of government that has oversight over the whole waste management sector, making it more difficult to drive and coordinate improvements. Creating a dedicated national waste management body (such as the National Solid Waste Management Advisory Board defined in the NSWMP's Policy Implementation Plan) would improve sector supervision and enable changes to be implemented more efficiently and effectively.

This body would need to be supported by a synchronized national, regional, and local approach for solid waste management. Such a system could be defined by a more in-depth assessment and stakeholder consultation process than covered by this project. The responsible entity would also need sufficient resources to be successful. As noted previously, existing government stakeholders currently lack the resources necessary to fulfill their responsibilities. The new entity would need to be allocated sufficient resources to ensure that it is able to meet its responsibilities and help other government stakeholders to do the same. The creation of a new body would also require clearly defined roles and responsibilities, as well as suitably qualified and trained staff.

For example, this body would be responsible for gathering specific follow-up data on waste management. Specifically, the following information would assist future improvements to the waste management system:

- **Monitoring recycling activities.** This is regulated by the EPA. Data to be tracked includes the quantities and sources of waste streams accepted, waste treatment or disposal, and assessing environmental impacts and emissions.
- **Tracking the waste accepted at transfer stations and classifying waste by source;** that is, whether the waste came from the MCC or the PCC (including the specific collection route or points serviced), from an SME or a CME (including the name of the relevant entity) or from other sources such as direct disposal by the private sector or the general public).
- **Classifying the waste accepted at the landfill facility by source** at the same level of detail as for transfer stations.
- **Maintaining an inventory of illegal dumpsites,** particularly in coastal zones (in accordance with the requirements of the EPM Act, which specifies conducting an inventory every two years), riparian areas, and near markets. As well as allowing for targeted cleanup operations, this information may be used to understand their causes (for example, lack of collection, avoiding the disposal fee, or a lack of awareness) and thereby identify ongoing steps to improve the collection rate.

Initiative 8: Improve stakeholder cooperation

Despite significant limitations on resources within existing waste managers and regulators (the EPA, the MCC, and the PCC), there is some overlap in the roles of these bodies, resulting in inefficiencies, friction between stakeholders, and lack of clarity for the sector. The key example identified was

the registration of waste collectors, which is done by both the EPA and the MCC. Whether or not a dedicated waste management body is created, clearly defining and agreeing upon the roles of each government body responsible for waste management would improve the governance of the sector.

More broadly, increased cooperation should be encouraged to facilitate the collection and use of data, enforce legislation, support awareness-raising and education campaigns, identify the needs for sector improvements, and work towards common goals. An appropriate system should be developed for dialogue and information-sharing. This would entail, for example, regular meetings, the creation of a focus group, and shared online data systems or platforms.

Initiative 9: Raise awareness

Developing an understanding within (and maximizing participation of) the population is key for ensuring the success of many of the proposed interventions. To support the implementation of changes to the waste management system, targeted awareness-raising and education campaigns should be undertaken. Depending on the subject matter and target audience, these campaigns could be held over discrete periods (to coincide with an implementation phase, for example) or they may be ongoing. Such campaigns should consider the key messages to be communicated, the target audiences, the chosen communication method, the duration of the campaign, as well as links with events and other awareness-raising efforts.

Possible topics for awareness-raising campaigns include:

- **The negative impacts of illegal dumping on environmental and public health** to encourage use of waste collection services
- **The positive impacts of community cleanup efforts** to encourage involvement
- **Why fees need to be charged for waste management,** including explanations of the fee structure and how the collected funds will be used
- **The advantages of separating waste at the source,** including sorting guidelines and information on the collection system and incentives
- **The benefits of switching to plastic alternatives, maximizing reuse, and recycling.**

Initiative 10: Establish a recyclers' association

The stakeholder consultations undertaken as part of the strategy's development revealed a shared willingness to develop the downstream private sector, as well as common challenges and barriers faced in undertaking downstream activities. Creating a recyclers' association would provide a forum for these stakeholders to discuss relevant issues, devise strategies to develop the sector, and get involved in related bodies and initiatives (for example, implementing this strategy and representing a national waste management body).

The main challenges associated with this intervention relate to the availability of time and technical and financial resources to create the group and transform ideas into actions, as well as the challenge of gaining and maintaining commitment of recyclers to sustain a functioning association that establishes and achieves objectives.

7.3 LOGISTIC RECOMMENDATIONS

Initiative 11: Characterization of waste

The waste characterization undertaken in preparing this strategy aimed to better understand the generation of plastic pollution. While it provides some indication of the composition of the waste generated in the study area, it represents only what has been leaked into the environment at each hotspot location and does not capture overall waste generation by households and businesses. A waste characterization that includes both compositional data and the quantification of generation by source (such as households by income level, businesses, and markets) would provide valuable data for developing strategies to prevent waste and improve its management. It would also provide baseline data from which the success of implemented interventions could be measured.

Initiative 12: Track use and disposal of fishing gear (fishing gear recommendation)

Despite the high value of fishing nets, fishing communities consulted in developing the strategy do not track their use, loss, or disposal of nets. Without this data, it is difficult to obtain an understanding of the size of the waste stream or the impacts (for cost and catch sizes) of moving away from monofilament nets to more sustainable cotton or multifilament options. Implementing a data-collection system for nets would capture valuable data on this waste stream that could be used to develop and track initiatives to support fishing communities as they transition to alternatives.

Key data to gather includes the number of nets purchased per season or year (by material, mesh size, dimensions, and supplier); the number lost at sea; and qualitative and quantitative indications on their effectiveness (in terms of catch size, ease of use, and repairability).

A recently approved PROBLUE grant includes the evaluation of regional waste fishing gear collection and recycling business models for West Africa.

Initiative 13: Improve access to potable water

The waste characterization exercise discovered that about a quarter of the PET bottles found at waste pollution hotspots were water bottles. LDPE water sachets are also a significant contributor to plastic pollution. While interventions to improve collection and recycling of these bottles and water sachets are encouraged in accordance with the waste management hierarchy, preventing such waste by removing the need for this type of packaging is preferable.

The National Agenda for Transformation 2030, which states that only a third of the Liberian population has access to water sources with adequate year-round supply, contains the goal of increasing access to safe water supply. As well as reducing plastic waste generation, improving access to potable water would have far-reaching benefits for public health. However, the impact of this intervention on numerous artisanal water sachet producers should be considered, along with the financial, human resource, and technical challenges associated with improving access to potable water.

Initiative 14: Investigate alternatives to plastic packaging

In addition to seeking a reduction in the use of plastic packaging for potable water, a broader study could be undertaken that investigates the possibilities for increasing the share of reusable and refillable plastic packaging, as well as alternatives to plastic.

In recognition of the significant challenges already involved in improving waste management services, preferred solutions should be simple and low cost for both the implementing body (government and private sector) and the consumer. For example, reusing existing plastic bags, crates, boxes, and so on could be encouraged by establishing "bag bins" in shops or markets in which customers can leave these items for reuse by future customers. Refilling options are likely to be easier to implement for locally packaged products than for those that are imported already packaged and are not recorded under the plastics code in customs data.

The private sector should be consulted to maximize its support for proposed initiatives to promote alternatives to plastic packaging. Proposed initiatives should consider related financial, environmental, and public health impacts, while also identifying any behavioral changes required for successful implementation.

Initiative 15: Source separation

Source separation was found to be a key indicator in the development of the value chain for plastic packaging. Source-separated materials provide higher-quality input streams for recycling activities because they are not contaminated (or at least have much lower contamination rates) by other streams, particularly organics. Separation of plastic waste at the source is currently minimal in Greater Monrovia. Some collectors coordinate directly with participating households, but these activities are small in scale.

The World Bank, previously through CLUS and currently through LURP, is supporting improved collection and source separation through results-based financing. Beyond this, the priority is to establish regular waste-collection services for general waste.

To identify viable source-separation models, it will be necessary to consider a range of factors, including but not limited to the technical and financial capacity of collection service providers, the logistics and costs of collection, aggregation and processing, and the quantity, quality, and price frameworks for domestic versus export markets.

An alternative to the municipal collection of source-separated streams is mobilizing the private and informal sectors and incentivizing the general public to separate specific streams by using financial incentives and alternative collection systems, such as buy-back kiosks.

Initiative 16: Provide regular waste collection

The lack of a reliable waste collection system, and therefore the low collection rate, is a key factor in the generation of plastic pollution in Greater Monrovia. While the challenges of providing this service are recognized (notably the lack of sufficient budget or suitable transfer and disposal infrastructure), the benefits are significant for preventing plastic pollution, improving public health and quality of life, and reducing environmental pollution from the burning of uncollected waste. The provision of adequate waste-collection services is an objective of both the NSWMP and the National Agenda for Transformation 2030.

A dedicated waste collection optimization study to determine the most feasible and efficient system would help to address these challenges. This study should consider: (i) different options for collection models (weighing up collection frequency and door-to-door versus dedicated collection points); (ii) zoning according to factors such as waste generation rates and centers; (iii) population density; (iv) road infrastructure and proximity to transfer and disposal infrastructure; (v) the integration of private and informal sector stakeholders; (vi) phasing; and (vii) an appropriate fee structure.

As noted under Initiative 15, the World Bank's results-based financing support includes improved coverage of waste collection as a prerequisite for disbursements of funds.

Initiative 17: Improve waste management at markets

The Liberia Marketing Association is responsible for assisting the city corporations with waste management at markets. However, at present, no successful solution is in place. The management of waste at markets is—like municipal solid waste collection and management—currently severely lacking and largely involves dumping and burning waste.

Improving the waste collection system requires finding solutions to waste management at markets. This process should aim to:

- **Assess and identify appropriate technical solutions** such as increased reuse, source separation, (particularly of bulky and easily separable items such as cardboard), and implementing dedicated collection points.
- **Drive collaboration between stakeholders** including by clearly defining the responsibilities of the MCC, the PCC, and the Liberia Marketing Association.
- Integrate small-scale and informal waste collectors.
- **Engage stall owners on their needs** and communicate to them the benefits of improving the system and changing behaviors.
- **Consider funding mechanisms,** for example, stall owners may need to contribute to waste management services.

Initiative 18 and Initiative 19: Upgrade MCC transfer station and develop PCC transfer station

The existing transfer infrastructure (consisting of two transfer stations in the MCC and none in the PCC) requires upgrading. Adequate transfer infrastructure is key for improving collection rates because it allows for more efficient collection routes (minimizing the distance between the generation source and load drop-off point) and more efficient transport logistics between transfer stations and the disposal site. The existing transfer stations were also identified as minor sources of waste pollution because ineffective waste containment allows for losses outside of the site's boundaries.

For the MCC, the two existing sites are already at capacity, even with the low collection rate, and therefore require upgrades and the completion of the transfer network with additional sites. Because the PCC does not have an operational transfer station, an assessment of needs (in terms of capacity and location) is needed to enable adequate facilities to be established.

The World Bank already supports various projects that aim to improve plastic waste management services and infrastructure in Liberia, including the Liberia Sustainable Management of Fisheries Project and LURP.

Initiative 20: Support community cleanup efforts

While small in number and scale, some community cleanup efforts have taken place in Greater Monrovia. These waste-removal initiatives should not be considered an alternative to upstream plastic pollution prevention. However, they do serve to remove material from the environment, so increasing the cleanliness and amenity of public spaces. These activities also demonstrate participants' understanding of the issue of plastic pollution and their willingness to contribute to solutions. The benefits of supporting such initiatives are therefore twofold: in addition to bringing environmental benefits by reducing the quantity of waste in the environment, they serve to raise awareness about plastic pollution and sound waste management.

Options for the types of incentives or support that may be offered are numerous and include providing funding and equipment, disposing of collected material, facilitating access to target areas, offering prizes and publicity for the event, and reducing fees or taxes. The type of support should be determined in consultation with the group involved to ensure that it is effective and aligned with its goals. It would be useful to track the number and size of these activities, as well as the quantity of waste they collect, to support improved data collection within the waste management sector.

Initiative 21: River waste barriers

Although preventing plastic pollution from being generated is preferable, it would also be useful to consider interventions that capture plastic pollution already present in the environment. As well as environmental benefits, litter-capture campaigns create opportunities to increase awareness of the issue and encourage sound waste-management practices (such as reducing illegal dumping). However, it is important to communicate to the public that these initiatives are not intended as a long-term solution or to replace upstream prevention or traditional waste-management measures (such as recycling), which are more expensive to implement.[30]

In the short term, the most effective way to capture waste pollution is to install fixed litter-capture equipment such as barriers to catch floating waste across the Mesurado river or nets across the outlets of drains or pipes. Rivers, drains, and pipes are key mechanisms for transporting plastic pollution from Greater Monrovia out to the ocean. Capturing waste pollution at strategic points along these waterways would significantly reduce plastic pollution from entering the environment while longer-term measures are being implemented.

[30] Nikiema J and Asiedu Z. 2022. "A Review of the Cost and Effectiveness of Solutions to Address Plastic Pollution." Environmental Science and Pollution Research 29: 24547–24573.

In addition to identifying the most appropriate types of, and locations for, litter-capturing equipment, consideration should be given to how the intervention will be managed. A team will need to periodically monitor the equipment and remove the waste, especially after heavy rainfall, and decisions will need to be made for the final disposal or sorting and recycling of the captured waste.

Initiative 22: Marine litter capture

In the medium term, a temporary—but higher-profile—intervention to capture plastic pollution would be to collaborate with a non-governmental organization that operates litter-removal vessels or devices. Using these vessels or devices in the Mesurado river or the ocean would remove plastic pollution from the marine environment while supporting awareness-raising efforts. Thought should be given to the most strategic location and timing for such an intervention to maximize the environmental and awareness impacts.

7.4 FINANCIAL RECOMMENDATIONS

Initiative 23: Support alternatives to monofilament nets (fishing gear recommendation)

Fishing communities have identified cost as a key barrier to the uptake of cotton or multifilament nets as alternatives to monofilament fishing nets. One solution would be to apply higher taxes to the (banned) monofilament nets. However, this may jeopardize the livelihoods of low-income fishing communities and stimulate the direct sourcing of nets from neighboring countries. A financial mechanism should therefore rather focus on either lowering the cost of alternatives by increasing supply and competition (which is currently limited to three shops in Greater Monrovia), or on applying subsidies or incentives.

It is also worth noting that, while the upfront cost of alternative nets is higher, these nets are more durable, meaning the real price per year or season is likely similar. However, there is currently no data on this comparison. For this reason, it would be useful to track the use and disposal of fishing gear to determine the extent to which monofilament net alternatives would be supported. To maximize uptake, it is important to ensure that the available alternatives have identical specifications or are at least as similar to monofilament nets as possible.

The PROBLUE grant noted under Initiative 12 includes consideration of alternative types of nets.

Initiative 24: Incentives for use of recycled plastic

Plastic recycling in Greater Monrovia is currently limited due to high equipment costs and the low supply of source material (due to low collection rates and little source separation). While private sector stakeholders have expressed an interest in increasing the scope and capacity of their activities, further support could be provided to drive the use of recycled plastic, both in locally recycled products and in imported plastic products. Locally, higher demand for recycled plastics would help to increase demand for input materials, thereby increasing the value of plastic waste, helping to drive collection and recycling rates, and ultimately improving the potential to achieve net revenues for related activities.

This intervention would require assessing the types of plastics to be targeted and developing appropriate standards for the integration of recycled material that consider product quality, food safety, and hygiene requirements. Due consideration should also be given to financial aspects, such as setting appropriate and effective incentives and mitigating any potential financial negative impacts on industry and the local population.

Initiative 25: Establish waste collection fees

One of the guiding principles of the NSWMP is to implement "cost effective mechanisms for financial sustainability", which includes the following strategies:

- **Promote tariffs that establish the fair distribution of cost** according to ability to pay for the service provided and the level of waste pollution removed.
- **Establish refuse collection and disposal rates in a manner that equitably allocates program costs among rate payers** and promotes rate stability.

Charging for waste collection would create an additional revenue source for the responsible bodies. However, there are several key challenges and factors to consider when establishing and maintaining an effective fee system:

- **The need to provide a regular and reliable waste collection service** in return for the demanded fees.
- **Determining rates that are appropriate** given the population's ability and willingness to pay.
- **Maintaining a system for tracking payments and penalizing users who do not pay.** Ensuring a high level of payment requires acceptance among the community of the need for the fee and the provision of a service that corresponds to their needs and expectations.
- **Ensuring that funds are used to finance waste management activities** and are not fed back into general government budgets and redistributed to other areas.

The World Bank provides technical support and capacity building for sustainable municipal solid waste financing through its project portfolio in Liberia.

Initiative 26: Low-interest loans for waste management projects

As noted, the high upfront cost for recycling equipment is a barrier to increasing recycling rates in Greater Monrovia. Coupled with a low supply of collected and source-separated material and high commercial interest rates, the private sector has a limited ability to invest in projects to increase its capacity and currently relies heavily on external funding agencies to support new initiatives.

Offering low-interest loans for projects that would contribute to achieving NSWMP objectives and reducing plastic pollution generation would help the private sector, reduce demand on municipal services and infrastructure, and drive economic development. Key challenges in implementing this intervention include developing an economically sound system for fixing rates and conditions on loans, the availability of sufficient financial resources to fund and monitor the system (including ensuring that the funds are used appropriately), and maintaining sufficiently high repayment rates.

Initiative 27: Regional cooperation on recycling

Compared with some neighboring West African countries, the population of Liberia (and Monrovia) is relatively small, and the overall quantity of waste generated is low. This restricts the economic viability of some recycling options, particularly for more ambitious activities such as bottle-to-bottle recycling for PET and niche waste streams like monofilament fishing nets. While internal recycling should remain the priority to support local job creation and minimize the transport of waste, regional cooperation to maximize recycling rates should also be encouraged.

The Economic Community of West African States (ECOWAS) is a group of 15 member countries, including Liberia, that aims to promote "cooperation and integration … in order to raise the living standards of its peoples, and to maintain and enhance economic stability, foster relations among Member States and contribute to the progress and development of the African continent".[31] In line with this vision, recycling within the region could be supported by removing economic barriers such as taxes or duties on waste that is transported between countries to be recycled. While this is most likely to increase recycling rates by making it economically viable to export waste from Liberia, it also creates the opportunity for Liberia to invest in (perhaps niche) recycling infrastructure and to import waste streams from other ECOWAS countries for recycling.

As with all transboundary waste movements, this would need to be carefully monitored to ensure that only targeted waste streams are transported. In addition, regional recycling options should not be allowed to take preference where feasible internal options are available to ensure support for the local industry.

A new PROBLUE grant includes analysis into recycling business models to address challenges regarding scale, infrastructure, and financial incentives and sustainability.

7.5 PRIORITY AND TIMELINE OF INTERVENTIONS

The interventions and pilot options have been assessed in terms of their level of priority and the timeframe for their implementation.

The level of priority to be given to each of the identified interventions was determined using an impact versus urgency matrix (Table 7) in which:

- **Impact** is defined as the level of impact the intervention is likely to have on the generation of plastic pollution.
- **Urgency** is defined as the degree to which the intervention is needed for a functioning waste management system.

31 See: https://www.ecowas.int/about-ecowas/

Table 7. Priority matrix (impact versus urgency)

Priority		Impact		
		Low	Medium	High
Urgency	High	Medium	High	High
	Medium	Low	Medium	High
	Low	Low	Low	Medium

Source: Original table produced for this publication.

In addition to the assessment by priority, the applicable timeframe for each intervention was identified. High-priority initiatives are not necessarily those that can be implemented in the short term, while interventions classed as low priority may still be "low-hanging fruit" that are easier and more quickly implemented in the short term. This timeframe is therefore based on whether the system is sufficiently established for the intervention to be successful (short-term interventions are those that can be implemented almost immediately, while long-term interventions require further development of the waste sector and implementation of the strategy before beginning). An asterisk indicates short-term interventions that will continue in the long term. For the purposes of the analysis, the timeframes were defined as follows:

- Short term: 1–2 years
- Medium term: 3–5 years
- Long term: 5–10 years.

The priorities and time frames were reviewed with the help of key stakeholders during two strategic workshops, held in June 2024. Table 8 and Table 9 present a non-exhaustive overview of the interaction between interventions to help visualize how they could be implemented. The overview does not include the pilot options, of which some may be implemented in the short term, based on the results of the associated SWOT and economic analyses as well as available resources. It will be necessary to periodically re-evaluate the initial priorities and how they are being coordinated to better integrate the evolving context.

Table 8. Holistic view of interventions towards plastic pollution reduction and prevention for Greater Monrovia (excluding the interventions for recycling pilots)

HIGH PRIORITY MEDIUM PRIORITY LOW PRIORITY	INTERVENTIONS TIME FRAME		
	Short term	**Medium term**	**Long term**
Regulatory	Implementation Plan for National Solid Waste Management Policy	Phase out single-use plastics	Extended producer responsibility
	Fulfill current regulatory obligations	Register waste pickers	
		Enforce laws on illegaly dumping	
Institutional	Improve stakeholder cooperation	Establish a dedicated national waste body	
	Raise awareness		
	Establish a recyclers' association		
Logistic	Characterization of waste	Improve access to potable water	Source separation
	Track use and disposal of fishing gear*	Investigate alternatives to plastic packaging	
	Provide regular waste collection	Improve waste management at markets	
	Support community cleanup efforts	Upgrade MCC transfer stations	
		Develop PCC transfer stations	
		River waste barriers	
		Marine litter capture	
Financial	Support alternatives to monofilament nets*	Incentives for use of recycled plastics	Establish waste collection fees
		Low-interest loans for waste management projects	
		Regional cooperation on recycling	

** While the overall set of recommendations broadly support plastic pollution reduction (terrestrial, estuarine, marine) and plastic recycling, these two are specifically focused on fishing gear.*

Table 9. Holistic view of interventions focused on recycling pilots

	PILOT OPTIONS TIME FRAME		
	Short term	**Medium term**	**Long term**
Recycling pilots	Centralized cleaning for recycling abroad*	Local net recycling*	Exchange of monofilament nets for cotton nets*
	Cleaning by communities for recycling abroad*		
	Buy-back kiosks for plastic packaging		
	PET collection with local recycling and export		
	Collection via buy-back kiosks with local recycling		

** While the overall set of recommendations broadly support plastic pollution reduction (terrestrial, estuarine, marine) and plastic recycling, these two are specifically focused on fishing gear.*

Since there are many high-priority, front-loaded interventions, it could be challenging to coordinate and implement them all at once. The project details how high-priority and short-term interventions could be better articulated to guarantee a successful implementation for the first steps of the strategy.

Bear in mind that the strategy is not immutable and may evolve in terms of initiative priorities. This flexibility makes it easier to cope with context evolutions, particularly after adopting the first initiatives.

7.6 DETAIL FOR HIGH-PRIORITY INVESTMENTS

REGULATORY RECOMMENDATIONS

1. Implementation plan for National Solid Waste Management Policy

Context	**Objectives**
The NSWMP was published in October 2024 but still needs to be implemented. There is neither a dedicated body for waste management nor any waste data collection system.	Develop a plan to implement the recently published NSWMP.

Description

The National Solid Waste Management Policy (NSWMP), developed by the MCC and the Ministry of Internal Affairs, was published in October 2024. The next step is to develop an implementation plan to realize the objectives of the NSWMP and maximize cooperation between stakeholders.

Such an implementation plan should include quantitative objectives with related indicators and identify parties responsible for collecting related data. The NSWMP's Policy Implementation Plan states that the policy should be reviewed and amended every five years.

Needs	**Key implementing stakeholders**
• Priority and resources • Agreement on updates and quantitative indicators.	• Ministry of Internal Affairs • The EPA • The MCC.

How

- Identify a dedicated body for waste management follow-up at national level
- Formalize all waste collection operators and integrate the informal recycling sector (develop a strategy to formalize it)
- Collect and analyze waste data to ensure regular follow up and communicate about the data
- Develop regulations and guidelines to tackle specific identified issues.

Challenges and critical points	**Technical and financial support**
• Needs recognized in the National Agenda for Transformation that need to be addressed • Define feasible quantitative objectives.	International donors can assist the Ministry and EPA in identifying relevant indicators and issues to be tackled, as well as defining the dedicated body, possibly financed by waste taxes.

Follow-up indicators

- Policy implementation plan developed
- Policy reviewed and amended (as necessary) every five years
- Quantitative indicators to be defined.

Starting year Start by the end of Year 1 and finish Year 2.	**Period** The implementation plan could be completed in two semesters and should entail substantial stakeholder engagement. As noted in the NSWMP, the plan should be updated every five years.

REGULATORY RECOMMENDATIONS

2. Fulfill current regulatory obligations

Context

There is no dedicated body for waste management, nor have responsibilities to enforce environmental regulations been shared.

Objectives

Make sure that each stakeholder knows their responsibility in enforcing environmental and waste management regulations.

Description

Now that the NSWMP has been finalized, the next step is to define specific regulations that will need to be enforced at different levels and by different stakeholders. If the EPA is to take a global view on these regulations, it would need to work with the national waste body (Initiative 7) and local waste managers like the MCC and the PCC. All parties would need to cooperate to gather data and develop and monitor progress towards shared objectives. They would also be responsible for ensuring that other stakeholders abide by the law.

The existing bodies do not currently have sufficient resources to meet their regulatory oversight requirements, such as services provision and regulation of waste management activities. The police might therefore need to play a supplementary role in enforcing the law.

Needs

- Assign responsibility for the enforcement of waste policy and partner with the police
- Make sure each entity fulfills its obligations in terms of data gathering and monitoring, using a shared data reporting system.

Key implementing stakeholders:

- Ministry of Internal Affairs
- The EPA
- Future waste management body
- The MCC and the PCC
- National or local police.

How:

- Mobilize stakeholders to gather and share data
- Set achievable action plans and develop a clear roadmap for achieving targets and objectives
- Provide additional resources and capacity building to regulatory bodies, which would allow for improved data collection by increasing the range of data collected (at a minimum meeting their regulatory requirements)
- Rely on the police, or a specific environmental squad, to ensure waste management policies are enforced (through fines, community services, and so on).

Challenges and critical points

- Availability of financial resources and technical expertise to gather and use the data (define new policies and communicate on progress and changes)
- The existing bodies do not currently have sufficient resources to meet their regulatory requirements
- Availability of financial resources to create a specific environmental squad.

Technical and financial support

In the long term, stakeholders should rely on their resources to make sure they fulfill their obligations. Waste regulation enforcement should rely on the police (or specific squads that could be managed by the police) and the national waste body.

Follow-up indicators

- Create a guideline that defines responsibilities between stakeholders
- Number of policemen dedicated to the enforcement of waste management regulation.

Starting year
Law enforcement should start from the Year 1.

Period If responsibilities can be defined and shared at the beginning, enforcement will be necessary throughout the years. Communicating on law enforcement and fines will help change negative behaviors.

INSTITUTIONAL RECOMMENDATIONS

8. Improve stakeholder cooperation

Context

Currently, the number of stakeholders in the waste management sector is relatively limited and there is a tendency for stakeholders to have multiple roles in the system (for example, collection and recycling). Despite this, there is little coordination or cooperation within the sector. Furthermore, there is very little interaction between regulatory bodies, waste managers, and upstream (pre-consumer) stakeholders (such as the sole plastics manufacturer and various bottlers and water sachet producers).

Objectives

Improve cooperation between stakeholders through formalized charters or more informal dedicated meetings.

Description

Despite significant limitations on resources within the existing waste managers and regulators (the EPA, the MCC, and the PCC), research for the development of the strategy revealed some overlap in the roles of these bodies, resulting in inefficiencies, friction between stakeholders, and lack of clarity for the sector. Clearly defining and agreeing on the roles of each government body responsible for waste management, whether or not a dedicated waste management entity is established, would improve efficiency and governance.

More broadly, increased cooperation with other stakeholders should be encouraged to facilitate the collection and use of data, enforce legislation, support awareness-raising and education campaigns, identify ways to improve the waste sector, and work towards common goals.

Needs

- Provide directions for the improvement of waste management in Liberia
- Maximize cooperation between stakeholders working towards a shared vision that could supplement the NSWMP
- A system for facilitating cooperation and communication.

Key implementing stakeholders

- The EPA
- Future waste management body
- The MCC
- The PCC.

How

- Identify the main government bodies (see Initiative 1 and Initiative 2) and their roles and responsibilities to draft a collaborative charter
- Identify stakeholders and their needs (including proactively engaging other public, private, and community entities) and regularly invite them to take part in discussions to refine the shared long-term vision and contribute to better waste management
- Organize capacity-building workshops and roundtables
- Establish a solid waste management advisory board comprising the representatives of all municipal authorities and other stakeholders.

Challenges and critical points

- Mutual agreement on roles and responsibilities
- Update the list of stakeholders, which may evolve.

Technical and financial support

Although these tasks are time-consuming, the financial needs could be limited to the working time of one person who drafts a charter and monitors its implementation.

Follow-up indicators

- Roles and responsibilities are clearly defined for each stakeholder in a charter (for example).

Starting year First year, with the possibility of working the implementation through three semesters.

Period If the implementation can be achieved in three semesters, it is necessary to coordinate cooperation throughout the years. The national waste management body could be responsible for this task.

INSTITUTIONAL RECOMMENDATIONS

9. Raise awareness

Context
Little has been done to raise awareness about the importance of recycling and proper waste management to avoid littering and increase waste collection rate for the proper disposal of land-based plastics.

Objectives
Develop understanding and maximize participation of the population as key factors for ensuring the success of many of the proposed interventions.

Description
Targeted awareness-raising and education campaigns would support positive changes to the waste management system. Depending on the subject and target audience, these campaigns may run over finite periods or may be ongoing. Each campaign should identify a message, a target audience, and a chosen communication method, as well as specify a duration and identify links with events and other awareness campaigns. Possible topics for awareness-raising campaigns include:

- The impacts of illegal dumping on environmental and public health to encourage use of waste collection services
- The positive impacts of community cleanup efforts
- The advantages of source separation, together with associated sorting guidelines, information on the collection system and incentives, and so on
- Why there is a need to charge fees for waste management
- The benefits of switching to plastic alternatives, maximizing reuse, and recycling.

Needs

- Functioning waste collection system so that the right habits can be adopted
- Waste body as key leader for recurrent activities, with the help of an external project leader to ensure training, the right messages, and recurring campaigns
- Technical assistance should produce awareness training materials for different target groups including operators, recyclers, schools, and technicians
- Financial resources for awareness campaigns
- Training of trainers.

Key implementing stakeholders

- Future waste management body
- The MCC and the PCC
- Local partners capable of running events.

How:

- Develop clear, targeted communications campaigns with information on what can be recycled. Use positive and engaging messages that resonate with citizens (such as civic pride, cost savings, sustainability, and job creation). Consider the importance of recurring actions to ensure long-term behavioral change
- Use a range of communication channels to engage local communities on good waste management practices (for example local TV or radio shows; banners, leaflets, and stickers; community roadshows; community leaders' engagements, and so on)
- Promote education programs and curricula at all levels of school and in higher education.

Challenges and critical points

- Long timeframe to change behaviors
- Recurring campaigns to pass the message
- Difficulty reaching the most reluctant audiences.

Technical and financial support
The waste body could oversee implementation. However, external technical assistance would be useful for ensuring that the awareness plan is consistent. Funding could come from local taxes (the “polluter pays” principle) or, occasionally, from donors.

Follow-up indicators

- Level of awareness within the population and an improved collection rate (indicating participation in waste management system).
- Number of awareness campaigns.

Starting year:
Second semester of Year 1.

Period: A preparation phase is necessary to build up knowledge about target audiences and their expectations, and to develop a communication and awareness plan. The plan can initially be rolled out over three semesters, with an eye to deploying campaigns over the long term.

LOGISTICAL RECOMMENDATIONS

15. Provide regular waste collection

Context
The lack of a reliable waste collection system, and therefore the low collection rate, is a key factor in the generation of plastic pollution in Greater Monrovia. While the challenges of providing this service are recognized, the benefits are significant in terms of preventing plastic pollution, improving public health and quality of life, and reducing environmental pollution from burning uncollected waste. The provision of adequate waste collection services is an objective of both the NSWMP and the National Agenda for Transformation 2030.

Objectives
Improve collection rate, support behavioral changes, and reduce illegal dumping to prevent plastic pollution.

Description
A dedicated waste-collection optimization study should be undertaken to determine the most feasible and efficient system for collecting waste in Greater Monrovia. This study could consider: (i) different collection models (door-to-door versus dedicated collection points) and collection frequencies; (ii) zoning based on factors such as waste-generation rates and centers; (iii) the density of the population; (iv) the presence of road infrastructure; (v) the proximity to transfer and disposal infrastructure; (vi) the integration of private and informal sector stakeholders; (vii) the optimal phasing for implementing collection services; and (vii) the development of an appropriate fee structure.

Needs
- Optimized waste collection is an institutional priority
- A dedicated study on improving the waste collection system by using a phased approach that considers collection models, zones, and a network of collection points
- Sufficient transfer, recycling, and disposal facilities for collected waste.

Key implementing stakeholders
- Ministry
- The EPA
- Future waste management body
- The MCC and the PCC
- The informal sector.

How
- Finance a technical and financial study to address all phases of waste management (pre-collection, collection, transfer, recycling, and disposal)
- Identify stakeholders that could contribute to optimizing waste collection (including the informal sector)
- Conduct a thorough analysis (technical, financial, and assessing willingness to take part) of potential collection models to ensure that the one selected is adapted to the context; a benchmark for collection models in similar countries can be conducted to support decision-making
- Ensure that relevant stakeholders are engaged to support the implementation and viability of the chosen model
- The data collection system (proposed in Initiative 1 and Initiative 7) should be able to track how the collection rate evolves, which would motivate stakeholders to continue pursuing waste management goals.

Challenges and critical points
- Sufficient long-term financial resources to support optimal waste collection
- Integration of existing collectors and informal sector.

Technical and financial support
The study should ideally be financed by external donors to ensure impartial results. Identify stakeholders that could contribute to optimizing waste collection (including the informal sector).

Follow-up indicators
- The number of active collection points
- The proportion of population with access to a waste collection service
- Tons collected annually
- Percent of generated waste collected.

Starting year Start with the dedicated study as soon as possible.

Period Because this intervention is foundational for the success of other interventions, it must be continued throughout the implementation of the strategy and beyond.

LOGISTICAL RECOMMENDATIONS

19. Support community cleanups

Context
Some community cleanups already exist and should be reinforced and valued. There is also no monitoring of existing initiatives, who runs them (whether associations, communities, or the private sector) and associated data (for example, the frequency of cleaning, the tonnages of waste collected, and possible waste characterization).

Objectives
Reduce the flow of waste from Greater Monrovia to the ocean, and support awareness-raising efforts.

Description

While small in both number and scale, some community cleanup efforts are, or have been, in place. These waste removal initiatives should not be considered an alternative to upstream plastic pollution prevention, but they do serve to remove material from the environment, increasing the cleanliness and amenity of public spaces. In addition, these activities demonstrate a public understanding of the issue of plastic pollution and a willingness to contribute to minimizing its impacts. The benefits of supporting these initiatives are therefore twofold: in addition to the environmental benefits of reducing the quantity of waste in the environment, awareness about plastic pollution is also being raised.

Incentives or support can come in many forms, including funding; providing equipment and waste collection or disposal services for collected material; facilitating access to target areas; providing prizes or publicity; providing a reduction in fees or taxes; offering invitations to events and conferences, and so on. The type of support should be decided with the target group to ensure that the support helps the group achieve its goals and maximize its impact.

Needs
- Availability of resources (financial and human)
- Interested community members or groups
- Training for local partners wishing to carry out waste characterizations
- Data collection system to share efforts.

Key implementing stakeholders
- The EPA
- Future waste management body
- The MCC and the PCC
- Local partners capable of running cleanups.

How
- Identify existing initiatives and their associated entities to promote the work already done and commit them to continuing their efforts (possibly by giving them a role in managing cleanups)
- Promote and expand community cleaning programs through initiatives such as the Cleanest Zone Competition and monthly cleaning campaigns
- Run interzonal cleaning competitions and related incentives to entice communities to participate in neighborhood cleanups in the long run
- Track the number and size of cleanup activities, as well as the quantity of waste they collect, as part of improved data collection practices (Initiative 1 and Initiative 7) and to raise awareness (Initiative 9)
- Combine cleanups with awareness-raising campaigns to draw attention to the issue and raise residents' consciousness while motivating them to take part in initiatives that are beneficial to their communities.

Challenges and critical points
- Ensuring appropriate use of funding
- Availability of recycling or disposal options for collected waste.

Technical and financial support
Taxes and fees from extended producer responsibility could help finance material for cleanups. The labor for cleanups is mostly provided on a volunteer basis.

Follow-up indicators
- Number of community groups and individuals involved
- Tons of abandoned waste collected per year.

Starting year As soon as possible.

Period The cleanups should take place at any time and on a recurring basis, as should the accompanying awareness-raising campaigns.

RECYCLING PILOT RECOMMENDATIONS

4. Establish buy-back centers

Context

The recycling landscape in Liberia faces numerous challenges, including limited infrastructure, inadequate waste-management systems, and a lack of awareness among the general public. Moreover, the current value chains for key materials are often incomplete and reliant on external markets. Therefore, it is deemed necessary to strengthen and increase the revenues and resilience of the recycling sector by establishing buy-back centers.

Objectives

Increase waste collection points that lead directly to recycling, encourage better source separation (higher quality waste stream, and create local jobs for collectors (waste pickers).

Description

Buy-back centers are established as multi-recycling centers that buy, sort, and resell various plastic materials and other recyclables. These centers act as satellite stations for larger recycling centers because they need to be where the collectors are. They are critical for ensuring that more recyclables can be reclaimed in a scalable manner, which benefits individuals (waste pickers) but also helps to improve the collection rate for recycling purposes.

Needs

- Identify community waste recycling initiatives
- Ensure that sufficient sources of recycling materials are established for buy-back centers (these sources will contribute to monthly volume recoveries)
- Identify materials through a feasibility study tailored to specific local conditions (for example, testing certain materials such as resin)
- Involve private local recyclers.

Key implementing stakeholders

- World Bank
- Local recyclers
- Waste pickers.

How

- Establishing a buy-back center requires government input to identify available land, conduct an environmental impact assessment, and grant an operating permit
- Financing a pilot would rely on external technical assistance
- Training and capacity building on entrepreneurship, small-scale business management, and recycling processes for local communities would need to be supported.

Challenges and critical points

- Upfront investment in equipment and training
- Maintaining sufficient tonnages collected by building trust among waste pickers.

Technical and financial support:

Buy-back centers are often directly supported by recycling companies that pay for the separated waste. International donors could help launch a pilot center (upfront investment), that would need to achieve financial stability to be viable in the long term.

Follow-up indicators

- Quality of material received (decline in rejection rate)
- Tons collected per annum (per resin)
- Number of collection points.

Starting year By the end of Year 2.

Period Year 2 could serve as a preparation phase and Year 3 as start-up phase, giving time to put the resources in place and create the networks of stakeholders needed to successfully implement the initiative.

RECYCLING PILOT RECOMMENDATIONS

5a. PET collection with local recycling

Context

The recycling industry in Monrovia is characterized by a small number of stakeholders. Only six active recyclers were identified (three main and three small-scale), with no aggregator or consolidator; waste is transferred either directly from generators to recyclers or collected via SMEs and CBEs and brought to recycling sites.

Objectives

Increase waste collection points that lead directly to recycling, encourage better source separation (to produce a higher-quality waste stream), and create local jobs for collectors and recyclers.

Description

The recycling landscape in Liberia faces numerous challenges, including limited infrastructure, inadequate waste management systems, and a lack of awareness on source separation among the general public. Due to the lack of monitoring or reporting on recycling activities, data was also difficult to gather but is essential to understand how the recycling sector could evolve. Given the estimated quantities for each plastic waste stream, the pilot study (see deliverable on the subject) identified the PET stream as the only one to appear economically viable.

Needs

- Identify the expectations of local recyclers to anticipate the sector's evolution and lay the foundations for a recycler's association (Initiative 8 and Initiative 10)
- Invest in recycling equipment
- Include the informal sector to guarantee a better collection network
- Raise awareness to encourage better source separation.

Key implementing stakeholders

- World Bank
- Plastic Recycling Africa
- Local recyclers
- Waste pickers.

How

- Establish recycling centers, collection points, and drop-off stations to encourage individuals and businesses to recycle PET bottles
- Set recycling priorities by collecting and analyzing waste data (or seeking data from similar-sized cities)
- Collect more waste to reach break-even point
- Expand the market for recyclable plastic waste and products locally by supporting technological improvements in recycling to increase local uptake of various plastic resins
- Support entrepreneurs and start-ups that collect and process PET bottles, so creating employment opportunities
- Design a system of financial incentives for stakeholders to separate and recycle PET
- Improve coordination between stakeholders (recyclers, collectors, and the state).

Challenges and critical points

- Upfront investment is needed for equipment and training
- Collecting sufficient tonnages on an ongoing basis requires reinforcement of the collection network.

Technical and financial support

The recycling companies could benefit from EPR taxes that are designed to promote recycling.

Follow-up indicators

- Quality of material received (decreased rejection rate)
- Tons collected of PET per year
- Number of collection points.

Starting year By the end of Year 2.

Period Year 2 could serve as a preparation phase and Year 3 as start-up phase, giving time to put the resources in place and create the networks of stakeholders needed to successfully implement the initiative.

© World Bank / ECOGEOS

CHAPTER 8

CONCLUSION

In Liberia, one of the poorest countries in the world, waste management services and infrastructure are inadequate to manage the 824,000 tons of annual waste that the country produces. About a quarter of this waste is produced in the country's coastal capital, Monrovia, where about 25,000 tons of plastic waste is produced each year.

Providing adequate waste management services and infrastructure remains a significant challenge in Monrovia. Here, a mere 19 percent of households take their waste to a dwindling number of designated disposal locations, and most businesses and homes dump their waste at informal collection points or at the side of the road. This illegally dumped waste—most of which is plastic—blocks waterways and drainage channels, causing the pollution of sensitive environmental areas such as wetlands and, ultimately, oceans.

The issue of plastic pollution—and the associated environmental, economic, and human health impacts—is being increasingly recognized around the world. In 2016, the United Nations Environment Assembly passed Resolution 2/11 on marine plastic litter and microplastics, which called on member states to "establish and implement necessary policies, regulatory frameworks, and measures" to combat marine pollution. In 2022, Resolution 5/14 was adopted to "develop an international legally binding instrument on plastic pollution, including in the marine environment".

In recognition of this issue and the waste management challenges that Liberia faces, the World Bank's PROBLUE program in Liberia extended its scope to address land-based sources of plastic pollution and promote sustainable waste management by creating an environment to support the circular economy for problem plastics. The World Bank also supports other projects in Liberia that aim to improve plastic waste management services and infrastructure, including the Liberia Sustainable Management of Fisheries Project and LURP.

Between July 2023 and May 2024, the World Bank supported efforts to characterize litter from pollution hotspots in Greater Monrovia, Liberia; assess solid waste management policies and practices at the national and local levels; and finely examine the recycling value chain in Monrovia. These efforts point to a Greater Monrovia in which policy and regulatory challenges relating to the management of solid waste combine with an underpowered plastic recycling sector to create an environment in which land-based plastic pollution leaks into the natural environment—and ultimately the ocean—with alarming frequency.

The key findings of the litter characterization and policy assessment are:

- **While some waste-management legislation is in place, regulations regarding Liberia's solid waste management is relatively limited.** The National Solid Waste Management Policy, published in October 2024, provides goals, objectives and strategies, but is yet to be fully implemented.
- **There is little qualitative or quantitative data on the generation of solid waste and plastics in Greater Monrovia.** Budget restrictions have contributed to unreliable municipal waste collection services and a decline in the number of active municipal waste collection points. While private sector waste collectors do exist, they primarily provide a door-to-door service to households and businesses that are willing and able to pay for the service.
- **The existing waste management infrastructure in Greater Monrovia is lacking in terms of capacity, condition, and resources to ensure efficient operations.** The World Bank is

supporting plans to expand and establish infrastructure for transfer and disposal, as well as recycling. It is also supporting work to define a sustainable financing and funding system.

- **The number of stakeholders in the waste management sector is relatively limited and there is a tendency for stakeholders to have multiple roles (for example, collection and recycling).** Despite having few stakeholders, coordination or cooperation within the sector is limited.
- **The recycling of plastics is limited, with only three companies in operation and very little waste-picking activity compared to similar developing countries.** Plastic recycling activities include recycling into simple products (bricks or cups for rubber collection) and pyrolysis. However, only a small portion of the plastic waste generated is recycled.
- **A large proportion (71 percent) of plastics in municipal solid waste is considered mismanaged.** Liberia is a net importer of plastics, which presents opportunities to both control the type and composition of imported plastics and to develop policies and interventions to drive internal collection and recycling. That said, the plastics value chain lacks the financial means to drive system improvements. The current value chains for key plastic waste streams are often incomplete and rely on external markets to supply virgin resin and demand for recycled plastics.

The report went on to propose a range of regulatory, institutional, logistical, and financial strategic measures to reduce and prevent plastic pollution in the short and medium to long term. These include:

- **Regulatory and institutional requirements:** Waste management stakeholders should recognize the importance of a guiding document for waste management in Liberia and prioritize the finalization of a plan to give effect to the recently published NSWMP. Defining a national waste management body, as well as its roles and responsibilities, should also be a priority to better coordinate the waste management strategy (see below). In addition, capacity building and training should be given to local authorities responsible for waste management at the local level, and a mutual understanding needs to be developed between various stakeholders to improve cooperation, collaboration, and data exchange. The national waste management body could also serve as a conductor to enforce current regulatory obligations and raise awareness.
- **Logistical requirements:** A data-collection system could be developed to monitor recycling-sector activities and waste transfer through transfer station(s) and disposal at the landfill site. An inventory of illegal dumpsites should also be developed to support monitoring of the abandoned waste issue, and the use and disposal of fishing nets should be tracked by fishing communities. Moreover, technical studies should be undertaken to determine: (i) how best to optimize the municipal waste collection system, including consideration of collection models, zones, collection point network, and fee structure; (ii) where and how to deploy marine litter barriers and nets, given available equipment and technologies, optimal locations and collection schedules, and the need to monitor and manage teams; (iii) the waste characterization of municipal solid, commercial, and industrial waste; and (iv) what level of logistical support should be provided to community cleanup efforts and waste collected via marine litter barriers and nets (for example, for recycling or disposal solutions).

- **Financial requirements:** There is a need to provide sufficient financial resources for essential tasks like finalizing the plan for executing the NSWMP, running awareness campaigns on the impacts of illegal dumping, supporting community cleanup efforts, and the technical studies listed above. It will also be necessary to ensure that waste generators contribute to the funding of waste collection and disposal services, and that waste-management bodies like MCC and PCC anticipate and have sustainable financial resources to manage the full solid waste management system.

The initiatives proposed above are designed to significantly improve the plastic problem in Monrovia, with varying degrees of impact and implementation in the short, medium, and long term. Although these initiatives could be undertaken independently, it would be more effective if a single entity—ideally a national waste body—propagated the overall vision and strategy while ensuring that the benefits accrue to all stakeholders.

In addition to making the policy and institutional recommendations above, the report proposed and assessed the technical and financial merits of a range of potential recycling projects. Given the estimated quantities for each waste stream, it was found that only Option 5a (PET collection with local recycling) is economically viable. However, this solution addresses only one of the three priority waste streams. While it is possible to recycle the other waste streams locally, the prices paid by local recyclers (which, in turn, depend on the value of the products made and the local population's ability to pay) are too low to cover collection and transport costs.

Regardless of which pathway is chosen to reduce plastic pollution in Monrovia and Liberia, public awareness will be foundational to its success. By engaging stakeholders from various levels of government, the private sector, NGOs, and local communities at frequent intervals during stakeholder engagements for this report, the study itself helped to plant the seeds of such awareness. Further effort to raise public awareness through targeted campaigns and education drives will be needed to drive broad participation in effective waste management, recycling at the source (especially of plastics), and beach cleanup drives.

1818 H Street NW, Washington DC 20433
Telephone: 202-473-1000; Internet: www.worldbank.org

PROBLUE
HEALTHY OCEAN • HEALTHY ECONOMIES • HEALTHY COMMUNITIES

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP