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PacWastePlus
PACIFIC WASTE MANAGEMENT

This initiative is supported by **PacWastePlus**-a 72 month project funded by the European Union (**EU**) and implemented by the Secretariat of the Pacific Regional Environment Programme (**SPREP**) **to sustainably and cost effectively improve regional management of waste and pollution.**

Papua New Guinea National Waste Audit Analysis Report

August 2023

This Waste data collation, analysis and reporting for the PNG National Waste Audit Analysis Report was guided by the overarching Regional Waste Data Collection, Monitoring, and Reporting (DCMR) Framework for the Pacific Island Countries and Territories (PICT).

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Our vision: A resilient Pacific environment sustaining our livelihoods and natural heritage in harmony with our cultures.

PacWaste Plus Programme

The Pacific – European Union (EU) Waste Management Programme, PacWaste Plus, is a 72-month programme funded by the EU and implemented by the Secretariat of the Pacific Regional Environment Programme (SPREP) to improve regional management of waste and pollution sustainably and cost-effectively.

About PacWaste Plus

The impact of waste and pollution is taking its toll on the health of communities, degrading natural ecosystems, threatening food security, impeding resilience to climate change, and adversely impacting social and economic development of countries in the region.

The PacWaste Plus programme is generating improved economic, social, health, and environmental benefits by enhancing existing activities and building capacity and sustainability into waste management practices for all participating countries.

Countries participating in the PacWaste Plus programme are: *Cook Islands, Democratic Republic of Timor-Leste, Federated States of Micronesia, Fiji, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Republic of Marshall Islands, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu*.

Key Objectives

Outcomes & Key Result Areas

The overall objective of PacWastePlus is "*to generate improved economic, social, health and environmental benefits arising from stronger regional economic integration and the sustainable management of natural resources and the environment*".

The specific objective is "*to ensure the safe and sustainable management of waste with due regard for the conservation of biodiversity, health and wellbeing of Pacific Island communities and climate change mitigation and adaptation requirements*".

Key Result Areas

- **Improved** data collection, information sharing, and education awareness
- **Policy & Regulation** - Policies and regulatory frameworks developed and implemented.
- **Best Practices** - Enhanced private sector engagement and infrastructure development implemented
- **Human Capacity** - Enhanced human capacity

Learn more about the PacWaste Plus programme by visiting

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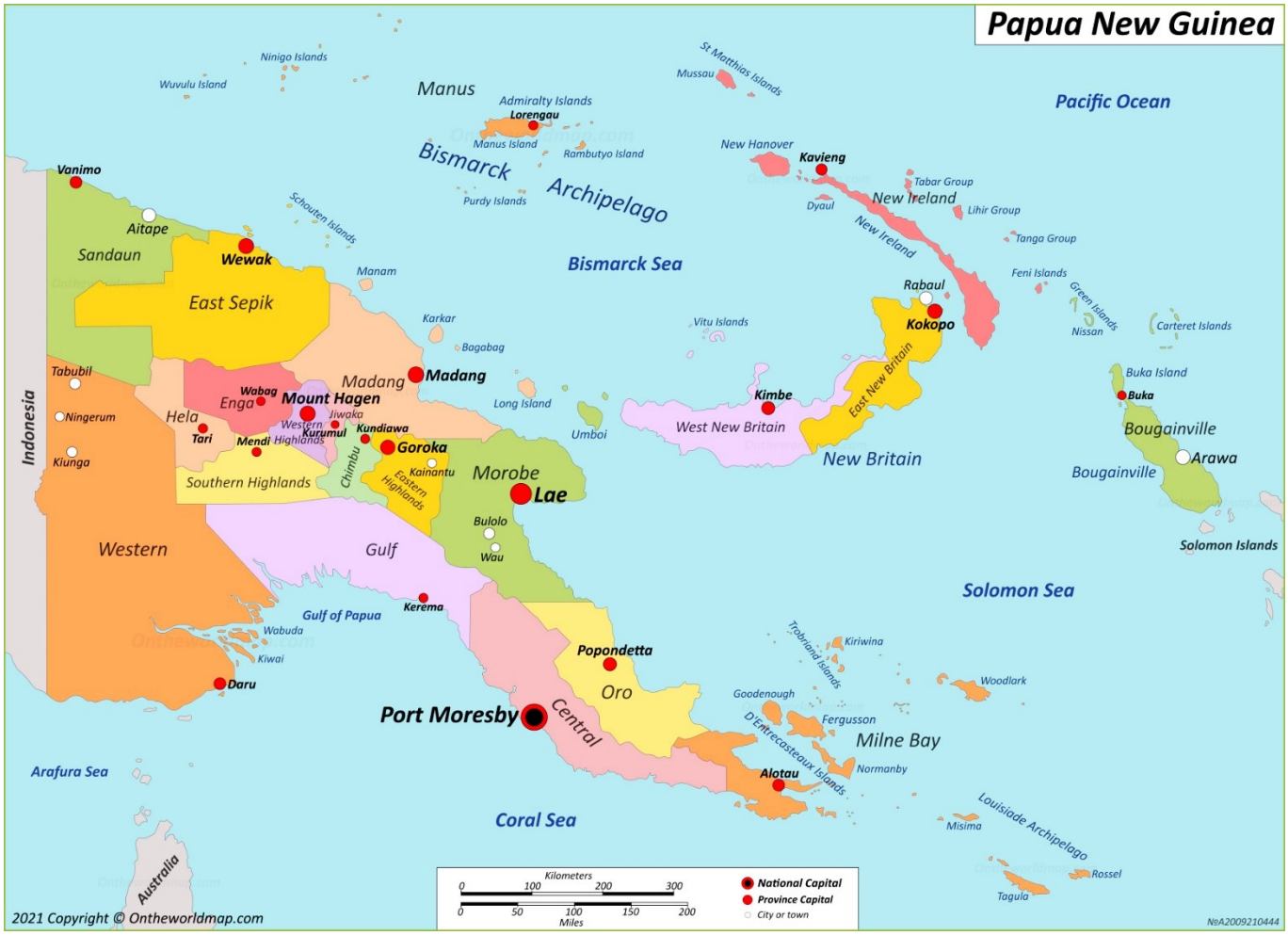
Map of Papua New Guinea (PNG)



Source: ***https://ontheworldmap.com/papua-new-guinea/***

Glossary

Acronym	Definition
C&D	Construction and Demolition (Waste)
C&I	Commercial and Industrial (Waste)
DCMR	Data Strategy & Collection, Monitoring, and Reporting (Framework)
KPI	Key Performance Indicator
MEA	Multilateral Environmental Agreement
MSW	Municipal Solid Waste (i.e., waste originating from the general public that is typically managed by local government entities, excludes commercial / business waste)
NCDC	National Capital District Commission
NGO	Non-Governmental Organisation
PICT	Pacific Island Countries & Territories
PNG	Papua New Guinea
PRIF	Pacific Regional Infrastructure Facility
SPREP	Secretariat of The Pacific Regional Environment Programme

Terminology	Definition
Capacity	The total maximum waste storage and processing that can take place at a facility (as capped by license conditions).
Capture rate	The proportion of total waste generated that is successfully captured and disposed or recovered in an environmentally responsible manner (e.g., by a formal collection service or self-hauled to a licensed facility)
Coverage	The proportion of total households that have access to a regular waste collection service.
Modern	A 'modern' facility employs 'sound waste management practices' (as defined by the UNEP) and results in minimal adverse impacts on the environment. A 'modern' facility must be licensed, staffed, have access to equipment and machinery such as a bulldozer, employ a leachate management system and implement a daily cover routine at a landfill, and must not be exceeding their maximum storage capacity.
Per capita	Units measured on a per person basis (i.e., to allow for extrapolation over a national population).
Recovery	Any activity that diverts waste material from landfill, including processing of dry recyclables (such as paper, cardboard, metal and plastics such as PET and HDPE), organics recovery, and energy recovery.
Unregulated	Typically, unlicensed waste facilities which do not follow international frameworks, rules, and guidelines to protect the health of the environment and community.
Waste facility	'Waste facilities' involved in the handling, disposal, or recovery of waste streams above a minimum processing threshold determined on country basis (i.e., tonnes of waste received per year). Can include landfills or dumpsites (that primarily rely on burying waste in a controlled manner), recycling facilities for dry recyclables, organics recovery facilities, and waste-to-energy facilities. Incinerators are not included in this analysis.

Executive Summary

Waste data collation, analysis and reporting for the PNG National Waste Audit Analysis Report was guided by the overarching Regional Waste Data Collection, Monitoring, and Reporting (DCMR) Framework for the Pacific Island Countries and Territories (PICT). The implementation of the DCMR Framework ensures that waste data is collected, analysed, and reported in a consistent and reliable way across the Pacific.

Table (a) Summary of Key Performance Indicators (KPIs) for PNG

Core KPIs	Result	Supplementary KPIs	Result
1. Count / capacity of modern waste facilities	0 / 0	1. Cost of disposal to landfill ($/annum)	PGK K14.80 (US $4.19)
2. Count / capacity of unregulated waste facilities	23 / Capacity unknown	2. Weight of waste disposed (tpa)	73,000
3. National recovery rate (%)	See Section 3.2	3. Weight of waste recovered (tpa)	See Section 3.2
4. Per capita waste generation rate (kg/capita/year)	134	4. Volume and type of stockpiled hazardous waste (m^3)	See Section 3.2
5. Municipal Solid Waste (MSW) composition (%)	Figure (a)	5. Marine plastic pollution potential (tpa)	126,000
6. Household waste capture rate (%)	12.33%	6. Awareness and support of waste management services (%)	No data
7. Household collection service coverage (%)	13.76%	7. Proportion of strategic waste management initiatives implemented (%)	81.25%
8. Fulfillment of MEA reporting requirements (%)	11.85%	8. Commercial waste capture rate (%)	See Section 3.2
		9. Commercial collection service coverage (%)	See Section 3.2
		10. Total weight of disaster waste disposed (tpa)	No data

Note: 'No data' indicates that the audit did not capture the parameters / measurements necessary to calculate the KPI.

Legend		
Sufficient data	Limited data	No data

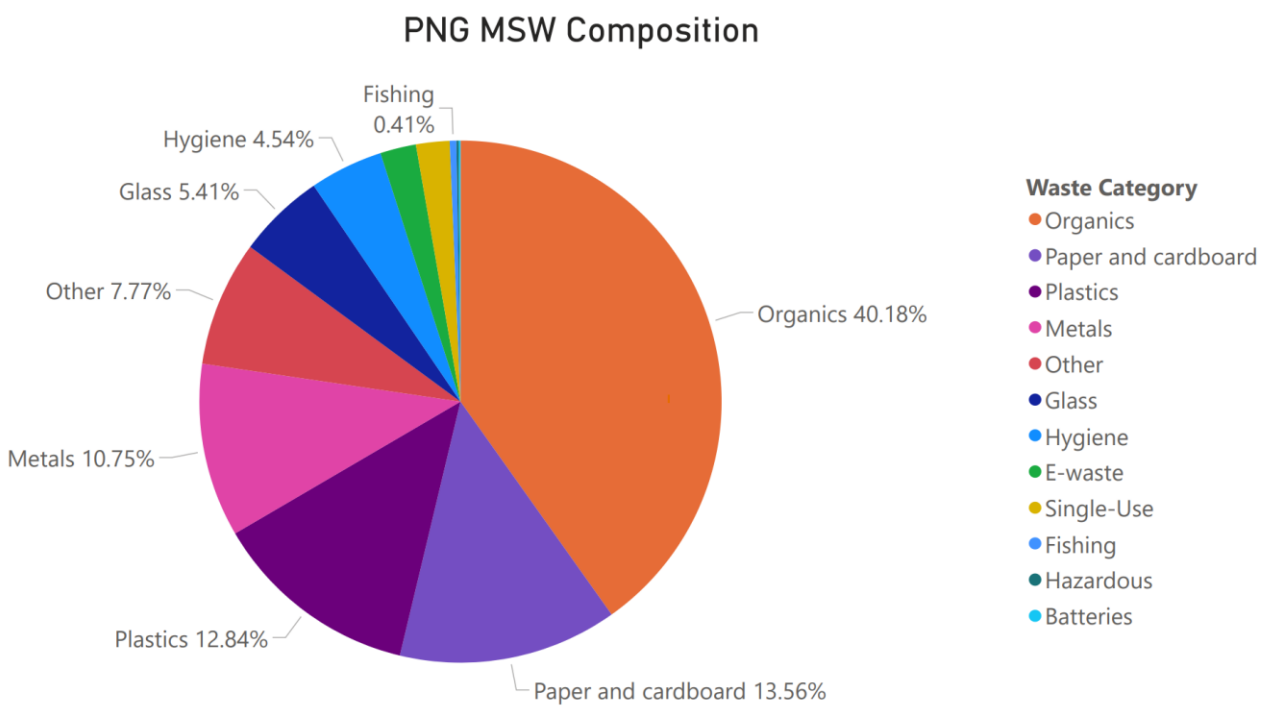


Figure (a) PNG Municipal Solid Waste (MSW) composition (% by weight)

1 Introduction

1.1 Background

Papua New Guinea (PNG) is one of fifteen Pacific Island Nations participating in the PacWaste Plus Programme implemented through SPREP and funded by the European Union Delegation of the Pacific. The PacWaste Plus Programme aims to improve waste management activities across the islands and strengthen the capacity of Governments, industries, and communities to manage wastes to protect human health and the environment.

PNG's waste management practices vary greatly between rural and urban areas. Some urban communities have access to waste collection services offered by private contractors. In most rural areas that don't have access to waste collection services, waste management consists of either dumping, burning or burying of waste.

Waste recovery in PNG is driven by the private sector. Targeted materials include scrap metals, e-waste, used oil, used lead-acid batteries, and PET plastic. These companies primarily export recyclable materials internationally. Informal waste pickers at the Baruni landfill in Port Moresby recover materials such as ferrous and non-ferrous metals and plastics. Some bulky waste items, including end-of-life vehicles, scrap steel, tyres, ceramic tiles, e-wastes, glass, gas cylinders, and white goods, are also recovered and stockpiled. Additionally, some larger retailers and wholesalers in PNG have implemented basic product stewardship schemes, and receive wastes such as printer cartridges, mobile phones, and e-wastes for export recycling.

Under the guidance of both domestic and international stakeholders, there is an expanding movement to establish a Waste Management and Recyclers Association in PNG, following the successful implementation of similar associations in Samoa, Vanuatu, and Solomon Islands. This association aims to include public sector and private industry members, reflecting a growing demand for improved waste management leadership within the country. The country requires investment in infrastructure, implementation of data-guided decision making, and increased general waste management education to improve the current situation.

1.2 Purpose and Aim

The purpose of this audit analysis and report is to establish a baseline position for PNG waste data and waste management systems.

The aim of this report is to:

- Validate pre-existing national waste audit data; and
- Build national waste insights based on new key performance indicators (KPIs) to understand waste management trends.

The results of this report, and the other fourteen SPREP country audit analysis reports, will be collated together to inform a broader Pacific Regional Data and Audit Analysis Report.

1.3 Scope

The scope of this report is limited to the following waste data collected in PNG:

- **PNG waste audit report 2021**: The audit was undertaken between February and March 2021 and provided an evaluation of household and business waste generated in PNG. Audit data and information was obtained via interviews at 100 households and 25 businesses, and waste collections from 95 households, and 32 businesses, followed by sorting and weighing. No landfill audits were conducted during the audit.

This national report examines the MSW, commercial and industrial (C&I), disaster waste and landfill waste streams. Landfills may receive a broad array of waste types, including construction and demolition (C&D) waste, hazardous waste, and other types of waste in addition to MSW and C&I waste. As such, landfill waste is considered a separate waste stream.

The potential for marine plastic pollution is considered for macroscopic plastic waste (i.e., plastics that can be identified through compositional audits) originating from household sources. Accurate data on the amount and management of macroscopic plastic waste in the region is limited.

1.4 Country Overview

PNG is located in the southwestern Pacific Ocean (a map is provided on page 4). The population of PNG was over 7 million people in 2011, with approximately 87% of residents living in rural areas and the remaining 13% in urban locations. The country's administrative divisions at the highest level are divided into four regions: Southern, Highlands, Momase and Islands. PNG has three levels of government: Central, Provincial and Municipal. There are 22 provinces in total, (20 integrated provinces, the autonomous province of Bougainville and the National Capital District) with 89 districts. Within the districts, there are 31 urban level local governments and 265 rural level local governments.

The PNG *National Environmental Management Strategy 2021-2025* highlights the importance of community participation and involvement in solid waste management programs, particularly in rural and remote areas where waste management infrastructure is limited. The strategy emphasises the need for a multi-sectoral approach to solid waste management, involving government agencies, local authorities, communities, and the private sector.

The institutional framework for waste management in PNG does not provide a clear breakdown of waste management responsibility in the country.

The waste management sector in PNG comprises both public and private organisations. PNG's three levels of government (national, provincial, local comprising urban and district) have specific interests regarding waste management applied through a range of legislation and subordinate regulations. Several key legislative instruments govern environmental protection and waste management and allocate responsibility to various levels of government.

2 Methodology

Waste data collation, analysis and reporting was guided by the overarching Regional Waste Data Collection, Monitoring, and Reporting (DCMR) Framework for the Pacific Island Countries and Territories (PICT). The implementation of the DCMR Framework ensures that waste data is collected, analysed, and reported in a consistent and reliable way across the Pacific.

2.1 Data Sources

Data collated and examined in this audit analysis report was sourced from the data sources listed in **Table 1.**

Table 1 Data sources examined and available data

Data Source	Methods for data collation	Reported data
PNG waste audit 2021	• Sample collection from households and businesses • Sort and weigh of household/business waste. • Household and business interviews • Landfill audit • Stockpile assessment	• Access to household and business waste collection Services • Household and business waste composition • Stockpile types and quantities
2011 PNG National census	• National census	• Population data • Household data (size, number)

2.1.1 PNG Waste Audit 2021

The audit was undertaken between February and March 2021 and utilised the Waste Audit Methodology produced by the Pacific Regional Infrastructure Facility (PRIF).

The study conducted audits over one month in the city of Port Moresby and Roku Village in the Central Province, received data from audits conducted in Lae and Alotau, and sourced historical data from audits conducted in Kokopo (2018) and Goroka (2019). The audits took place over one month in the city of Port Moresby and across the Central Province. Results were developed based on the most recent household and commercial statistics from the PNG National Statistics Office. Data was collected from households in urban, peri-urban and rural areas as well as in commercial premises. A total of 95 household samples were gathered, and a total 100 household interviews were conducted. 63 samples were taken in Port Moresby and 32 in the Central Province. A total of 32 businesses were sampled and interviewed across Port Moresby, Lae, and Alotau.

Landfill audits and stockpile assessments were also planned, but due to the pandemic, heightened security conditions and heavy rainfall during the audit period, it was not recommended to send staff to conduct full day audits at the Baruni Landfill. The recovered material stockpiles assessment was also cancelled as permission to access stockpile sites was not received.

Table 2 Sample locations for audits

Sample Location	Population (2011)	Classification
Port Moresby (Urban area)	291,300	Urban
Port Moresby (Peri-urban area)	72,828	Peri-urban
Roku Village in Central Province	269,756	Rural

2.2 Data Analysis

Each country's audit reports, audit data, and other relevant data sources were inspected for relevant information which was subsequently collated into country specific databases. The extracted audit data was then used to calculate the DCMR Framework KPIs. KPI reporting followed the calculation methodologies as detailed in the DCMR Framework.

The main assumptions made during the analysis are discussed below.

Where it was necessary to modify calculation methodologies or assumptions (e.g., in cases of missing data or when certain parameters had to be calculated using assumptions derived from external data sources like census data), details of the changes are provided under their corresponding KPI in **Section 3.2.**

2.2.1 Main Assumptions

- The audit data provided for 'urban', and 'peri-urban' areas (Port Moresby) and 'rural' areas (Central Province) (see **Table 2**) is assumed to be representative of the rest of the country.
- All population estimates used to calculate performance indicators are based on national census data from 2011, which predates the audit (completed in 2021).
- All waste plastics which are not managed in an environmentally sound manner are assumed to have the potential risk of polluting oceans and estuarine waterways.
- Commercial waste service coverage reporting has relied primarily on survey information conducted during audits of commercial business waste.

2.3 Key Performance Indicators

The DCMR Framework introduces a series of KPIs (see

Table 3). The KPIs were developed to guide data analysis with the aim of improving the efficiency of data collection activities by building on pre-existing data collection practices across the region.

Each of the KPIs were designed to be reported to using corresponding data collection methodologies.

These comprise of:

- a waste facility registers;
- household waste audits and community surveys;
- business waste audits and surveys;
- a policy survey; and,
- landfill and stockpile audits.

Table 3 Key Performance Indicators (KPIs) from the DCMR Framework

Core KPIs	Supplementary KPIs
1. Count / capacity of modern waste facilities	1. Cost of disposal to landfill
2. Count / capacity of unregulated waste facilities	2. Weight of waste disposed
3. National recovery rate	3. Weight of waste recovered
4. Per capita waste generation rate	4. Volume and type of stockpiled hazardous waste
5. Municipal Solid Waste (MSW) composition	5. Marine plastic pollution potential
6. Household waste capture rate	6. Awareness and support of waste management services
7. Household collection service coverage	7. Proportion of strategic waste management initiatives implemented
8. Fulfillment of Multilateral Environmental Agreement (MEA) reporting requirements	8. Commercial waste capture rate
	9. Commercial collection service coverage
	10. Total weight of disaster waste disposed

3 Audit Analysis Results

3.1 Summary of Data Availability

The waste audits provided varying levels of data and information for the purposes of calculating performance via the indicators introduced in the DCMR Framework. The extent to which there was adequate data and information to calculate the KPIs is represented below in **Table 4.**

Table 4 Summary of data availability for reporting against DCMR Framework KPIs

Core KPIs		Supplementary KPIs	
1. Count / capacity of modern waste facilities		1. Cost of disposal to landfill	
2. Count / capacity of unregulated waste facilities		2. Weight of waste disposed	
3. National recovery rate		3. Weight of waste recovered	
4. Per capita waste generation rate		4. Volume and type of stockpiled hazardous waste	
5. Municipal Solid Waste (MSW) composition		5. Marine plastic pollution potential	
6. Household waste capture rate		6. Awareness and support of waste management services	
7. Household collection service coverage		7. Proportion of strategic waste management initiatives implemented	
8. Fulfillment of MEA reporting requirements		8. Commercial waste capture rate	
		9. Commercial collection service coverage	
Legend		10. Total weight of disaster waste disposed	
Sufficient data	Limited data	No data	

Note: 'No data' indicates that the audit did not capture the parameters/measurements necessary to calculate the KPI.

In summary:

- The audit reports provided adequate information for Core KPIs 2, and 4 to 8, and Supplementary KPIs 5, and 7.
- There was limited data available to calculate Core KPIs 1, 2, and 3, and Supplementary KPIs 1 to 4, 8, and 9
  - Storage and processing capacities, and the annual amount of waste disposed to landfill, were identified for only one facility (Baruni Landfill) in the audit report. No landfill audits occurred during the audit due to security and weather complications. The total amount of waste disposed of in PNG is not truly representative of the entire country, only the facility audited.
  - Operational costs were only identified for Baruni landfill. As such extrapolation of supplementary KPI 1 to the national level is unrealistic.
  - There were some measurements of volume for used oil, but no mention of measurements for all other hazardous waste categories. The stockpiles audits were undertaken using different methodologies across the sites and reported measurements in different units.
  - All recycling in PNG is private. The report only provided two estimates for annual tonnes of waste recovered per annum. Data is inadequate to confidently extrapolate an accurate result to the national level.
  - There was some information on the collection service coverage and waste capture rate for commercials presented in the audit report, however it is difficult to confidently extrapolate the results of the indicator to the national level due to data insufficiency.
- No data was available to inform supplementary KPIs 6 and 10.

In the future, improved data capture and data quality will benefit performance assessment by reducing the extent to which assumptions and substitutions are necessary. In turn, the KPIs will reflect a more accurate depiction of the status of waste management in PNG.

3.2 KPI Reporting Results

The following sections present the results of the collated and analysed waste audit data for each of the eight core and ten supplementary KPIs introduced in the DCMR Framework. The results of the analysis will serve as a baseline position for PNG to compare future data to, and to guide subsequent waste ma nagement or waste data related activities.

Core KPI 1: Count / capacity of modern waste facilities

Result	**Count of modern waste facilities: 0** • The most developed landfills in PNG are Baruni (in Port Moresby) and Seven Second (in Lae). Neither site is lined to manage leachate, and the audit report found no evidence for daily cover systems at any disposal site in PNG. For these reasons, neither facility can be classified as 'modern' under the DCMR framework. • The report states that aside from Baruni and Seven Second facilities, there are 21 other disposal sites across PNG, but all are unlikely to be lined or covered daily. Based on this information it is assumed there are no 'modern' facilities in PNG. • At the time of the audit report, plans were in place to construct a hazardous waste landfill cell, featuring multiple liners, a leak detection barrier, and systems for collecting and storing leachate. The landfill will be situated in the Integrated Waste Management Facility in Roku, Central Province, and will be able to receive fixated and stabilised hazardous wastes, as well as inert and putrescible wastes, meeting USEPA standards. It was expected to be operational by the end of 2021. • An incineration plant for hazardous waste in Roku, commissioned in 2019, operates to EU standards for incineration and complies with USEPA emission standards for incineration. Only limited information was available in the audit report for reporting to the DCMR Framework KPIs. The incinerator would be classified as 'modern' but does not contribute to KPI reporting as no energy recovery was attributed to the facility. • Mining, oil, and gas operations in PNG construct and operate their own waste management infrastructure to service their projects. These are all regional, and not generally accessible to the public. They are typically constructed to international standards and are lined for leachate management. These sites are not included in this analysis. **Capacity of modern waste facilities (tonnes per annum): 0** • Since none of the disposal facilities in PNG meet 'modern' requirements, the capacity of modern facilities is 0.
Assumptions	• None
Data gaps	• No estimates or parameters were used to calculate the maximum annual processing capacity (tpa) of any of the PNG disposal sites, aside from the incinerator.
Key considerations	• There are no waste facilities, landfills, or dumpsites in PNG which are up to 'modern' standards. • Lack of leachate management at these facilities means that both the environment and community are at risk of hazards due to contamination and material flow. • No daily cover usage at the landfill sites means that these sites are very susceptible to material flow during climate-related weather events such as cyclones. • Investment to upgrade existing landfills on PNG to meet with modern standards/best practice will lead to better outcomes for the local environment and community health. – A landfill cell at the waste management facility in the Central Province is under construction. It is designed to have modern leachate management equipment.

Core KPI 2: Count / capacity of unregulated waste facilities

Result	**Count of unregulated waste facilities: 23** • Aside from Baruni and Seven Second facilities, the audit report states that there are 21 other disposal sites across PNG, but all are unlikely to be lined or covered daily. Information on staffing and equipment access for the unaudited sites was not provided. • Based on this information it is assumed all facilities are 'unregulated'. **Capacity of unregulated waste facilities (tonnes per annum): Insufficient data** • Insufficient data provided in the audit report.
Assumptions	• None
Data gaps	• No estimates or parameters were used to calculate the maximum annual processing capacity (tpa) of any PNG disposal sites.
Key considerations	• All facilities are classified as 'unregulated'. • Lack of leachate management at these facilities means that both the environment and community are at risk of hazards due to contamination and material flow. • No daily cover usage at the landfill sites means that these sites are very susceptible to material flow during climate-related weather events such as cyclones. • The identified unregulated facilities present investment opportunities to upgrade existing sites to align with best practice. Reducing the number of these facilities will lead to better outcomes for the local environmental and community health

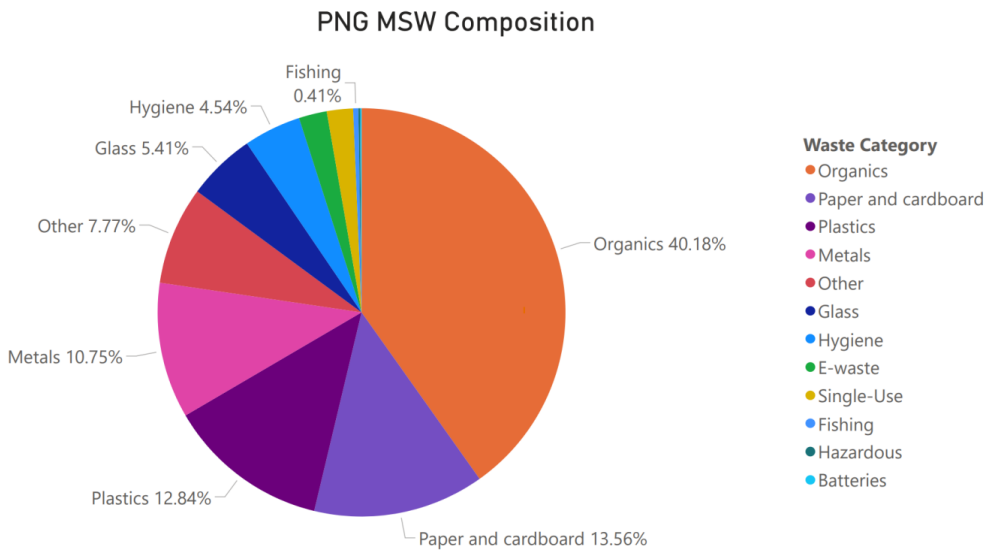
Core KPI 3: National recovery rate

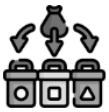
Results	**National recovery rate (%): Insufficient data** • Recycling in PNG is conducted by the private sector and is limited to scrap steel, e-wastes, oil, vehicle batteries and PET plastics. The audit report also mentions informal waste picking, particularly at Baruni landfill, as an additional contributor to waste recovery in PNG. Waste that is diverted from landfill is exported internationally.
Assumptions	• None
Data gaps	• Insufficient data provided on the amount of waste recovered by private recycling operations in PNG. • Insufficient information regarding the tonnes disposed at all waste facilities (landfills/disposal sites) in PNG.
Key considerations	• According to the data available in the audit report, there are multiple dedicated recovery operations in PNG. • There is insufficient data to calculate a national recovery rate. • This measurement is expected to change once data is collected from recovery operations and PNG's landfills/dumpsites in the future, with data collected in the waste facility register suggested by the DCMR Framework.

Core KPI 4: Per capita waste generation rate

Results	**Per capita waste generation rate (kg/capita/year): 134** – kg/capita/day: 0.366 – kg/household/day: 1.97
Assumptions	• Household waste audit data was converted from a per household basis to a per capita basis, then grouped and averaged based on geographic position (i.e., rural, semi-urban or urban), and extrapolated using census data of the national population. • For regions with no audit data (i.e., Highlands, Momase, and Islands) average waste generation rates were extrapolated based on data for household audits and surveys conducted in the Central Province. • The populations of each district (the 22 sub-divisions which make up each of PNG's four provinces) were sourced from 2011 national census data. • Port Moresby was divided into an urban and peri-urban zone in accordance with the audit methodology, allowing for extrapolation at the national level accounting for both urban and peri-urban locations in PNG.
Data gaps	• No information recorded in the Highlands, Momase, and Islands regions. • Most of the population of PNG can be classified as living in 'rural' areas. Only one rural sample taken in the Central Province of the Southern region was provided.
Key considerations	• It is recommended that future audits provide greater data coverage of rural areas. • Future per capita waste generation rates will provide insight into waste management trends and changes for PNG.

Core KPI 5: Municipal Solid Waste (MSW) composition

Results	Organics is the most prevalent waste type for household waste in PNG. This is followed by paper and cardboard, plastics and then metals. • Organics: 40.18% • Paper and cardboard 13.56% • Plastics: 12.84% • Metal: 10.75%  Figure 1 PNG Municipal Solid Waste (MSW) composition (% by weight)
Assumptions	• None
Data gaps	• Categories presented are based on the PRIF waste audit guidelines. Future and past audits may record different categories.
Key considerations	• The prevalence of organics in the household waste stream is likely due to reliance on local subsistence agriculture, as rural communities often have fewer options for food and goods, which can result in a greater reliance on locally grown or produced items. • Organics recovery systems, such as a local or national composting service could help support local farmers and reduce the amount of organic waste destined for landfill. • It is recommended that compositional data is updated data on a regular basis. Impacts of the pandemic and climate change or weather events will have changed the proportions of waste types sourced from households. • Household waste compositions provide an insight into the types of waste contained inside the MSW stream. Knowledge of the waste types and proportion of these wastes present within the household waste stream allows for targeted decision making and prioritisation of problem waste types.



Core KPI 6: Household waste capture rate

Results	**Household waste capture rate (%): 12.33%** – Total weight of household waste generated = 982,847 – Total weight of household waste captured responsibly = 121,22
Assumptions	• The survey and audits did not capture the weight of waste captured by management services, so census data was used and extrapolated across household audit results. $$Household\ waste\ capture\ rate\ (\%) = \frac{weight\ of\ managed\ waste\ (tpa)}{total\ household\ waste\ generated\ (tpa)}$$ Total weight of managed waste is calculated as the product of: $$weight\ of\ managed\ waste\ (tpa) = \frac{household\ collection\ coverage\ (\%)}{total\ household\ waste\ generated\ (tpa)}$$ Collection service coverage (%) is the product of: $$household\ collection\ coverage\ (\%) = \frac{number\ of\ households\ with\ some\ form\ of\ collection\ service}{total\ number\ of\ households}$$ Total household waste generated is the summation of waste generation tonnages for all sampling locations. Waste generation rates for individual sampling locations are calculated by: $$total\ household\ waste\ generated\ (tpa) = average\ waste\ generation\ rate\ of\ location\ \left(\frac{\frac{kg}{capita}}{year}\right) \times location\ population$$ • Additionally, survey respondents in rural areas indicated no collection services were available. This had a large impact on the calculation of the performance indicator, as the majority of PNG is rural. Extrapolation to the national level meant that all rural areas were assumed to have no collection services, and as such all waste generated in rural areas was considered to be 'unmanaged'.
Data gaps	• Audit and conducted surveys did not capture the weight of waste captured by management services.
Key considerations	• The burning of waste was a common disposal method across all surveyed areas. • Just 12% of the waste generated in PNG is captured by formal collection services, either officially collected or dropped off at dumpsites personally. Many households are required to rely on dumping, burning, or burying waste as their primary form of disposal because of low collection service coverage. • This KPI is expected to change significantly in the future as relevant data is collected to calculate the household waste capture rate more accurately.

Core KPI 7: Household collection service coverage

Results	**Household collection service coverage (%): 13.76%** • The vast majority of households in PNG do not have access to a waste collection service. Many are forced to rely on dumping, burning, or burying waste as their primary form of disposal. • The responsibility of providing waste collection services sits with local governments. The type of service and coverage of services varies between the 31 urban local level governments in PNG.
Assumptions	• Information on waste service coverages in the following cities and villages was provided to the auditors directly by local authorities: – Port Moresby: 70% – Lae 40% – Alotau: 80% – Kokopo Vunamami: 32% • Household surveys returned the following coverages: – Urban: 97% of 31 surveyed – Peri-urban: 87.5% of 32 surveyed – Rural: 0% of 32 surveyed • Because Port Moresby was divided into an urban and peri-urban zone for the purpose of the 2021 audit, Port Moresby collection service coverages used in this calculation are based on the survey results from the audit. Where applicable, the coverages for Lae, Atolau and Kokopo Vunamami were used representatively for their corresponding districts. All other districts were assigned coverages based on urban, peri-urban and rural zonings.
Data gaps	• No surveys were conducted in any region aside from the Southern region.
Key considerations	• About 14% of the population of PNG has access to some reliable form of waste collection service. • Survey results revealed that rural residents were willing to pay more for waste collection services than urban communities, potentially reflecting the strain that a lack of collection is currently having on the community. • This KPI is expected to change in the future as relevant data is collected to calculate the household collection service coverage percentage more accurately.

Core KPI 8: Fulfillment of Multilateral Environmental Agreement (MEA) reporting requirements

Results	**Fulfillment of MEA reporting requirements (%): 11.85%**

Convention	Status	Reporting requirements	Reports delivered
Basel Convention	Accession	Annual reports (27)	1
Stockholm Convention	Ratification	5 reporting cycles (5)	1

Assumptions	• Only MEA's with mandatory reporting requirements were included in the calculation of this KPI. • For conventions like the Waigani Convention, strict reporting requirements are not enforced and so are not included in the calculation.
Data gaps	• None
Key considerations	• PNG is behind on required reports for both the Basel and Stockholm Conventions.

Supplementary KPI 1: Cost of disposal to landfill

Results	**Cost of disposal to landfill ($/tonne): PGK K14.79** • Operating costs for Baruni landfill were estimated to be K1,080,000 in 2021.
Assumptions	• Operating costs for Baruni landfill are representative of the case nationally.
Data gaps	• Operational cost data was only provided for Baruni landfill. No cost information was identified for any other landfill in PNG.
Key considerations	• At Baruni landfill, the nation's most developed waste facility as the time of the audit, waste disposal costs K14.79 to per tonne of waste. • Completion of the waste facility register suggested by the DCMR Framework will provide sufficient data to accurately calculate this indicator to work as a benchmark for comparing disposal costs against previous periods, other countries, and the region.

Supplementary KPI 2: Total weight of waste disposed

Results	**Total weight of waste disposed (tonnes per annum): Insufficient data**
Assumptions	• None
Data gaps	• The only reported tonnage per year for any landfill in PNG was from Baruni. • No weights of wastes sampled at landfill were recorded by the audit. • No weights of wastes were provided for any other landfill in PNG.
Key considerations	• The audit report only provided disposal estimates for one landfill, estimating approximately 73,000 tonnes of waste are disposed of at Baruni landfill per year. This figure is not representative of the whole country as data was only available for the one landfill. As such, this figure does not reflect the total weight of waste disposed at landfill at the national level. • This performance indicator provides an indication of the effectiveness of a country's waste management system in diverting waste from the environment via landfill. This result can be used to evaluate the need for additional investment into waste disposal infrastructure and identify opportunities for improved recycling.

Supplementary KPI 3: Total weight of waste recovered

Results	**Total weight of waste recovered (tonnes per annum): Insufficient data**
Assumptions	• Although recovery estimates (weight of materials recovered per annum) were presented in the audit report, they were found through desktop research, and not validated by audit results. Therefore, they cannot be confidently extrapolated to the national level.
Data gaps	• Insufficient information regarding the tonnes disposed at all waste facilities (landfills/disposal sites) in PNG.
Key considerations	• According to the data available in the audit report, there are multiple dedicated recovery operations in PNG. However, due to the lack of reliable estimates for weight of waste recovered via the recovery operations, there was insufficient data to calculate a national recovery rate. • It is recommended that future audits follow the suggested methodologies presented in the DCMR framework to collate data for calculation of this performance indicator.

Supplementary KPI 4: Volumes of stockpiled hazardous waste

Results	**Volumes of stockpiled hazardous wastes (m^3):** – Asbestos: 21 m^3 – E-waste: 238 m^3 – Healthcare and pharmaceutical waste: No data – Used oil: No data – Used tyres: 50 m^3 – Obsolete chemicals: 2 m^3 (gas bottles) • Due to access issues, stockpiled materials were audited exclusively at the Baruni landfill. Auditors also sourced recovery data from publications and other relevant documentation.
Assumptions	• Asbestos represented by roofing iron stockpiles.
Data gaps	• Additional stockpiles of hazardous wastes are assumed to exist. • No stockpile volume measurements recorded in audit data for any other hazardous waste categories. • No stockpile assessment or landfill audits were undertaken during the 2021 audit. The data presented in the audit report was reliant on already available data.
Key considerations	• The volume of other hazardous waste stockpiles in PNG remains unknown. • Landfill audits, stockpile assessments, and the completion of the waste facility register proposed by the DCMR Framework will provide the information required to calculate this performance indicator.

Supplementary KPI 5: Marine plastic pollution potential

Results	**Marine plastic pollution potential (tonnes per annum): 126,000**
Assumptions	• Assumes a national weight of mismanaged waste, based on household audit samples. – This calculation uses the total weight of waste generated, subtracted by the weight of waste captured by collection services. The difference is the estimate for mismanaged waste used in this calculation. – Mismanaged waste is defined as all waste which is not captured in collection services, and ends up buried / burned / littered etc. • Uses proportion of plastics captured in MSW composition.
Data gaps	• Requires a more reliable metric for mismanaged waste.
Key considerations	• Waste plastics which are not managed in an environmentally sound manner are assumed to pose a significant risk of polluting oceans and estuarine waterways.

Supplementary KPI 6: Awareness of waste management services

Results	**Awareness of waste services (%): No data**
Assumptions	• None
Data gaps	• Unable to calculate based on audit reports as this performance indicator requires completion of community survey, specifically gathering responses on: – Number of positive responses indicating awareness; – Number of available services; and – Number of survey participants.
Key considerations	• Completion of community survey in the future is required to report to this KPI. Monitoring the community's awareness is an important measure to indicate success of education initiatives and effective use of existing waste management services.

Supplementary KPI 7: Proportion of strategic waste management initiatives implemented

Results	**Proportion of waste management initiatives implemented (%): 81.25%** – Number of successfully implemented initiatives = 13 out of 16 – Number of pipeline/planned initiatives = 3 • Implemented initiatives include: – National Implementation Plan for Management of Persistent Organic Pollutants in Papua New Guinea – National Climate Compatible Development Management Policy – National Strategy for Responsible Sustainable Development for Papua New Guinea 2014 • Pipeline initiatives include: – Adoption of specific waste management legislation – Plastic bag import ban – Chemical and waste management system
Assumptions	• None
Data gaps	• None
Key considerations	• The institutional framework for waste management in PNG does not provide a clear indication of who has primarily responsible for waste management: – Several acts and regulations exist at the national level to manage waste, but their implementation is fragmented across various government bodies. – Local authorities are responsible for waste collection and disposal, but revenue collection is limited outside of major cities, resulting in inadequate waste management infrastructure in most areas. – PNG has recognised the need improve its waste management policies and strategies to rectify this situation, and to fulfill its commitments to relevant international agreements. – An audit conducted in 2010 recommended that the Department of Environment and Conservation create a comprehensive law to address solid waste management in PNG, but no such law has been passed yet. • Pipeline activities include: – Chemical and waste management system via partnership with the UNEP Chemicals and Waste Management Programme – The adoption of specific waste management legislation: The lack of legislation addressing solid waste management has been recognised as a key gap in PNG.

Supplementary KPI 8: Commercial waste capture rate

Results	**Commercial waste capture rate (%): Insufficient data** • Measured as the fraction of the total waste captured through formal waste management services over the total waste generated by businesses. • It is noted that waste collection services are only available in Port Moresby, and only for general commercial and healthcare waste. • Without further estimates of commercial waste generation rates, total commercial waste generated and the number of businesses in PNG, this indicator cannot be calculated.
Assumptions	• None
Data gaps	• No estimate for the total amount of commercial waste successfully captured by management services identified. • No estimate for the number of businesses in PNG in the audit report. • No information on the total amount of waste generated by businesses. • No information on waste generation rates of businesses in the audit report.
Key considerations	• Accurate calculation relies on an estimate of total numbers of businesses in the country categorised by business type, and an estimate of the commercial waste generation rates for each business type. • Completion of business surveys suggested in the DCMR Framework will provide an indication of how many businesses are using collection services, and other forms of waste management, and to what extent these businesses access the service.

Supplementary KPI 9: Commercial collection service coverage

Results	**Commercial collection service coverage (%): Insufficient data** • A total of 25 businesses were interviewed during the PNG audit. • It is noted that waste collection services are only available in Port Moresby, and only for general commercial and healthcare waste.
Assumptions	• None
Data gaps	• No specific commercial waste collection service coverage was provided in the audit report. • The proportion of interviewed businesses with access to a collection service was not presented in the audit report. • No information on the total number of businesses participating nationally.
Key considerations	• Accurate calculation relies on understanding the total number of businesses participating nationally, and specific collection service coverages for businesses. • Completion of business surveys suggested in the DCMR Framework, would provide an indication of how regular

Supplementary KPI 10: Weight of disaster waste disposed

Results	**Weight of disaster waste disposed (tpa): No data** • Measured as a sum of the recorded weight of disaster waste disposed to landfill or received and stockpiled at waste facility following a disaster event. • No disaster waste data was recorded during the examined audits.
Assumptions	• Only captures disaster waste which ends up disposed of or stored at waste facilities, including landfills, disposal sites and recovery facilities. • Assumes that the waste facility register has been completed to capture disaster waste information separately of other waste loads received post-event (i.e., information on disaster waste categorised separately to other waste types/streams).
Data gaps	• The calculation of this performance indicator relies on estimations of the weight of disaster waste (tonnes) landfilled or received at a waste disposal facility following disaster events.
Key considerations	• Calculation of this performance indicator provides an estimate of the amount of disaster waste being effectively managed and the total amount of disaster waste generated in a year. • Calculating this KPI can be undertaken by regularly updating the waste facility register. Tracking the vehicle capacity and percentage fullness of the load of any 'disaster waste' carrying vehicles entering the facility will help reconcile waste amounts disposed if these wastes are not managed separately.

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